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# **ezdxf Documentation**

***Release 0.18***

**Manfred Moitzi**

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Welcome! This is the documentation for ezdxf release 0.18, last updated Jul 29, 2022.

- *ezdxf* is a Python package to create new DXF files and read/modify/write existing DXF files
- MIT-License
- the intended audience are programmers
- requires at least Python 3.7
- OS independent
- tested with CPython and pypy3
- has type annotations and passes `mypy --ignore-missing-imports -p ezdxf` successful
- additional required packages for the core package without add-ons: `typing_extensions`, `pyparsing`
- read/write/new support for DXF versions: R12, R2000, R2004, R2007, R2010, R2013 and R2018
- read-only support for DXF versions R13/R14 (upgraded to R2000)
- read-only support for older DXF versions than R12 (upgraded to R12)
- read/write support for ASCII DXF and Binary DXF
- retains third-party DXF content
- optional C-extensions for CPython are included in the binary wheels, available on [PyPI](#) for Windows, Linux and macOS



# CHAPTER 1

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## Included Extensions

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Additional packages required for these add-ons are not automatically installed during the *basic* setup, for more information about the setup & dependencies visit the [documentation](#).

- *drawing* add-on to visualise and convert DXF files to images which can be saved to various formats such as png, pdf and svg
- *r12writer* add-on to write basic DXF entities direct and fast into a DXF R12 file or stream
- *iterdxf* add-on to iterate over DXF entities from the modelspace of huge DXF files (> 5GB) which do not fit into memory
- *importer* add-on to import entities, blocks and table entries from another DXF document
- *dxf2code* add-on to generate Python code for DXF structures loaded from DXF documents as starting point for parametric DXF entity creation
- *acadctb* add-on to read/write *Plot Style Files (CTB/STB)*
- *pycsg* add-on for Constructive Solid Geometry (CSG) modeling technique
- *MTextExplode* add-on for exploding MTEXT entities into single-line TEXT entities
- *text2path* add-on to convert text into linear paths
- *geo* add-on to support the \_\_geo\_interface\_\_
- *meshex* add-on for exchanging meshes with other tools as STL, OFF or OBJ files
- *openscad* add-on, an interface to [OpenSCAD](#)
- *odafc* add-on, an interface to the [ODA File Converter](#) to read and write DWG files



## CHAPTER 2

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### Website

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<https://ezdxf.mozman.at/>



# CHAPTER 3

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## Documentation

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Documentation of development version at <https://ezdxf.mozman.at/docs>

Documentation of latest release at <http://ezdxf.readthedocs.io/>



# CHAPTER 4

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## Source Code & Feedback

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Source Code: <http://github.com/mozman/ezdxf.git>

Issue Tracker: <http://github.com/mozman/ezdxf/issues>

Forum: <https://github.com/mozman/ezdxf/discussions>



# CHAPTER 5

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## Questions and Answers

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Please post questions at the [forum](#) or [stack overflow](#) to make answers available to other users as well.



# CHAPTER 6

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## Contents

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## 6.1 Introduction

### 6.1.1 What is ezdxf

*ezdxf* is a [Python](#) interface to the [DXF](#) (drawing interchange file) format developed by Autodesk, *ezdxf* allows developers to read and modify existing DXF drawings or create new DXF drawings.

The main objective in the development of *ezdxf* was to hide complex DXF details from the programmer but still support most capabilities of the [DXF](#) format. Nevertheless, a basic understanding of the DXF format is required, also to understand which tasks and goals are possible to accomplish by using the the DXF format.

Not all DXF features are supported yet, but additional features will be added in the future gradually.

*ezdxf* is also a replacement for my `dxfwrite` and my `dxfgrabber` packages but with different APIs, for more information see also: [\*What is the Relationship between ezdxf, dxfwrite and dxfgrabber?\*](#)

### 6.1.2 What ezdxf can't do

- *ezdxf* is not a DXF converter: *ezdxf* can not convert between different DXF versions, if you are looking for an appropriate application, try the free [ODAFileConverter](#) from the [Open Design Alliance](#), which converts between different DXF version and also between the DXF and the DWG file format.
- *ezdxf* is not a CAD file format converter: *ezdxf* can not convert DXF files to other CAD formats such as DWG
- *ezdxf* is not a CAD kernel and does not provide high level functionality for construction work, it is just an interface to the DXF file format. If you are looking for a CAD kernel with [Python](#) scripting support, look at [FreeCAD](#).

### 6.1.3 Supported Python Versions

*ezdxf* requires at least Python 3.7 and will be tested with the latest stable CPython version and the latest stable release of pypy3 during development.

*ezdxf* is written in pure Python with optional Cython implementations of some low level math classes and requires only *pyparser* and *typing\_extensions* as additional library beside the Python Standard Library. *pytest* is required to run the unit and integration tests. Data to run the stress and audit test can not be provided, because I don't have the rights for publishing this DXF files.

### 6.1.4 Supported Operating Systems

*ezdxf* is OS independent and runs on all platforms which provide an appropriate Python interpreter (>=3.7).

### 6.1.5 Supported DXF Versions

Version	AutoCAD Release
AC1009	AutoCAD R12
AC1012	AutoCAD R13 -> R2000
AC1014	AutoCAD R14 -> R2000
AC1015	AutoCAD R2000
AC1018	AutoCAD R2004
AC1021	AutoCAD R2007
AC1024	AutoCAD R2010
AC1027	AutoCAD R2013
AC1032	AutoCAD R2018

*ezdxf* also reads older DXF versions but saves it as DXF R12.

### 6.1.6 Embedded DXF Information of 3rd Party Applications

The DXF format allows third-party applications to embed application-specific information. *ezdxf* manages DXF data in a structure-preserving form, but for the price of large memory requirement. Because of this, processing of DXF information of third-party applications is possible and will be retained on rewriting.

### 6.1.7 License

*ezdxf* is licensed under the very liberal [MIT-License](#).

## 6.2 Setup & Dependencies

The primary goal is to keep the dependencies of the *core* package as small as possible. The add-ons are not part of the core package and can therefore use as many packages as needed. The only requirement for these packages is an easy way to install them on *Windows*, *Linux* and *macOS*, preferably as:

```
pip3 install eздxf
```

The *pyparsing* package and the *typing\_extensions* are the only hard dependency and will be installed automatically by *pip3*!

The minimal required Python version is determined by the latest stable version of *pypy3* and the Python version deployed by the *Raspberry Pi* OS, which is currently Python 3.7 (2021).

## 6.2.1 Basic Installation

The most common case is the installation by `pip3` including the optional C-extensions from PyPI as binary wheels:

```
pip3 install eздxf
```

## 6.2.2 Installation with Extras

To use all features of the drawing add-on, add the `[draw]` tag:

```
pip3 install eздxf[draw]
```

Tag	Additional Installed Packages
<code>[draw]</code>	<code>Matplotlib</code> , <code>PySide6</code>
<code>[draw5]</code>	<code>Matplotlib</code> , <code>PyQt5</code> (use only if <code>PySide6</code> is not available)
<code>[test]</code>	<code>geomdl</code> , <code>pytest</code>
<code>[dev]</code>	<code>setuptools</code> , <code>wheel</code> , <code>Cython</code> + <code>[test]</code>
<code>[all]</code>	<code>[draw]</code> + <code>[test]</code> + <code>[dev]</code>
<code>[all5]</code>	<code>[draw5]</code> + <code>[test]</code> + <code>[dev]</code> (use only if <code>PySide6</code> is not available)

## 6.2.3 Binary Wheels

Ezdx includes some C-extensions, which will be deployed automatically at each release to PyPI as binary wheels to PyPI:

- *Windows*: only amd64 packages
- *Linux*: manylinux and musllinux packages for x86\_64 & aarch64
- *macOS*: x86\_64, arm64 and universal packages

The wheels are created by the continuous integration (CI) service provided by GitHub and the build container cibuildwheel provided by PyPA the Python Packaging Authority. The workflows are kept short and simple, so my future me will understand what's going on and they are maybe also helpful for other developers which do not touch CI services every day.

The C-extensions are disabled for pypy3, because the JIT compiled code of pypy is much faster than the compiled C-extensions for pypy.

## 6.2.4 Disable C-Extensions

It is possible to disable the C-Extensions by setting the environment variable `EZDXF_DISABLE_C_EXT` to 1 or true:

```
set EZDXF_DISABLE_C_EXT=1
```

or on Linux:

```
export EZDXF_DISABLE_C_EXT=1
```

This has to be done **before** anything from ezdx is imported! If you are working in an interactive environment, you have to restart the interpreter.

## 6.2.5 Installation from GitHub

Install the latest development version by *pip3* from [GitHub](#):

```
pip3 install git+https://github.com/mozman/ezdxf.git@master
```

## 6.2.6 Build and Install from Source

This is only required if you want the compiled C-extensions, the *ezdxf* installation by *pip* from the source code package works without the C-extension but is slower. There are many binary wheels including the compiles C-extensions available on [PyPi](#).

### Windows 10

Make a build directory and a virtual environment:

```
mkdir build
cd build
py -m venv py310
py310/Scripts/activate.bat
```

A working C++ compiler setup is required to compile the C-extensions from source code. Windows users need the build tools from Microsoft: <https://visualstudio.microsoft.com/de/downloads/>

Download and install the required Visual Studio Installer of the community edition and choose the option: *Visual Studio Build Tools 20..*

Install required packages to build and install *ezdxf* with C-extensions:

```
pip3 install setuptools wheel cython
```

Clone the [GitHub](#) repository:

```
git clone https://github.com/mozman/ezdxf.git
```

Build and install *ezdxf* from source code:

```
cd eздxf
pip3 install .
```

Check if the installation was successful:

```
python3 -m eздxf -V
```

The *ezdxf* command should run without a preceding *python3 -m*, but calling the launcher through the interpreter guarantees to call the version which was installed in the venv if there exist a global installation of *ezdxf* like in my case.

The output should look like this:

```
ezdxf 0.17.2b4 from D:\Source\build\py310\lib\site-packages\ezdxf
Python version: 3.10.1 (tags/v3.10.1:2cd268a, Dec 6 2021, 19:10:37) [MSC v.1929 64_
bit (AMD64)]
using C-extensions: yes
using Matplotlib: no
```

To install optional packages go to section: [Install Optional Packages](#)

To run the included tests go to section: [Run the Tests](#)

## WSL & Ubuntu

I use sometimes the Windows Subsystem for Linux ([WSL](#)) with [Ubuntu](#) 20.04 LTS for some tests (how to install [WSL](#)).

By doing as fresh install on *WSL & Ubuntu*, I encountered an additional requirement, the *build-essential* package adds the required C++ support:

```
sudo apt install build-essential
```

The system Python 3 interpreter has the version 3.8, but I will show in a later section how to install an additional newer Python version from the source code:

```
cd ~
mkdir build
cd build
python3 -m venv py38
source py38/bin/activate
```

Install *Cython* and *wheel* in the venv to get the C-extensions compiled:

```
pip3 install cython wheel
```

Clone the [GitHub](#) repository:

```
git clone https://github.com/mozman/ezdxf.git
```

Build and install ezdxf from source code:

```
cd ezdxf
pip3 install .
```

Check if the installation was successful:

```
python3 -m ezdxf -V
```

The output should look like this:

```
ezdxf 0.17.2b4 from /home/mozman/src/py38/lib/python3.8/site-packages/ezdxf
Python version: 3.8.10 (default, Nov 26 2021, 20:14:08)
[GCC 9.3.0]
using C-extensions: yes
using Matplotlib: no
```

To install optional packages go to section: [Install Optional Packages](#)

To run the included tests go to section: [Run the Tests](#)

## Raspberry Pi OS

Testing platform is a [Raspberry Pi 400](#) and the OS is the [Raspberry Pi OS](#) which runs on 64bit hardware but is a 32bit OS. The system Python 3 interpreter comes in version 3.7, but I will show in a later section how to install an additional newer Python version from the source code.

Install the build requirements, [Matplotlib](#) and the [PyQt5](#) bindings from the distribution repository:

```
sudo apt install python3-pip python3-matplotlib python3-pyqt5
```

Installing [Matplotlib](#) and the [PyQt5](#) bindings by *pip* from [piwheels](#) in the venv worked, but the packages showed errors at import, seems to be an packaging error in the required [numpy](#) package. [PySide6](#) is the preferred Qt binding but wasn't available on [Raspberry Pi OS](#) at the time of writing this - [PyQt5](#) is supported as fallback.

Create the venv with access to the system site-packages for using [Matplotlib](#) and the Qt bindings from the system installation:

```
cd ~  
mkdir build  
cd build  
python3 -m venv --system-site-packages py37  
source py37/bin/activate
```

Install [Cython](#) and [wheel](#) in the venv to get the C-extensions compiled:

```
pip3 install cython wheel
```

Clone the [GitHub](#) repository:

```
git clone https://github.com/mozman/ezdxf.git
```

Build and install ezdxf from source code:

```
cd eздxf  
pip3 install .
```

Check if the installation was successful:

```
python3 -m eздxf -V
```

The output should look like this:

```
ezdxf 0.17.2b4 from /home/pi/src/py37/lib/python3.7/site-packages/ezdxf  
Python version: 3.7.3 (default, Jan 22 2021, 20:04:44)  
[GCC 8.3.0]  
using C-extensions: yes  
using Matplotlib: yes
```

To run the included tests go to section: [Run the Tests](#)

### Manjaro on Raspberry Pi

Because the (very well working) [Raspberry Pi OS](#) is only a 32bit OS, I searched for a 64bit alternative like [Ubuntu](#), which just switched to version 21.10 and always freezes at the installation process! So I tried [Manjaro](#) as rolling release, which I used prior in a virtual machine and wasn't really happy, because there is always something to update. Anyway the distribution looks really nice and has Python 3.9.9 installed.

Install build requirements and optional packages by the system packager *pacman*:

```
sudo pacman -S python-pip python-matplotlib python-pyqt5
```

Create and activate the venv:

```
cd ~
mkdir build
cd build
python3 -m venv --system-site-packages py39
source py39/bin/activate
```

The rest is the same procedure as for the [Raspberry Pi OS](#):

```
pip3 install cython wheel
git clone https://github.com/mozman/ezdxf.git
cd ezdxf
pip3 install .
python3 -m ezdxf -V
```

To run the included tests go to section: [Run the Tests](#)

## Ubuntu Server 21.10 on Raspberry Pi

I gave the [Ubuntu](#) Server 21.10 a chance after the desktop version failed to install by a nasty bug and it worked well. The distribution comes with Python 3.9.4 and after installing some requirements:

```
sudo apt install build-essential python3-pip python3.9-venv
```

The remaining process is like on [WSL & Ubuntu](#) except for the newer Python version. Installing [Matplotlib](#) by *pip* works as expected and is maybe useful even on a headless server OS to create SVG and PNG from DXF files. [PySide6](#) is not available by *pip* and the installation of [PyQt5](#) starts from the source code package which I stopped because this already didn't finished on [Manjaro](#), but the installation of the [PyQt5](#) bindings by *apt* works:

```
sudo apt install python3-pyqt5
```

Use the `--system-site-packages` option for creating the venv to get access to the [PyQt5](#) package.

### 6.2.7 Install Optional Packages

Install the optional dependencies by *pip* only for [Windows 10](#) and [WSL & Ubuntu](#), for [Raspberry Pi OS](#) and [Manjaro on Raspberry Pi](#) install these packages by the system packager:

```
pip3 install matplotlib PySide6
```

### 6.2.8 Run the Tests

This is the same procedure for all systems, assuming you are still in the build directory `build/ezdxf` and `ezdxf` is now installed in the venv.

Install the test dependencies and run the tests:

```
pip3 install pytest geomdl
python3 -m pytest tests integration_tests
```

## 6.2.9 Build Documentation

Assuming you are still in the build directory *build/ezdxf* of the previous section.

Install Sphinx:

```
pip3 install Sphinx sphinx-rtd-theme
```

Build the HTML documentation:

```
cd docs  
make html
```

The output is located in *build/ezdxf/docs/build/html*.

## 6.2.10 Python from Source

Debian based systems have often very outdated software installed and sometimes there is no easy way to install a newer Python version. This is a brief summery how I installed Python 3.9.9 on the [Raspberry Pi OS](#), for more information go to the source of the recipe: [Real Python](#)

Install build requirements:

```
sudo apt-get update  
sudo apt-get upgrade  
  
sudo apt-get install -y make build-essential libssl-dev zlib1g-dev \  
libbz2-dev libreadline-dev libsqlite3-dev wget curl llvm \  
libncurses5-dev libncursesw5-dev xz-utils tk-dev
```

Make a build directory:

```
cd ~  
mkdir build  
cd build
```

Download and unpack the source code from [Python.org](#), replace 3.9.9 by your desired version:

```
wget https://www.python.org/ftp/python/3.9.9/Python-3.9.9.tgz  
tar -xvzf Python-3.9.9.tgz  
cd Python-3.9.9/
```

Configure the build process, use a prefix to the directory where the interpreter should be installed:

```
./configure --prefix=/opt/python3.9.9 --enable-optimizations
```

Build & install the Python interpreter. The *-j* option simply tells *make* to split the building into parallel steps to speed up the compilation, my [Raspberry Pi](#) 400 has 4 cores so 4 seems to be a good choice:

```
make -j 4  
sudo make install
```

The building time was ~25min and the new Python 3.9.9 interpreter is now installed as */opt/python3.9.9/bin/python3*.

At the time there were no system packages for [Matplotlib](#) and [PyQt5](#) for this new Python version available, so there is no benefit of using the option *--system-site-packages* for building the venv:

```
cd ~/build
/opt/python3.9.9/bin/python3 -m venv py39
source py39/bin/activate
```

I have not tried to build Matplotlib and PyQt5 by myself and the installation by *pip* from [piwheels](#) did not work, in this case you don't get Matplotlib support for better font measuring and the *drawing* add-on will not work.

Proceed with the *ezdxf* installation from source as shown for the *Raspberry Pi OS*.

## 6.3 Usage for Beginners

This section shows the intended usage of the *ezdxf* package. This is just a brief overview for new *ezdxf* users, follow the provided links for more detailed information.

First import the package:

```
import eздxf
```

### 6.3.1 Loading DXF Files

*ezdxf* supports loading ASCII and binary DXF files from a file:

```
doc = eздxf.readfile(filename)
```

or from a zip-file:

```
doc = e Zukxf.readzip(zipfilename[, filename])
```

Which loads the DXF file *filename* from the zip-file *zipfilename* or the first DXF file in the zip-file if *filename* is absent.

It is also possible to read a DXF file from a stream by the *e Zukxf.read()* function, but this is a more advanced feature, because this requires detection of the file encoding in advance.

This works well with DXF files from trusted sources like AutoCAD or BricsCAD, for loading DXF files with minor or major flaws look at the *e Zukxf.recover* module.

**See also:**

Documentation for *e Zukxf.readfile()*, *e Zukxf.readzip()* and *e Zukxf.read()*, for more information about file management go to the *Document Management* section. For loading DXF files with structural errors look at the *e Zukxf.recover* module.

### 6.3.2 Saving DXF Files

Save the DXF document with a new name:

```
doc.saveas("new_name.dxf")
```

or with the same name as loaded:

```
doc.save()
```

**See also:**

Documentation for `ezdxf.document.Drawing.save()` and `ezdxf.document.Drawing.saveas()`, for more information about file management go to the [Document Management](#) section.

### 6.3.3 Create a New DXF File

Create new file for the latest supported DXF version:

```
doc = ezdxf.new()
```

Create a new DXF file for a specific DXF version, e.g for DXF R12:

```
doc = ezdxf.new("R12")
```

To setup some basic DXF resources use the `setup` argument:

```
doc = ezdxf.new(setup=True)
```

**See also:**

Documentation for `ezdxf.new()`, for more information about file management go to the [Document Management](#) section.

### 6.3.4 Layouts and Blocks

Layouts are containers for DXF entities like LINE or CIRCLE. The most important layout is the modelspace labeled as “Model” in CAD applications which represents the “world” work space. Paperspace layouts represents plottable sheets which contains often the framing and the tile block of a drawing and VIEWPORT entities as scaled and clipped “windows” into the modelspace.

The modelspace is always present and can not be deleted. The active paperspace is also always present in a new DXF document but can be deleted, in that case another paperspace layout gets the new active paperspace, but you can not delete the last paperspace layout.

Getting the modelspace of a DXF document:

```
msp = doc.modelspace()
```

Getting a paperspace layout by the name as shown in the tab of a CAD application:

```
psp = doc.layout("Layout1")
```

A block is just another kind of entity space, which can be inserted multiple times into other layouts and blocks by the INSERT entity also called block references, this is a very powerful and important concept of the DXF format.

Getting a block layout by the block name:

```
blk = doc.blocks.get("NAME")
```

All these layouts have factory functions to create graphical DXF entities for their entity space, for more information about creating entities see section: [Create new DXF Entities](#)

### 6.3.5 Create New Blocks

The block definitions of a DXF document are managed by the `BlocksSection` object:

```
my_block = doc.blocks.new("MyBlock")
```

**See also:**

[Tutorial for Blocks](#)

### 6.3.6 Query DXF Entities

As said in the [Layouts and Blocks](#) section, all graphical DXF entities are stored in layouts, all these layouts can be iterated and support the index operator e.g. `layout[-1]` returns the last entity.

The main difference between iteration and index access is, that iteration filters destroyed entities, but the index operator returns also destroyed entities until these entities are purged by `layout.purge()` more about this topic in section: [Delete Entities](#).

There are two advanced query methods: `query()` and `groupby()`.

Get all lines of layer "MyLayer":

```
lines = msp.query('LINE[layer=="MyLayer"]')
```

This returns an `EntityQuery` container, which also provides the same `query()` and `groupby()` methods.

Get all lines categorized by a DXF attribute like color:

```
all_lines_by_color = msp.query("LINE").groupby("color")
lines_with_color_1 = all_lines_by_color.get(1, [])
```

The `groupby()` method returns a regular Python `dict` with colors as key and a regular Python `list` of entities as values (not an `EntityQuery` container).

**See also:**

For more information go to the [Tutorial for getting data from DXF files](#)

### 6.3.7 Examine DXF Entities

Each DXF entity has a `dxf` namespace attribute, which stores the named DXF attributes, some DXF attributes are only indirect available like the vertices in the LWPOLYLINE entity. More information about the DXF attributes of each entity can found in the documentation of the `ezdxf.entities` module.

Get some basic DXF attributes:

```
layer = entity.dxf.layer # default is "0"
color = entity.dxf.color # default is 256 = BYLAYER
```

Most DXF attributes have a default value, which will be returned if the DXF attribute is not present, for DXF attributes without a default value you can check in the attribute really exist:

```
entity.dxf.hasattr("true_color")
```

or use the `get()` method and a default value:

```
entity.dxf.get("true_color", 0)
```

**See also:**

*Common graphical DXF attributes*

### 6.3.8 Create New DXF Entities

The factory methods for creating new graphical DXF entities are located in the `BaseLayout` class. This means this factory methods are available for all entity containers:

- `Modelspace`
- `Paperspace`
- `BlockLayout`

The usage is simple:

```
msp = doc.modelspace()
msp.add_line((0, 0), (1, 0), dxfattribs={"layer": "MyLayer"})
```

**See also:**

*Thematic Index of Layout Factory Methods*

A few important or required DXF attributes are explicit method arguments, most additional and optional DXF attributes are given as a regular Python dict object. The supported DXF attributes can be found in the documentation of the `ezdxf.entities` module.

**Warning:** Do not instantiate DXF entities by yourself and add them to layouts, always use the provided factory function to create new graphical entities, this is the intended way to use `ezdxf`.

### 6.3.9 Create Block References

A block reference is just another DXF entity called INSERT, but the term “Block Reference” is a better choice and so the `Insert` entity is created by the factory function: `add_blockref()`:

```
msp.add_blockref("MyBlock", (0, 0))
```

**See also:**

See *Tutorial for Blocks* for more advanced features like using `Attrib` entities.

### 6.3.10 Create New Layers

A layer is not an entity container, a layer is just another DXF attribute stored in the entity and this entity can inherit some properties from this `Layer` object. Layer objects are stored in the layer table which is available as attribute `doc.layers`.

You can create your own layers:

```
my_layer = doc.layer.add("MyLayer")
```

The layer object also controls the visibility of entities which references this layer, the on/off state of the layer is unfortunately stored as positive or negative color value which make the raw DXF attribute of layers useless, to change the color of a layer use the property `Layer.color`

```
my_layer.color = 1
```

To change the state of a layer use the provided methods of the `Layer` object, like `on()`, `off()`, `freeze()` or `thaw()`:

```
my_layer.off()
```

#### See also:

[Layer Concept](#)

### 6.3.11 Delete Entities

The safest way to delete entities is to delete the entity from the layout containing that entity:

```
line = msp.add_line((0, 0), (1, 0))
msp.delete_entity(line)
```

This removes the entity immediately from the layout and destroys the entity. The property `is_alive` returns `False` for a destroyed entity and all Python attributes are deleted, so `line.dxf.color` will raise an `AttributeError` exception, because `line` does not have a `dxf` attribute anymore.

`Ezdx`f also supports also destruction of entities by calling method `destroy()` manually:

```
line.destroy()
```

Manually destroyed entities are not removed immediately from entities containers like `Modelspace` or `EntityQuery`, but iterating such a container will filter destroyed entities automatically, so a `for e in msp: ...` loop will never yield destroyed entities. The index operator and the `len()` function do **not** filter deleted entities, to avoid getting deleted entities call the `purge()` method of the container manually to remove deleted entities.

### 6.3.12 Further Information

- [Reference](#) documentation
- Documentation of package internals: [Developer Guides](#).

## 6.4 Basic Concepts

The Basic Concepts section teach the intended meaning of DXF attributes and structures without teaching the application of this information or the specific implementation by `ezdxf`, if you are looking for more information about the `ezdxf` internals look at the [Reference](#) section or if you want to learn how to use `ezdxf` go to the [Tutorials](#) section and for the solution of specific problems go to the [Howto](#) section.

### 6.4.1 What is DXF?

The common assumption is also the cite of [Wikipedia](#):

AutoCAD DXF (Drawing eXchange Format) is a CAD data file format developed by Autodesk for enabling data interoperability between AutoCAD and **other** applications.

DXF was originally introduced in December 1982 as part of AutoCAD 1.0, and was intended to provide an exact representation of the data in the AutoCAD native file format, DWG (Drawing). For many years Autodesk did not publish specifications making correct imports of DXF files difficult. Autodesk now publishes the DXF specifications online.

The more precise cite from the [DXF reference](#) itself:

The DXF™ format is a tagged data representation of all the information contained in an AutoCAD® drawing file. Tagged data means that each data element in the file is preceded by an integer number that is called a group code. A group code's value indicates what type of data element follows. This value also indicates the meaning of a data element for a given object (or record) type. Virtually all user-specified information in a drawing file can be represented in DXF format.

No mention of interoperability between AutoCAD and **other** applications.

In reality the DXF format was designed to ensure AutoCAD cross-platform compatibility in the early days when different hardware platforms with different binary data formats were used. The name DXF (Drawing eXchange Format) may suggest an universal exchange format, but it is not. It is based on the infrastructure installed by Autodesk products (fonts) and the implementation details of AutoCAD (MTEXT) or on licensed third party technologies (embedded ACIS entities).

For more information about the AutoCAD history see the document: [The Autodesk File - Bits of History, Words of Experience](#) by *John Walker*, founder of *Autodesk, Inc.* and co-author of *AutoCAD*.

## **DXF Reference Quality**

The [DXF reference](#) is by far no specification nor a standard like the W3C standard for [SVG](#) or the ISO standard for [PDF](#).

The reference describes many but not all DXF entities and some basic concepts like the tag structure or the arbitrary axis algorithm. But the existing documentation (reference) is incomplete and partly misleading or wrong. Also missing from the reference are some important parts like the complex relationship between the entities to create higher order structures like block definitions, layouts (model space & paper space) or dynamic blocks to name a few.

## **Reliable CAD Applications**

Because of the suboptimal quality of the DXF reference not all DXF viewers, creators or processors are of equal quality. I consider a CAD application as a *reliable CAD application* when the application creates valid DXF documents in the meaning and interpretation of [Autodesk](#) and a reliable DXF viewer when the result matches in most parts the result of the free [Trueview](#) viewer provided by Autodesk.

These are some applications which do fit the criteria of a reliable CAD application:

- [AutoCAD](#) and [Trueview](#)
- CAD applications based on the [OpenDesignAlliance](#) (ODA) SDK, see also [ODA on wikipedia](#), even [Autodesk](#) is a corporate member, see their blog post from [22 Sep 2020](#) at [adsknews](#) but only to use the ODA IFC tools and not to improve the DWG/DXF compatibility
- [BricsCAD](#) (ODA based)
- [GstarCAD](#) (ODA based)
- [ZWCAD](#) (ODA based)

Unfortunately, I cannot recommend any open source applications because everyone I know has serious shortcomings, at least as a DXF viewer, and I don't trust them as a DXF creator either. To be clear, not even *ezdxf* (which is not a CAD application) is a *reliable* library in this sense - it just keeps getting better, but is far from *reliable*.

BTW: Don't send bug reports based on [LibreCAD](#) or [QCAD](#), I won't waste my time on them.

## 6.4.2 AutoCAD Color Index (ACI)

The `color` attribute represents an *ACI* (AutoCAD Color Index). AutoCAD and many other *CAD* application provides a default color table, but pen table would be the more correct term. Each ACI entry defines the color value, the line weight and some other attributes to use for the pen. This pen table can be edited by the user or loaded from an *CTB* or *STB* file. *Ezdx*f provides functions to create (`new()`) or modify (`ezdxf.acadctb.load()`) plot styles files.

DXF R12 and prior are not good in preserving the layout of a drawing, because of the lack of a standard color table defined by the DXF reference and missing DXF structures to define these color tables in the DXF file. So if a CAD user redefined an ACI and do not provide a *CTB* or *STB* file, you have no ability to determine which color or linewidth was used. This is better in later DXF versions by providing additional DXF attributes like `lineweight` and `true_color`.

**See also:**

[Plot Style Files \(CTB/STB\) `ezdxf.colors`](#)

## 6.4.3 Layer Concept

Every object has a layer as one of its properties. You may be familiar with layers - independent drawing spaces that stack on top of each other to create an overall image - from using drawing programs. Most CAD programs use layers as the primary organizing principle for all the objects that you draw. You use layers to organize objects into logical groups of things that belong together; for example, walls, furniture, and text notes usually belong on three separate layers, for a couple of reasons:

- Layers give you a way to turn groups of objects on and off - both on the screen and on the plot.
- Layers provide the most efficient way of controlling object color and linetype

Create a layer table entry `Layer` by `Drawing.layers.new()`, assign the layer properties such as color and linetype. Then assign those layers to other DXF entities by setting the DXF attribute `layer` to the layer name as string.

It is possible to use layers without a layer definition but not recommend, just use a layer name without a layer definition, the layer has the default linetype 'Continuous' and the default color is 7.

The advantage of assigning a linetype and a color to a layer is that entities on this layer can inherit this properties by using 'BYLAYER' as linetype string and 256 as color, both values are default values for new entities.

**See also:**

[Tutorial for Layers](#)

## 6.4.4 Linetypes

The `linetype` defines the pattern of a line. The linetype of an entity can be specified by the DXF attribute `linetype`, this can be an explicit named linetype or the entity can inherit its line type from the assigned layer by setting `linetype` to 'BYLAYER', which is also the default value. CONTINUOUS is the default line type for layers with unspecified line type.

*ezdxf* creates several standard linetypes, if the argument *setup* is `True` at calling `new()`, this simple line types are supported by all DXF versions:

```
doc = ezdxf.new('R2007', setup=True)
```

CONTINUOUS



CENTER



CENTERX2



CENTER2



DASHED



DASHEDX2



DASHED2



PHANTOM



PHANTOMX2



PHANTOM2



DASHDOT



DASHDOTX2



DASHDOT2



DOT



DOTX2



DOT2



DIVIDE



In DXF R13 Autodesk introduced complex linetypes, containing TEXT or SHAPES in linetypes. *ezdxf* v0.8.4 and later supports complex linetypes.

**See also:**

*Tutorial for Linetypes*

## Linetype Scaling

Global linetype scaling can be changed by setting the header variable `doc.header['$LTSCALE'] = 2`, which stretches the line pattern by factor 2.

To change the linetype scaling for single entities set scaling factor by DXF attribute `ltscale`, which is supported since DXF version R2000.

### 6.4.5 Lineweights

The `lineweight` attribute represents the linewidth as integer value in millimeters \* 100, e.g. 0.25mm = 25, independently from the unit system used in the DXF document. The `lineweight` attribute is supported by DXF version R2000 and newer.

Only certain values are valid, they are stored in `ezdxf.lldxf.const.VALID_DXF_LINEWEIGHTS`: 0, 5, 9, 13, 15, 18, 20, 25, 30, 35, 40, 50, 53, 60, 70, 80, 90, 100, 106, 120, 140, 158, 200, 211.

Values < 0 have a special meaning and can be imported as constants from `ezdxf.lldxf.const`

-1	LINEWEIGHT_BYLAYER
-2	LINEWEIGHT_BYBLOCK
-3	LINEWEIGHT_DEFAULT

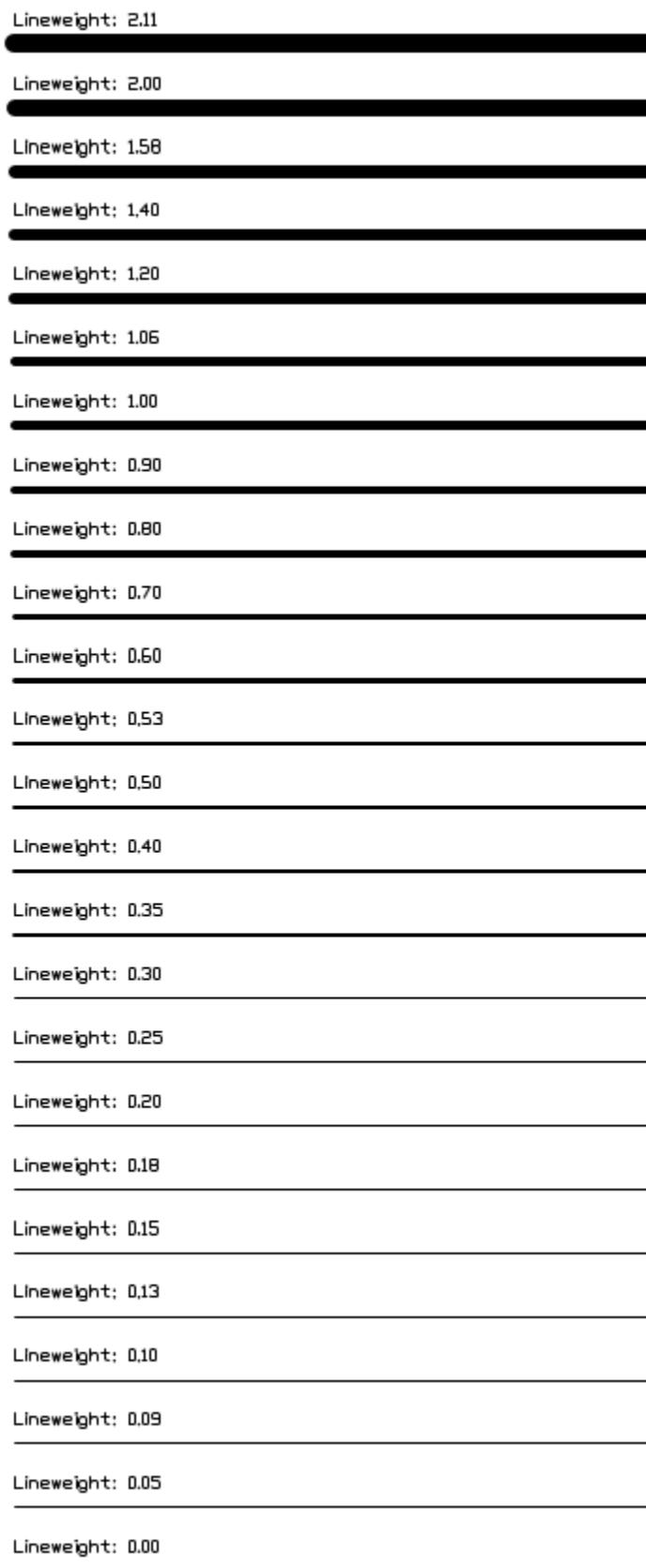
The validator function: `ezdxf.lldxf.validator.is_valid_lineweight()` returns `True` for valid linewidth values otherwise `False`.

Sample file which shows all valid lineweights: `valid_lineweights.dxf`

You have to enable the option to show lineweights in your CAD application or viewer to see the effect on screen, which is often disabled by default, the same has to be done in the page setup options for plotting lineweights.

Setting the HEADER variable `$LWDISPLAY` to 1 may activate support for showing lineweights on screen and `$LWDISPSCALE` may scale the linewidth on screen:

```
# activate on screen linewidth display
doc.header["$LWDISPLAY"] = 1
# linewidth scaling factor for on screen display
doc.header["$LWDISPSCALE"] = 0.55
```



The linewidth value can be overridden by [CTB](#) or [STB](#) files.

## 6.4.6 Coordinate Systems

[AutoLISP Reference to Coordinate Systems](#) provided by Autodesk.

To brush up your knowledge about vectors, watch the YouTube tutorials of [3Blue1Brown](#) about [Linear Algebra](#).

### WCS

World coordinate system - the reference coordinate system. All other coordinate systems are defined relative to the WCS, which never changes. Values measured relative to the WCS are stable across changes to other coordinate systems.

### UCS

User coordinate system - the working coordinate system defined by the user to make drawing tasks easier. All points passed to AutoCAD commands, including those returned from AutoLISP routines and external functions, are points in the current UCS. As far as I know, all coordinates stored in DXF files are always WCS or OCS never UCS.

User defined coordinate systems are not just helpful for interactive CAD, therefore ezdxf provides a converter class [UCS](#) to translate coordinates from UCS into WCS and vice versa, but always remember: store only WCS or OCS coordinates in DXF files, because there is no method to determine which UCS was active or used to create UCS coordinates.

#### See also:

- Table entry [UCS](#)
- [ezdxf.math.UCS](#) - converter between WCS and UCS

### OCS

Object coordinate system - coordinates relative to the object itself. These points are usually converted into the WCS, current UCS, or current DCS, according to the intended use of the object. Conversely, points must be translated into an OCS before they are written to the database. This is also known as the entity coordinate system.

Because *ezdxf* is just an interface to DXF, it does not automatically convert OCS into WCS, this is the domain of the user/application. And further more, the main goal of OCS is to place 2D elements in 3D space, this maybe was useful in the early years of CAD, I think nowadays this is an not often used feature, but I am not an AutoCAD user.

OCS differ from WCS only if extrusion != (0, 0, 1), convert OCS into WCS:

```
# circle is an DXF entity with extrusion != (0, 0, 1)
ocs = circle.ocs()
wcs_center = ocs.to_wcs(circle.dxf.center)
```

#### See also:

- [Object Coordinate System \(OCS\)](#) - deeper insights into OCS
- [ezdxf.math.OCS](#) - converter between WCS and OCS

## DCS

Display coordinate system - the coordinate system into which objects are transformed before they are displayed. The origin of the DCS is the point stored in the AutoCAD system variable TARGET, and its z-axis is the viewing direction. In other words, a viewport is always a plan view of its DCS. These coordinates can be used to determine where something will be displayed to the AutoCAD user.

### 6.4.7 Object Coordinate System (OCS)

- DXF Reference for OCS provided by Autodesk.

The points associated with each entity are expressed in terms of the entity's own object coordinate system (OCS). The OCS was referred to as ECS in previous releases of AutoCAD.

With OCS, the only additional information needed to describe the entity's position in 3D space is the 3D vector describing the z-axis of the OCS (often referenced as extrusion vector), and the elevation value, which is the distance of the entity xy-plane to the WCS/OCS origin.

For a given z-axis (extrusion) direction, there are an infinite number of coordinate systems, defined by translating the origin in 3D space and by rotating the x- and y-axis around the z-axis. However, for the same z-axis direction, there is only one OCS. It has the following properties:

- Its origin coincides with the WCS origin.
- The orientation of the x- and y-axis within the xy-plane are calculated in an arbitrary but consistent manner. AutoCAD performs this calculation using the arbitrary axis algorithm (see below).
- Because of *Arbitrary Axis Algorithm* the OCS can only represent a **right-handed** coordinate system!

The following entities do not lie in a particular plane. All points are expressed in world coordinates. Of these entities, only lines and points can be extruded. Their extrusion direction can differ from the world z-axis.

- *Line*
- *Point*
- *3DFace*
- *Polyline* (3D)
- *Vertex* (3D)
- *Polymesh*
- *Polyface*
- *Viewport*

These entities are planar in nature. All points are expressed in object coordinates. All of these entities can be extruded. Their extrusion direction can differ from the world z-axis.

- *Circle*
- *Arc*
- *Solid*
- *Trace*
- *Text*
- *Attrib*
- *Attdef*

- *Shape*
- *Insert*
- *Polyline* (2D)
- *Vertex* (2D)
- *LWPolyline*
- *Hatch*
- *Image*

Some of a *Dimension*'s points are expressed in WCS and some in OCS.

## Elevation

Elevation group code 38:

Exists only in output from versions prior to R11. Otherwise, Z coordinates are supplied as part of each of the entity's defining points.

## Arbitrary Axis Algorithm

- DXF Reference for Arbitrary Axis Algorithm provided by Autodesk.

The arbitrary axis algorithm is used by AutoCAD internally to implement the arbitrary but consistent generation of object coordinate systems for all entities that use object coordinates.

Given a unit-length vector to be used as the z-axis of a coordinate system, the arbitrary axis algorithm generates a corresponding x-axis for the coordinate system. The y-axis follows by application of the **right-hand** rule.

We are looking for the arbitrary x- and y-axis to go with the normal Az (the arbitrary z-axis). They will be called Ax and Ay (using *Vec3*):

```
Az = Vec3(entity.dxf.extrusion).normalize()    # normal (extrusion) vector
if (abs(Az.x) < 1/64.) and (abs(Az.y) < 1/64.):
    Ax = Vec3(0, 1, 0).cross(Az).normalize()    # the cross-product operator
else:
    Ax = Vec3(0, 0, 1).cross(Az).normalize()    # the cross-product operator
Ay = Az.cross(Ax).normalize()
```

## WCS to OCS

```
def wcs_to_ocs(point):
    px, py, pz = Vec3(point)    # point in WCS
    x = px * Ax.x + py * Ax.y + pz * Ax.z
    y = px * Ay.x + py * Ay.y + pz * Ay.z
    z = px * Az.x + py * Az.y + pz * Az.z
    return Vec3(x, y, z)
```

## OCS to WCS

```

Wx = wcs_to_ocs((1, 0, 0))
Wy = wcs_to_ocs((0, 1, 0))
Wz = wcs_to_ocs((0, 0, 1))

def ocs_to_wcs(point):
    px, py, pz = Vec3(point) # point in OCS
    x = px * Wx.x + py * Wy.y + pz * Wz.z
    y = px * Wy.x + py * Wy.y + pz * Wy.z
    z = px * Wz.x + py * Wz.y + pz * Wz.z
    return Vec3(x, y, z)

```

## 6.4.8 DXF Units

The DXF reference has no explicit information how to handle units in DXF, any information in this section is based on experiments with BricsCAD and may differ in other CAD application, BricsCAD tries to be as compatible with AutoCAD as possible. Therefore, this information should also apply to AutoCAD.

Please open an issue on [github](#) if you have any corrections or additional information about this topic.

### Length Units

Any length or coordinate value in DXF is unitless in the first place, there is no unit information attached to the value. The unit information comes from the context where a DXF entity is used. The document/modelspace get the unit information from the header variable \$INSUNITS, paperspace and block layouts get their unit information from the attribute *units*. The modelspace object has also a units property, but this value do not represent the modelspace units, this value is always set to 0 “unitless”.

Get and set document/modelspace units as enum by the *Drawing* property *units*:

```

import ezdxf
from ezdxf import units

doc = ezdxf.new()
# Set centimeter as document/modelspace units
doc.units = units.CM
# which is a shortcut (including validation) for
doc.header['$INSUNITS'] = units.CM

```

### Block Units

As said each block definition can have independent units, but there is no implicit unit conversion applied, not in CAD applications and not in ezdxf.

When inserting a block reference (INSERT) into the modelspace or another block layout with different units, the scaling factor between these units **must** be applied explicit as scaling DXF attributes (xscale,...) of the *Insert* entity, e.g. modelspace in meters and block in centimeters, x-, y- and z-scaling has to be 0.01:

```

doc.units = units.M
my_block = doc.blocks.new('MYBLOCK')
my_block.units = units.CM
block_ref = msp.add_block_ref('MYBLOCK')
# Set uniform scaling for x-, y- and z-axis
block_ref.set_scale(0.01)

```

Use helper function `conversion_factor()` to calculate the scaling factor between units:

```
factor = units.conversion_factor(doc.units, my_block.units)
# factor = 100 for 1m is 100cm
# scaling factor = 1 / factor
block_ref.set_scale(1.0/factor)
```

---

**Hint:** It is never a good idea to use different measurement system in one document, ask the NASA about their Mars Climate Orbiter from 1999. The same applies for units of the same measurement system, just use one unit like meters or inches.

---

## Angle Units

Angles are always in degrees (360 deg = full circle) and in counter clockwise orientation, unless stated explicit otherwise.

## Display Format

How values are shown in the CAD GUI is controlled by the header variables \$LUNITS and \$AUNITS, but this has no meaning for values stored in DXF files.

## \$INSUNITS

The most important setting is the header variable \$INSUNITS, this variable defines the drawing units for the modelspace and therefore for the DXF document if no further settings are applied.

The modelspace LAYOUT entity has a property `units` as any layout like object, but it seem to have no meaning for the modelspace, BricsCAD set this property always to 0, which means unitless.

The most common units are 6 for meters and 1 for inches.

Changed in version 0.17.2: added an enumeration `ezdxf.enums.InsertUnits`

```
doc.header['$INSUNITS'] = 6
```

0	Unitless
1	Inches, units.IN
2	Feet, units.FT
3	Miles, units.MI
4	Millimeters, units.MM
5	Centimeters, units.CM
6	Meters, units.M
7	Kilometers, units.KM
8	Microinches
9	Mils
10	Yards, units.YD
11	Angstroms
12	Nanometers
13	Microns
14	Decimeters, units.DM
15	Decameters
16	Hectometers
17	Gigameters
18	Astronomical units
19	Light years
20	Parsecs
21	US Survey Feet
22	US Survey Inch
23	US Survey Yard
24	US Survey Mile

## \$MEASUREMENT

The header variable \$MEASUREMENT controls whether the current drawing uses imperial or metric hatch pattern and linetype files, this setting is not applied correct in *ezdxf* yet, but will be fixed in the future:

This setting is independent from \$INSUNITS, it is possible to set the drawing units to inch and use metric linetypes and hatch pattern.

In BricsCAD the base scaling of the linetypes is only depending from the \$MEASUREMENT value, is not relevant if \$INSUNITS is meter, centimeter, millimeter, ... and so on and the same is valid for hatch pattern.

Changed in version 0.17.2: added an enumeration `ezdxf.enums.Measurement`

```
doc.header['$MEASUREMENT'] = 1
```

0	English
1	Metric

## \$LUNITS

The header variable \$LUNITS defines how CAD applications show linear values in the GUI and has no meaning for *ezdxf*:

Changed in version 0.17.2: added an enumeration `ezdxf.enums.LengthUnits`

```
doc.header['$LUNITS'] = 2
```

1	Scientific
2	Decimal (default)
3	Engineering
4	Architectural
5	Fractional

## \$AUNITS

The header variable \$AUNITS defines how CAD applications show angular values in the GUI and has no meaning for *ezdxf*, DXF angles are always degrees in counter-clockwise orientation, unless stated explicit otherwise:

Changed in version 0.17.2: added an enumeration `ezdxf.enums.AngularUnits`

```
doc.header['$AUNITS'] = 0
```

0	Decimal degrees
1	Degrees/minutes/seconds
2	Grad
3	Radians

## Helper Tools

```
ezdxf.units.conversion_factor(source_units:      eздxf.enums.InsertUnits,      target_units:  
                                eздxf.enums.InsertUnits) → float
```

Returns the conversion factor to represent *source\_units* in *target\_units*.

E.g. millimeter in centimeter `conversion_factor(MM, CM)` returns 0.1, because 1 mm = 0.1 cm

```
ezdxf.units.unit_name(enum: int) → str
```

Returns the name of the unit enum.

```
ezdxf.units.angle_unit_name(enum: int) → str
```

Returns the name of the angle unit enum.

## 6.4.9 Layout Extents and Limits

The *extents* and *limits* of an layout represents borders which can be referenced by the ZOOM command or read from some header variables from the [HeaderSection](#), if the creator application maintains these values – *ezdxf* does it not automatically.

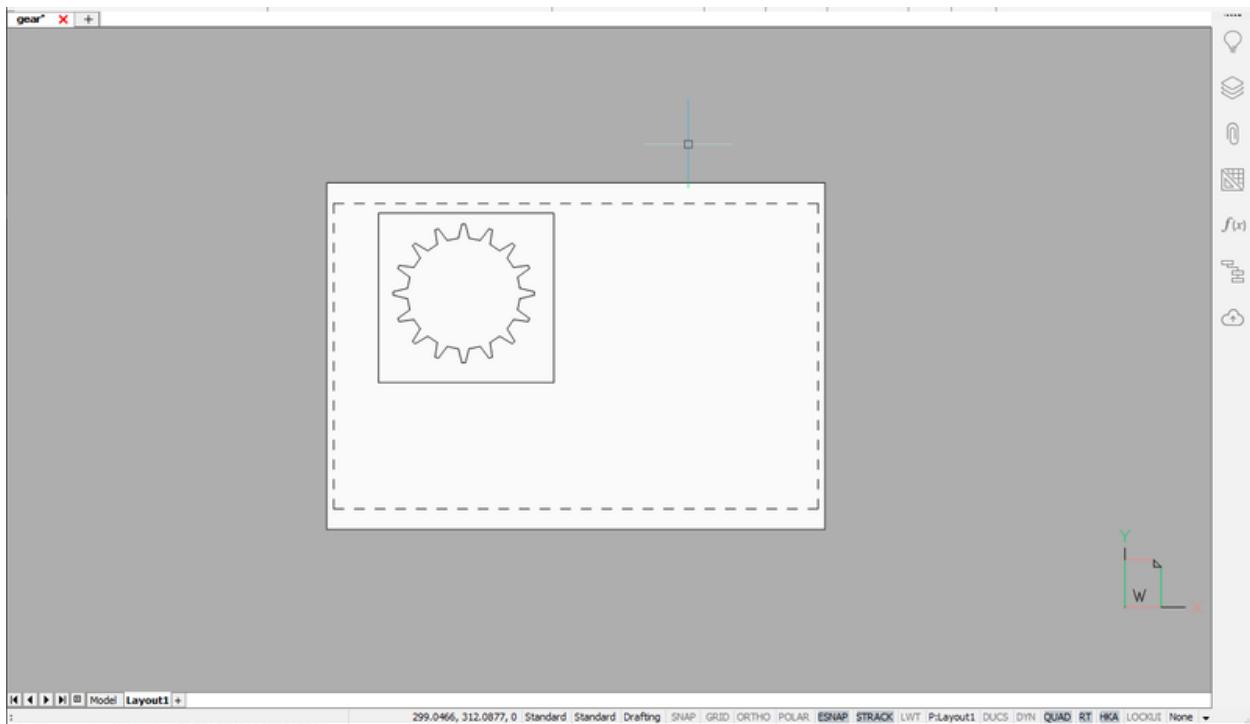
### Extents

The *extents* of an layout are determined by the maximum extents of all DXF entities that are in this layout. The command:

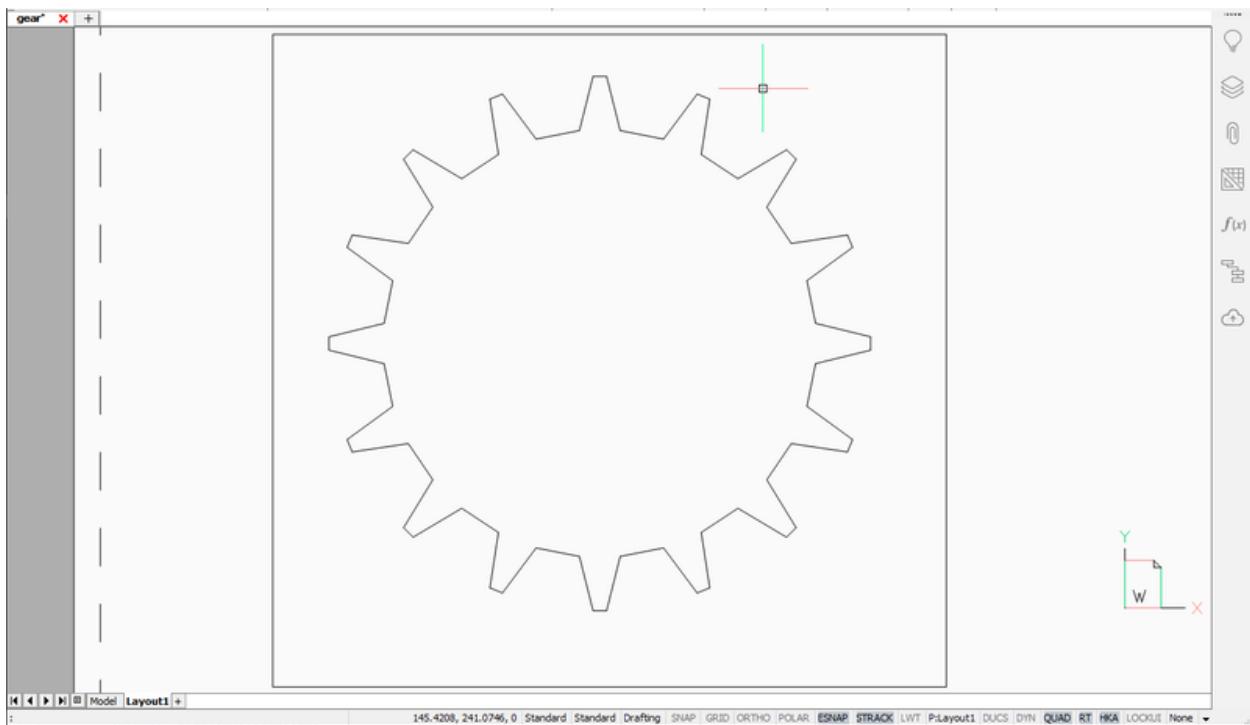
```
ZOOM extents
```

sets the current viewport to the extents of the currently selected layout.

A paper space layout in an arbitrary zoom state:



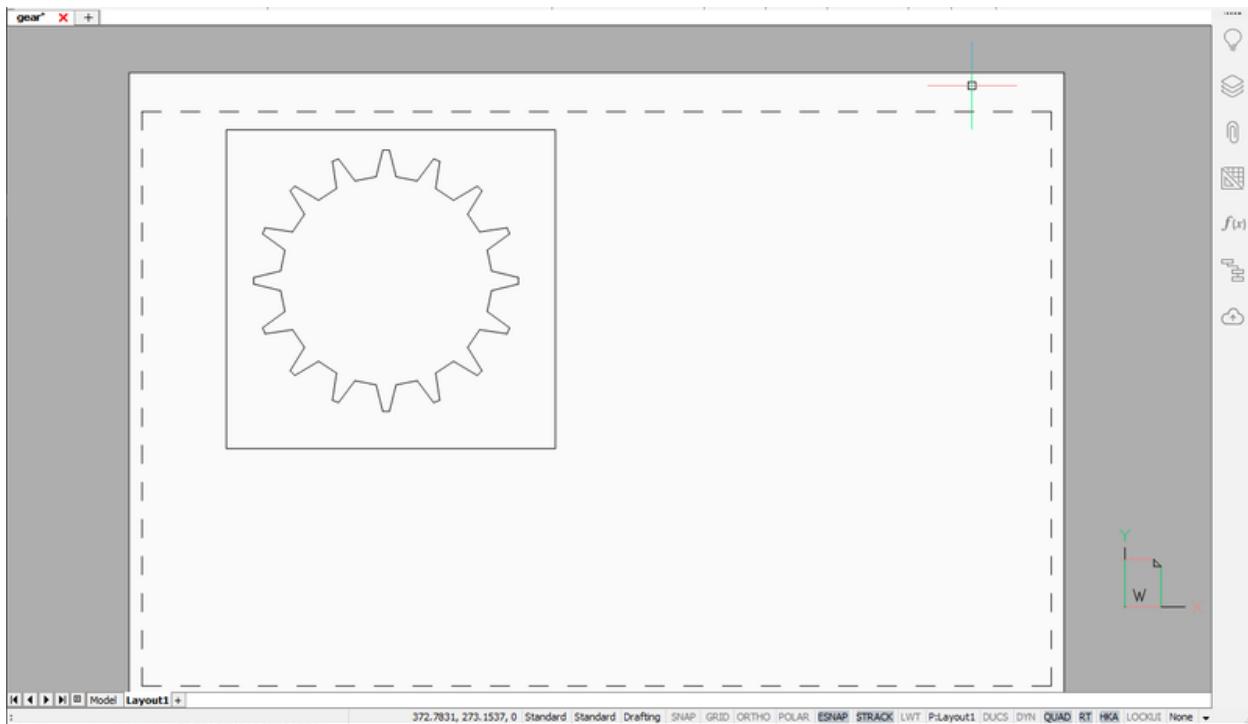
The same layout after the ZOOM extents command:



## Limits

Sets an invisible rectangular boundary in the drawing area that can limit the grid display and limit clicking or entering point locations. The default limits for paper space layouts is defined by the paper size.

The layout from above after the `ZOOM all` command:



### See also:

The AutoCAD online reference for the `ZOOM` and the `LIMITS` command.

## Read Stored Values

The extents of the model space (the tab called “Model”) are stored in the header variable `$EXTMIN` and `$EXTMAX`. The default values of `$EXTMIN` is  $(+1e20, +1e20, +1e20)$  and `$EXTMAX` is  $(-1e20, -1e20, -1e20)$ , which do not describe real borders. These values are copies of the `extents` attributes of the `Layout` object as `Layout.dxf.extmin` and `Layout.dxf.extmax`.

The limits of the modelspace are stored in the header variables `$LIMMIN` and `$LIMMAX` and have default values of  $(0, 0)$  and  $(420, 297)$ , the default paper size of `ezdxf` in drawing units. These are copies of the `Layout` attributes `Layout.dxf.extmin` and `Layout.dxf.extmax`.

The extents and the limits of the *actual* paper space layout, which is the last activated paper space layout tab, stored in the header variable `$PEXTMIN`, `$PEXTMAX`, `$PLIMMIN` and `$PLIMMAX`.

Each paper space layout has its own values stored in the `Layout` attributes `Layout.dxf.extmin`, `Layout.dxf.extmax`, `Layout.dxf.limmin` and `Layout.dxf.limmax`.

## Setting Extents and Limits

Since v0.16 `ezdxf` it is sufficient to define the attributes for `extents` and `limits` (`Layout.dxf.extmax`, `Layout.dxf.limmin` and `Layout.dxf.limmax`) of `Layout` object. The header variables are synchronized when the

document is saved.

The extents of a layout are not calculated automatically by *ezdxf*, as this can take a long time for large documents and correct values are not required to create a valid DXF document.

**See also:**

How to: *Calculate Extents for the Modelspace*

## 6.4.10 Font Resources

DXF relies on the infrastructure installed by AutoCAD like the included SHX files or True Type fonts. There is no simple way to store additional information about a used fonts beside the plain file system name like "arial.ttf". The CAD application or viewer which opens the DXF file has to have access to the specified fonts used in your DXF document or it has to use an appropriate replacement font, which is not that easy in the age of unicode. Later DXF versions can store font family names in the XDATA of the STYLE entity but not all CAD application use this information.

## 6.5 Tutorials

### 6.5.1 Tutorial for getting data from DXF files

In this tutorial I show you how to get data from an existing DXF drawing. If you are a new *ezdxf* user, read also the tutorial *Usage for Beginners*.

Loading the DXF file:

```
import sys
import ezdxf

try:
    doc = ezdxf.readfile("your_dxf_file.dxf")
except IOError:
    print(f"Not a DXF file or a generic I/O error.")
    sys.exit(1)
except ezdxf.DXFStructureError:
    print(f"Invalid or corrupted DXF file.")
    sys.exit(2)
```

This works well for DXF files from trusted sources like AutoCAD or BricsCAD, for loading DXF files with minor or major flaws look at the *ezdxf.recover* module.

**See also:**

- *Document Management*
- *Usage for Beginners*

## Layouts

I use the term layout as synonym for an arbitrary entity space which can contain DXF entities like LINE, CIRCLE, TEXT and so on. Every DXF entity can only reside in exact one layout.

There are three different layout types:

- *Modelspace*: this is the common construction space

- *Paperspace*: used to create print layouts
- *BlockLayout*: reusable elements, every block has its own entity space

A DXF drawing consist of exact one modelspace and at least of one paperspace. DXF R12 has only one unnamed paperspace the later DXF versions support more than one paperspace and each paperspace has a name.

## Getting the modelspace layout

The modelspace contains the “real” world representation of the drawing subjects in real world units. The modelspace has the fixed name “Model” and the DXF document has a special getter method `modelspace()`.

```
msp = doc.modelspace()
```

## Iterate over DXF entities of a layout

Iterate over all DXF entities in modelspace. Although this is a possible way to retrieve DXF entities, I would like to point out that *entity queries* are the better way.

```
# helper function
def print_entity(e):
    print("LINE on layer: %s\n" % e.dxf.layer)
    print("start point: %s\n" % e.dxf.start)
    print("end point: %s\n" % e.dxf.end)

# iterate over all entities in modelspace
msp = doc.modelspace()
for e in msp:
    if e.dxftype() == "LINE":
        print_entity(e)

# entity query for all LINE entities in modelspace
for e in msp.query("LINE"):
    print_entity(e)
```

All layout objects supports the standard Python iterator protocol and the `in` operator.

## Access DXF attributes of an entity

Check the type of an DXF entity by `e.dxftype()`. The DXF type is always uppercase. All DXF attributes of an entity are grouped in the namespace attribute `dxf`:

```
e.dxf.layer # layer of the entity as string
e.dxf.color # color of the entity as integer
```

See *Common graphical DXF attributes*

If a DXF attribute is not set (a valid DXF attribute has no value), a `DXFValueError` will be raised. To avoid this use the `get_dxf_attrib()` method with a default value:

```
# If DXF attribute 'paperspace' does not exist, the entity defaults
# to modelspace:
p = e.get_dxf_attrib("paperspace", 0)
```

An unsupported DXF attribute raises an `DXFAttributeError`.

## Getting a paperspace layout

```
paperspace = doc.layout("layout0")
```

Retrieves the paperspace named `layout0`, the usage of the `Layout` object is the same as of the modelspace object. DXF R12 provides only one paperspace, therefore the paperspace name in the method call `doc.layout("layout0")` is ignored or can be left off. For newer DXF versions you can get a list of the available layout names by the methods `layout_names()` and `layout_names_in_taborder()`.

## Retrieve entities by query language

`ezdxf` provides a flexible query language for DXF entities. All layout types have a `query()` method to start an entity query or use the `ezdxf.query.new()` function.

The query string is the combination of two queries, first the required entity query and second the optional attribute query, enclosed in square brackets: "EntityQuery [AttributeQuery]"

The entity query is a whitespace separated list of DXF entity names or the special name `*`. Where `*` means all DXF entities, all other DXF names have to be uppercase. The `*` search can exclude entity types by adding the entity name with a preceding `!` (e.g. `* !LINE`, search all entities except lines).

The attribute query is used to select DXF entities by its DXF attributes. The attribute query is an addition to the entity query and matches only if the entity already match the entity query. The attribute query is a boolean expression, supported operators: `and`, `or`, `!`.

### See also:

[Entity Query String](#)

Get all LINE entities from the modelspace:

```
msp = doc.modelspace()
lines = msp.query("LINE")
```

The result container `EntityQuery` also provides the `query()` method, get all LINE entities at layer construction:

```
construction_lines = lines.query('*[layer=="construction"]')
```

The `*` is a wildcard for all DXF types, in this case you could also use `LINE` instead of `*`, `*` works here because `lines` just contains entities of DXF type `LINE`.

All together as one query:

```
lines = msp.query('LINE[layer=="construction"]')
```

The ENTITIES section also supports the `query()` method:

```
lines_and_circles = doc.entities.query('LINE CIRCLE[layer=="construction"]')
```

Get all modelspace entities at layer construction, but excluding entities with linetype DASHED:

```
not_dashed_entities = msp.query('*[layer=="construction" and linetype!="DASHED"]')
```

## Retrieve entities by groupby() function

Search and group entities by a user defined criteria. As example let's group all entities from modelspace by layer, the result will be a dict with layer names as dict-key and a list of all entities from modelspace matching this layer as dict-value. Usage as dedicated function call:

```
from eздxf.groupby import groupby
group = groupby(entities=msp, dxffattrib="layer")
```

The *entities* argument can be any container or generator which yields *DXFEntity* or inherited objects. Shorter and simpler to use as method of *BaseLayout* (modelspace, paperspace layouts, blocks) and query results as *EntityQuery* objects:

```
group = msp.groupby(dxffattrib="layer")

for layer, entities in group.items():
    print(f'Layer "{layer}" contains following entities:')
    for entity in entities:
        print(f"    {entity}")
    print("-" * 40)
```

The previous example shows how to group entities by a single DXF attribute, but it is also possible to group entities by a custom key, to do so create a custom key function, which accepts a DXF entity as argument and returns a hashable value as dict-key or None to exclude the entity. The following example shows how to group entities by layer and color, so each result entry has a tuple (*layer*, *color*) as key and a list of entities with matching DXF attributes as values:

```
def layer_and_color_key(entity):
    # return None to exclude entities from result container
    if entity.dxf.layer == "0": # exclude entities from default layer "0"
        return None
    else:
        return entity.dxf.layer, entity.dxf.color

group = msp.groupby(key=layer_and_color_key)
for key, entities in group.items():
    print(f'Grouping criteria "{key}" matches following entities:')
    for entity in entities:
        print(f"    {entity}")
    print("-" * 40)
```

To exclude entities from the result container the *key* function should return None. The *groupby()* function catches DXFAttributeError exceptions while processing entities and excludes this entities from the result container. So there is no need to worry about DXF entities which do not support certain attributes, they will be excluded automatically.

See also:

[groupby\(\)](#) documentation

## 6.5.2 Tutorial for creating simple DXF drawings

*r12writer* - create simple DXF R12 drawings with a restricted entities set: LINE, CIRCLE, ARC, TEXT, POINT, SOLID, 3DFACE and POLYLINE. Advantage of the *r12writer* is the speed and the low memory footprint, all entities are written direct to the file/stream without building a drawing data structure in memory.

See also:

## r12writer

Create a new DXF drawing with `ezdxf.new()` to use all available DXF entities:

```
import ezdxf

# Create a new DXF R2010 drawing, official DXF version name: "AC1024"
doc = ezdxf.new('R2010')

# Add new entities to the modelspace:
msp = doc.modelspace()
# Add a LINE entity
msp.add_line((0, 0), (10, 0))
doc.saveas('line.dxf')
```

New entities are always added to layouts, a layout can be the model space, a paper space layout or a block layout.

### See also:

*Thematic Index of Layout Factory Methods*

## 6.5.3 Tutorial for Layers

If you are not familiar with the concept of layers, please read this first: [Layer Concept](#)

### Create a Layer Definition

```
import ezdxf

doc = ezdxf.new(setup=True) # setup required line types
msp = doc.modelspace()
doc.layers.add(name="MyLines", color=7, linetype="DASHED")
```

The advantage of assigning a linetype and a color to a layer is that entities on this layer can inherit this properties by using "BYLAYER" as linetype string and 256 as color, both values are default values for new entities so you can leave off these assignments:

```
msp.add_line((0, 0), (10, 0), dxftattribs={"layer": "MyLines"})
```

The new created line will be drawn with color 7 and linetype "DASHED".

### Changing Layer State

Get the layer definition object:

```
my_lines = doc.layers.get('MyLines')
```

Check the state of the layer:

```
my_lines.is_off() # True if layer is off
my_lines.is_on() # True if layer is on
my_lines.is_locked() # True if layer is locked
layer_name = my_lines.dxf.name # get the layer name
```

Change the state of the layer:

```
# switch layer off, entities at this layer will not shown in CAD applications/viewers
my_lines.off()

# lock layer, entities at this layer are not editable in CAD applications
my_lines.lock()
```

Get/set default color of a layer by property `Layer.color`, because the DXF attribute `Layer.dxf.color` is misused for switching the layer on and off, layer is off if the color value is negative.

Changing the default layer values:

```
my_lines.dxf.linetype = "DOTTED"
my_lines.color = 13 # preserves on/off state of layer
```

#### See also:

For all methods and attributes see class [Layer](#).

### Check Available Layers

The layers object supports some standard Python protocols:

```
# iteration
for layer in doc.layers:
    if layer.dxf.name != "0":
        layer.off() # switch all layers off except layer "0"

# check for existing layer definition
if "MyLines" in doc.layers:
    layer = doc.layers.get("MyLines")

layer_count = len(doc.layers) # total count of layer definitions
```

### Deleting a Layer

Delete a layer definition:

```
doc.layers.remove("MyLines")
```

This just deletes the layer definition, all DXF entities with the DXF attribute `layer` set to "MyLines" are still there, but if they inherit color and/or linetype from the layer definition they will be drawn now with linetype "Continuous" and color 1.

## 6.5.4 Tutorial for Blocks

### What are Blocks?

Blocks are collections of DXF entities which can be placed multiple times as block references in different layouts and other block definitions. The block reference ([Insert](#)) can be rotated, scaled, placed in 3D space by [OCS](#) and arranged in a grid like manner, each [Insert](#) entity can have individual attributes ([Attrib](#)) attached.

## Create a Block

Blocks are managed as `BlockLayout` objects by the `BlocksSection` object, every drawing has only one blocks section stored in the attribute: `Drawing.blocks`.

```
import ezdxf
import random # needed for random placing points

def get_random_point():
    """Returns random x, y coordinates."""
    x = random.randint(-100, 100)
    y = random.randint(-100, 100)
    return x, y

# Create a new drawing in the DXF format of AutoCAD 2010
doc = ezdxf.new('R2010')

# Create a block with the name 'FLAG'
flag = doc.blocks.new(name='FLAG')

# Add DXF entities to the block 'FLAG'.
# The default base point (= insertion point) of the block is (0, 0).
flag.add_lwpolyline([(0, 0), (0, 5), (4, 3), (0, 3)]) # the flag symbol as 2D
# polyline
flag.add_circle((0, 0), .4, dxftattribs={'color': 2}) # mark the base point with a
# circle
```

## Block References (Insert)

A block reference is a DXF `Insert` entity and can be placed in any layout: `Modelspace`, any `Paperspace` or `BlockLayout` (which enables nested block references). Every block reference can be placed, scaled and rotated individually. Scaling by negative values is mirroring.

Lets insert some random flags into the modelspace:

```
# Get the modelspace of the drawing.
msp = doc.modelspace()

# Get 50 random placing points.
placing_points = [get_random_point() for _ in range(50)]

for point in placing_points:
    # Every flag has a different scaling and a rotation of -15 deg.
    random_scale = 0.5 + random.random() * 2.0
    # Add a block reference to the block named 'FLAG' at the coordinates 'point'.
    msp.add_blockref('FLAG', point, dxftattribs={
        'xscale': random_scale,
        'yscale': random_scale,
        'rotation': -15
    })

# Save the drawing.
doc.saveas("blockref_tutorial.dxf")
```

Query all block references of block FLAG:

```
for flag_ref in msp.query('INSERT[name=="FLAG"]'):
    print(str(flag_ref))
```

When inserting a block reference into the modelspace or another block layout with different units, the scaling factor between these units should be applied as scaling attributes (`xscale`, ...) e.g. modelspace in meters and block in centimeters, `xscale` has to be 0.01.

## What are Attributes?

An attribute (`Attrib`) is a text annotation attached to a block reference with an associated tag. Attributes are often used to add information to blocks which can be evaluated and exported by CAD programs. An attribute can be visible or hidden. The simple way to use attributes is just to add an attribute to a block reference by `Insert.add_attrib()`, but the attribute is geometrically not related to the block reference, so you have to calculate the insertion point, rotation and scaling of the attribute by yourself.

## Using Attribute Definitions

The second way to use attributes in block references is a two step process, first step is to create an attribute definition (template) in the block definition, the second step is adding the block reference by `Layout.add_blockref()` and attach and fill attribute automatically by the `add_auto_attribs()` method to the block reference. The advantage of this method is that all attributes are placed relative to the block base point with the same rotation and scaling as the block, but has the disadvantage that non uniform scaling is not handled very well. The method `Layout.add_auto_blockref()` handles non uniform scaling better by wrapping the block reference and its attributes into an anonymous block and let the CAD application do the transformation work which will create correct graphical representations at least by AutoCAD and BricsCAD. This method has the disadvantage of a more complex evaluation of attached attributes

Using attribute definitions (`Attdef`):

```
# Define some attributes for the block 'FLAG', placed relative
# to the base point, (0, 0) in this case.
flag.add_attdef('NAME', (0.5, -0.5), dxftattribs={'height': 0.5, 'color': 3})
flag.add_attdef('XPOS', (0.5, -1.0), dxftattribs={'height': 0.25, 'color': 4})
flag.add_attdef('YPOS', (0.5, -1.5), dxftattribs={'height': 0.25, 'color': 4})

# Get another 50 random placing points.
placing_points = [get_random_point() for _ in range(50)]

for number, point in enumerate(placing_points):
    # values is a dict with the attribute tag as item-key and
    # the attribute text content as item-value.
    values = {
        'NAME': "P(%d)" % (number + 1),
        'XPOS': "x = %.3f" % point[0],
        'YPOS': "y = %.3f" % point[1]
    }

    # Every flag has a different scaling and a rotation of +15 deg.
    random_scale = 0.5 + random.random() * 2.0
    blockref = msp.add_blockref('FLAG', point, dxftattribs={
        'rotation': 15
    }).set_scale(random_scale)
    blockref.add_auto_attribs(values)
```

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```
# Save the drawing.
doc.saveas("auto_blockref_tutorial.dxf")
```

## Get/Set Attributes of Existing Block References

See the howto: [Get/Set Block Reference Attributes](#)

## Evaluate Wrapped Block References

As mentioned above evaluation of block references wrapped into anonymous blocks is complex:

```
# Collect all anonymous block references starting with '*U'
anonymous_block_refs = modelspace.query('INSERT[name ? "^\*U.+"]')

# Collect real references to 'FLAG'
flag_refs = []
for block_ref in anonymous_block_refs:
    # Get the block layout of the anonymous block
    block = doc.blocks.get(block_ref.dxf.name)
    # Find all block references to 'FLAG' in the anonymous block
    flag_refs.extend(block.query('INSERT[name=="FLAG"]'))

# Evaluation example: collect all flag names.
flag_numbers = [
    flag.get_attrib_text("NAME")
    for flag in flag_refs
    if flag.has_attrib("NAME")]
]

print(flag_numbers)
```

## Exploding Block References

This is an advanced feature and because *ezdxf* is still not a CAD application, the results may no be perfect. **Non uniform scaling** lead to incorrect results for text entities (TEXT, MTEXT, ATTRIB) and some other entities like HATCH with arc or ellipse path segments.

By default the “exploded” entities are added to the same layout as the block reference is located.

```
for flag_ref in msp.query('INSERT[name=="FLAG"]'):
    flag_ref.explode()
```

## Examine Entities of Block References

If you just want to examine the entities of a block reference use the `virtual_entities()` method. This methods yields “virtual” entities with attributes identical to “exploded” entities but they are not stored in the entity database, have no handle and are not assigned to any layout.

```
for flag_ref in msp.query('INSERT[name=="FLAG"]'):
    for entity in flag_ref.virtual_entities():
        if entity.dxftype() == "LWPOLYLINE":
            print(f"Found {str(entity)}")
```

## 6.5.5 Tutorial for LWPolyline

The *LWPolyline* is defined as a single graphic entity, which differs from the old-style *Polyline* entity, which is defined as a group of sub-entities. *LWPolyline* display faster (in AutoCAD) and consume less disk space, it is a planar element, therefore all points in *OCS* as (x, y) tuples (LWPolyline.dxf.elevation is the z-axis value).

Create a simple polyline:

```
import ezdxf

doc = ezdxf.new("R2000")
msp = doc.modelspace()

points = [(0, 0), (3, 0), (6, 3), (6, 6)]
msp.add_lwpolyline(points)

doc.saveas("lwpolyline1.dxf")
```

Append multiple points to a polyline:

```
doc = ezdxf.readfile("lwpolyline1.dxf")
msp = doc.modelspace()

line = msp.query("LWPOLYLINE").first
if line is not None:
    line.append_points([(8, 7), (10, 7)])

doc.saveas("lwpolyline2.dxf")
```

The LWPOLYLINE entity always returns polyline points as 5-tuple (x, y, start\_width, end\_width, bulge), the start\_width, end\_width and bulge values are 0 if not present:

```
first_point = line[0]
x, y, start_width, end_width, bulge = first_point
```

Use the method *points()* as context manager to edit polyline points, this method was introduced because accessing single points was very slow in early versions of *ezdxf*, but now direct access by the index operator [] is very fast and using the context manager is not required anymore. The advantage of the context manager is the ability to use a user defined point format:

```
doc = ezdxf.readfile("lwpolyline2.dxf")
msp = doc.modelspace()

line = msp.query("LWPOLYLINE").first

with line.points("xyseb") as points:
    # points is a standard Python list
    # existing points are 5-tuples, but new points can be
    # set as (x, y, [start_width, [end_width, [bulge]]]) tuple
```

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```
# set start_width, end_width to 0 to be ignored (x, y, 0, 0, bulge).

# delete last 2 points
del points[-2:]
# adding two points
points.extend([(4, 7), (0, 7)])

doc.saveas("lwpolyline3.dxf")
```

Each line segment can have a different start- and end-width, if omitted start- and end-width is 0:

```
doc = ezdxf.new("R2000")
msp = doc.modelspace()

# point format = (x, y, [start_width, [end_width, [bulge]]])
# set start_width, end_width to 0 to be ignored (x, y, 0, 0, bulge).

points = [(0, 0, .1, .15), (3, 0, .2, .25), (6, 3, .3, .35), (6, 6)]
msp.add_lwpolyline(points)

doc.saveas("lwpolyline4.dxf")
```

The first point carries the start- and end-width of the first segment, the second point of the second segment and so on, the start- and end-width value of the last point is used for the closing segment if the polyline is closed else these values are ignored. Start- and end-width only works if the DXF attribute `dxf.const_width` is unset, to be sure delete it:

```
# no exception will be raised if const_width is already unset:
del line.dxf.const_width
```

LWPolyline can also have curved elements, they are defined by the *Bulge* value:

```
doc = ezdxf.new("R2000")
msp = doc.modelspace()

# point format = (x, y, [start_width, [end_width, [bulge]]])
# set start_width, end_width to 0 to be ignored (x, y, 0, 0, bulge).

points = [(0, 0, 0, .05), (3, 0, .1, .2, -.5), (6, 0, .1, .05), (9, 0)]
msp.add_lwpolyline(points)

doc.saveas("lwpolyline5.dxf")
```



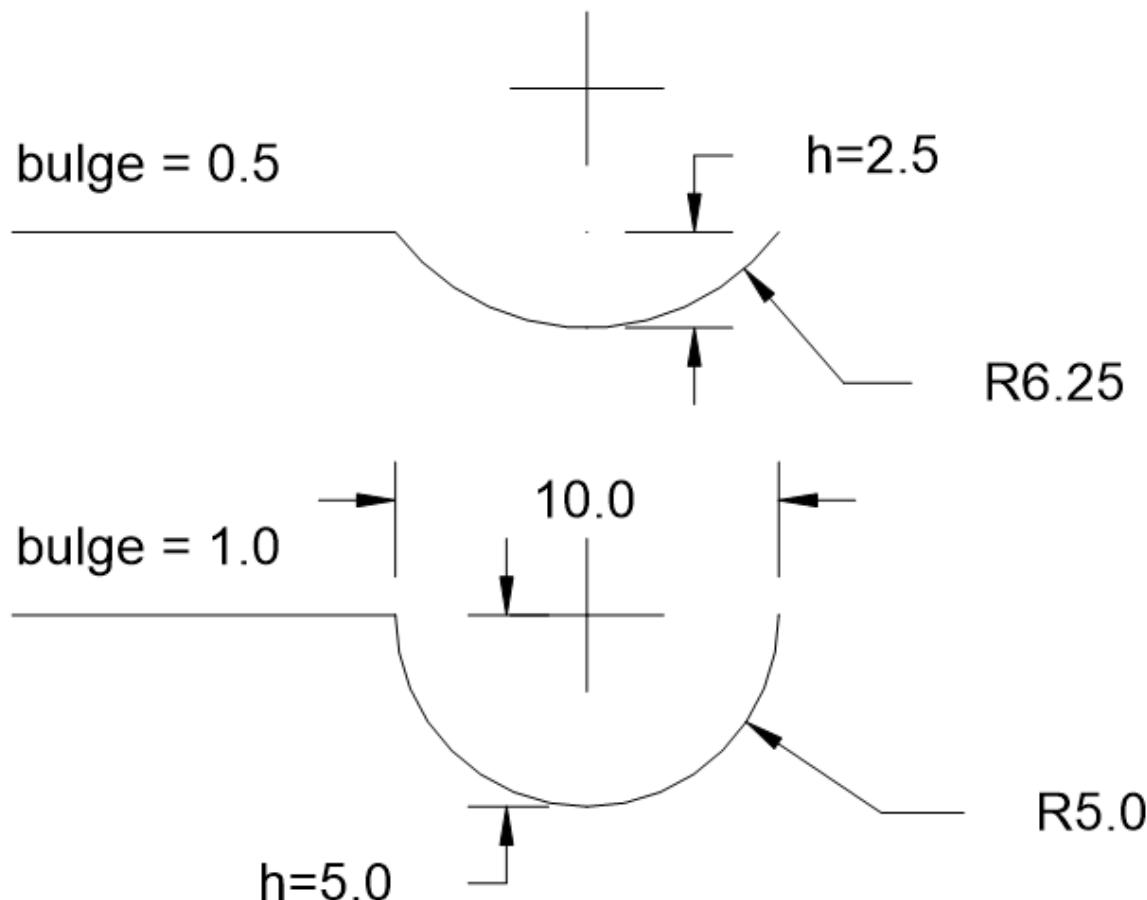
The curved segment is drawn from the point which defines the *bulge* value to the following point, the curved segment is always an arc. The bulge value defines the ratio of the arc sagitta ( $h$ ) to half line segment length

(point distance), a bulge value of 1 defines a semicircle. The curve is on the right side of the line for a bulge value > 0, and on the left side of the line for a bulge value < 0.

The user defined point format, default is `xyseb`:

- `x` = x coordinate
- `y` = y coordinate
- `s` = start width
- `e` = end width
- `b` = bulge value
- `v` =  $(x, y)$  as tuple

```
msp.add_lwpolyline([(0, 0, 0), (10, 0, 1), (20, 0, 0)], format="xyb")
msp.add_lwpolyline([(0, 10, 0), (10, 10, .5), (20, 10, 0)], format="xyb")
```



## 6.5.6 Tutorial for Text

Add a simple one line text entity by factory function `add_text()`.

```

import ezdxf

# TEXT is a basic entity and is supported by every DXF version.
# Argument setup=True for adding standard linetypes and text styles.
doc = ezdxf.new('R12', setup=True)
msp = doc.modelspace()

# use set_pos() for proper TEXT alignment:
# The relations between DXF attributes 'halign', 'valign',
# 'insert' and 'align_point' are tricky.
msp.add_text("A Simple Text").set_pos((2, 3), align='MIDDLE_RIGHT')

# Using a text style
msp.add_text("Text Style Example: Liberation Serif",
            dxftattribs={
                'style': 'LiberationSerif',
                'height': 0.35
            }.set_pos((2, 6), align='LEFT')

doc.saveas("simple_text.dxf")

```

Valid text alignments for argument `align` in `Text.set_pos()`:

Vert/Horiz	Left	Center	Right
Top	TOP_LEFT	TOP_CENTER	TOP_RIGHT
Middle	MIDDLE_LEFT	MIDDLE_CENTER	MIDDLE_RIGHT
Bottom	BOTTOM_LEFT	BOTTOM_CENTER	BOTTOM_RIGHT
Baseline	LEFT	CENTER	RIGHT

Special alignments are `ALIGNED` and `FIT`, they require a second alignment point, the text is justified with the vertical alignment `Baseline` on the virtual line between these two points.

Align- ment	Description
<code>ALIGNED</code>	Text is stretched or compressed to fit exactly between <code>p1</code> and <code>p2</code> and the text height is also adjusted to preserve height/width ratio.
<code>FIT</code>	Text is stretched or compressed to fit exactly between <code>p1</code> and <code>p2</code> but only the text width is adjusted, the text height is fixed by the <code>height</code> attribute.
<code>MIDDLE</code>	also a <i>special</i> adjustment, but the result is the same as for <code>MIDDLE_CENTER</code> .

## Standard Text Styles

Setup some standard text styles and linetypes by argument `setup=True`:

```
doc = ezdxf.new('R12', setup=True)
```

Replaced all proprietary font declarations in `setup_styles()` (`ARIAL`, `ARIAL_NARROW`, `ISOCPEUR` and `TIMES`) by open source fonts, this is also the style name (e.g. `{'style': 'OpenSans-Italic'}`):

*LiberationMono-Italic*  
**LiberationMono-BoldItalic**  
**LiberationMono-Bold**  
LiberationMono  
*LiberationSerif-Italic*  
**LiberationSerif-BoldItalic**  
**LiberationSerif-Bold**  
LiberationSerif  
*LiberationSans-Italic*  
**LiberationSans-BoldItalic**  
**LiberationSans-Bold**  
LiberationSans  
*OpenSansCondensed-Italic*  
OpenSansCondensed-Light  
**OpenSansCondensed-Bold**  
**OpenSans-ExtraBoldItalic**  
**OpenSans-ExtraBold**  
**OpenSans-BoldItalic**  
**OpenSans-Bold**  
**OpenSans-SemiBoldItalic**  
**OpenSans-SemiBold**  
*OpenSans-Italic*  
OpenSans  
*OpenSans-Light-Italic*  
OpenSans-Light  
STANDARD

## New Text Style

Creating a new text style is simple:

```
doc.styles.new('myStandard', dxfattribs={'font' : 'OpenSans-Regular.ttf'})
```

But getting the correct font name is often not that simple, especially on Windows. This shows the required steps to get the font name for *Open Sans*:

- open font folder *c:\windows\fonts*
- select and open the font-family *Open Sans*
- right-click on *Open Sans Standard* and select *Properties*
- on top of the first tab you see the font name: 'OpenSans-Regular.ttf'

The style name has to be unique in the DXF document, else *ezdxf* will raise an `DXFTableEntryError` exception. To replace an existing entry, delete the existing entry by `doc.styles.remove(name)`, and add the replacement entry.

## 3D Text

It is possible to place the 2D `Text` entity into 3D space by using the *OCS*, for further information see: [Tutorial for OCS/UCS Usage](#).

### 6.5.7 Tutorial for MText and MTextEditor

The `MText` entity is a multi line entity with extended formatting possibilities and requires at least DXF version R2000, to use all features (e.g. background fill) DXF R2007 is required.

Prolog code:

```
import ezdxf

doc = ezdxf.new("R2007", setup=True)
msp = doc.modelspace()

lorem_ipsum = """
Lorem ipsum dolor sit amet, consectetur adipiscing elit,
sed do eiusmod tempor incididunt ut labore et dolore magna
aliqua. Ut enim ad minim veniam, quis nostrud exercitation
ullamco laboris nisi ut aliquip ex ea commodo consequat.
Duis aute irure dolor in reprehenderit in voluptate velit
esse cillum dolore eu fugiat nulla pariatur. Excepteur sint
occaecat cupidatat non proident, sunt in culpa qui officia
deserunt mollit anim id est laborum.
"""
```

## Adding a MText entity

The `MText` entity can be added to any layout (modelspace, paperspace or block) by the `add_mtext()` function.

```
# store MText entity for additional manipulations
mtext = msp.add_mtext(lorem_ipsum, dxfattribs={"style": "OpenSans"})
```

This adds a MText entity with text style “OpenSans”. The MText content can be accessed by the `text` attribute, this attribute can be edited like any Python string:

```
mttext.text += "Append additional text to the MText entity."  
# even shorter with __iadd__() support:  
mttext += "Append additional text to the MText entity."
```

**Latin text example:**

  Lorem ipsum dolor sit amet, consectetur adipiscing elit,  
  sed do eiusmod tempor incididunt ut labore et dolore magna  
  aliqua. Ut enim ad minim veniam, quis nostrud exercitation  
  ullamco laboris nisi ut aliquip ex ea commodo consequat.  
  Duis aute irure dolor in reprehenderit in voluptate velit  
  esse cillum dolore eu fugiat nulla pariatur. Excepteur sint  
  occaecat cupidatat non proident, sunt in culpa qui officia  
  deserunt mollit anim id est laborum.

Append additional text to the MText entity.

---

**Important:** Line endings “\n” will be replaced by the MTEXT line endings “\P” at DXF export, but **not** vice versa “\P” by “\n” at DXF file loading.

---

## Text placement

The location of the MText entity is defined by the `MText.dxf.insert` and the `MText.dxf.attachment_point` attributes. The `attachment_point` defines the text alignment relative to the `insert` location, default value is 1.

Attachment point constants defined in `ezdxf.lldxf.const`:

<code>MText.dxf.attachment_point</code>	Value
<code>MTEXT_TOP_LEFT</code>	1
<code>MTEXT_TOP_CENTER</code>	2
<code>MTEXT_TOP_RIGHT</code>	3
<code>MTEXT_MIDDLE_LEFT</code>	4
<code>MTEXT_MIDDLE_CENTER</code>	5
<code>MTEXT_MIDDLE_RIGHT</code>	6
<code>MTEXT_BOTTOM_LEFT</code>	7
<code>MTEXT_BOTTOM_CENTER</code>	8
<code>MTEXT_BOTTOM_RIGHT</code>	9

The MText entity has a method for setting `insert`, `attachment_point` and `rotation` attributes by one call: `set_location()`

## Character height

The character height is defined by the DXF attribute `MText.dxf.char_height` in drawing units, which has also consequences for the line spacing of the MText entity:

```
mtext.dxf.char_height = 0.5
```

The character height can be changed inline, see also [MText formatting](#) and [MText Inline Codes](#).

### Text rotation (direction)

The `MText.dxf.rotation` attribute defines the text rotation as angle between the x-axis and the horizontal direction of the text in degrees. The `MText.dxf.text_direction` attribute defines the horizontal direction of MText as vector in WCS or OCS, if an [OCS](#) is defined. Both attributes can be present at the same entity, in this case the `MText.dxf.text_direction` attribute has the higher priority.

The `MText` entity has two methods to get/set rotation: `get_rotation()` returns the rotation angle in degrees independent from definition as angle or direction, and `set_rotation()` set the `rotation` attribute and removes the `text_direction` attribute if present.

### Defining a wrapping border

The wrapping border limits the text width and forces a line break for text beyond this border. Without attribute `dxf.width` (or setting 0) the lines are wrapped only at the regular line endings " \P" or "\n", setting the reference column width forces additional line wrappings at the given width. The text height can not be limited, the text always occupies as much space as needed.

```
mtext.dxf.width = 60
```

```

Lorem ipsum dolor sit amet,
consectetur adipiscing elit,
sed do eiusmod tempor incididunt ut
labore et dolore magna
aliqua. Ut enim ad minim veniam,
quis nostrud exercitation
ullamco laboris nisi ut aliquip ex ea
commodo consequat.
Duis aute irure dolor in
reprehenderit in voluptate velit
esse cillum dolore eu fugiat nulla
pariatur. Excepteur sint
occaecat cupidatat non proident,
sunt in culpa qui officia
deserunt mollit anim id est laborum.
Append additional text to the MText
entity.

```

### MText formatting

`MText` supports inline formatting by special codes: [MText Inline Codes](#)

```
mtext.text = "{\C1;red text} - {\C3;green text} - {\C5;blue text}"
```

## red text - green text - blue text

See also new section for the new support class *MTextEditor* in *ezdxf* v0.17.

### Stacked text

MText also supports stacked text:

```
# the space ' ' in front of 'Lower' and the ';' behind 'Lower' are necessary
# combined with vertical center alignment
mtext.text = "\\\A1;\\\SUpper^ Lower; - \\\SUpper/ Lower; } - \\\SUpper# Lower;"
```

The diagram illustrates stacked text. The word "Upper" is displayed in a large, bold font. It appears in three different locations: once above "Lower" (underlined), once to the left of "Lower" (with a diagonal line through it), and once below "Lower".

See also new section for the new support class *MTextEditor* in *ezdxf* v0.17.

### Background color (filling)

The MText entity can have a background filling:

- AutoCAD Color Index (ACI)
- true color value as (r, g, b) tuple
- color name as string, use special name 'canvas' to use the canvas background color

Because of the complex dependencies *ezdxf* provides a method to set all required DXF attributes at once:

```
mtext.set_bg_color(2, scale=1.5)
```

The parameter *scale* determines how much border there is around the text, the value is based on the text height, and should be in the range of 1 - 5, where 1 fits exact the MText entity.

## MTextEditor

New in version 0.17.

**Warning:** The MTextEditor assembles just the inline code, which has to be parsed and rendered by the target CAD application, *ezdxf* has no influence to that result.

Keep inline formatting as simple as possible, don't test the limits of its capabilities, this will not work across different CAD applications and keep the formatting in a logic manner like, do not change paragraph properties in the middle of a paragraph.

**There is no official documentation for the inline codes!**

The `MTextEditor` class provides a floating interface to build `MText` content in an easy way.

This example only shows the connection between `MTText` and the `MTextEditor`, and shows no additional features to the first example of this tutorial:

## Init Editor

```
import eздxf
from eздxf.tools.text import MTextEditor

doc = eздxf.new("R2007", setup=True)
msp = doc.modelspace()

lorem_ipsum = """
Lorem ipsum dolor sit amet, consectetur adipiscing elit, ... see prolog code
"""

# create a new editor object with an initial text:
editor = MTextEditor(lorem_ipsum)

# get the MTEXT content string from the editor by the str() function:
mtext = msp.add_mtext(str(editor), dxftattribs={"style": "OpenSans"})
```

Tutorial Prolog:

```
# use constants defined in MTextEditor:
NP = MTextEditor.NEW_PARAGRAPH

ATTRIBS = {
    "char_height": 0.7,
    "style": "OpenSans",
    "width": 10,
}
editor = MTextEditor("using colors:" + NP)
```

## Set Text Color

There are three ways to change the color inline:

- by color name “red”, “green”, “blue”, “yellow”, “cyan”, “magenta”, “white”
- by *AutoCAD Color Index (ACI)*
- by RGB values

```
# RED: set color by name - red, green, blue, yellow, cyan, magenta, white
editor.color("red").append("RED" + NP)
# RED: the color stays the same until the next change
editor.append("also RED" + NP)

# GREEN: change color by ACI (AutoCAD Color Index)
editor.aci(3).append("GREEN" + NP)

# BLUE: change color by RGB tuples
editor.rgb((0, 0, 255)).append("BLUE" + NP)

# add the MTEXT entity to the model space:
msp.add_mtext(str(editor), attribs)
```



### Changing Text Height

The `MtextEditor.height()` method set the text height as absolute value in drawing units (text height = cap height):

```
attribs = dict(ATTRIBS)
attribs["width"] = 40.0
editor = MTextEditor("changing text height absolute: default height is 0.7" + NP)
# doubling the default height = 1.4
editor.height(1.4)
editor.append("text height: 1.4" + NP)
editor.height(3.5).append("text height: 3.5" + NP)
editor.height(0.7).append("back to default height: 0.7" + NP)
msp.add_mtext(str(editor), attribs)
```



The `MtextEditor.scale_height()` method set the text height by a relative factor, the `MtextEditor` object does not keep track of current text height, you have to do this by yourself. The initial text height is `MText.dxf.char_height`:

```
attribs = dict(ATTRIBS)
attribs["width"] = 40.0
editor = MTextEditor("changing text height relative: default height is 0.7" + NP)
# this is the default text height in the beginning:
current_height = attribs["char_height"]
# The text height can only be changed by a factor:
editor.scale_height(2) # scale by 2 = 1.4
# keep track of the actual height:
current_height *= 2
editor.append("text height: 1.4" + NP)
# to set an absolute height, calculate the required factor:
desired_height = 3.5
factor = desired_height / current_height
editor.scale_height(factor).append("text height: 3.5" + NP)
current_height = desired_height
# and back to 0.7
editor.scale_height(0.7 / current_height).append("back to default height: 0.7" + NP)
msp.add_mtext(str(editor), attribs).set_location(insert=location)
```

## Changing Font

The font name for changing MText fonts inline is the font family name! The font family name is the name shown in font selection widgets in desktop applications: “Arial”, “Times New Roman”, “Comic Sans MS”. The font has to be installed at the target system, else then CAD default font will be used, in AutoCAD/BricsCAD is this the font defined for the text style “Standard”.

---

**Important:** The DXF/DWG format is not optimal for preserving text layouts across multiple systems, and it's getting really bad across different CAD applications.

---

```
attribs = dict(ATTRIBS)
attribs["width"] = 15.0
editor = MTextEditor("changing fonts:" + NP)
editor.append("Default: Hello World!" + NP)
editor.append("SimSun: ")
# change font in a group to revert back to the default font at the end:
simsun_editor = MTextEditor().font("SimSun").append(" " + NP)
# reverts the font back at the end of the group:
editor.group(str(simsun_editor))
# back to default font OpenSans:
editor.append("Times New Roman: ")
# change font outside of a group until next font change:
editor.font("Times New Roman").append(" !" + NP)
# If the font does not exist, a replacement font will be used:
editor.font("Does not exist").append("This is the replacement font!")
msp.add_mtext(str(editor), attribs)
```

changing fonts:  
 Default: Hello World!  
 SimSun: 你好，世界  
 Times New Roman: Привет мир!  
 This is the replacement  
 font!

## Set Paragraph Properties

The paragraph properties are set by the `paragraph()` method and a `ParagraphProperties` object, which bundles all paragraph properties in a named tuple.

Each paragraph can have its own properties for:

- indentation arguments:
  - `indent` is the left indentation of the first line
  - `left` is the left side indentation of the paragraph
  - `right` is the right side indentation of the paragraph
- text adjustment: `align`, by enum `MTextParagraphAlignment`
  - `MTextParagraphAlignment.LEFT`
  - `MTextParagraphAlignment.RIGHT`
  - `MTextParagraphAlignment.CENTER`
  - `MTextParagraphAlignment.JUSTIFIED`
  - `MTextParagraphAlignment.DISTRIBUTED`
- tabulator stops: `tab_stops`, a tuple of tabulator stops

Indentation and tabulator stops are multiples of the default `MText` text height stored in `MText.dxf.char_height`. Calculate the drawing units for indentation and tabulator stops, by multiplying the the indentation value by the `char_height` value.

`Mtext` paragraphs are separated by new paragraph “P” characters.

```
# import support classes:
from ezdxf.tools.text import ParagraphProperties, MTextParagraphAlignment

ATTRIBS = {
    "align": MTextParagraphAlignment.CENTER,
    "left": 1000,
    "right": 1000,
    "tab_stops": [(1000, "left")],
}
```

(continues on next page)

(continued from previous page)

```

attribs["char_height"] = 0.25
attribs["width"] = 7.5
editor = MTextEditor("Indent the first line:" + NP)
props = ParagraphProperties(
    indent=1, # indent first line = 1x0.25 drawing units
    align=MTextParagraphAlignment.JUSTIFIED
)
editor.paragraph(props)
editor.append(lorem_ipsum)
msp.add_mtext(str(editor), attribs)

```

### Indent the first line:

Lorem ipsum dolor sit amet, consetetur sadipscing elitr, sed diam nonumy eirmod tempor invidunt ut labore et dolore magna aliquyam erat, sed diam voluptua. At vero eos et accusam et justo duo dolores et ea rebum. Stet clita kasd gubergren, no sea takimata sanctus est Lorem ipsum dolor sit amet. Lorem ipsum dolor sit amet, consetetur sadipscing elitr, sed diam nonumy eirmod tempor invidunt ut labore et dolore magna aliquyam erat, sed diam voluptua. At vero eos et accusam et justo duo dolores et ea rebum. Stet clita kasd gubergren, no sea takimata sanctus est Lorem ipsum dolor sit amet.

The first line indentation “indent” is relative to the “left” indentation.

```

# import support classes:
from ezdxf.tools.text import ParagraphProperties, MTextParagraphAlignment

attribs = dict(ATTRIBS)
attribs["char_height"] = 0.25
attribs["width"] = 7.5
editor = MTextEditor("Indent left paragraph side:" + NP)
indent = 0.7 # 0.7 * 0.25 = 0.175 drawing units
props = ParagraphProperties(
    # first line indentation is relative to "left", this reverses the
    # left indentation:
    indent=-indent, # first line
    # indent left paragraph side:
    left=indent,
    align=MTextParagraphAlignment.JUSTIFIED
)
editor.paragraph(props)
editor.append(" ".join(lorem_ipsum(100)))
msp.add_mtext(str(editor), attribs).set_location(insert=location)

```

Indent left paragraph side:

  Lorem ipsum dolor sit amet, consetetur  
   sadipscing elitr, sed diam nonumy eirmod  
   tempor invidunt ut labore et dolore  
   magna aliquyam erat, sed diam voluptua.  
   At vero eos et accusam et justo duo  
   dolores et ea rebum. Stet clita kasd  
   gubergren, no sea takimata sanctus est  
   Lorem ipsum dolor sit amet. Lorem ipsum  
   dolor sit amet, consetetur sadipscing elitr,  
   sed diam nonumy eirmod tempor  
   invidunt ut labore et dolore magna  
   aliquyam erat, sed diam voluptua. At vero  
   eos et accusam et justo duo dolores et ea  
   rebum. Stet clita kasd gubergren, no sea  
   takimata sanctus est Lorem ipsum dolor  
   sit amet.

## Bullet List

There are no special commands to build bullet list, the list is build of indentation and a tabulator stop. Each list item needs a marker as an arbitrary string. For more information about paragraph indentation and tabulator stops see also chapter [Set Paragraph Properties](#).

```
attribs = dict(ATTRIBS)
attribs["char_height"] = 0.25
attribs["width"] = 7.5
bullet = ". " # alt + numpad 7
editor = MTextEditor("Bullet List:" + NP)
editor.bullet_list(
    indent=1,
    bullets=[bullet] * 3, # each list item needs a marker
    content=[
        "First item",
        "Second item",
        " ".join(lorem_ipsum(30)),
    ])
msp.add_mtext(str(editor), attribs)
```

**Bullet List:**

- First item
- Second item
- Lorem ipsum dolor sit amet, consetetur sadipscing elitr, sed diam nonumy eirmod tempor invidunt ut labore et dolore magna aliquyam erat, sed diam voluptua. At vero eos et accusam et

**Numbered List**

There are no special commands to build numbered list, the list is build of indentation and a tabulator stop. There is no automatic numbering, but therefore the absolute freedom for using any string as list marker. For more information about paragraph indentation and tabulator stops see also chapter [Set Paragraph Properties](#).

```
attribs = dict(ATTRIBS)
attribs["char_height"] = 0.25
attribs["width"] = 7.5
editor = MTextEditor("Numbered List:" + NP)
editor.bullet_list(
    indent=1,
    bullets=["1.", "2.", "3."],
    content=[
        "First item",
        "Second item",
        " ".join(lorem_ipsum(30)),
    ])
msp.add_mtext(str(editor), attribs)
```

**Numbered List:**

1. First item
2. Second item
3. Lorem ipsum dolor sit amet, consetetur sadipscing elitr, sed diam nonumy eirmod tempor invidunt ut labore et dolore magna aliquyam erat, sed diam voluptua. At vero eos et accusam et

## Stacked Text

MText supports stacked text (fractions) as a single inline code, which means it is not possible to change any property inside the fraction. This example shows a fraction with scaled down text height, placed in a group to revert the text height afterwards:

```
editor = MTextEditor("Stacked text:" + NP)

stack = MTextEditor().scale_height(0.6).stack("1", "2", "^")
editor.append("over: ").group(str(stack)).append(NP)

stack = MTextEditor().scale_height(0.6).stack("1", "2", "/")
editor.append("fraction: ").group(str(stack)).append(NP)

stack = MTextEditor().scale_height(0.6).stack("1", "2", "#")
editor.append("slanted: ").group(str(stack)).append(NP)

# Additional formatting in numerator and denominator is not supported
# by AutoCAD or BricsCAD, switching the color inside the stacked text
# to red does not work:
numerator = MTextEditor().color("red").append("1")
stack = MTextEditor().scale_height(0.6).stack(str(numerator), "2", "#")
editor.append("color red: ").group(str(stack)).append(NP)

msp.add_mtext(str(editor), attribs)
```



### See also:

- `MTextEditor` example code on [github](#).
- Documentation of `MTextEditor`

## 6.5.8 Tutorial for Spline

Background information about B-spline at [Wikipedia](#).

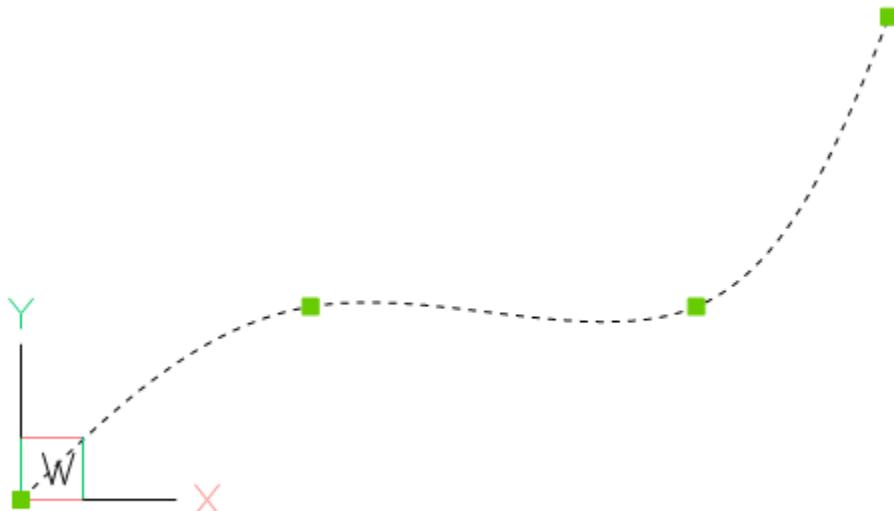
## Splines from fit points

Splines can be defined by fit points only, this means the curve goes through all given fit points. AutoCAD and BricsCAD generates required control points and knot values by itself, if only fit points are present.

Create a simple spline:

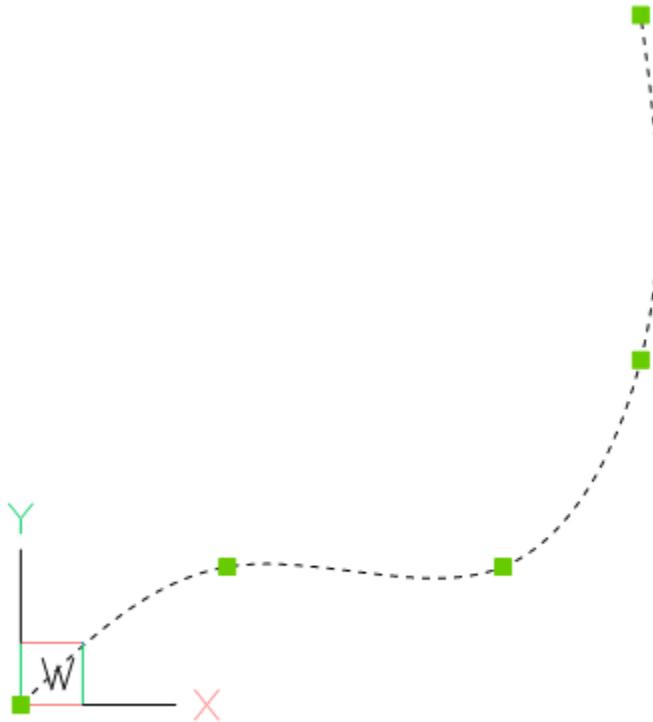
```
doc = ezdxf.new('R2000')

fit_points = [(0, 0, 0), (750, 500, 0), (1750, 500, 0), (2250, 1250, 0)]
msp = doc.modelspace()
spline = msp.add_spline(fit_points)
```



Append a fit point to a spline:

```
# fit_points, control_points, knots and weights are list-like containers:
spline.fit_points.append((2250, 2500, 0))
```



You can set additional *control points*, but if they do not fit the auto-generated AutoCAD values, they will be ignored and don't mess around with `knot` values.

Solve problems of incorrect values after editing a spline generated by AutoCAD:

```
doc = ezdxf.readfile("AutoCAD_generated.dxf")

msp = doc.modelspace()
spline = msp.query('SPLINE').first

# fit_points, control_points, knots and weights are list-like objects:
spline.fit_points.append((2250, 2500, 0))
```

As far as I have tested, this approach works without complaints from AutoCAD, but for the case of problems remove invalid data:

```
# current control points do not match spline defined by fit points
spline.control_points = []

# count of knots is not correct:
# count of knots = count of control points + degree + 1
spline.knots = []

# same for weights, count of weights == count of control points
spline.weights = []
```

## Splines by control points

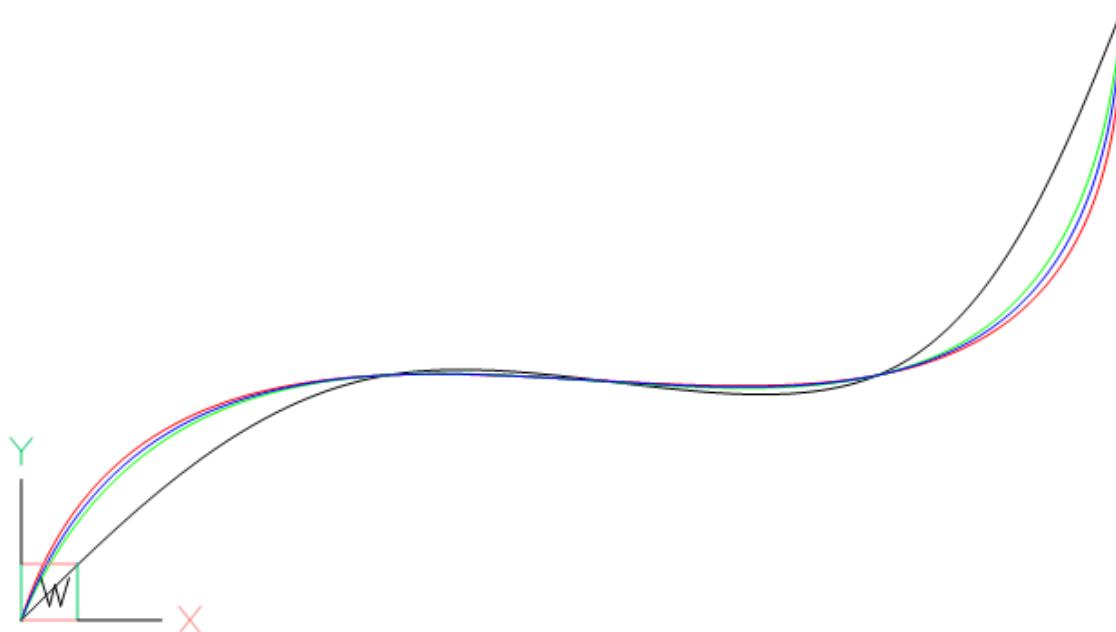
To create splines from fit points is the easiest way to create splines, but this method is also the least accurate, because a spline is defined by control points and knot values, which are generated for the case of a definition by fit points, and the worst fact is that for every given set of fit points exist an infinite number of possible splines as solution.

AutoCAD (and BricsCAD also) uses an proprietary algorithm to generate control points and knot values from fit points, which differs from the well documented [Global Curve Interpolation](#). Therefore splines generated from fit points by `ezdxf` do not match splines generated by AutoCAD (BricsCAD).

To ensure the same spline geometry for all CAD applications, the spline has to be defined by control points. The method `add_spline_control_frame()` adds a spline trough fit points by calculating the control points by the [Global Curve Interpolation](#) algorithm. There is also a low level function `ezdxf.math.global_bspline_interpolation()` which calculates the control points from fit points.

```
msp.add_spline_control_frame(fit_points, method='uniform', dxfattribs={'color': 1})
msp.add_spline_control_frame(fit_points, method='chord', dxfattribs={'color': 3})
msp.add_spline_control_frame(fit_points, method='centripetal', dxfattribs={'color': 5}
    ↵)
```

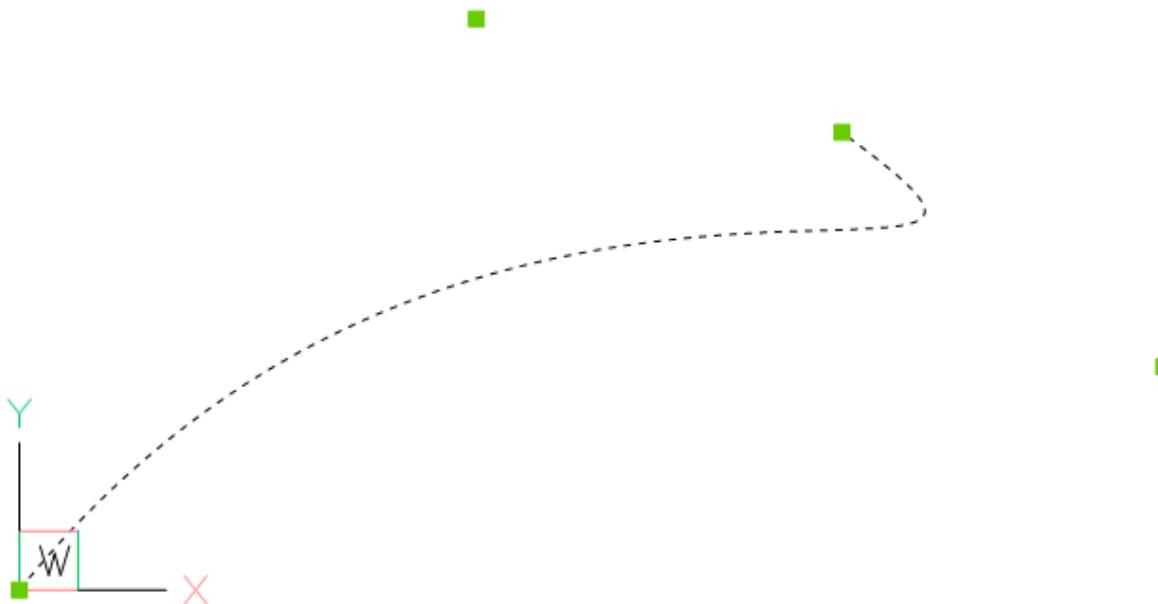
- black curve: AutoCAD/BricsCAD spline generated from fit points
- red curve: spline curve interpolation, “uniform” method
- green curve: spline curve interpolation, “chord” method
- blue curve: spline curve interpolation, “centripetal” method



## Open Spline

Add and open (clamped) spline defined by control points with the method `add_open_spline()`. If no knot values are given, an open uniform knot vector will be generated. A clamped B-spline starts at the first control point and ends at the last control point.

```
control_points = [(0, 0, 0), (1250, 1560, 0), (3130, 610, 0), (2250, 1250, 0)]
msp.add_open_spline(control_points)
```

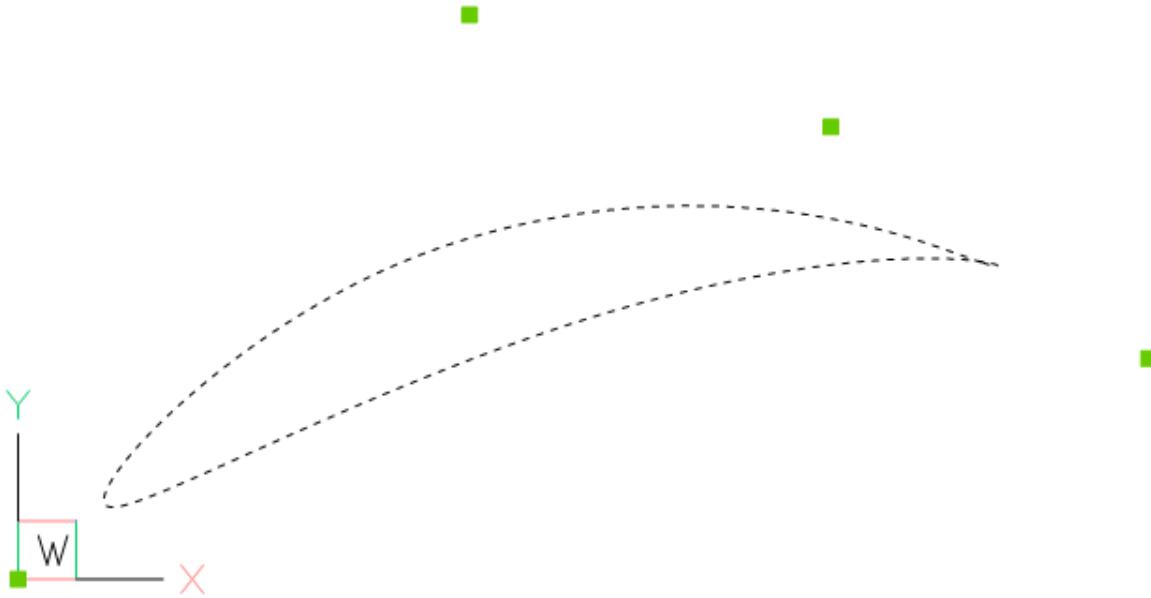


## Rational Spline

Rational B-splines have a weight for every control point, which can raise or lower the influence of the control point, default weight = 1, to lower the influence set a weight < 1 to raise the influence set a weight > 1. The count of weights has to be always equal to the count of control points.

Example to raise the influence of the first control point:

```
msp.add_closed_rational_spline(control_points, weights=[3, 1, 1, 1])
```



## Spline properties

Check if spline is a closed curve or close/open spline, for a closed spline the last point is connected to the first point:

```
if spline.closed:
    # this spline is closed
    pass

# close spline
spline.closed = True

# open spline
spline.closed = False
```

Set start- and end tangent for splines defined by fit points:

```
spline.dxf.start_tangent = (0, 1, 0)  # in y-axis
spline.dxf.end_tangent = (1, 0, 0)  # in x-axis
```

Get data count as stored in DXF file:

```
count = spline.dxf.n_fit_points
count = spline.dxf.n_control_points
count = spline.dxf.n_knots
```

Get data count of real existing data:

```
count = spline.fit_point_count
count = spline.control_point_count
count = spline.knot_count
```

## 6.5.9 Tutorial for Polyface

The `Polyface` entity represents a 3D mesh build of vertices and faces and is just an extended POLYLINE entity with a complex VERTEX structure. The `Polyface` entity was used in DXF R12 and older DXF versions and is still supported by newer DXF versions. The new `Mesh` entity stores the same data much more efficient but requires DXF R2000 or newer. The `Polyface` entity supports only triangles and quadrilaterals as faces the `Mesh` entity supports n-gons.

Its recommended to use the `MeshBuilder` objects to create 3D meshes and render them as POLYFACE entities by the `render_polymesh()` method into a layout:

```
import ezdxf
from ezdxf import colors
from ezdxf.gfxattribs import GfxAttribs
from ezdxf.render import forms

cube = forms.cube().scale_uniform(10).subdivide(2)
red = GfxAttribs(color=colors.RED)
green = GfxAttribs(color=colors.GREEN)
blue = GfxAttribs(color=colors.BLUE)

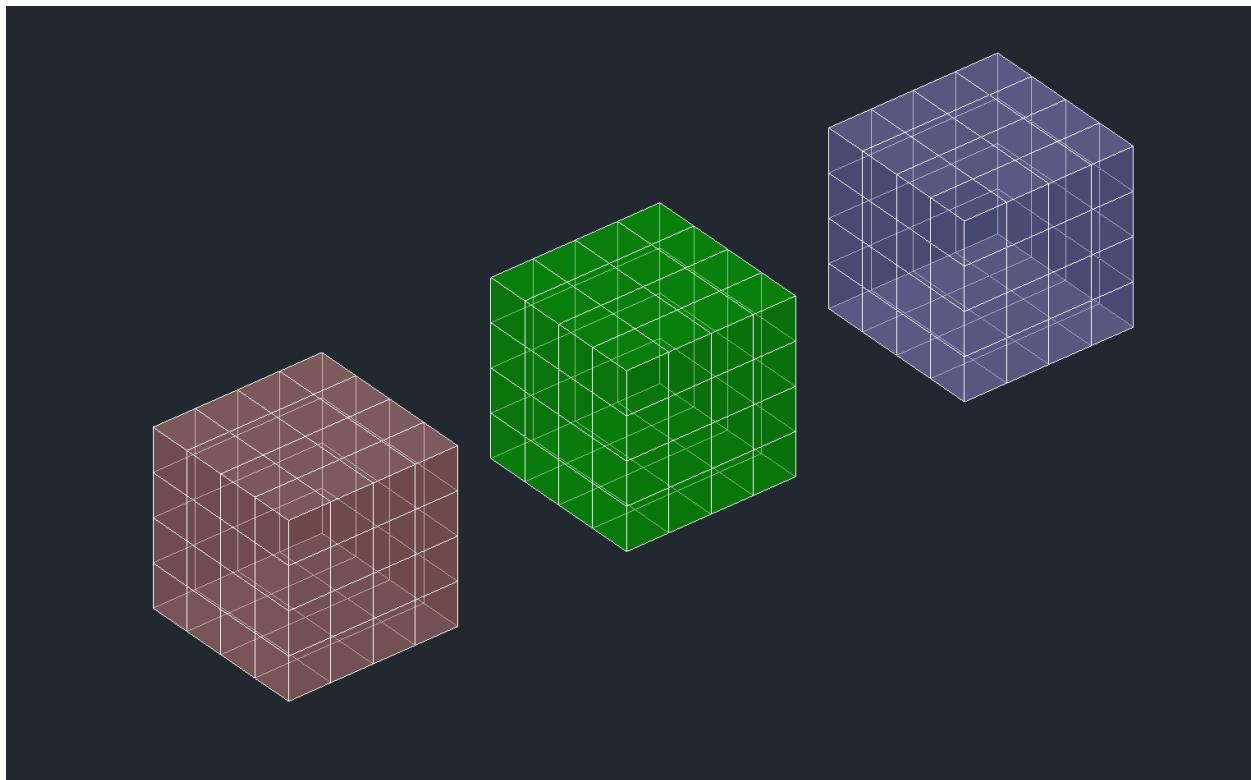
doc = ezdxf.new()
msp = doc.modelspace()

# render as MESH entity
cube.render(msp, dxfattribs=red)
cube.translate(20)

# render as POLYFACE a.k.a. POLYLINE entity
cube.render_polyface(msp, dxfattribs=green)
cube.translate(20)

# render as unconnected 3DFACE entities
cube.render_3dfaces(msp, dxfattribs=blue)

doc.saveas("meshes.dxf")
```



**Warning:** If the mesh contains n-gons the render methods for POLYFACE and 3DFACES subdivides the n-gons into triangles, which does **not** work for concave faces.

The usage of the `MeshBuilder` object is also recommended for inspecting Polyface entities:

- `MeshBuilder.vertices` is a sequence of 3D points as `ezdxf.math.Vec3` objects
- a face in `MeshBuilder.faces` is a sequence of indices into the `MeshBuilder.vertices` sequence

```
import ezdxf
from ezdxf.render import MeshBuilder

def process(mesh):
    # vertices is a sequence of 3D points
    vertices = mses.vertices
    # a face is a sequence of indices into the vertices sequence
    faces = mesh.faces
    ...

doc = ezdxf.readfile("meshes.dxf")
msp = doc.modelspace()
for polyline in msp.query("POLYLINE"):
    if polyline.is_poly_face_mesh:
        mesh = MeshBuilder.from_polyface(polyline)
        process(mesh)
```

## 6.5.10 Tutorial for Mesh

Create a cube mesh by direct access to base data structures:

```
import ezdxf

# 8 corner vertices
cube_vertices = [
    (0, 0, 0),
    (1, 0, 0),
    (1, 1, 0),
    (0, 1, 0),
    (0, 0, 1),
    (1, 0, 1),
    (1, 1, 1),
    (0, 1, 1),
]

# 6 cube faces
cube_faces = [
    [0, 1, 2, 3],
    [4, 5, 6, 7],
    [0, 1, 5, 4],
    [1, 2, 6, 5],
    [3, 2, 6, 7],
    [0, 3, 7, 4]
]

# MESH requires DXF R2000 or later
doc = ezdxf.new("R2000")
msp = doc.modelspace()
mesh = msp.add_mesh()
# do not subdivide cube, 0 is the default value
mesh.dxf.subdivision_levels = 0
with mesh.edit_data() as mesh_data:
    mesh_data.vertices = cube_vertices
    mesh_data.faces = cube_faces

doc.saveas("cube_mesh_1.dxf")
```

Create a cube mesh by assembling single faces and the `edit_data()` context manager of the `Mesh` class, using the helper class `MeshData`:

```
import ezdxf

# 8 corner vertices
p = [
    (0, 0, 0),
    (1, 0, 0),
    (1, 1, 0),
    (0, 1, 0),
    (0, 0, 1),
    (1, 0, 1),
    (1, 1, 1),
    (0, 1, 1),
]
```

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```
# MESH requires DXF R2000 or later
doc = ezdxf.new("R2000")
msp = doc.modelspace()
mesh = msp.add_mesh()

with mesh.edit_data() as mesh_data:
    mesh_data.add_face([p[0], p[1], p[2], p[3]])
    mesh_data.add_face([p[4], p[5], p[6], p[7]])
    mesh_data.add_face([p[0], p[1], p[5], p[4]])
    mesh_data.add_face([p[1], p[2], p[6], p[5]])
    mesh_data.add_face([p[3], p[2], p[6], p[7]])
    mesh_data.add_face([p[0], p[3], p[7], p[4]])
    # optional call optimize(): minimizes the vertex count
    mesh_data.optimize()

doc.saveas("cube_mesh_2.dxf")
```

## 6.5.11 Tutorial for Hatch

### Create hatches with one boundary path

The simplest form of the `Hatch` entity has one polyline path with only straight lines as boundary path:

```
import ezdxf

# hatch requires DXF R2000 or later
doc = ezdxf.new("R2000")
msp = doc.modelspace()

# by default a solid fill hatch with fill color=7 (white/black)
hatch = msp.add_hatch(color=2)

# every boundary path is a 2D element
# vertex format for the polyline path is: (x, y[, bulge])
# there are no bulge values in this example
hatch.paths.add_polyline_path(
    [(0, 0), (10, 0), (10, 10), (0, 10)], is_closed=True
)

doc.saveas("solid_hatch_polyline_path.dxf")
```

But like all polyline entities the polyline path can also have bulge values:

```
import ezdxf

# hatch requires the DXF R2000 or later
doc = ezdxf.new("R2000")
msp = doc.modelspace()

# by default a solid fill hatch with fill color=7 (white/black)
hatch = msp.add_hatch(color=2)

# every boundary path is a 2D element
```

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```
# vertex format for the polyline path is: (x, y[, bulge])
# bulge value 1 = an arc with diameter=10 (= distance to next vertex * bulge value)
# bulge value > 0 ... arc is right of line
# bulge value < 0 ... arc is left of line
hatch.paths.add_polyline_path(
    [(0, 0, 1), (10, 0), (10, 10, -0.5), (0, 10)], is_closed=True
)

doc.saveas("solid_hatch_polyline_path_with_bulge.dxf")
```

The most flexible way to define a boundary path is the edge path. An edge path can have multiple edges and each edge can be one of the following elements:

- line EdgePath.add\_line()
- arc EdgePath.add\_arc()
- ellipse EdgePath.add\_ellipse()
- spline EdgePath.add\_spline()

Create a solid hatch with an edge path (ellipse) as boundary path:

```
import ezdxf

# hatch requires the DXF R2000 or later
doc = ezdxf.new("R2000")
msp = doc.modelspace()

# important: major axis >= minor axis (ratio <= 1.)
# minor axis length = major axis length * ratio
msp.add_ellipse((0, 0), major_axis=(0, 10), ratio=0.5)

# by default a solid fill hatch with fill color=7 (white/black)
hatch = msp.add_hatch(color=2)

# every boundary path is a 2D element
edge_path = hatch.paths.add_edge_path()
# each edge path can contain line, arc, ellipse and spline elements
# important: major axis >= minor axis (ratio <= 1.)
edge_path.add_ellipse((0, 0), major_axis=(0, 10), ratio=0.5)

doc.saveas("solid_hatch_ellipse.dxf")
```

## Create hatches with multiple boundary paths (islands)

The DXF attribute `hatch_style` defines the island detection style:

0	nested - altering filled and unfilled areas
1	outer - area between <i>external</i> and <i>outermost</i> path is filled
2	ignore - <i>external</i> path is filled

```
hatch = msp.add_hatch(
    color=1,
    dxftattribs={
```

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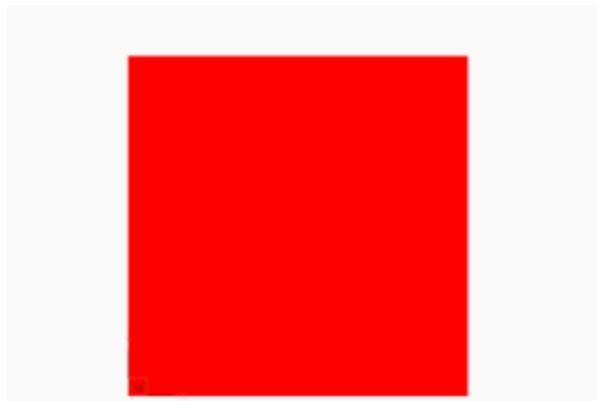
```

    "hatch_style": ezdxf.const.HATCH_STYLE_NESTED,
    # 0 = nested: ezdxf.const.HATCH_STYLE_NESTED
    # 1 = outer: ezdxf.const.HATCH_STYLE_OUTERMOST
    # 2 = ignore: ezdxf.const.HATCH_STYLE_IGNORE
},
)

# The first path has to set flag: 1 = external
# flag const.BOUNDARY_PATH_POLYLINE is added (OR) automatically
hatch.paths.add_polyline_path(
    [(0, 0), (10, 0), (10, 10), (0, 10)],
    is_closed=True,
    flags=ezdxf.const.BOUNDARY_PATH_EXTERNAL,
)

```

This is also the result for all 4 paths and `hatch_style` set to 2 (ignore).

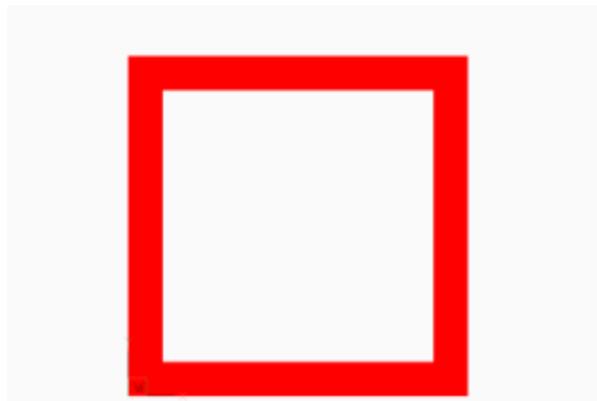


```

# The second path has to set flag: 16 = outermost
hatch.paths.add_polyline_path(
    [(1, 1), (9, 1), (9, 9), (1, 9)],
    is_closed=True,
    flags=ezdxf.const.BOUNDARY_PATH_OUTERMOST,
)

```

This is also the result for all 4 paths and `hatch_style` set to 1 (outer).



```

# The third path has to set flag: 0 = default
hatch.paths.add_polyline_path(

```

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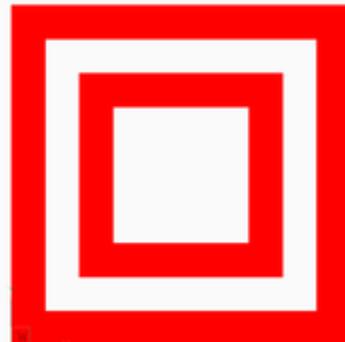
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```
[ (2, 2), (8, 2), (8, 8), (2, 8)],
is_closed=True,
flags=ezdxf.const.BOUNDARY_PATH_DEFAULT,
)
```



```
# The forth path has to set flag: 0 = default, and so on
hatch.paths.add_polyline_path(
    [(3, 3), (7, 3), (7, 7), (3, 7)],
    is_closed=True,
    flags=ezdxf.const.BOUNDARY_PATH_DEFAULT,
)

doc.saveas(OUTDIR / "solid_hatch_islands_04.dxf")
```



The expected result of combinations of various `hatch_style` values and paths `flags`, or the handling of overlapping paths is not documented by the DXF reference, so don't ask me, ask Autodesk or just try it by yourself and post your experience in the forum.

### Example for Edge Path Boundary

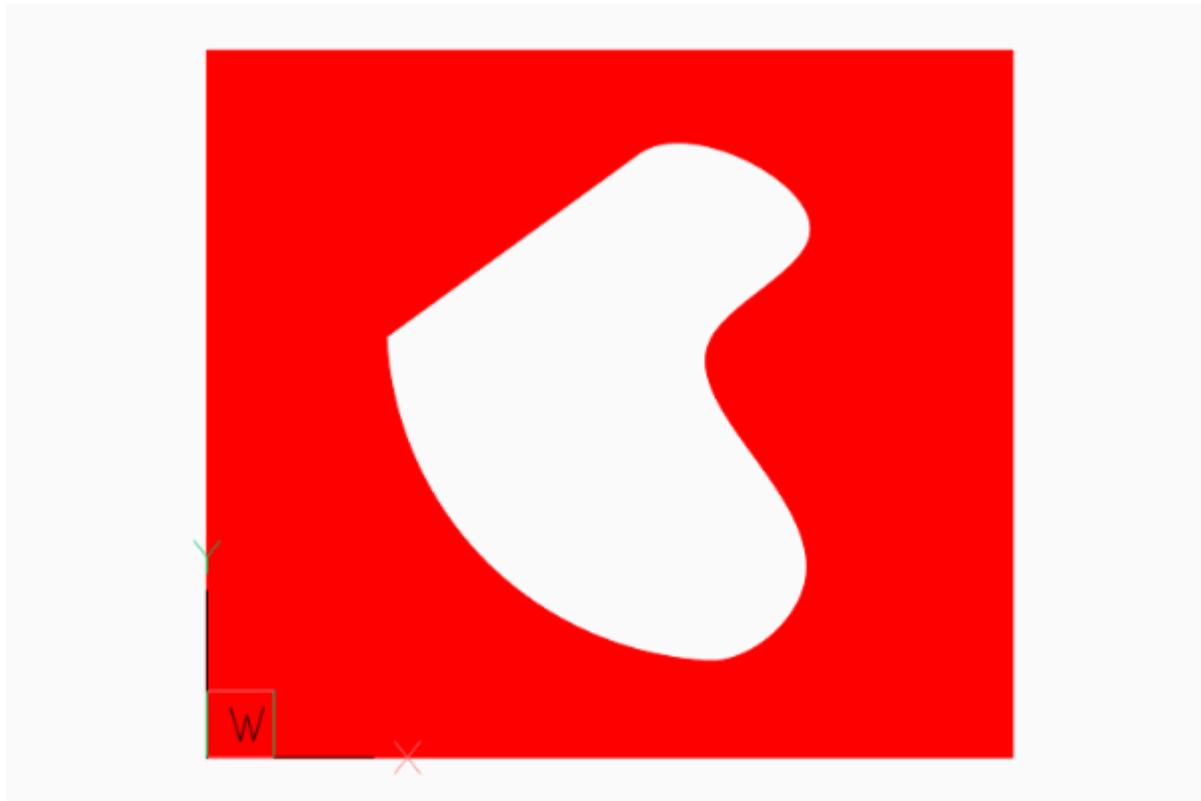
```
hatch = msp.add_hatch(color=1)

# 1. polyline path
hatch.paths.add_polyline_path(
    [
        (240, 210, 0),
```

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```
(0, 210, 0),
(0, 0, 0.0),
(240, 0, 0),
],
is_closed=1,
flags=ezdxf.const.BOUNDARY_PATH_EXTERNAL,
)
# 2. edge path
edge_path = hatch.paths.add_edge_path(flags=ezdxf.const.BOUNDARY_PATH_OUTERMOST)
edge_path.add_spline(
    control_points=[
        (126.658105895725, 177.0823706957212),
        (141.5497003747484, 187.8907860433995),
        (205.8997365206943, 154.7946313459515),
        (113.0168862297068, 117.8189380884978),
        (202.9816918983783, 63.17222935389572),
        (157.363511042264, 26.4621294342132),
        (144.8204003260554, 28.4383294369643),
    ],
    knot_values=[
        0.0,
        0.0,
        0.0,
        0.0,
        55.20174685732758,
        98.33239645153571,
        175.1126541251052,
        213.2061566683142,
        213.2061566683142,
        213.2061566683142,
        213.2061566683142,
    ],
)
edge_path.add_arc(
    center=(152.6378550678883, 128.3209356351659),
    radius=100.1880612627354,
    start_angle=94.4752130054052,
    end_angle=177.1345242028005,
)
edge_path.add_line(
    (52.57506282464041, 123.3124200796114),
    (126.658105895725, 177.0823706957212),
)
```



## Associative Boundary Paths

A HATCH entity can be associative to a base geometry, which means if the base geometry is edited in a CAD application the HATCH get the same modification. Because *ezdxf* is **not** a CAD application, this association is **not** maintained nor verified by *ezdxf*, so if you modify the base geometry afterwards the geometry of the boundary path is not updated and no verification is done to check if the associated geometry matches the boundary path, this opens many possibilities to create invalid DXF files: USE WITH CARE.

This example associates a LWPOLYLINE entity to the hatch created from the LWPOLYLINE vertices:

```
# Create base geometry
lwpolyline = msp.add_lwpolyline(
    [(0, 0, 0), (10, 0, 0.5), (10, 10, 0), (0, 10, 0)],
    format="xyb",
    close=True,
)

hatch = msp.add_hatch(color=1)
path = hatch.paths.add_polyline_path(
    # get path vertices from associated LWPOLYLINE entity
    lwpolyline.get_points(format="xyb"),
    # get closed state also from associated LWPOLYLINE entity
    is_closed=lwpolyline.closed,
)

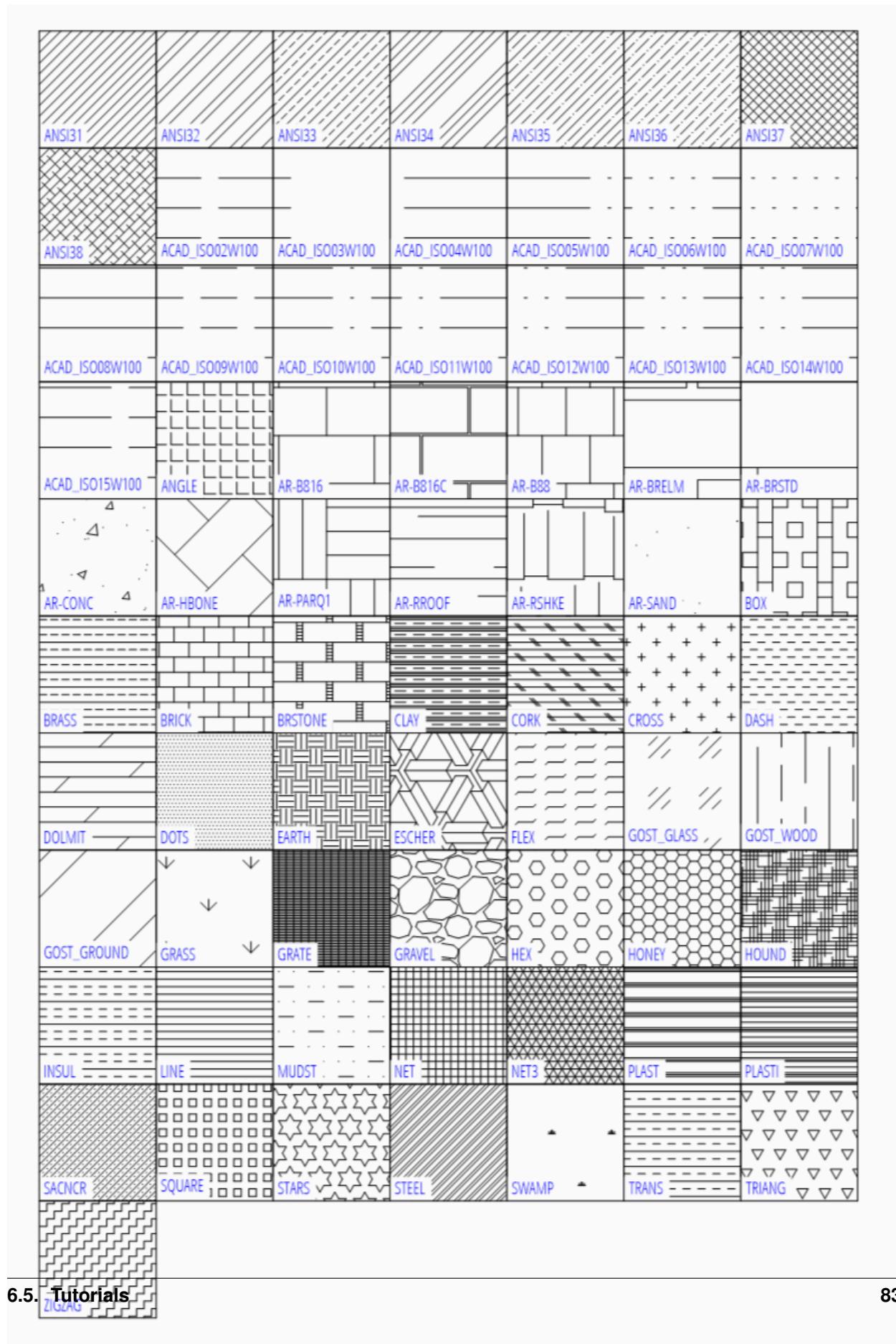
# Set association between boundary path and LWPOLYLINE
hatch.associate(path, [lwpolyline])
```

An EdgePath needs associations to all geometry entities forming the boundary path.

## Predefined Hatch Pattern

Use predefined hatch pattern by name:

```
hatch.set_pattern_fill("ANSI31", scale=0.5)
```



## Create hatches with gradient fill

TODO

## 6.5.12 Tutorial for Hatch Pattern Definition

TODO

## 6.5.13 Tutorial for Image and ImageDef

Insert a raster image into a DXF document, the raster image is NOT embedded in the DXF file:

```
import ezdxf

# The IMAGE entity requires the DXF R2000 format or later.
doc = ezdxf.new("R2000")

# The IMAGEDEF entity is like a block definition, it just defines the image.
my_image_def = doc.add_image_def(
    filename="mycat.jpg", size_in_pixel=(640, 360)
)

msp = doc.modelspace()
# The IMAGE entity is like the INSERT entity, it's just an image reference,
# and there can be multiple references to the same picture in a DXF document.

# 1st image reference
msp.add_image(
    insert=(2, 1),
    size_in_units=(6.4, 3.6),
    image_def=my_image_def,
    rotation=0
)
# 2nd image reference
msp.add_image(
    insert=(4, 5),
    size_in_units=(3.2, 1.8),
    image_def=my_image_def,
    rotation=30
)

# Get existing image definitions from the OBJECTS section:
image_defs = doc.objects.query("IMAGEDEF")

doc.saveas("dxf_with_cat.dxf")
```

## 6.5.14 Tutorial for Underlay and UnderlayDefinition

Insert a PDF, DWF, DWFX or DGN file as drawing underlay, the underlay file is NOT embedded into the DXF file:

```
import ezdxf
```

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```
doc = ezdxf.new('AC1015') # underlay requires the DXF R2000 format or later
my_underlay_def = doc.add_underlay_def(filename='my_underlay.pdf', name='1')
# The (PDF)DEFINITION entity is like a block definition, it just defines the underlay
# 'name' is misleading, because it defines the page/sheet to be displayed
# PDF: name is the page number to display
# DGN: name='default' ???
# DWF: ????

msp = doc.modelspace()
# add first underlay
msp.add_underlay(my_underlay_def, insert=(2, 1, 0), scale=0.05)
# The (PDF)UNDERLAY entity is like the INSERT entity, it creates an underlay_
# reference,
# and there can be multiple references to the same underlay in a drawing.

msp.add_underlay(my_underlay_def, insert=(4, 5, 0), scale=.5, rotation=30)

# get existing underlay definitions, Important: UNDERLAYDEFS resides in the objects_
# section
pdf_defs = doc.objects.query('PDFDEFINITION') # get all pdf underlay defs in drawing

doc.saveas("dxf_with_underlay.dxf")
```

## 6.5.15 Tutorial for Linetypes

## Simple line type example:

You can define your own linetypes. A linetype definition has a name, a description and line pattern elements:

```
elements = [total_pattern_length, elem1, elem2, ...]
```

**total\_pattern\_length** Sum of all linetype elements (absolute values)

**elem** if elem > 0 it is a line, if el

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Setup some predefined linetypes:

```
for name, desc, pattern in linetypes():
    if name not in doc.linetypes:
        doc.linetypes.add(
            name=name,
            pattern= pattern,
            description=desc,
        )
```

## Check Available Linetypes

The linetypes object supports some standard Python protocols:

```
# iteration
print("available linetypes:")
for lt in doc.linetypes:
    print(f"{lt.dxf.name}: {lt.dxf.description}")

# check for existing linetype
if "DOTTED" in doc.linetypes:
    pass

count = len(doc.linetypes) # total count of linetypes
```

## Removing Linetypes

**Warning:** Ezdxf does not check if a linetype is still in use and deleting a linetype which is still in use generates an invalid DXF file. The audit process `audit()` of the DXF document removes linetype attributes referencing non existing linetypes.

You can delete a linetype:

```
doc.layers.remove("DASHED")
```

This just removes the linetype definition, the `linetype` attribute of DXF entities may still refer the removed linetype definition “DASHED” and AutoCAD will not open DXF files including undefined linetypes.

## 6.5.16 Tutorial for Complex Linetypes

In DXF R13 Autodesk introduced complex linetypes, containing TEXT or SHAPES in line types.

Complex linetype example with text:

Complex line type example with shapes:

For easy usage the pattern string for complex line types is mostly the same string as the pattern definition strings in AutoCAD “.lin” files.

Example for complex line type TEXT:

```
doc = ezdxf.new("R2018") # DXF R13 or later is required

doc.linetypes.add(
    name="GASLEITUNG2",
    # linetype definition string from acad.lin:
    pattern='A,.5,-.2,[ "GAS", STANDARD, S=.1, U=0.0, X=-0.1, Y=-.05],-.25',
    description= "Gasleitung2 ----GAS----GAS----GAS----GAS----GAS----",
    length=1, # required for complex line types
)}
```

The pattern always starts with an “A”, the following float values have the same meaning as for simple linetypes, a value  $> 0$  is a line, a value  $< 0$  is a gap, and a 0 is a point, the opening square bracket “[” starts the complex part of the linetype pattern.

The text after the “[” defines the complex linetype:

- A text in quotes (e.g. “GAS”) defines a *complex TEXT linetype* and represents the pattern text itself.
- A text without quotes is a SHAPE name (in “.lin” files) and defines a *complex SHAPE linetype*. Ezdxf can not translate this SHAPE name from the “.lin” file into the required shape file index, so \*YOU have to translate this SHAPE name into the shape file index, e.g. saving the file with AutoCAD as DXF and searching for the DXF linetype definition, see example below and the DXF Internals: [LTYPE Table](#).

For *complex TEXT linetypes* the second parameter is the text style, for *complex SHAPE linetypes* the second parameter is the shape file name, the shape file has to be in the same directory as the DXF file or in one of the CAD application support paths.

The meaning of the following complex linetype parameters are shown in the table below:

S	scaling factor, always $> 0$ , if S=0 the TEXT or SHAPE is not visible
R or U	rotation relative to the line direction
X	x-direction offset (along the line)
Y	y-direction offset (perpendicular to the line)

These parameters are case insensitive and the closing square bracket “]” ends the complex part of the linetype pattern.

The fine tuning of this parameters is a try an error process, for *complex TEXT linetypes* the scaling factor (e.g. the STANDARD text style) sets the text height (e.g. “S=0.1” sets the text height to 0.1 units), by shifting in y-direction by

half of the scaling factor, the text is vertically centered to the line. For the x-direction it seems to be a good practice to place a gap in front of the text and after the text, find x shifting value and gap sizes by try and error. The overall length is at least the sum of all line and gap definitions (absolute values).

Example for complex line type SHAPE:

```
doc.linetypes.add("GRENZE2",
    # linetype definition in acad.lin:
    # A,.25,-.1,[BOX,ltypeshp.shx,x=-.1,s=.1],-.1,1
    # replacing BOX by shape index 132 (got index from an AutoCAD file),
    # ezdxf can't get shape index from ltypeshp.shx
    pattern="A,.25,-.1,[132,ltypeshp.shx,x=-.1,s=.1],-.1,1",
    description="Grenze eckig ----[]-----[]----[ ]----[ ]---",
    length= 1.45, # required for complex line types
)}
```

Complex line types with shapes only work if the associated shape file (e. g. ltypeshp.shx) and the DXF file are in the same directory or the shape file is placed in one of the CAD application support folders.

### 6.5.17 Tutorial for OCS/UCS Usage

For OCS/UCS usage is a basic understanding of vectors required, for a brush up, watch the YouTube tutorials of [3Blue1Brown](#) about [Linear Algebra](#).

Second read the [Coordinate Systems](#) introduction please.

#### See also:

The free online book [3D Math Primer for Graphics and Game Development](#) is a very good resource for learning vector math and other graphic related topics, it is easy to read for beginners and especially targeted to programmers.

For [WCS](#) there is not much to say as, it is what it is: the main world coordinate system, and a drawing unit can have any real world unit you want. Autodesk added some mechanism to define a scale for dimension and text entities, but because I am not an AutoCAD user, I am not familiar with it, and further more I think this is more an AutoCAD topic than a DXF topic.

#### Object Coordinate System (OCS)

The [OCS](#) is used to place planar 2D entities in 3D space. **ALL** points of a planar entity lay in the same plane, this is also true if the plane is located in 3D space by an OCS. There are three basic DXF attributes that gives a 2D entity its spatial form.

#### Extrusion

The extrusion vector defines the OCS, it is a normal vector to the base plane of a planar entity. This *base plane* is always located in the origin of the [WCS](#). But there are some entities like [Ellipse](#), which have an extrusion vector, but do not establish an OCS. For this entities the extrusion vector defines only the extrusion direction and thickness defines the extrusion distance, but all other points in WCS.

#### Elevation

The elevation value defines the z-axis value for all points of a planar entity, this is an OCS value, and defines the distance of the entity plane from the *base plane*.

This value exists only in output from DXF versions prior to R11 as separated DXF attribute (group code 38). In DXF R12 and later, the elevation value is supplied as z-axis value of each point. But as always in DXF, this simple rule does not apply to all entities: [LWPolyline](#) and [Hatch](#) have an DXF attribute `elevation`, where the z-axis of this point is the elevation height and the x-axis = y-axis = 0.

## Thickness

Defines the extrusion distance for an entity.

---

**Note:** There is a new edition of this tutorial using UCS based transformation, which are available in *ezdxf* v0.11 and later: [Tutorial for UCS Based Transformations](#)

This edition shows the **hard way** to accomplish the transformations by low level operations.

---

## Placing 2D Circle in 3D Space

The colors for axis follow the AutoCAD standard:

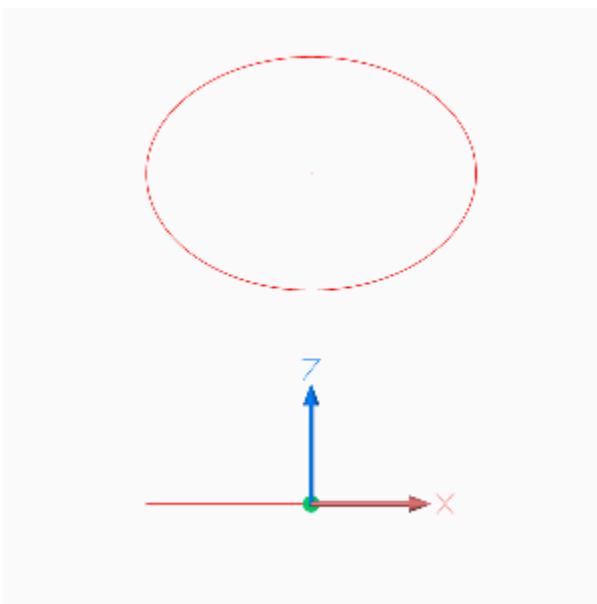
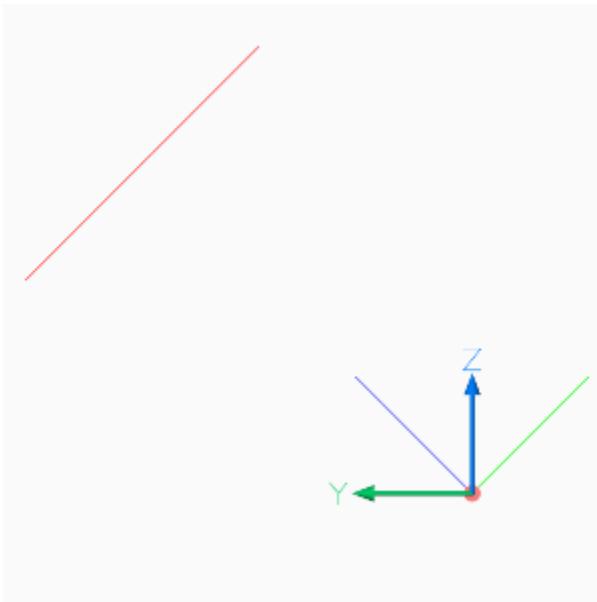
- red is x-axis
- green is y-axis
- blue is z-axis

```
import ezdxf
from ezdxf.math import OCS

doc = ezdxf.new('R2010')
msp = doc.modelspace()

# For this example the OCS is rotated around x-axis about 45 degree
# OCS z-axis: x=0, y=1, z=1
# extrusion vector must not normalized here
ocs = OCS((0, 1, 1))
msp.add_circle(
    # You can place the 2D circle in 3D space
    # but you have to convert WCS into OCS
    center=ocs.from_wcs((0, 2, 2)),
    # center in OCS: (0.0, 0.0, 2.82842712474619)
    radius=1,
    dxftattribs={
        # here the extrusion vector should be normalized,
        # which is granted by using the ocs.uz
        'extrusion': ocs.uz,
        'color': 1,
    })
# mark center point of circle in WCS
msp.add_point((0, 2, 2), dxftattribs={'color': 1})
```

The following image shows the 2D circle in 3D space in AutoCAD *Left* and *Front* view. The blue line shows the OCS z-axis (extrusion direction), elevation is the distance from the origin to the center of the circle in this case 2.828, and you see that the x- and y-axis of OCS and WCS are not aligned.



## Placing LWPolyline in 3D Space

For simplicity of calculation I use the `UCS` class in this example to place a 2D pentagon in 3D space.

```
# The center of the pentagon should be (0, 2, 2), and the shape is
# rotated around x-axis about 45 degree, to accomplish this I use an
# UCS with z-axis (0, 1, 1) and an x-axis parallel to WCS x-axis.
ucs = UCS(
    origin=(0, 2, 2), # center of pentagon
    ux=(1, 0, 0), # x-axis parallel to WCS x-axis
    uz=(0, 1, 1), # z-axis
)
# calculating corner points in local (UCS) coordinates
points = [Vec3.from_deg_angle((360 / 5) * n) for n in range(5)]
```

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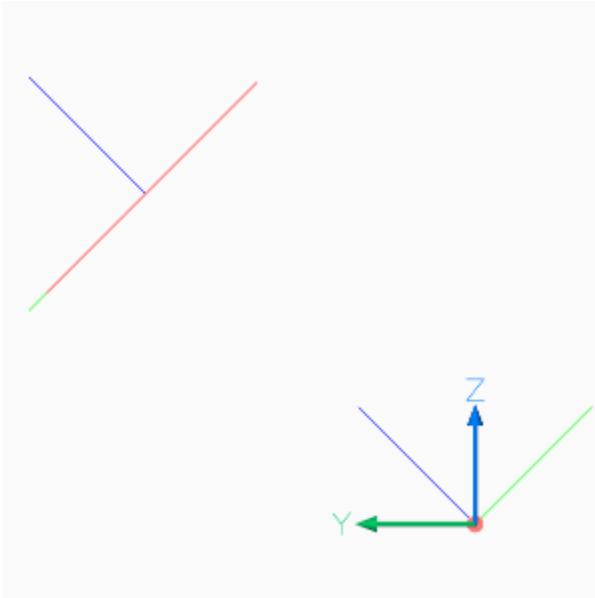
```
# converting UCS into OCS coordinates
ocs_points = list(ucs.points_to_ocs(points))

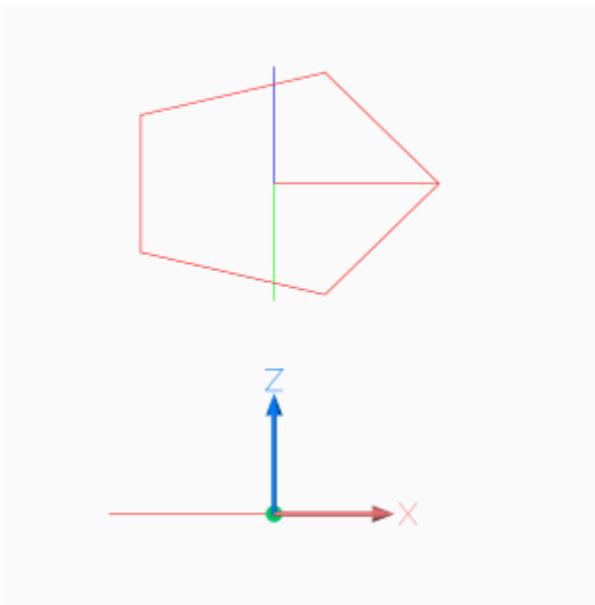
# LWPOLYLINE accepts only 2D points and has an separated DXF attribute elevation.
# All points have the same z-axis (elevation) in OCS!
elevation = ocs_points[0].z

msp.add_lwpolyline(
    points=ocs_points,
    format='xy', # ignore z-axis
    close=True,
    dxfattribs={
        'elevation': elevation,
        'extrusion': ucs.uz,
        'color': 1,
    })
}
```

The following image shows the 2D pentagon in 3D space in AutoCAD *Left*, *Front* and *Top* view. The three lines from the center of the pentagon show the UCS, the three colored lines in the origin show the OCS the white lines in the origin show the WCS.

The z-axis of the UCS and the OCS show the same direction (extrusion direction), and the x-axis of the UCS and the WCS show the same direction. The elevation is the distance from the origin to the center of the pentagon and all points of the pentagon have the same elevation, and you see that the y- axis of UCS, OCS and WCS are not aligned.





## Using UCS to Place 3D Polyline

It is much simpler to use a 3D `Polyline` to create the 3D pentagon. The `UCS` class is handy for this example and all kind of 3D operations.

```
# Using an UCS simplifies 3D operations, but UCS definition can happen later
# calculating corner points in local (UCS) coordinates without Vec3 class
angle = math.radians(360 / 5)
corners_ucs = [(math.cos(angle * n), math.sin(angle * n), 0) for n in range(5)]

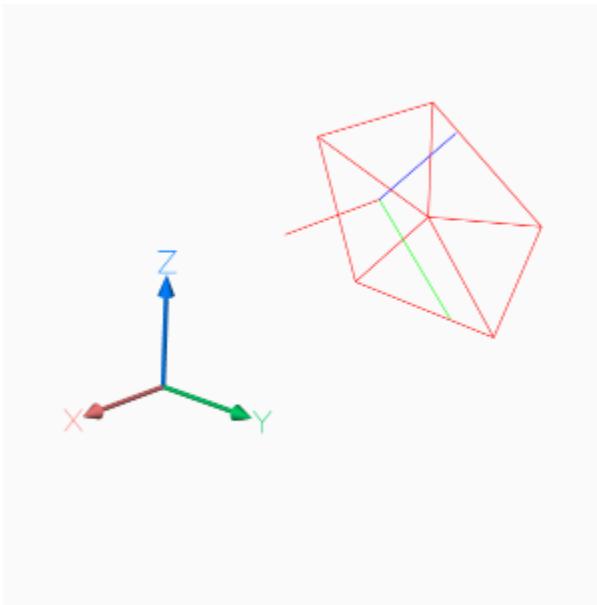
# let's do some transformations
tmatrix = Matrix44.chain( # creating a transformation matrix
    Matrix44.z_rotate(math.radians(15)), # 1. rotation around z-axis
    Matrix44.translate(0, .333, .333), # 2. translation
)
transformed_corners_ucs = tmatrix.transform_vertices(corners_ucs)

# transform UCS into WCS
ucs = UCS(
    origin=(0, 2, 2), # center of pentagon
    ux=(1, 0, 0), # x-axis parallel to WCS x-axis
    uz=(0, 1, 1), # z-axis
)
corners_wcs = list(ucs.points_to_wcs(transformed_corners_ucs))

msp.add_polyline3d(
    points=corners_wcs,
    close=True,
)

# add lines from center to corners
center_wcs = ucs.to_wcs((0, .333, .333))
for corner in corners_wcs:
    msp.add_line(center_wcs, corner, dxftattribs={'color': 1})

ucs.render_axis(msp)
```



## Placing 2D Text in 3D Space

The problem by placing text in 3D space is the text rotation, which is always counter clockwise around the OCS z-axis, and 0 degree is in direction of the positive OCS x-axis, and the OCS x-axis is calculated by the [Arbitrary Axis Algorithm](#).

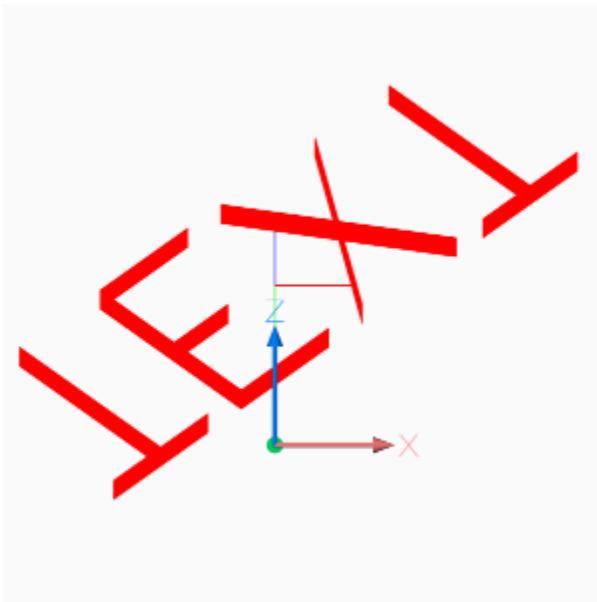
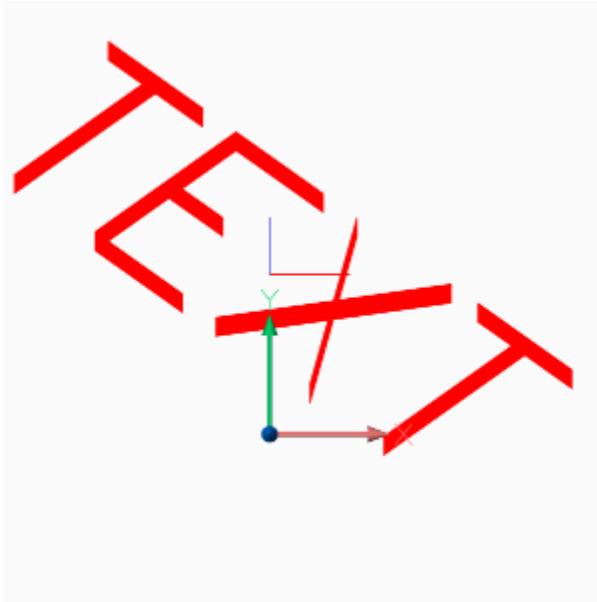
Calculate the OCS rotation angle by converting the TEXT rotation angle (in UCS or WCS) into a vector or begin with text direction as vector, transform this direction vector into OCS and convert the OCS vector back into an angle in the OCS xy-plane (see example), this procedure is available as `UCS.to_ocs_angle_deg()` or `UCS.to_ocs_angle_rad()`.

AutoCAD supports thickness for the TEXT entity only for `.shx` fonts and not for true type fonts.

```
# Thickness for text works only with shx fonts not with true type fonts
doc.styles.new('TXT', dxftattribs={'font': 'romans.shx'})

ucs = UCS(origin=(0, 2, 2), ux=(1, 0, 0), uz=(0, 1, 1))
# calculation of text direction as angle in OCS:
# convert text rotation in degree into a vector in UCS
text_direction = Vec3.from_deg_angle(-45)
# transform vector into OCS and get angle of vector in xy-plane
rotation = ucs.to_ocs(text_direction).angle_deg

text = msp.add_text(
    text="TEXT",
    dxftattribs={
        # text rotation angle in degrees in OCS
        'rotation': rotation,
        'extrusion': ucs.uz,
        'thickness': .333,
        'color': 1,
        'style': 'TXT',
    })
# set text position in OCS
text.set_pos(ucs.to_ocs((0, 0, 0)), align='MIDDLE_CENTER')
```



---

**Hint:** For calculating OCS angles from an UCS, be aware that 2D entities, like TEXT or ARC, are placed parallel to the xy-plane of the UCS.

---

### Placing 2D Arc in 3D Space

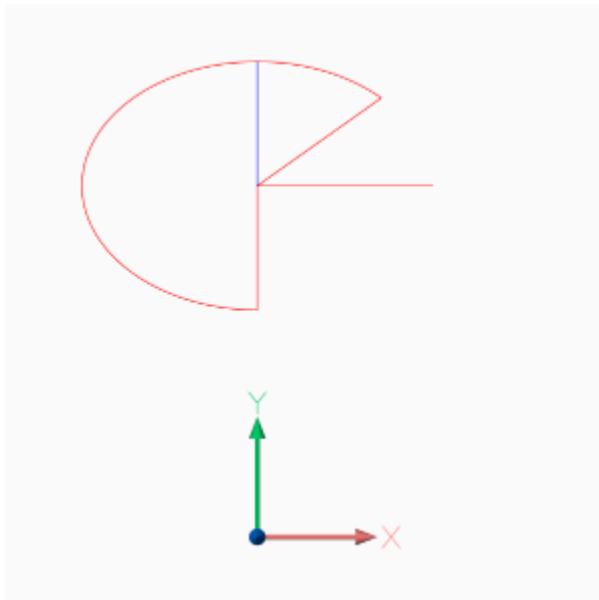
Here we have the same problem as for placing text, you need the start and end angle of the arc in degrees in OCS, and this example also shows a shortcut for calculating the OCS angles.

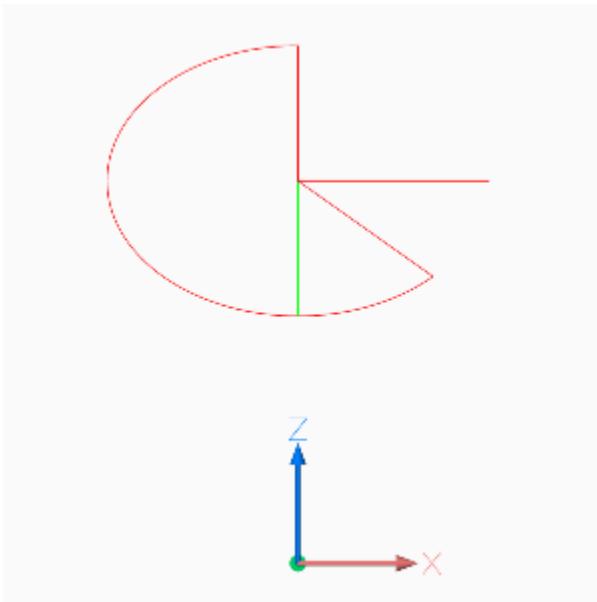
```
ucs = UCS(origin=(0, 2, 2), ux=(1, 0, 0), uz=(0, 1, 1))
msp.add_arc(
    center=ucs.to_ocs((0, 0)),
    radius=1,
```

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```
start_angle=ucs.to_ocs_angle_deg(45),
end_angle=ucs.to_ocs_angle_deg(270),
dxftattribs={
    'extrusion': ucs.uz,
    'color': 1,
})
center = ucs.to_wcs((0, 0))
msp.add_line(
    start=center,
    end=ucs.to_wcs(Vec3.from_deg_angle(45)),
    dxftattribs={'color': 1},
)
msp.add_line(
    start=center,
    end=ucs.to_wcs(Vec3.from_deg_angle(270)),
    dxftattribs={'color': 1},
)
```





## Placing Block References in 3D Space

Despite the fact that block references (`Insert`) can contain true 3D entities like `Line` or `Mesh`, the `Insert` entity uses the same placing principle as `Text` or `Arc` shown in the previous chapters.

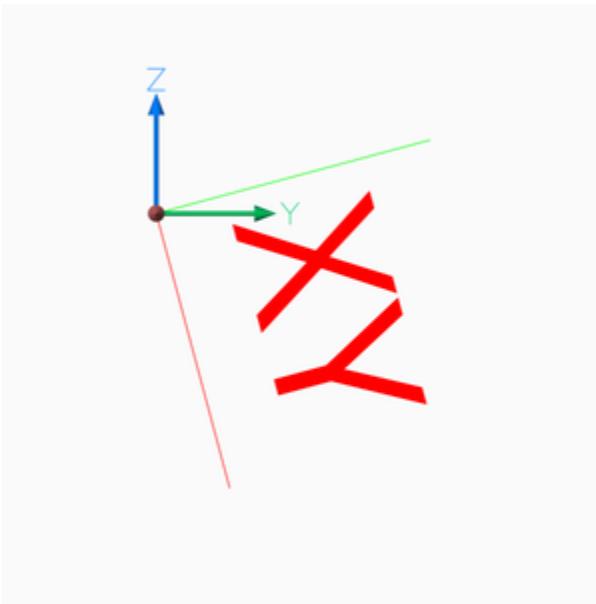
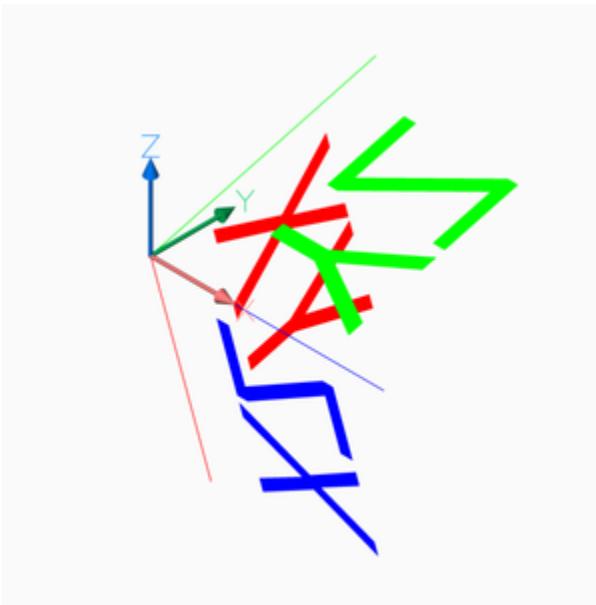
Simple placing by OCS and rotation about the z-axis, can be achieved the same way as for generic 2D entity types. The DXF attribute `Insert.dxf.rotation` rotates a block reference around the block z-axis, which is located in the `Block.dxf.base_point`. To rotate the block reference around the WCS x-axis, a transformation of the block z-axis into the WCS x-axis is required by rotating the block z-axis 90 degree counter clockwise around y-axis by using an UCS:

This is just an excerpt of the important parts, see the whole code of `insert.py` at [github](#).

```
# rotate UCS around an arbitrary axis:
def ucs_rotation(ucs: UCS, axis: Vec3, angle: float):
    # new in ezdxf v0.11: UCS.rotate(axis, angle)
    t = Matrix44.axis_rotate(axis, math.radians(angle))
    ux, uy, uz = t.transform_vertices([ucs.ux, ucs.uy, ucs.uz])
    return UCS(origin=ucs.origin, ux=ux, uy=uy, uz=uz)

doc = ezdxf.new('R2010', setup=True)
blk = doc.blocks.new('CSYS')
setup_csys(blk)
msp = doc.modelspace()

ucs = ucs_rotation(UCS(), axis=Y_AXIS, angle=90)
# transform insert location to OCS
insert = ucs.to_ocs((0, 0, 0))
# rotation angle about the z-axis (= WCS x-axis)
rotation = ucs.to_ocs_angle_deg(15)
msp.add_blockref('CSYS', insert, dxftattribs={
    'extrusion': ucs.uz,
    'rotation': rotation,
})
```



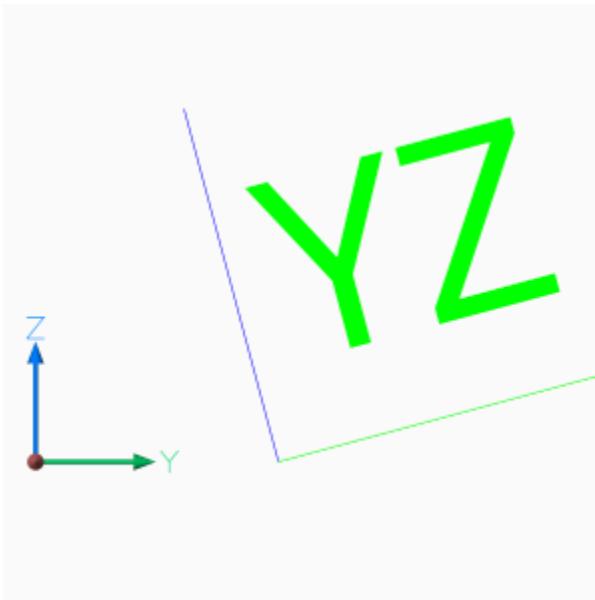
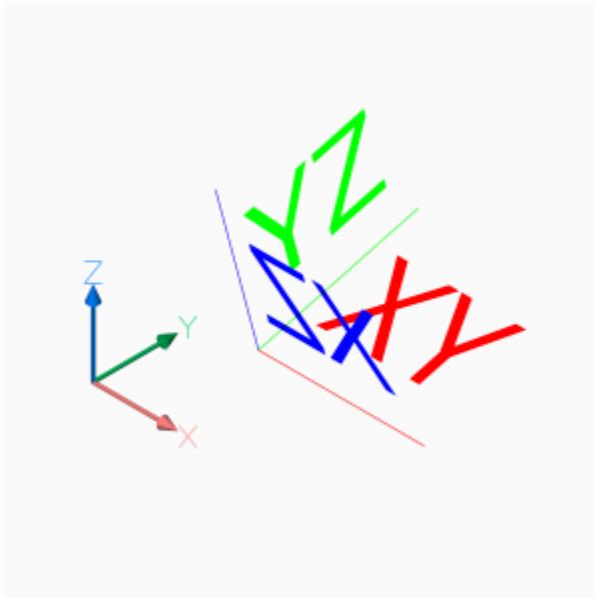
To rotate a block reference around another axis than the block z-axis, you have to find the rotated z-axis (extrusion vector) of the rotated block reference, following example rotates the block reference around the block x-axis by 15 degrees:

```
# t is a transformation matrix to rotate 15 degree around the x-axis
t = Matrix44.axis_rotate(axis=X_AXIS, angle=math.radians(15))
# transform block z-axis into new UCS z-axis (= extrusion vector)
uz = Vec3(t.transform(Z_AXIS))
# create new UCS at the insertion point, because we are rotating around the x-axis,
# ux is the same as the WCS x-axis and uz is the rotated z-axis.
ucs = UCS(origin=(1, 2, 0), ux=X_AXIS, uz=uz)
# transform insert location to OCS, block base_point=(0, 0, 0)
insert = ucs.to_ocs((0, 0, 0))
# for this case a rotation around the z-axis is not required
rotation = 0
```

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```
blockref = msp.add_blockref('CSYS', insert, dxfattribs={
    'extrusion': ucs.uz,
    'rotation': rotation,
})
```



The next example shows how to translate a block references with an already established OCS:

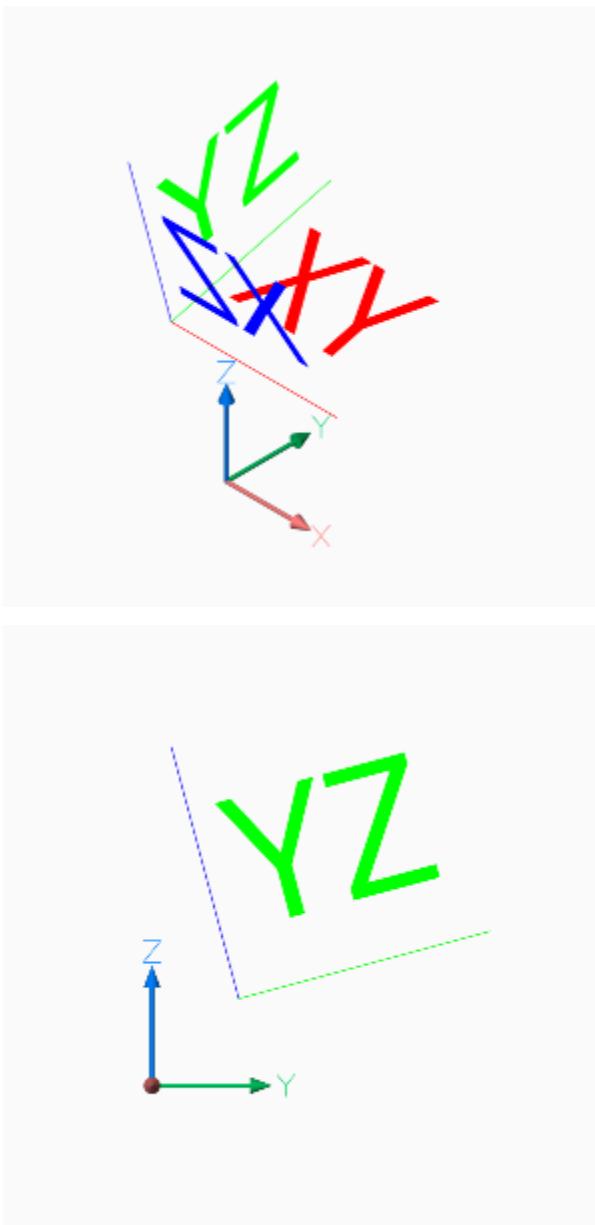
```
# translate a block references with an established OCS
translation = Vec3(-3, -1, 1)
# get established OCS
ocs = blockref.ocs()
# get insert location in WCS
actual_wcs_location = ocs.to_wcs(blockref.dxf.insert)
# translate location
```

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```
new_wcs_location = actual_wcs_location + translation
# convert WCS location to OCS location
blockref.dxf.insert = ocs.from_wcs(new_wcs_location)
```

Setting a new insert location is the same procedure without adding a translation vector, just transform the new insert location into the OCS.



The next operation is to rotate a block reference with an established OCS, rotation axis is the block y-axis, rotation angle is -90 degrees. First transform block y-axis (rotation axis) and block z-axis (extrusion vector) from OCS into WCS:

```
# rotate a block references with an established OCS around the block y-axis about 90degree
ocs = blockref.ocs()
```

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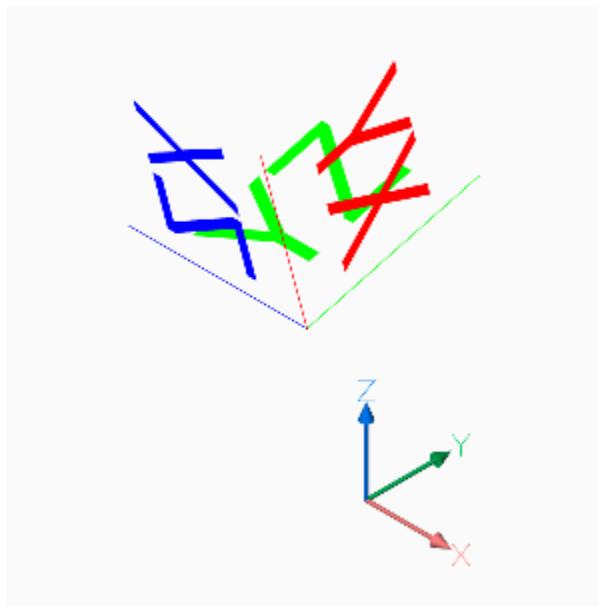
```
# convert block y-axis (= rotation axis) into WCS vector
rotation_axis = ocs.to_wcs((0, 1, 0))
# convert local z-axis (=extrusion vector) into WCS vector
local_z_axis = ocs.to_wcs((0, 0, 1))
```

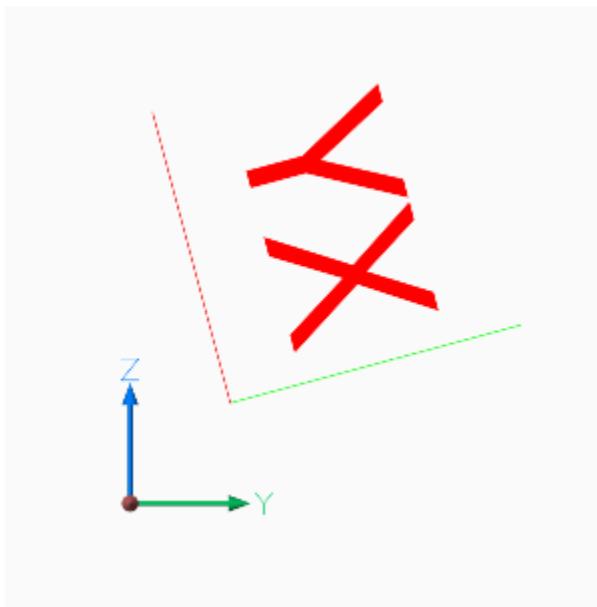
Build transformation matrix and transform extrusion vector and build new UCS:

```
# build transformation matrix
t = Matrix44.axis_rotate(axis=rotation_axis, angle=math.radians(-90))
uz = t.transform(local_z_axis)
uy = rotation_axis
# the block reference origin stays at the same location, no rotation needed
wcs_insert = ocs.to_wcs(blockref.dxf.insert)
# build new UCS to convert WCS locations and angles into OCS
ucs = UCS(origin=wcs_insert, uy=uy, uz=uz)
```

Set new OCS attributes, we also have to set the rotation attribute even though we do not rotate the block reference around the local z-axis, the new block x-axis (0 deg) differs from OCS x-axis and has to be adjusted:

```
# set new OCS
blockref.dxf.extrusion = ucs.uz
# set new insert
blockref.dxf.insert = ucs.to_ocs((0, 0, 0))
# set new rotation: we do not rotate the block reference around the local z-axis,
# but the new block x-axis (0 deg) differs from OCS x-axis and has to be adjusted
blockref.dxf.rotation = ucs.to_ocs_angle_deg(0)
```





And here is the point, where my math knowledge ends, for more advanced CAD operation you have to look elsewhere.

### 6.5.18 Tutorial for UCS Based Transformations

With *ezdxf* v0.11 a new feature for entity transformation was introduced, which makes working with OCS/UCS much easier, this is a new edition of the older *Tutorial for OCS/UCS Usage*. For the basic information read the old tutorial please. In *ezdxf* v0.13 the `transform_to_wcs()` interface was replaced by the general transformation interface: `transform()`.

For this tutorial we don't have to worry about the OCS and the extrusion vector, this is done automatically by the `transform()` method of each DXF entity.

#### Placing 2D Circle in 3D Space

To recreate the situation of the old tutorial instantiate a new UCS and rotate it around the local x-axis. Use UCS coordinates to place the 2D CIRCLE in 3D space, and transform the UCS coordinates to the WCS.

```
import math
import ezdxf
from ezdxf.math import UCS

doc = ezdxf.new('R2010')
msp = doc.modelspace()

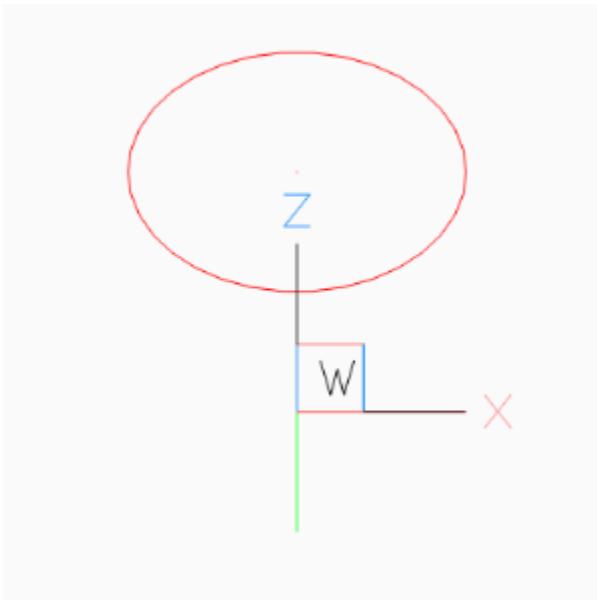
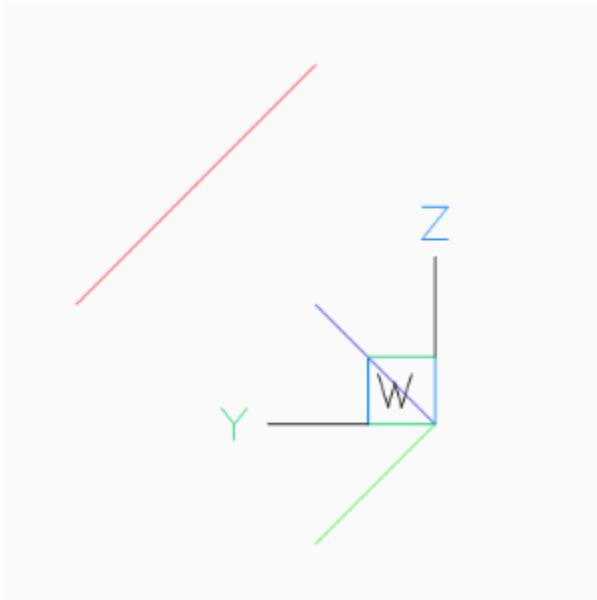
ucs = UCS() # New default UCS
# All rotation angles in radians, and rotation
# methods always return a new UCS.
ucs = ucs.rotate_local_x(math.radians(-45))
circle = msp.add_circle(
    # Use UCS coordinates to place the 2d circle in 3d space
    center=(0, 0, 2),
    radius=1,
    dxftattribs={'color': 1}
)
```

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```
circle.transform(ucs.matrix)

# mark center point of circle in WCS
msp.add_point((0, 0, 2), dxftattribs={'color': 1}).transform(ucs.matrix)
```



## Placing LWPolyline in 3D Space

Simplified LPOLYLINE example:

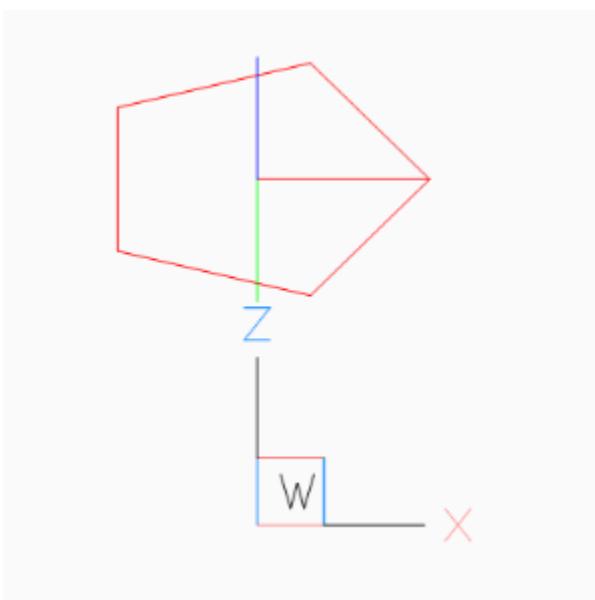
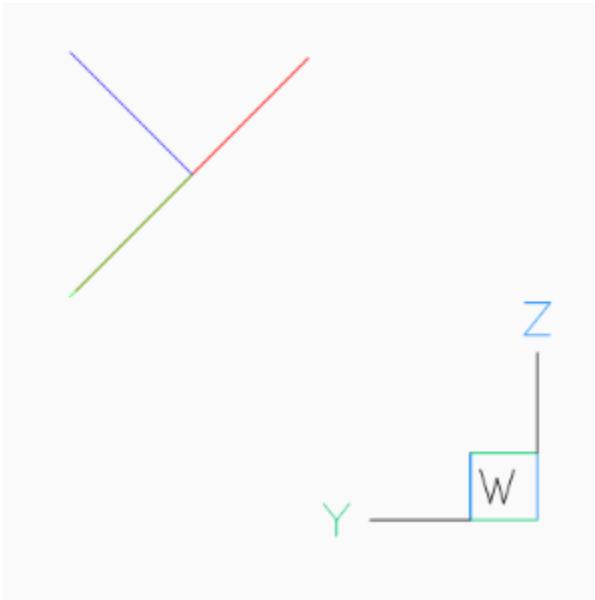
```
# The center of the pentagon should be (0, 2, 2), and the shape is
# rotated around x-axis about -45 degree
ucs = UCS(origin=(0, 2, 2)).rotate_local_x(math.radians(-45))
```

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```
msp.add_lwpolyline(  
    # calculating corner points in UCS coordinates  
    points=(Vec3.from_deg_angle((360 / 5) * n) for n in range(5)),  
    format='xy', # ignore z-axis  
    close=True,  
    dxftattribs={  
        'color': 1,  
    }
```

The 2D pentagon in 3D space in BricsCAD *Left* and *Front* view.



## Using UCS to Place 3D Polyline

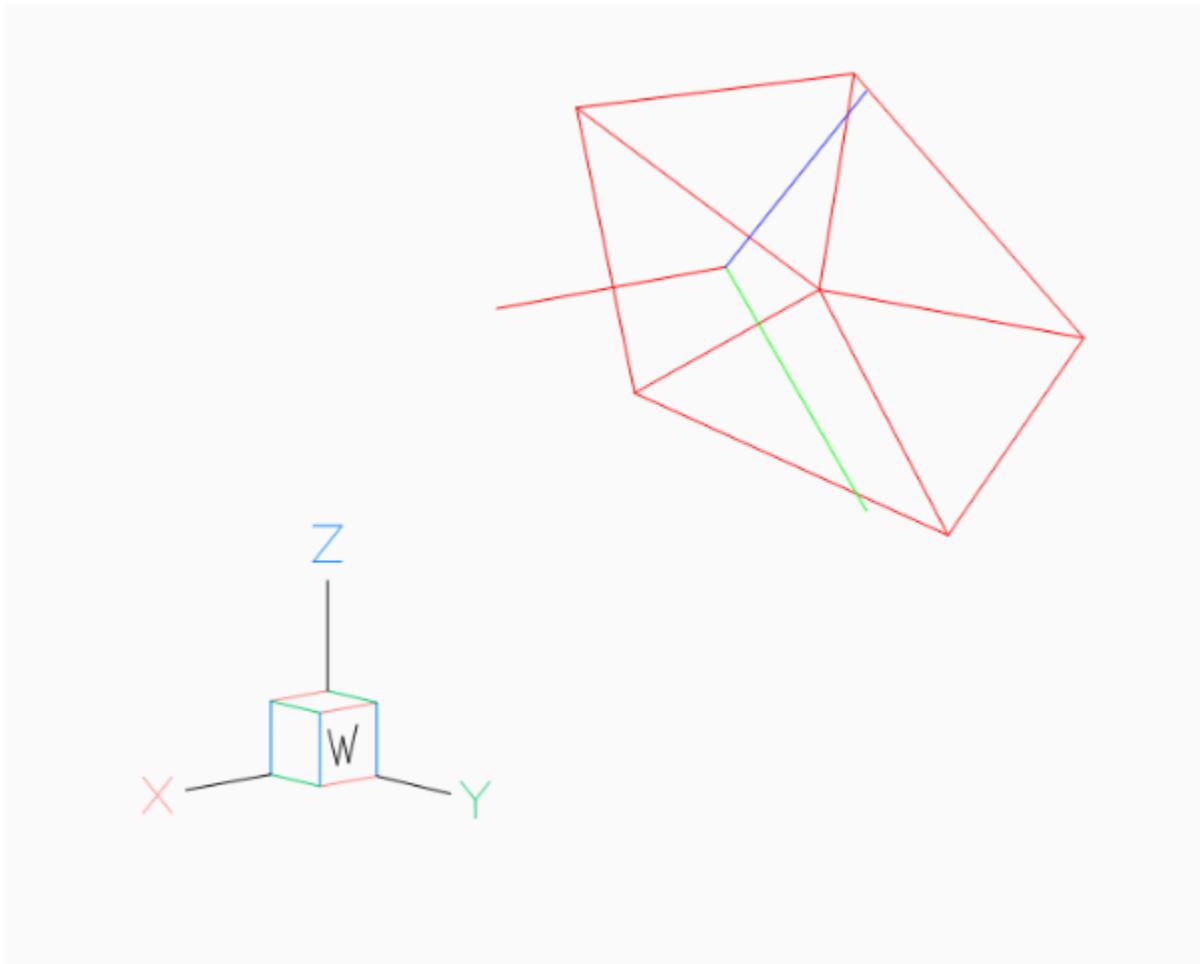
Simplified POLYLINE example: Using a first UCS to transform the POLYLINE and a second UCS to place the POLYLINE in 3D space.

```
# using an UCS simplifies 3D operations, but UCS definition can happen later
# calculating corner points in local (UCS) coordinates without Vec3 class
angle = math.radians(360 / 5)
corners_ucs = [(math.cos(angle * n), math.sin(angle * n), 0) for n in range(5)]

# let's do some transformations by UCS
transformation_ucs = UCS().rotate_local_z(math.radians(15)) # 1. rotation around z-
#axis
transformation_ucs.shift((0, .333, .333)) # 2. translation (inplace)
corners_ucs = list(transformation_ucs.points_to_wcs(corners_ucs))

location_ucs = UCS(origin=(0, 2, 2)).rotate_local_x(math.radians(-45))
msp.add_polyline3d(
    points=corners_ucs,
    close=True,
    dxftattribs={
        'color': 1,
    }
).transform(location_ucs.matrix)

# Add lines from the center of the POLYLINE to the corners
center_ucs = transformation_ucs.to_wcs((0, 0, 0))
for corner in corners_ucs:
    msp.add_line(
        center_ucs, corner, dxftattribs={'color': 1}
    ).transform(location_ucs.matrix)
```



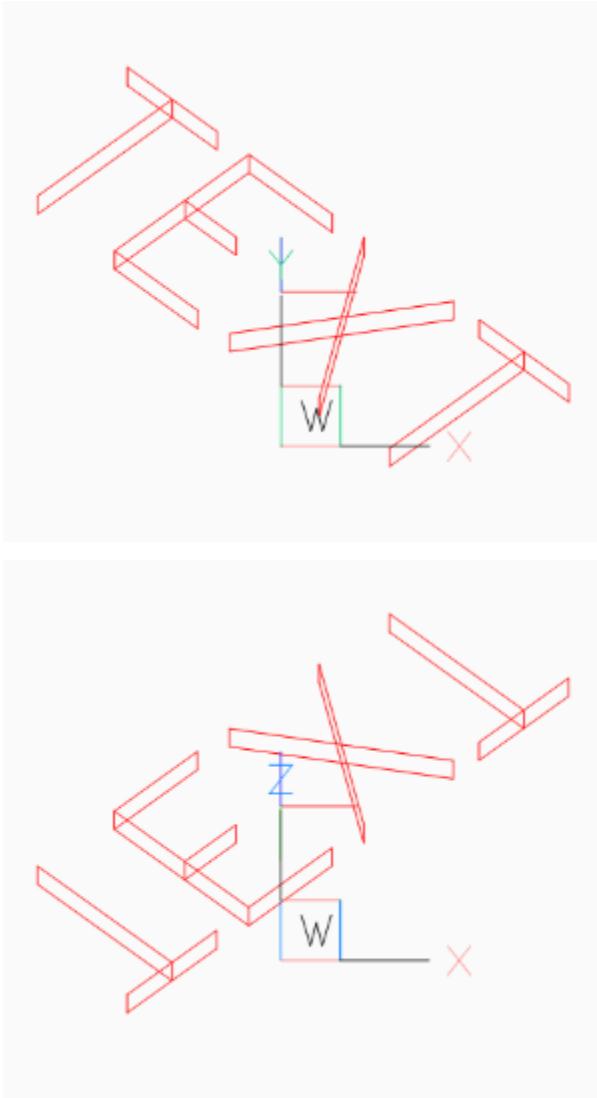
## Placing 2D Text in 3D Space

The problem with the text rotation in the old tutorial disappears (or better it is hidden in `transform()`) with the new UCS based transformation method:

AutoCAD supports thickness for the TEXT entity only for `.shx` fonts and not for true type fonts.

```
# thickness for text works only with shx fonts not with true type fonts
doc.styles.new('TXT', dxfattribs={'font': 'romans.shx'})

ucs = UCS(origin=(0, 2, 2)).rotate_local_x(math.radians(-45))
text = msp.add_text(
    text="TEXT",
    dxfattribs={
        # text rotation angle in degrees in UCS
        'rotation': -45,
        'thickness': .333,
        'color': 1,
        'style': 'TXT',
    }
)
# set text position in UCS
text.set_pos((0, 0, 0), align='MIDDLE_CENTER')
text.transform(ucs.matrix)
```



## Placing 2D Arc in 3D Space

Same as for the text example, OCS angle transformation can be ignored:

```
ucs = UCS(origin=(0, 2, 2)).rotate_local_x(math.radians(-45))

CENTER = (0, 0)
START_ANGLE = 45
END_ANGLE = 270

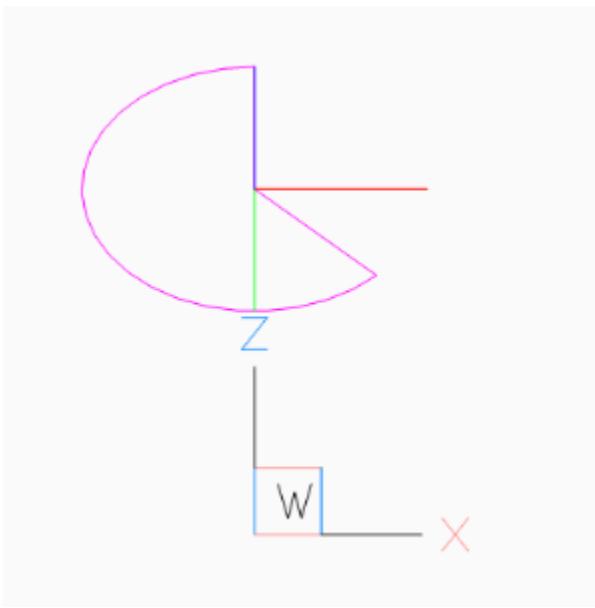
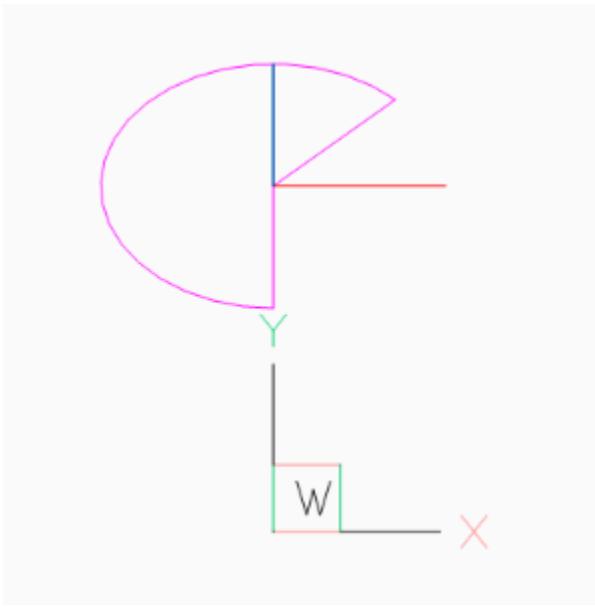
msp.add_arc(
    center=CENTER,
    radius=1,
    start_angle=START_ANGLE,
    end_angle=END_ANGLE,
    dxftattribs={'color': 6},
).transform(ucs.matrix)
```

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```
msp.add_line(
    start=CENTER,
    end=Vec3.from_deg_angle(START_ANGLE),
    dxftattribs={'color': 6},
).transform(ucs.matrix)

msp.add_line(
    start=CENTER,
    end=Vec3.from_deg_angle(END_ANGLE),
    dxftattribs={'color': 6},
).transform(ucs.matrix)
```



## Placing Block References in 3D Space

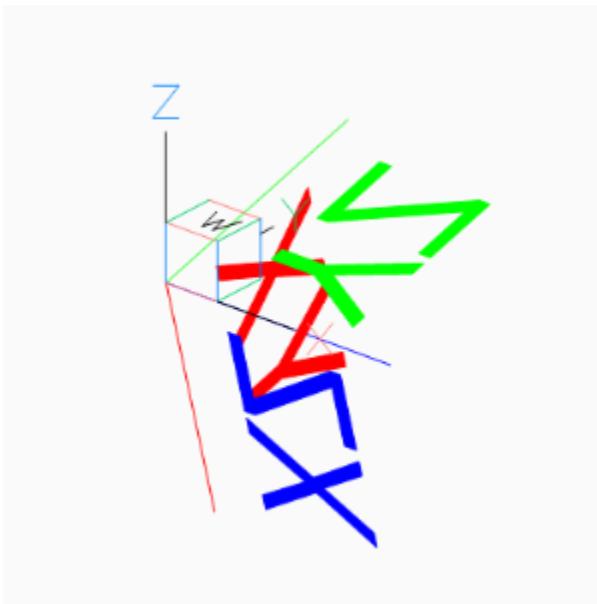
Despite the fact that block references (INSERT) can contain true 3D entities like LINE or MESH, the INSERT entity uses the same placing principle as TEXT or ARC shown in the previous chapters.

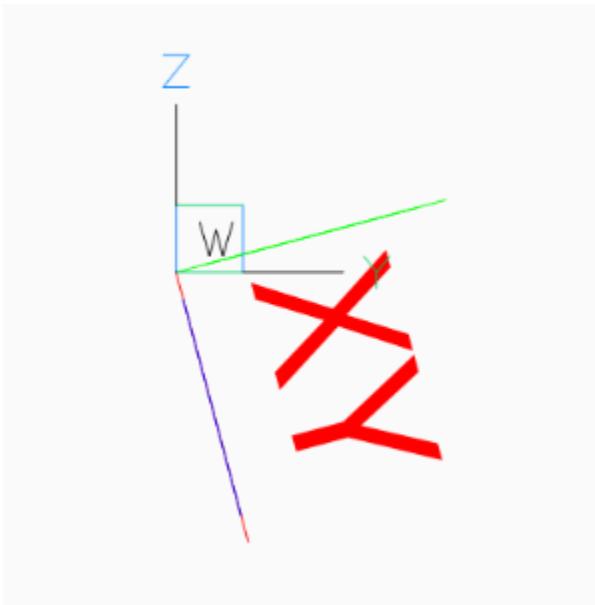
To rotate the block reference 15 degrees around the WCS x-axis, we place the block reference in the origin of the UCS, and rotate the UCS 90 degrees around its local y-axis, to align the UCS z-axis with the WCS x-axis:

This is just an excerpt of the important parts, see the whole code of [insert.py](#) at [github](#).

```
doc = ezdxf.new('R2010', setup=True)
blk = doc.blocks.new('CSYS')
setup_csys(blk)
msp = doc.modelspace()

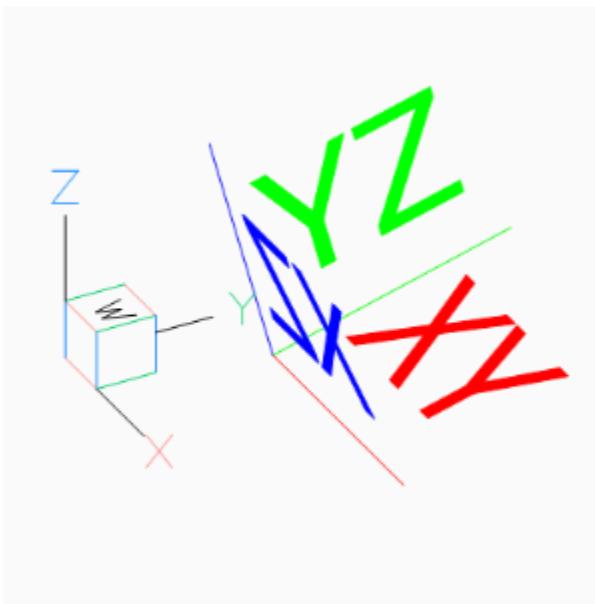
ucs = UCS().rotate_local_y(angle=math.radians(90))
msp.add_blockref(
    'CSYS',
    insert=(0, 0),
    # rotation around the block z-axis (= WCS x-axis)
    dxftattribs={'rotation': 15},
).transform(ucs.matrix)
```

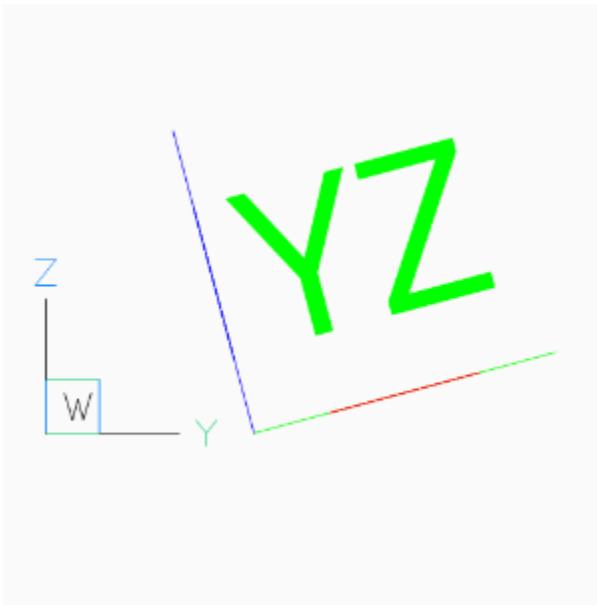




A more simple approach is to ignore the `rotate` attribute at all and just rotate the UCS. To rotate a block reference around any axis rather than the block z-axis, rotate the UCS into the desired position. Following example rotates the block reference around the block x-axis by 15 degrees:

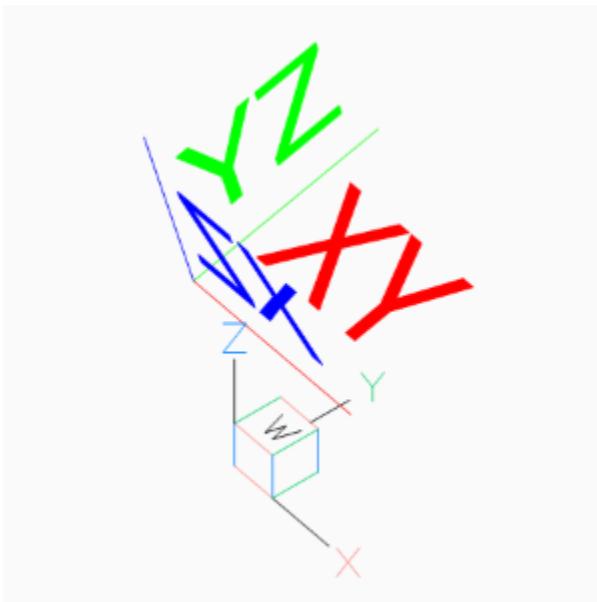
```
ucs = UCS(origin=(1, 2, 0)).rotate_local_x(math.radians(15))
blockref = msp.add_blockref('CSYS', insert=(0, 0, 0))
blockref.transform(ucs.matrix)
```

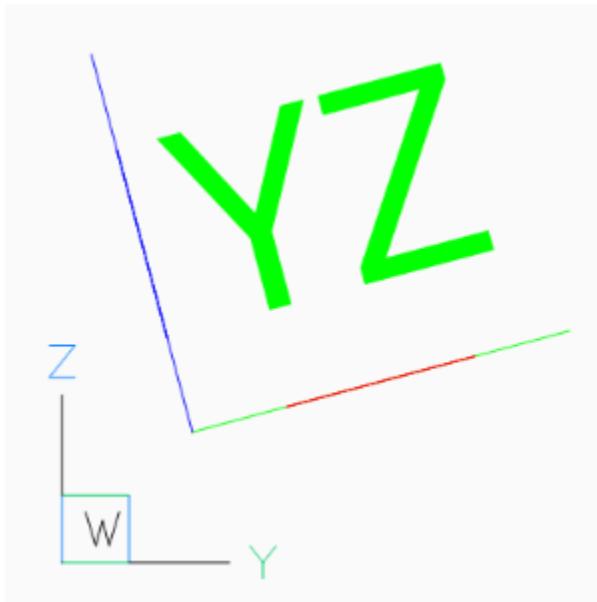




The next example shows how to translate a block references with an already established OCS:

```
# New UCS at the translated location, axis aligned to the WCS
ucs = UCS((-3, -1, 1))
# Transform an already placed block reference, including
# the transformation of the established OCS.
blockref.transform(ucs.matrix)
```





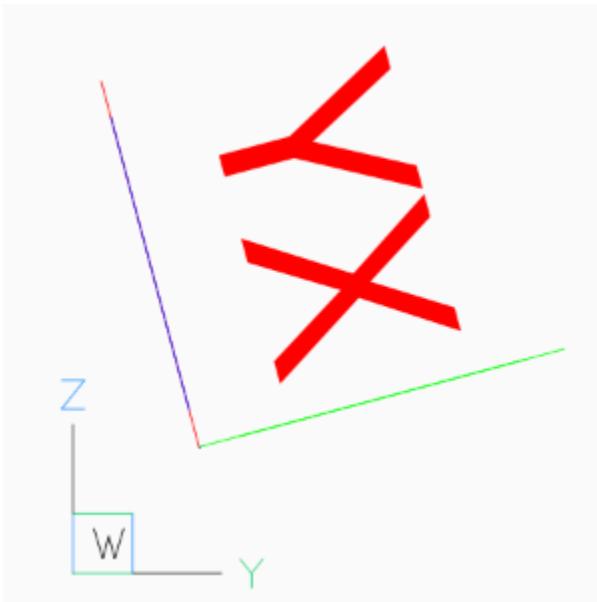
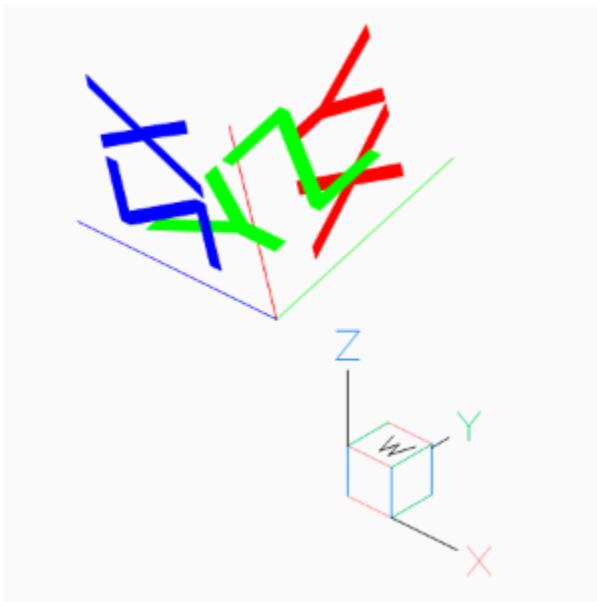
The next operation is to rotate a block reference with an established OCS, rotation axis is the block y-axis, rotation angle is -90 degrees. The idea is to create an UCS in the origin of the already placed block reference, UCS axis aligned to the block axis and resetting the block reference parameters for a new WCS transformation.

```
# Get UCS at the block reference insert location, UCS axis aligned
# to the block axis.
ucs = blockref.ucs()
# Rotate UCS around the local y-axis.
ucs = ucs.rotate_local_y(math.radians(-90))
```

Reset block reference parameters, this places the block reference in the UCS origin and aligns the block axis to the UCS axis, now we do a new transformation from UCS to WCS:

```
# Reset block reference parameters to place block reference in
# UCS origin, without any rotation and OCS.
blockref.reset_transformation()

# Transform block reference from UCS to WCS
blockref.transform(ucs.matrix)
```



### 6.5.19 Tutorial for Linear Dimensions

The [Dimension](#) entity is the generic entity for all dimension types, but unfortunately AutoCAD is **not willing** to show a dimension line defined only by this dimension entity, it also needs an anonymous block which contains the dimension line *rendering* in this documentation, beside the fact this is not a real graphical rendering. BricsCAD is a much more friendly CAD application, which do show the dimension entity without the graphical rendering as block, which was very useful for testing, because there is no documentation how to apply all the dimension style variables (more than 80). This seems to be the reason why dimension lines are rendered so differently by many CAD application.

Don't expect to get the same rendering results by *ezdxf* as you get from AutoCAD, *ezdxf* tries to be as close to the results rendered by BricsCAD, but it is not possible to implement all the various combinations of dimension style parameters, which often affect one another.

---

**Note:** *Ezdx*f does not consider all DIMSTYLE variables, so the rendering results are different from CAD applications.

---

Text rendering is another problem, because *ezdxf* has no real rendering engine. Some font properties, like the real text width, which is only available to *ezdxf* if the *Matplotlib* package is installed and may also vary slightly for different CAD applications. Without access to the *Matplotlib* package the text properties in *ezdxf* are based on an abstract monospaced font and are bigger than required by true type fonts.

Not all DIMENSION and DIMSTYLE features are supported by all DXF versions, especially DXF R12 does not support many features, but in this case the required rendering of dimension lines is an advantage, because if the application just shows the rendered block, all features which can be used in DXF R12 are displayed like linetypes, but this features will disappear if the dimension line will be edited in the CAD application. *Ezdx*f writes only the supported DIMVARS of the used DXF version to avoid invalid DXF files. So it is not that critical to know all the supported features of a DXF version, except for limits and tolerances, *ezdxf* uses the advanced features of the MTEXT entity to create limits and tolerances and therefore they are not supported (displayed) in DXF R12 files.

#### See also:

- Graphical reference of many DIMVARS and some advanced information: [DIMSTYLE Table](#)
- Source code file `standards.py` shows how to create your own DIMSTYLES.
- The Script `dimension_linear.py` shows examples for linear dimensions.

### Horizontal Dimension

```
import ezdxf

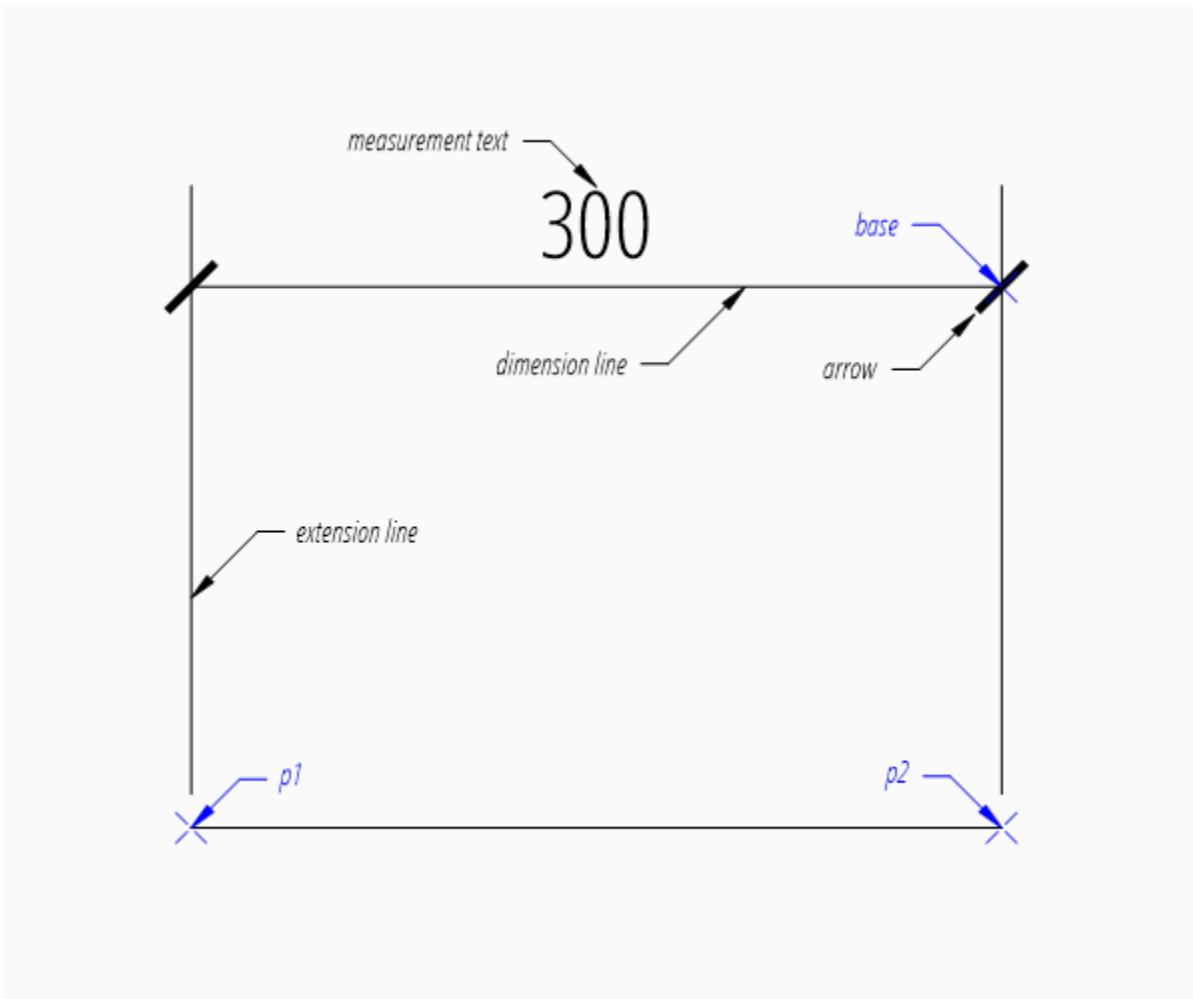
# Create a DXF R2010 document:
# Use argument setup=True to setup the default dimension styles.
doc = ezdxf.new("R2010", setup=True)

# Add new dimension entities to the modelspace:
msp = doc.modelspace()

# Add a LINE entity for visualization, not required to create the DIMENSION
# entity:
msp.add_line((0, 0), (3, 0))

# Add a horizontal linear DIMENSION entity:
dim = msp.add_linear_dim(
    base=(3, 2), # location of the dimension line
    p1=(0, 0), # 1st measurement point
    p2=(3, 0), # 2nd measurement point
    dimstyle="EZDXF", # default dimension style
)

# Necessary second step to create the BLOCK entity with the dimension geometry.
# Additional processing of the DIMENSION entity could happen between adding
# the entity and the rendering call.
dim.render()
doc.saveas("dim_linear_horiz.dxf")
```



The example above creates a horizontal `Dimension` entity. The default dimension style “EZDXF” is defined as:

- 1 drawing unit = 1m
- measurement text height = 0.25 (drawing scale = 1:100)
- the length factor `dimlfac` = 100, which creates a measurement text in cm.
- arrow is “ARCHTICK”, arrow size `dimasz` = 0.175

Every dimension style which does not exist will be replaced by the dimension style “Standard” at DXF export by `save()` or `saveas()` (e.g. dimension style setup was not initiated).

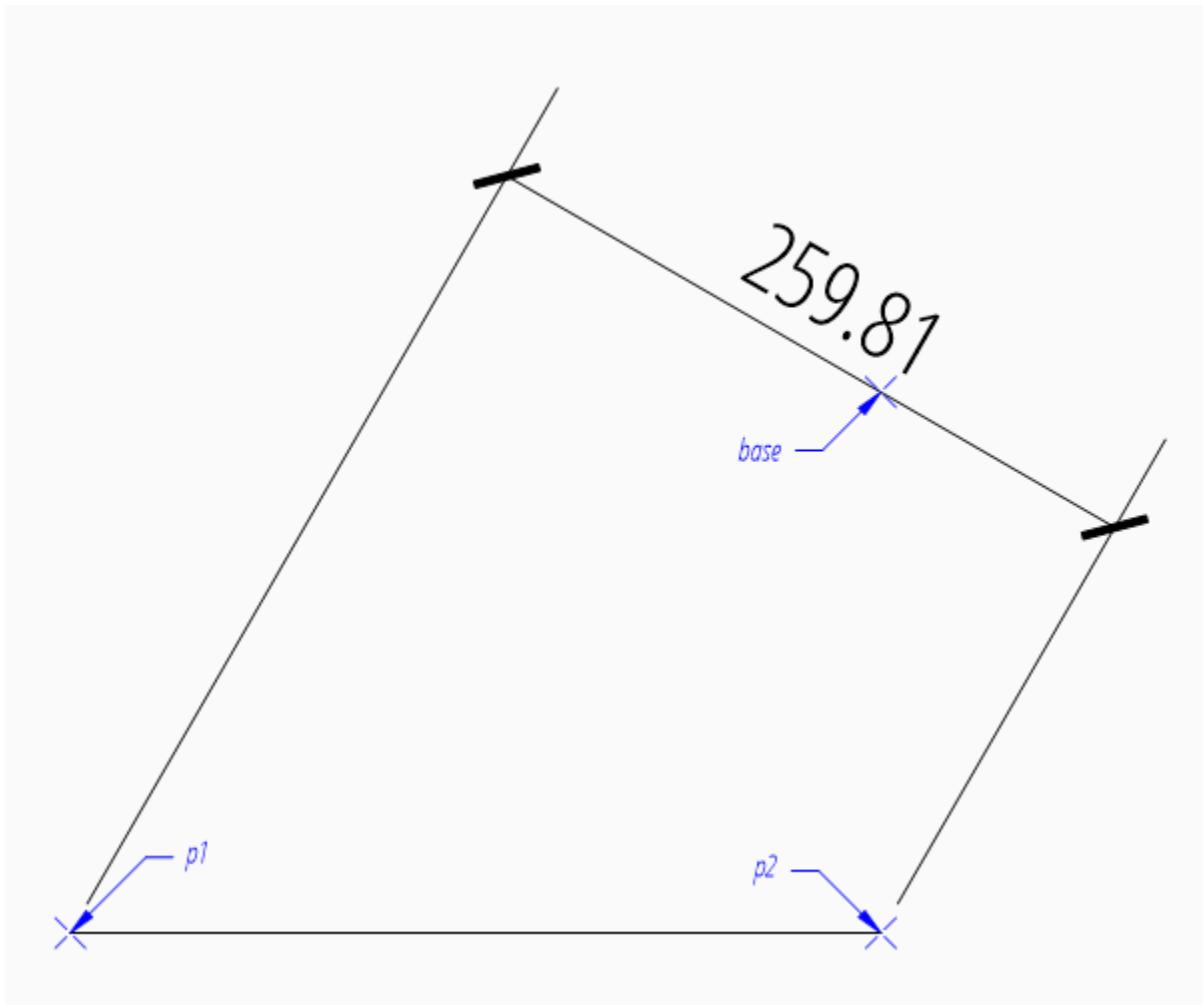
The `base` point defines the location of the dimension line, `ezdxf` accepts any point on the dimension line, the point `p1` defines the start point of the first extension line, which also defines the first measurement point and the point `p2` defines the start point of the second extension line, which also defines the second measurement point.

The return value `dim` is **not** a dimension entity, instead a `DimStyleOverride` object is returned, the dimension entity is stored as attribute `dim.dimension`.

## Vertical and Rotated Dimension

Argument `angle` defines the angle of the dimension line in relation to the x-axis of the WCS or UCS, measurement is the distance between first and second measurement point in direction of `angle`.

```
# assignment to dim is not necessary, if no additional processing happens
msp.add_linear_dim(base=(3, 2), p1=(0, 0), p2=(3, 0), angle=-30).render()
doc.saveas("dim_linear_rotated.dxf")
```

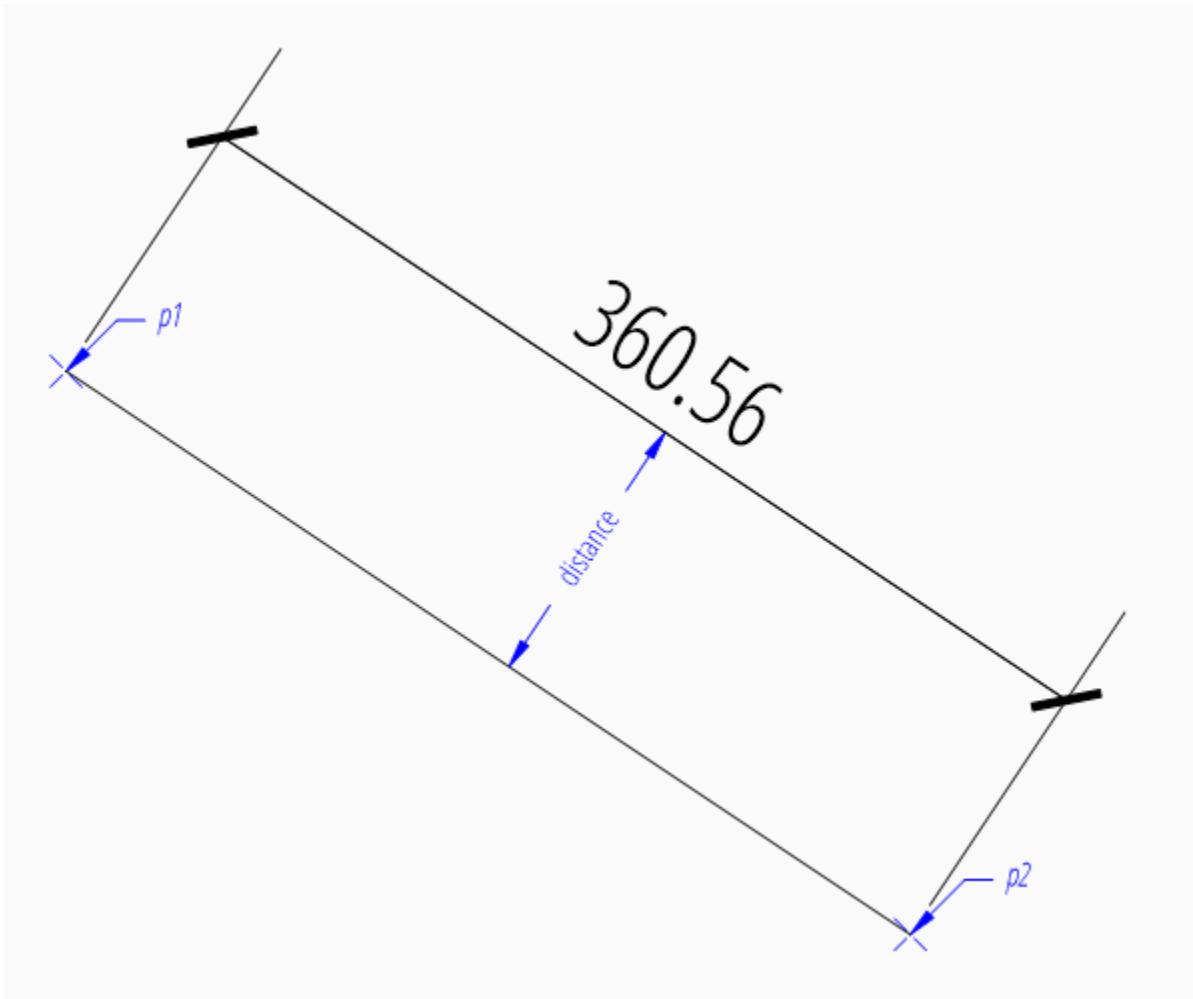


For a vertical dimension set argument *angle* to 90 degree, but in this example the vertical distance would be 0.

### Aligned Dimension

An aligned dimension line is parallel to the line defined by the definition points *p1* and *p2*. The placement of the dimension line is defined by the argument *distance*, which is the distance between the definition line and the dimension line. The *distance* of the dimension line is orthogonal to the base line in counter clockwise orientation.

```
msp.add_line((0, 2), (3, 0))
dim = msp.add_aligned_dim(p1=(0, 2), p2=(3, 0), distance=1)
doc.saveas("dim_linear_aligned.dxf")
```



## Dimension Style Override

Many dimension styling options are defined by the associated `DimStyle` entity. But often you wanna change just a few settings without creating a new dimension style, therefore the DXF format has a protocol to store this changed settings in the dimension entity itself. This protocol is supported by `ezdxf` and every factory function which creates dimension entities supports the `override` argument. This `override` argument is a simple Python dictionary (e.g. `override = {"dimtad": 4}`, place measurement text below dimension line).

The overriding protocol is managed by the `DimStyleOverride` object, which is returned by the most dimension factory functions.

## Placing Measurement Text

The default location of the measurement text depends on various `DimStyle` parameters and is applied if no user defined text location is defined.

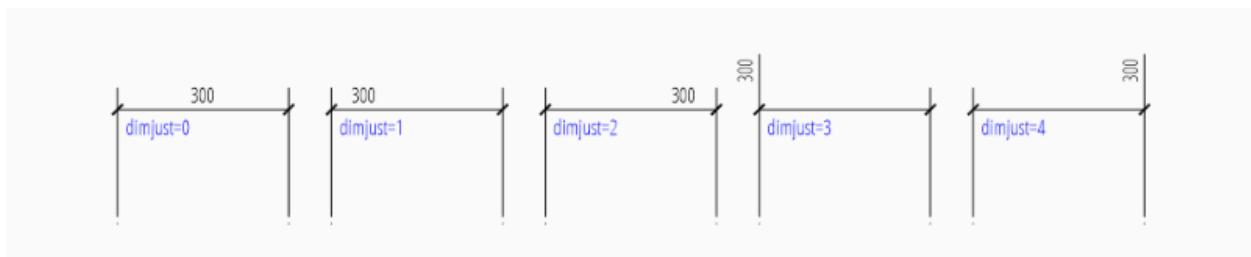
## Default Text Locations

“Horizontal direction” means in direction of the dimension line and “vertical direction” means perpendicular to the dimension line direction.

The “horizontal” location of the measurement text is defined by `dimjust`:

0	Center of dimension line
1	Left side of the dimension line, near first extension line
2	Right side of the dimension line, near second extension line
3	Over first extension line
4	Over second extension line

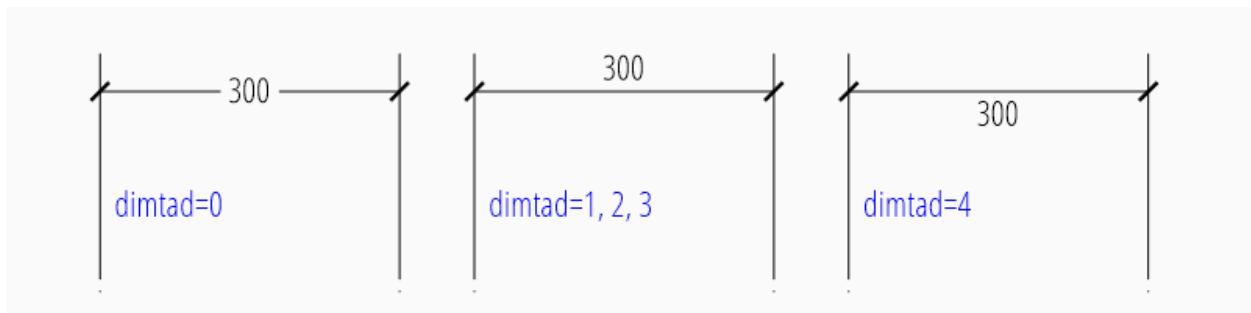
```
msp.add_linear_dim(
    base=(3, 2), p1=(0, 0), p2=(3, 0), override={"dimjust": 1}
).render()
```



The “vertical” location of the measurement text relative to the dimension line is defined by `dimtad`:

0	Center, it is possible to adjust the vertical location by <code>dimtvp</code>
1	Above
2	Outside, handled like <code>Above</code> by <code>ezdxf</code>
3	JIS, handled like <code>Above</code> by <code>ezdxf</code>
4	Below

```
msp.add_linear_dim(
    base=(3, 2), p1=(0, 0), p2=(3, 0), override={"dimtad": 4}
).render()
```



The distance between text and dimension line is defined by `dimgap`.

The `DimStyleOverride` object has a method `set_text_align()` to set the default text location in an easy way, this is also the reason for the 2 step creation process of dimension entities:

```
dim = msp.add_linear_dim(base=(3, 2), p1=(0, 0), p2=(3, 0))
dim.set_text_align(halign="left", valign="center")
dim.render()
```

halign	“left”, “right”, “center”, “above1”, “above2”
valign	“above”, “center”, “below”

Run function `example_for_all_text_placings_R2007()` in the example script `dimension_linear.py` to create a DXF file with all text placings supported by `ezdxf`.

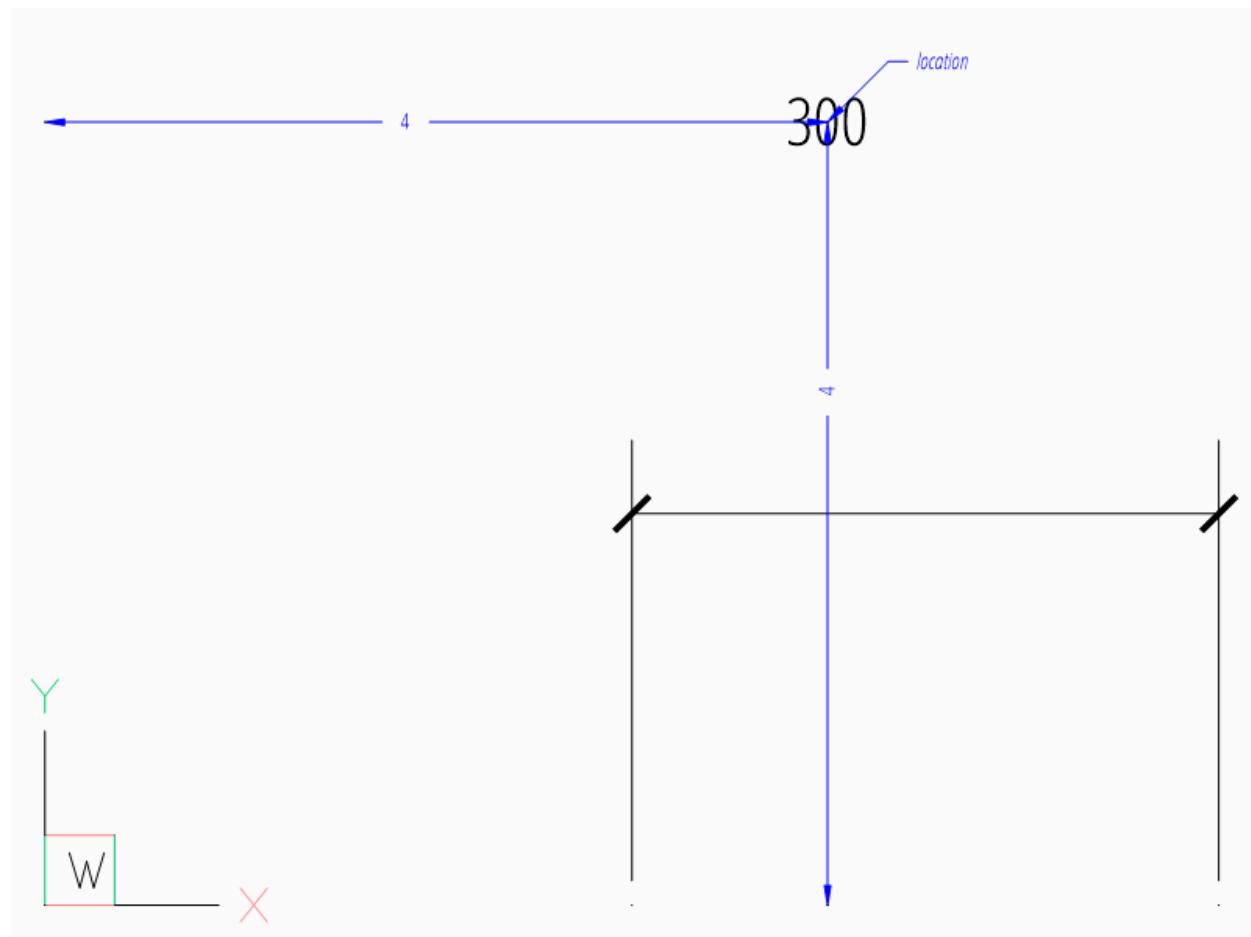
## User Defined Text Locations

Beside the default location, it is possible to locate the measurement text freely.

### Location Relative to Origin

The user defined text location can be set by the argument `location` in most dimension factory functions and always references the midpoint of the measurement text:

```
msp.add_linear_dim(
    base=(3, 2), p1=(3, 0), p2=(6, 0), location=(4, 4)
).render()
```

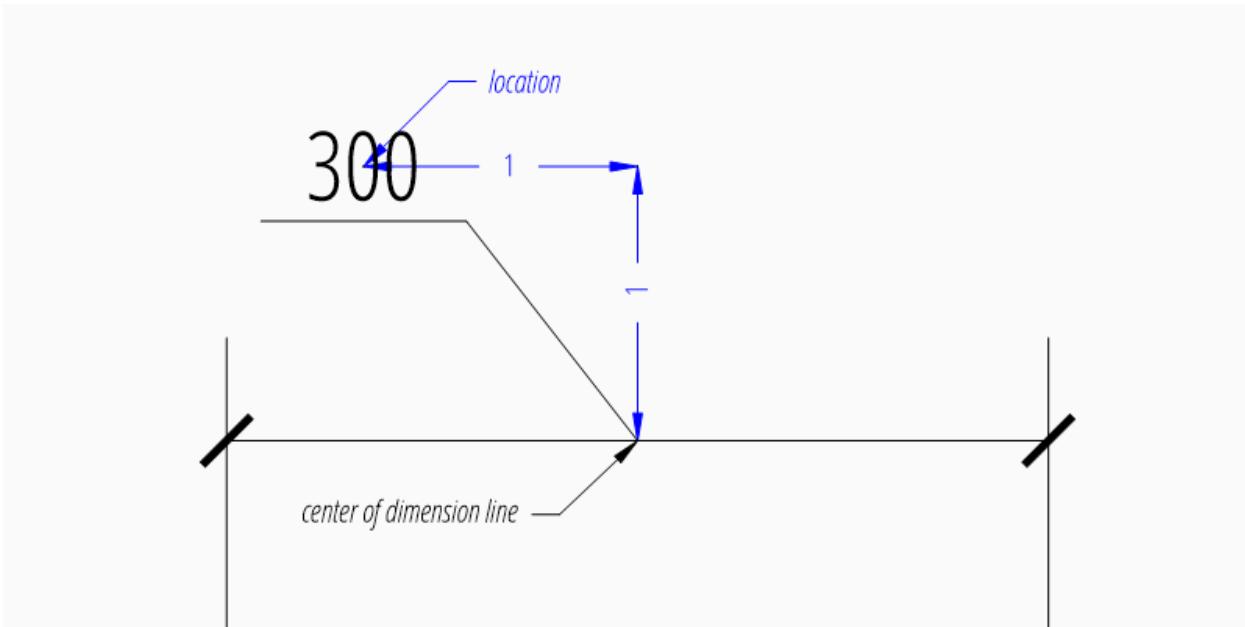


The `location` is relative to origin of the active coordinate system or WCS if no UCS is defined in the `render()` method, the user defined `location` can also be set by `user_location_override()`.

## Location Relative to Center of Dimension Line

The method `set_location()` has additional features for linear dimensions. Argument `leader = True` adds a simple leader from the measurement text to the center of the dimension line and argument `relative = True` places the measurement text relative to the center of the dimension line.

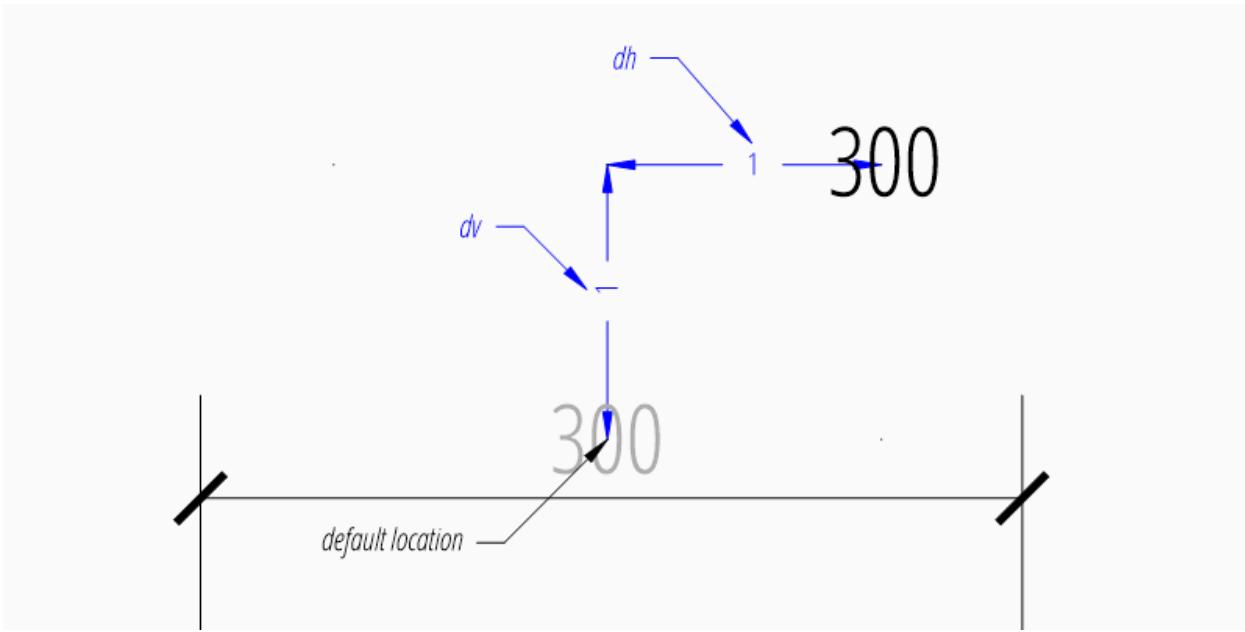
```
dim = msp.add_linear_dim(base=(3, 2), p1=(3, 0), p2=(6, 0))
dim.set_location(location=(-1, 1), leader=True, relative=True)
dim.render()
```



## Location Relative to Default Location

The method `shift_text()` shifts the measurement text away from the default text location. The shifting directions are aligned to the text direction, which is the direction of the dimension line in most cases, `dh` (for delta horizontal) shifts the text parallel to the text direction, `dv` (for delta vertical) shifts the text perpendicular to the text direction. This method does not support leaders.

```
dim = msp.add_linear_dim(base=(3, 2), p1=(3, 0), p2=(6, 0))
dim.shift_text(dh=1, dv=1)
dim.render()
```



## Overriding Text Rotation

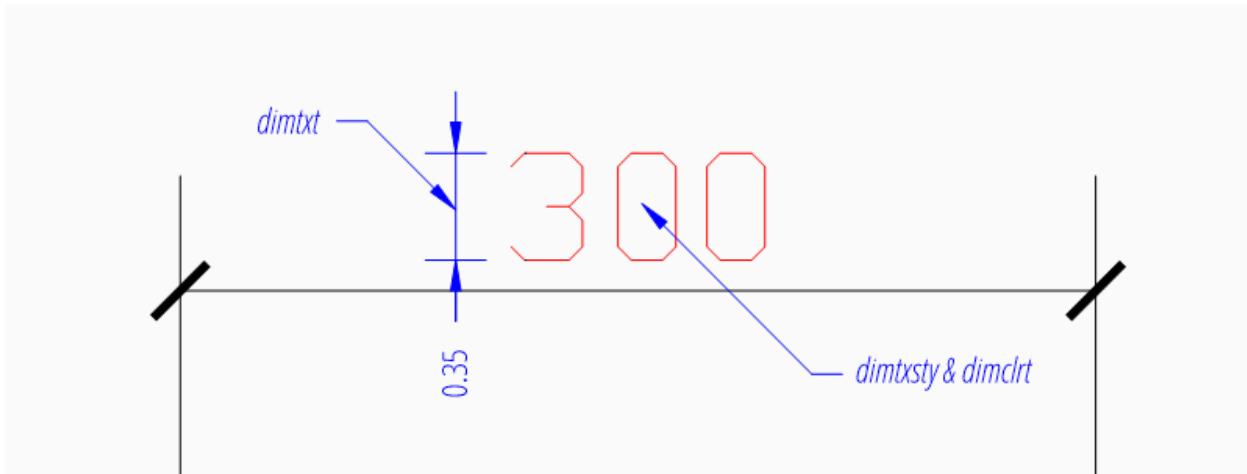
All factory methods supporting the argument `text_rotation` can override the measurement text rotation. The user defined rotation is relative to the render UCS x-axis (default is WCS).

## Measurement Text Formatting and Styling

### Text Properties

DIMVAR	Description
<code>dimtxsty</code>	Specifies the text style of the dimension as <code>Textstyle</code> name.
<code>dimtxt</code>	Text height in drawing units.
<code>dimclrt</code>	Measurement text color as <code>AutoCAD Color Index (ACI)</code> .

```
msp.add_linear_dim(
    base=(3, 2),
    p1=(3, 0),
    p2=(6, 0),
    override={
        "dimtxsty": "Standard",
        "dimtxt": 0.35,
        "dimclrt": 1,
    }
).render()
```



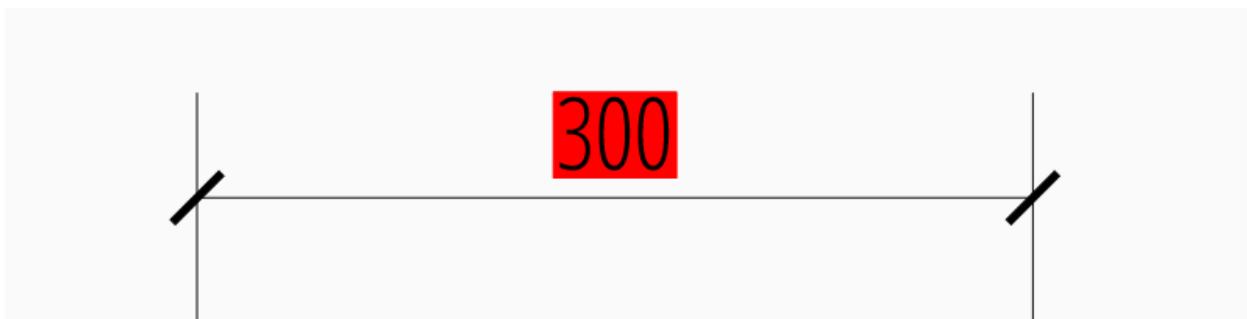
## Background Filling

Background fillings are supported since DXF R2007, and *ezdxf* uses the MTEXT entity to implement this feature, so setting background filling in DXF R12 has no effect. The DIMVAR *dimtfill* defines the kind of background filling and the DIMVAR *dimtfillclr* defines the fill color.

DIMVAR	Description
<i>dimtfill</i>	Enables background filling if bigger than 0
<i>dimtfillclr</i>	Fill color as <i>AutoCAD Color Index (ACI)</i> , if <i>dimtfill</i> is 2

dmtfill	Description
0	disabled
1	canvas color
2	color defined by <i>dimtfillclr</i>

```
msp.add_linear_dim(
    base=(3, 2),
    p1=(3, 0),
    p2=(6, 0),
    override={
        "dimtfill": 2,
        "dimtfillclr": 1,
    }
).render()
```



## Text Formatting

- **decimal places:** `dimdec` defines the number of decimal places displayed for the primary units of a dimension. (DXF R2000)
- **decimal point character:** `dimdsep` defines the decimal point as ASCII code, get the ASCII code by `ord('.')`
- **rounding:** `dimrnd`, rounds all dimensioning distances to the specified value, for instance, if `dimrnd` is set to 0.25, all distances round to the nearest 0.25 unit. If `dimrnd` is set to 1.0, all distances round to the nearest integer. For more information look at the documentation of the `ezdxf.math.xround()` function.
- **zero trimming:** `dimzin`, `ezdxf` supports only a subset of values:
  - 4 to suppress leading zeros
  - 8 to suppress trailing zeros
  - 12 as the combination of both
- **measurement factor:** scale measurement by factor `dimlfac`, e.g. to get the dimensioning text in cm for a DXF file where 1 drawing unit represents 1m, set `dimlfac` to 100.
- **text template:** `dimpost`, “<>” represents the measurement text, e.g. “~<>cm” produces “~300cm” for measurement in previous example.

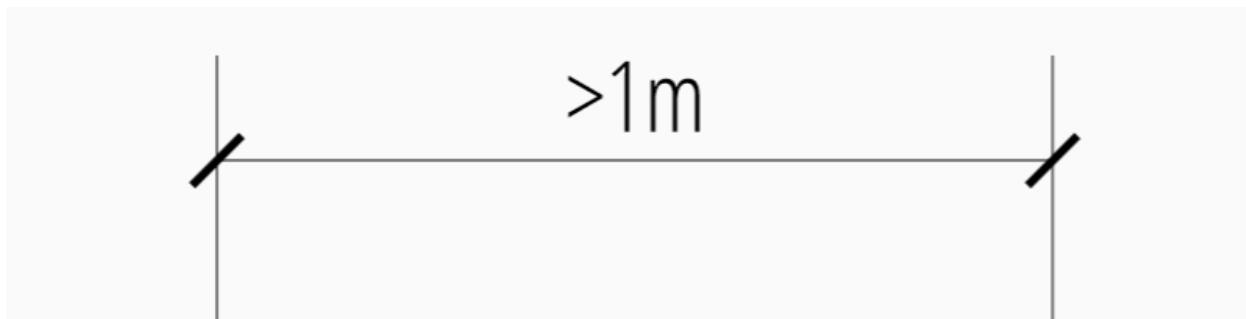
To set this values the `ezdxf.entities.DimStyle.set_text_format()` and `ezdxf.entities.DimStyleOverride.set_text_format()` methods are very recommended.

## Overriding Measurement Text

This feature allows overriding the real measurement text by a custom measurement text, the text is stored as string in the `Dimension` entity as attribute `text`. Special values of the `text` attribute are: one space “ ” to suppress the measurement text at all, an empty string “” or “<>” to display the real measurement.

All factory functions have an explicit `text` argument, which always replaces the `text` value in the `dxftattribs` dict.

```
msp.add_linear_dim(base=(3, 2), p1=(3, 0), p2=(6, 0), text=">1m").render()
```

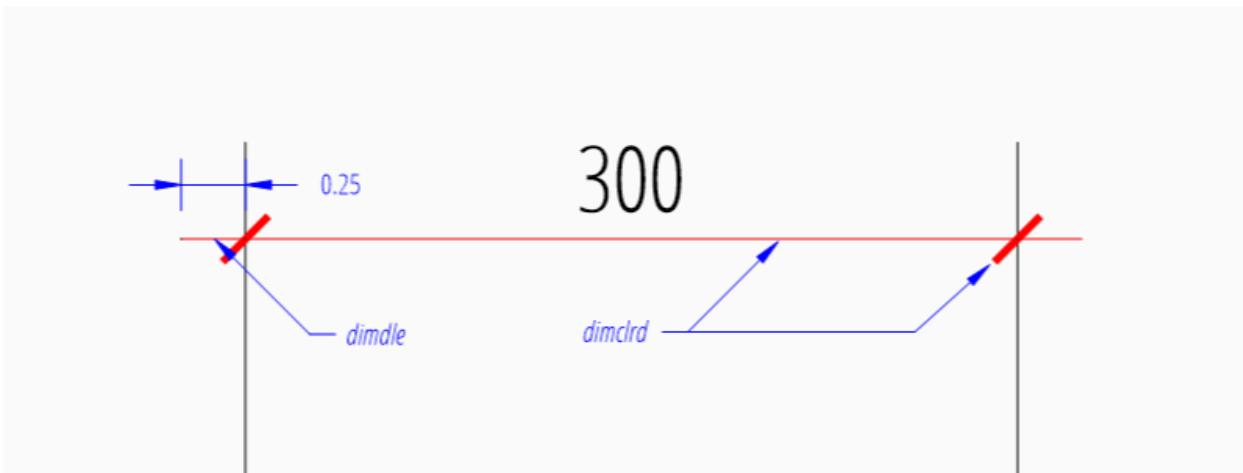


## Dimension Line Properties

The *dimension line color* is defined by the DIMVAR `dimclrd` as *AutoCAD Color Index (ACI)*, `dimclrd` and also defines the color of the arrows. The *linetype* is defined by `dimltype` and requires DXF R2007. The *linewidth* is defined by `dimlwd` and requires DXF R2000, see also the `lineweight` reference for valid values. The `dimdle` is the extension of the dimension line beyond the extension lines, this dimension line extension is not supported for all arrows.

DIMVAR	Description
dimclrd	dimension line and arrows color as <i>AutoCAD Color Index (ACI)</i>
dimltype	linetype of dimension line
dimlwd	line weight of dimension line
dimdle	extension of dimension line in drawing units

```
msp.add_linear_dim(
    base=(3, 2),
    p1=(3, 0),
    p2=(6, 0),
    override={
        "dimclrd": 1, # red
        "dimdle": 0.25,
        "dimltype": "DASHED2",
        "dimlwd": 35, # 0.35mm line weight
    }
).render()
```



`DimStyleOverride()` method:

```
dim = msp.add_linear_dim(base=(3, 2), p1=(3, 0), p2=(6, 0))
dim.set_dimline_format(
    color=1, linetype="DASHED2", linewidth=35, extension=0.25
)
dim.render()
```

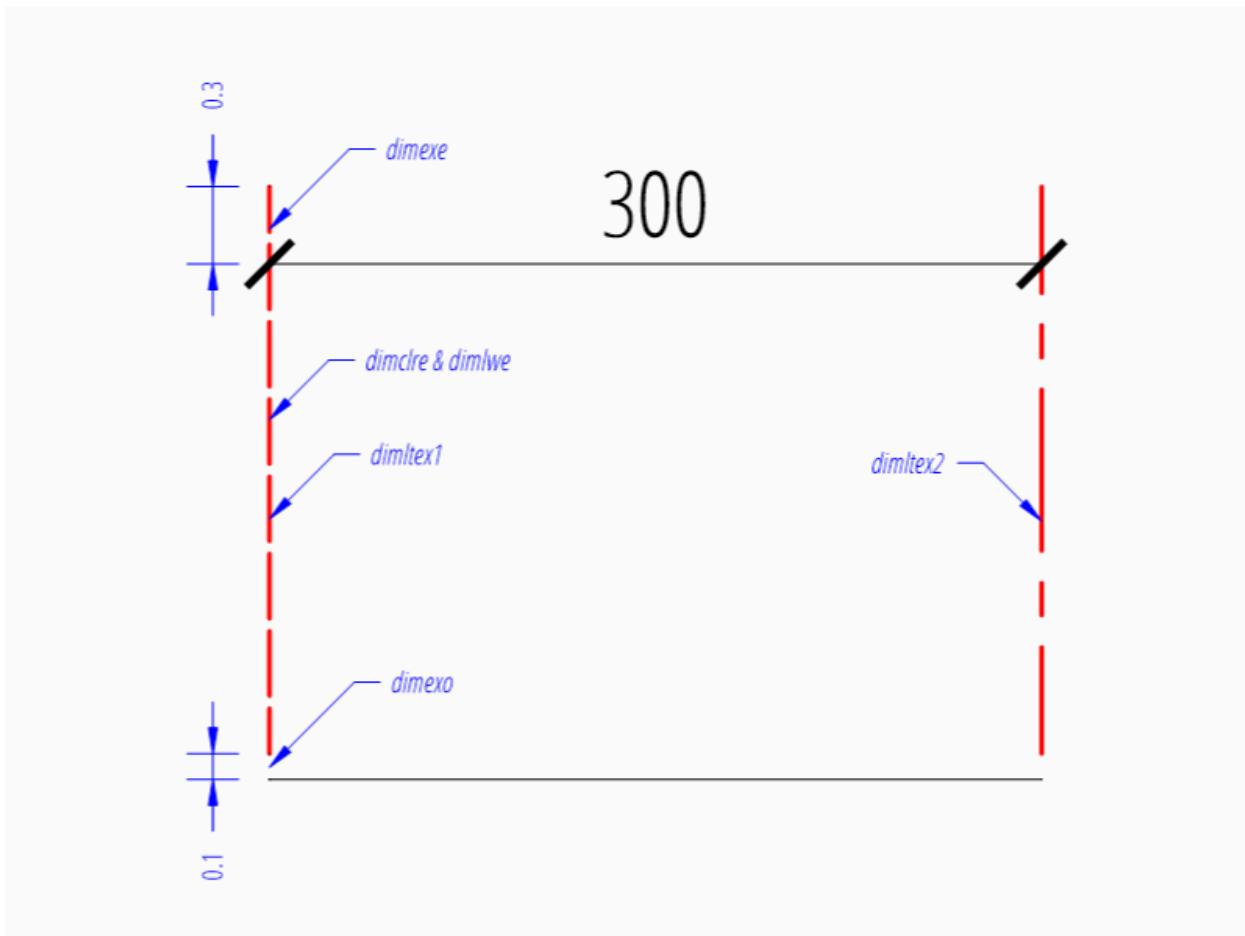
## Extension Line Properties

The *extension line color* is defined by the DIMVAR `dimclre` as *AutoCAD Color Index (ACI)*. The *linetype* for the first and the second extension line is defined by `dimltx1` and `dimltx2` and requires DXF R2007. The *linewidth* is defined by `dimlwe` and required DXF R2000, see also the `linewidth` reference for valid values.

The `dimexe` is the extension of the extension line beyond the dimension line, and `dimexo` defines the offset of the extension line from the measurement point.

DIMVAR	Description
dimclre	extension line color as <i>AutoCAD Color Index (ACI)</i>
dimltex1	linetype of first extension line
dimltex2	linetype of second extension line
dimlwe	line weight of extension line
dimexe	extension beyond dimension line in drawing units
dimexo	offset of extension line from measurement point
dimfxlon	set to 1 to enable fixed length extension line
dimfxl	length of fixed length extension line in drawing units
dimse1	suppress first extension line if 1
dimse2	suppress second extension line if 1

```
msp.add_linear_dim(  
    base=(3, 2),  
    p1=(3, 0),  
    p2=(6, 0),  
    override={  
        "dimclre": 1,      # red  
        "dimltex1": "DASHED2",  
        "dimltex2": "CENTER2",  
        "dimlwe": 35,     # 0.35mm line weight  
        "dimexe": 0.3,    # length above dimension line  
        "dimexo": 0.1,    # offset from measurement point  
    }  
).render()
```

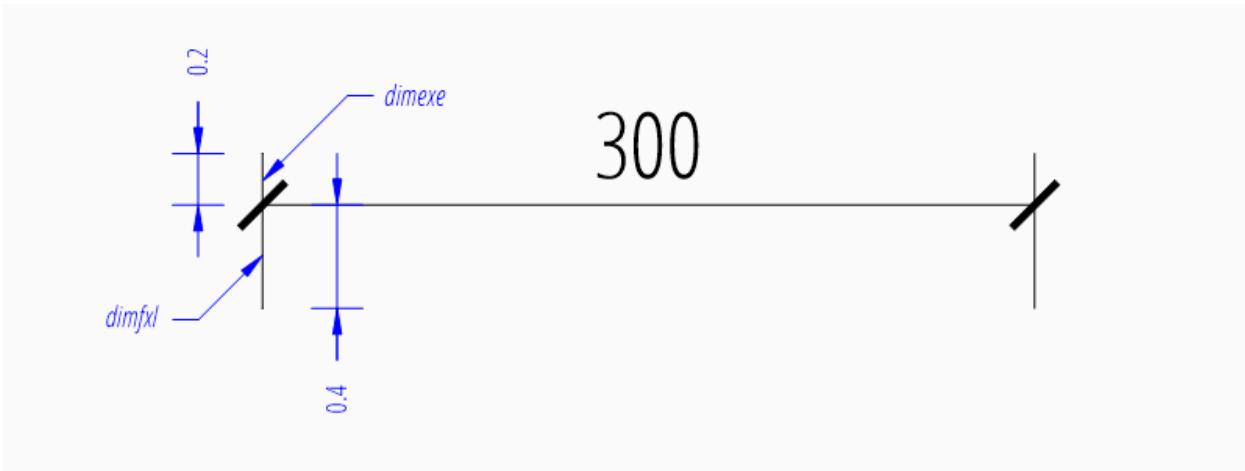


`DimStyleOverride()` methods:

```
dim = msp.add_linear_dim(base=(3, 2), p1=(3, 0), p2=(6, 0))
dim.set_extline_format(color=1, linewidth=35, extension=0.3, offset=0.1)
dim.set_extline1(linetype="DASHED2")
dim.set_extline2(linetype="CENTER2")
dim.render()
```

Fixed length extension lines are supported in DXF R2007, set `dimfxlon` to 1 and `dimfxl` defines the length of the extension line starting at the dimension line.

```
msp.add_linear_dim(
    base=(3, 2),
    p1=(3, 0),
    p2=(6, 0),
    override={
        "dimfxlon": 1, # fixed length extension lines
        "dimexe": 0.2, # length above dimension line
        "dimfxl": 0.4, # length below dimension line
    }
).render()
```



`DimStyleOverride()` method:

```
dim = msp.add_linear_dim(base=(3, 2), p1=(3, 0), p2=(6, 0))
dim.set_extline_format(extension=0.2, fixed_length=0.4)
dim.render()
```

To suppress extension lines set `dimse1` to 1 to suppress the first extension line and `dimse2` to 1 to suppress the second extension line.

```
msp.add_linear_dim(
    base=(3, 2),
    p1=(3, 0),
    p2=(6, 0),
    override={
        "dimse1": 1, # suppress first extension line
        "dimse2": 1, # suppress second extension line
        "dimblk": ezdxf.ARROWS.closed_filled, # arrows just looks better
    }
).render()
```



`DimStyleOverride()` methods:

```
dim = msp.add_linear_dim(base=(3, 2), p1=(3, 0), p2=(6, 0))
dim.set_arrows(blk=ezdxf.ARROWS.closed_filled)
dim.set_extline1(disable=True)
dim.set_extline2(disable=True)
dim.render()
```

## Arrows

“Arrows” mark then beginning and the end of a dimension line, and most of them do not look like arrows.

DXF distinguish between the simple tick (a slanted line) and arrows as blocks.

To use a simple tick as “arrow” set `dimtsz` to a value greater than 0, this also disables arrow blocks as side effect:

```
dim = msp.add_linear_dim(base=(3, 2), p1=(3, 0), p2=(6, 0))
dim.set_tick(size=0.25)
dim.render()
```

*Ezdx*f uses the “ARCTICK” block at double size to render the tick (AutoCAD and BricsCad just draw a simple line), so there is no advantage of using the tick instead of an arrow.

Using arrows:

```
dim = msp.add_linear_dim(base=(3, 2), p1=(3, 0), p2=(6, 0))
dim.set_arrow(blk="OPEN_30", size=0.25)
dim.render()
```

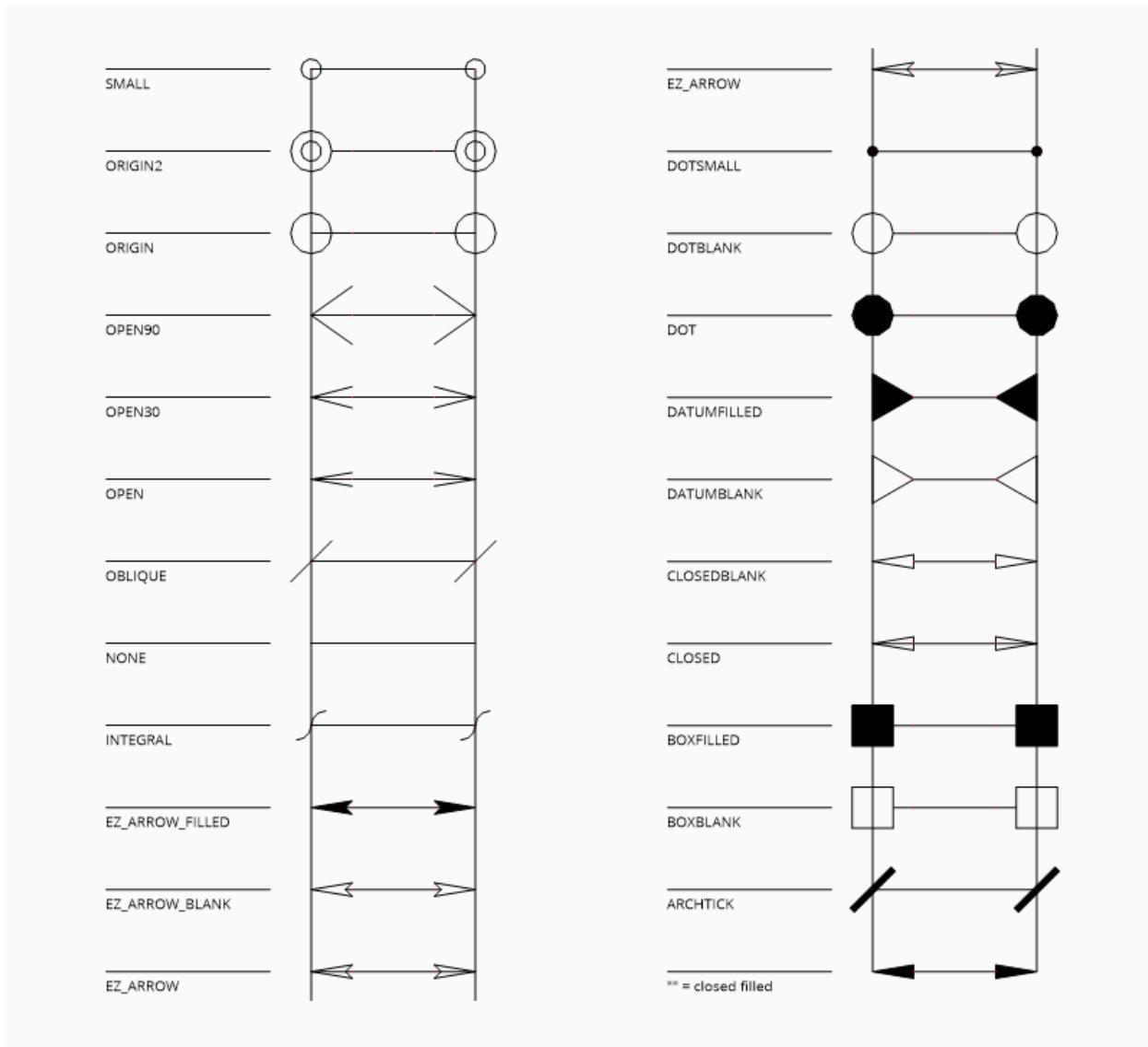
DIMVAR	Description
dimtsz	tick size in drawing units, set to 0 to use arrows
dimblk	set both arrow block names at once
dimblk1	first arrow block name
dimblk2	second arrow block name
dimasz	arrow size in drawing units

```
msp.add_linear_dim(
    base=(3, 2),
    p1=(3, 0),
    p2=(6, 0),
    override={
        "dimtsz": 0, # set tick size to 0 to enable arrow usage
        "dimasz": 0.25, # arrow size in drawing units
        "dimblk": "OPEN_30", # arrow block name
    }
).render()
```

The dimension line extension (`dimdle`) works only for a few arrow blocks and the simple tick:

- “ARCTICK”
- “OBLIQUE”
- “NONE”
- “SMALL”
- “DOTSMALL”
- “INTEGRAL”

## Arrow Shapes



## Arrow Names

The arrow names are stored as attributes in the `ezdxf.ARROWS` object.

closed_filled	"" (empty string)
dot	"DOT"
dot_small	"DOTSMALL"
dot_blank	"DOTBLANK"
origin_indicator	"ORIGIN"
origin_indicator_2	"ORIGIN2"
open	"OPEN"
right_angle	"OPEN90"
open_30	"OPEN30"
closed	"CLOSED"
dot_smallblank	"SMALL"
none	"NONE"
oblique	"OBIQUE"
box_filled	"BOXFILLED"
box	"BOXBLANK"
closed_blank	"CLOSEDBLANK"
datum_triangle_filled	"DATUMFILLED"
datum_triangle	"DATUMBLANK"
integral	"INTEGRAL"
architectural_tick	"ARCTICK"
ez_arrow	"EZ_ARROW"
ez_arrow_blank	"EZ_ARROW_BLANK"
ez_arrow_filled	"EZ_ARROW_FILLED"

## Tolerances and Limits

The tolerances and limits features are implemented by using inline codes for the `MText` entity, therefore DXF R2000 is required. It is not possible to use both tolerances and limits at the same time.

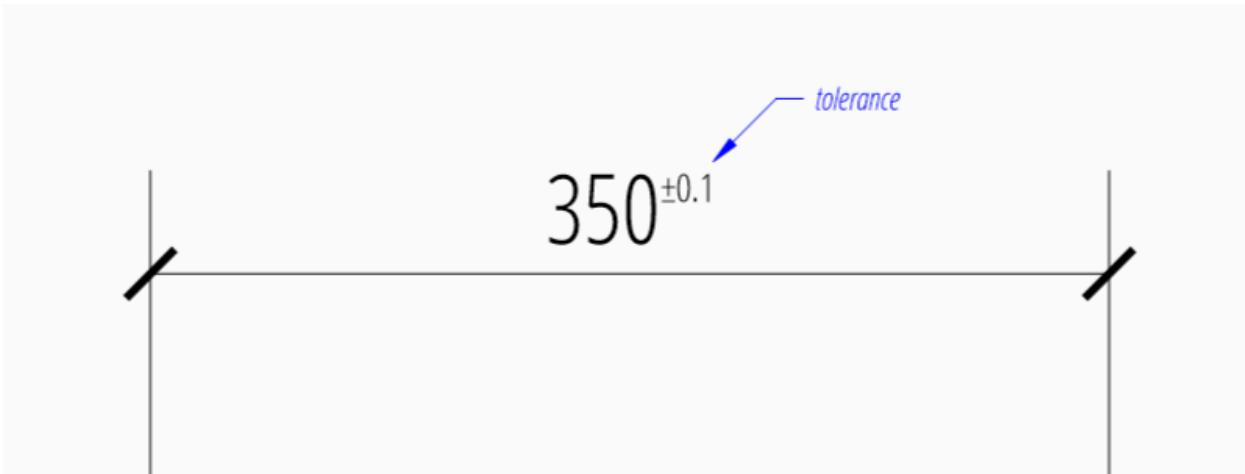
### Tolerances

Geometrical tolerances are shown as additional text appended to the measurement text. It is recommend to use `set_tolerance()` method in `DimStyleOverride` or `DimStyle`.

The attribute `dimtp` defines the upper tolerance value, `dimtm` defines the lower tolerance value if present, else the lower tolerance value is the same as the upper tolerance value. Tolerance values are shown as given!

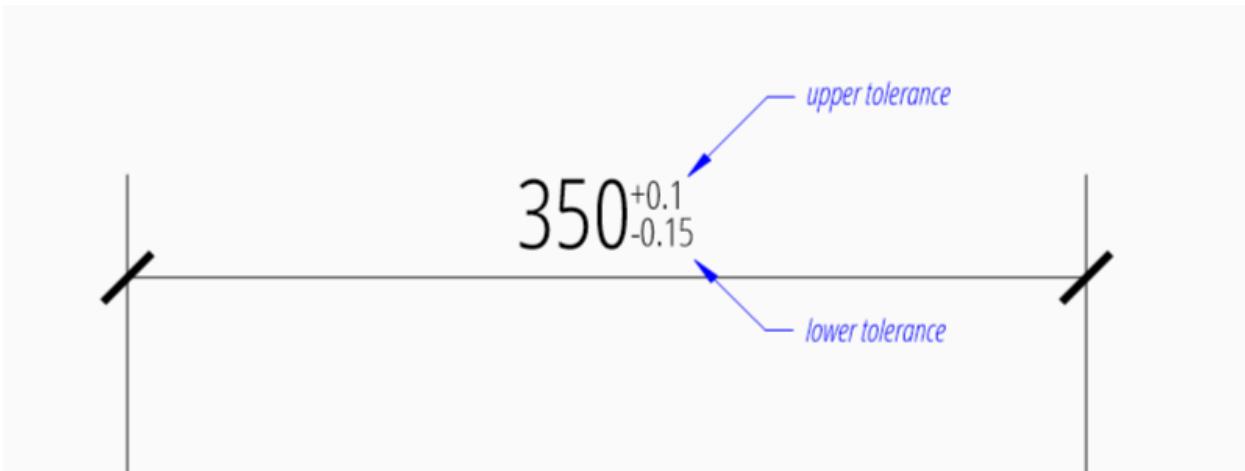
Same upper and lower tolerance value:

```
dim = msp.add_linear_dim(base=(0, 3), p1=(3, 0), p2=(6.5, 0))
dim.set_tolerance(.1, hfactor=.4, align="top", dec=2)
dim.render()
```



Different upper and lower tolerance values:

```
dim = msp.add_linear_dim(base=(0, 3), p1=(3, 0), p2=(6.5, 0))
dim.set_tolerance(upper=.1, lower=-.15, hfactor=.4, align="middle", dec=2)
dim.render()
```



The attribute `dimtfac` specifies a scale factor for the text height of limits and tolerance values relative to the dimension text height, as set by `dimtxt`. For example, if `dimtfac` is set to 1.0, the text height of fractions and tolerances is the same height as the dimension text. If `dimtxt` is set to 0.75, the text height of limits and tolerances is three-quarters the size of dimension text.

Vertical justification for tolerances is specified by `dimtolj`:

<code>dimtolj</code>	Description
0	Align with bottom line of dimension text
1	Align vertical centered to dimension text
2	Align with top line of dimension text

DIM-VAR	Description
dimtol	set to 1 to enable tolerances
dimtp	set the maximum (or upper) tolerance limit for dimension text
dimtm	set the minimum (or lower) tolerance limit for dimension text
dimtfac	specifies a scale factor for the text height of limits and tolerance values relative to the dimension text height, as set by dimtxt.
dimtzin	4 to suppress leading zeros, 8 to suppress trailing zeros or 12 to suppress both, like dimzin for dimension text, see also <a href="#">Text Formatting</a>
dimtolj	set the vertical justification for tolerance values relative to the nominal dimension text.
dimtdec	set the number of decimal places to display in tolerance values

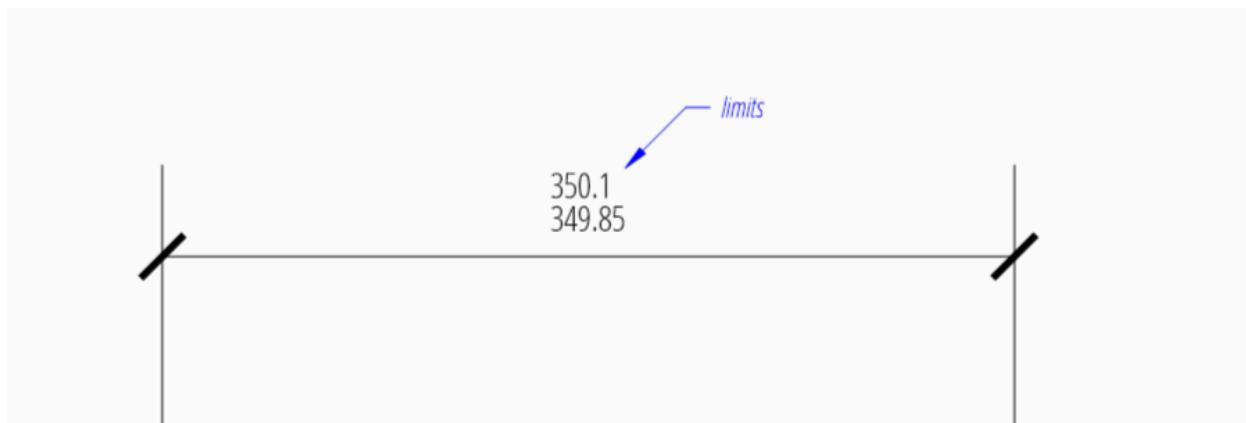
## Limits

The geometrical limits are shown as upper and lower measurement limit and replaces the usual measurement text. It is recommended to use `set_limits()` method in `DimStyleOverride` or `DimStyle`.

For limits the tolerance values are drawing units scaled by measurement factor `dimlfac`, the upper limit is scaled measurement value + `dimtp` and the lower limit is scaled measurement value - `dimtm`.

The attributes `dimtfac`, `dimtzin` and `dimtdec` have the same meaning for limits as for tolerances.

```
dim = msp.add_linear_dim(base=(0, 3), p1=(3, 0), p2=(6.5, 0))
dim.set_limits(upper=.1, lower=.15, hfactor=.4, dec=2)
dim.render()
```



DIMVAR	Description
dimlim	set to 1 to enable limits

## Alternative Units

Alternative units are not supported.

### 6.5.20 Tutorial for Radius Dimensions

Please read the [Tutorial for Linear Dimensions](#) before, if you haven't.

---

**Note:** *Ezdx*f does not consider all DIMSTYLE variables, so the rendering results are different from CAD applications.

---

```
import ezdxf

# DXF R2010 drawing, official DXF version name: 'AC1024',
# setup=True setups the default dimension styles
doc = ezdxf.new("R2010", setup=True)

msp = doc.modelspace()    # add new dimension entities to the modelspace
msp.add_circle((0, 0), radius=3)  # add a CIRCLE entity, not required
# add default radius dimension, measurement text is located outside
dim = msp.add_radius_dim(
    center=(0, 0), radius=3, angle=45, dimstyle="EZ_RADIUS"
)
# necessary second step, to create the BLOCK entity with the dimension geometry.
dim.render()
doc.saveas("radius_dimension.dxf")
```

The example above creates a 45 degrees slanted radius *Dimension* entity, the default dimension style “EZ\_RADIUS” is defined as 1 drawing unit = 1m, drawing scale = 1:100 and the length factor = 100, which creates a measurement text in cm, the default location for the measurement text is outside of the circle.

The *center* point defines the the center of the circle but there doesn’t have to exist a circle entity, *radius* defines the circle radius, which is also the measurement, and *angle* defines the slope of the dimension line, it is also possible to define the circle by a measurement point *mpoint* on the circle.

The return value *dim* is **not** a dimension entity, instead a *DimStyleOverride* object is returned, the dimension entity is stored as *dim.dimension*.

## Placing Measurement Text

There are different predefined DIMSTYLES to achieve various text placing locations.

The basic DIMSTYLE “EZ\_RADIUS” settings are:

- 1 drawing unit = 1m
- scale 1:100
- the length factor *dimlfac* = 100, which creates a measurement text in cm.
- uses a closed filled arrow, arrow size *dimasz* = 0.25

---

**Note:** Not all possibles features of DIMSTYLE are supported by the *ezdx*f rendering procedure and especially for the radial dimension there are less features implemented than for the linear dimension because of the lack of good documentation.

---

### See also:

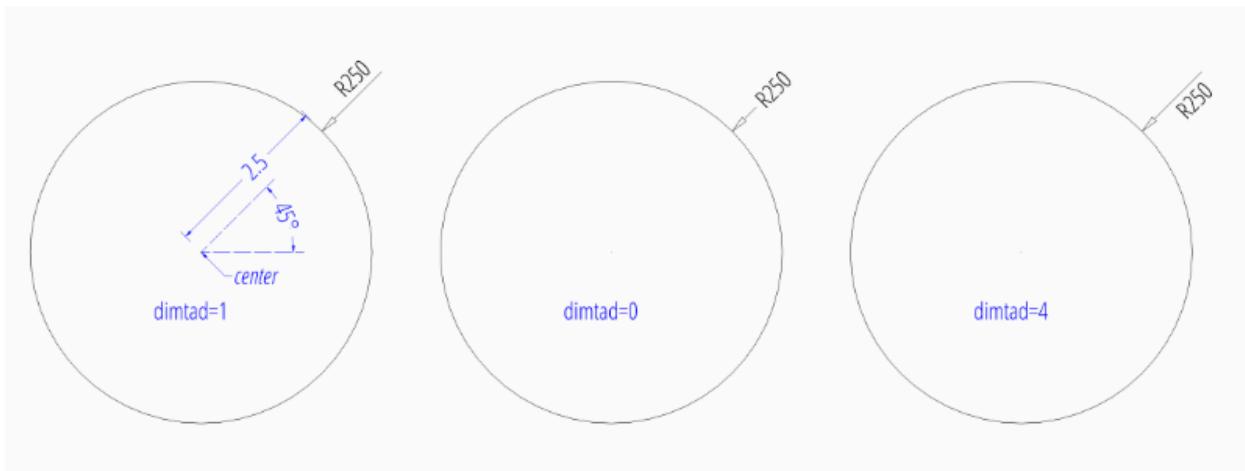
- Graphical reference of many DIMVARS and some advanced information: *DIMSTYLE Table*
- Source code file *standards.py* shows how to create your own DIMSTYLES.
- The Script *dimension\_radius.py* shows examples for radius dimensions.

## Default Text Locations Outside

Advanced “EZ\_RADIUS” settings for placing the text outside of the circle:

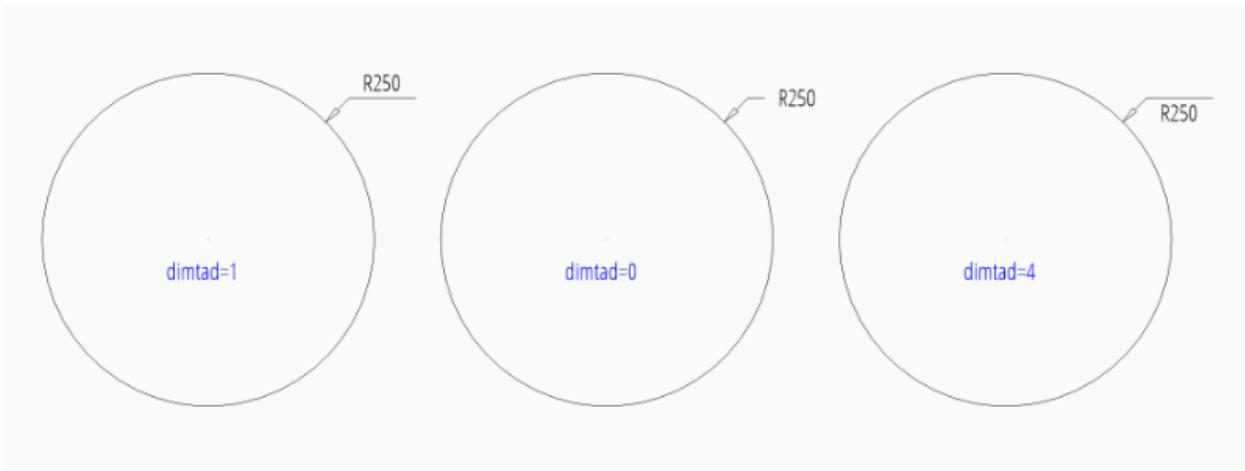
tmove	1 = add a leader when dimension text is moved, this is the best setting for text outside to preserve the appearance of the DIMENSION entity, if editing afterwards in a CAD application.
dimtad	1 = place the text vertical above the dimension line

```
dim = msp.add_radius_dim(
    center=(0, 0),
    radius=2.5,
    angle=45,
    dimstyle="EZ_RADIUS"
)
dim.render()  # always required, but not shown in the following examples
```



To force text outside horizontal set `dimtoh` to 1:

```
dim = msp.add_radius_dim(
    center=(0, 0),
    radius=2.5,
    angle=45,
    dimstyle="EZ_RADIUS",
    override={"dimtoh": 1}
)
```



### Default Text Locations Inside

DIMSTYLE “EZ\_RADIUS\_INSIDE” can be used to place the dimension text inside the circle at a default location.

The basic DIMSTYLE “EZ\_RADIUS\_INSIDE” settings are:

- 1 drawing unit = 1m
- scale 1:100, length\_factor is 100 which creates
- the length factor dimlfac = 100, which creates a measurement text in cm.
- uses a closed filled arrow, arrow size dimasz = 0.25

Advanced “EZ\_RADIUS\_INSIDE” settings to place (force) the text inside of the circle:

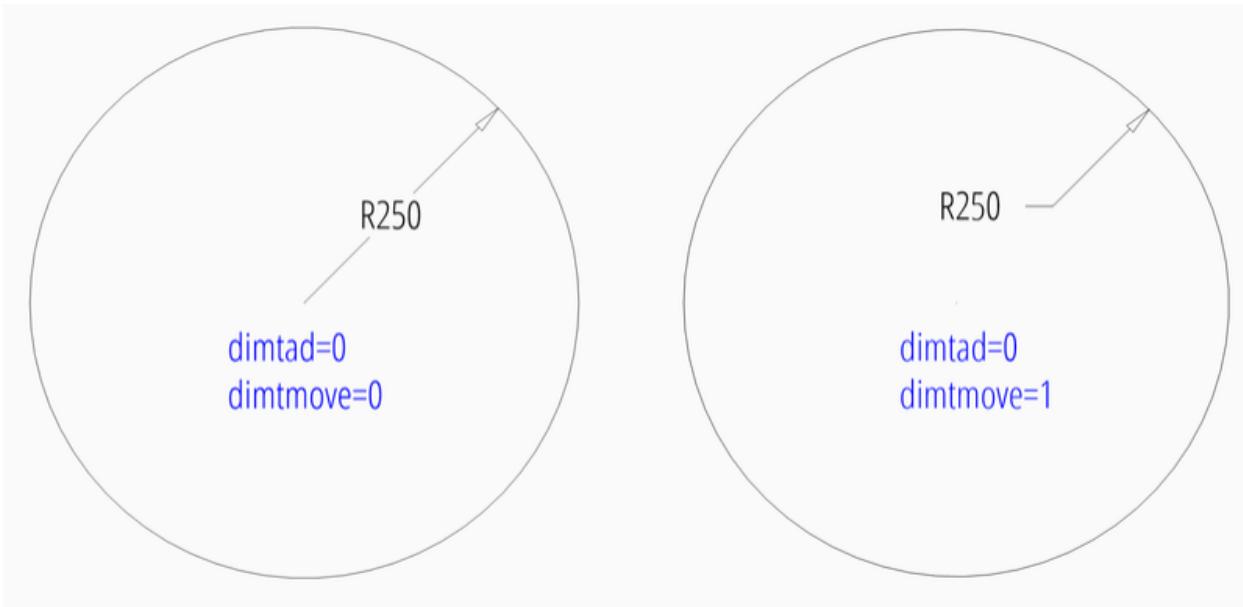
tmove	0 = moves the dimension line with dimension text, this is the best setting for text inside to preserve the appearance of the DIMENSION entity, if editing afterwards in a CAD application.
dimtix	1 = force text inside
dimmat-fit	0 = force text inside, required by BricsCAD and AutoCAD
dimtad	0 = center text vertical, BricsCAD and AutoCAD always create a vertical centered text, <i>ezdxf</i> let you choose the vertical placement (above, below, center), but editing the DIMENSION in BricsCAD or AutoCAD will reset text to center placement.

```
dim = msp.add_radius_dim(
    center=(0, 0),
    radius=2.5,
    angle=45,
    dimstyle="EZ_RADIUS_INSIDE"
)
```



To force text inside horizontal set `dimtih` to 1:

```
dim = msp.add_radius_dim(  
    center=(0, 0),  
    radius=2.5,  
    angle=45,  
    dimstyle="EZ_RADIUS_INSIDE",  
    override={"dimtih": 1}  
)
```



### User Defined Text Locations

Beside the default location it is always possible to override the text location by a user defined location. This location also determines the angle of the dimension line and overrides the argument *angle*. For user defined locations it is not necessary to force text inside (*dimtix*=1), because the location of the text is explicit given, therefore the DIMSTYLE “EZ\_RADIUS” can be used for all this examples.

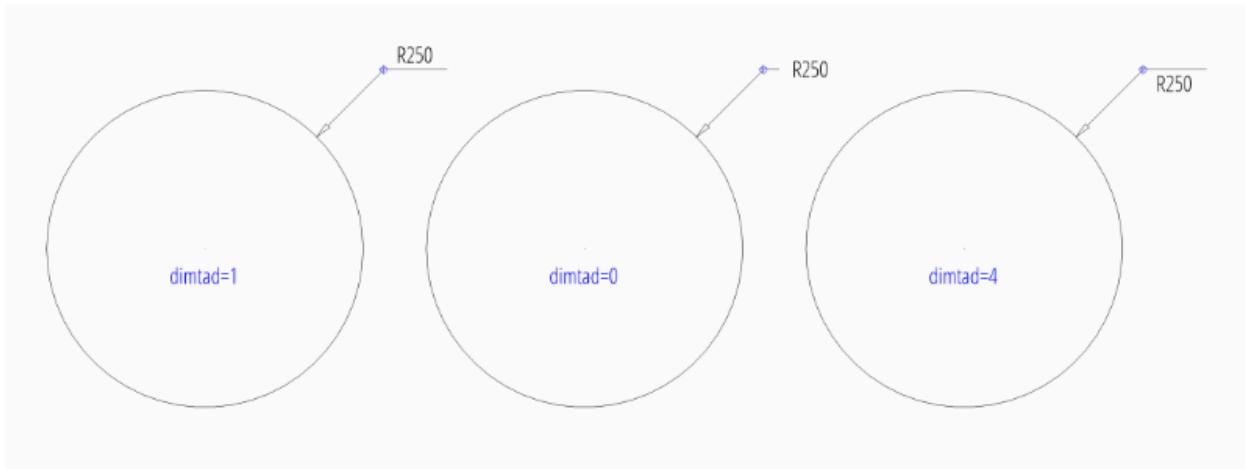
User defined location outside of the circle:

```
dim = msp.add_radius_dim(
    center=(0, 0),
    radius=2.5,
    location=(4, 4),
    dimstyle="EZ_RADIUS"
)
```



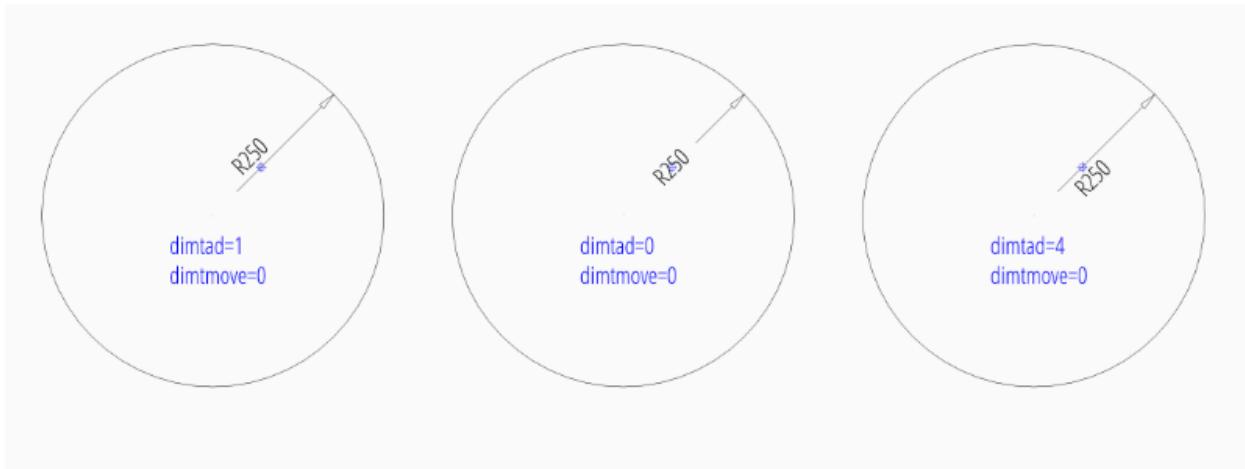
User defined location outside of the circle and forced horizontal text:

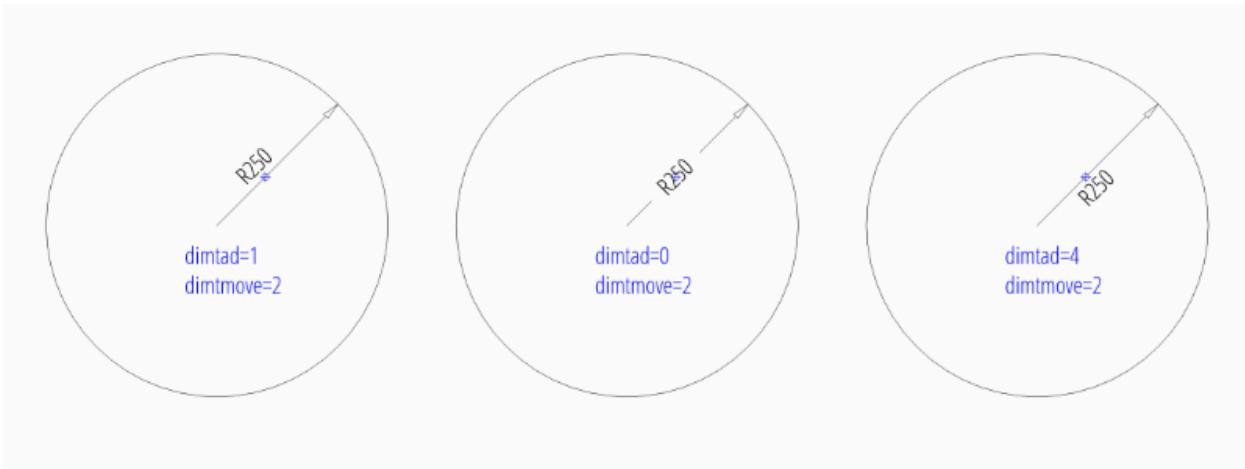
```
dim = msp.add_radius_dim(  
    center=(0, 0),  
    radius=2.5,  
    location=(4, 4),  
    dimstyle="EZ_RADIUS",  
    override={"dimtoh": 1}  
)
```



User defined location inside of the circle:

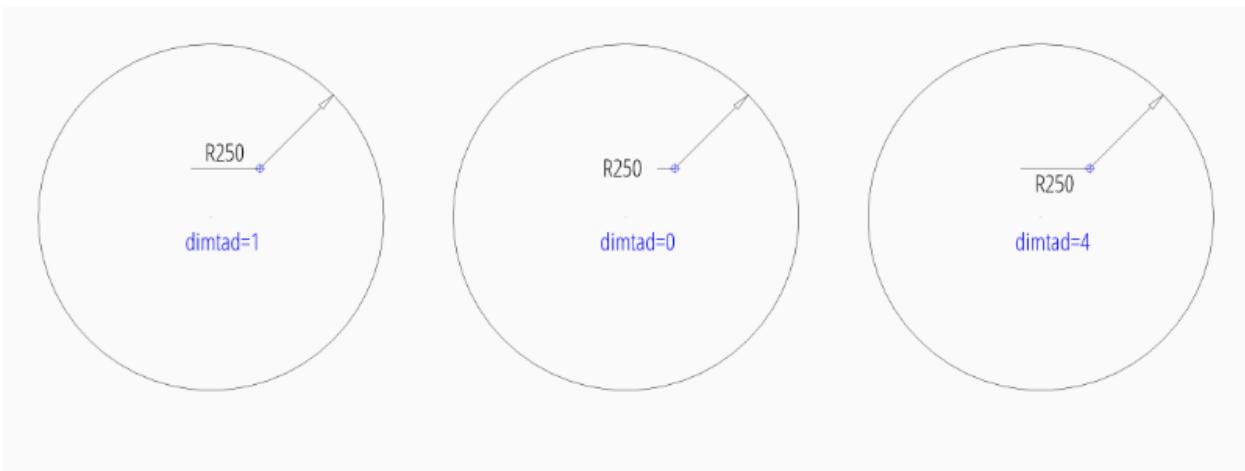
```
dim = msp.add_radius_dim(  
    center=(0, 0),  
    radius=2.5,  
    location=(1, 1),  
    dimstyle="EZ_RADIUS"  
)
```





User defined location inside of the circle and forced horizontal text:

```
dim = msp.add_radius_dim(
    center=(0, 0),
    radius=2.5,
    location=(1, 1),
    dimstyle="EZ_RADIUS",
    override={"dimtih": 1},
)
```



## Center Mark/Lines

Center mark/lines are controlled by `dimcen`, default value is 0 for predefined dimstyles “EZ\_RADIUS” and “EZ\_RADIUS\_INSIDE”:

0	Center mark is off
>0	Create center mark of given size
<0	Create center lines

```
dim = msp.add_radius_dim(
    center=(0, 0),
```

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```
radius=2.5,
angle=45,
dimstyle="EZ_RADIUS",
override={"dimcen": 0.25},
)
```



## Overriding Measurement Text

See Linear Dimension Tutorial: [Overriding Measurement Text](#)

## Measurement Text Formatting and Styling

See Linear Dimension Tutorial: [Measurement Text Formatting and Styling](#)

### 6.5.21 Tutorial for Diameter Dimensions

Please read the [Tutorial for Radius Dimensions](#) before, if you haven't.

---

**Note:** Ezdxf does not consider all DIMSTYLE variables, so the rendering results are different from CAD applications.

---

This is a repetition of the radius tutorial, just with diameter dimensions.

```
import ezdxf

# setup=True setups the default dimension styles
doc = ezdxf.new("R2010", setup=True)

msp = doc.modelspace() # add new dimension entities to the modelspace
msp.add_circle((0, 0), radius=3) # add a CIRCLE entity, not required
# add default diameter dimension, measurement text is located outside
dim = msp.add_diameter_dim(
    center=(0, 0),
    radius=3,
    angle=45,
    dimstyle="EZ_RADIUS"
```

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```
)
dim.render()
doc.saveas("diameter_dimension.dxf")
```

The example above creates a 45 degrees slanted diameter *Dimension* entity, the default dimension style “EZ\_RADIUS” (same as for radius dimensions) is defined as 1 drawing unit = 1m, drawing scale = 1:100 and the length factor = 100, which creates a measurement text in cm, the default location for the measurement text is outside of the circle.

The *center* point defines the the center of the circle but there doesn’t have to exist a circle entity, *radius* defines the circle radius and *angle* defines the slope of the dimension line, it is also possible to define the circle by a measurement point *mpoint* on the circle.

The return value *dim* is **not** a dimension entity, instead a *DimStyleOverride* object is returned, the dimension entity is stored as *dim.dimension*.

## Placing Measurement Text

There are different predefined DIMSTYLES to achieve various text placing locations.

The basic DIMSTYLE “EZ\_RADIUS” settings are:

- 1 drawing unit = 1m
- scale 1:100
- the length factor dimlfac = 100, which creates a measurement text in cm.
- uses a closed filled arrow, arrow size dimasz = 0.25

---

**Note:** Not all possible features of DIMSTYLE are supported by the *ezdxf* rendering procedure and especially for the diameter dimension there are less features implemented than for the linear dimension because of the lack of good documentation.

---

### See also:

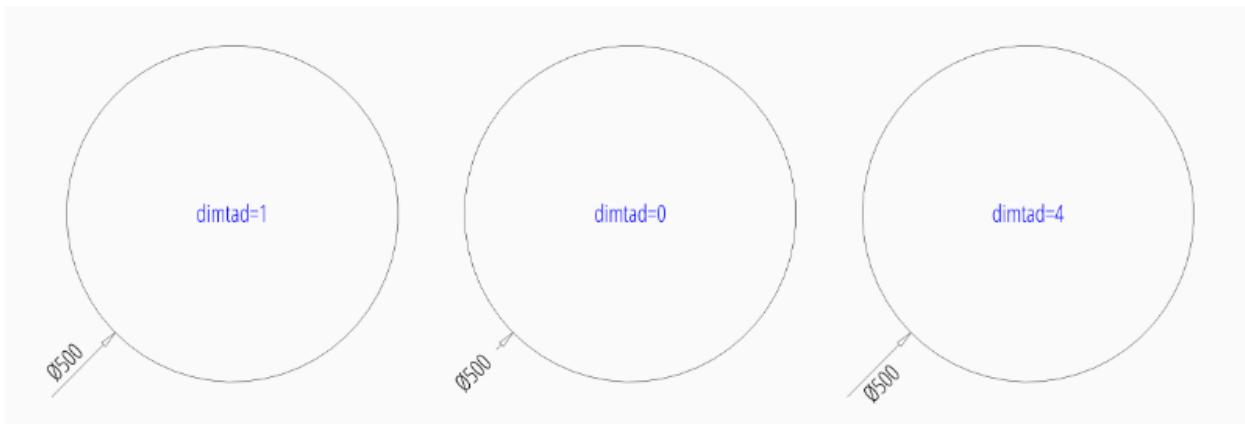
- Graphical reference of many DIMVARS and some advanced information: *DIMSTYLE Table*
- Source code file `standards.py` shows how to create your own DIMSTYLES.
- The Script `dimension_diameter.py` shows examples for radius dimensions.

## Default Text Locations Outside

“EZ\_RADIUS” default settings for to place text outside:

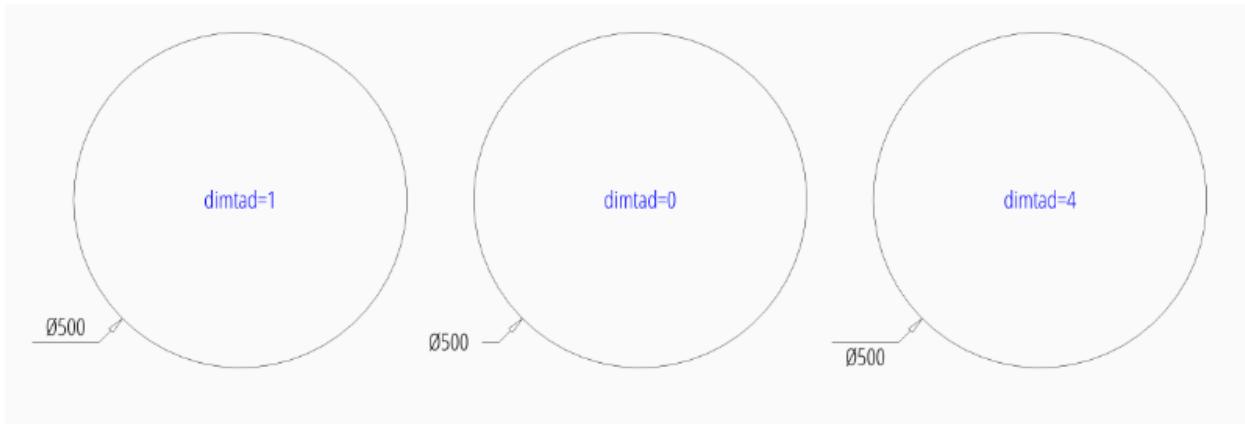
tmove	1 = add a leader when dimension text is moved, this is the best setting for text outside to preserve the appearance of the DIMENSION entity, if editing afterwards in a CAD application.
dim-tad	1 = place the text vertical above the dimension line

```
dim = msp.add_diameter_dim(
    center=(0, 0),
    radius=2.5,
    angle=45,
    dimstyle="EZ_RADIUS"
)
dim.render()  # always required, but not shown in the following examples
```



To force text outside horizontal set `dimtoh` to 1:

```
dim = msp.add_diameter_dim(
    center=(0, 0),
    radius=2.5,
    angle=45,
    dimstyle="EZ_RADIUS",
    override={"dimtoh": 1}
)
```



### Default Text Locations Inside

DIMSTYLE “EZ\_RADIUS\_INSIDE” can be used to place the dimension text inside the circle at a default location.

The basic DIMSTYLE settings are:

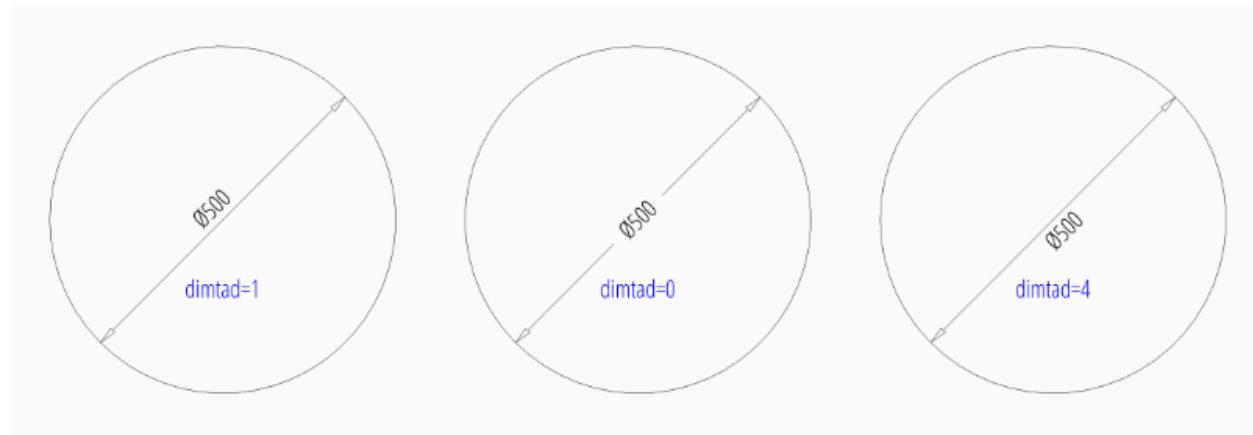
- 1 drawing unit = 1m
- scale 1:100, length\_factor is 100 which creates

- the length factor `dimlfac = 100`, which creates a measurement text in cm.
- uses a closed filled arrow, arrow size `dimasz = 0.25`

Advanced “EZ\_RADIUS\_INSIDE” settings to place (force) the text inside of the circle:

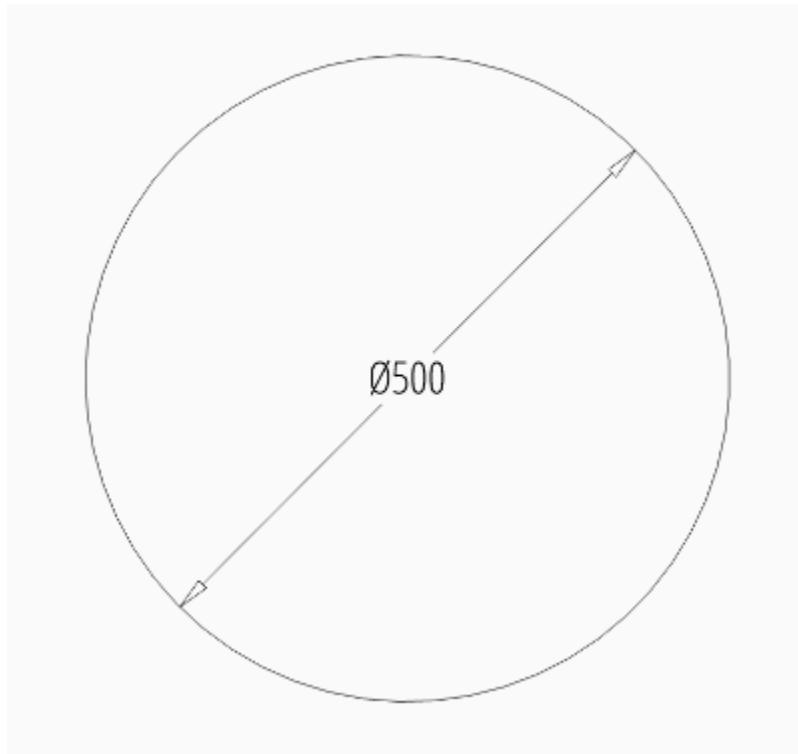
<code>tmove</code>	0 = moves the dimension line with dimension text, this is the best setting for text inside to preserve the appearance of the DIMENSION entity, if editing afterwards in a CAD application.
<code>dmtix</code>	1 = force text inside
<code>dimmatfit</code>	0 = force text inside, required by BricsCAD and AutoCAD
<code>dimtad</code>	0 = center text vertical, BricsCAD and AutoCAD always create a vertical centered text, <i>ezdxf</i> let you choose the vertical placement (above, below, center), but editing the DIMENSION in BricsCAD or AutoCAD will reset text to center placement.

```
dim = msp.add_diameter_dim(
    center=(0, 0),
    radius=2.5,
    angle=45,
    dimstyle="EZ_RADIUS_INSIDE"
)
```



To force text inside horizontal set `dmtih` to 1:

```
dim = msp.add_diameter_dim(
    center=(0, 0),
    radius=2.5,
    angle=45,
    dimstyle="EZ_RADIUS_INSIDE",
    override={"dmtih": 1}
)
```

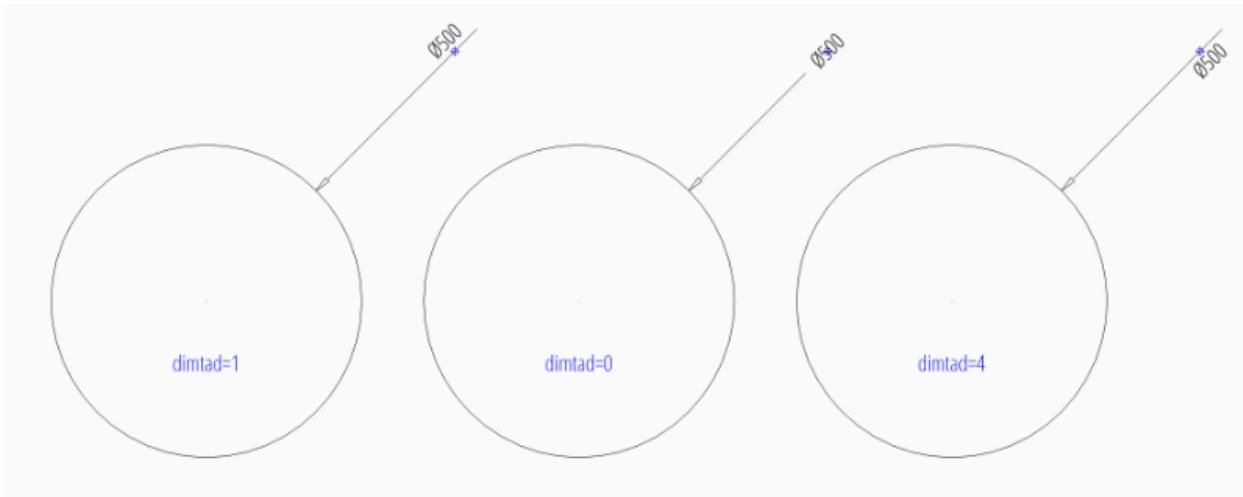


## User Defined Text Locations

Beside the default location it is always possible to override the text location by a user defined location. This location also determines the angle of the dimension line and overrides the argument *angle*. For user defined locations it is not necessary to force text inside (`dimtext=1`), because the location of the text is explicit given, therefore the DIMSTYLE “EZ\_RADIUS” can be used for all this examples.

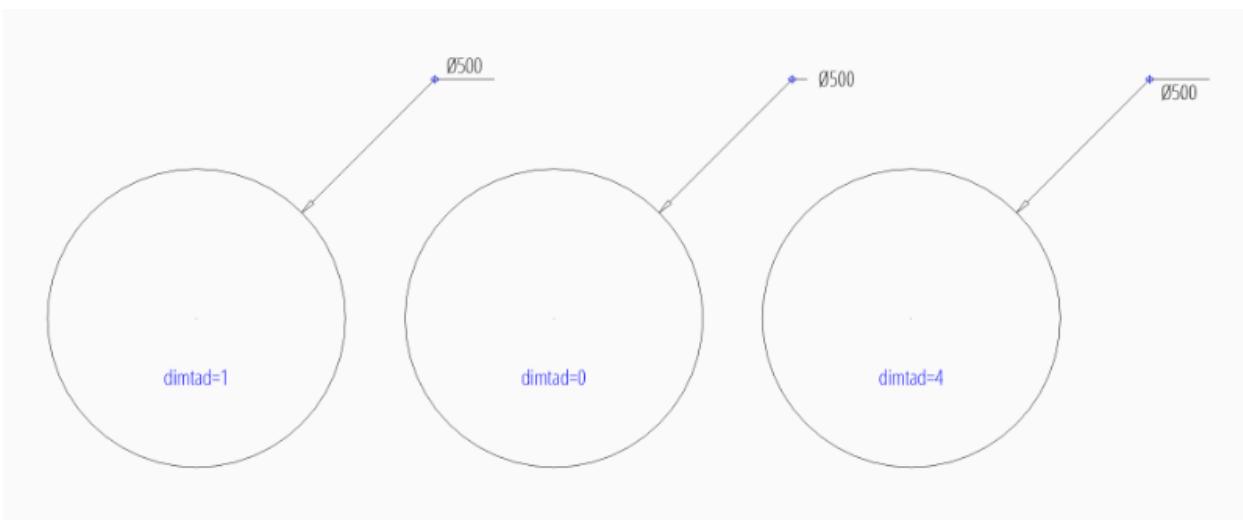
User defined location outside of the circle:

```
dim = msp.add_diameter_dim(  
    center=(0, 0),  
    radius=2.5,  
    location=(4, 4),  
    dimstyle="EZ_RADIUS"  
)
```



User defined location outside of the circle and forced horizontal text:

```
dim = msp.add_diameter_dim(  
    center=(0, 0),  
    radius=2.5,  
    location=(4, 4),  
    dimstyle="EZ_RADIUS",  
    override={"dimtoh": 1}  
)
```



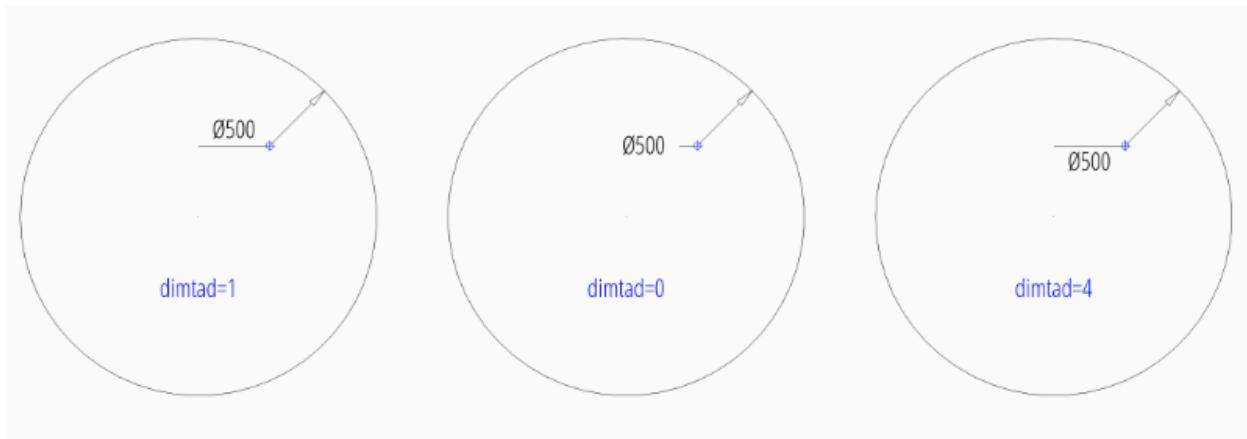
User defined location inside of the circle:

```
dim = msp.add_diameter_dim(  
    center=(0, 0),  
    radius=2.5,  
    location=(1, 1),  
    dimstyle="EZ_RADIUS"  
)
```



User defined location inside of the circle and forced horizontal text:

```
dim = msp.add_diameter_dim(
    center=(0, 0),
    radius=2.5,
    location=(1, 1),
    dimstyle="EZ_RADIUS",
    override={"dimtih": 1},
)
```



## Center Mark/Lines

See Radius Dimension Tutorial: [Center Mark/Lines](#)

## Overriding Measurement Text

See Linear Dimension Tutorial: [Overriding Measurement Text](#)

## Measurement Text Formatting and Styling

See Linear Dimension Tutorial: [Measurement Text Formatting and Styling](#)

## 6.5.22 Tutorial for Angular Dimensions

Please read the [Tutorial for Linear Dimensions](#) before, if you haven't.

---

**Note:** *Ezdx*f does not consider all DIMSTYLE variables, so the rendering results are different from CAD applications.

---

### Dimension Style “EZ\_CURVED”

All factory methods to create angular dimensions uses the dimension style “EZ\_CURVED” for curved dimension lines which is defined as:

- angle unit is decimal degrees, dimaunit = 0
- measurement text height = 0.25 (drawing scale = 1:100)
- measurement text location is above the dimension line
- closed filled arrow and arrow size dimasz = 0.25
- dimazin = 2, suppresses trailing zeros (e.g. 12.5000 becomes 12.5)

This DIMENSION style only exist if the argument *setup* is True for creating a new DXF document by *ezdxf.new()*. Every dimension style which does not exist will be replaced by the dimension style “Standard” at DXF export by *save()* or *saveas()* (e.g. dimension style setup was not initiated).

Add all *ezdxf* specific resources (line types, text- and dimension styles) to an existing DXF document:

```
import ezdxf
from ezdxf.tools.standards import setup_drawing

doc = ezdxf.readfile("your.dxf")
setup_drawing(doc, topics="all")
```

### Factory Methods to Create Angular Dimensions

#### Defined by Center, Radius and Angles

The first example shows an angular dimension defined by the center point, radius, start- and end angles:

```
import ezdxf

# Create a DXF R2010 document:
# Use argument setup=True to setup the default dimension styles.
doc = ezdxf.new("R2010", setup=True)

# Add new entities to the modelspace:
msp = doc.modelspace()

# Add an angular DIMENSION defined by the center point, start- and end angles,
# the measurement text is placed at the default location above the dimension
# line:
dim = msp.add_angular_dim_cra(
    center=(5, 5), # center point of the angle
    radius=7, # distance from center point to the start of the extension lines
    start_angle=60, # start angle in degrees
```

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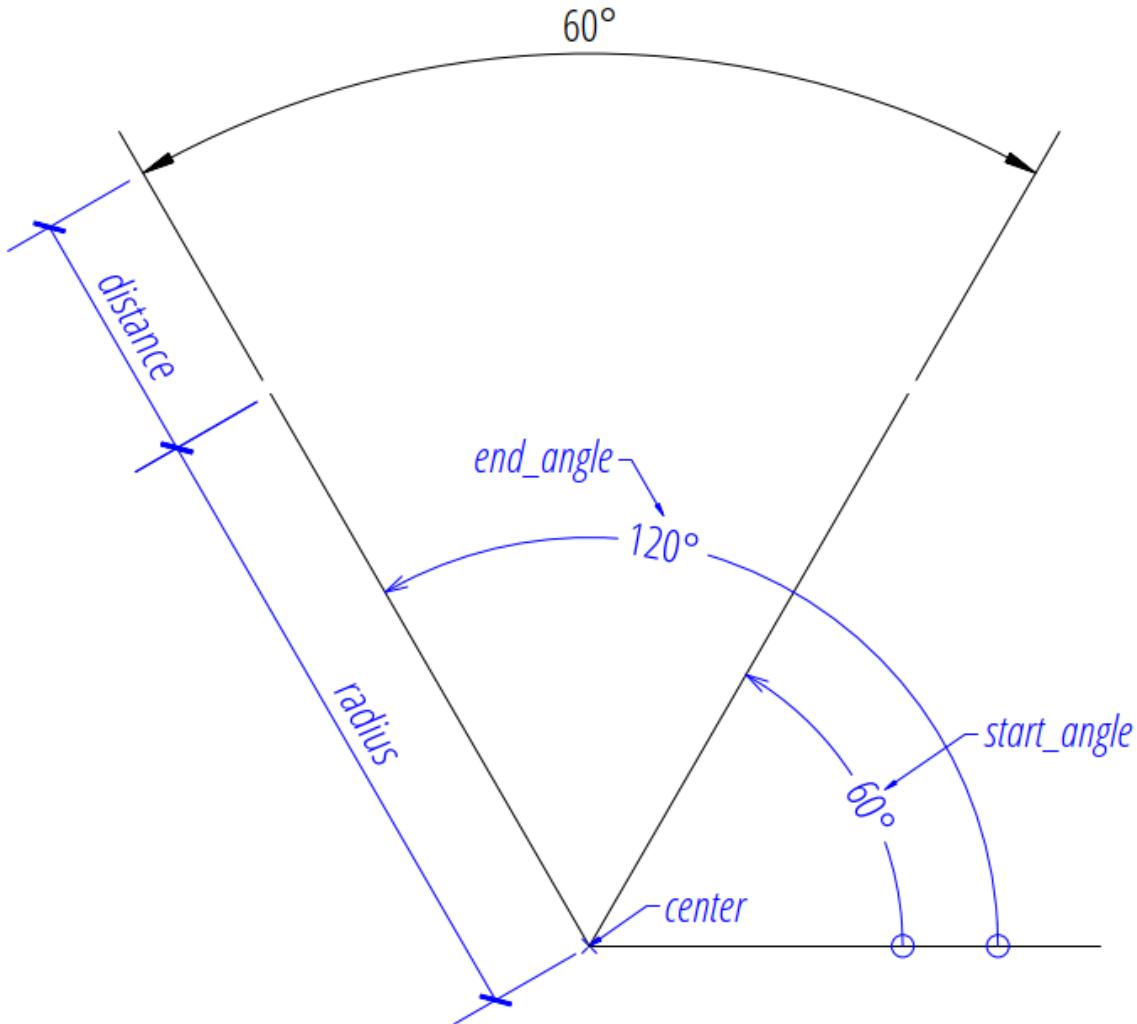
```

end_angle=120, # end angle in degrees
distance=3, # distance from start of the extension lines to the dimension line
dimstyle="EZ_CURVED", # default angular dimension style
)

# Necessary second step to create the BLOCK entity with the dimension geometry.
# Additional processing of the DIMENSION entity could happen between adding
# the entity and the rendering call.
dim.render()
doc.saveas("angular_dimension_cra.dxf")

```

The return value `dim` is **not** a dimension entity, instead a `DimStyleOverride` object is returned, the dimension entity is stored as `dim.dimension`.



### Angle by 2 Lines

The next example shows an angular dimension for an angle defined by two lines:

```
import ezdxf

doc = ezdxf.new(setup=True)
msp = doc.modelspace()

# Setup the geometric parameters for the DIMENSION entity:
base = (5.8833, -6.3408) # location of the dimension line
p1 = (2.0101, -7.5156) # start point of 1st leg
p2 = (2.7865, -10.4133) # end point of 1st leg
p3 = (6.7054, -7.5156) # start point of 2nd leg
p4 = (5.9289, -10.4133) # end point of 2nd leg

# Draw the lines for visualization, not required to create the
# DIMENSION entity:
msp.add_line(p1, p2)
msp.add_line(p3, p4)

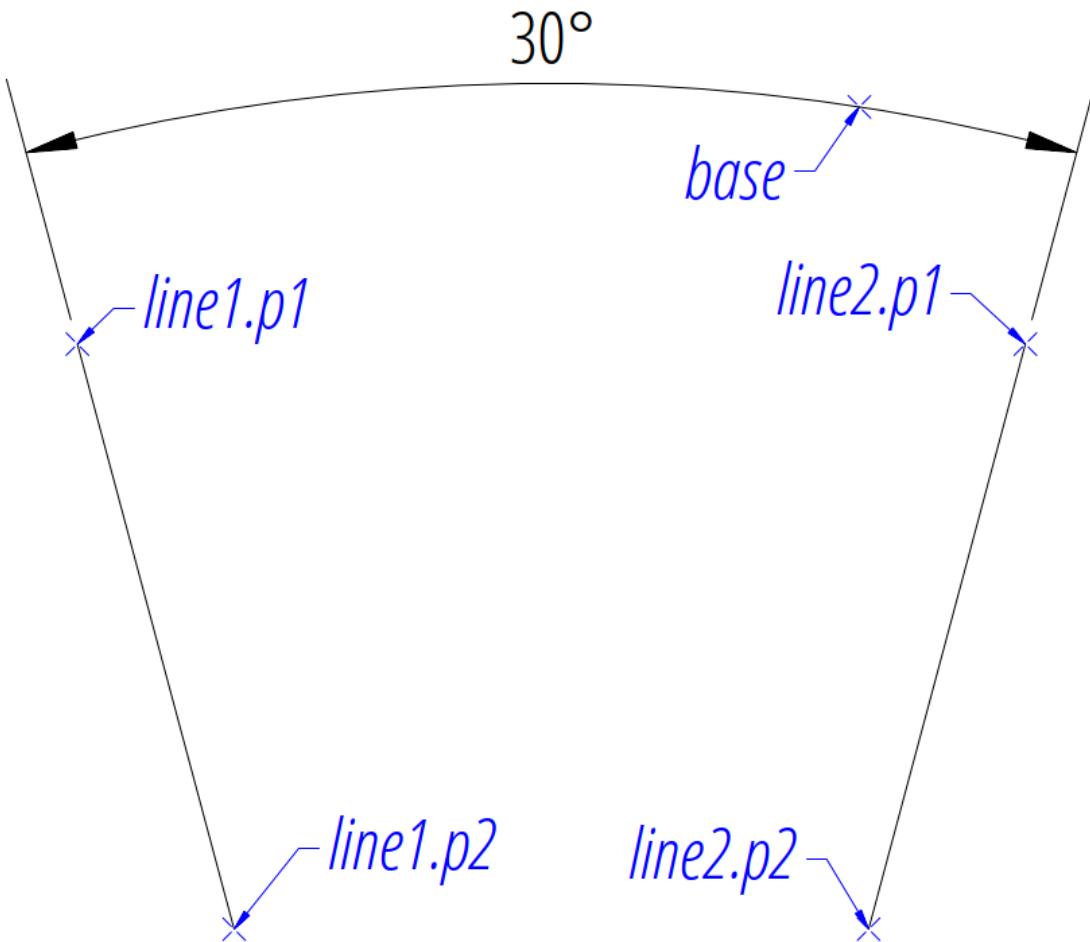
# Add an angular DIMENSION defined by two lines, the measurement text is
# placed at the default location above the dimension line:
dim = msp.add_angular_dim_2l(
    base=base, # defines the location of the dimension line
    line1=(p1, p2), # start leg of the angle
    line2=(p3, p4), # end leg of the angle
    dimstyle="EZ_CURVED", # default angular dimension style
)

# Necessary second step to create the dimension line geometry:
dim.render()
doc.saveas("angular_dimension_2l.dxf")
```

The example above creates an angular *Dimension* entity to measures the angle between two lines (*line1* and *line2*).

The *base* point defines the location of the dimension line (arc), any point on the dimension line is valid. The points *p1* and *p2* define the first leg of the angle, *p1* also defines the start point of the first extension line. The points *p3* and *p4* define the second leg of the angle and point *p3* also defines the start point of the second extension line.

The measurement of the DIMENSION entity is the angle enclosed by the first and the second leg and where the dimension line passes the *base* point.



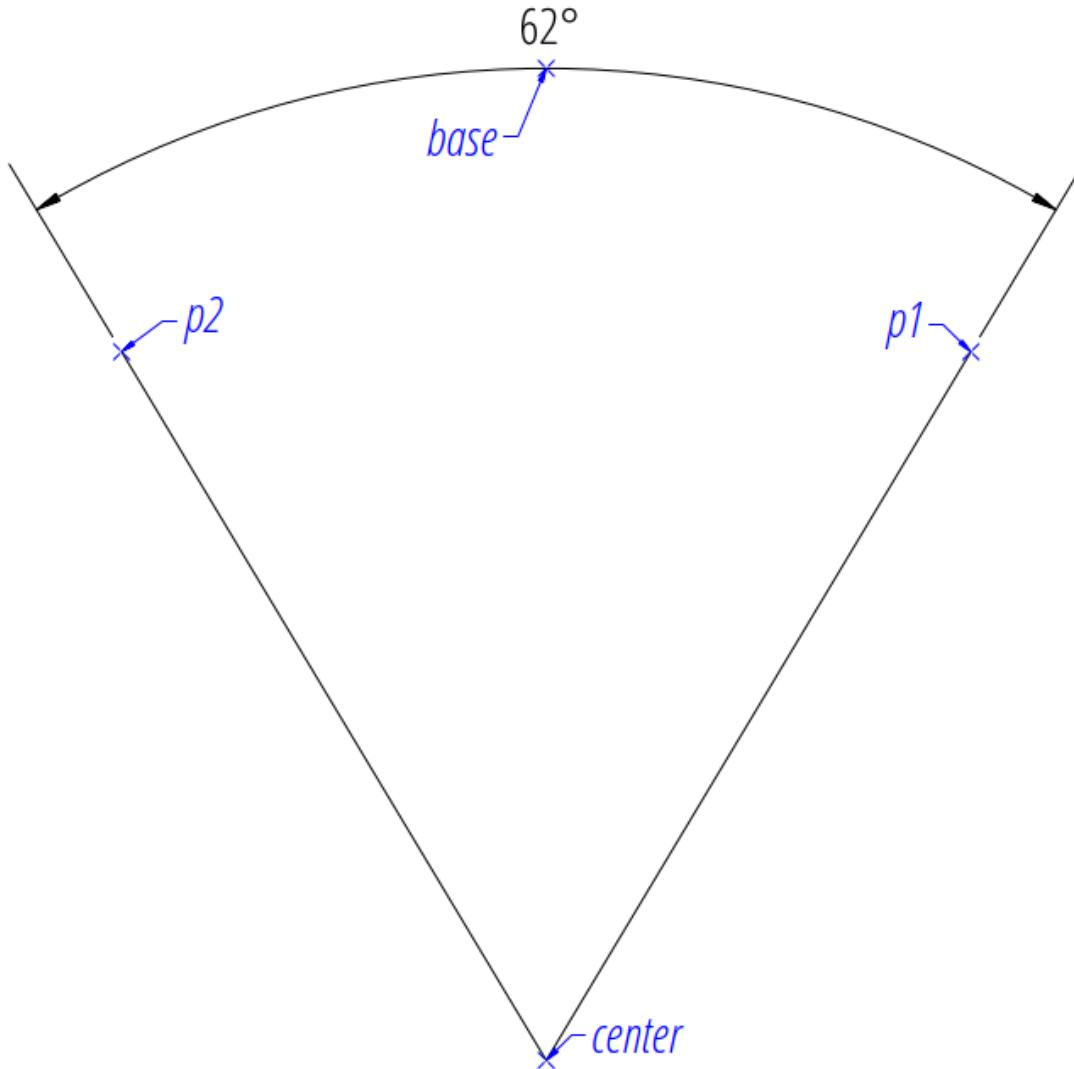
### Angle by 3 Points

The next example shows an angular dimension defined by three points, a center point and the two end points of the angle legs:

```
import ezdxf

doc = ezdxf.new(setup=True)
msp = doc.modelspace()

msp.add_angular_dim_3p(
    base=(0, 7), # location of the dimension line
    center=(0, 0), # center point
    p1=(-3, 5), # end point of 1st leg = start angle
    p2=(3, 5), # end point of 2nd leg = end angle
).render()
```



## Angle from ConstructionArc

The `ezdxf.math.ConstructionArc` provides various class methods for creating arcs and the construction tool can be created from an ARC entity.

Add an angular dimension to an ARC entity:

```
import ezdxf

doc = ezdxf.new(setup=True)
msp = doc.modelspace()

arc = msp.add_arc(
    center=(0, 0),
    radius=5,
    start_angle = 60,
```

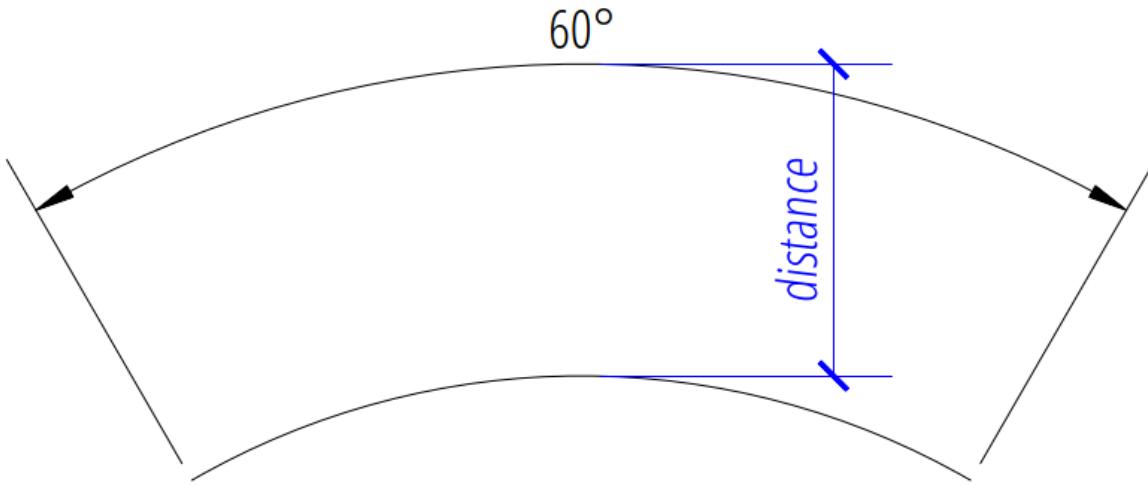
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```

        end_angle = 120,
)
msp.add_angular_dim_arc(
    arc.construction_tool(),
    distance=2,
).render()

```



## Placing Measurement Text

The default location of the measurement text depends on various *DimStyle* parameters and is applied if no user defined text location is defined.

---

**Note:** Not all possible features of DIMSTYLE are supported by the *ezdxf* rendering procedure and especially for the angular dimension there are less features implemented than for the linear dimension because of the lack of good documentation.

---

### See also:

- Graphical reference of many DIMVARS and some advanced information: [DIMSTYLE Table](#)
- Source code file `standards.py` shows how to create your own DIMSTYLES.
- The Script `dimension_angular.py` shows examples for angular dimensions.

## Default Text Locations

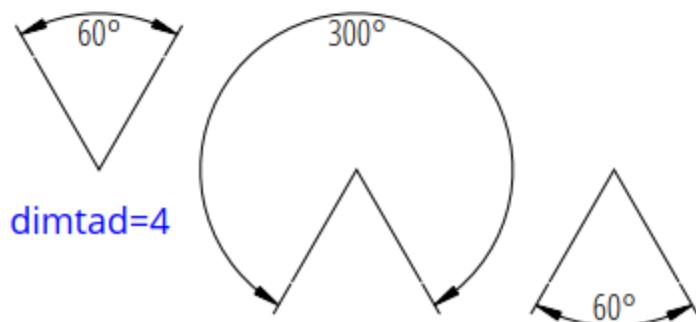
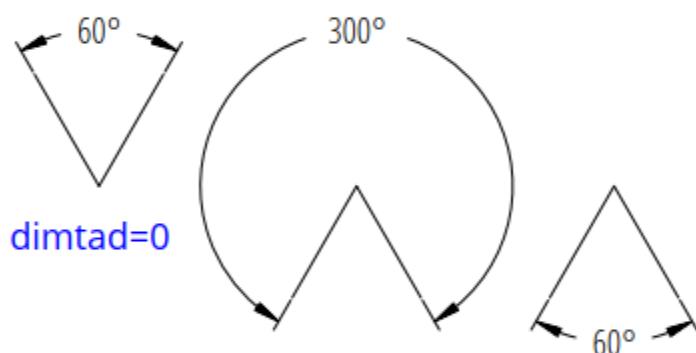
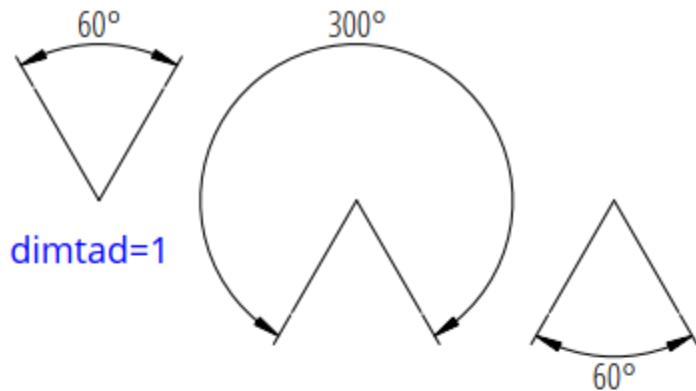
The DIMSTYLE “EZ\_CURVED” places the measurement text in the center of the angle above the dimension line. The first examples above show the measurement text at the default text location.

The text direction angle is always perpendicular to the line from the text center to the center point of the angle unless this angle is manually overridden.

The “vertical” location of the measurement text relative to the dimension line is defined by `dimtad`:

0	Center, it is possible to adjust the vertical location by <a href="#">dimtvp</a>
1	Above
2	Outside, handled like <i>Above</i> by <i>ezdxf</i>
3	JIS, handled like <i>Above</i> by <i>ezdxf</i>
4	Below

```
msp.add_angular_dim_cra(  
    center=(3, 3),  
    radius=3,  
    distance=1,  
    start_angle=60,  
    end_angle=120,  
    override={  
        "dimtad": 1, # 0=center; 1=above; 4=below;  
    },  
) .render()
```



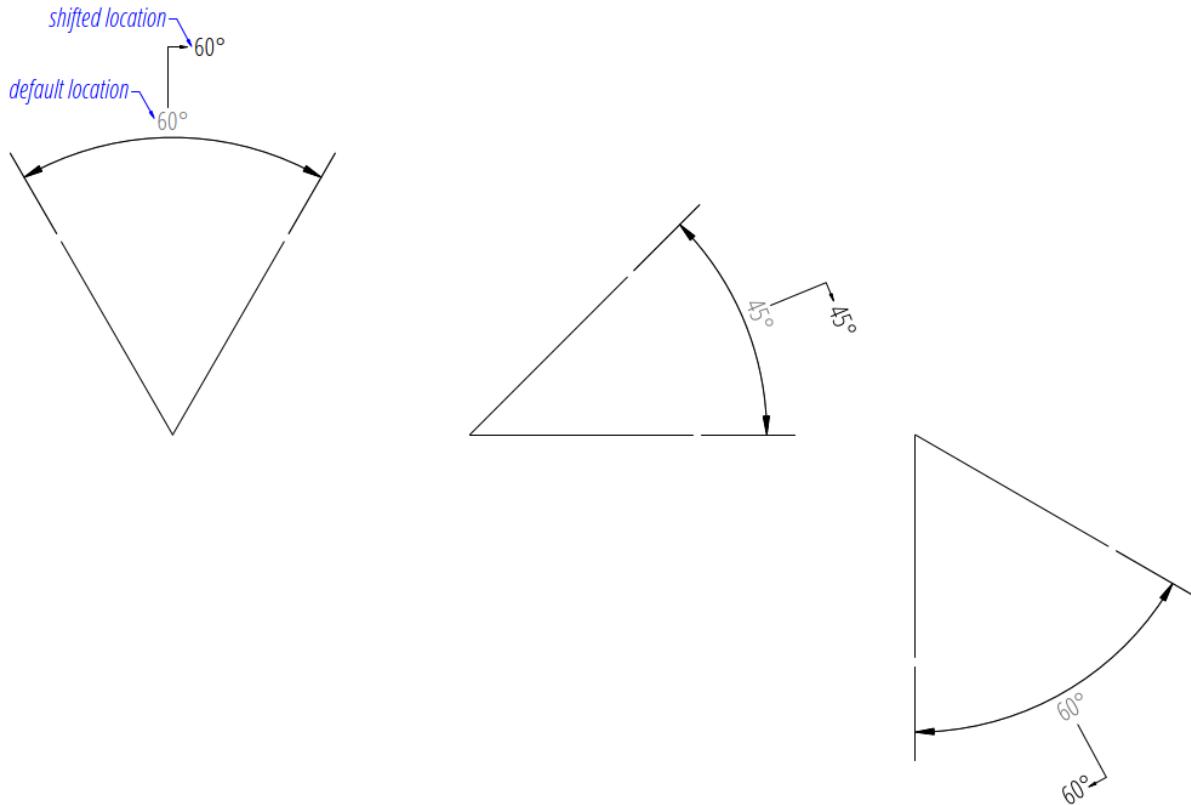
Arrows and measurement text are placed “outside” automatically if the available space between the extension lines isn’t sufficient. This overrides the `dimtad` value by 1 (“above”). *Ezdx*f follows its own rules, ignores the `dimatfit` attribute and works similar to `dimatfit = 1`, move arrows first, then text:



## Shift Text From Default Location

The method `shift_text()` shifts the measurement text away from the default location. The shifting direction is aligned to the text rotation of the default measurement text.

```
dim = msp.add_angular_dim_cra(
    center=(3, 3),
    radius=3,
    distance=1,
    start_angle=60,
    end_angle=120,
)
# shift text from default text location:
dim.shift_text(0.5, 1.0)
dim.render()
```



This is just a rendering effect, editing the dimension line in a CAD application resets the text to the default location.

## User Defined Text Locations

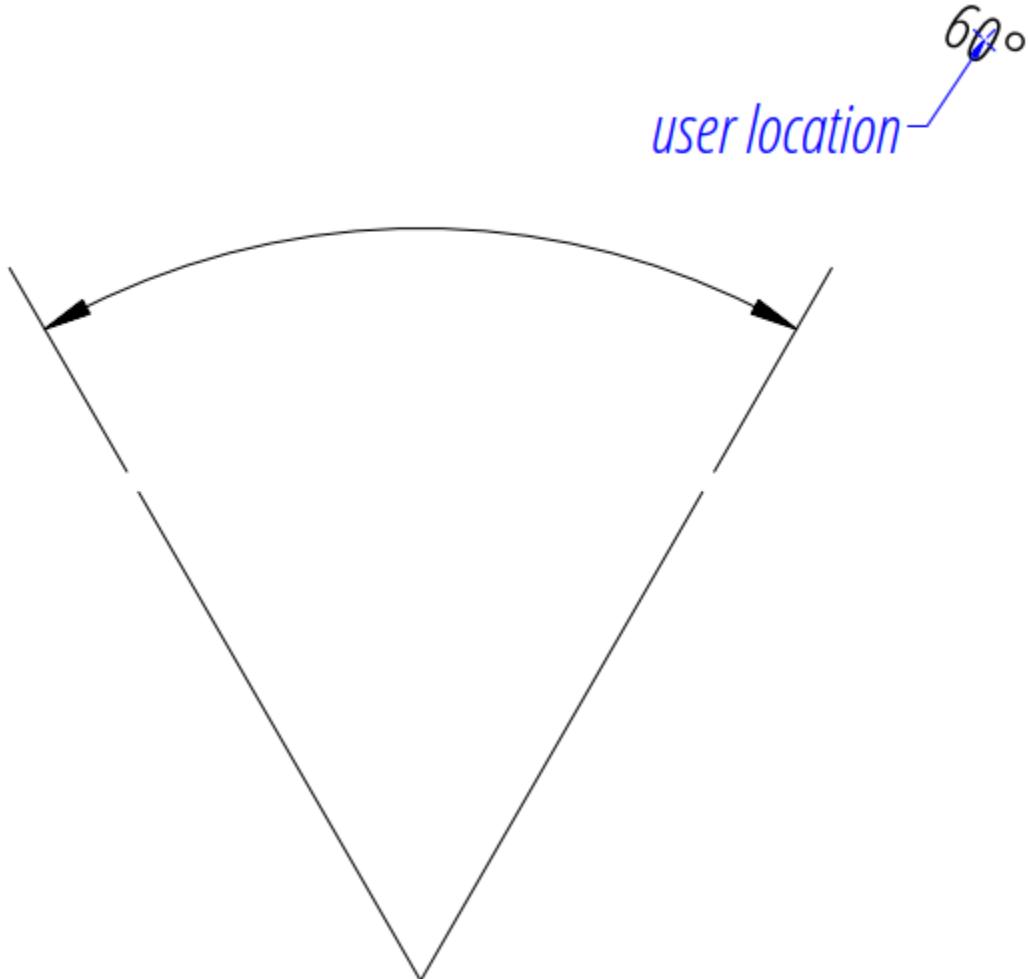
Beside the default location it is always possible to override the text location by a user defined location.

The coordinates of user locations are located in the rendering UCS and the default rendering UCS is the [WCS](#).

### Absolute User Location

Absolute placing of the measurement text means relative to the origin of the render UCS. The user location is stored in the DIMENSION entity, which means editing the dimension line in a CAD application does not alter the text location. This location also determines the rotation of the measurement text.

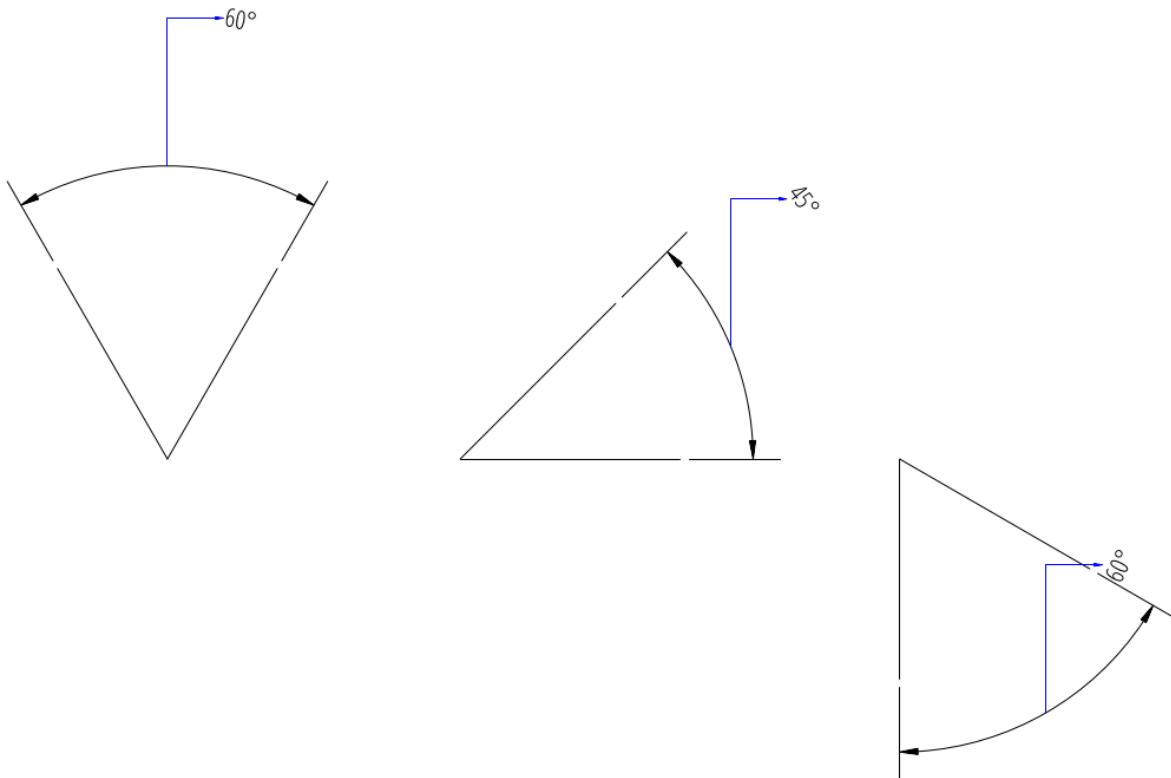
```
dim = msp.add_angular_dim_cra(  
    center=(3, 3),  
    radius=3,  
    distance=1,  
    start_angle=60,  
    end_angle=120,  
    location=(5, 8),  # user defined measurement text location  
)  
dim.render()
```



## Relative User Location

Relative placing of the measurement text means relative to the middle of the dimension line. This is only possible by calling the `set_location()` method, and the argument `relative` has to be `True`. The user location is stored in the `DIMENSION` entity, which means editing the dimension line in a CAD application does not alter the text location. This location also determines the rotation of the measurement text.

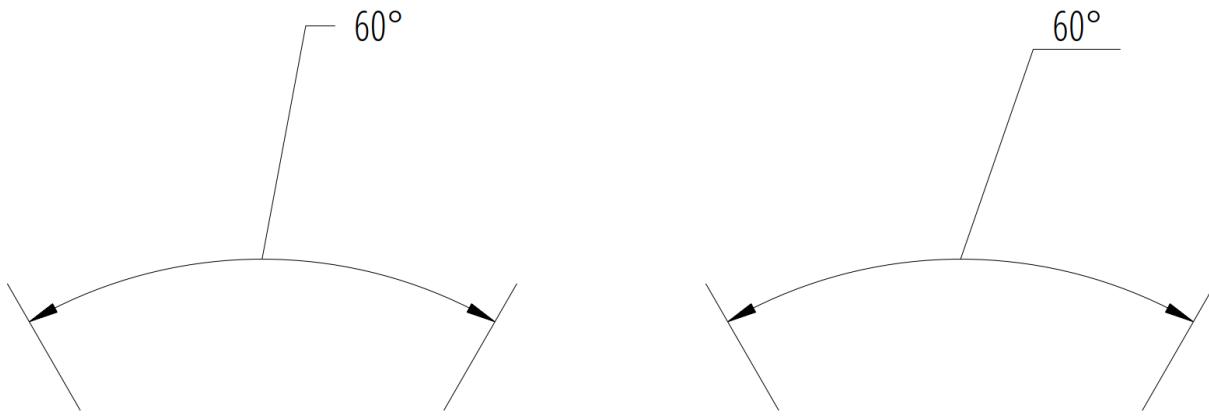
```
dim = msp.add_angular_dim_cra(
    center=(3, 3),
    radius=3,
    distance=1,
    start_angle=60,
    end_angle=120,
)
dim.set_location((1, 2), relative=True)
dim.render()
```



## Adding a Leader

The method `set_location()` has the option to add a leader line to the measurement text. This also aligns the text rotation to the render UCS x-axis, this means in the default case the measurement text is horizontal. The leader line can be “below” the text or start at the “left” or “right” center of the text, this location is defined by the `dimtad` attribute, 0 means “center” and any value != 0 means “below”.

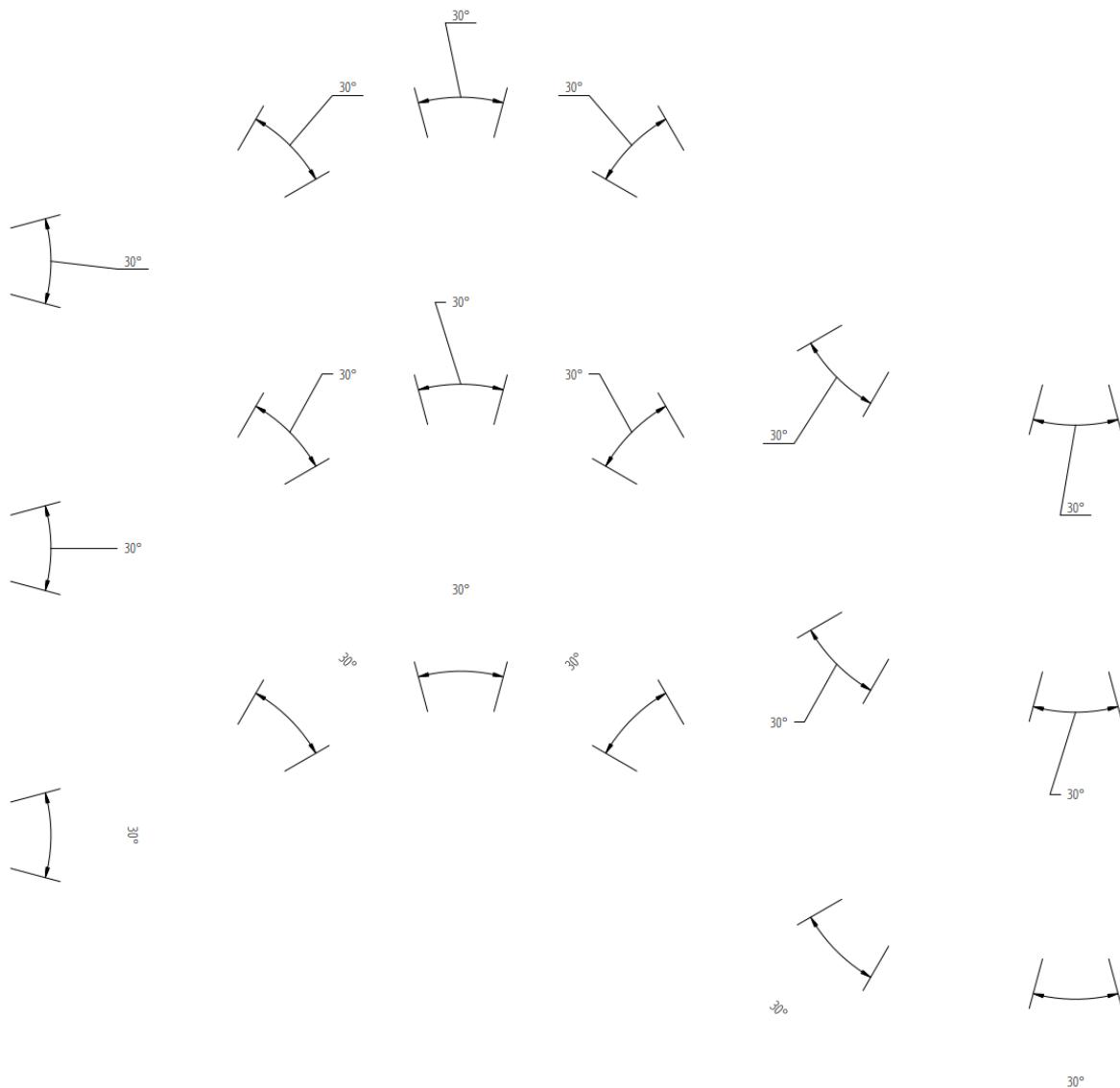
```
for dimtad, x in [(0, 0), (4, 6)]:
    dim = msp.add_angular_dim_cra(
        center=(3 + x, 3),
        radius=3,
        distance=1,
        start_angle=60,
        end_angle=120,
        override={"dimtad": dimtad} # "center" == 0; "below" != 0;
    )
    dim.set_location((1, 2), relative=True, leader=True)
    dim.render()
```



Advanced version which calculates the relative text location: The user location vector has a length 2 and the orientation is defined by *center\_angle* pointing away from the center of the angle.

```
import ezdxf
from ezdxf.math import Vec3

doc = ezdxf.new(setup=True)
msp = doc.modelspace()
for dimtad, y, leader in [
    [0, 0, False],
    [0, 7, True],
    [4, 14, True],
]:
    for x, center_angle in [
        (0, 0), (7, 45), (14, 90), (21, 135), (26, 225), (29, 270)
    ]:
        dim = msp.add_angular_dim_cra(
            center=(x, y),
            radius=3.0,
            distance=1.0,
            start_angle=center_angle - 15.0,
            end_angle=center_angle + 15.0,
            override={"dimtad": dimtad},
        )
        # The user location is relative to the center of the dimension line:
        usr_location = Vec3.from_deg_angle(angle=center_angle, length=2.0)
        dim.set_location(usr_location, leader=leader, relative=True)
        dim.render()
```



## Overriding Text Rotation

All factory methods supporting the argument `text_rotation` can override the measurement text rotation. The user defined rotation is relative to the render UCS x-axis (default is WCS).

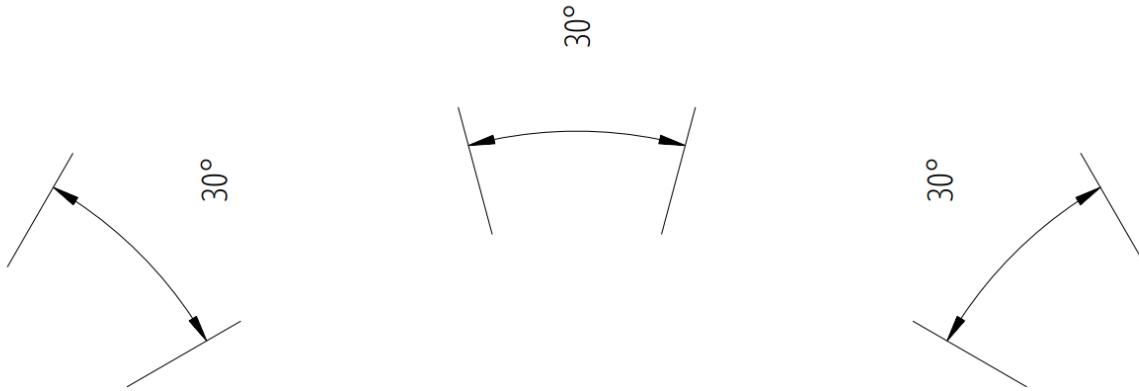
This example uses a relative text location without a leader and forces the text rotation to 90 degrees:

```
for x, center_angle in [(7, 45), (14, 90), (21, 135)]:
    dim = msp.add_angular_dim_cra(
        center=(x, 0),
        radius=3.0,
        distance=1.0,
        start_angle=center_angle - 15.0,
        end_angle=center_angle + 15.0,
        text_rotation=90, # vertical text
    )
```

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```
usr_location = Vec3.from_deg_angle(angle=center_angle, length=1.0)
dim.set_location(usr_location, leader=False, relative=True)
dim.render()
```



## Angular Units

Angular units are set by `dimaunit`:

0	Decimal degrees
1	Degrees/Minutes/Seconds, <code>dimadec</code> controls the shown precision <ul style="list-style-type: none"> <li>• <code>dimadec=0: 30°</code></li> <li>• <code>dimadec=2: 30°35'</code></li> <li>• <code>dimadec=4: 30°35'25"</code></li> <li>• <code>dimadec=7: 30°35'25.15"</code></li> </ul>
2	Grad
3	Radians

```
d1 = 15
d2 = 15.59031944
for x, (dimaunit, dimadec) in enumerate(
    [
        (0, 4),
        (1, 7),
        (2, 4),
        (3, 4),
    ]
):
    dim = msp.add_angular_dim_cra(
        center=(x * 4.0, 0.0),
        radius=3.0,
        distance=1.0,
        start_angle=90.0 - d1,
```

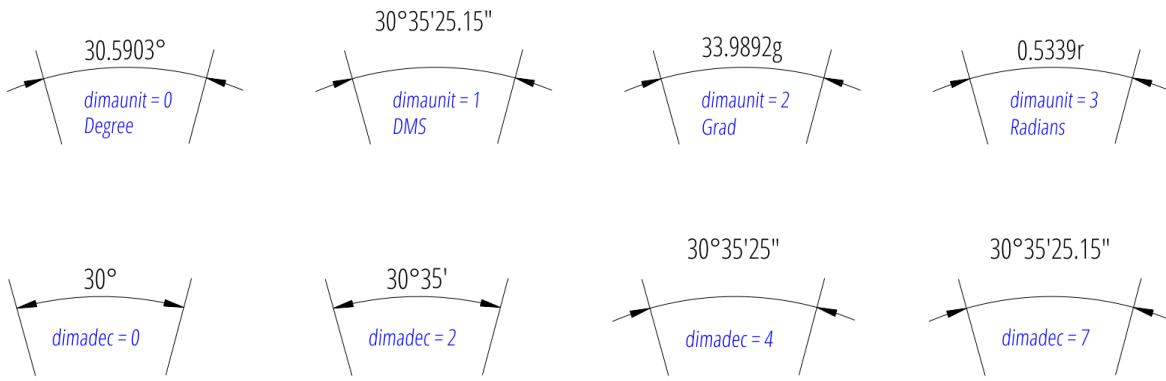
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```

        end_angle=90.0 + d2,
        override={
            "dimauunit": dimauunit,
            "dimadec": dimadec,
        },
    )
dim.render()

```



## Overriding Measurement Text

See Linear Dimension Tutorial: [Overriding Measurement Text](#)

## Measurement Text Formatting and Styling

See Linear Dimension Tutorial: [Measurement Text Formatting and Styling](#)

## Tolerances and Limits

See Linear Dimension Tutorial: [Tolerances and Limits](#)

### 6.5.23 Tutorial for Arc Dimensions

Please read the [Tutorial for Linear Dimensions](#) before, if you haven't. This is a repetition of the [Tutorial for Angular Dimensions](#), because `ezdxf` reuses the angular dimension to render arc dimensions. This approach is very different to CAD applications, but also much less work.

---

**Note:** `Ezdx`f does not render the arc dimension like CAD applications and does not consider all DIMSTYLE variables, so the rendering results are **very** different from CAD applications.

---

## Dimension Style “EZ\_CURVED”

All factory methods to create arc dimensions uses the dimension style “EZ\_CURVED” for curved dimension lines which is defined as:

- angle unit is decimal degrees, dimaunit = 0
- measurement text height = 0.25 (drawing scale = 1:100)
- measurement text location is above the dimension line
- closed filled arrow and arrow size dimasz = 0.25
- dimzin = 2, suppresses trailing zeros (e.g. 12.5000 becomes 12.5)
- dimarcsty = 2, disables the arc symbol, 0 renders only an open round bracket "(" in front of the text and 1 for arc symbol above the text is not supported, renders like disabled

For more information go to: [Dimension Style “EZ\\_CURVED”](#)

## Factory Methods to Create Arc Dimensions

### Defined by Center, Radius and Angles

The first example shows an arc dimension defined by the center point, radius, start- and end angles:

```
import ezdxf

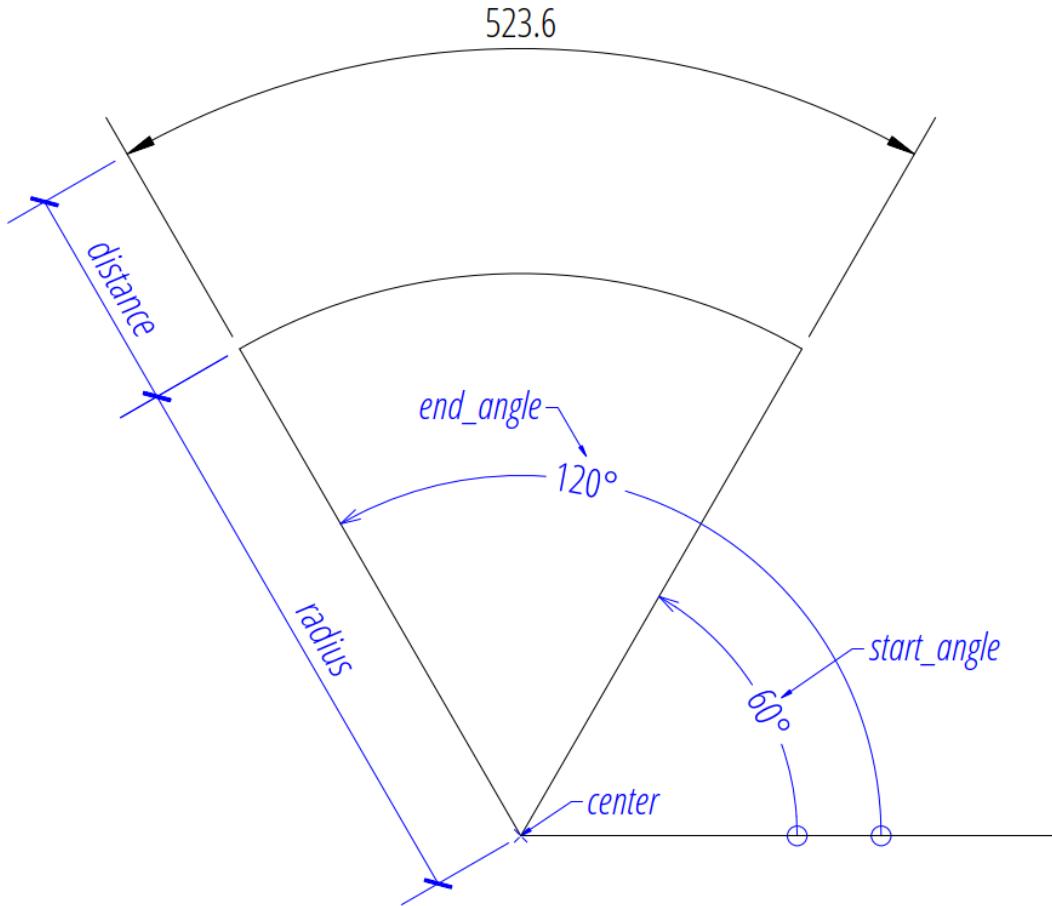
# Use argument setup=True to setup the default dimension styles.
doc = ezdxf.new(setup=True)

# Add new entities to the modelspace:
msp = doc.modelspace()

# Add an arc DIMENSION defined by the center point, start- and end angles,
# the measurement text is placed at the default location above the dimension
# line:
dim = msp.add_arc_dim_cra(
    center=(5, 5), # center point of the angle
    radius=5, # distance from center point to the start of the extension lines
    start_angle=60, # start angle in degrees
    end_angle=120, # end angle in degrees
    distance=2, # distance from start of the extension lines to the dimension line
    dimstyle="EZ_CURVED", # default angular dimension style
)

# Necessary second step to create the BLOCK entity with the dimension geometry.
# Additional processing of the DIMENSION entity could happen between adding
# the entity and the rendering call.
dim.render()
doc.saveas("arc_dimension_cra.dxf")
```

The return value `dim` is **not** a dimension entity, instead a `DimStyleOverride` object is returned, the dimension entity is stored as `dim.dimension`.



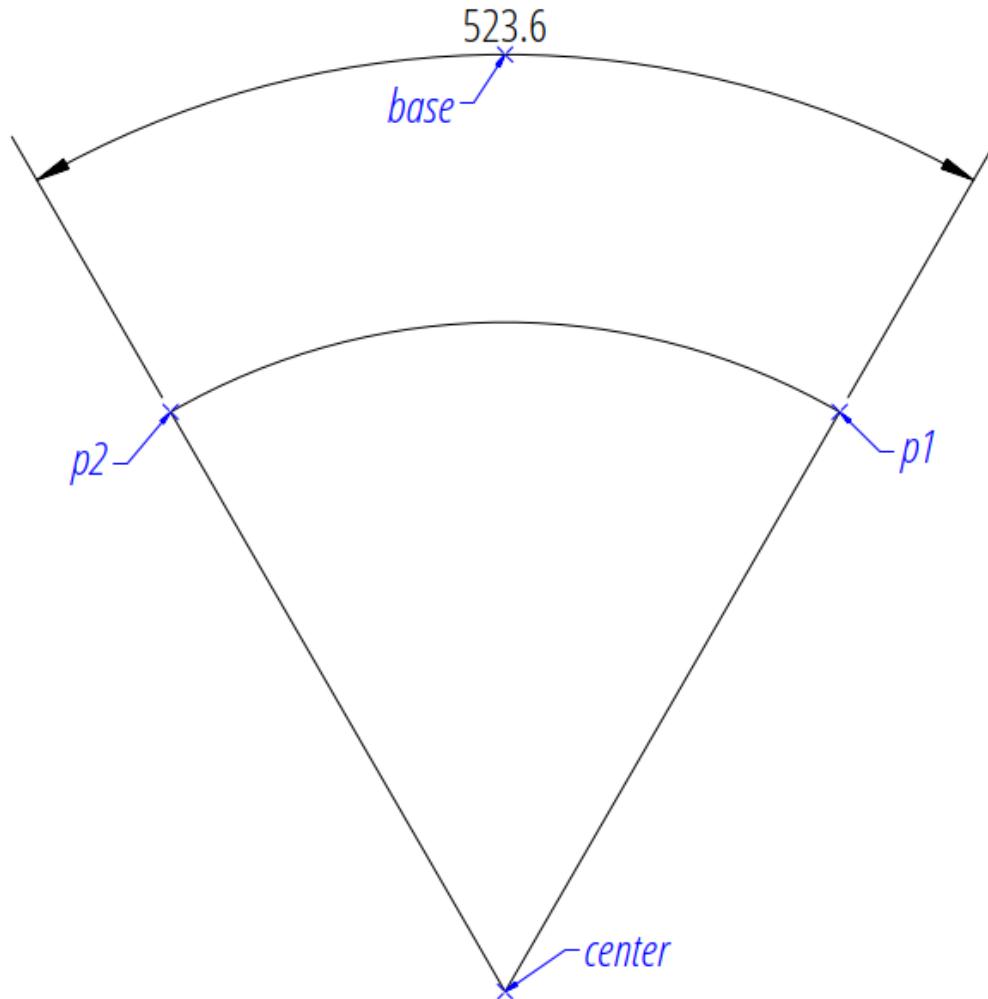
## Arc by 3 Points

The next example shows an angular dimension defined by three points, a center point and the two end points of the angle legs, the first point defines the radius, the second point defines only the end angle, the distance from the center point is not relevant:

```
import ezdxf

doc = ezdxf.new(setup=True)
msp = doc.modelspace()

msp.add_arc_dim_3p(
    base=(0, 7), # location of the dimension line
    center=(0, 0), # center point
    p1=(2.5, 4.330127018922193), # 1st point of arc defines start angle and radius
    p2=(-2.5, 4.330127018922194), # 2nd point defines the end angle
).render()
```



## Angle from ConstructionArc

The `ezdxf.math.ConstructionArc` provides various class methods for creating arcs and the construction tool can be created from an ARC entity.

Add an angular dimension to an ARC entity:

```
import ezdxf

doc = ezdxf.new(setup=True)
msp = doc.modelspace()

arc = msp.add_arc(
    center=(0, 0),
    radius=5,
    start_angle = 60,
    end_angle = 120,
```

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```

)
msp.add_arc_dim_arc(
    arc.construction_tool(),
    distance=2,
).render()

```

## Placing Measurement Text

The default location of the measurement text depends on various *DimStyle* parameters and is applied if no user defined text location is defined.

---

**Note:** Not all possible features of DIMSTYLE are supported by the *ezdxf* rendering procedure and especially for the arc dimension there are less features implemented than for the linear dimension because of the lack of good documentation. If the arc symbol is enabled (*dimarc sym* = 0) only an open round bracket “(“ is rendered in front of the measurement text!

---

### See also:

- Graphical reference of many DIMVARS and some advanced information: *DIMSTYLE Table*
- Source code file `standards.py` shows how to create your own DIMSTYLES.
- The Script `dimension_arc.py` shows examples for angular dimensions.

## Default Text Locations

The DIMSTYLE “EZ\_CURVED” places the measurement text in the center of the angle above the dimension line. The first examples above show the measurement text at the default text location.

The text direction angle is always perpendicular to the line from the text center to the center point of the angle unless this angle is manually overridden.

Arrows and measurement text are placed “outside” automatically if the available space between the extension lines isn’t sufficient.

For more information go to: *Default Text Locations*

## Shift Text From Default Location

The method `shift_text()` shifts the measurement text away from the default location. The shifting direction is aligned to the text rotation of the default measurement text.

For more information go to: *Shift Text From Default Location*

## User Defined Text Locations

Beside the default location it is always possible to override the text location by a user defined location.

The coordinates of user locations are located in the rendering UCS and the default rendering UCS is the *WCS*.

For more information go to: *User Defined Text Locations*

## Absolute User Location

Absolute placing of the measurement text means relative to the origin of the render UCS.

For more information go to: [User Defined Text Locations](#)

## Relative User Location

Relative placing of the measurement text means relative to the middle of the dimension line.

For more information go to: [User Defined Text Locations](#)

## Adding a Leader

Add a leader line to the measurement text and set the text rotation to “horizontal”.

For more information go to: [User Defined Text Locations](#)

## Overriding Text Rotation

All factory methods supporting the argument `text_rotation` can override the measurement text rotation. The user defined rotation is relative to the render UCS x-axis (default is WCS).

For more information go to: [User Defined Text Locations](#)

## Overriding Measurement Text

See Linear Dimension Tutorial: [Overriding Text Rotation](#)

## Measurement Text Formatting and Styling

See Linear Dimension Tutorial: [Measurement Text Formatting and Styling](#)

## Tolerances and Limits

See Linear Dimension Tutorial: [Tolerances and Limits](#)

## 6.5.24 Tutorial for Ordinate Dimensions

Please read the [Tutorial for Linear Dimensions](#) before, if you haven't.

---

**Note:** *Ezdx*f does not consider all DIMSTYLE variables, so the rendering results are different from CAD applications.

## Local Coordinate System

Ordinate dimensioning is used when the x- and the y-coordinates from a location (feature), are the only dimensions necessary. The dimensions to each feature, originate from one datum location, called “origin” in this tutorial.

The local coordinate system (LCS) in which the measurement is done, is defined by the *origin* and the *rotation* angle around the z-axis in the rendering UCS, which is the *WCS* by default.

## Factory Methods to Create Ordinate Dimensions

All factory methods for creating ordinate dimensions expect global coordinates to define the feature location.

## Global Feature Location

The first example shows ordinate dimensions defined in the render UCS, in this example the *WCS*, this is how the DIMENSION entity expects the coordinates of the feature location:

```
import ezdxf
from ezdxf.math import Vec3
from ezdxf.render import forms

# Use argument setup=True to setup the default dimension styles.
doc = ezdxf.new(setup=True)

# Add new entities to the modelspace:
msp = doc.modelspace()
# Add a rectangle: width=4, height = 2.5, lower left corner is WCS(x=2, y=3)
origin = Vec3(2, 3)
msp.add_lwpolyline(
    forms.translate(forms.box(4, 2.5), origin),
    close=True
)

# Add an x-type ordinate DIMENSION with global feature locations:
msp.add_ordinate_x_dim(
    # lower left corner
    feature_location=origin + (0, 0), # feature location in the WCS
    offset=(0, -2), # end of leader, relative to the feature location
    origin=origin,
).render()

msp.add_ordinate_x_dim(
    # lower right corner
    feature_location=origin + (4, 0), # feature location in the WCS
    offset=(0, -2),
    origin=origin,
).render()

# Add an y-type ordinate DIMENSION with global feature locations:
msp.add_ordinate_y_dim(
    # lower right corner
    feature_location=origin + (4, 0), # feature location in the WCS
    offset=(2, 0),
    origin=origin,
).render()

msp.add_ordinate_y_dim()
```

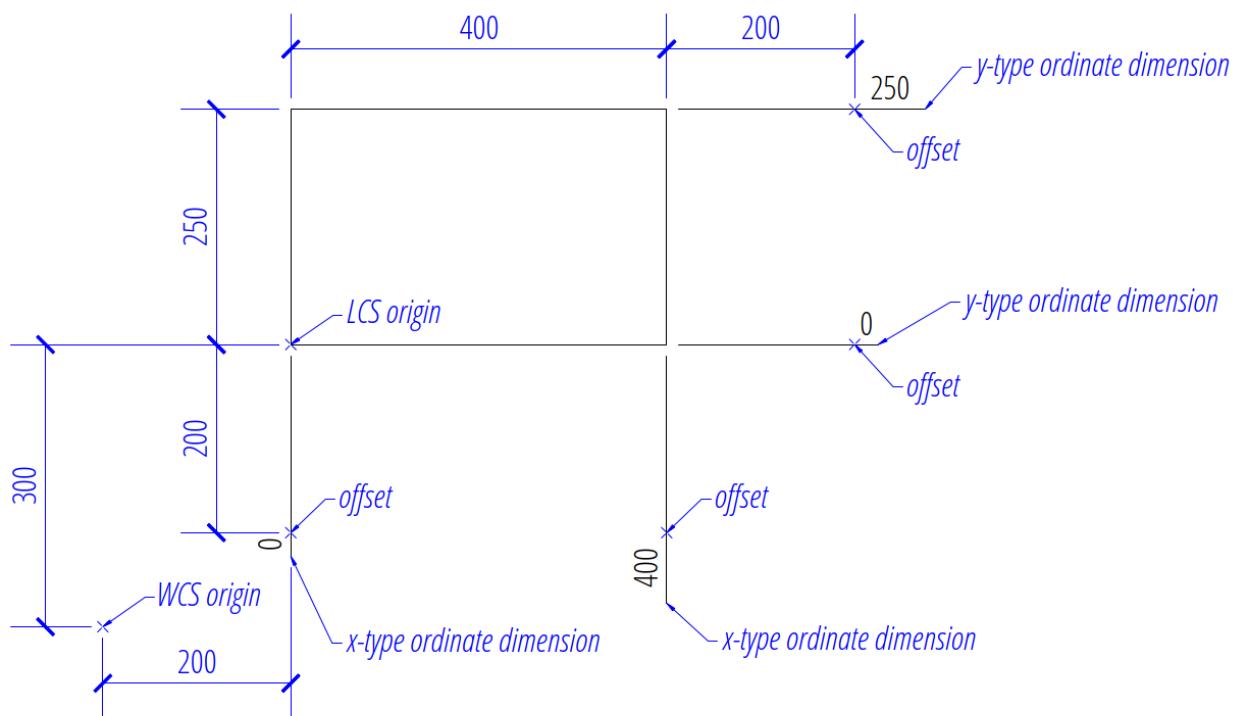
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```
# upper right corner
feature_location=origin + (4, 2.5), # feature location in the WCS
offset=(2, 0),
origin=origin,
).render()

# Necessary second step to create the BLOCK entity with the dimension geometry.
# Additional processing of the DIMENSION entity could happen between adding
# the entity and the rendering call.
doc.saveas("ord_global_features.dxf")
```

The return value `dim` is **not** a dimension entity, instead a `DimStyleOverride` object is returned, the dimension entity is stored as `dim.dimension`.



## Local Feature Location

The previous examples shows that the calculation of the global feature location is cumbersome and it gets even more complicated for a rotated LCS.

This example shows how to use a render `UCS` for using locale coordinates to define the feature locations:

```
import ezdxf
from ezdxf.math import Vec3, UCS
from ezdxf.render import forms

doc = ezdxf.new(setup=True)
msp = doc.modelspace()
```

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```

# Create a special DIMSTYLE for "vertical" centered measurement text:
dimstyle = doc.dimstyles.duplicate_entry("EZDXF", "ORD_CENTER")
dimstyle.dxf.dimtad = 0 # "vertical" centered measurement text

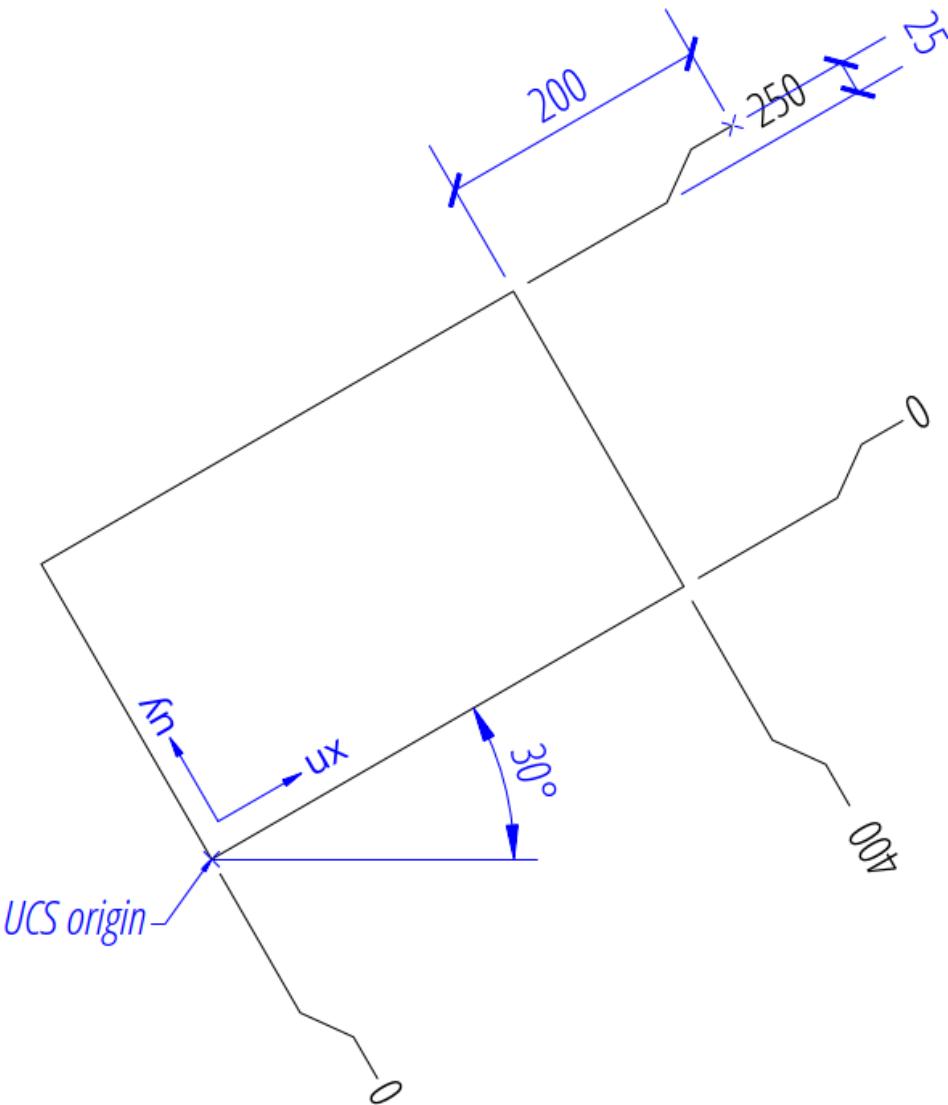
# Add a rectangle: width=4, height = 2.5, lower left corner is WCS(x=2, y=3),
# rotated about 30 degrees:
origin = Vec3(2, 3)
msp.add_lwpolyline(
    forms.translate(forms.rotate(forms.box(4, 2.5), 30), origin),
    close=True
)

# Define the rotated local render UCS.
# The origin is the lower-left corner of the rectangle and the axis are
# aligned to the rectangle edges:
# The y-axis "uy" is calculated automatically by the right-hand rule.
ucs = UCS(origin, ux=Vec3.from_deg_angle(30), uz=(0, 0, 1))

# Add a x-type ordinate DIMENSION with local feature locations:
# the origin is now the origin of the UCS, which is (0, 0) the default value of
# "origin" and the feature coordinates are located in the UCS:
msp.add_ordinate_x_dim(
    # lower left corner
    feature_location=(0, 0), # feature location in the UCS
    offset=(0.25, -2), # leader with a "knee"
    dimstyle="ORD_CENTER",
).render(ucs=ucs) # Important when using a render UCS!
msp.add_ordinate_x_dim(
    # lower right corner
    feature_location=(4, 0), # feature location in the UCS
    offset=(0.25, -2), # leader with a "knee"
    dimstyle="ORD_CENTER",
).render(ucs=ucs) # Important when using a render UCS!

# Add a y-type ordinate DIMENSION with local feature coordinates:
msp.add_ordinate_y_dim(
    # lower right corner
    feature_location=(4, 0), # feature location in the UCS
    offset=(2, 0.25), # leader with a "knee"
    dimstyle="ORD_CENTER",
).render(ucs=ucs) # Important when using a render UCS!
msp.add_ordinate_y_dim(
    # upper right corner
    feature_location=(4, 2.5), # feature location in the UCS
    offset=(2, 0.25), # leader with a "knee"
    dimstyle="ORD_CENTER",
).render(ucs=ucs) # Important when using a render UCS!
doc.saveas("ord_local_features.dxf")

```



## Placing Measurement Text

The *ezdxf* ordinate DIMENSION renderer places the measurement text always at the default location, because the location of the leader end point is given by the argument *offset* in the factory methods, which provides a flexible way to place the measurement text, overriding the text location by an explicit user location is not supported, also the user text rotation is not supported, the text is always aligned to the local coordinate system x- and y-axis.

### See also:

- Graphical reference of many DIMVARS and some advanced information: [DIMSTYLE Table](#)
- Source code file `standards.py` shows how to create your own DIMSTYLES.
- The Script `dimension_ordinate.py` shows examples for angular dimensions.

## Overriding Measurement Text

See Linear Dimension Tutorial: [Overriding Text Rotation](#)

## Measurement Text Formatting and Styling

See Linear Dimension Tutorial: [Measurement Text Formatting and Styling](#)

## Tolerances and Limits

See Linear Dimension Tutorial: [Tolerances and Limits](#)

### 6.5.25 Tutorial for the Geo Add-on

This tutorial shows how to load a GPS track into a geo located DXF file and also the inverse operation, exporting geo located DXF entities as GeoJSON files.

Please read the section [Intended Usage](#) in the documentation of the `ezdxf.addons.geo` module first.

#### Warning: TO ALL BEGINNERS!

If you are just learning to work with geospatial data, using DXF files is not the way to go! DXF is not the first choice for storing data for spatial data analysts. If you run into problems I cannot help you as I am just learning myself.

The complete source code and test data for this tutorial are available in the github repository:

<https://github.com/mozman/ezdxf/tree/master/docs/source/tutorials/src/geo>

#### Setup Geo Location Reference

The first step is setting up the geo location reference, which is **not** doable with ezdxf yet - this feature may come in the future - but for now you have to use a CAD application to do this. If the DXF file has no geo location reference the projected 2D coordinates are most likely far away from the WCS origin (0, 0), use the CAD command “ZOOM EXTENDS” to find the data.

#### Load GPX Data

The GPX format stores GPS data in a XML format, use the `ElementTree` class to load the data:

```
def load_gpx_track(p: Path) -> Iterable[Tuple[float, float]]:
    """Load all track points from all track segments at once."""
    gpx = ET.parse(p)
    root = gpx.getroot()
    for track_point in root.findall("./gpx:trkpt", GPX_NS):
        data = track_point.attrib
        # Elevation is not supported by the geo add-on.
        yield float(data["lon"]), float(data["lat"])
```

The loaded GPS data has a WSG84 EPSG:4326 projection as longitude and latitude in decimal degrees. The next step is to create a `GeoProxy` object from this data, the `GeoProxy.parse()` method accepts a `__geo_interface__` mapping or a Python object with a `__geo_interface__` attribute/property. In this case as simple “`LineString`” object for all GPS points is sufficient:

```
def add_gpx_track(msp, track_data, layer: str):
    geo_mapping = {
        "type": "LineString",
        "coordinates": track_data,
    }
    geo_track = geo.GeoProxy.parse(geo_mapping)
```

Transform the data from the polar representation EPSG:4326 into a 2D cartesian map representation EPSG:3395 called “World Mercator”, this is the only projection supported by the add-on, without the need to write a custom transformation function:

```
geo_track.globe_to_map()
```

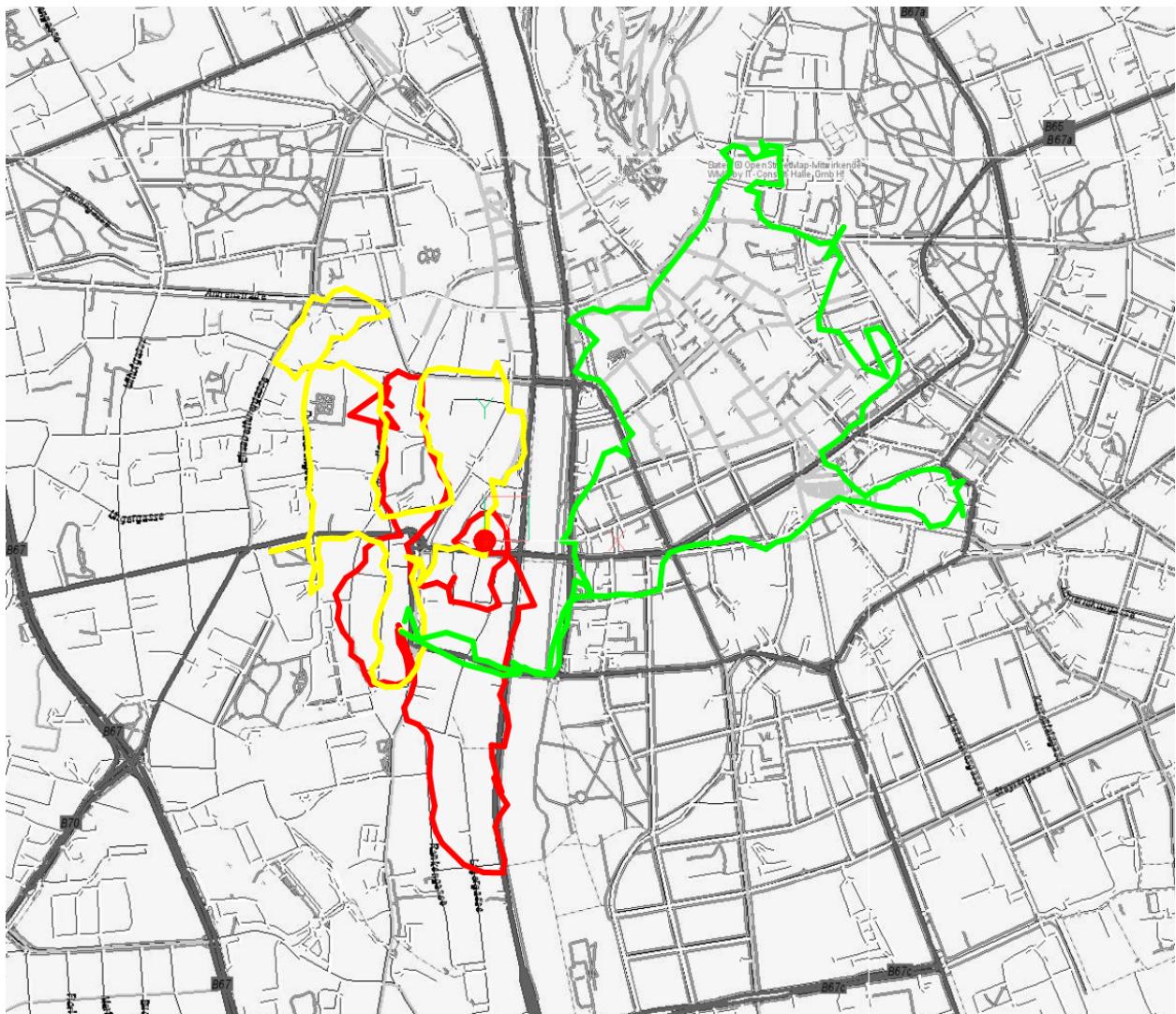
The data is now transformed into 2D cartesian coordinates in meters and most likely far away from origin (0, 0), the data stored in the GEODATA entity helps to transform the data into the DXF WCS in modelspace units, if the DXF file has no geo location reference you have to stick with the large coordinates:

```
# Load geo data information from the DXF file:
geo_data = msp.get_geodata()
if geo_data:
    # Get the transformation matrix and epsg code:
    m, epsg = geo_data.get_crs_transformation()
else:
    # Identity matrix for DXF files without a geo location reference:
    m = Matrix44()
    epsg = 3395
# Check for compatible projection:
if epsg == 3395:
    # Transform CRS coordinates into DXF WCS:
    geo_track.crs_to_wcs(m)
    # Create DXF entities (LWPOLYLINE)
    for entity in geo_track.to_dxf_entities(dxfattribs={"layer": layer}):
        # Add entity to the modelspace:
        msp.add_entity(entity)
else:
    print(f"Incompatible CRS EPSG: {epsg}")
```

We are ready to save the final DXF file:

```
doc.saveas(str(out_path))
```

In BricsCAD the result looks like this, the underlying images were added by the BricsCAD command MAPCONNECT and such a feature is **not** planned for the add-on:



## Export DXF Entities as GeoJSON

This will only work with a proper geo location reference, the code shown accepts also WCS data from DXF files without a GEODATA object, but the result is just unusable - but in valid GeoJSON notation.

First get epsg code and the CRS transformation matrix:

```
# Get the geo location information from the DXF file:
geo_data = msp.get_geodata()
if geo_data:
    # Get transformation matrix and epsg code:
    m, epsg = geo_data.get_crs_transformation()
else:
    # Identity matrix for DXF files without geo reference data:
    m = Matrix44()
```

Query the DXF entities to export:

```
for track in msp.query("LWPOLYLINE"):
    export_geojson(track, m)
```

Create a GeoProxy object from the DXF entity:

```
def export_geojson(entity, m):
    # Convert DXF entity into a GeoProxy object:
    geo_proxy = geo.proxy(entity)
```

Transform DXF WCS coordinates in modelspace units into the CRS coordinate system by the transformation matrix *m*:

```
# Transform DXF WCS coordinates into CRS coordinates:
geo_proxy.wcs_to_crs(m)
```

The next step assumes a EPSG:3395 projection, everything else needs a custom transformation function:

```
# Transform 2D map projection EPSG:3395 into globe (polar)
# representation EPSG:4326
geo_proxy.map_to_globe()
```

Use the `json` module from the Python standard library to write the GeoJSON data, provided by the `GeoProxy.__geo_interface__` property:

```
# Export GeoJSON data:
name = entity.dxf.layer + ".geojson"
with open(TRACK_DATA / name, "wt", encoding="utf8") as fp:
    json.dump(geo_proxy.__geo_interface__, fp, indent=2)
```

The content of the GeoJSON file looks like this:

```
{
    "type": "LineString",
    "coordinates": [
        [
            [15.430999, 47.06503],
            [15.431039, 47.064797]
        ],
        [
            [15.431206, 47.064582],
            [15.431283, 47.064342]
        ],
        ...
    ]
}
```

## Custom Transformation Function

This sections shows how to use the GDAL package to write a custom transformation function. The example reimplements the builtin transformation from unprojected WGS84 coordinates to 2D map coordinates EPSG:3395 “World Mercator”:

```

from osgeo import osr
from ezdxf.math import Vec3

# GPS track in WGS84, load_gpx_track() code see above
gpx_points = list(load_gpx_track('track1.gpx'))

# Create source coordinate system:
src_datum = osr.SpatialReference()
src_datum.SetWellKnownGeoCS('WGS84')

# Create target coordinate system:
target_datum = osr.SpatialReference()
target_datum.SetWellKnownGeoCS('EPSG:3395')

# Create transformation object:
ct = osr.CoordinateTransform(src_datum, target_datum)

# Create GeoProxy() object:
geo_proxy = GeoProxy.parse({
    'type': 'LineString',
    'coordinates': gpx_points
})

# Apply a custom transformation function to all coordinates:
geo_proxy.apply(lambda v: Vec3(ct.TransformPoint(v.x, v.y)))

```

The same example with the pyproj package:

```

from pyproj import Transformer
from ezdxf.math import Vec3

# GPS track in WGS84, load_gpx_track() code see above
gpx_points = list(load_gpx_track('track1.gpx'))

# Create transformation object:
ct = Transformer.from_crs('EPSG:4326', 'EPSG:3395')

# Create GeoProxy() object:
geo_proxy = GeoProxy.parse({
    'type': 'LineString',
    'coordinates': gpx_points
})

# Apply a custom transformation function to all coordinates:
geo_proxy.apply(lambda v: Vec3(ct.transform(v.x, v.y)))

```

## Polygon Validation by Shapely

Ezdx tries to avoid to create invalid polygons from HATCH entities like a hole in another hole, but not all problems are detected by ezdx, especially overlapping polygons. For a reliable and robust result use the Shapely package to check for valid polygons:

```

import ezdxf
from ezdxf.addons import geo
from shapely.geometry import shape

```

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```

# Load DXF document including HATCH entities.
doc = ezdxf.readfile('hatch.dxf')
msp = doc.modelspace()

# Test a single entity
# Get the first DXF hatch entity:
hatch_entity = msp.query('HATCH').first

# Create GeoProxy() object:
hatch_proxy = geo.proxy(hatch_entity)

# Shapely supports the __geo_interface__
shapely_polygon = shape(hatch_proxy)

if shapely_polygon.is_valid:
    ...
else:
    print(f'Invalid Polygon from {str(hatch_entity)} .')

# Remove invalid entities by a filter function
def validate(geo_proxy: geo.GeoProxy) -> bool:
    # Multi-entities are divided into single entities:
    # e.g. MultiPolygon is verified as multiple single Polygon entities.
    if geo_proxy.geotype == 'Polygon':
        return shape(geo_proxy).is_valid
    return True

# The gfilter() function let only pass compatible DXF entities
msp_proxy = geo.GeoProxy.from_dxf_entities(geo.gfilter(msp))

# remove all mappings for which validate() returns False
msp_proxy.filter(validate)

```

## Interface to GDAL/OGR

The GDAL/OGR package has no direct support for the `__geo_interface__`, but has builtin support for the GeoJSON format:

```

from osgeo import ogr
from ezdxf.addons import geo
from ezdxf.render import random_2d_path
import json

p = geo.GeoProxy({'type': 'LineString', 'coordinates': list(random_2d_path(20))})
# Create a GeoJSON string from the __geo_interface__ object by the json
# module and feed the result into ogr:
line_string = ogr.CreateGeometryFromJson(json.dumps(p.__geo_interface__))

# Parse the GeoJSON string from ogr by the json module and feed the result
# into a GeoProxy() object:
p2 = geo.GeoProxy.parse(json.loads(line_string.ExportToJson()))

```

## 6.5.26 Storing Custom Data in DXF Files

This tutorial describes how to store custom data in DXF files using standard DXF features.

Saving data in comments is not covered in this section, because comments are not a reliable way to store information in DXF files and *ezdxf* does not support adding comments to DXF files. Comments are also ignored by *ezdxf* and many other DXF libraries when loading DXF files, but there is a *ezdxf.comments* module to load comments from DXF files.

The DXF data format is a very versatile and flexible data format and supports various ways to store custom data. This starts by setting special header variables, storing XData, AppData and extension dictionaries in DXF entities and objects, storing XRecords in the OBJECTS section and ends by using proxy entities or even extending the DXF format by user defined entities and objects.

This is the common prolog for all Python code examples shown in this tutorial:

```
import ezdxf
doc = ezdxf.new()
msp = doc.modelspace()
```

### Retrieving User Data

Retrieving the is a simple task by *ezdxf*, but often not possible in CAD applications without using the scripting features (AutoLISP) or even the SDK.

### AutoLISP Resources

- Autodesk Developer Documentation
- AfraLISP
- Lee Mac Programming

**Warning:** I have no experience with AutoLISP so far and I created this scripts for AutoLISP while writing this tutorial. There may be better ways to accomplish these tasks, and feedback on this is very welcome. Everything is tested with BricsCAD and should also work with the full version of AutoCAD.

### Header Section

The HEADER section has tow ways to store custom data.

### Predefined User Variables

There are ten predefined user variables, five 16-bit integer variables called \$USERI1 up to \$USERI5 and five floating point variables (reals) called \$USERR1 up to \$USERR5. This is very limited and the data maybe will be overwritten by the next application which opens and saves the DXF file. Advantage of this methods is, it works for all supported DXF versions starting at R12.

Settings the data:

```
doc.header["$USERI1"] = 4711
doc.header["$USERR1"] = 3.141592
```

Getting the data by *ezdxf*:

```
i1 = doc.header["$USERI1"]
r1 = doc.header["$USERR1"]
```

Getting the data in *BricsCAD* at the command line:

```
: USERI1
New current value for USERI1 (-32768 to 32767) <4711>:
```

Getting the data by AutoLISP:

```
: (getvar 'USERI1)
4711
```

Setting the value by AutoLISP:

```
: (setvar 'USERI1 1234)
1234
```

## Custom Document Properties

This method defines custom document properties, but requires at least DXF R2004. The custom document properties are stored in a *CustomVars* instance in the *custom\_vars* attribute of the *HeaderSection* object and supports only string values.

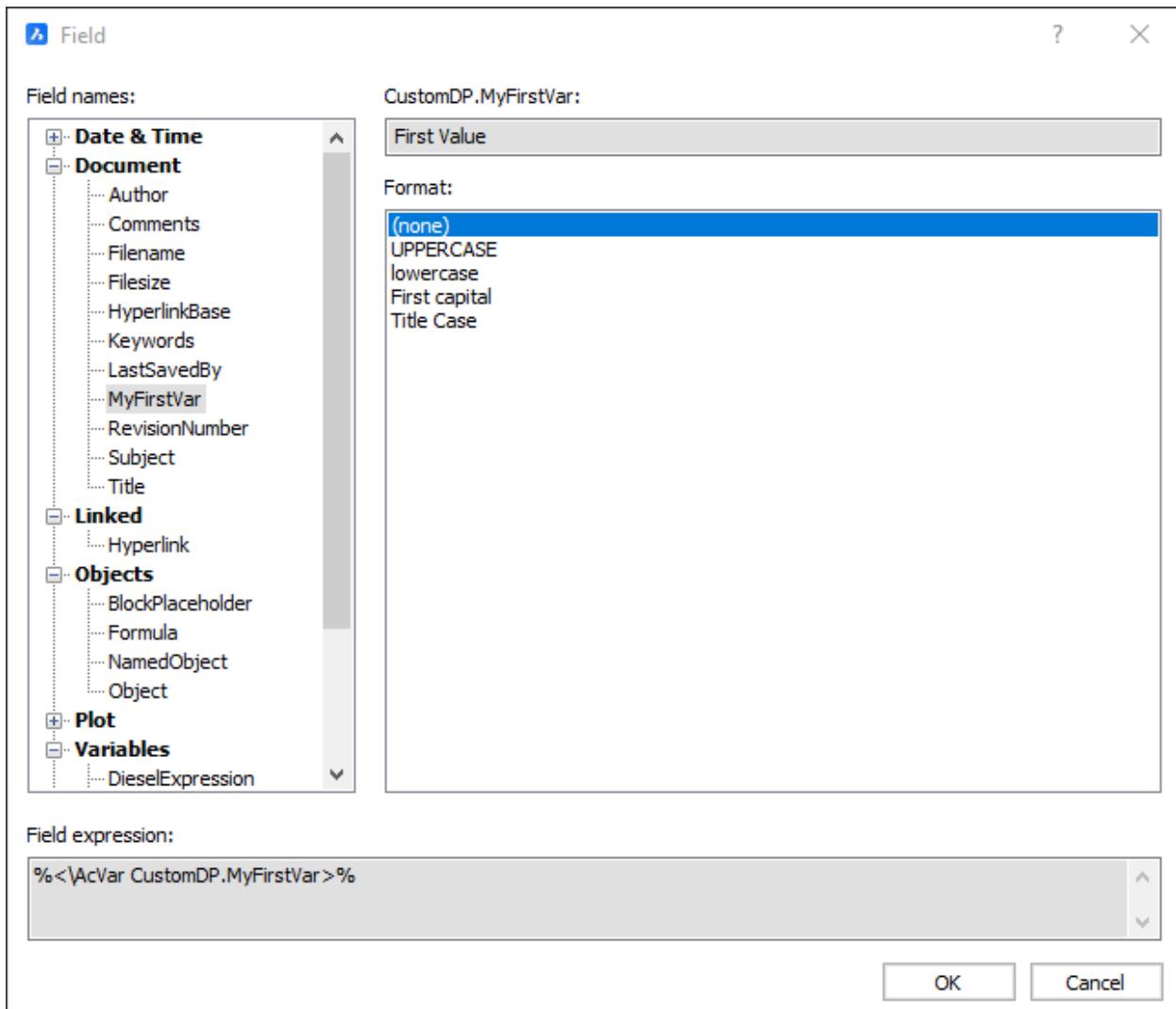
Settings the data:

```
doc.header.custom_vars.append("MyFirstVar", "First Value")
```

Getting the data by *ezdxf*:

```
my_first_var = doc.header.custom_vars.get("MyFirstVar", "Default Value")
```

The document property MyFirstVar is available in *BricsCAD* as FIELD variable:



AutoLISP script for getting the custom document properties:

```
(defun C:CUSTOMDOCPROPS (/ Info Num Index Custom)
  (vl-load-com)
  (setq acadObject (vlax-get-acad-object))
  (setq acadDocument (vla-get-ActiveDocument acadObject))

  ;;Get the SummaryInfo
  (setq Info (vlax-get-Property acadDocument 'SummaryInfo))
  (setq Num (vla-NumCustomInfo Info))
  (setq Index 0)
  (repeat Num
    (vla-getCustomByIndex Info Index 'ID 'Value)
    (setq Custom (cons (cons ID Value) Custom)))
    (setq Index (1+ Index)))
  ) ;repeat

  (if Custom (reverse Custom))
)
```

Running the script in BricsCAD:

```
: (load "customdocprops.lsp")
C:CUSTOMDOCPROPS
: CUSTOMDOCPROPS
(("MyFirstVar" . "First Value"))
```

## Meta Data

Starting with version v0.16.4 *ezdxf* stores some meta data in the DXF file and the AppID EZDXF will be created. Two entries will be added to the *MetaData* instance, the CREATED\_BY\_EZDXF for DXF documents created by *ezdxf* and the entry WRITTEN\_BY\_EZDXF if the DXF document will be saved by *ezdxf*. The marker string looks like this "0.17b0 @ 2021-09-18T05:14:37.921826+00:00" and contains the *ezdxf* version and an UTC timestamp in ISO format.

You can add your own data to the *MetaData* instance as a string with a maximum of 254 characters and choose a good name which may never be used by *ezdxf* in the future.

```
metadata = doc.ezdxf_metadata()
metadata["MY_UNIQUE_KEY"] = "my additional meta data"

print(metadata.get("CREATED_BY_EZDXF"))
print(metadata.get("MY_UNIQUE_KEY"))
```

The data is stored as XDATA in then BLOCK entity of the model space for DXF R12 and for DXF R2000 and later as a DXF *Dictionary* in the root dictionary by the key EZDXF\_META. See following chapters for accessing such data by AutoLISP.

## XDATA

*Extended Data (XDATA)* is a way to attach arbitrary data to DXF entities. Each application needs a unique AppID registered in the AppID table to add XDATA to an entity. The AppID ACAD is reserved and by using *ezdxf* the AppID EZDXF is also registered automatically. The total size of XDATA for a single DXF entity is limited to 16kB for AutoCAD. XDATA is supported by all DXF versions and is accessible by AutoLISP.

The valid group codes for extended data are limited to the following values, see also the internals of *Extended Data*:

Group Code	Description
1000	Strings up to 255 bytes long
1001	(fixed) Registered application name up to 31 bytes long
1002	(fixed) An extended data control string '{' or '}'
1004	Binary data
1005	Database Handle of entities in the drawing database
1010	3D point, in the order X, Y, Z that will not be modified at any transformation of the entity
1011	A WCS point that is moved, scaled, rotated and mirrored along with the entity
1012	A WCS displacement that is scaled, rotated and mirrored along with the entity, but not moved
1013	A WCS direction that is rotated and mirrored along with the entity but not moved and scaled.
1040	A real value
1041	Distance, a real value that is scaled along with the entity
1042	Scale Factor, a real value that is scaled along with the entity
1070	A 16-bit integer (signed or unsigned)
1071	A 32-bit signed (long) integer

Group codes are not unique in the XDATA section and can be repeated, therefore tag order matters.

```

# register your appid
APPID = "YOUR_UNIQUE_ID"
doc.appids.add(APPID)

# create a DXF entity
line = msp.add_line((0, 0), (1, 0))

# setting the data
line.set_xdata(APPID, [
    # basic types
    (1000, "custom text"),
    (1040, 3.141592),
    (1070, 4711), # 16bit
    (1071, 1_048_576), # 32bit
    # points and vectors
    (1010, (10, 20, 30)),
    (1011, (11, 21, 31)),
    (1012, (12, 22, 32)),
    (1013, (13, 23, 33)),
    # scaled distances and factors
    (1041, 10),
    (1042, 10),
])

# getting the data
if line.has_xdata(APPID):
    tags = line.get_xdata(APPID)
    print(f"{str(line)} has {len(tags)} tags of XDATA for AppID {APPID!r}")
    for tag in tags:
        print(tag)

```

AutoLISP script for getting XDATA for AppID YOUR\_UNIQUE\_ID:

```

(defun C:SHOWXDATA (/ entity_list xdata_list)
  (setq entity_list (entget (car (entsel)) '("YOUR_UNIQUE_ID")))
  (setq xdata_list (assoc -3 entity_list))
  (car (cdr xdata_list)))
)

```

Script output:

```

: SHOWXDATA
Select entity: ("YOUR_UNIQUE_ID" (1000 . "custom text") (1040 . 3.141592) ...

```

#### See also:

- [AfraLISP XDATA tutorial](#)
- [Extended Data \(XDATA\) Reference](#)

### XDATA Helper Classes

The `XDataUserList` and `XDataUserDict` are helper classes to manage XDATA content in a simple way.

Both classes store the Python types `int`, `float` and `str` and the `ezdxf` type `Vec3`. As the names suggests has the `XDataUserList` a list-like interface and the `XDataUserDict` a dict-like interface. This classes can not contain additional container types, but multiple lists and/or dicts can be stored in the same XDATA section for the same AppID.

These helper classes uses a fixed group code for each data type:

1001	strings (max. 255 chars)
1040	floats
1071	32-bit ints
1010	Vec3

Additional required imports for these examples:

```
from eздxf.math import Vec3
from eздxf.entities.xdata import XDataUserDict, XDataUserList
```

Example for *XDataUserDict*:

Each XDataUserDict has a unique name, the default name is “DefaultDict” and the default AppID is EZDXF. If you use your own AppID, don’t forget to create the requited AppID table entry like doc.appids.new("MyAppID"), otherwise AutoCAD will not open the DXF file.

```
doc = eздxf.new()
msp = doc.modelspace()
line = msp.add_line((0, 0), (1, 0))

with XDataUserDict.entity(line) as user_dict:
    user_dict["CreatedBy"] = "mozman"
    user_dict["Float"] = 3.1415
    user_dict["Int"] = 4711
    user_dict["Point"] = Vec3(1, 2, 3)
```

If you modify the content of without using the context manager *entity()*, you have to call *commit()* by yourself, to transfer the modified data back into the XDATA section.

Getting the data back from an entity:

```
with XDataUserDict.entity(line) as user_dict:
    print(user_dict)
    # acts like any other dict()
    storage = dict(user_dict)
```

Example for *XDataUserList*:

This example stores the data in a XDataUserList named “AppendedPoints”, the default name is “DefaultList” and the default AppID is EZDXF.

```
with XDataUserList.entity(line, name="AppendedPoints") as user_list:
    user_list.append(Vec3(1, 0, 0))
    user_list.append(Vec3(0, 1, 0))
    user_list.append(Vec3(0, 0, 1))
```

Now the content of both classes are stored in the same XDATA section for AppID EZDXF. The XDataUserDict is stored by the name “DefaultDict” and the XDataUserList is stored by the name “AppendedPoints”.

Getting the data back from an entity:

```
with XDataUserList.entity(line, name="AppendedPoints") as user_list:
    print(user_list)
    storage = list(user_list)

print(f"Copy of XDataUserList: {storage}")
```

**See also:**

- [XDataUserList](#) class
- [XDataUserDict](#) class

**Extension Dictionaries**

Extension dictionaries are another way to attach custom data to any DXF entity. This method requires DXF R13/14 or later. I will use the short term XDICT for extension dictionaries in this tutorial.

The [Extension Dictionary](#) is a regular DXF [Dictionary](#) which can store (key, value) pairs where the key is a string and the value is a DXF object from the OBJECTS section but not graphical DXF entities. The usual objects to store custom data are [DictionaryVar](#) to store simple strings and [XRecord](#) to store complex data.

Unlike XDATA, custom data attached by extension dictionary will not be transformed along with the DXF entity!

This example shows how to manage the XDICT and to store simple strings as [DictionaryVar](#) objects in the XDICT, to store more complex data go to the next section [XRecord](#).

1. Get or create the XDICT for an entity:

```
# create a DXF entity
line = msp.add_line((0, 0), (1, 0))

if line.has_extension_dict:
    # get the extension dictionary
    xdict = line.get_extension_dict()
else:
    # create a new extension dictionary
    xdict = line.new_extension_dict()
```

2. Add strings as [DictionaryVar](#) objects to the XDICT. No AppIDs required, but existing keys will be overridden, so be careful by choosing your keys:

```
xdict.add_dictionary_var("DATA1", "Your custom data string 1")
xdict.add_dictionary_var("DATA2", "Your custom data string 2")
```

3. Retrieve the strings from the XDICT as [DictionaryVar](#) objects:

```
print(f"DATA1 is '{xdict['DATA1'].value}'")
print(f"DATA2 is '{xdict['DATA2'].value}'")
```

The AutoLISP access to DICTIONARIES is possible, but it gets complex and I'm only referring to the [AfraLISP Dictionaries and XRecords](#) tutorial.

**See also:**

- [AfraLISP Dictionaries and XRecords Tutorial](#)
- [Extension Dictionary Reference](#)
- DXF [Dictionary Reference](#)
- [DictionaryVar Reference](#)

**XRecord**

The [XRecord](#) object can store arbitrary data like the XDATA section, but is not limited by size and can use all group codes in the range from 1 to 369 for [DXF Tags](#). The [XRecord](#) can be referenced by any DXF [Dictionary](#), other

XRecord objects (tricky ownership!), the XDATA section (store handle by group code 1005) or any other DXF object by adding the XRecord object to the *Extension Dictionary* of the DXF entity.

It is recommended to follow the DXF reference to assign appropriate group codes to *DXF Tags*. My recommendation is shown in the table below, but all group codes from 1 to 369 are valid. I advice against using the group codes 100 and 102 (structure tags) to avoid confusing generic tag loaders. Unfortunately, Autodesk doesn't like general rules and uses DXF format exceptions everywhere.

1	strings (max. 2049 chars)
2	structure tags as strings like " { " and " } "
10	points and vectors
40	floats
90	integers
330	handles

Group codes are not unique in XRecord and can be repeated, therefore tag order matters.

This example shows how to attach a *XRecord* object to a LINE entity by *Extension Dictionary*:

```
line = msp.add_line((0, 0), (1, 0))
line2 = msp.add_line((0, 2), (1, 2))

if line.has_extension_dict:
    xdict = line.get_extension_dict()
else:
    xdict = line.new_extension_dict()

xrecord = xdict.add_xrecord("DATA1")
xrecord.reset([
    (1, "text1"), # string
    (40, 3.141592), # float
    (90, 256), # 32-bit int
    (10, (1, 2, 0)), # points and vectors
    (330, line2.dxf.handle) # handles
])

print(xrecord.tags)
```

Script output:

```
[DXFTag(1, 'text1'),
 DXFTag(40, 3.141592),
 DXFTag(90, 256),
 DXFVertex(10, (1.0, 2.0, 0.0)),
 DXFTag(330, '30')]
```

Unlike XDATA, custom data attached by extension dictionary will not be transformed along with the DXF entity! To react to entity modifications by a CAD applications it is possible to write event handlers by AutoLISP, see the [AfraLISP Reactors Tutorial](#) for more information. This very advanced stuff!

## See also:

- [AfraLISP Dictionaries and XRecords Tutorial](#)
- [AfraLISP Reactors Tutorial](#)
- [XRecord Reference](#)

- helper functions: `ezdxf.lldxf.types.dxftag()` and `ezdxf.lldxf.types.tuples_to_tags()`

## XRecord Helper Classes

The `UserRecord` and `BinaryRecord` are helper classes to manage XRECORD content in a simple way. The `UserRecord` manages the data as plain Python types: `dict`, `list`, `int`, `float`, `str` and the `ezdxf` types `Vec2` and `Vec3`. The top level type for the `UserRecord.data` attribute has to be a `list`. The `BinaryRecord` stores arbitrary binary data as `BLOB`. These helper classes uses fixed group codes to manage the data in XRECORD, you have no choice to change them.

Additional required imports for these examples:

```
from pprint import pprint
import ezdxf
from ezdxf.math import Vec3
from ezdxf.urecord import UserRecord, BinaryRecord
from ezdxf.entities import XRecord
import zlib
```

Example 1: Store entity specific data in the *Extension Dictionary*:

```
line = msp.add_line((0, 0), (1, 0))
xdict = line.new_extension_dict()
xrecord = xdict.add_xrecord("MyData")

with UserRecord(xrecord) as user_record:
    user_record.data = [  # top level has to be a list!
        "MyString",
        4711,
        3.1415,
        Vec3(1, 2, 3),
        {
            "MyIntList": [1, 2, 3],
            "MyFloatList": [4.5, 5.6, 7.8],
        },
    ]
```

Example 1: Get entity specific data back from the *Extension Dictionary*:

```
if line.has_extension_dict:
    xdict = line.get_extension_dict()
    xrecord = xdict.get("MyData")
    if isinstance(xrecord, XRecord):
        user_record = UserRecord(xrecord)
        pprint(user_record.data)
```

If you modify the content of `UserRecord.data` without using the context manager, you have to call `commit()` by yourself, to store the modified data back into the XRECORD.

Example 2: Store arbitrary data in DICTIONARY objects. The XRECORD is stored in the named DICTIONARY, called `rootdict` in `ezdxf`. This DICTIONARY is the root entity for the tree-like data structure stored in the OBJECTS section, see also the documentation of the `ezdxf.sections.objects` module.

```
# Get the existing DICTIONARY object or create a new DICTIONARY object:
my_dict = doc.objects.rootdict.get_required_dict("MyDict")
```

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```
# Create a new XRECORD object, the DICTIONARY object is the owner of this
# new XRECORD:
xrecord = my_dict.add_xrecord("MyData")

# This example creates the user record without the context manager.
user_record = UserRecord(xrecord)

# Store user data:
user_record.data = [
    "Just another user record",
    4711,
    3.1415,
]
# Store user data in associated XRECORD:
user_record.commit()
```

**Example 2:** Get user data back from the DICTIONARY object

```
my_dict = doc.rootdict.get_required_dict("MyDict")
entity = my_dict["MyData"]
if isinstance(entity, XRecord):
    user_record = UserRecord(entity)
    pprint(user_record.data)
```

**Example 3:** Store arbitrary binary data

```
my_dict = doc.rootdict.get_required_dict("MyDict")
xrecord = my_dict.add_xrecord("MyBinaryData")
with BinaryRecord(xrecord) as binary_record:
    # The content is stored as hex strings (e.g. ABBAFEFE...) in one or more
    # group code 310 tags.
    # A preceding group code 160 tag stores the data size in bytes.
    data = b"Store any binary data, even line breaks\r\n" * 20
    # compress data if required
    binary_record.data = zlib.compress(data, level=9)
```

**Example 3:** Get binary data back from the DICTIONARY object

```
entity = my_dict["MyBinaryData"]
if isinstance(entity, XRecord):
    binary_record = BinaryRecord(entity)
    print("\ncompressed data:")
    pprint(binary_record.data)

    print("\nuncompressed data:")
    pprint(zlib.decompress(binary_record.data))
```

---

**Hint:** Don't be fooled, the ability to save any binary data such as images, office documents, etc. in the DXF file doesn't impress AutoCAD, it simply ignores this data, this data only has a meaning for your application!

---

**See also:**

- [urecord module](#)
- [UserRecord class](#)

- *BinaryRecord* class

## AppData

*Application-Defined Data (AppData)* was introduced in DXF R13/14 and is used by AutoCAD internally to store the handle to the *Extension Dictionary* and the *Reactors* in DXF entities. *Ezdx*f supports these kind of data storage for any AppID and the data is preserved by AutoCAD and BricsCAD, but I haven't found a way to access this data by AutoLISP or even the SDK. So I don't recommend this feature to store application defined data, because *Extended Data (XDATA)* and the *Extension Dictionary* are well documented and safe ways to attach custom data to entities.

```
# register your appid
APPID = "YOUR_UNIQUE_ID"
doc.appids.add(APPID)

# create a DXF entity
line = msp.add_line((0, 0), (1, 0))

# setting the data
line.set_app_data(APPID, [(300, "custom text"), (370, 4711), (460, 3.141592)])

# getting the data
if line.has_app_data(APPID):
    tags = line.get_app_data(APPID)
    print(f"{str(line)} has {len(tags)} tags of AppData for AppID {APPID!r}")
    for tag in tags:
        print(tag)
```

Printed output:

```
LINE(#30) has 3 tags of AppData for AppID 'YOUR_UNIQUE_ID'
(300, 'custom text')
(370, 4711)
(460, 3.141592)
```

## 6.5.27 Tutorial for MultiLeader

New in version 0.18.

A multileader object typically consists of an arrowhead, a horizontal landing (a.k.a. “dogleg”), a leader line or curve, and either a MTEXT object or a BLOCK.

Factory methods of the *BaseLayout* class to create new *MultiLeader* entities:

- *add\_multileader\_mtext()*
- *add\_multileader\_block()*

Because of the complexity of the MULTILEADER entity, the factory method *add\_multileader\_mtext()* returns a *MultiLeaderMTextBuilder* instance to build a new entity and the factory method *add\_multileader\_block()* returns a *MultiLeaderBlockBuilder* instance.

Due to the lack of good documentation it's not possible to support all combinations of MULTILEADER properties with decent quality, so stick to recipes and hints shown in this tutorial to get usable results otherwise, you will enter uncharted territory.

The rendering result of the MULTILEADER entity is highly dependent on the CAD application. The MULTILEADER entity does not have a pre-rendered anonymous block of DXF primitives like all DIMENSION entities, so results may

vary from CAD application to CAD application. The general support for this entity is only good in Autodesk products other CAD applications often struggle when rendering MULTILEADERS, even my preferred testing application BricsCAD has rendering issues.

---

**Important:** MULTILEADER support has flaws in many CAD applications except Autodesk products!

---

**See also:**

- `ezdxf.render.MultiLeaderBuilder` classes
- `ezdxf.entities.MultiLeader` class
- `ezdxf.entities.MLeaderStyle` class
- `ezdxf.tools.text.MTextEditor` class
- *MULTILEADER Internals*

## MTEXT Quick Draw

Full Python script: `mtext_quick_leader.py`

The `quick_leader()` method of a MTEXT - MULTILEADER entity constructs the geometry parameters in reverse manner, starting from a given target point:

DXF document setup:

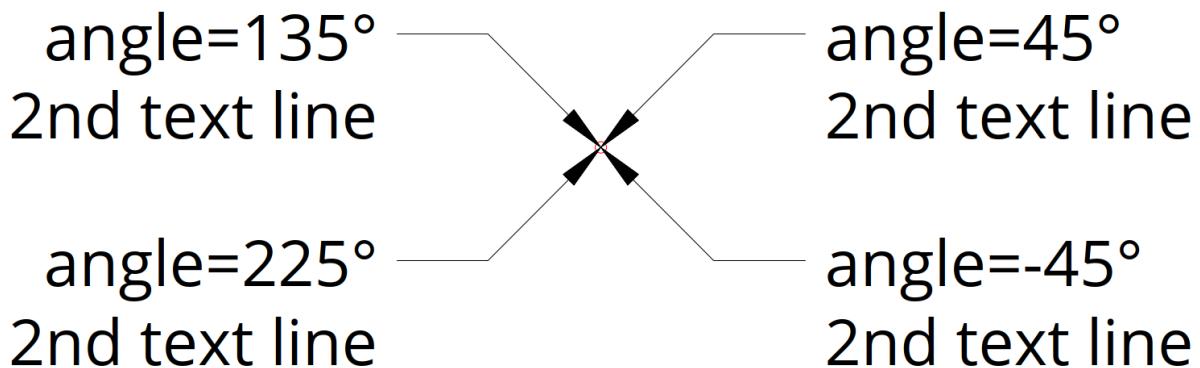
```
doc = ezdxf.new(setup=True)
# Create a new custom MLEADERSTYLE:
mleaderstyle = doc.mleader_styles.duplicate_entry("Standard", "EZDXF")
# The required TEXT style "OpenSans" was created by ezdxf.new() because setup is_
→True:
    mleaderstyle.set_mtext_style("OpenSans")
msp = doc.modelspace()
```

Draw a red circle to mark the target point:

```
target_point = Vec2(40, 15)
msp.add_circle(
    target_point, radius=0.5, dxfattribs=GfxAttribs(color=colors.RED)
)
```

Create four horizontal placed MULTILEADER entities pointing at the target point, the first segment of the leader line is determined by an angle in this example pointing away from the target point:

```
for angle in [45, 135, 225, -45]:
    ml_builder = msp.add_multileader_mtext("EZDXF")
    ml_builder.quick_leader(
        f"angle={angle}°\n2nd text line",
        target=target_point,
        segment1=Vec2.from_deg_angle(angle, 14),
    )
```



The content is automatically aligned to the end of the leader line. The first segment is a relative vector to the target point and the optional second segment vector is relative to the end of the first segment. The default connection type is horizontal but can be changed to vertical:

A smaller text size is required:

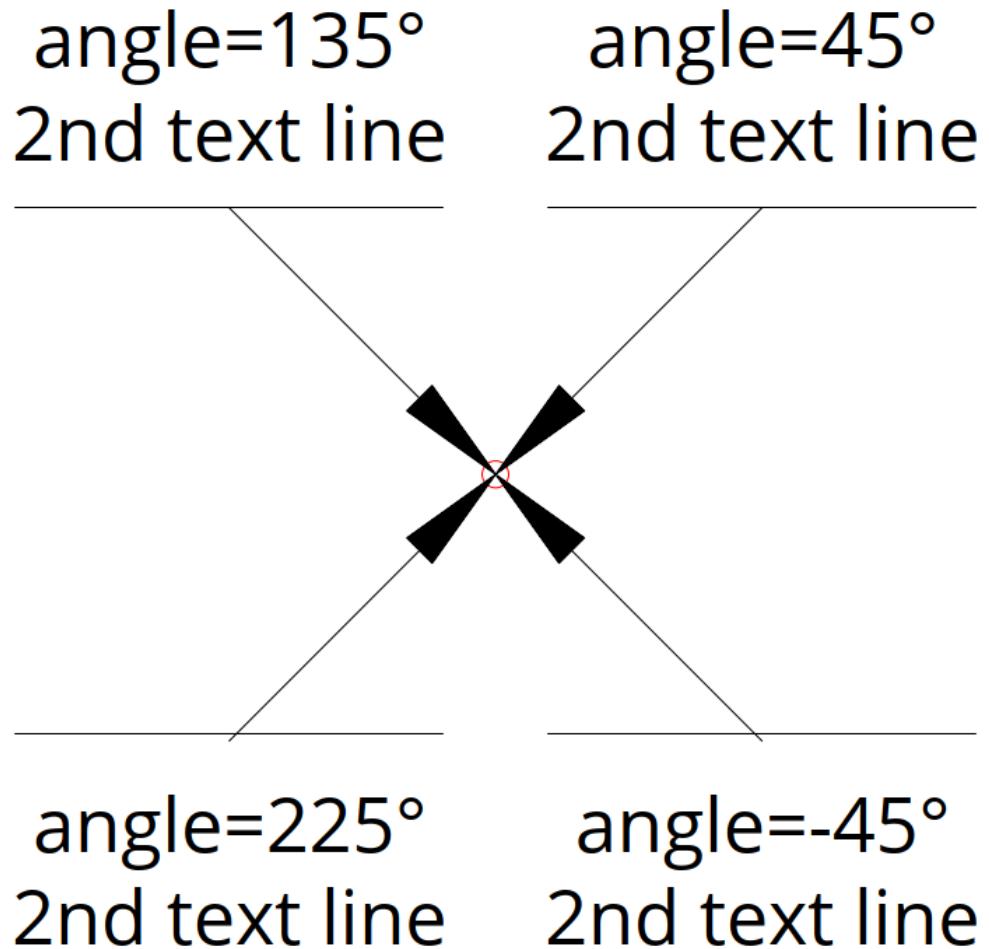
```
mleaderstyle = doc.mleader_styles.duplicate_entry("Standard", "EZDXF")
mleaderstyle.set_mtext_style("OpenSans")
mleaderstyle.dxf.char_height = 2.0 # set the default char height of MTEXT
```

Adding vertical placed MULTILEADER entities:

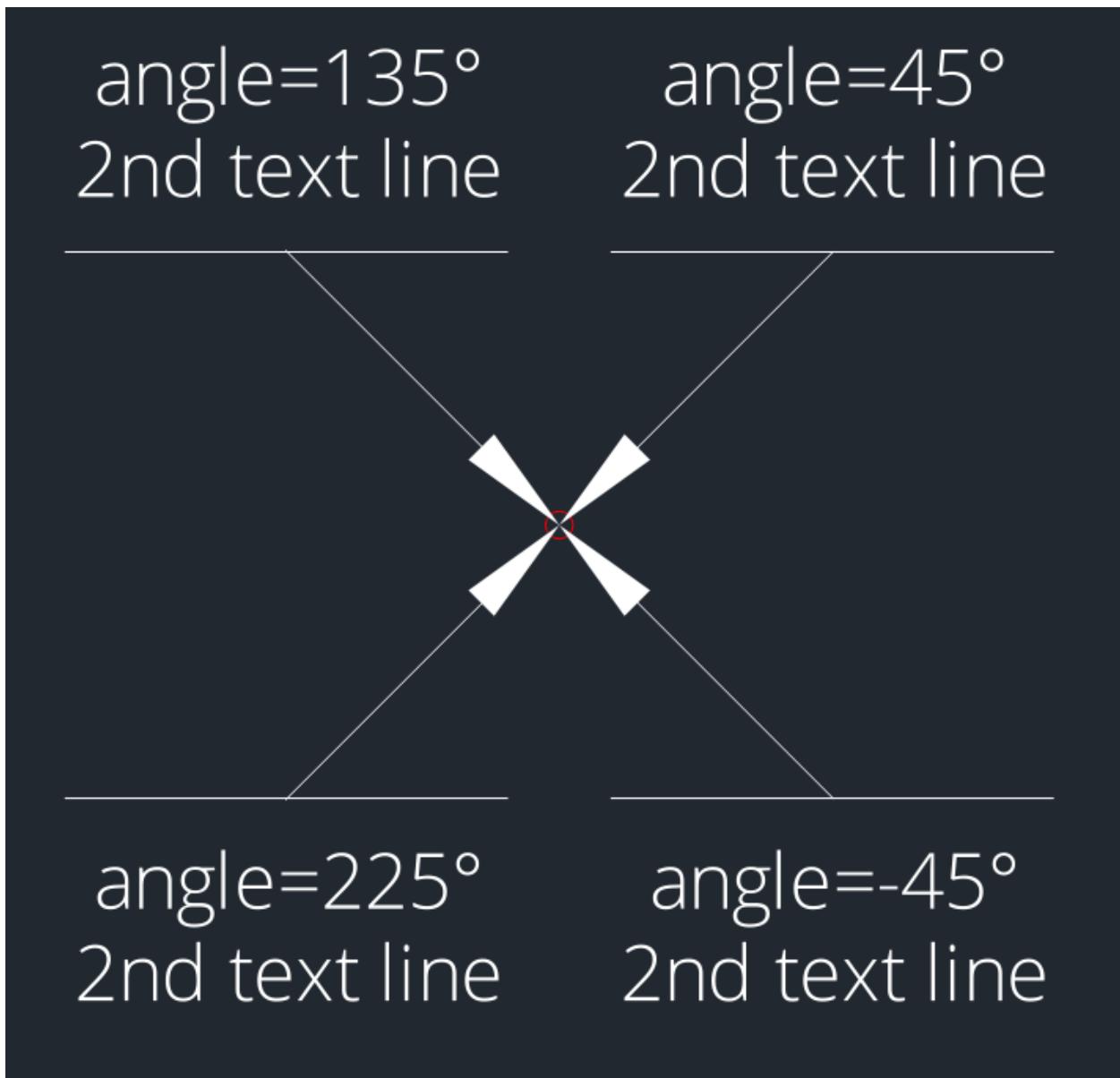
```
for angle in [45, 135, 225, -45]:
    ml_builder = msp.add_multileader_mtext("EZDXF")
    ml_builder.quick_leader(
        f"angle={angle}°\n2nd text line",
        target=target_point,
        segment1=Vec2.from_deg_angle(angle, 14),
        connection_type=mleader.VerticalConnection.center_overline,
```

This example already shows the limitation caused by different text renderings in various CAD applications. The *ezdxf* text measurement by *matplotlib* is different to AutoCAD and BricsCAD and the result is a misalignment of the overline and the leader line.

The DXF file shown in BricsCAD:



The same DXF file shown with the `ezdxf view` command (drawing add-on):



My advice is to avoid vertical placed MULTILEADER entities at all and for horizontal placed MULTILEADER entities avoid styles including an “underline” or an “overline”.

The `quick_leader()` method is not very customizable for ease of use, but follows the settings of the associated `MLeaderStyle`.

The following sections show how to have more control when adding MULTILEADER entities.

### Create MTEXT Content

Full Python script: [mtext\\_content.py](#)

This section shows how to create a MULTILEADER entity with MTEXT content the manual way with full control over all settings.

For good results the MTEXT alignment should match the leader connection side, e.g. if you attach leaders to the left side also align the MTEXT to the left side, for leaders attached at the right side, align the MTEXT to the right side and

if you attach leaders at both sides one side will fit better than the other or maybe a center aligned MTEXT is a good solution, for further details see section [MTEXT Alignment](#).

The first example uses the default connection type of the MLEADERSTYLE “Standard” which is “middle of the top line” for left and right attached leaders. The render UCS for this example is the WCS to keep things simple.

Create a new MULTILEADER entity.

```
msp = doc.modelspace()
```

Set MTEXT content, text style and alignment.

```
ml_builder = msp.add_multileader_mtext("Standard")
ml_builder.set_content(
    "Line1\nLine2",
    style="OpenSans",
    alignment=mleader.TextAlignment.left, # set MTEXT alignment!
```

Add the first leader on the left side. The leader points always to the first given vertex and all vertices are given in render UCS coordinates (= WCS in this example).

```
)
```

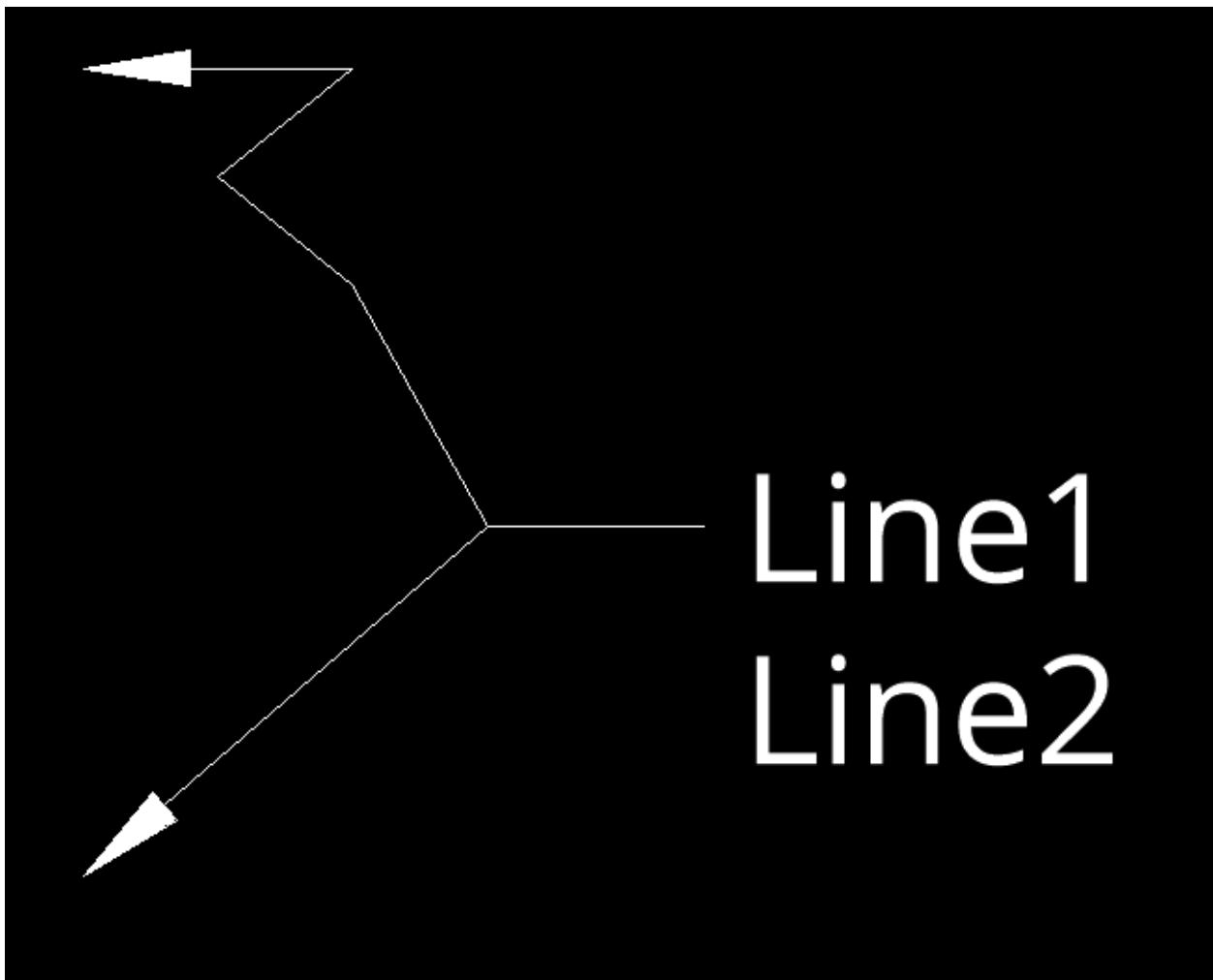
More than one vertex per leader can be used:

```
ml_builder.add_leader_line(mleader.ConnectionSide.left, [Vec2(-20, -15)])
ml_builder.add_leader_line(
    mleader.ConnectionSide.left,
    [Vec2(-20, 15), Vec2(-10, 15), Vec2(-15, 11), Vec2(-10, 7)],
```

The insert point of the `build()` method is the alignment point for the MTEXT content.

```
)
```

The “dogleg” settings are defined by the MLEADERSTYLE “Standard”.



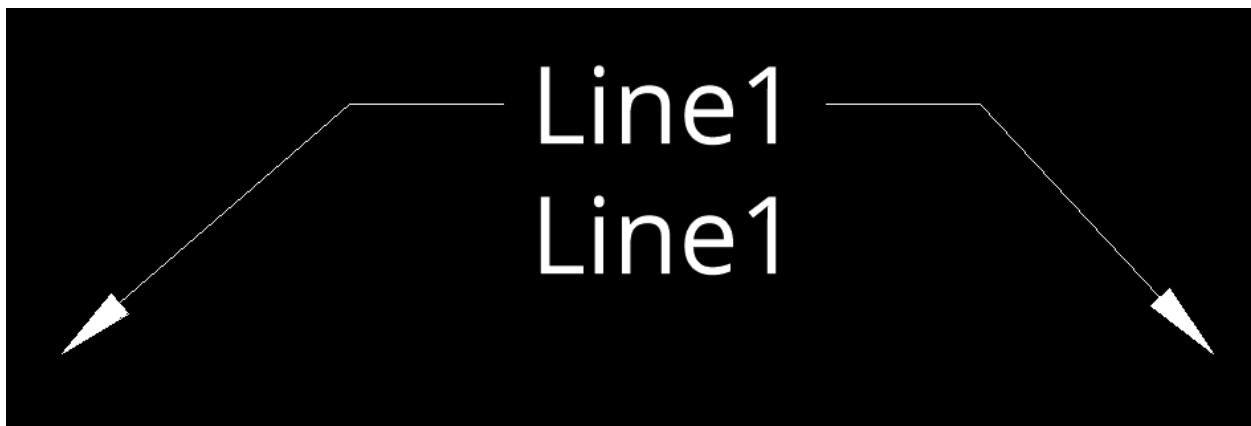
This example shows a leader attached to the right side and the MTEXT aligned to the right side.

```
msp = doc.modelspace()
ml_builder = msp.add_multileader_mtext("Standard")
ml_builder.set_content(
    "Line1\nLine2",
    style="OpenSans",
    alignment=mleader.TextAlignment.right, # set MTEXT alignment!
)
ml_builder.add_leader_line(mleader.ConnectionSide.right, [Vec2(40, -15)])
```



This example shows two leaders attached to both sides and the MTEXT aligned to the left side, which shows that the right landing gap (space between text and start of vertex) is bigger than the gap on the left size. This is due to the different text size calculations from AutoCAD/BricsCAD and Matplotlib. The longer the text, the greater the error.

```
msp = doc.modelspace()
ml_builder = msp.add_multileader_mtext("Standard")
ml_builder.set_content(
    "Line1\nLine1",
    style="OpenSans",
    alignment=mleader.TextAlignment.left, # set MTEXT alignment!
)
ml_builder.add_leader_line(mleader.ConnectionSide.left, [Vec2(-20, -15)])
ml_builder.add_leader_line(mleader.ConnectionSide.right, [Vec2(40, -15)])
```



A centered MTEXT alignment gives a more even result.

```
msp = doc.modelspace()
ml_builder = msp.add_multileader_mtext("Standard")
ml_builder.set_content(
    "First Line\n2. Line",
    style="OpenSans",
```

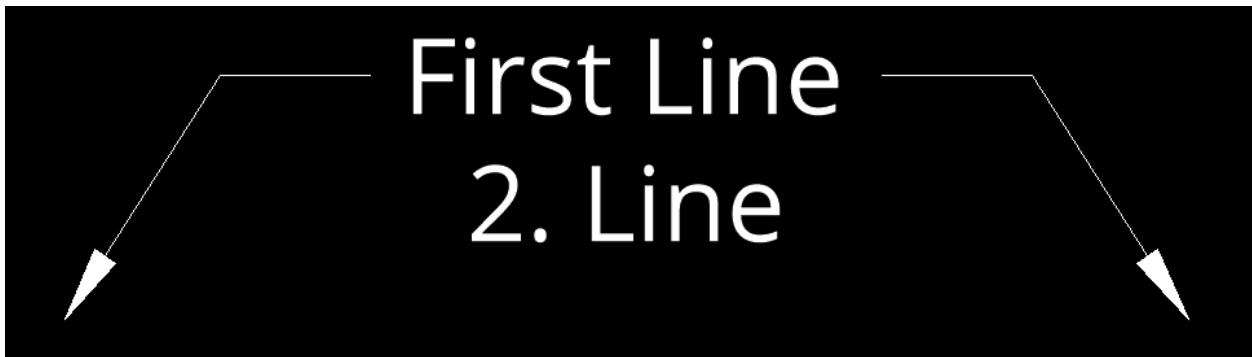
(continues on next page)

(continued from previous page)

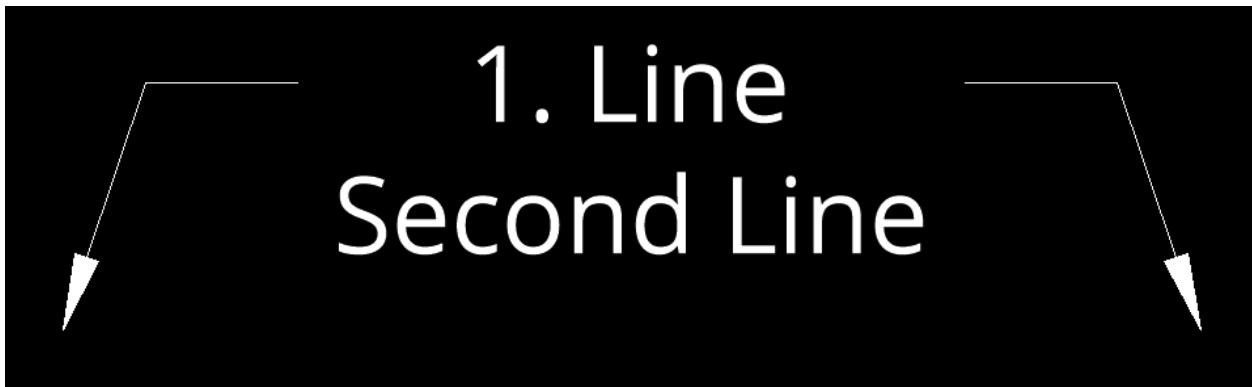
```

        alignment=mleader.TextAlignment.center, # set MTEXT alignment!
    )
ml_builder.add_leader_line(mleader.ConnectionSide.left, [Vec2(-20, -15)])
ml_builder.add_leader_line(mleader.ConnectionSide.right, [Vec2(40, -15)])

```



But even this has its disadvantages, the attachment calculation is always based on the bounding box of the MTEXT content.



## MTEXT Connection Types

There are four connection sides defined by the enum `ezdxf.render.ConnectionSide`:

- left
- right
- top
- bottom

The MultiLeader entity supports as the name says multiple leader lines, but all have to have a horizontal (left/right) connection side or a vertical (top/bottom) connection side, it's not possible to mix left/right and top/bottom connection sides. This is determined by the DXF format.

There are different connection types available for the horizontal and the vertical connection sides. All leaders connecting to the same side have the same connection type. The horizontal connection sides support following connection types, defined by the enum `ezdxf.render.HorizontalConnection`:

- by\_style
- top\_of\_top\_line

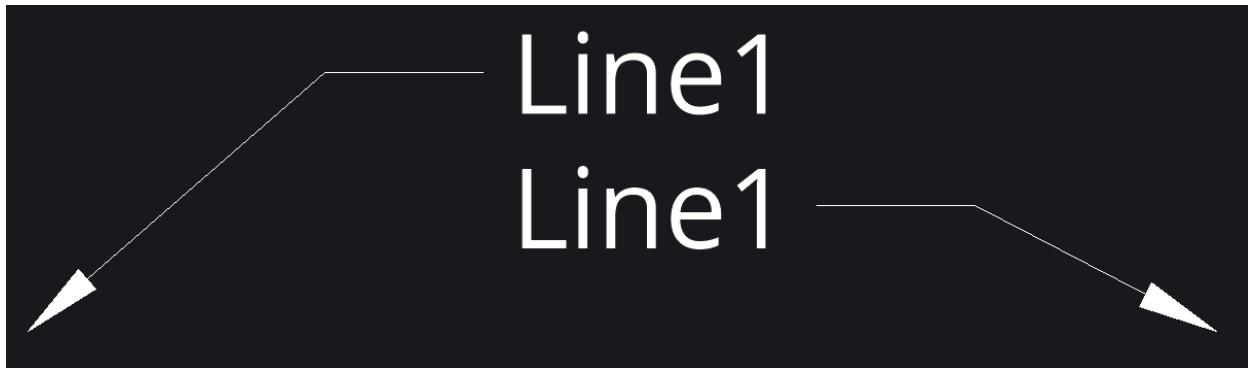
- middle\_of\_top\_line
- middle\_of\_text
- middle\_of\_bottom\_line
- bottom\_of\_bottom\_line
- bottom\_of\_bottom\_line\_underline (not recommended)
- bottom\_of\_top\_line\_underline (not recommended)
- bottom\_of\_top\_line
- bottom\_of\_top\_line\_underline\_all (not recommended)

The vertical connection sides support following connection types, defined by the enum `ezdxf.render.VerticalConnection`:

- by\_style
- center
- center\_overline (not recommended)

The connection type for each side can be set by the method `set_connection_types()`, the default for all sides is `by_style`:

```
ml_builder.add_leader_line(mleader.ConnectionSide.right, [Vec2(40, -15)])
ml_builder.set_connection_types(
    left=mlayer.HorizontalConnection.middle_of_top_line,
    right=mlayer.HorizontalConnection.middle_of_bottom_line,
```



---

**Hint:** As shown in the quick draw section using connection types including underlines or overlines do not render well in AutoCAD/BricsCAD because of the different text measurement of *matplotlib*, therefore it's not recommended to use any of these connection types when creating MULTILEADERS by *ezdxf*.

---

## MTEXT Alignment

In contrast to the standalone MTEXT entity supports the MTEXT content entity only three text alignments defined by the enum `ezdxf.render.TextAlignment`.

- left
- center
- right

The MTEXT alignment is set as argument *alignment* of the `set_content()` method and the alignment point is the insert point of the `build()` method.

## Create BLOCK Content

Full Python script: `block_content.py`

This section shows how to create a MULTILEADER entity with BLOCK content the manual way with full control over all settings.

The BLOCK content consist of a BLOCK layout and optional ATTDEF entities which defines the location and DXF attributes of dynamically created ATTRIB entities.

Create the BLOCK content, the full `create_square_block()` function can be found in the `block_content.py` script.

```
block = create_square_block(
    doc, size=8.0, margin=0.25, base_point=base_point
)
```

Create the MULTILEADER and set the content:

```
ml_builder = msp.add_multileader_block(style="Standard")
ml_builder.set_content(
    name=block.name, alignment=mleader.BlockAlignment.insertion_point
)
```

Set the BLOCK attribute content as text:

```
ml_builder.set_attribute("ONE", "Data1")
ml_builder.set_attribute("TWO", "Data2")
```

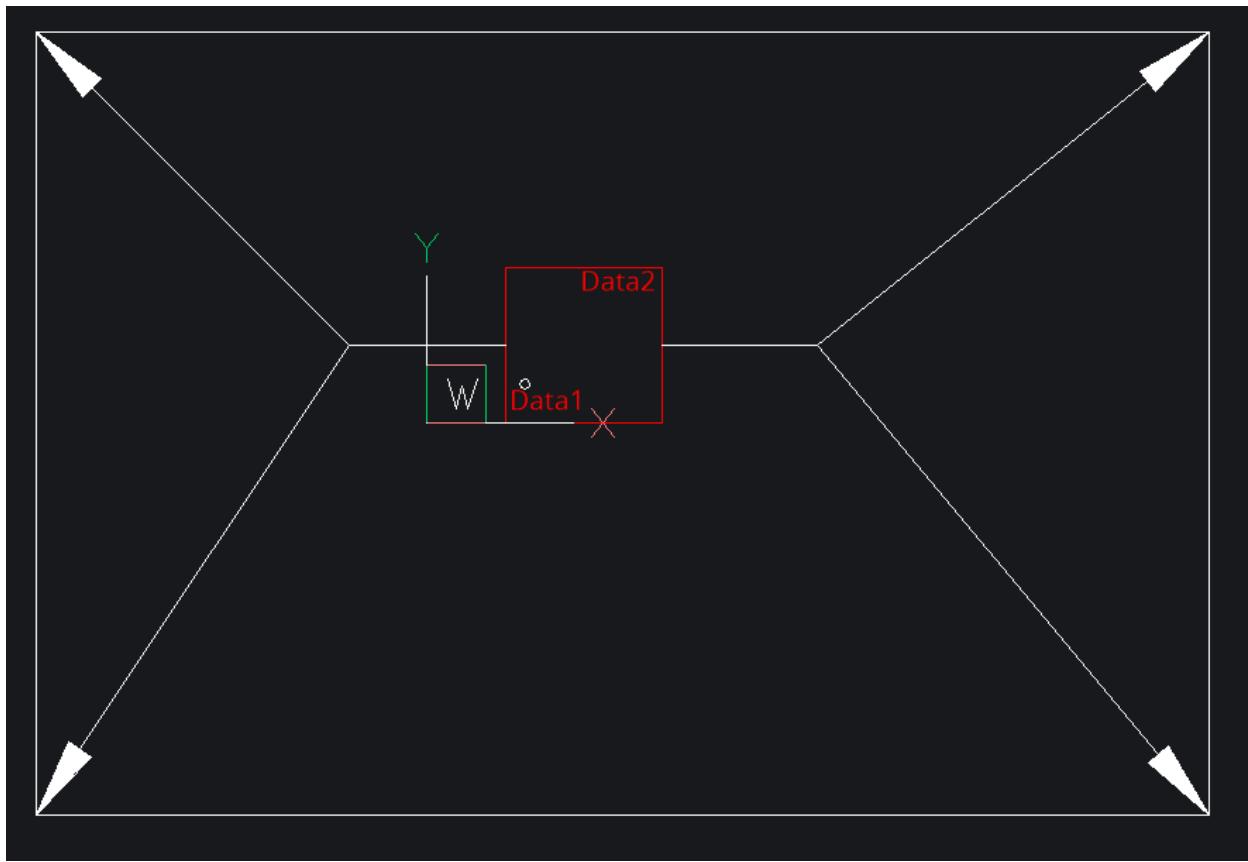
Add some leader lines to the left and right side of the BLOCK:

Construction plane of the entity is defined by a render UCS. The leader lines vertices are expected in render UCS coordinates, which means relative to the UCS origin and this example shows the simple case where the UCS is the WCS which is also the default setting.

```
ml_builder.add_leader_line(mleader.ConnectionSide.right, [Vec2(x2, y1)])
ml_builder.add_leader_line(mleader.ConnectionSide.right, [Vec2(x2, y2)])
ml_builder.add_leader_line(mleader.ConnectionSide.left, [Vec2(x1, y1)])
ml_builder.add_leader_line(mleader.ConnectionSide.left, [Vec2(x1, y2)])
```

Last step is to build the final MULTILEADER entity. This example uses the alignment type *insertion\_point* where the insert point of the `build()` method is the base point of the BLOCK:

```
ml_builder.build(insert=Vec2(5, 2), rotation=30)
```



The result is shown in BricsCAD as expected, although BricsCAD shows “Center extents” as attachment type in the properties dialog instead of the correct attachment type “Insertion point”.

## BLOCK Connection Types

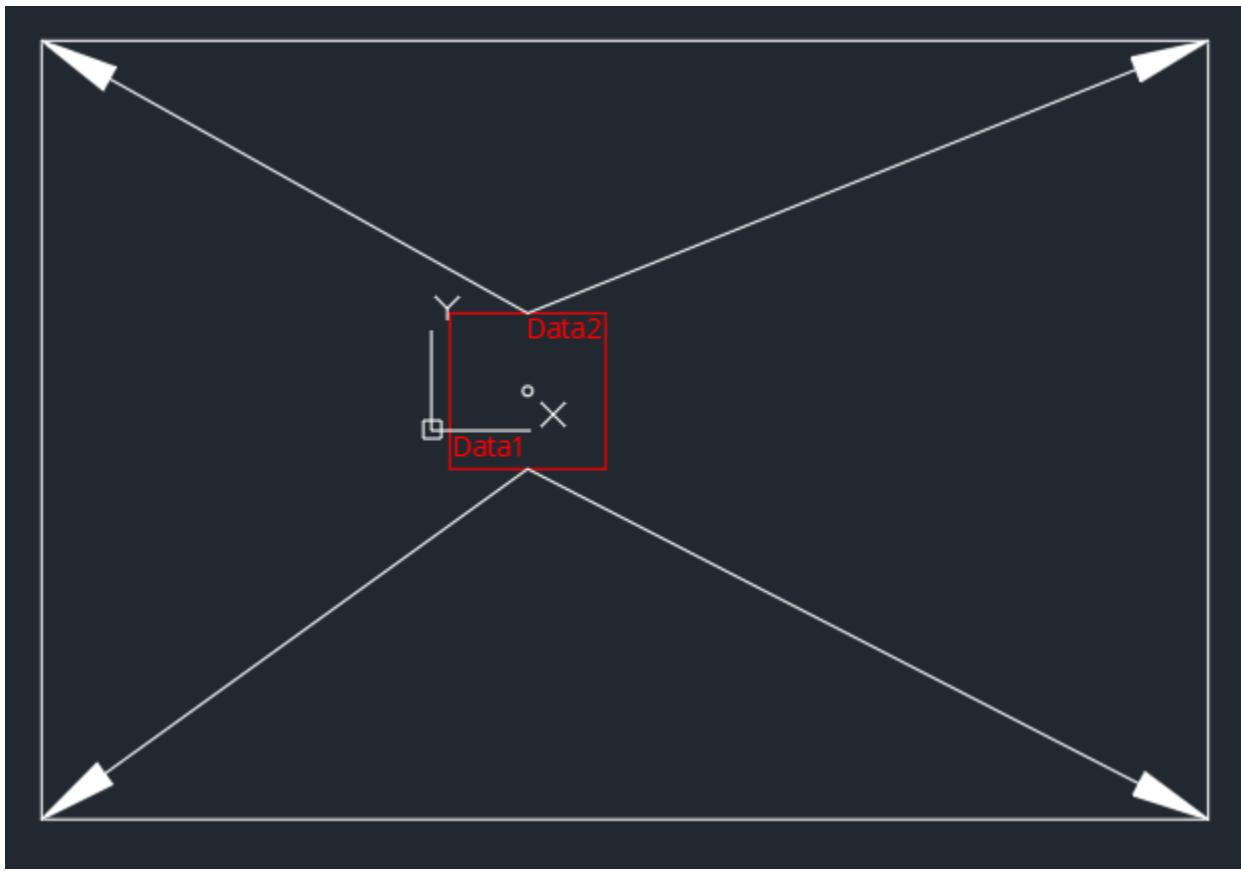
There are four connection sides defined by the enum `ezdxf.render.ConnectionSide`:

- left
- right
- top
- bottom

The connection point for leader lines is always the center of the side of the block bounding box the leader is connected to and has the same limitation as for the MTEXT content, it's not possible to mix the connection sides left/right and top/bottom.

The connection side is set when adding the leader line by the `add_leader_line()` method.

Unfortunately BricsCAD has an error in version 22.2.03 and renders all connection types as left/right, this is top/bottom connection shown in Autodesk TrueView 2022:



The top/bottom connection type does not support the “dogleg” feature.

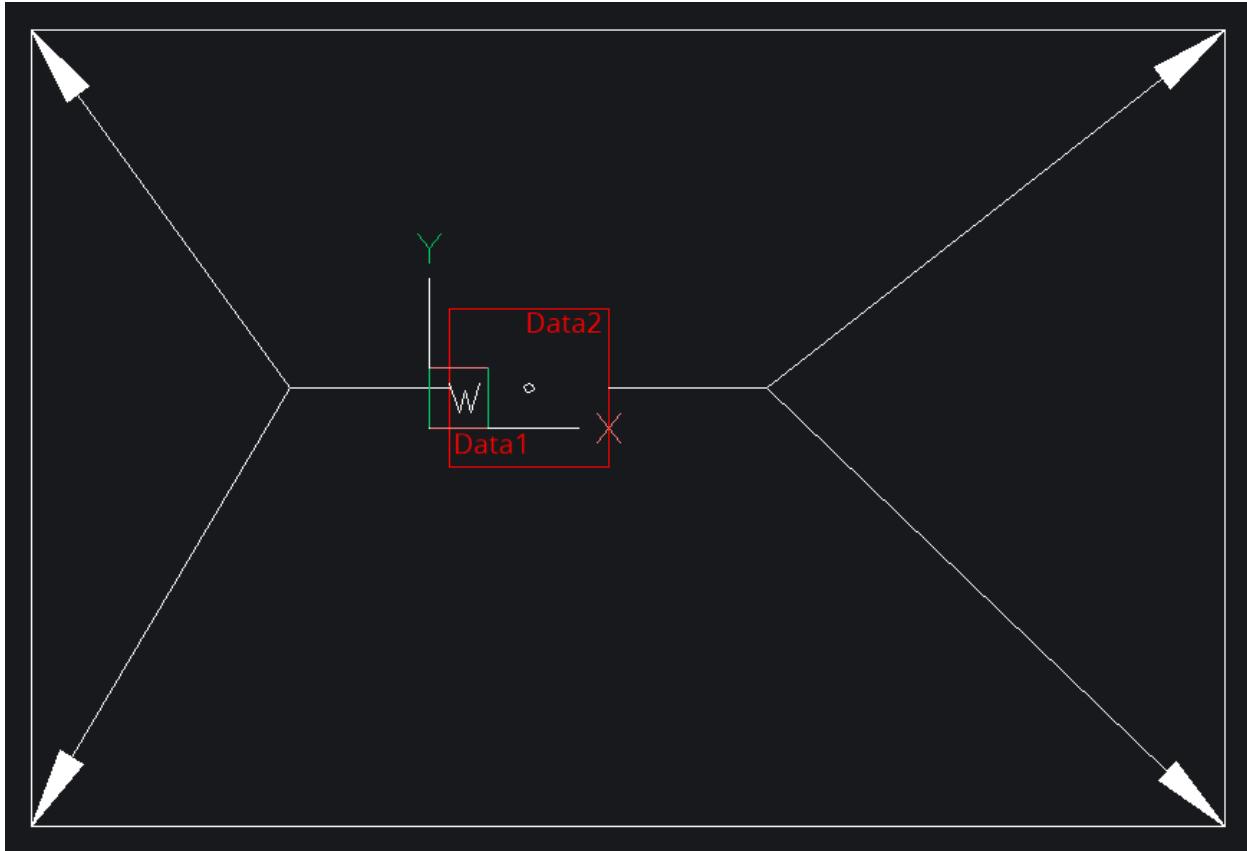
## BLOCK Alignment

There are two alignments types, defined by the enum `ezdxf.render.BlockAlignment`

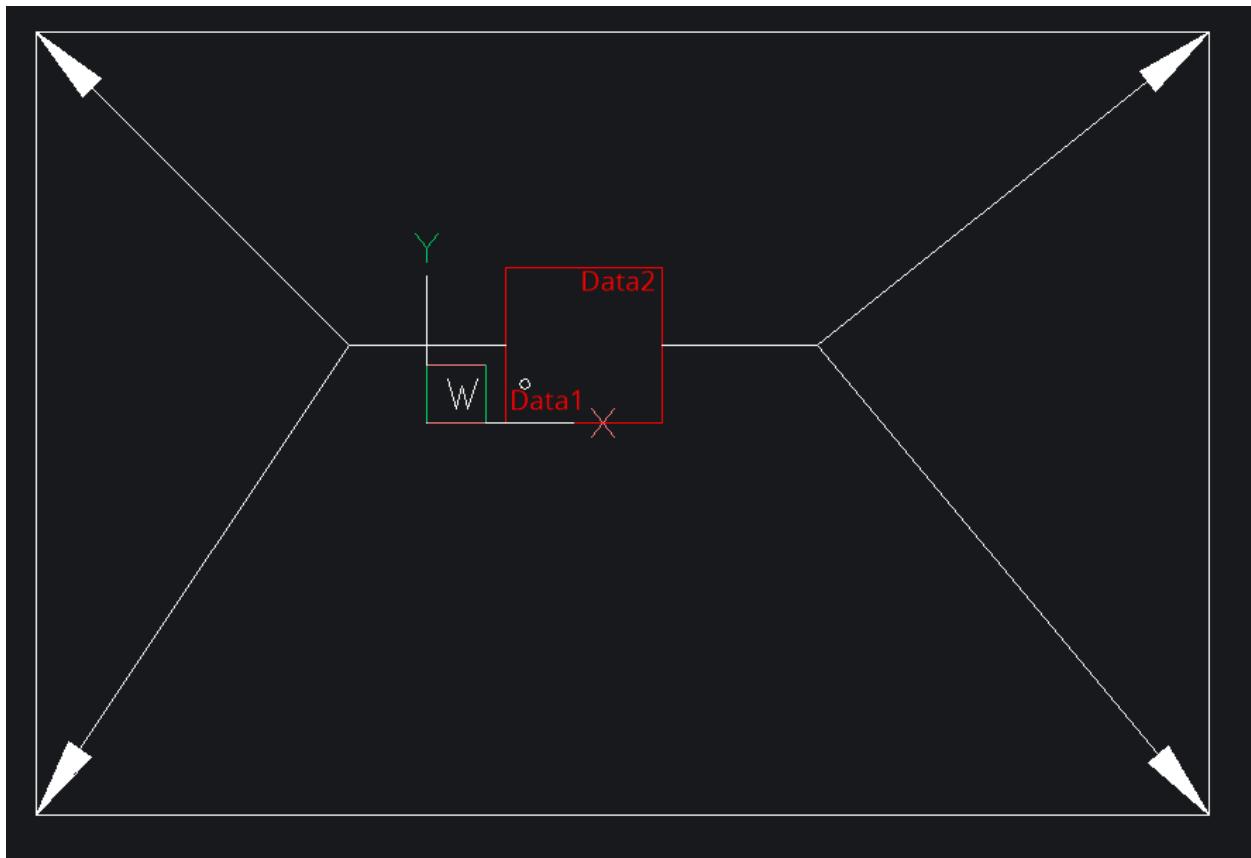
- `center_extent`
- `insertion_point`

The alignment is set by the `set_content()` method.

The alignment type `center_extent` inserts the BLOCK with the center of the bounding box at the insert point of the `build()` method. The insert point is (5, 2) in this example:



The same MULTILEADER with alignment type `insert_point`:



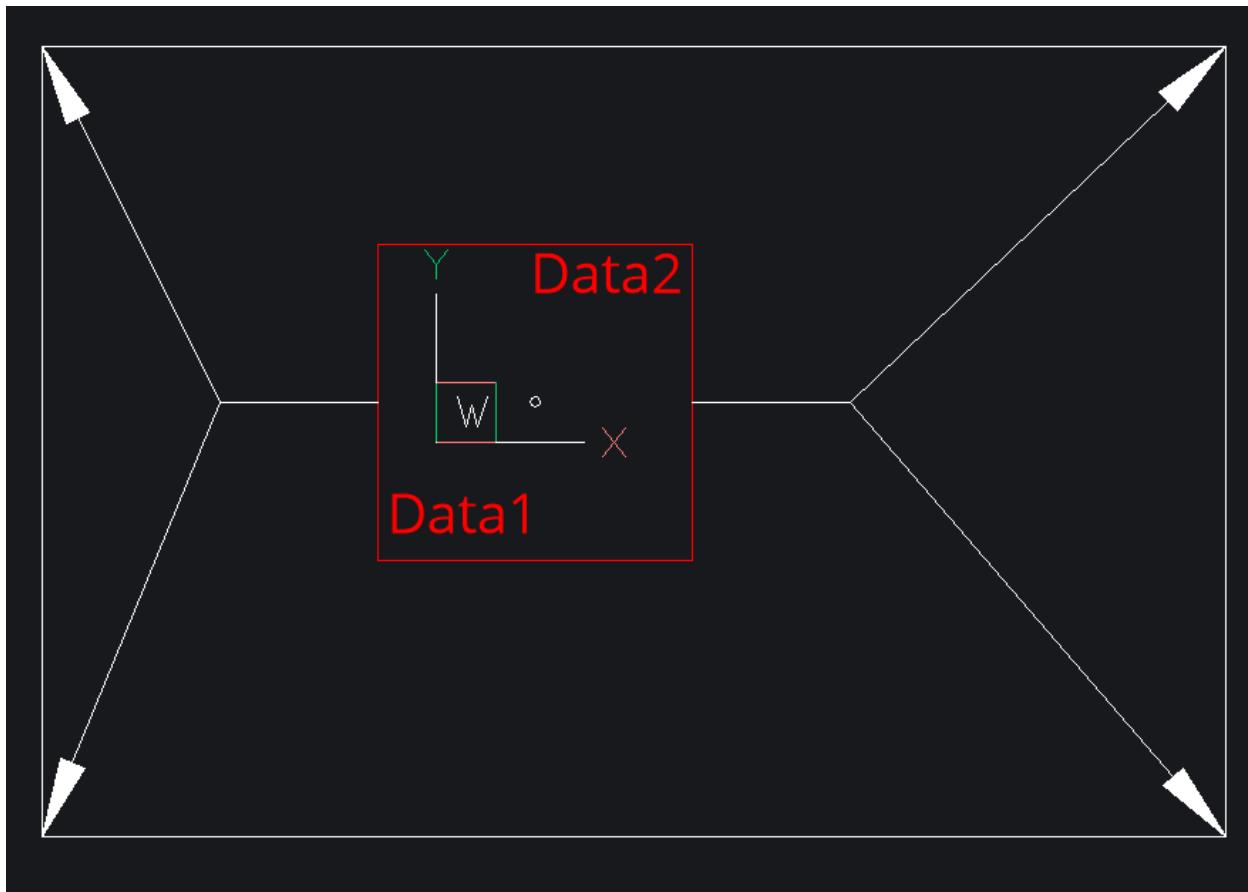
## BLOCK Scaling

The BLOCK content can be scaled independently from the overall scaling of the MULTILEADER entity:

The block scaling factor is set by the `set_content()` method:

```
ml_builder.set_content(  
    name=block.name, scale=2.0, alignment=mleader.BlockAlignment.center_extents  
)
```

This is the first example with a block scaling factor of 2. The BLOCK and the attached ATTRIB entities are scaled but not the arrows.

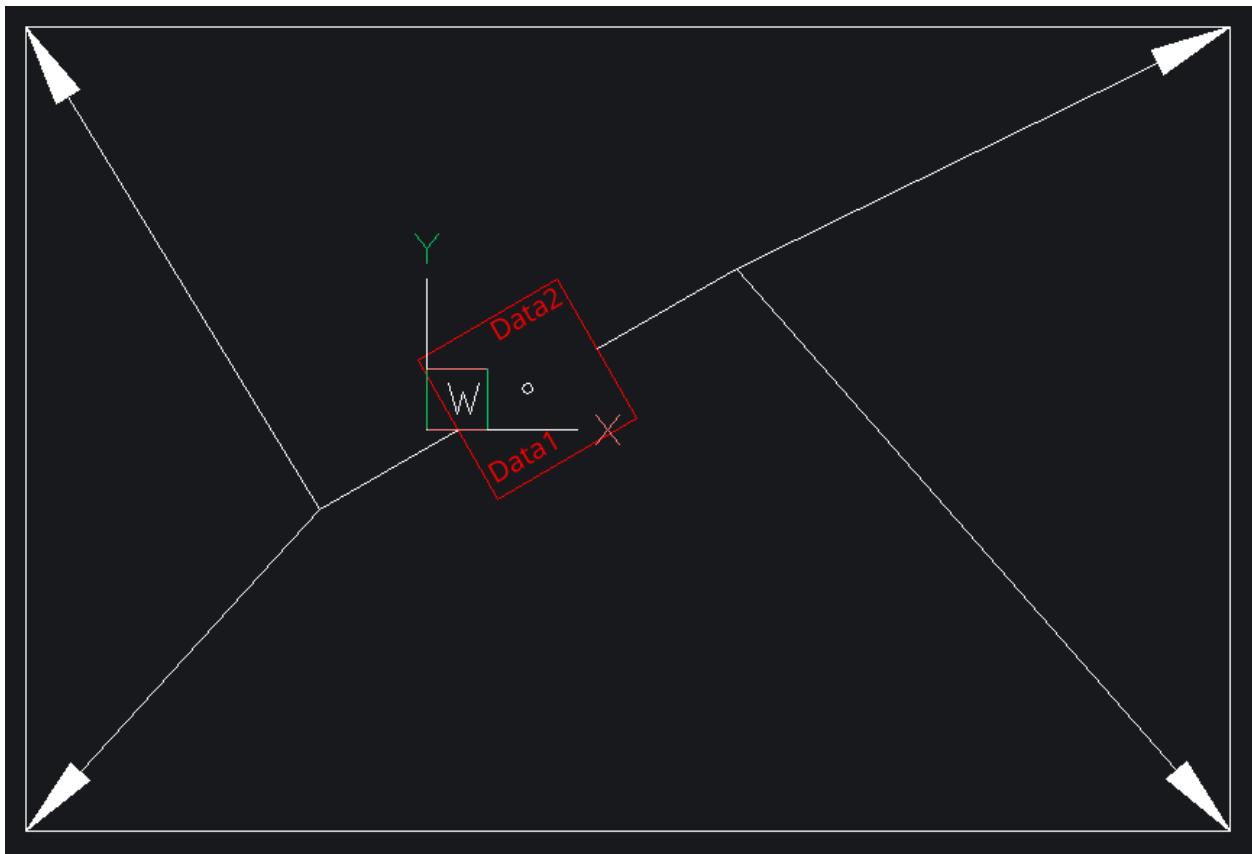


## BLOCK Rotation

The rotation around the render UCS z-axis in degrees is applied by the `build()` method:

```
ml_builder.build(insert=Vec2(5, 2), rotation=30)
```

This is the first example with a rotation of 30 degrees. The BLOCK, the attached ATTRIB entities and the last connection lines (“dogleg”) are rotated.



## BLOCK Attributes

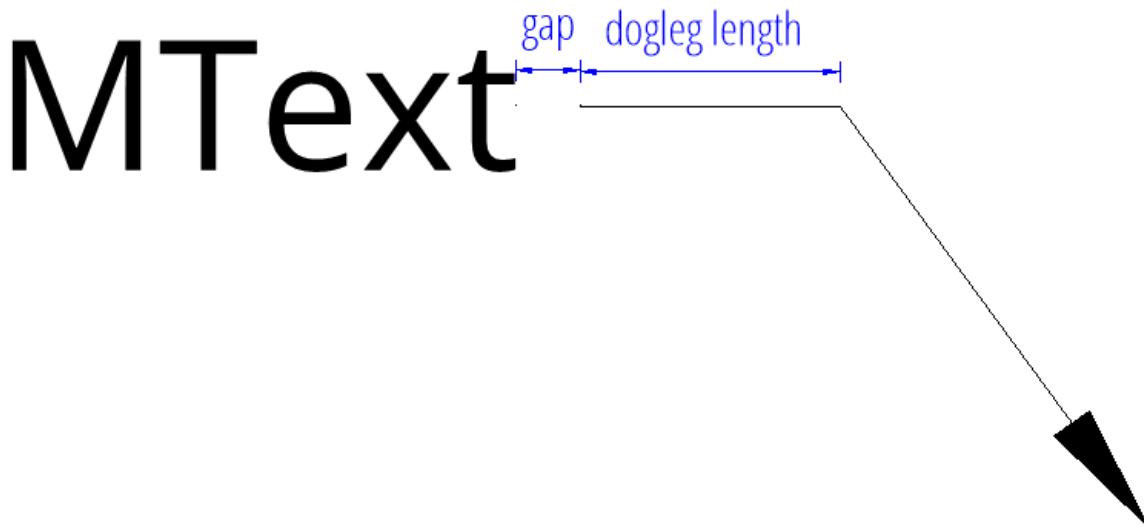
BLOCK attributes are defined as ATTDEF entities in the BLOCK layout. This ATTDEF entities will be replaced by ATTRIB entities at the rendering process of the CAD application. Only the text content and the text width factor can be changed for each MULTILEADER entity individually by the `set_attribute()` method. The ATTDEF is addressed by it's DXF *tag* attribute:

```
ml_builder.set_attribute("ONE", "Data1")
ml_builder.set_attribute("TWO", "Data2")
```

## Leader Properties

### “Dogleg” Properties

The “dogleg” is the last line segment from the last leader vertex to the MULTILEADER content for polyline leaders.

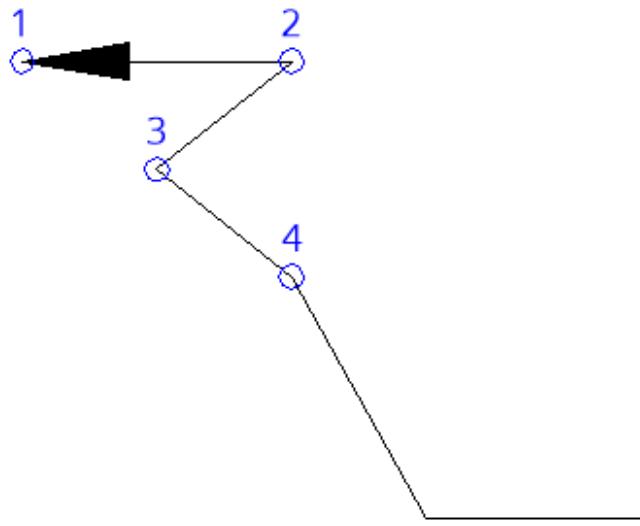


The length of the dogleg and the landing gap size is set by the `set_connection_properties()`.

### Polyline Leader

A polygon leader line has only straight line segments and is added by the `add_leader_line()`:

```
m1_builder.add_leader_line(  
    mleader.ConnectionSide.left,  
    [Vec2(-20, 15), Vec2(-10, 15), Vec2(-15, 11), Vec2(-10, 7)],  
)
```



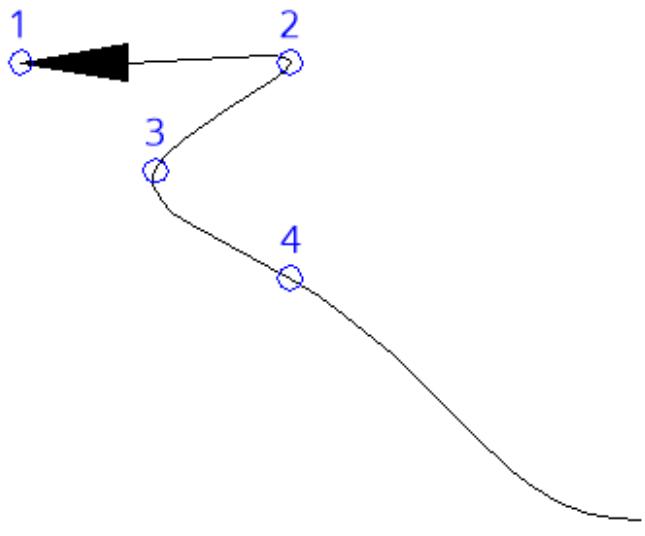
# MText

All leader line vertices have render UCS coordinates and the start- and end-vertex of the “dogleg” is calculated automatically.

## Spline Leader

A spline leader line has a single curved line as leader line and is also added by the `add_leader_line()`. This is spline leader has the same vertices as the previous created polyline leader:

```
ml_builder.set_leader_properties(leader_type=mleader.LeaderType.splines)
ml_builder.add_leader_line(
    mleader.ConnectionSide.left,
    [Vec2(-20, 15), Vec2(-10, 15), Vec2(-15, 11), Vec2(-10, 7)],
)
```



# MText

The spline leader has no “dogleg” and spline leaders and polyline leaders can not be mixed in a single MULTILEADER entity.

The leader type is set by the `set_leader_properties()` method.

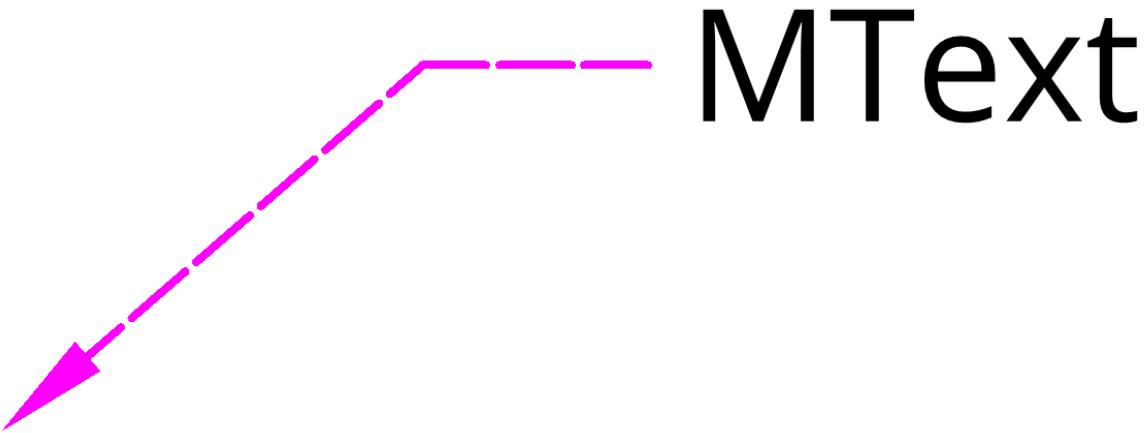
The `LeaderType` enum:

- none
- straight\_lines
- splines

## Line Styling

The leader color, linetype and linewidth is set by the `set_leader_properties()` method:

```
ml_builder.set_leader_properties(  
    color=colors.MAGENTA,  
    linetype="DASHEDX2",  
    linewidth=70,  
)
```

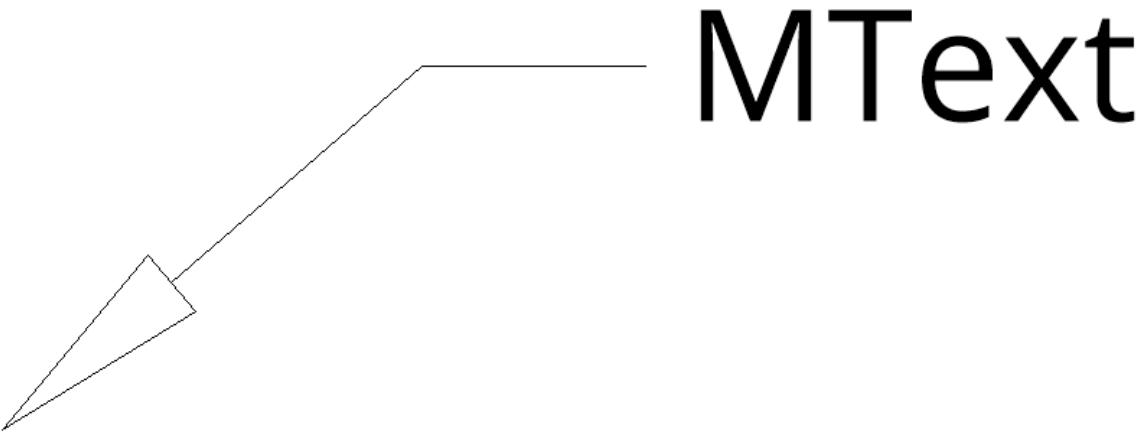


All leader lines have the same properties.

### Arrowheads

The arrow head is set by the `set_arrow_properties()` method:

```
from ezdxf.render import ARROWS
ml_builder.set_arrow_properties(name=ARROWS.closed_blank, size=8.0)
```



All leader lines have the same arrow head and size. The available arrow heads are defined in the `ARROWS` object.

## Overall Scaling

The overall scaling has to be applied by the `set_overall_scaling()` method and scales the MTEXT or BLOCK content **and** the arrows.

## Setup MLEADERSTYLE

The `MLeaderStyle` stores many of the MULTILEADER settings but most of them are copied to the MULTILINE entity at initialization. So changing the MLEADERSTYLE style afterwards has little to no effect for existing MULTILEADER entities.

Create a new MLEADERSTYLE called “MY\_STYLE” and set the MTEXT style to “OpenSans”:

```
my_style = doc.mleader_styles.duplicate_entry("Standard", "MY_STYLE")
my_style.set_mtext_style("OpenSans")
```

The style for a MULTILEADER is set at the `add_multileader_mtext()` and `add_multileader_block()` factory methods.

## 6.6 Howto

The Howto section show how to accomplish specific tasks with *ezdxf* in a straight forward way without teaching basics or internals, if you are looking for more information about the *ezdxf* internals look at the [Reference](#) section or if you want to learn how to use *ezdxf* go to the [Tutorials](#) section or to the [Basic Concepts](#) section.

### 6.6.1 General Document

General preconditions:

```
import sys
import ezdxf

try:
    doc = ezdxf.readfile("your_dxf_file.dxf")
except IOError:
    print(f"Not a DXF file or a generic I/O error.")
    sys.exit(1)
except ezdxf.DXFStructureError:
    print(f"Invalid or corrupted DXF file.")
    sys.exit(2)
msp = doc.modelspace()
```

This works well with DXF files from trusted sources like AutoCAD or BricsCAD, for loading DXF files with minor or major flaws look at the `ezdxf.recover` module.

#### Load DXF Files with Structure Errors

If you know the files you will process have most likely minor or major flaws, use the `ezdxf.recover` module:

```

import sys
from ezdxf import recover

try:    # low level structure repair:
    doc, auditor = recover.readfile(name)
except IOError:
    print(f"Not a DXF file or a generic I/O error.")
    sys.exit(1)
except ezdxf.DXFStructureError:
    print(f"Invalid or corrupted DXF file: {name}.")
    sys.exit(2)

# DXF file can still have unrecoverable errors, but this is maybe
# just a problem when saving the recovered DXF file.
if auditor.has_errors:
    print(f"Found unrecoverable errors in DXF file: {name}.")
    auditor.print_error_report()

```

For more loading scenarios follow the link: [ezdxf.recover](#)

## Set/Get Header Variables

*ezdxf* has an interface to get and set HEADER variables:

```

doc.header["VarName"] = value
value = doc.header["VarName"]

```

### See also:

[HeaderSection](#) and online documentation from Autodesk for available header variables.

## Set DXF Drawing Units

The header variable \$INSUNITS defines the drawing units for the modelspace and therefore for the DXF document if no further settings are applied. The most common units are 6 for meters and 1 for inches.

Use this HEADER variables to setup the default units for CAD applications opening the DXF file. This setting is not relevant for *ezdxf* API calls, which are unitless for length values and coordinates and decimal degrees for angles (in most cases).

Sets drawing units:

```

doc.header["$INSUNITS"] = 6

```

For more information see section [DXF Units](#).

## Create More Readable DXF Files (DXF Pretty Printer)

DXF files are plain text files, you can open this files with every text editor which handles bigger files. But it is not really easy to get quick the information you want.

Create a more readable HTML file (DXF Pretty Printer):

This creates a HTML file with a nicer layout than a plain text file, and handles are links between DXF entities, this simplifies the navigation between the DXF entities.

Changed in version 0.16: The *dxpp* command was replaced by a sub-command of the *ezdxf* launcher.

```
usage: eздxf pp [-h] [-o] [-r] [-x] [-l] FILE [FILE ...]

positional arguments:
  FILE           DXF files pretty print

optional arguments:
  -h, --help      show this help message and exit
  -o, --open       open generated HTML file with the default web browser
  -r, --raw        raw mode - just print tags, no DXF structure interpretation
  -x, --nocompile  don't compile points coordinates into single tags (only in
                  raw mode)
  -l, --legacy     legacy mode - reorders DXF point coordinates
```

---

**Important:** This does not render the graphical content of the DXF file to a HTML canvas element.

---

## Calculate Extents for the Modelspace

Since *ezdxf* v0.16 exist a *ezdxf.bbox* module to calculate bounding boxes for DXF entities. This module makes the extents calculation very easy, but read the documentation for the *bbox* module to understand its limitations.

```
import eздxf
from eздxf import bbox

doc = eздxf.readfile("your.dxf")
msp = doc.modelspace()

extents = bbox.extents(msp)
```

The returned *extents* is a *ezdxf.math.BoundingBox* object.

## Set Initial View/Zoom for the Modelspace

To show an arbitrary location of the modelspace centered in the CAD application window, set the '*\*Active*' VPORT to this location. The DXF attribute *dxf.center* defines the location in the modelspace, and the *dxf.height* specifies the area of the modelspace to view. Shortcut function:

```
doc.set_modelspace_vport(height=10, center=(10, 10))
```

New in version 0.16.

The new *ezdxf.zoom* module of *ezdxf* v0.16, makes this task much easier.

Setting the initial view to the extents of all entities in the modelspace:

```
import eздxf
from eздxf import zoom

doc = eздxf.readfile("your.dxf")
msp = doc.modelspace()
zoom.extents(msp)
```

Setting the initial view to the extents of just some entities:

```
lines = msp.query("LINES")
zoom.objects(lines)
```

The `zoom` module also works for paperspace layouts.

---

**Important:** The `zoom` module uses the `bbox` module to calculate the bounding boxes for DXF entities. Read the documentation for the `bbox` module to understand its limitations and the bounding box calculation for large documents can take a while!

---

## Hide the UCS Icon

The visibility of the UCS icon is controlled by the DXF `ucs_icon` attribute of the `VPort` entity:

- bit 0: 0=hide, 1=show
- bit 1: 0=display in lower left corner, 1=display at origin

The state of the UCS icon can be set in conjunction with the initial `VPort` of the model space, this code turns off the UCS icon:

```
doc.set_modelspace_vport(10, center=(10, 10), dxfattribs={"ucs_icon": 0})
```

Alternative: turn off UCS icons for all `VPort` entries in the active viewport configuration:

```
for vport in doc.viewports.get_config("*Active"):
    vport.dxf.ucs_icon = 0
```

## Show Lineweights in DXF Viewers

By default lines and curves are shown without lineweights in DXF viewers. By setting the header variable `$LWDISPLAY` to 1 the DXF viewer should display lineweights, if supported by the viewer.

```
doc.header["$LWDISPLAY"] = 1
```

## Add ezdxf Resources to Existing DXF Document

Add all `ezdxf` specific resources (line types, text- and dimension styles) to an existing DXF document:

```
import ezdxf
from ezdxf.tools.standards import setup_drawing

doc = ezdxf.readfile("your.dxf")
setup_drawing(doc, topics="all")
```

## Set Logging Level of ezdxf

Set the logging level of the `ezdxf` package to a higher level to minimize logging messages from `ezdxf`. At level `ERROR` only severe errors will be logged and `WARNING`, `INFO` and `DEBUG` messages will be suppressed:

```
import logging  
  
logging.getLogger("ezdxf").setLevel(logging.ERROR)
```

## 6.6.2 DXF Viewer

### A360 Viewer Problems

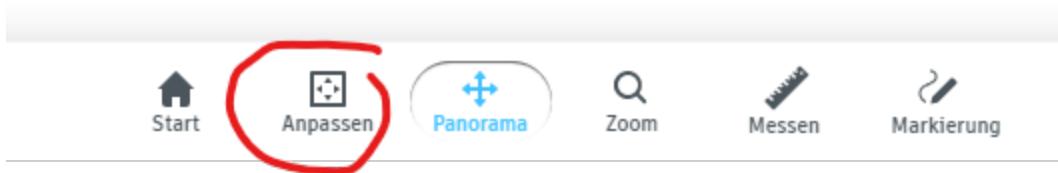
AutoDesk web service A360 seems to be more picky than the AutoCAD desktop applications, may be it helps to use the latest DXF version supported by ezdxf, which is DXF R2018 (AC1032) in the year of writing this lines (2018).

#### DXF Entities Are Not Displayed in the Viewer

*ezdxf* does not automatically locate the main viewport of the modelspace at the entities, you have to perform the “Zoom to Extents” command, here in TrueView 2020:



And here in the Autodesk Online Viewer:



Add this line to your code to relocate the main viewport, adjust the *center* (in modelspace coordinates) and the *height* (in drawing units) arguments to your needs:

```
doc.set_modelspace_vport(height=10, center=(0, 0))
```

### Show IMAGES/XREFS on Loading in AutoCAD

If you are adding XREFS and IMAGES with relative paths to existing drawings and they do not show up in AutoCAD immediately, change the HEADER variable \$PROJECTNAME=' ' to (*not really*) solve this problem. The ezdxf templates for DXF R2004 and later have \$PROJECTNAME=' ' as default value.

Thanks to David Booth:

If the filename in the IMAGEDEF contains the full path (absolute in AutoCAD) then it shows on loading, otherwise it won't display (reports as unreadable) until you manually reload using XREF manager.

A workaround (to show IMAGES on loading) appears to be to save the full file path in the DXF or save it as a DWG.

So far - no solution for showing IMAGES with relative paths on loading.

### Set Initial View/Zoom for the Modelspace

See section "General Document": *Set Initial View/Zoom for the Modelspace*

### Show Lineweights in DXF Viewers

By default lines and curves are shown without lineweights in DXF viewers. By setting the header variable \$LWDISPLAY to 1 the DXF viewer should display lineweights, if supported by the viewer.

```
doc.header["$LWDISPLAY"] = 1
```

## 6.6.3 DXF Content

General preconditions:

```
import sys
import ezdxf

try:
```

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```
doc = ezdxf.readfile("your_dxf_file.dxf")
except IOError:
    print(f'Not a DXF file or a generic I/O error.')
    sys.exit(1)
except ezdxf.DXFStructureError:
    print(f'Invalid or corrupted DXF file.')
    sys.exit(2)
msp = doc.modelspace()
```

## Get/Set Entity Color

The entity color is stored as *ACI* (AutoCAD Color Index):

```
aci = entity.dxf.color
```

Default value is 256 which means BYLAYER:

```
layer = doc.layers.get(entity.dxf.layer)
aci = layer.get_color()
```

The special `get_color()` method is required, because the color attribute `Layer.dxf.color` is misused as layer on/off flag, a negative color value means the layer is off.

ACI value 0 means BYBLOCK, which means the color from the block reference (INSERT entity).

Set color as ACI value as int in range [0, 256]:

```
entity.dxf.color = 1
```

The ACI value 7 has a special meaning, it is white on dark backgrounds and black on light backgrounds.

## Get/Set Entity RGB Color

RGB true color values are supported since DXF R13 (AC1012), the 24-bit RGB value is stored as integer in the DXF attribute `true_color`:

```
# 24 bit binary value: 0bRRRRRRRGGGGGGGGBBBBBBBB or hex value: 0xRRGGBB
# set true color value to red
entity.dxf.true_color = 0xFF0000
```

Use the helper functions from the `ezdxf.colors` module for RGB integer value handling:

```
from ezdxf import colors

entity.dxf.true_color = colors.rgb2int((0xFF, 0, 0))
r, g, b = colors.int2rgb(entity.dxf.true_color)
```

The RGB values of the AutoCAD default colors are not officially documented, but an accurate translation table is included in `ezdxf`:

```
# Warning: ACI value 256 (BYLAYER) raises an IndexError!
rgb24 = colors.DXF_DEFAULT_COLORS[aci]
print(f"RGB Hex Value: #{rgb24:06X}")
r, g, b = colors.int2rgb(rgb24)
print(f"RGB Channel Values: R={r:02X} G={g:02X} B={b:02X}")
```

If `color` and `true_color` values are set, BricsCAD and AutoCAD use the `true_color` value as display color for the entity.

## Get/Set True Color as RGB-Tuple

Get/Set the true color value as (r, g, b)-tuple by the `rgb` property of the `DXFGraphic` entity:

```
# set true color value to red
entity.rgb = (0xFF, 0, 0)

# get true color values
r, g, b = entity.rgb
```

## Get/Set Block Reference Attributes

Block references (`Insert`) can have attached attributes (`Attrib`), these are simple text annotations with an associated tag appended to the block reference.

Iterate over all appended attributes:

```
# get all INSERT entities with entity.dxf.name == "Part12"
blockrefs = msp.query('INSERT[name=="Part12"]')
if len(blockrefs):
    entity = blockrefs[0] # process first entity found
    for attrib in entity.attribs:
        if attrib.dxf.tag == "diameter": # identify attribute by tag
            attrib.dxf.text = "17mm" # change attribute content
```

Get attribute by tag:

```
diameter = entity.get_attrib('diameter')
if diameter is not None:
    diameter.dxf.text = "17mm"
```

## Adding XDATA to Entities

Adding XDATA as list of tuples (group code, value) by `set_xdata()`, overwrites data if already present:

```
doc.appids.new('YOUR_APPID') # IMPORTANT: create an APP ID entry

circle = msp.add_circle((10, 10), 100)
circle.set_xdata(
    'YOUR_APPID',
    [
        (1000, 'your_web_link.org'),
        (1002, '{'),
        (1000, 'some text'),
        (1002, '}'),
        (1071, 1),
        (1002, '}'),
        (1002, '}')
    ]
)
```

For group code meaning see DXF reference section [DXF Group Codes in Numerical Order Reference](#), valid group codes are in the range 1000 - 1071.

Method `get_xdata()` returns the extended data for an entity as `Tags` object.

**See also:**

Tutorial: [Storing Custom Data in DXF Files](#)

## Get Overridden DIMSTYLE Values from DIMENSION

In general the `Dimension` styling and config attributes are stored in the `Dimstyle` entity, but every attribute can be overridden for each `DIMENSION` entity individually, get overwritten values by the `DimstyleOverride` object as shown in the following example:

```
for dimension in msp.query('DIMENSION'):
    dimstyle_override = dimension.override()    # requires v0.12
    dimtol = dimstyle_override['dimtol']
    if dimtol:
        print(f'{str(dimension)} has tolerance values:')
        dimtp = dimstyle_override['dimtp']
        dimtm = dimstyle_override['dimtm']
        print(f'Upper tolerance: {dimtp}')
        print(f'Lower tolerance: {dimtm}'')
```

The `DimstyleOverride` object returns the value of the underlying `DIMSTYLE` objects if the value in `DIMENSION` was not overwritten, or `None` if the value was neither defined in `DIMSTYLE` nor in `DIMENSION`.

## Override DIMSTYLE Values for DIMENSION

Same as above, the `DimstyleOverride` object supports also overriding `DIMSTYLE` values. But just overriding this values have no effect on the graphical representation of the `DIMENSION` entity, because CAD applications just show the associated anonymous block which contains the graphical representation on the `DIMENSION` entity as simple DXF entities. Call the `render` method of the `DimstyleOverride` object to recreate this graphical representation by `ezdxf`, but `ezdxf` **does not** support all `DIMENSION` types and `DIMVARS` yet, and results **will differ** from AutoCAD or BricsCAD renderings.

```
dimstyle_override = dimension.override()
dimstyle_override.set_tolerance(0.1)

# delete associated geometry block
del doc.blocks[dimension.dxf.geometry]

# recreate geometry block
dimstyle_override.render()
```

## 6.6.4 Fonts

### Rendering SHX Fonts

The SHX font format is not documented nor supported by many libraries/packages like `Matplotlib` and `Qt`, therefore only SHX fonts which have corresponding TTF-fonts can be rendered by these backends. The mapping from/to SHX/TTF fonts is hard coded in the source code file: `ezdxf/tools/fonts.py`

## Rebuild Internal Font Cache

*Ezdx*f uses Matplotlib to manage fonts and caches the collected information. If you wanna use new installed fonts which are not included in the default cache files of *ezdx*f you have to rebuild the cache files:

```
import ezdxf
from ezdxf.tools import fonts

# xdg_path() returns "$XDG_CACHE_HOME/ezdxf" or "~/.cache/ezdxf" if
# $XDG_CACHE_HOME is not set
font_cache_dir = ezdxf.options.xdg_path("XDG_CACHE_HOME", ".cache")
fonts.build_system_font_cache(path=font_cache_dir)
ezdxf.options.font_cache_directory = font_cache_dir
# Save changes to the default config file "~/.config/ezdxf/ezdxf.ini"
# to load the font cache always from the new location.
ezdxf.options.write_home_config()
```

For more information see the `ezdxf.options` and the `ezdxf.tools.fonts` module.

## Matplotlib Doesn't Find Fonts

If *Matplotlib* does not find an installed font and rebuilding the matplotlib font cache does not help, deleting the cache file `~/.matplotlib/fontlist-v330.json` (or similar file in newer versions) may help.

For more information see the `ezdxf.tools.fonts` module.

## 6.7 FAQ

### 6.7.1 What is the Relationship between ezdxf, dxfwrite and dxfgabber?

In 2010 I started my first Python package for creating DXF documents called *dxfwrite*, this package can't read DXF files and writes only the DXF R12 (AC1009) version. While *dxfwrite* works fine, I wanted a more versatile package, that can read and write DXF files and maybe also supports newer DXF formats than DXF R12.

This was the start of the *ezdxf* package in 2011, but the progress was so slow, that I created a spin off in 2012 called *dxfgabber*, which implements only the reading part of *ezdxf*, which I needed for my work and I wasn't sure if *ezdxf* will ever be usable. Luckily in 2014 the first usable version of *ezdxf* could be released. The *ezdxf* package has all the features of *dxfwrite* and *dxfgabber* and much more, but with a different API. So *ezdxf* is not a drop-in replacement for *dxfgabber* or *dxfwrite*.

Since *ezdxf* can do all the things that *dxfwrite* and *dxfgabber* can do, I focused on the development of *ezdxf*, *dxfwrite* and *dxfgabber* are in maintenance-only mode and will not get any new features, just bugfixes.

There are no advantages of *dxfwrite* over *ezdxf*, *dxfwrite* has a smaller memory footprint, but the *r12writer* add-on does the same job as *dxfwrite* without any in-memory structures by writing direct to a stream or file and there is also no advantage of *dxfgabber* over *ezdxf* for ordinary DXF files, the smaller memory footprint of *dxfgabber* is not noticeable and for really big files the *iterdxf* add-on does a better job.

### 6.7.2 Imported ezdxf package has no content. (readfile, new)

1. `AttributeError: partially initialized module 'ezdxf' has no attribute 'readfile'` (most likely due to a circular import)

Did you name your file/script “`ezdxf.py`”? This causes problems with circular imports. Renaming your file/script should solve this issue.

2. `AttributeError: module ‘ezdxf’ has no attribute ‘readfile’`

This could be a hidden permission error, for more information about this issue read Petr Zemeks article: <https://blog.petrzemek.net/2020/11/17/when-you-import-a-python-package-and-it-is-empty/>

### 6.7.3 How to add/edit ACIS based entities like 3DSOLID, REGION or SURFACE?

The BODY, 3DSOLID, SURFACE, REGION and so on, are stored as ACIS data embedded in the DXF file. The ACIS data is stored as SAT (text) format in the entity itself for DXF R2000-R2010 and as SAB (binary) format in the ACDS DATA section for DXF R2013+. *Ezdx*f can read SAT and SAB data, but only write SAT data.

The ACIS data is a proprietary format from [Spatial Inc.](#), and there exist no free available documentation or open source libraries to create or edit SAT or SAB data, and also *ezdxf* provides no functionality for creating or editing ACIS data.

The ACIS support provided by *ezdxf* is only useful for users which have access to the ACIS SDK from [Spatial Inc.](#).

### 6.7.4 Are OLE/OLE2 entities supported?

TLDR; NO!

The Wikipedia definition of [OLE](#): Object Linking & Embedding (OLE) is a proprietary technology developed by Microsoft that allows embedding and linking to documents and other objects. For developers, it brought OLE Control Extension (OCX), a way to develop and use custom user interface elements. On a technical level, an OLE object is any object that implements the `IObject` interface, possibly along with a wide range of other interfaces, depending on the object’s needs.

Therefore *ezdxf* does not support this entities in any way, this only work on Windows and with the required editing application installed. The binary data stored in the OLE objects cannot be used without the editing application.

In my opinion, using OLE objects in a CAD drawing is a very bad design decision that can and will cause problems opening these files in the future, even in AutoCAD on Windows when the required editing application is no longer available or the underlying technology is no longer supported.

All of this is unacceptable for a data storage format that should be accessed for many years or decades (e.g. construction drawings for buildings or bridges).

### 6.7.5 Rendering SHX Fonts

The SHX font format is not documented nor supported by many libraries/packages like *Matplotlib* and *Qt*, therefore only SHX fonts which have corresponding TTF-fonts can be rendered by these backends. See also how-tos about [Fonts](#)

## 6.8 Reference

The [DXF Reference](#) is online available at [Autodesk](#).

Quoted from the original DXF 12 Reference which is not available on the web:

Since the AutoCAD drawing database (.dwg file) is written in a compact format that changes significantly as new features are added to AutoCAD, we do not document its format and do not recommend that you attempt to write programs to read it directly. To assist in interchanging drawings between AutoCAD and

other programs, a Drawing Interchange file format (DXF) has been defined. All implementations of AutoCAD accept this format and are able to convert it to and from their internal drawing file representation.

## 6.8.1 DXF Document

### Document Management

#### Create New Drawings

`ezdxf.new(dxfversion='AC1027', setup=False, units=6) → Drawing`

Create a new Drawing from scratch, `dxfversion` can be either “AC1009” the official DXF version name or “R12” the AutoCAD release name.

`new()` can create drawings for following DXF versions:

Version	AutoCAD Release
AC1009	AutoCAD R12
AC1015	AutoCAD R2000
AC1018	AutoCAD R2004
AC1021	AutoCAD R2007
AC1024	AutoCAD R2010
AC1027	AutoCAD R2013
AC1032	AutoCAD R2018

The `units` argument defines the document and modelspace units. The header variable `$MEASUREMENT` will be set according to the given `units`, 0 for inch, feet, miles, ... and 1 for metric units. For more information go to module `ezdxf.units`

#### Parameters

- `dxfversion` – DXF version specifier as string, default is “AC1027” respectively “R2013”
- `setup` – setup default styles, `False` for no setup, `True` to setup everything or a list of topics as strings, e.g. `["linetypes", "styles"]` to setup only some topics:

Topic	Description
linetypes	setup line types
styles	setup text styles
dimstyles	setup default <code>ezdxf</code> dimension styles
visualstyles	setup 25 standard visual styles

- `units` – document and modelspace units, default is 6 for meters

### Open Drawings

Open DXF drawings from file system or text stream, byte stream usage is not supported.

DXF files prior to R2007 requires file encoding defined by header variable `$DWGCODEPAGE`, DXF R2007 and later requires an UTF-8 encoding.

`ezdxf` supports reading of files for following DXF versions:

Version	Release	Encoding	Remarks
< AC1009		\$DWGCODEPAGE	pre AutoCAD R12 upgraded to AC1009
AC1009	R12	\$DWGCODEPAGE	AutoCAD R12
AC1012	R13	\$DWGCODEPAGE	AutoCAD R13 upgraded to AC1015
AC1014	R14	\$DWGCODEPAGE	AutoCAD R14 upgraded to AC1015
AC1015	R2000	\$DWGCODEPAGE	AutoCAD R2000
AC1018	R2004	\$DWGCODEPAGE	AutoCAD R2004
AC1021	R2007	UTF-8	AutoCAD R2007
AC1024	R2010	UTF-8	AutoCAD R2010
AC1027	R2013	UTF-8	AutoCAD R2013
AC1032	R2018	UTF-8	AutoCAD R2018

`ezdxf.readfile(filename: Union[str, Path], encoding: str = None, errors: str = 'surrogateescape') → Drawing`  
Read the DXF document *filename* from the file-system.

This is the preferred method to load existing ASCII or Binary DXF files, the required text encoding will be detected automatically and decoding errors will be ignored.

Override encoding detection by setting argument *encoding* to the estimated encoding. (use Python encoding names like in the `open()` function).

If this function struggles to load the DXF document and raises a `DXFStructureError` exception, try the `ezdxf.recover.readfile()` function to load this corrupt DXF document.

#### Parameters

- **filename** – filename of the ASCII- or Binary DXF document
- **encoding** – use `None` for auto detect (default), or set a specific encoding like “utf-8”, argument is ignored for Binary DXF files
- **errors** – specify decoding error handler
  - “surrogateescape” to preserve possible binary data (default)
  - “ignore” to use the replacement char U+FFFD “” for invalid data
  - “strict” to raise an `UnicodeDecodeError` exception for invalid data

#### Raises

- `IOError` – not a DXF file or file does not exist
- `DXFStructureError` – for invalid or corrupted DXF structures
- `UnicodeDecodeError` – if *errors* is “strict” and a decoding error occurs

`ezdxf.read(stream: TextIO) → ezdxf.document.Drawing`

Read a DXF document from a text-stream. Open stream in text mode (`mode='rt'`) and set correct text encoding, the stream requires at least a `readline()` method.

Since DXF version R2007 (AC1021) file encoding is always “utf-8”, use the helper function `dxf_stream_info()` to detect the required text encoding for prior DXF versions. To preserve possible binary data in use `errors='surrogateescape'` as error handler for the import stream.

If this function struggles to load the DXF document and raises a `DXFStructureError` exception, try the `ezdxf.recover.read()` function to load this corrupt DXF document.

**Parameters** `stream` – input text stream opened with correct encoding

**Raises** `DXFStructureError` – for invalid or corrupted DXF structures

---

`ezdxf.readzip(zipfile: str, filename: str = None, errors: str = 'surrogateescape') → ezdxf.document.Drawing`  
 Load a DXF document specified by *filename* from a zip archive, or if *filename* is `None` the first DXF document in the zip archive.

#### Parameters

- **zipfile** – name of the zip archive
- **filename** – filename of DXF file, or `None` to load the first DXF document from the zip archive.
- **errors** – specify decoding error handler
  - “surrogateescape” to preserve possible binary data (default)
  - “ignore” to use the replacement char U+FFFD “” for invalid data
  - “strict” to raise an `UnicodeDecodeError` exception for invalid data

#### Raises

- `IOError` – not a DXF file or file does not exist or if *filename* is `None` - no DXF file found
- `DXFStructureError` – for invalid or corrupted DXF structures
- `UnicodeDecodeError` – if *errors* is “strict” and a decoding error occurs

`ezdxf.decode_base64(data: bytes, errors: str = 'surrogateescape') → ezdxf.document.Drawing`  
 Load a DXF document from base64 encoded binary data, like uploaded data to web applications.

#### Parameters

- **data** – DXF document base64 encoded binary data
- **errors** – specify decoding error handler
  - “surrogateescape” to preserve possible binary data (default)
  - “ignore” to use the replacement char U+FFFD “” for invalid data
  - “strict” to raise an `UnicodeDecodeError` exception for invalid data

#### Raises

- `DXFStructureError` – for invalid or corrupted DXF structures
- `UnicodeDecodeError` – if *errors* is “strict” and a decoding error occurs

---

**Hint:** This works well with DXF files from trusted sources like AutoCAD or BricsCAD, for loading DXF files with minor or major flaws look at the `ezdxf.recover` module.

---

## Save Drawings

Save the DXF document to the file system by *Drawing* methods `save()` or `saveas()`. Write the DXF document to a text stream with `write()`, the text stream requires at least a `write()` method. Get required output encoding for text streams by property `Drawing.output_encoding`

## Drawing Settings

The *HeaderSection* stores meta data like modelspace extensions, user name or saving time and current application settings, like actual layer, text style or dimension style settings. These settings are not necessary to process DXF data and therefore many of this settings are not maintained by *ezdxf* automatically.

### Header variables set at new

\$ACADVER	DXF version
\$TDCREATE	date/time at creating the drawing
\$FINGERPRINTGUID	every drawing gets a GUID

### Header variables updated at saving

\$TDUPDATE	actual date/time at saving
\$HANDSEED	next available handle as hex string
\$DWGCODEPAGE	encoding setting
\$VERSIONGUID	every saved version gets a new GUID

#### See also:

- Howto: *Set/Get Header Variables*
- Howto: *Set DXF Drawing Units*

## Ezdx~~f~~ Metadata

New in version 0.17.

Store internal metadata like *ezdxf* version and creation time for a new created document as metadata in the DXF file. Only standard DXF features are used to store meta data and this meta data is preserved by Autodesk products, BricsCAD and of course *ezdxf*. Other 3rd party DXF libraries may remove this meta data.

For DXF R12 the meta data is stored as XDATA by AppID EZDXF in the model space BLOCK entity in the BLOCKS section.

For DXF R2000+ the meta data is stored in the “root” DICTIONARY in the OBJECTS section as a DICTIONARY object by the key EZDXF\_META.

The MetaData object has a dict-like interface and can also store custom metadata:

```
metadata = doc.ezdxf_metadata()

# set data
metadata["MY_CUSTOM_META_DATA"] = "a string with max. length of 254"

# get data, raises a KeyError() if key not exist
value = metadata["MY_CUSTOM_META_DATA"]

# get data, returns an empty string if key not exist
value = metadata.get("MY_CUSTOM_META_DATA")
```

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```
# delete entry, raises a KeyError() if key not exist
del metadata["MY_CUSTOM_META_DATA"]

# discard entry, does not raise a KeyError() if key not exist
metadata.discard("MY_CUSTOM_META_DATA")
```

Keys and values are limited to strings with a max. length of 254 characters and line ending \n will be replaced by \P.

Keys used by `ezdxf`:

- WRITTEN\_BY\_EZDXF: `ezdxf` version and UTC time in ISO format
- CREATED\_BY\_EZDXF: `ezdxf` version and UTC time in ISO format

Example of the `ezdxf` marker string: 0.16.4b1 @ 2021-06-12T07:35:34.898808+00:00

```
class ezdxf.document.MetaData
```

`MetaData.__contains__(key: str) → bool`

Returns `key` in self.

`MetaData.__getitem__(key: str) → str`

Returns the value for `self[key]`.

**Raises** `KeyError` – `key` does not exist

`MetaData.get(key: str, default: str = "") → str`

Returns the value for `key`. Returns `default` if `key` not exist.

`MetaData.__setitem__(key: str, value: str) → None`

Set `self[key]` to `value`.

`MetaData.__delitem__(key: str) → None`

Delete `self[key]`.

**Raises** `KeyError` – `key` does not exist

`MetaData.discard(key: str) → None`

Remove `key`, does **not** raise an exception if `key` not exist.

## Drawing Object

```
class ezdxf.document.Drawing
```

The `Drawing` class manages all entities and tables related to a DXF drawing.

**dxversion**

Actual DXF version like 'AC1009', set by `ezdxf.new()` or `ezdxf.readfile()`.

For supported DXF versions see *Document Management*

**acad\_release**

The AutoCAD release name like 'R12' or 'R2000' for actual `dxversion`.

**encoding**

Text encoding of `Drawing`, the default encoding for new drawings is 'cp1252'. Starting with DXF R2007 (AC1021), DXF files are written as UTF-8 encoded text files, regardless of the attribute `encoding`. The text encoding can be changed to encodings listed below.

see also: *DXF File Encoding*

supported	encodings
'cp874'	Thai
'cp932'	Japanese
'gbk'	UnifiedChinese
'cp949'	Korean
'cp950'	TradChinese
'cp1250'	CentralEurope
'cp1251'	Cyrillic
'cp1252'	WesternEurope
'cp1253'	Greek
'cp1254'	Turkish
'cp1255'	Hebrew
'cp1256'	Arabic
'cp1257'	Baltic
'cp1258'	Vietnam

**output\_encoding**

Returns required output encoding for saving to filesystem or encoding to binary data.

**filename**

*Drawing* filename, if loaded by `ezdxf.readfile()` else None.

**rootdict**

Reference to the root dictionary of the OBJECTS section.

**header**

Reference to the `HeaderSection`, get/set drawing settings as header variables.

**entities**

Reference to the EntitySection of the drawing, where all graphical entities are stored, but only from modelspace and the *active* paperspace layout. Just for your information: Entities of other paperspace layouts are stored as `BlockLayout` in the `BlocksSection`.

**objects**

Reference to the objects section, see also `ObjectsSection`.

**blocks**

Reference to the blocks section, see also `BlocksSection`.

**tables**

Reference to the tables section, see also `TablesSection`.

**classes**

Reference to the classes section, see also `ClassesSection`.

**layouts**

Reference to the layout manager, see also `Layouts`.

**groups**

Collection of all groups, see also `GroupCollection`.

requires DXF R13 or later

**layers**

Shortcut for `Drawing.tables.layers`

Reference to the layers table, where you can create, get and remove layers, see also `Table` and `Layer`

**styles**

Shortcut for Drawing.tables.styles

Reference to the styles table, see also Style.

**dimstyles**

Shortcut for Drawing.tables.dimstyles

Reference to the dimstyles table, see also DimStyle.

**linetypes**

Shortcut for Drawing.tables.linetypes

Reference to the linetypes table, see also Linetype.

**views**

Shortcut for Drawing.tables.views

Reference to the views table, see also View.

**viewports**

Shortcut for Drawing.tables.viewports

Reference to the viewports table, see also Viewport.

**ucs**

Shortcut for Drawing.tables.ucs

Reference to the ucs table, see also UCS.

**appids**

Shortcut for Drawing.tables.appids

Reference to the appids table, see also AppID.

**materials**

MaterialCollection of all Material objects.

**mline\_styles**

MLineStyleCollection of all *MLineStyle* objects.

**mleader\_styles**

MLeaderStyleCollection of all *MLeaderStyle* objects.

**units**

Get and set the document/modelspace base units as enum, for more information read this: [DXF Units](#).

**save**(*encoding*: str = None, *fmt*: str = 'asc') → None

Write drawing to file-system by using the *filename* attribute as filename. Override file encoding by argument *encoding*, handle with care, but this option allows you to create DXF files for applications that handles file encoding different than AutoCAD.

**Parameters**

- **encoding** – override default encoding as Python encoding string like 'utf-8'
- **fmt** – 'asc' for ASCII DXF (default) or 'bin' for Binary DXF

**saveas**(*filename*: Union[str, Path], *encoding*: str = None, *fmt*: str = 'asc') → None

Set *Drawing* attribute *filename* to *filename* and write drawing to the file system. Override file encoding by argument *encoding*, handle with care, but this option allows you to create DXF files for applications that handles file encoding different than AutoCAD.

**Parameters**

- **filename** – file name as string

- **encoding** – override default encoding as Python encoding string like 'utf-8'
- **fmt** – 'asc' for ASCII DXF (default) or 'bin' for Binary DXF

**write** (*stream: Union[TextIO, BinaryIO]*, *fmt: str = 'asc'*) → None

Write drawing as ASCII DXF to a text stream or as Binary DXF to a binary stream. For DXF R2004 (AC1018) and prior open stream with drawing *encoding* and mode='wt'. For DXF R2007 (AC1021) and later use *encoding='utf-8'*, or better use the later added *Drawing* property *output\_encoding* which returns the correct encoding automatically. The correct and required error handler is *errors='dxffreplace'*!

If writing to a *StringIO* stream, use *Drawing.encode()* to encode the result string from *StringIO.getvalue()*:

```
binary = doc.encode(stream.getvalue())
```

### Parameters

- **stream** – output text stream or binary stream
- **fmt** – 'asc' for ASCII DXF (default) or 'bin' for binary DXF

**encode\_base64** () → bytes

Returns DXF document as base64 encoded binary data.

**encode** (*s: str*) → bytes

Encode string *s* with correct encoding and error handler.

**query** (*query: str = '\*'*) → ezdxf.query.EntityQuery

Entity query over all layouts and blocks, excluding the OBJECTS section.

**Parameters** **query** – query string

### See also:

*Entity Query String* and *Retrieve entities by query language*

**groupby** (*dxfattrib=*”, *key=None*) → dict

Groups DXF entities of all layouts and blocks (excluding the OBJECTS section) by a DXF attribute or a key function.

### Parameters

- **dxfattrib** – grouping DXF attribute like 'layer'
- **key** – key function, which accepts a DXFEntity as argument and returns a hashable grouping key or None to ignore this entity.

### See also:

*groupby()* documentation

**modelspace** () → ezdxf.layouts.layout.Modelspace

Returns the modelspace layout, displayed as 'Model' tab in CAD applications, defined by block record named '\*Model\_Space'.

**layout** (*name: str = None*) → Layout

Returns paperspace layout *name* or returns first layout in tab order if *name* is None.

**active\_layout** () → Layout

Returns the active paperspace layout, defined by block record name '\*Paper\_Space'.

**layout\_names** () → Iterable[str]

Returns all layout names (modelspace 'Model' included) in arbitrary order.

**layout\_names\_in\_taborder()** → Iterable[str]

Returns all layout names in tab order, layout “Model” (model space) is always the first name.

**new\_layout(name, dxfsattribs=None)** → Layout

Create a new paperspace layout *name*. Returns a [Layout](#) object. DXF R12 (AC1009) supports only one paperspace layout, only the active paperspace layout is saved, other layouts are dismissed.

**Parameters**

- **name** – unique layout name
- **dxfsattribs** – additional DXF attributes for the `DXFLayout` entity

**Raises** `DXFValueError` – *Layout* *name* already exist

**delete\_layout(name: str)** → None

Delete paper space layout *name* and all entities owned by this layout. Available only for DXF R2000 or later, DXF R12 supports only one paperspace and it can't be deleted.

**add\_image\_def(filename: str, size\_in\_pixel: Tuple[int, int], name=None)**

Add an image definition to the objects section.

Add an `ImageDef` entity to the drawing (objects section). *filename* is the image file name as relative or absolute path and *size\_in\_pixel* is the image size in pixel as (x, y) tuple. To avoid dependencies to external packages, `ezdxf` can not determine the image size by itself. Returns a `ImageDef` entity which is needed to create an image reference. *name* is the internal image name, if set to None, name is auto-generated.

Absolute image paths works best for AutoCAD but not really good, you have to update external references manually in AutoCAD, which is not possible in TrueView. If the drawing units differ from 1 meter, you also have to use: `set_raster_variables()`.

**Parameters**

- **filename** – image file name (absolute path works best for AutoCAD)
- **size\_in\_pixel** – image size in pixel as (x, y) tuple
- **name** – image name for internal use, None for using filename as name (best for AutoCAD)

**See also:**

[Tutorial for Image and ImageDef](#)

**set\_raster\_variables(frame: int = 0, quality: int = 1, units: str = 'm')**

Set raster variables.

**Parameters**

- **frame** – 0 = do not show image frame; 1 = show image frame
- **quality** – 0 = draft; 1 = high
- **units** – units for inserting images. This defines the real world unit for one drawing unit for the purpose of inserting and scaling images with an associated resolution.

mm	Millimeter
cm	Centimeter
m	Meter (ezdxf default)
km	Kilometer
in	Inch
ft	Foot
yd	Yard
mi	Mile

**set\_wipeout\_variables (frame=0)**

Set wipeout variables.

**Parameters** **frame** – 0 = do not show image frame; 1 = show image frame

**add\_underlay\_def (filename: str, fmt: str = 'ext', name: str = None)**

Add an UnderlayDef entity to the drawing (OBJECTS section). *filename* is the underlay file name as relative or absolute path and *fmt* as string (pdf, dwf, dgn). The underlay definition is required to create an underlay reference.

**Parameters**

- **filename** – underlay file name
- **fmt** – file format as string 'pdf' | 'dwf' | 'dgn' or 'ext' for getting file format from filename extension
- **name** – pdf format = page number to display; dgn format = 'default'; dwf: ????

**See also:**

*Tutorial for Underlay and UnderlayDefinition*

**add\_xref\_def (filename: str, name: str, flags: int = 20)**

Add an external reference (xref) definition to the blocks section.

**Parameters**

- **filename** – external reference filename
- **name** – name of the xref block
- **flags** – block flags

**layouts\_and\_blocks () → Iterator[GenericLayoutType]**

Iterate over all layouts (modelspace and paperspace) and all block definitions.

**chain\_layouts\_and\_blocks () → Iterator[DXFEntity]**

Chain entity spaces of all layouts and blocks. Yields an iterator for all entities in all layouts and blocks.

**reset\_fingerprint\_guid()**

Reset fingerprint GUID.

**reset\_version\_guid()**

Reset version GUID.

**set\_modelspace\_vport (height, center=(0, 0), \*, dxfattribs=None) → VPort**

Set initial view/zoom location for the modelspace, this replaces the current “\*Active” viewport configuration (*VPort*) and reset the coordinate system to the *WCS*.

**Parameters**

- **height** – modelspace area to view
- **center** – modelspace location to view in the center of the CAD application window.
- **dxfattribs** – additional DXF attributes for the VPORT entity

Changed in version 0.17.2: added argument *dxfattribs* to pass additional DXF attributes to the VPORT entity

**audit () → ezdxf.audit.Auditor**

Checks document integrity and fixes all fixable problems, not fixable problems are stored in *Auditor.errors*.

If you are messing around with internal structures, call this method before saving to be sure to export valid DXF documents, but be aware this is a long running task.

**validate** (*print\_report=True*) → bool

Simple way to run an audit process. Fixes all fixable problems, return `False` if not fixable errors occurs, to get more information about not fixable errors use `audit()` method instead.

**Parameters** `print_report` – print report to stdout

Returns: `True` if no errors occurred

**ezdxf\_metadata()** → ezdxf.document.MetaData

Returns the `ezdxf.ezdxf.Document.MetaData` object, which manages `ezdxf` and custom metadata in DXF files. For more information see: [Ezdx Metadata](#).

New in version 0.17.

## Recover

New in version v0.14.

This module provides functions to “recover” ASCII DXF documents with structural flaws, which prevents the regular `ezdxf.read()` and `ezdxf.readfile()` functions to load the document.

The `read()` and `readfile()` functions will repair as much flaws as possible and run the required audit process automatically afterwards and return the result of this audit process:

```
import sys
import eздxf
from eздxf import recover

try:
    doc, auditor = recover.readfile("messy.dxf")
except IOError:
    print(f'Not a DXF file or a generic I/O error.')
    sys.exit(1)
except eздxf.DXFStructureError:
    print(f'Invalid or corrupted DXF file.')
    sys.exit(2)

# DXF file can still have unrecoverable errors, but this is maybe just
# a problem when saving the recovered DXF file.
if auditor.has_errors:
    auditor.print_error_report()
```

This efforts cost some time, loading the DXF document with `ezdxf.read()` or `ezdxf.readfile()` will be faster.

**Warning:** This module will load DXF files which have decoding errors, most likely binary data stored in XRECORD entities, these errors are logged as unrecoverable `AuditError.DECODE_ERRORS` in the `Auditor.errors` attribute, but no `DXFStructureError` exception will be raised, because for many use cases this errors can be ignored.

Writing such files back with `ezdxf` may create **invalid** DXF files, or at least some **information will be lost** - handle with care!

To avoid this problem use `recover.readfile(filename, errors='strict')` which raises an `UnicodeDecodeError` exception for such binary data. Catch the exception and handle this DXF files as

unrecoverable.

## Loading Scenarios

### 1. It will work

Mostly DXF files from AutoCAD or BricsCAD (e.g. for In-house solutions):

```
try:
    doc = ezdxf.readfile(name)
except IOError:
    print(f'Not a DXF file or a generic I/O error.')
    sys.exit(1)
except ezdxf.DXFStructureError:
    print(f'Invalid or corrupted DXF file: {name}.')
    sys.exit(2)
```

### 2. DXF file with minor flaws

DXF files have only minor flaws, like undefined resources:

```
try:
    doc = ezdxf.readfile(name)
except IOError:
    print(f'Not a DXF file or a generic I/O error.')
    sys.exit(1)
except ezdxf.DXFStructureError:
    print(f'Invalid or corrupted DXF file: {name}.')
    sys.exit(2)

auditor = doc.audit()
if auditor.has_errors:
    auditor.print_error_report()
```

### 3. Try Hard

From trusted and untrusted sources but with good hopes, the worst case works like a cache miss, you pay for the first try and pay the extra fee for the recover mode:

```
try: # Fast path:
    doc = ezdxf.readfile(name)
except IOError:
    print(f'Not a DXF file or a generic I/O error.')
    sys.exit(1)
# Catch all DXF errors:
except ezdxf.DXFError:
    try: # Slow path including fixing low level structures:
        doc, auditor = recover.readfile(name)
    except ezdxf.DXFStructureError:
        print(f'Invalid or corrupted DXF file: {name}.')
        sys.exit(2)
```

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```
# DXF file can still have unrecoverable errors, but this is maybe
# just a problem when saving the recovered DXF file.
if auditor.has_errors:
    print(f'Found unrecoverable errors in DXF file: {name}.')
    auditor.print_error_report()
```

## 4. Just use the slow recover module

Untrusted sources and expecting many invalid or corrupted DXF files, you always pay an extra fee for the recover mode:

```
try: # Slow path including fixing low level structures:
    doc, auditor = recover.readfile(name)
except IOError:
    print(f'Not a DXF file or a generic I/O error.')
    sys.exit(1)
except ezdxf.DXFStructureError:
    print(f'Invalid or corrupted DXF file: {name}.')
    sys.exit(2)

# DXF file can still have unrecoverable errors, but this is maybe
# just a problem when saving the recovered DXF file.
if auditor.has_errors:
    print(f'Found unrecoverable errors in DXF file: {name}.')
    auditor.print_error_report()
```

## 5. Unrecoverable Decoding Errors

If files contain binary data which can not be decoded by the document encoding, it is maybe the best to ignore this files, this works in normal and recover mode:

```
try:
    doc, auditor = recover.readfile(name, errors='strict')
except IOError:
    print(f'Not a DXF file or a generic I/O error.')
    sys.exit(1)
except ezdxf.DXFStructureError:
    print(f'Invalid or corrupted DXF file: {name}.')
    sys.exit(2)
except UnicodeDecodeError:
    print(f'Decoding error in DXF file: {name}.')
    sys.exit(3)
```

## 6. Ignore/Locate Decoding Errors

Sometimes ignoring decoding errors can recover DXF files or at least you can detect where the decoding errors occur:

```
try:
    doc, auditor = recover.readfile(name, errors='ignore')
except IOError:
```

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```

print(f'Not a DXF file or a generic I/O error.')
sys.exit(1)
except ezdxf.DXFStructureError:
    print(f'Invalid or corrupted DXF file: {name}.')
    sys.exit(2)
if auditor.has_errors:
    auditor.print_report()

```

The error messages with code `AuditError.DECODING_ERROR` shows the approximate line number of the decoding error: “Fixed unicode decoding error near line: xxx.”

---

**Hint:** This functions can handle only ASCII DXF files!

---

`ezdxf.recover.readfile(filename: Union[str, pathlib.Path], errors: str = 'surrogateescape') → Tuple[Drawing, Auditor]`

Read a DXF document from file system similar to `ezdxf.readfile()`, but this function will repair as much flaws as possible, runs the required audit process automatically the DXF document and the Auditor.

#### Parameters

- **filename** – file-system name of the DXF document to load
- **errors** – specify decoding error handler
  - “surrogateescape” to preserve possible binary data (default)
  - “ignore” to use the replacement char U+FFFD “” for invalid data
  - “strict” to raise an `UnicodeDecodeError` exception for invalid data

#### Raises

- `DXFStructureError` – for invalid or corrupted DXF structures
- `UnicodeDecodeError` – if `errors` is “strict” and a decoding error occurs

`ezdxf.recover.read(stream: BinaryIO, errors: str = 'surrogateescape') → Tuple[Drawing, Auditor]`

Read a DXF document from a binary-stream similar to `ezdxf.read()`, but this function will detect the text encoding automatically and repair as much flaws as possible, runs the required audit process afterwards and returns the DXF document and the Auditor.

#### Parameters

- **stream** – data stream to load in binary read mode
- **errors** – specify decoding error handler
  - “surrogateescape” to preserve possible binary data (default)
  - “ignore” to use the replacement char U+FFFD “” for invalid data
  - “strict” to raise an `UnicodeDecodeError` exception for invalid data

#### Raises

- `DXFStructureError` – for invalid or corrupted DXF structures
- `UnicodeDecodeError` – if `errors` is “strict” and a decoding error occurs

`ezdxf.recover.explore(filename: Union[str, pathlib.Path], errors: str = 'ignore') → Tuple[Drawing, Auditor]`

Read a DXF document from file system similar to `readfile()`, but this function will use a special tag loader,

which synchronise the tag stream if invalid tags occur. This function is intended to load corrupted DXF files and should only be used to explore such files, data loss is very likely.

#### Parameters

- **filename** – file-system name of the DXF document to load
- **errors** – specify decoding error handler
  - “surrogateescape” to preserve possible binary data (default)
  - “ignore” to use the replacement char U+FFFD “” for invalid data
  - “strict” to raise an `UnicodeDecodeError` exception for invalid data

#### Raises

- `DXFStructureError` – for invalid or corrupted DXF structures
- `UnicodeDecodeError` – if `errors` is “strict” and a decoding error occurs

## Application Settings

New in version 0.18. This is a high-level module for working with CAD application settings and behaviors. None of these settings have any influence on the behavior of `ezdxf`, since `ezdxf` only takes care of the content of the DXF file and not of the way it is presented to the user.

---

**Important:** You need to understand that these settings work at the application level, `ezdxf` cannot force an application to do something in a certain way! The functionality of this module has been tested with Autodesk TrueView and BricsCAD, other applications may show different results or ignore the settings.

---

## Set Current Properties

The current properties are used by the CAD application to create new entities, these settings do not affect how `ezdxf` creates new entities.

The module `ezdxf.gfxattribs` provides the class `GfxAttribs()`, which can load the current graphical entity settings from the HEADER section for creating new entities by `ezdxf`: `load_from_header()`

```
ezdxf.appsettings.set_current_layer(doc: Drawing, name: str)
    Set current layer.

ezdxf.appsettings.set_current_color(doc: Drawing, color: int)
    Set current AutoCAD Color Index (ACI).

ezdxf.appsettings.set_current_linetype(doc: Drawing, name: str)
    Set current linetype.

ezdxf.appsettings.set_current_lineweight(doc: Drawing, linewidth: int)
    Set current linewidth, see Lineweights reference for valid values.

ezdxf.appsettings.set_current_linetype_scale(doc: Drawing, scale: float)
    Set current linetype scale.

ezdxf.appsettings.set_current_textstyle(doc: Drawing, name: str)
    Set current textstyle.

ezdxf.appsettings.set_current_dimstyle(doc: Drawing, name: str)
    Set current dimstyle.
```

## Restore the WCS

```
ezdxf.appsettings.restore_wcs (doc: Drawing)
```

Restore the UCS settings in the HEADER section to the [WCS](#) and reset all active viewports to the WCS.

## Update Extents

```
ezdxf.appsettings.update_extents (doc: Drawing) → ezdxf.math.bbox.BoundingBox
```

Calculate the extents of the model space, update the HEADER variables \$EXTMIN and \$EXTMAX and returns the result as [ezdxf.math.BoundingBox](#). Note that this function uses the [ezdxf.bbox](#) module to calculate the extent of the model space. This module is not very fast and not very accurate for text and ignores all [ACIS](#) based entities.

The function updates only the values in the HEADER section, to zoom the active viewport to this extents, use this recipe:

```
import ezdxf
from ezdxf import zoom, appsettings

doc = ezdxf.readfile("your.dxf")
extents = appsettings.update_extents(doc)
zoom.center(doc.modelspace(), extents.center, extents.size)
```

See also:

- the [ezdxf.bbox](#) module to understand the limitations of the extent calculation
- the [ezdxf.zoom](#) module

## Show Lineweight

```
ezdxf.appsettings.show_lineweight (doc: Drawing, state=True) → None
```

The CAD application or DXF viewer should show lines and curves with “thickness” (lineweight) if *state* is True.

## 6.8.2 DXF Structures

### Sections

#### Header Section

The drawing settings are stored in the HEADER section, which is accessible by the [header](#) attribute of the [Drawing](#) object. See the online documentation from Autodesk for available header variables.

See also:

DXF Internals: [HEADER Section](#)

```
class ezdxf.sections.header.HeaderSection
```

```
custom_vars
```

Stores the custom drawing properties in a [CustomVars](#) object.

---

**`__len__()`** → int  
 Returns count of header variables.

**`__contains__(key)`** → bool  
 Returns True if header variable `key` exist.

**`varnames()`** → KeysView[KT]  
 Returns an iterable of all header variable names.

**`get(key: str, default: Any = None)`** → Any  
 Returns value of header variable `key` if exist, else the `default` value.

**`getitem(key: str)`** → Any  
 Get header variable `key` by index operator like: `drawing.header['$ACADVER']`

**`setitem(key: str, value: Any)`** → None  
 Set header variable `key` to `value` by index operator like: `drawing.header['$ANGDIR'] = 1`

**`delitem(key: str)`** → None  
 Delete header variable `key` by index operator like: `del drawing.header['$ANGDIR']`

**`reset_wcs()`**  
 Reset the current UCS settings to the [WCS](#).

**`class ezdxf.sections.header.CustomVars`**  
 Stores custom properties in the DXF header as \$CUSTOMPROPERTYTAG and \$CUSTOMPROPERTY values.  
 Custom properties are just supported by DXF R2004 (AC1018) or later. `ezdxf` can create custom properties at older DXF versions, but AutoCAD will not show this properties.

**`properties`**  
 List of custom drawing properties, stored as string tuples (`tag, value`). Multiple occurrence of the same custom tag is allowed, but not well supported by the interface. This is a standard python list and it is save to change this list as long you store just tuples of strings in the format (`tag, value`).

**`__len__()`** → int  
 Count of custom properties.

**`__iter__()`** → Iterable[Tuple[str, str]]  
 Iterate over all custom properties as (`tag, value`) tuples.

**`clear()`** → None  
 Remove all custom properties.

**`get(tag: str, default: str = None)`**  
 Returns the value of the first custom property `tag`.

**`has_tag(tag: str)`** → bool  
 Returns True if custom property `tag` exist.

**`append(tag: str, value: str)`** → None  
 Add custom property as (`tag, value`) tuple.

**`replace(tag: str, value: str)`** → None  
 Replaces the value of the first custom property `tag` by a new `value`.  
 Raises `DXFValueError` if `tag` does not exist.

**`remove(tag: str, all: bool = False)`** → None  
 Removes the first occurrence of custom property `tag`, removes all occurrences if `all` is True.  
 Raises `:class:'DXFValueError'` if `tag` does not exist.

## Classes Section

The CLASSES section in DXF files holds the information for application-defined classes whose instances appear in [Layout](#) objects. As usual package user there is no need to bother about CLASSES.

See also:

DXF Internals: [CLASSES Section](#)

**class** ezdxf.sections.classes.**ClassesSection**

### **classes**

Storage of all [DXFClass](#) objects, they are not stored in the entities database, because CLASS has no handle attribute.

#### **register()**

##### **add\_class** (*name: str*)

Register a known class by *name*.

##### **get** (*name: str*) → ezdxf.entities.dxclass.DXFClass

Returns the first class matching *name*.

Storage key is the (*name, cpp\_class\_name*) tuple, because there are some classes with the same name but different *cpp\_class\_names*.

##### **add\_required\_classes** (*dxversion: str*) → None

Add all required CLASS definitions for *dxversion*.

##### **update\_instance\_counters()** → None

Update CLASS instance counter for all registered classes, requires DXF R2004+.

**class** ezdxf.entities.**DXFClass**

Information about application-defined classes.

#### **dxfl.name**

Class DXF record name.

#### **dxfl.cpp\_class\_name**

C++ class name. Used to bind with software that defines object class behavior.

#### **dxfl.app\_name**

Application name. Posted in Alert box when a class definition listed in this section is not currently loaded.

#### **dxfl.flags**

Proxy capabilities flag

0	No operations allowed (0)
1	Erase allowed (0x1)
2	Transform allowed (0x2)
4	Color change allowed (0x4)
8	Layer change allowed (0x8)
16	Linetype change allowed (0x10)
32	Linetype scale change allowed (0x20)
64	Visibility change allowed (0x40)
128	Cloning allowed (0x80)
256	Lineweight change allowed (0x100)
512	Plot Style Name change allowed (0x200)
895	All operations except cloning allowed (0x37F)
1023	All operations allowed (0x3FF)
1024	Disables proxy warning dialog (0x400)
32768	R13 format proxy (0x8000)

**dx.dxf.instance\_count**

Instance count for a custom class.

**dx.dxf.was\_a\_proxy**

Set to 1 if class was not loaded when this DXF file was created, and 0 otherwise.

**dx.dxf.is\_an\_entity**

Set to 1 if class was derived from the *DXFGraphic* class and can reside in layouts. If 0, instances may appear only in the OBJECTS section.

**key**

Unique name as (name, cpp\_class\_name) tuple.

## Tables Section

The TABLES section is the home of all TABLE objects of a DXF document.

### See also:

DXF Internals: *TABLES Section*

**class** ezdxf.sections.tables.TablesSection

**layers**

*LayerTable* object for *Layer* objects

**linetypes**

*LineTypesTable* object for *Linetype* objects

**styles**

*TextstyleTable* object for *Textstyle* objects

**dimstyles**

*DimStyleTable* object for *DimStyle* objects

**appids**

*AppIDTable* object for *AppID* objects

**ucs**

*UCSTable* object for *UCSTable* objects

**views**

`ViewTable` object for `View` objects

**viewports**

`ViewportTable` object for `VPort` objects

**block\_records**

`BlockRecordTable` object for `BlockRecord` objects

## Blocks Section

The BLOCKS section is the home all block definitions (`BlockLayout`) of a DXF document.

**See also:**

DXF Internals: `BLOCKS Section` and `Block Management Structures`

**class** `ezdxf.sections.blocks.BlocksSection`

**\_\_iter\_\_** () → Iterator[`ezdxf.layouts.blocklayout.BlockLayout`]

Iterable of all `BlockLayout` objects.

**\_\_contains\_\_** (name: str) → bool

Returns True if `BlockLayout name` exist.

**\_\_getitem\_\_** (name: str) → `ezdxf.layouts.blocklayout.BlockLayout`

Returns `BlockLayout name`, raises `DXFKeyError` if `name` not exist.

**\_\_delitem\_\_** (name: str) → None

Deletes `BlockLayout name` and all of its content, raises `DXFKeyError` if `name` not exist.

**get** (name: str, default=None) → `ezdxf.layouts.blocklayout.BlockLayout`

Returns `BlockLayout name`, returns `default` if `name` not exist.

**new** (name: str, base\_point: Union[Sequence[float], `ezdxf.math._vector.Vec2`, `ezdxf.math._vector.Vec3`] =

`Vec3(0.0, 0.0, 0.0)`, dxfsattribs: Optional[dict] = None) → `BlockLayout`

Create and add a new `BlockLayout`, `name` is the BLOCK name, `base_point` is the insertion point of the BLOCK.

**new\_anonymous\_block** (type\_char: str = 'U', base\_point: Union[Sequence[float], `ezdxf.math._vector.Vec2`, `ezdxf.math._vector.Vec3`] = `Vec3(0.0, 0.0, 0.0)`) → `ezdxf.layouts.blocklayout.BlockLayout`

Create and add a new anonymous `BlockLayout`, `type_char` is the BLOCK type, `base_point` is the insertion point of the BLOCK.

type_char	Anonymous Block Type
'U'	'*U###' anonymous BLOCK
'E'	'*E###' anonymous non-uniformly scaled BLOCK
'X'	'*X###' anonymous HATCH graphic
'D'	'*D###' anonymous DIMENSION graphic
'A'	'*A###' anonymous GROUP
'T'	'*T###' anonymous block for ACAD_TABLE content

**rename\_block** (old\_name: str, new\_name: str) → None

Rename `BlockLayout old_name` to `new_name`

**delete\_block** (name: str, safe: bool = True) → None

Delete block. If `safe` is True, check if block is still referenced.

## Parameters

- **name** – block name (case insensitive)
- **safe** – check if block is still referenced or special block without explicit references

## Raises

- `DXFKeyError` – if block not exists
- `DXFBlockInUseError` – if block is still referenced, and save is True

`delete_all_blocks()` → None

Delete all blocks without references except modelspace- or paperspace layout blocks, special arrow- and anonymous blocks (DIMENSION, ACAD\_TABLE).

**Warning:** There could exist undiscovered references to blocks which are not documented in the DXF reference, hidden in extended data sections or application defined data, which could produce invalid DXF documents if such referenced blocks will be deleted.

Changed in version 0.14: removed unsafe mode

## Entities Section

The ENTITIES section is the home of all *Modelspace* and active *Paperspace* layout entities. This is a real section in the DXF file, for *ezdxf* the *EntitySection* is just a proxy for modelspace and the active paperspace linked together.

### See also:

DXF Internals: *ENTITIES Section*

`class ezdxf.sections.entities.EntitySection`

- `__iter__()` → Iterator[DXFEntity]  
Iterable for all entities of modelspace and active paperspace.
- `__len__()` → int  
Returns count of all entities of modelspace and active paperspace.

## Objects Section

The OBJECTS section is the home of all none graphical objects of a DXF document. The OBJECTS section is accessible by `Drawing.objects`.

Convenience methods of the *Drawing* object to create required structures in the OBJECTS section:

- IMAGEDEF: `add_image_def()`
- UNDERLAYDEF: `add_underlayer_def()`
- RASTERVARIABLES: `set_raster_variables()`
- WIPEOUTVARIABLES: `set_wipeout_variables()`

### See also:

DXF Internals: *OBJECTS Section*

```
class ezdxf.sections.objects.ObjectsSection
```

**rootdict**

the named DICTIONARY.

**Type** Returns the root DICTIONARY, or as AutoCAD calls it

**\_\_len\_\_ () → int**

Returns count of DXF objects.

**\_\_iter\_\_ ()**

Returns iterable of all DXF objects in the OBJECTS section.

**\_\_getitem\_\_ (index) → DXFObject**

Get entity at *index*.

The underlying data structure for storing DXF objects is organized like a standard Python list, therefore *index* can be any valid list indexing or slicing term, like a single index `objects[-1]` to get the last entity, or an index slice `objects[:10]` to get the first 10 or less objects as List [DXFObject].

**\_\_contains\_\_ (entity)**

Returns True if *entity* stored in OBJECTS section.

**Parameters** **entity** – DXFObject or handle as hex string

**query (query: str = '\*') → ezdxf.query.EntityQuery**

Get all DXF objects matching the *Entity Query String*.

**add\_dictionary (owner: str = '0', hard\_owned: bool = True) → ezdxf.entities.dictionary.Dictionary**

Add new *Dictionary* object.

**Parameters**

- **owner** – handle to owner as hex string.
- **hard\_owned** – True to treat entries as hard owned.

**add\_dictionary\_with\_default (owner='0', default='0', hard\_owned: bool = True) → DictionaryWithDefault**

Add new *DictionaryWithDefault* object.

**Parameters**

- **owner** – handle to owner as hex string.
- **default** – handle to default entry.
- **hard\_owned** – True to treat entries as hard owned.

**add\_dictionary\_var (owner: str = '0', value: str = '') → DictionaryVar**

Add a new *DictionaryVar* object.

**Parameters**

- **owner** – handle to owner as hex string.
- **value** – value as string

**add\_geodata (owner: str = '0', dxfattribs: dict = None) → GeoData**

Creates a new GeoData entity and replaces existing ones. The GEODATA entity resides in the OBJECTS section and NOT in the layout entity space and it is linked to the layout by an extension dictionary located in BLOCK\_RECORD of the layout.

The GEODATA entity requires DXF version R2010+. The DXF Reference does not document if other layouts than model space supports geo referencing, so getting/setting geo data may only make sense for the model space layout, but it is also available in paper space layouts.

### Parameters

- **owner** – handle to owner as hex string
- **dxfattribs** – DXF attributes for `GeoData` entity

**add\_image\_def** (*filename*: str, *size\_in\_pixel*: Tuple[int, int], *name*=None) → ImageDef

Add an image definition to the objects section.

Add an `ImageDef` entity to the drawing (objects section). *filename* is the image file name as relative or absolute path and *size\_in\_pixel* is the image size in pixel as (x, y) tuple. To avoid dependencies to external packages, `ezdxf` can not determine the image size by itself. Returns a `ImageDef` entity which is needed to create an image reference. *name* is the internal image name, if set to None, name is auto-generated.

Absolute image paths works best for AutoCAD but not really good, you have to update external references manually in AutoCAD, which is not possible in TrueView. If the drawing units differ from 1 meter, you also have to use: `set_raster_variables()`.

### Parameters

- **filename** – image file name (absolute path works best for AutoCAD)
- **size\_in\_pixel** – image size in pixel as (x, y) tuple
- **name** – image name for internal use, None for using filename as name (best for AutoCAD)

**add\_placeholder** (*owner*: str = '0') → Placeholder

Add a new `Placeholder` object.

**Parameters** **owner** – handle to owner as hex string.

**add\_underlay\_def** (*filename*: str, *fmt*: str = 'pdf', *name*: str = None) → UnderlayDefinition

Add an `UnderlayDefinition` entity to the drawing (OBJECTS section). *filename* is the underlay file name as relative or absolute path and *fmt* as string (pdf, dwf, dgn). The underlay definition is required to create an underlay reference.

### Parameters

- **filename** – underlay file name
- **fmt** – file format as string 'pdf' | 'dwf' | 'dgn'
- **name** – pdf format = page number to display; dgn format = 'default'; dwf: ????

**add\_xrecord** (*owner*: str = '0') → XRecord

Add a new `XRecord` object.

**Parameters** **owner** – handle to owner as hex string.

**set\_raster\_variables** (*frame*: int = 0, *quality*: int = 1, *units*: str = 'm') → None

Set raster variables.

### Parameters

- **frame** – 0 = do not show image frame; 1 = show image frame
- **quality** – 0 = draft; 1 = high
- **units** – units for inserting images. This defines the real world unit for one drawing unit for the purpose of inserting and scaling images with an associated resolution.

mm	Millimeter
cm	Centimeter
m	Meter (ezdxf default)
km	Kilometer
in	Inch
ft	Foot
yd	Yard
mi	Mile

(internal API), public interface `set_raster_variables()`

**set\_wipeout\_variables** (`frame: int = 0`) → None

Set wipeout variables.

**Parameters** `frame` – 0 = do not show image frame; 1 = show image frame

(internal API)

## Tables

### Table Classes

#### Generic Table Class

**class** `ezdxf.sections.table.Table`

Generic collection of table entries. Table entry names are case insensitive: “Test” == “TEST”.

**static key** (`name: str`) → str

Unified table entry key.

**has\_entry** (`name: str`) → bool

Returns True if an table entry `name` exist.

**\_\_contains\_\_** (`name: str`) → bool

Returns True if an table entry `name` exist.

**\_\_len\_\_** () → int

Count of table entries.

**\_\_iter\_\_** () → Iterator[T]

Iterable of all table entries.

**new** (`name: str, dxfattribs: dict = None`) → T

Create a new table entry `name`.

#### Parameters

- **name** – name of table entry, case insensitive
- **dxfattribs** – additional DXF attributes for table entry

**get** (`name: str`) → T

Get table entry `name` (case insensitive). Raises `DXFValueError` if table entry does not exist.

**remove** (`name: str`) → None

Removes table entry `name`. Raises `DXFValueError` if table-entry does not exist.

**duplicate\_entry** (`name: str, new_name: str`) → T

Returns a new table entry `new_name` as copy of `name`, replaces entry `new_name` if already exist.

**Raises** `DXFValueError` – `name` does not exist

## Layer Table

**class** `ezdxf.sections.table.LayerTable`

Subclass of `Table`.

Collection of `Layer` objects.

**add** (`name: str`, \*, `color: int = 256`, `true_color: int = None`, `linetype: str = 'Continuous'`, `lineweight: int = -1`, `plot: bool = True`, `transparency: Optional[float] = None`, `dxfattribs: Dict[KT, VT] = None`) → `Layer`  
Add a new `Layer`.

### Parameters

- `name (str)` – layer name
- `color (int)` – *AutoCAD Color Index (ACI)* value, default is BYLAYER
- `true_color (int)` – true color value, use `ezdxf.rgb2int()` to create `int` values from RGB values
- `linetype (str)` – line type name, default is “Continuous”
- `lineweight (int)` – line weight, default is BYLAYER
- `plot (bool)` – plot layer as bool, default is True
- `transparency` – transparency value in the range [0, 1], where 1 is 100% transparent and 0 is opaque
- `dxfattribs (dict)` – additional DXF attributes

New in version 0.17.

## Linetype Table

**class** `ezdxf.sections.table.LinetypeTable`

Subclass of `Table`.

Collection of `Linetype` objects.

**add** (`name: str`, `pattern: Union[List[float], str]`, \*, `description: str = ''`, `length: float = 0.0`, `dxfattribs: Dict[KT, VT] = None`) → `Linetype`  
Add a new line type entry. The simple line type pattern is a list of floats [`total_pattern_length`, `elem1`, `elem2`, ...] where an element > 0 is a line, an element < 0 is a gap and an element == 0.0 is a dot. The definition for complex line types are strings, like: 'A, .5, -.2, ["GAS", STANDARD, S=.1, U=0.0, X=-0.1, Y=-.05], -.25' similar to the line type definitions stored in the line definition `.lin` files, for more information see the tutorial about complex line types. Be aware that not many CAD applications and DXF viewers support complex linetypes.

### See also:

- Tutorial for simple line types
- Tutorial for complex line types

### Parameters

- `name (str)` – line type name

- **pattern** – line type pattern as list of floats or as a string
- **description** (*str*) – line type description, optional
- **length** (*float*) – total pattern length, only for complex line types required
- **dxfattribs** (*dict*) – additional DXF attributes

New in version 0.17.

## Style Table

**class** `ezdxf.sections.table.TextstyleTable`

Subclass of `Table`.

Collection of `Textstyle` objects.

**add** (*name: str, \*, font: str, dxfattribs: Dict[KT, VT] = None*) → `Textstyle`

Add a new text style entry for TTF fonts. The entry must not yet exist, otherwise an `DXFTableEntryError` exception will be raised.

Finding the TTF font files is the task of the DXF viewer and each viewer is different (hint: support files).

### Parameters

- **name** (*str*) – text style name
- **font** (*str*) – TTF font file name like “Arial.ttf”, the real font file name from the file system is required and remember only Windows is case insensitive.
- **dxfattribs** (*dict*) – additional DXF attributes

New in version 0.17.

**add\_shx** (*shx\_file: str, \*, dxfattribs: Dict[KT, VT] = None*) → `Textstyle`

Add a new shape font (SHX file) entry. These are special text style entries and have no name. The entry must not yet exist, otherwise an `DXFTableEntryError` exception will be raised.

Finding the SHX files is the task of the DXF viewer and each viewer is different (hint: support files).

### Parameters

- **shx\_file** (*str*) – shape file name like “gdt.shx”
- **dxfattribs** (*dict*) – additional DXF attributes

New in version 0.17.

**get\_shx** (*shx\_file: str*) → `Textstyle`

Get existing entry for a shape file (SHX file), or create a new entry.

Finding the SHX files is the task of the DXF viewer and each viewer is different (hint: support files).

**Parameters** **shx\_file** (*str*) – shape file name like “gdt.shx”

**find\_shx** (*shx\_file: str*) → `Optional[Textstyle]`

Find the shape file (SHX file) text style table entry, by a case insensitive search.

A shape file table entry has no name, so you have to search by the font attribute.

**Parameters** **shx\_file** (*str*) – shape file name like “gdt.shx”

## DimStyle Table

```
class ezdxf.sections.table.DimStyleTable
    Subclass of Table.
```

Collection of [DimStyle](#) objects.

**add** (*name: str*, \*, *dxfattribs: Dict[KT, VT] = None*) → DimStyle  
Add a new dimension style table entry.

### Parameters

- **name** (*str*) – dimension style name
- **dxfattribs** (*dict*) – DXF attributes

New in version 0.17.

## AppID Table

```
class ezdxf.sections.table.AppIDTable
    Subclass of Table.
```

Collection of [AppID](#) objects.

**add** (*name: str*, \*, *dxfattribs: Dict[KT, VT] = None*) → AppID  
Add a new appid table entry.

### Parameters

- **name** (*str*) – appid name
- **dxfattribs** (*dict*) – DXF attributes

New in version 0.17.

## UCS Table

```
class ezdxf.sections.table.UCSTable
    Subclass of Table.
```

Collection of [UCSTableEntry](#) objects.

**add** (*name: str*, \*, *dxfattribs: Dict[KT, VT] = None*) → UCSTableEntry  
Add a new UCS table entry.

### Parameters

- **name** (*str*) – UCS name
- **dxfattribs** (*dict*) – DXF attributes

New in version 0.17.

## View Table

```
class ezdxf.sections.table.ViewTable
    Subclass of Table.
```

Collection of [View](#) objects.

**add** (*name*: str, \*, *dxfattribs*: Dict[KT, VT] = None) → View  
Add a new view table entry.

#### Parameters

- **name** (str) – view name
- **dxfattribs** (dict) – DXF attributes

New in version 0.17.

## Viewport Table

**class** ezdxf.sections.table.**ViewportTable**

The viewport table stores the modelspace viewport configurations. A viewport configuration is a tiled view of multiple viewports or just one viewport. In contrast to other tables the viewport table can have multiple entries with the same name, because all viewport entries of a multi-viewport configuration are having the same name - the viewport configuration name.

The name of the actual displayed viewport configuration is “\*ACTIVE”.

Duplication of table entries is not supported: `duplicate_entry()` raises `NotImplementedError`

**add** (*name*: str, \*, *dxfattribs*: Dict[KT, VT] = None) → VPort

Add a new modelspace viewport entry. A modelspace viewport configuration can consist of multiple viewport entries with the same name.

#### Parameters

- **name** (str) – viewport name, multiple entries possible
- **dxfattribs** (dict) – additional DXF attributes

New in version 0.17.

**get\_config** (*self*, *name*: str) → List[VPort]

Returns a list of `VPort` objects, for the multi-viewport configuration *name*.

**delete\_config** (*name*: str) → None

Delete all `VPort` objects of the multi-viewport configuration *name*.

## Block Record Table

**class** ezdxf.sections.table.**BlockRecordTable**

Subclass of `Table`.

Collection of `BlockRecord` objects.

**add** (*name*: str, \*, *dxfattribs*: Dict[KT, VT] = None) → BlockRecord

Add a new block record table entry.

#### Parameters

- **name** (str) – block record name
- **dxfattribs** (dict) – DXF attributes

New in version 0.17.

## Layer

LAYER ([DXF Reference](#)) definition, defines attribute values for entities on this layer for their attributes set to BYLAYER.

Subclass of	<code>ezdxf.entities.DXFEntity</code>
DXF type	'LAYER'
Factory function	<code>Drawing.layers.new()</code>

### See also:

[Layer Concept](#) and [Tutorial for Layers](#)

**class** `ezdxf.entities.Layer`

#### `dxf.handle`

DXF handle (feature for experts)

#### `dxf.owner`

Handle to owner ([LayerTable](#)).

#### `dxf.name`

Layer name, case insensitive and can not contain any of this characters: <>/\":;?\*|=` (str)

#### `dxf.flags`

Layer flags (bit-coded values, feature for experts)

1	Layer is frozen; otherwise layer is thawed; use <code>is_frozen()</code> , <code>freeze()</code> and <code>thaw()</code>
2	Layer is frozen by default in new viewports
4	Layer is locked; use <code>is_locked()</code> , <code>lock()</code> , <code>unlock()</code>
16	If set, table entry is externally dependent on an xref
32	If both this bit and bit 16 are set, the externally dependent xref has been successfully resolved
64	If set, the table entry was referenced by at least one entity in the drawing the last time the drawing was edited. (This flag is for the benefit of AutoCAD commands. It can be ignored by most programs that read DXF files and need not be set by programs that write DXF files)

#### `dxf.color`

Layer color, but use property `Layer.color` to get/set color value, because color is negative for layer status *off* (int)

#### `dxf.true_color`

Layer true color value as int, use property `Layer.rgb` to set/get true color value as (r, g, b) tuple.

(requires DXF R2004)

#### `dxf.linetype`

Name of line type (str)

#### `dxf.plot`

Plot flag (int). Whether entities belonging to this layer should be drawn when the document is exported (plotted) to pdf. Does not affect visibility inside the CAD application itself.

1	plot layer (default value)
0	don't plot layer

**dx<sub>f</sub>.lineweight**

Line weight in mm times 100 (e.g. 0.13mm = 13). Smallest line weight is 13 and biggest line weight is 200, values outside this range prevents AutoCAD from loading the file.

ezdxf.lldxf.const.LINEWEIGHT\_DEFAULT for using global default line weight.

(requires DXF R13)

**dx<sub>f</sub>.plotstyle\_handle**

Handle to plot style name?

(requires DXF R13)

**dx<sub>f</sub>.material\_handle**

Handle to default Material.

(requires DXF R13)

**rgb**

Get/set DXF attribute `dxf.true_color` as (r, g, b) tuple, returns None if attribute `dxf.true_color` is not set.

```
layer.rgb = (30, 40, 50)
r, g, b = layer.rgb
```

This is the recommend method to get/set RGB values, when ever possible do not use the DXF low level attribute `dxf.true_color`.

**color**

Get/set layer color, preferred method for getting the layer color, because `dxf.color` is negative for layer status off.

**description**

Get/set layer description as string

**transparency**

Get/set layer transparency as float value in the range from 0 to 1. 0 for no transparency (opaque) and 1 for 100% transparency.

**is\_frozen()** → bool

Returns True if layer is frozen.

**freeze()** → None

Freeze layer.

**thaw()** → None

Thaw layer.

**is\_locked()** → bool

Returns True if layer is locked.

**lock()** → None

Lock layer, entities on this layer are not editable - just important in CAD applications.

**unlock()** → None

Unlock layer, entities on this layer are editable - just important in CAD applications.

**is\_off()** → bool

Returns True if layer is off.

**is\_on()** → bool

Returns True if layer is on.

**on()** → None  
 Switch layer *on* (visible).

**off()** → None  
 Switch layer *off* (invisible).

**get\_color()** → int  
 Use property *Layer.color* instead.

**set\_color(value: int)** → None  
 Use property *Layer.color* instead.

**rename(name: str)** → None  
 Rename layer and all known (documented) references to this layer.

**Warning:** Renaming layers may damage the DXF file in some circumstances!

**Parameters** `name` – new layer name

**Raises**

- `ValueError` – *name* contains invalid characters: <>/:;?\*|=‘
- `ValueError` – layer *name* already exist
- `ValueError` – renaming of layers '0' and 'DEFPOINTS' not possible

**get\_vp\_overrides()** → `LayerOverrides`  
 Returns the *LayerOverrides* object for this layer.

## LayerOverrides

**class** `ezdxf.entities.LayerOverrides`

This object stores the layer attribute overridden in *Viewport* entities, where each *Viewport* can have individual layer attribute overrides.

Layer attributes which can be overridden:

- ACI color
- true color (rgb)
- linetype
- linewidth
- transparency

Get the override object for a certain layer by the `Layer.get_vp_overrides()` method.

It is important to write changes back by calling `commit()`, otherwise the changes are lost.

---

**Important:** The implementation of this feature as DXF structures is not documented by the DXF reference, so if you encounter problems or errors, **ALWAYS** provide the DXF files, otherwise it is not possible to help.

---

**has\_overrides(vp\_handle: str = None)** → bool

Returns True if attribute overrides exist for the given *Viewport* handle. Returns True if *any* attribute overrides exist if the given handle is None.

**commit()** → None

Write `Viewport` overrides back into the `Layer` entity. Without a commit() all changes are lost!

**get\_color(vp\_handle: str)** → int

Returns the *AutoCAD Color Index (ACI)* override or the original layer value if no override exist.

**set\_color(vp\_handle: str, value: int)** → None

Override the *AutoCAD Color Index (ACI)*.

**Raises** ValueError – invalid color value

**get\_rgb(vp\_handle: str)** → Optional[Tuple[int, int, int]]

Returns the RGB override or the original layer value if no override exist. Returns None if no true color value is set.

**set\_rgb(vp\_handle: str, value: Optional[Tuple[int, int, int]])**

Set the RGB override as (red, green, blue) tuple or None to remove the true color setting.

**Raises** ValueError – invalid RGB value

**get\_transparency(vp\_handle: str)** → float

Returns the transparency override or the original layer value if no override exist. Returns 0.0 for opaque and 1.0 for fully transparent.

**set\_transparency(vp\_handle: str, value: float)** → None

Set the transparency override. A transparency of 0.0 is opaque and 1.0 is fully transparent.

**Raises** ValueError – invalid transparency value

**get\_linetype(vp\_handle: str)** → str

Returns the linetype override or the original layer value if no override exist.

**set\_linetype(vp\_handle: str, value: str)** → None

Set the linetype override.

**Raises** ValueError – linetype without a LTYPE table entry

**get\_lineweight(vp\_handle: str)** → int

Returns the linewidth override or the original layer value if no override exist.

**set\_lineweight(vp\_handle: str, value: int)** → None

Set the linewidth override.

**Raises** ValueError – invalid linewidth value

**discard(vp\_handle: str = None)** → None

Discard all attribute overrides for the given `Viewport` handle or for all `Viewport` entities if the handle is None.

## Style

---

**Important:** DXF is not a layout preserving data format like PDF. It is more similar to the MS Word format. Many applications can open MS Word documents, but the displayed or printed document does not look perfect like the result of MS Word.

The final rendering of DXF files is highly dependent on the interpretation of DXF entities by the rendering engine, and the DXF reference does not provide any guidelines for rendering entities. The biggest visual differences of CAD applications are the text renderings, therefore the only way to get the exact same result is to use the same CAD application.

---

The DXF format does not and **can not** embed TTF fonts like the PDF format!

The `Textstyle` entity defines a text style (DXF Reference), and can be used by the entities: `Text`, `Attrib`, `Attdef`, `MText`, `Dimension`, `Leader` and `MultiLeader`.

Example to create a new text style “Arial” and to apply this text style:

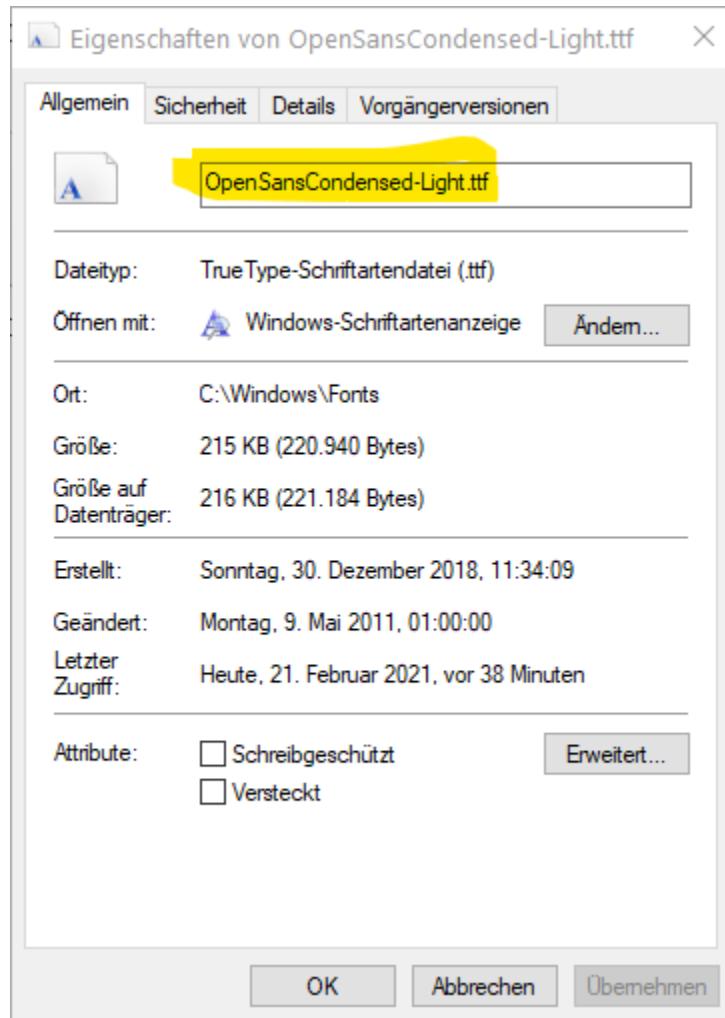
```
doc.styles.add("Arial", font="Arial.ttf")
msp = doc.modelspace()
msp.add_text("my text", dxfattribs={"style": "Arial"})
```

The settings stored in the `Textstyle` entity are the default text style values used by CAD applications if the text settings are not stored in the text entity itself. But not all setting are substituted by the default value. The `height` or `width` attribute must be stored in the text entities itself in order to influence the appearance of the text. It is *recommended* that you do not rely on the default settings in the `Textstyle` entity, set all attributes in the text entity itself if supported.

## Font Settings

Just a few settings are available exclusive by the `Textstyle` entity:

The most important setting is the `font` attribute, this attribute defines the rendering font as raw TTF file name, e.g. “Arial.ttf” or “OpenSansCondensed-Light.ttf”, this file name is often **not** the name displayed in GUI application and you have to digg down into the fonts folder e.g. (“C:\Windows\Fonts”) to get the the real file name for the TTF font. Do not include the path!



AutoCAD supports beyond the legacy SHX fonts **only** TTF fonts. The SHX font format is not documented and only available in some CAD applications. The *ezdxf drawing* add-on replaces the SHX fonts by TTF fonts, which look similar to the SHX fonts, unfortunately the license of these fonts is unclear, therefore they can not be packaged with *ezdxf*. They are installed automatically if you use an Autodesk product like *TrueView*, or search the internet at your own risk for these TTF fonts.

The extended font data can provide extra information for the font, it is stored in the XDATA section, not well documented and not widely supported.

---

**Important:** The DXF format does not and **can not** embed TTF fonts like the PDF format!

You need to make sure that the CAD application is properly configured to have access to the system fonts. The DXF format has no setting where the CAD application should search for fonts, and does not guarantee that the text rendering on other computers or operating systems looks the same as on your current system on which you created the DXF.

---

The second exclusive setting is the vertical text flag in `Textstyle.flags`. The vertical text style is enabled for *all* entities using the text style. Vertical text works only for SHX fonts and is not supported for TTF fonts (in AutoCAD) and works only for the single line entities `Text` and `Attrib`. Most CAD applications beside AutoCAD and BricsCAD do not support vertical text rendering and even AutoCAD and BricsCAD have problems with vertical text rendering in some circumstances. Using the vertical text feature is not recommended.

Subclass of	<code>ezdxf.entities.DXFEntity</code>
DXF type	'STYLE'
Factory function	<code>Drawing.styles.new()</code>

**See also:**

[Tutorial for Text](#) and DXF internals for [DIMSTYLE Table](#).

**class ezdxf.entities.Textstyle****dxft.handle**

DXF handle (feature for experts).

**dxft.owner**

Handle to owner ([TextstyleTable](#)).

**dxft.name**

Style name (str)

**dxft.flags**

Style flags (feature for experts).

1	If set, this entry describes a shape
4	Vertical text
16	If set, table entry is externally dependent on an xref
32	If both this bit and bit 16 are set, the externally dependent xref has been successfully resolved
64	If set, the table entry was referenced by at least one entity in the drawing the last time the drawing was edited. (This flag is only for the benefit of AutoCAD)commands. It can be ignored by most programs that read DXF files and need not be set by programs that write DXF files)

**dxft.height**

Fixed height in drawing units as float value, 0 for not fixed.

**dxft.width**

Width factor as float value, default value is 1.

**dxft.oblique**

Oblique (slanting) angle in degrees as float value, default value is 0 for no slanting.

**dxft.generation\_flags**

Text generations flags as int value.

2	text is backward (mirrored along the x-axis)
4	text is upside down (mirrored about the base line)

**dxft.last\_height**

Last height used in drawing units as float value.

**dxft.font**

Raw font file name as string without leading path, e.g. "Arial.ttf" for TTF fonts or the SHX font name like "TXT" or "TXT.SHX".

**dxft.bigfont**

Big font name as string, blank if none. No documentation how to use this feature, maybe just a legacy artifact.

**get\_extended\_font\_data()** → Tuple[str, bool, bool]

Returns extended font data as tuple (font-family, italic-flag, bold-flag).

The extended font data is optional and not reliable! Returns ("", False, False) if extended font data is not present.

**set\_extended\_font\_data(family: str = "", \*, italic=False, bold=False)** → None

Set extended font data, the font-family name *family* is not validated by *ezdxf*. Overwrites existing data.

**discard\_extended\_font\_data()**

Discard extended font data.

**make\_font(cap\_height: float = None, width\_factor: float = None)** → AbstractFont

Returns a font abstraction *AbstractFont* for this text style. Returns a font for a cap height of 1, if the text style has auto height (*Textstyle.dxf.height* is 0) and the given *cap\_height* is None or 0. Uses the *Textstyle.dxf.width* attribute if the given *width\_factor* is None or 0, the default value is 1. The attribute *Textstyle.dxf.big\_font* is ignored.

## Linetype

Defines a linetype ([DXF Reference](#)).

Subclass of	<i>ezdxf.entities.DXFEntity</i>
DXF type	'LTYPE'
Factory function	<code>Drawing.linetypes.new()</code>

See also:

*Tutorial for Linetypes*

DXF Internals: *LTYPE Table*

**class** *ezdxf.entities.Linetype*

**dxfl.name**

Linetype name (str).

**dxfl.owner**

Handle to owner ([Table](#)).

**dxfl.description**

Linetype description (str).

**dxfl.length**

Total pattern length in drawing units (float).

**dxfl.items**

Number of linetype elements (int).

## DimStyle

**DIMSTYLE** ([DXF Reference](#)) defines the appearance of *Dimension* entities. Each of this dimension variables starting with "dim..." can be overridden for any *Dimension* entity individually.

Subclass of	<code>ezdxf.entities.DXFEntity</code>
DXF type	'DIMSTYLE'
Factory function	<code>Drawing.dimstyles.new()</code>

**class** `ezdxf.entities.DimStyle`

**dx.f.owner**

Handle to owner (*Table*).

**dx.f.name**

Dimension style name.

**dx.f.flags**

Standard flag values (bit-coded values):

16	If set, table entry is externally dependent on an xref
32	If both this bit and bit 16 are set, the externally dependent XREF has been successfully resolved
64	If set, the table entry was referenced by at least one entity in the drawing the last time the drawing was edited. (This flag is only for the benefit of AutoCAD)

**dx.f.dimpost**

Prefix/suffix for primary units dimension values.

**dx.f.dimapost**

Prefix/suffix for alternate units dimensions.

**dx.f.dimblk**

Block type to use for both arrowheads as name string.

**dx.f.dimblk1**

Block type to use for first arrowhead as name string.

**dx.f.dimblk2**

Block type to use for second arrowhead as name string.

**dx.f.dimscale**

Global dimension feature scale factor. (default=1)

**dx.f.dimasz**

Dimension line and arrowhead size. (default=0.25)

**dx.f.dimexo**

Distance from origin points to extension lines. (default imperial=0.0625, default metric=0.625)

**dx.f.dimdli**

Incremental spacing between baseline dimensions. (default imperial=0.38, default metric=3.75)

**dx.f.dimexe**

Extension line distance beyond dimension line. (default imperial=0.28, default metric=2.25)

**dx.f.dimrnd**

Rounding value for decimal dimensions. (default=0)

Rounds all dimensioning distances to the specified value, for instance, if DIMRND is set to 0.25, all distances round to the nearest 0.25 unit. If you set DIMRND to 1.0, all distances round to the nearest integer.

**dx.f.dimdle**

Dimension line extension beyond extension lines. (default=0)

**dx<sub>f</sub>.dimtp**

Upper tolerance value for tolerance dimensions. (default=0)

**dx<sub>f</sub>.dimtm**

Lower tolerance value for tolerance dimensions. (default=0)

**dx<sub>f</sub>.dimtxt**

Size of dimension text. (default imperial=0.28, default metric=2.5)

**dx<sub>f</sub>.dimcen**

Controls placement of center marks or centerlines. (default imperial=0.09, default metric=2.5)

**dx<sub>f</sub>.dimtsz**

Controls size of dimension line tick marks drawn instead of arrowheads. (default=0)

**dx<sub>f</sub>.dimaltf**

Alternate units dimension scale factor. (default=25.4)

**dx<sub>f</sub>.dimlfac**

Scale factor for linear dimension values. (default=1)

**dx<sub>f</sub>.dimtvp**

Vertical position of text above or below dimension line if *dimtad* is 0. (default=0)

**dx<sub>f</sub>.dimtfac**

Scale factor for fractional or tolerance text size. (default=1)

**dx<sub>f</sub>.dimgap**

Gap size between dimension line and dimension text. (default imperial=0.09, default metric=0.625)

**dx<sub>f</sub>.dimaltrnd**

Rounding value for alternate dimension units. (default=0)

**dx<sub>f</sub>.dimtol**

Toggles creation of appended tolerance dimensions. (default imperial=1, default metric=0)

**dx<sub>f</sub>.dimlim**

Toggles creation of limits-style dimension text. (default=0)

**dx<sub>f</sub>.dimtih**

Orientation of text inside extension lines. (default imperial=1, default metric=0)

**dx<sub>f</sub>.dimtoh**

Orientation of text outside extension lines. (default imperial=1, default metric=0)

**dx<sub>f</sub>.dimse1**

Toggles suppression of first extension line. (default=0)

**dx<sub>f</sub>.dimse2**

Toggles suppression of second extension line. (default=0)

**dx<sub>f</sub>.dimtad**

Sets vertical text placement relative to dimension line. (default imperial=0, default metric=1)

0	center
1	above
2	outside, handled like above by <i>ezdxf</i>
3	JIS, handled like above by <i>ezdxf</i>
4	below

**dx<sub>f</sub>.dimzin**

Zero suppression for primary units dimensions. (default imperial=0, default metric=8)

Values 0-3 affect feet-and-inch dimensions only.

0	Suppresses zero feet and precisely zero inches
1	Includes zero feet and precisely zero inches
2	Includes zero feet and suppresses zero inches
3	Includes zero inches and suppresses zero feet
4	Suppresses leading zeros in decimal dimensions (for example, 0.5000 becomes .5000)
8	Suppresses trailing zeros in decimal dimensions (for example, 12.5000 becomes 12.5)
12	Suppresses both leading and trailing zeros (for example, 0.5000 becomes .5)

#### dx.f.dimazin

Controls zero suppression for angular dimensions. (default=0)

0	Displays all leading and trailing zeros
1	Suppresses leading zeros in decimal dimensions (for example, 0.5000 becomes .5000)
2	Suppresses trailing zeros in decimal dimensions (for example, 12.5000 becomes 12.5)
3	Suppresses leading and trailing zeros (for example, 0.5000 becomes .5)

#### dx.f.dimalt

Enables or disables alternate units dimensioning. (default=0)

#### dx.f.dimaltd

Controls decimal places for alternate units dimensions. (default imperial=2, default metric=3)

#### dx.f.dimtofl

Toggles forced dimension line creation. (default imperial=0, default metric=1)

#### dx.f.dim сах

Toggles appearance of arrowhead blocks. (default=0)

#### dx.f.dimtix

Toggles forced placement of text between extension lines. (default=0)

#### dx.f.dimsoxd

Suppresses dimension lines outside extension lines. (default=0)

#### dx.f.dimclrd

Dimension line, arrowhead, and leader line color. (default=0)

#### dx.f.dimclre

Dimension extension line color. (default=0)

#### dx.f.dimclrt

Dimension text color. (default=0)

#### dx.f.dimadec

Controls the number of decimal places for angular dimensions.

#### dx.f.dimunit

Obsolete, now use DIMLUNIT AND DIMFRAC

#### dx.f.dimdec

Decimal places for dimension values. (default imperial=4, default metric=2)

#### dx.f.dimtdec

Decimal places for primary units tolerance values. (default imperial=4, default metric=2)

#### dx.f.dimaltu

Units format for alternate units dimensions. (default=2)

**dx<sub>f</sub>.dimaltd**

Decimal places for alternate units tolerance values. (default imperial=4, default metric=2)

**dx<sub>f</sub>.dimaunit**

Unit format for angular dimension values. (default=0)

**dx<sub>f</sub>.dimfrac**

Controls the fraction format used for architectural and fractional dimensions. (default=0)

**dx<sub>f</sub>.dimlunit**

Specifies units for all nonangular dimensions. (default=2)

**dx<sub>f</sub>.dimdsep**

Specifies a single character to use as a decimal separator. (default imperial = “.”, default metric = “;”) This is an integer value, use `ord(" . ")` to write value.

**dx<sub>f</sub>.dimtmove**

Controls the format of dimension text when it is moved. (default=0)

0	Moves the dimension line with dimension text
1	Adds a leader when dimension text is moved
2	Allows text to be moved freely without a leader

**dx<sub>f</sub>.dimjust**

Horizontal justification of dimension text. (default=0)

0	Center of dimension line
1	Left side of the dimension line, near first extension line
2	Right side of the dimension line, near second extension line
3	Over first extension line
4	Over second extension line

**dx<sub>f</sub>.dimsd1**

Toggles suppression of first dimension line. (default=0)

**dx<sub>f</sub>.dimsd2**

Toggles suppression of second dimension line. (default=0)

**dx<sub>f</sub>.dimtolj**

Vertical justification for dimension tolerance text. (default=1)

0	Align with bottom line of dimension text
1	Align vertical centered to dimension text
2	Align with top line of dimension text

**dx<sub>f</sub>.dimtzin**

Zero suppression for tolerances values, see `DimStyle.dxf.dimzin`

**dx<sub>f</sub>.dimaltz**

Zero suppression for alternate units dimension values. (default=0)

**dx<sub>f</sub>.dimaltz**

Zero suppression for alternate units tolerance values. (default=0)

**dx<sub>f</sub>.dimfit**

Obsolete, now use DIMATFIT and DIMTMOVE

**dx.f.dimupt**

Controls user placement of dimension line and text. (default=0)

**dx.f.dimatfit**

Controls placement of text and arrowheads when there is insufficient space between the extension lines. (default=3)

**dx.f.dimtxsty**

Text style used for dimension text by name.

**dx.f.dimtxsty\_handle**

Text style used for dimension text by handle of STYLE entry. (use *DimStyle.dxf.dimtxsty* to get/set text style by name)

**dx.f.dimldrbblk**

Specify arrowhead used for leaders by name.

**dx.f.dimldrbblk\_handle**

Specify arrowhead used for leaders by handle of referenced block. (use *DimStyle.dxf.dimldrbblk* to get/set arrowhead by name)

**dx.f.dimblk\_handle**

Block type to use for both arrowheads, handle of referenced block. (use *DimStyle.dxf.dimblk* to get/set arrowheads by name)

**dx.f.dimblk1\_handle**

Block type to use for first arrowhead, handle of referenced block. (use *DimStyle.dxf.dimblk1* to get/set arrowhead by name)

**dx.f.dimblk2\_handle**

Block type to use for second arrowhead, handle of referenced block. (use *DimStyle.dxf.dimblk2* to get/set arrowhead by name)

**dx.f.dimlwd**

Lineweight value for dimension lines. (default=-2, BYBLOCK)

**dx.f.dimlwe**

Lineweight value for extension lines. (default=-2, BYBLOCK)

**dx.f.dimltype**

Specifies the linetype used for the dimension line as linetype name, requires DXF R2007+

**dx.f.dimltype\_handle**

Specifies the linetype used for the dimension line as handle to LTYPE entry, requires DXF R2007+ (use *DimStyle.dxf.dimltype* to get/set linetype by name)

**dx.f.dimltex1**

Specifies the linetype used for the extension line 1 as linetype name, requires DXF R2007+

**dx.f.dimlex1\_handle**

Specifies the linetype used for the extension line 1 as handle to LTYPE entry, requires DXF R2007+ (use *DimStyle.dxf.dimltex1* to get/set linetype by name)

**dx.f.dimltex2**

Specifies the linetype used for the extension line 2 as linetype name, requires DXF R2007+

**dx.f.dimlex2\_handle**

Specifies the linetype used for the extension line 2 as handle to LTYPE entry, requires DXF R2007+ (use *DimStyle.dxf.dimltex2* to get/set linetype by name)

**dx.f.dimfxlon**

Extension line has fixed length if set to 1, requires DXF R2007+

**dx.dxf.dimfxl**

Length of extension line below dimension line if fixed (`DimStyle.dxf.dimtfxlon == 1`), `DimStyle.dxf.dimexen` defines the the length above the dimension line, requires DXF R2007+

**dx.dxf.dimtfill**

Text fill 0=off; 1=background color; 2=custom color (see `DimStyle.dxf.dimtfillclr`), requires DXF R2007+

**dx.dxf.dimtfillclr**

Text fill custom color as color index (1-255), requires DXF R2007+

**dx.dxf.dimarcssym**

Display arc symbol, supported only by `ArcDimension`:

0	arc symbol preceding the measurement text
1	arc symbol above the measurement text
2	disable arc symbol

**copy\_to\_header (doc: Drawing)**

Copy all dimension style variables to HEADER section of `doc`.

**set\_arrows (blk: str = "", blk1: str = "", blk2: str = "", ldrblk: str = "") → None**

Set arrows by block names or AutoCAD standard arrow names, set DIMTSZ to 0 which disables tick.

**Parameters**

- **blk** – block/arrow name for both arrows, if DIMSAH is 0
- **blk1** – block/arrow name for first arrow, if DIMSAH is 1
- **blk2** – block/arrow name for second arrow, if DIMSAH is 1
- **ldrblk** – block/arrow name for leader

**set\_tick (size: float = 1) → None**

Set tick `size`, which also disables arrows, a tick is just an oblique stroke as marker.

**Parameters size** – arrow size in drawing units**set\_text\_align (halign: str = None, valign: str = None, vshift: float = None) → None**

Set measurement text alignment, `halign` defines the horizontal alignment (requires DXF R2000+), `valign` defines the vertical alignment, `above1` and `above2` means above extension line 1 or 2 and aligned with extension line.

**Parameters**

- **halign** – “left”, “right”, “center”, “above1”, “above2”, requires DXF R2000+
- **valign** – “above”, “center”, “below”
- **vshift** – vertical text shift, if `valign` is “center”; >0 shift upward, <0 shift downwards

**set\_text\_format (prefix: str = "", postfix: str = "", rnd: float = None, dec: int = None, sep: str = None, leading\_zeros: bool = True, trailing\_zeros: bool = True)**

Set dimension text format, like prefix and postfix string, rounding rule and number of decimal places.

**Parameters**

- **prefix** – Dimension text prefix text as string
- **postfix** – Dimension text postfix text as string

- **rnd** – Rounds all dimensioning distances to the specified value, for instance, if DIMRND is set to 0.25, all distances round to the nearest 0.25 unit. If you set DIMRND to 1.0, all distances round to the nearest integer.
- **dec** – Sets the number of decimal places displayed for the primary units of a dimension, requires DXF R2000+
- **sep** – “.” or “,” as decimal separator, requires DXF R2000+
- **leading\_zeros** – Suppress leading zeros for decimal dimensions if `False`
- **trailing\_zeros** – Suppress trailing zeros for decimal dimensions if `False`

**set\_dimline\_format** (`color: int = None, linetype: str = None, linewidth: int = None, extension: float = None, disable1: bool = None, disable2: bool = None`)

Set dimension line properties

#### Parameters

- **color** – color index
- **linetype** – linetype as string, requires DXF R2007+
- **linewidth** – line weight as int, 13 = 0.13mm, 200 = 2.00mm, requires DXF R2000+
- **extension** – extension length
- **disable1** – True to suppress first part of dimension line, requires DXF R2000+
- **disable2** – True to suppress second part of dimension line, requires DXF R2000+

**set\_extline\_format** (`color: int = None, linewidth: int = None, extension: float = None, offset: float = None, fixed_length: float = None`)

Set common extension line attributes.

#### Parameters

- **color** – color index
- **linewidth** – line weight as int, 13 = 0.13mm, 200 = 2.00mm
- **extension** – extension length above dimension line
- **offset** – offset from measurement point
- **fixed\_length** – set fixed length extension line, length below the dimension line

**set\_extline1** (`linetype: str = None, disable=False`)

Set extension line 1 attributes.

#### Parameters

- **linetype** – linetype for extension line 1, requires DXF R2007+
- **disable** – disable extension line 1 if `True`

**set\_extline2** (`linetype: str = None, disable=False`)

Set extension line 2 attributes.

#### Parameters

- **linetype** – linetype for extension line 2, requires DXF R2007+
- **disable** – disable extension line 2 if `True`

```
set_tolerance(upper: float, lower: float = None, hfactor: float = 1.0, align:  
    ezdxf.enums.MTextLineAlignment = None, dec: int = None, leading_zeros:  
    bool = None, trailing_zeros: bool = None) → None
```

Set tolerance text format, upper and lower value, text height factor, number of decimal places or leading and trailing zero suppression.

#### Parameters

- **upper** – upper tolerance value
- **lower** – lower tolerance value, if None same as upper
- **hfactor** – tolerance text height factor in relation to the dimension text height
- **align** – tolerance text alignment enum `ezdxf.enums.MTextLineAlignment` requires DXF R2000+
- **dec** – Sets the number of decimal places displayed, requires DXF R2000+
- **leading\_zeros** – suppress leading zeros for decimal dimensions if `False`, requires DXF R2000+
- **trailing\_zeros** – suppress trailing zeros for decimal dimensions if `False`, requires DXF R2000+

Changed in version 0.17.2: argument `align` as enum `ezdxf.enums.MTextLineAlignment`

```
set_limits(upper: float, lower: float, hfactor: float = 1.0, dec: int = None, leading_zeros: bool =  
    None, trailing_zeros: bool = None) → None
```

Set limits text format, upper and lower limit values, text height factor, number of decimal places or leading and trailing zero suppression.

#### Parameters

- **upper** – upper limit value added to measurement value
- **lower** – lower lower value subtracted from measurement value
- **hfactor** – limit text height factor in relation to the dimension text height
- **dec** – Sets the number of decimal places displayed, requires DXF R2000+
- **leading\_zeros** – suppress leading zeros for decimal dimensions if `False`, requires DXF R2000+
- **trailing\_zeros** – suppress trailing zeros for decimal dimensions if `False`, requires DXF R2000+

## VPort

The viewport table ([DXF Reference](#)) stores the modelspace viewport configurations. So this entries just modelspace viewports, not paperspace viewports, for paperspace viewports see the [`Viewport`](#) entity.

Subclass of	<code>ezdxf.entities.DXFEntity</code>
DXF type	'VPORT'
Factory function	<code>Drawing.viewports.new()</code>

#### See also:

DXF Internals: [`VPORT Configuration Table`](#)

**class** ezdxf.entities.VPortSubclass of [DXFEntity](#)

Defines a viewport configurations for the modelspace.

**dxfs.owner**Handle to owner ([ViewportTable](#)).**dxfs.name**

Viewport name

**dxfs.flags**

Standard flag values (bit-coded values):

16	If set, table entry is externally dependent on an xref
32	If both this bit and bit 16 are set, the externally dependent xref has been successfully resolved
64	If set, the table entry was referenced by at least one entity in the drawing the last time the drawing was edited. (This flag is only for the benefit of AutoCAD)

**dxfs.lower\_left**

Lower-left corner of viewport

**dxfs.upper\_right**

Upper-right corner of viewport

**dxfs.center**View center point (in [DCS](#))**dxfs.snap\_base**Snap base point (in [DCS](#))**dxfs.snap\_spacing**

Snap spacing X and Y

**dxfs.grid\_spacing**

Grid spacing X and Y

**dxfs.direction\_point**View direction from target point (in [WCS](#))**dxfs.target\_point**View target point (in [WCS](#))**dxfs.height**

View height

**dxfs.aspect\_ratio****dxfs.lens\_length**

Lens focal length in mm

**dxfs.front\_clipping**

Front clipping plane (offset from target point)

**dxfs.back\_clipping**

Back clipping plane (offset from target point)

**dxfs.snap\_rotation**

Snap rotation angle in degrees

**dxfs.view\_twist**

View twist angle in degrees

```
dxf.status
dxf.view_mode
dxf.circle_zoom
dxf.fast_zoom
dxf.ucs_icon
    • bit 0: 0=hide, 1=show
    • bit 1: 0=display in lower left corner, 1=display at origin
dxf.snap_on
dxf.grid_on
dxf.snap_style
dxf.snap_isopair
reset_wcs() → None
    Reset coordinate system to the WCS.
```

## View

The View table ([DXF Reference](#)) stores named views of the model or paperspace layouts. This stored views makes parts of the drawing or some view points of the model in a CAD applications more accessible. This views have no influence to the drawing content or to the generated output by exporting PDFs or plotting on paper sheets, they are just for the convenience of CAD application users.

Subclass of	<a href="#">ezdxf.entities.DXFEntity</a>
DXF type	'VIEW'
Factory function	Drawing.views.new()

### See also:

DXF Internals: [VIEW Table](#)

**class** `ezdxf.entities.View`

`dxf.owner`

Handle to owner ([Table](#)).

`dxf.name`

Name of view.

`dxf.flags`

Standard flag values (bit-coded values):

1	If set, this is a paper space view
16	If set, table entry is externally dependent on an xref
32	If both this bit and bit 16 are set, the externally dependent xref has been successfully resolved
64	If set, the table entry was referenced by at least one entity in the drawing the last time the drawing was edited. (This flag is only for the benefit of AutoCAD)

`dxf.height`

View height (in DCS)

`dxf.width`  
View width (in DCS)

`dxf.center_point`  
View center point (in DCS)

`dxf.direction_point`  
View direction from target (in WCS)

`dxf.target_point`  
Target point (in WCS)

`dxf.lens_length`  
Lens length

`dxf.front_clipping`  
Front clipping plane (offset from target point)

`dxf.back_clipping`  
Back clipping plane (offset from target point)

`dxf.view_twist`  
Twist angle in degrees.

`dxf.view_mode`  
View mode (see VIEWMODE system variable)

`dxf.render_mode`

0	2D Optimized (classic 2D)
1	Wireframe
2	Hidden line
3	Flat shaded
4	Gouraud shaded
5	Flat shaded with wireframe
6	Gouraud shaded with wireframe

`dxf.ucs`  
1 if there is a UCS associated to this view; 0 otherwise

`dxf.ucs_origin`  
UCS origin as (x, y, z) tuple (appears only if `ucs` is set to 1)

`dxf.ucs_xaxis`  
UCS x-axis as (x, y, z) tuple (appears only if `ucs` is set to 1)

`dxf.ucs_yaxis`  
UCS y-axis as (x, y, z) tuple (appears only if `ucs` is set to 1)

`dxf.ucs_ortho_type`  
Orthographic type of UCS (appears only if `ucs` is set to 1)

0	UCS is not orthographic
1	Top
2	Bottom
3	Front
4	Back
5	Left
6	Right

**dx.f.elevation**

UCS elevation

**dx.f.ucs\_handle**

Handle of UCSTable if UCS is a named UCS. If not present, then UCS is unnamed (appears only if `ucs` is set to 1)

**dx.f.base\_ucs\_handle**

Handle of UCSTable of base UCS if UCS is orthographic. If not present and `ucs_ortho_type` is non-zero, then base UCS is taken to be WORLD (appears only if `ucs` is set to 1)

**dx.f.camera\_plottable**

1 if the camera is plottable

**dx.f.background\_handle**

Handle to background object (optional)

**dx.f.live\_selection\_handle**

Handle to live section object (optional)

**dx.f.visual\_style\_handle**

Handle to visual style object (optional)

**dx.f.sun\_handle**

Sun hard ownership handle.

## AppID

Defines an APPID ([DXF Reference](#)). These table entries maintain a set of names for all registered applications.

Subclass of	<i>ezdxf.entities.DXFEntity</i>
DXF type	'APPID'
Factory function	<code>Drawing.appids.new()</code>

**class ezdxf.entities.AppID****dx.f.owner**

Handle to owner ([Table](#)).

**dx.f.name**

User-supplied (or application-supplied) application name (for extended data).

**dx.f.flags**

Standard flag values (bit-coded values):

16	If set, table entry is externally dependent on an xref
32	If both this bit and bit 16 are set, the externally dependent xref has been successfully resolved
64	If set, the table entry was referenced by at least one entity in the drawing the last time the drawing was edited. (This flag is only for the benefit of AutoCAD)

## UCS

Defines an named or unnamed user coordinate system ([DXF Reference](#)) for usage in CAD applications. This UCS table entry does not interact with `ezdxf` in any way, to do coordinate transformations by `ezdxf` use the `ezdxf.math.UCS` class.

Subclass of	<code>ezdxf.entities.DXFEntity</code>
DXF type	'UCS'
Factory function	<code>Drawing.ucs.new()</code>

See also:

`UCS` and `OCS`

**class** `ezdxf.entities.UCSTableEntry`

`dxf.owner`

Handle to owner (`Table`).

`dxf.name`

UCS name (str).

`dxf.flags`

Standard flags (bit-coded values):

16	If set, table entry is externally dependent on an xref
32	If both this bit and bit 16 are set, the externally dependent xref has been successfully resolved
64	If set, the table entry was referenced by at least one entity in the drawing the last time the drawing was edited. (This flag is only for the benefit of AutoCAD)

`dxf.origin`

Origin as (x, y, z) tuple

`dxf.xaxis`

X-axis direction as (x, y, z) tuple

`dxf.yaxis`

Y-axis direction as (x, y, z) tuple

`ucs()` → `ezdxf.math.UCS`

Returns an `ezdxf.math.UCS` object for this UCS table entry.

## BlockRecord

BLOCK\_RECORD ([DXF Reference](#)) is the core management structure for `BlockLayout` and `Layout`. This is an internal DXF structure managed by `ezdxf`, package users don't have to care about it.

Subclass of	<code>ezdxf.entities.DXFentity</code>
DXF type	'BLOCK_RECORD'
Factory function	<code>Drawing.block_records.new()</code>

```
class ezdxf.entities.BlockRecord
```

**dx.f.owner**

Handle to owner ([Table](#)).

**dx.f.name**

Name of associated BLOCK.

**dx.f.layout**

Handle to associated DXFLayout, if paperspace layout or modelspace else "0"

**dx.f.explode**

1 for BLOCK references can be exploded else 0

**dx.f.scale**

1 for BLOCK references can be scaled else 0

**dx.f.units**

BLOCK insert units

0	Unitless
1	Inches
2	Feet
3	Miles
4	Millimeters
5	Centimeters
6	Meters
7	Kilometers
8	Microinches
9	Mils
10	Yards
11	Angstroms
12	Nanometers
13	Microns
14	Decimeters
15	Decameters
16	Hectometers
17	Gigameters
18	Astronomical units
19	Light years
20	Parsecs
21	US Survey Feet
22	US Survey Inch
23	US Survey Yard
24	US Survey Mile

## Internal Structure

Do not change this structures, this is just an information for experienced developers!

The BLOCK\_RECORD is the owner of all the entities in a layout and stores them in an [EntitySpace](#) object (`BlockRecord.entity_space`). For each layout exist a BLOCK definition in the BLOCKS section, a reference to the [Block](#) entity is stored in `BlockRecord.block`.

[Modelspace](#) and [Paperspace](#) layouts require an additional [DXFLayout](#) object in the OBJECTS section.

#### See also:

More information about [Block Management Structures](#) and [Layout Management Structures](#).

## Blocks

A block definition ([BlockLayout](#)) is a collection of DXF entities, which can be placed multiply times at different layouts or other blocks as references to the block definition.

#### See also:

[Tutorial for Blocks](#) and DXF Internals: [Block Management Structures](#)

## Block

BLOCK ([DXF Reference](#)) entity is embedded into the [BlockLayout](#) object. The BLOCK entity is accessible by the `BlockLayout.block` attribute.

Subclass of	<code>ezdxf.entities.DXFEntity</code>
DXF type	'BLOCK'
Factory function	<code>Drawing.blocks.new()</code> (returns a <a href="#">BlockLayout</a> )

#### See also:

[Tutorial for Blocks](#) and DXF Internals: [Block Management Structures](#)

### `class ezdxf.entities.Block`

<code>dxfl.handle</code>	BLOCK handle as plain hex string. (feature for experts)
<code>dxfl.owner</code>	Handle to owner as plain hex string. (feature for experts)
<code>dxfl.layer</code>	Layer name as string; default value is '0'
<code>dxfl.name</code>	BLOCK name as string. (case insensitive)
<code>dxfl.base_point</code>	BLOCK base point as (x, y, z) tuple, default value is (0, 0, 0)
	Insertion location referenced by the <a href="#">Insert</a> entity to place the block reference and also the center of rotation and scaling.
<code>dxfl.flags</code>	BLOCK flags (bit-coded)

1	Anonymous block generated by hatching, associative dimensioning, other internal operations, or an application
2	Block has non-constant attribute definitions (this bit is not set if the block has any attribute definitions that are constant, or has no attribute definitions at all)
4	Block is an external reference (xref)
8	Block is an xref overlay
16	Block is externally dependent
32	This is a resolved external reference, or dependent of an external reference (ignored on input)
64	This definition is a referenced external reference (ignored on input)

**dx.f.xref\_path**

File system path as string, if this block defines an external reference (XREF).

**is\_layout\_block**

Returns True if this is a *Modelspace* or *Paperspace* block definition.

**is\_anonymous**

Returns True if this is an anonymous block generated by hatching, associative dimensioning, other internal operations, or an application.

**is\_xref**

Returns True if block is an external referenced file.

**is\_xref\_overlay**

Returns True if block is an external referenced overlay file.

## EndBlk

ENDBLK entity is embedded into the *BlockLayout* object. The ENDBLK entity is accessible by the *BlockLayout.endblk* attribute.

Subclass of	<i>ezdxf.entities.DXFEntity</i>
DXF type	'ENDBLK'

**class ezdxf.entities.EndBlk****dx.f.handle**

BLOCK handle as plain hex string. (feature for experts)

**dx.f.owner**

Handle to owner as plain hex string. (feature for experts)

**dx.f.layer**

Layer name as string; should always be the same as *Block.dx.f.layer*

## Insert

Block reference (DXF Reference) with maybe attached attributes (*Attrib*).

Subclass of	<i>ezdxf.entities.DXFGraphic</i>
DXF type	'INSERT'
Factory function	<i>ezdxf.layouts.BaseLayout.add_blockref()</i>
Inherited DXF attributes	<i>Common graphical DXF attributes</i>

**See also:**

*Tutorial for Blocks*

**Warning:** Do not instantiate entity classes by yourself - always use the provided factory functions!

TODO: influence of layer, linetype, color DXF attributes to block entities

**class ezdxf.entities.Insert**

**dx<sub>f</sub>.name**

BLOCK name (str)

**dx<sub>f</sub>.insert**

Insertion location of the BLOCK base point as (2D/3D Point in *OCS*)

**dx<sub>f</sub>.xscale**

Scale factor for x direction (float)

**dx<sub>f</sub>.yscale**

Scale factor for y direction (float)

Not all CAD applications support non-uniform scaling (e.g. LibreCAD).

**dx<sub>f</sub>.zscale**

Scale factor for z direction (float)

Not all CAD applications support non-uniform scaling (e.g. LibreCAD).

**dx<sub>f</sub>.rotation**

Rotation angle in degrees (float)

**dx<sub>f</sub>.row\_count**

Count of repeated insertions in row direction, MININSERT entity if > 1 (int)

**dx<sub>f</sub>.row\_spacing**

Distance between two insert points (MININSERT) in row direction (float)

**dx<sub>f</sub>.column\_count**

Count of repeated insertions in column direction, MININSERT entity if > 1 (int)

**dx<sub>f</sub>.column\_spacing**

Distance between two insert points (MININSERT) in column direction (float)

**attribs**

A list of all attached *Attrib* entities.

**has\_scaling**

Returns True if any axis scaling is applied.

**has\_uniform\_scaling**

Returns True if scaling is uniform in x-, y- and z-axis ignoring reflections e.g. (1, 1, -1) is uniform scaling.

**mcount**

Returns the multi-insert count, MININSERT (multi-insert) processing is required if *mcount* > 1.

**set\_scale (factor: float)**

Set uniform scaling.

**block () → Optional[BlockLayout]**

Returns associated *BlockLayout*.

**place** (*insert: Union[Sequence[float], ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3, None] = None, scale: Optional[Tuple[float, float, float]] = None, rotation: Optional[float] = None*) → ezdxf.entities.insert.Insert  
Set block reference placing location *insert*, scaling and rotation attributes. Parameters which are *None* will not be altered.

#### Parameters

- **insert** – insert location as (x, y [, z]) tuple
- **scale** – (x-scale, y-scale, z-scale) tuple
- **rotation** – rotation angle in degrees

**grid** (*size: Tuple[int, int] = (1, 1), spacing: Tuple[float, float] = (1, 1)*) → ezdxf.entities.insert.Insert  
Place block reference in a grid layout, grid *size* defines the row- and column count, *spacing* defines the distance between two block references.

#### Parameters

- **size** – grid size as (row\_count, column\_count) tuple
- **spacing** – distance between placing as (row\_spacing, column\_spacing) tuple

**has\_attrib** (*tag: str, search\_const: bool = False*) → bool  
Returns True if ATTRIB *tag* exist, for *search\_const* doc see [get\\_attrib\(\)](#).

#### Parameters

- **tag** – tag name as string
- **search\_const** – search also const ATTDEF entities

**get\_attrib** (*tag: str, search\_const: bool = False*) → Optional[Union[Attrib, AttDef]]  
Get attached *Attrib* entity with *dxf.tag == tag*, returns *None* if not found. Some applications may not attach constant ATTRIB entities, set *search\_const* to True, to get at least the associated *AttDef* entity.

#### Parameters

- **tag** – tag name
- **search\_const** – search also const ATTDEF entities

**get\_attrib\_text** (*tag: str, default: str = "", search\_const: bool = False*) → str  
Get content text of attached *Attrib* entity with *dxf.tag == tag*, returns *default* if not found. Some applications may not attach constant ATTRIB entities, set *search\_const* to True, to get content text of the associated *AttDef* entity.

#### Parameters

- **tag** – tag name
- **default** – default value if ATTRIB *tag* is absent
- **search\_const** – search also const ATTDEF entities

**add\_attrib** (*tag: str, text: str, insert: Union[Sequence[float], ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3] = (0, 0), dxffattribs=None*) → Attrib  
Attach an *Attrib* entity to the block reference.

Example for appending an attribute to an INSERT entity with none standard alignment:

```
e.add_attrib('EXAMPLETAG', 'example text').set_placement(  
    (3, 7), align=TextEntityAlignment.MIDDLE_CENTER  
)
```

## Parameters

- **tag** – tag name as string
- **text** – content text as string
- **insert** – insert location as tuple (`x`, `y`[, `z`]) in `WCS`
- **dxfattribs** – additional DXF attributes for the ATTRIB entity

**add\_auto\_attribs** (`values: Dict[str, str]`) → `ezdxf.entities.insert.Insert`

Attach for each `Attdef` entity, defined in the block definition, automatically an `Attrib` entity to the block reference and set tag/value DXF attributes of the ATTRIB entities by the key/value pairs (both as strings) of the `values` dict. The ATTRIB entities are placed relative to the insert location of the block reference, which is identical to the block base point.

This method avoids the wrapper block of the `add_auto_blockref()` method, but the visual results may not match the results of CAD applications, especially for non uniform scaling. If the visual result is very important to you, use the `add_auto_blockref()` method.

**Parameters** `values` – `Attrib` tag values as tag/value pairs

**delete\_attrib** (`tag: str, ignore=False`) → None

Delete an attached `Attrib` entity from INSERT. If `ignore` is `False`, an `DXFKeyError` exception is raised, if ATTRIB `tag` does not exist.

## Parameters

- **tag** – ATTRIB name
- **ignore** – `False` for raising `DXFKeyError` if ATTRIB `tag` does not exist.

**Raises** `DXFKeyError` – if ATTRIB `tag` does not exist.

**delete\_all\_attribs** () → None

Delete all `Attrib` entities attached to the INSERT entity.

**reset\_transformation** () → None

Reset block reference parameters *location*, *rotation* and *extrusion* vector.

**transform** (`m: ezdxf.math._matrix44.Matrix44`) → `ezdxf.entities.insert.Insert`

Transform INSERT entity by transformation matrix `m` inplace.

Unlike the transformation matrix `m`, the INSERT entity can not represent a non-orthogonal target coordinate system, for this case an `InsertTransformationError` will be raised.

**translate** (`dx: float, dy: float, dz: float`) → `ezdxf.entities.insert.Insert`

Optimized INSERT translation about `dx` in x-axis, `dy` in y-axis and `dz` in z-axis.

**virtual\_entities** (`skipped_entity_callback: Optional[Callable[[ezdxf.entities.dxfgfx.DXFGraphic, str], None]] = None`) → Iterable[`ezdxf.entities.dxfgfx.DXFGraphic`]

Yields “virtual” entities of a block reference. This method is meant to examine the block reference entities at the “exploded” location without really “exploding” the block reference. The ‘`skipped_entity_callback()`’ will be called for all entities which are not processed, signature: `skipped_entity_callback(entity: DXFEntity, reason: str)`, `entity` is the original (untransformed) DXF entity of the block definition, the `reason` string is an explanation why the entity was skipped.

This entities are not stored in the entity database, have no handle and are not assigned to any layout. It is possible to convert this entities into regular drawing entities by adding the entities to the entities database and a layout of the same DXF document as the block reference:

```
doc.entitydb.add(entity)
msp = doc.modelspace()
msp.add_entity(entity)
```

This method does not resolve the MINsert attributes, only the sub-entities of the base INSERT will be returned. To resolve MINsert entities check if multi insert processing is required, that's the case if property `Insert.mcount > 1`, use the `Insert.multi_insert()` method to resolve the MINsert entity into single INSERT entities.

**Warning:** **Non uniform scaling** may return incorrect results for text entities (TEXT, MTEXT, ATTRIB) and maybe some other entities.

**Parameters** `skipped_entity_callback` – called whenever the transformation of an entity is not supported and so was skipped

`multi_insert() → Iterable[ezdxf.entities.insert.Insert]`

Yields a virtual INSERT entity for each grid element of a MINsert entity (multi-insert).

`explode(target_layout: BaseLayout = None) → EntityQuery`

Explode block reference entities into target layout, if target layout is `None`, the target layout is the layout of the block reference. This method destroys the source block reference entity.

Transforms the block entities into the required `WCS` location by applying the block reference attributes `insert, extrusion, rotation` and the scaling values `xscale, yscale` and `zscale`.

Attached ATTRIB entities are converted to TEXT entities, this is the behavior of the BURST command of the AutoCAD Express Tools.

Returns an `EntityQuery` container with all “exploded” DXF entities.

**Warning:** **Non uniform scaling** may lead to incorrect results for text entities (TEXT, MTEXT, ATTRIB) and maybe some other entities.

**Parameters** `target_layout` – target layout for exploded entities, `None` for same layout as source entity.

`ucs()`

Returns the block reference coordinate system as `ezdxf.math.ucs` object.

## Attrib

The ATTRIB ([DXF Reference](#)) entity represents a text value associated with a tag. In most cases an ATTRIB is appended to an `Insert` entity, but it can also appear as standalone entity.

Subclass of	<code>ezdxf.entities.Text</code>
DXF type	'ATTRIB'
Factory function	<code>ezdxf.layouts.BaseLayout.add_attrib()</code> (stand alone entity)
Factory function	<code>Insert.add_attrib()</code> (attached to <code>Insert</code> )
Inherited DXF attributes	<code>Common graphical DXF attributes</code>

See also:

## Tutorial for Blocks

**Warning:** Do not instantiate entity classes by yourself - always use the provided factory functions!

**class** ezdxf.entities.**Attrib**

ATTRIB supports all DXF attributes and methods of parent class *Text*.

**dxf.tag**

Tag to identify the attribute (str)

**dxf.text**

Attribute content as text (str)

**virtual\_mtext\_entity()** → ezdxf.entities.mtext.MText

Returns the embedded MTEXT entity as a regular but virtual *MText* entity with the same graphical properties as the host entity.

**plain\_mtext(fast=True)** → str

Returns the embedded MTEXT content without formatting codes. Returns an empty string if no embedded MTEXT entity exist.

The “fast” mode is accurate if the DXF content was created by reliable (and newer) CAD applications like AutoCAD or BricsCAD. The “accurate” mode is for some rare cases where the content was created by older CAD applications or unreliable DXF libraries and CAD applications.

The “accurate” mode is **much** slower than the “fast” mode.

**Parameters** **fast** – uses the “fast” mode to extract the plain MTEXT content if `True` or the “accurate” mode if set to `False`

**set\_mtext(mtext: ezdxf.entities.mtext.MText, graphic\_properties=True)** → None

Set multi-line properties from a *MText* entity.

The multi-line ATTRIB/ATTDEF entity requires DXF R2018, otherwise an ordinary single line ATTRIB/ATTDEF entity will be exported.

**Parameters**

- **mtext** – source *MText* entity
- **graphic\_properties** – copy graphic properties (color, layer, ...) from source MTEXT if `True`

**embed\_mtext(mtext: ezdxf.entities.mtext.MText, graphic\_properties=True)** → None

Set multi-line properties from a *MText* entity and destroy the source entity afterwards.

The multi-line ATTRIB/ATTDEF entity requires DXF R2018, otherwise an ordinary single line ATTRIB/ATTDEF entity will be exported.

**Parameters**

- **mtext** – source *MText* entity
- **graphic\_properties** – copy graphic properties (color, layer, ...) from source MTEXT if `True`

## AttDef

The ATTDEF (DXF Reference) entity is a template in a *BlockLayout*, which will be used to create an attached *Attrib* entity for an *Insert* entity.

Subclass of	<code>ezdxf.entities.Text</code>
DXF type	'ATTDEF'
Factory function	<code>ezdxf.layouts.BaseLayout.add_attdef()</code>
Inherited DXF attributes	<i>Common graphical DXF attributes</i>

**See also:**

[Tutorial for Blocks](#)

**Warning:** Do not instantiate entity classes by yourself - always use the provided factory functions!

**class** `ezdxf.entities.AttDef`

ATTDEF supports all DXF attributes and methods of parent class `Text`.

**dx.dxf.tag**

Tag to identify the attribute (str)

**dx.dxf.text**

Attribute content as text (str)

**dx.dxf.prompt**

Attribute prompt string. (CAD application feature)

**dx.dxf.field\_length**

Just relevant to CAD programs for validating user input

**virtual\_mtext\_entity () → ezdxf.entities.mtext.MText**

Returns the embedded MTEXT entity as a regular but virtual `MText` entity with the same graphical properties as the host entity.

**plain\_mtext (fast=True) → str**

Returns the embedded MTEXT content without formatting codes. Returns an empty string if no embedded MTEXT entity exist.

The “fast” mode is accurate if the DXF content was created by reliable (and newer) CAD applications like AutoCAD or BricsCAD. The “accurate” mode is for some rare cases where the content was created by older CAD applications or unreliable DXF libraries and CAD applications.

The “accurate” mode is **much** slower than the “fast” mode.

**Parameters** **fast** – uses the “fast” mode to extract the plain MTEXT content if `True` or the “accurate” mode if set to `False`

**set\_mtext (mtext: ezdxf.entities.mtext.MText, graphic\_properties=True) → None**

Set multi-line properties from a `MText` entity.

The multi-line ATTRIB/ATTDEF entity requires DXF R2018, otherwise an ordinary single line ATTRIB/ATTDEF entity will be exported.

**Parameters**

- **mtext** – source `MText` entity
- **graphic\_properties** – copy graphic properties (color, layer, ...) from source MTEXT if `True`

**embed\_mtext (mtext: ezdxf.entities.mtext.MText, graphic\_properties=True) → None**

Set multi-line properties from a `MText` entity and destroy the source entity afterwards.

The multi-line ATTRIB/ATTDEF entity requires DXF R2018, otherwise an ordinary single line ATTRIB/ATTDEF entity will be exported.

### Parameters

- **mtext** – source `MText` entity
- **graphic\_properties** – copy graphic properties (color, layer, ...) from source `MTEXT` if True

## Layouts

### Layout Manager

The layout manager is unique to each DXF drawing, access the layout manager as `layouts` attribute of the `Drawing` object (e.g. `doc.layouts.rename("Layout1", "PlanView")`).

#### `class ezdxf.layouts.Layouts`

The `Layouts` class manages `Paperspace` layouts and the `Modelspace`.

##### `__len__() → int`

Returns count of existing layouts, including the modelspace layout.

##### `__contains__(name: str) → bool`

Returns True if layout `name` exist.

##### `__iter__() → Iterator[ezdxf.layouts.layout.Layout]`

Returns iterable of all layouts as `Layout` objects, including the modelspace layout.

##### `names() → List[str]`

Returns a list of all layout names, all names in original case sensitive form.

##### `names_in_taborder() → List[str]`

Returns all layout names in tab order as shown in `CAD` applications.

##### `modelspace() → ezdxf.layouts.layout.Modelspace`

Returns the `Modelspace` layout.

##### `get(name: Optional[str]) → ezdxf.layouts.layout.Layout`

Returns `Layout` by `name`, case insensitive “Model” == “MODEL”.

**Parameters** `name` – layout name as shown in tab, e.g. ‘Model’ for modelspace

##### `new(name: str, dxfattribs: dict = None) → ezdxf.layouts.layout.Paperspace`

Returns a new `Paperspace` layout.

### Parameters

- **name** – layout name as shown in tabs in `CAD` applications
- **dxfattribs** – additional DXF attributes for the `DXFLayout` entity

### Raises

- `DXFValueError` – Invalid characters in layout name.

- `DXFValueError` – Layout `name` already exist.

##### `rename(old_name: str, new_name: str) → None`

Rename a layout from `old_name` to `new_name`. Can not rename layout ‘Model’ and the new name of a layout must not exist.

### Parameters

- **old\_name** – actual layout name, case insensitive
- **new\_name** – new layout name, case insensitive

**Raises**

- DXFValueError – try to rename 'Model'
- DXFValueError – Layout *new\_name* already exist.

**delete**(*name*: str) → NoneDelete layout *name* and destroy all entities in that layout.**Parameters** **name** (str) – layout name as shown in tabs**Raises**

- DXFKeyError – if layout *name* do not exists
- DXFValueError – deleting modelspace layout is not possible
- DXFValueError – deleting last paperspace layout is not possible

**active\_layout**() → ezdxf.layouts.layout.Paperspace

Returns the active paperspace layout.

**set\_active\_layout**(*name*: str) → NoneSet layout *name* as active paperspace layout.**get\_layout\_for\_entity**(*entity*: ezdxf.entities.dxfentity.DXFEntity) → ezdxf.layouts.layout.LayoutReturns the owner layout for a DXF *entity*.

→

## Layout Types

A Layout represents and manages DXF entities, there are three different layout objects:

- *Modelspace* is the common working space, containing basic drawing entities.
- *Paperspace* is arrangement of objects for printing and plotting, this layout contains basic drawing entities and viewports to the *Modelspace*.
- *BlockLayout* works on an associated Block, Blocks are collections of drawing entities for reusing by block references.

**Warning:** Do not instantiate layout classes by yourself - always use the provided factory functions!

## Entity Ownership

A layout owns all entities residing in their entity space, this means the `dx.dxf.owner` attribute of any `DXFGraphic` in this layout is the `dx.dxf.handle` of the layout, and deleting an entity from a layout is the end of life of this entity, because it is also deleted from the `EntityDB`. But it is possible to just unlink an entity from a layout, so it can be assigned to another layout, use the `move_to_layout()` method to move entities between layouts.

## BaseLayout

**class** ezdxf.layouts.**BaseLayout**

*BaseLayout* is the common base class for *Layout* and *BlockLayout*.

**is\_alive**

`False` if layout is deleted.

**is\_active\_paperspace**

`True` if is active layout.

**is\_any\_paperspace**

`True` if is any kind of paperspace layout.

**is\_modelspace**

`True` if is modelspace layout.

**is\_any\_layout**

`True` if is any kind of modelspace or paperspace layout.

**is\_block\_layout**

`True` if not any kind of modelspace or paperspace layout, just a regular block definition.

**units**

*set drawing units.*

**Type** Get/Set layout/block drawing units as enum, see also

**Type** ref

**\_\_len\_\_()** → int

Returns count of entities owned by the layout.

**\_\_iter\_\_()** → Iterator[DXFGraphic]

Returns iterable of all drawing entities in this layout.

**\_\_getitem\_\_(index)**

Get entity at `index`.

The underlying data structure for storing entities is organized like a standard Python list, therefore `index` can be any valid list indexing or slicing term, like a single index `layout[-1]` to get the last entity, or an index slice `layout[:10]` to get the first 10 or less entities as `List[DXFGraphic]`.

**get\_extension\_dict()** → ExtensionDict

Returns the associated extension dictionary, creates a new one if necessary.

**delete\_entity(entity: DXFGraphic)** → None

Delete `entity` from layout entity space and the entity database, this destroys the `entity`.

**delete\_all\_entities()** → None

Delete all entities from this layout and from entity database, this destroys all entities in this layout.

**unlink\_entity(entity: DXFGraphic)** → None

Unlink `entity` from layout but does not delete entity from the entity database, this removes `entity` just from the layout entity space.

**purge()**

Remove all destroyed entities from the layout entity space.

**query(query: str = '\*')** → ezdxf.query.EntityQuery

Get all DXF entities matching the *Entity Query String*.

**groupby(dxfattrib: str = "", key: KeyFunc = None)** → dict

Returns a `dict` of entity lists, where entities are grouped by a `dxfattrib` or a `key` function.

**Parameters**

- **dxfattrib** – grouping by DXF attribute like 'layer'

- **key** – key function, which accepts a `DXFGraphic` entity as argument and returns the grouping key of an entity or `None` to ignore the entity. Reason for ignoring: a queried DXF attribute is not supported by entity.

`move_to_layout(entity: DXFGraphic, layout: BaseLayout) → None`

Move entity to another layout.

#### Parameters

- **entity** – DXF entity to move
- **layout** – any layout (modelspace, paperspace, block) from **same** drawing

`add_entity(entity: DXFGraphic) → None`

Add an existing `DXFGraphic` entity to a layout, but be sure to unlink (`unlink_entity()`) entity from the previous owner layout. Adding entities from a different DXF drawing is not supported.

`add_foreign_entity(entity: DXFGraphic, copy=True) → None`

Add a foreign DXF entity to a layout, this foreign entity could be from another DXF document or an entity without an assigned DXF document. The intention of this method is to add **simple** entities from another DXF document or from a DXF iterator, for more complex operations use the `importer` add-on. Especially objects with BLOCK section (INSERT, DIMENSION, MLEADER) or OBJECTS section dependencies (IMAGE, UNDERLAY) can not be supported by this simple method.

Not all DXF types are supported and every dependency or resource reference from another DXF document will be removed except attribute layer will be preserved but only with default attributes like color 7 and linetype CONTINUOUS because the layer attribute doesn't need a layer table entry.

If the entity is part of another DXF document, it will be unlinked from this document and its entity database if argument `copy` is `False`, else the entity will be copied. Unassigned entities like from DXF iterators will just be added.

Supported DXF types:

- POINT
- LINE
- CIRCLE
- ARC
- ELLIPSE
- LWPOLYLINE
- SPLINE
- POLYLINE
- 3DFACE
- SOLID
- TRACE
- SHAPE
- MESH
- ATTRIB
- ATTDEF
- TEXT
- MTEXT

- HATCH

#### Parameters

- **entity** – DXF entity to copy or move
- **copy** – if True copy entity from other document else unlink from other document

**add\_point** (*location*: Union[Sequence[float], ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3], *dxftattribs*=None) → Point  
Add a *Point* entity at *location*.

#### Parameters

- **location** – 2D/3D point in *WCS*
- **dxftattribs** – additional DXF attributes

**add\_line** (*start*: Union[Sequence[float], ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3], *end*: Union[Sequence[float], ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3], *dxftattribs*=None) → Line  
Add a *Line* entity from *start* to *end*.

#### Parameters

- **start** – 2D/3D point in *WCS*
- **end** – 2D/3D point in *WCS*
- **dxftattribs** – additional DXF attributes

**add\_circle** (*center*: Union[Sequence[float], ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3], *radius*: float, *dxftattribs*=None) → Circle  
Add a *Circle* entity. This is an 2D element, which can be placed in space by using *OCS*.

#### Parameters

- **center** – 2D/3D point in *WCS*
- **radius** – circle radius
- **dxftattribs** – additional DXF attributes

**add\_ellipse** (*center*: Union[Sequence[float], ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3], *major\_axis*: Union[Sequence[float], ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3] = (1, 0, 0), *ratio*: float = 1, *start\_param*: float = 0, *end\_param*: float = 6.283185307179586, *dxftattribs*=None) → Ellipse

Add an *Ellipse* entity, *ratio* is the ratio of minor axis to major axis, *start\_param* and *end\_param* defines start and end point of the ellipse, a full ellipse goes from 0 to  $2\pi$ . The ellipse goes from start to end param in counter clockwise direction.

#### Parameters

- **center** – center of ellipse as 2D/3D point in *WCS*
- **major\_axis** – major axis as vector (x, y, z)
- **ratio** – ratio of minor axis to major axis in range +/-[1e-6, 1.0]
- **start\_param** – start of ellipse curve
- **end\_param** – end param of ellipse curve
- **dxftattribs** – additional DXF attributes

**add\_arc** (*center*: Union[Sequence[float], *ezdxf.math.\_vector*.Vec2, *ezdxf.math.\_vector*.Vec3], *radius*: float, *start\_angle*: float, *end\_angle*: float, *is\_counter\_clockwise*: bool = True, *dxfattribs*=None) → Arc

Add an *Arc* entity. The arc goes from *start\_angle* to *end\_angle* in counter clockwise direction by default, set parameter *is\_counter\_clockwise* to False for clockwise orientation.

#### Parameters

- **center** – center of arc as 2D/3D point in *WCS*
- **radius** – arc radius
- **start\_angle** – start angle in degrees
- **end\_angle** – end angle in degrees
- **is\_counter\_clockwise** – False for clockwise orientation
- **dxfattribs** – additional DXF attributes

**add\_solid** (*points*: Iterable[Union[Sequence[float], *ezdxf.math.\_vector*.Vec2, *ezdxf.math.\_vector*.Vec3]], *dxfattribs*=None) → *ezdxf.entities.spline.Spline*

Add a *Solid* entity, *points* is an iterable of 3 or 4 points.

---

**Hint:** The last two vertices are in reversed order: a square has the vertex order 0-1-3-2

---

#### Parameters

- **points** – iterable of 3 or 4 2D/3D points in *WCS*
- **dxfattribs** – additional DXF attributes

**add\_trace** (*points*: Iterable[Union[Sequence[float], *ezdxf.math.\_vector*.Vec2, *ezdxf.math.\_vector*.Vec3]], *dxfattribs*=None) → Trace

Add a *Trace* entity, *points* is an iterable of 3 or 4 points.

---

**Hint:** The last two vertices are in reversed order: a square has the vertex order 0-1-3-2

---

#### Parameters

- **points** – iterable of 3 or 4 2D/3D points in *WCS*
- **dxfattribs** – additional DXF attributes

**add\_3dface** (*points*: Iterable[Union[Sequence[float], *ezdxf.math.\_vector*.Vec2, *ezdxf.math.\_vector*.Vec3]], *dxfattribs*=None) → Face3d

Add a 3DFace entity, *points* is an iterable 3 or 4 2D/3D points.

---

**Hint:** In contrast to SOLID and TRACE, the last two vertices are in regular order: a square has the vertex order 0-1-2-3

---

#### Parameters

- **points** – iterable of 3 or 4 2D/3D points in *WCS*
- **dxfattribs** – additional DXF attributes

---

**add\_text** (*text: str*, \*, *height: Optional[float] = None*, *rotation: Optional[float] = None*, *dxfattribs=None*) → *Text*  
 Add a *Text* entity, see also *Textstyle*.

#### Parameters

- **text** – content string
- **height** – text height in drawing units
- **rotation** – text rotation in degrees
- **dxfattribs** – additional DXF attributes

**add\_blockref** (*name: str*, *insert: Union[Sequence[float], ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3]*, *dxfattribs=None*) → *Insert*  
 Add an *Insert* entity.

When inserting a block reference into the modelspace or another block layout with different units, the scaling factor between these units should be applied as scaling attributes (`xscale`, ...) e.g. modelspace in meters and block in centimeters, `xscale` has to be 0.01.

#### Parameters

- **name** – block name as str
- **insert** – insert location as 2D/3D point in *WCS*
- **dxfattribs** – additional DXF attributes

**add\_auto\_blockref** (*name: str*, *insert: Union[Sequence[float], ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3]*, *values: Dict[str, str]*, *dxfattribs=None*) → *Insert*

Add an *Insert* entity. This method adds for each *Attdef* entity, defined in the block definition, automatically an *Attrib* entity to the block reference and set (tag, value) DXF attributes of the ATTRIB entities by the (key, value) pairs (both as strings) of the *values* dict.

The *Attrib* entities are placed relative to the insert point, which is equal to the block base point.

This method wraps the INSERT and all the ATTRIB entities into an anonymous block, which produces the best visual results, especially for non uniform scaled block references, because the transformation and scaling is done by the CAD application. But this makes evaluation of block references with attributes more complicated, if you prefer INSERT and ATTRIB entities without a wrapper block use the `add_blockref_with_attribs()` method.

#### Parameters

- **name** – block name
- **insert** – insert location as 2D/3D point in *WCS*
- **values** – *Attrib* tag values as (tag, value) pairs
- **dxfattribs** – additional DXF attributes

**add\_attdef** (*tag: str*, *insert: Union[Sequence[float], ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3] = (0, 0)*, *text: str = ", "*, *height: Optional[float] = None*, *rotation: Optional[float] = None*, *dxfattribs=None*) → *AttDef*  
 Add an *AttDef* as stand alone DXF entity.

Set position and alignment by the idiom:

```
layout.add_attdef("NAME").set_placement(
    (2, 3), align=TextEntityAlignment.MIDDLE_CENTER
)
```

### Parameters

- **tag** – tag name as string
- **insert** – insert location as 2D/3D point in *WCS*
- **text** – tag value as string
- **height** – text height in drawing units
- **rotation** – text rotation in degrees
- **dxfattribs** – additional DXF attributes

```
add polyline2d(points:           Iterable[Union[Sequence[float],      ezdxf.math._vector.Vec2,
                                                ezdxf.math._vector.Vec3]], format: Optional[str] = None, *, close: bool =
                                                False, dxfattribs=None) → Polyline
```

Add a 2D *Polyline* entity.

### Parameters

- **points** – iterable of 2D points in *WCS*
- **close** – True for a closed polyline
- **format** – user defined point format like `add_lwpolyline()`, default is None
- **dxfattribs** – additional DXF attributes

```
add polyline3d(points:           Iterable[Union[Sequence[float],      ezdxf.math._vector.Vec2,
                                                ezdxf.math._vector.Vec3]], *, close: bool = False, dxfattribs=None) → Polyline
```

Add a 3D *Polyline* entity.

### Parameters

- **points** – iterable of 3D points in *WCS*
- **close** – True for a closed polyline
- **dxfattribs** – additional DXF attributes

```
add polymesh(size: Tuple[int, int] = (3, 3), dxfattribs=None) → Polymesh
```

Add a *Polymesh* entity, which is a wrapper class for the POLYLINE entity. A polymesh is a grid of *mcount* x *ncount* vertices and every vertex has its own (x, y, z)-coordinates.

### Parameters

- **size** – 2-tuple (*mcount*, *ncount*)
- **dxfattribs** – additional DXF attributes

```
add polyface(dxfattribs=None) → Polyface
```

Add a *Polyface* entity, which is a wrapper class for the POLYLINE entity.

**Parameters** **dxfattribs** – additional DXF attributes for *Polyline* entity

```
add shape(name: str, insert: Union[Sequence[float],      ezdxf.math._vector.Vec2,
                                         ezdxf.math._vector.Vec3] = (0, 0), size: float = 1.0, dxfattribs=None) → Shape
```

Add a *Shape* reference to a external stored shape.

### Parameters

- **name** – shape name as string
- **insert** – insert location as 2D/3D point in *WCS*
- **size** – size factor

- **dxfattribs** – additional DXF attributes

```
add_lwpolyline(points: Iterable[Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3]], format: str = 'xyseb', *, close: bool = False, dxfattribs=None) → LWPolyline
```

Add a 2D polyline as [LWPolyline](#) entity. A points are defined as (x, y, [start\_width, [end\_width, [bulge]]]) tuples, but order can be redefined by the *format* argument. Set *start\_width*, *end\_width* to 0 to be ignored like (x, y, 0, 0, bulge).

The [LWPolyline](#) is defined as a single DXF entity and needs less disk space than a [Polyline](#) entity. (requires DXF R2000)

Format codes:

- x = x-coordinate
- y = y-coordinate
- s = start width
- e = end width
- b = bulge value
- v = (x, y [,z]) tuple (z-axis is ignored)

#### Parameters

- **points** – iterable of (x, y, [start\_width, [end\_width, [bulge]]]) tuples
- **format** – user defined point format, default is “xyseb”
- **close** – True for a closed polyline
- **dfattribs** – additional DXF attributes

```
add_mtext(text: str, dfattribs=None) → MText
```

Add a multiline text entity with automatic text wrapping at boundaries as [MText](#) entity. (requires DXF R2000)

#### Parameters

- **text** – content string
- **dfattribs** – additional DXF attributes

```
add_mtext_static_columns(content: Iterable[str], width: float, gutter_width: float, height: float, dfattribs=None) → MText
```

Add a multiline text entity with static columns as [MText](#) entity. The content is spread across the columns, the count of content strings determine the count of columns.

This factory method adds automatically a column break "\N" at the end of each column text to force a new column. The *height* attribute should be big enough to reserve enough space for the tallest column. Too small values produce valid DXF files, but the visual result will not be as expected. The *height* attribute also defines the total height of the MTEXT entity.

(requires DXF R2000)

#### Parameters

- **content** – iterable of column content
- **width** – column width
- **gutter\_width** – distance between columns

- **height** – max. column height
- **dxfattribs** – additional DXF attributes

New in version 0.17.

```
add_mtext_dynamic_manual_height_columns(content: str, width: float, gutter_width: float,  
heights: Sequence[float], dxfattribs=None)
```

→ MText

Add a multiline text entity with dynamic columns as `MText` entity. The content is spread across the columns automatically by the CAD application. The `heights` sequence determine the height of the columns, except for the last column, which always takes the remaining content. The height value for the last column is required but can be 0, because the value is ignored. The count of `heights` also determines the count of columns, and `max(heights)` defines the total height of the MTEXT entity, which may be wrong if the last column requires more space.

This current implementation works best for DXF R2018, because the content is stored as a continuous text in a single MTEXT entity. For DXF versions prior to R2018 the content should be distributed across multiple MTEXT entities (one entity per column), which is not done by `ezdxf`, but the result is correct for advanced DXF viewers and CAD application, which do the MTEXT content distribution completely by itself.

(requires DXF R2000)

#### Parameters

- **content** – column content as a single string
- **width** – column width
- **gutter\_width** – distance between columns
- **heights** – column height for each column
- **dxfattribs** – additional DXF attributes

New in version 0.17.

```
add_mtext_dynamic_auto_height_columns(content: str, width: float, gutter_width: float,  
height: float, count: int, dxfattribs=None) →  
MText
```

Add a multiline text entity with as much columns as needed for the given common fixed `height`. The content is spread across the columns automatically by the CAD application. The `height` argument also defines the total height of the MTEXT entity. To get the correct column `count` requires an **exact** MTEXT rendering like AutoCAD, which is not done by `ezdxf`, therefore passing the expected column `count` is required to calculate the correct total width.

This current implementation works best for DXF R2018, because the content is stored as a continuous text in a single MTEXT entity. For DXF versions prior to R2018 the content should be distributed across multiple MTEXT entities (one entity per column), which is not done by `ezdxf`, but the result is correct for advanced DXF viewers and CAD application, which do the MTEXT content distribution completely by itself.

Because of the current limitations the use of this method is not recommended. This situation may improve in future releases, but the exact rendering of the content will also slow down the processing speed dramatically.

(requires DXF R2000)

#### Parameters

- **content** – column content as a single string
- **width** – column width

- **gutter\_width** – distance between columns
- **height** – max. column height
- **count** – expected column count
- **dxfattribs** – additional DXF attributes

New in version 0.17.

**add\_ray** (*start*: Union[Sequence[float], ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3], *unit\_vector*: Union[Sequence[float], ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3], *dxfattribs*=None) → Ray  
Add a [Ray](#) that begins at *start* point and continues to infinity (construction line). (requires DXF R2000)

#### Parameters

- **start** – location 3D point in [WCS](#)
- **unit\_vector** – 3D vector (x, y, z)
- **dxfattribs** – additional DXF attributes

**add\_xline** (*start*: Union[Sequence[float], ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3], *unit\_vector*: Union[Sequence[float], ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3], *dxfattribs*=None) → XLine  
Add an infinity [XLine](#) (construction line). (requires DXF R2000)

#### Parameters

- **start** – location 3D point in [WCS](#)
- **unit\_vector** – 3D vector (x, y, z)
- **dxfattribs** – additional DXF attributes

**add\_mline** (*vertices*: Optional[Iterable[Union[Sequence[float], ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3]]] = None, *\**, *close*: bool = False, *dxfattribs*=None) → MLine  
Add a [MLine](#) entity

#### Parameters

- **vertices** – MLINE vertices (in [WCS](#))
- **close** – True to add a closed MLINE
- **dxfattribs** – additional DXF attributes

**add\_spline** (*fit\_points*: Optional[Iterable[Union[Sequence[float], ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3]]] = None, *degree*: int = 3, *dxfattribs*=None) → ezdxf.entities.spline.Spline  
Add a B-spline ([Spline](#) entity) defined by the given *fit\_points* - the control points and knot values are created by the CAD application, therefore it is not predictable how the rendered spline will look like, because for every set of fit points exists an infinite set of B-splines.

If *fit\_points* is None, an “empty” spline will be created, all data has to be set by the user.

The SPLINE entity requires DXF R2000.

AutoCAD creates a spline through fit points by a global curve interpolation and an unknown method to estimate the direction of the start- and end tangent.

#### See also:

- [Tutorial for Spline](#)

- `ezdxf.math.fit_points_to_cad_cv()`

#### Parameters

- **fit\_points** – iterable of fit points as (x, y[, z]) in `WCS`, creates an empty `Spline` if None
- **degree** – degree of B-spline, max. degree supported by AutoCAD is 11
- **dxfattribs** – additional DXF attributes

```
add_cad_spline_control_frame(fit_points: Iterable[Union[Sequence[float],  
          eздxf.math._vector.Vec2, eздxf.math._vector.Vec3]]],  
                           tangents: Optional[Iterable[Union[Sequence[float],  
          eздxf.math._vector.Vec2, eздxf.math._vector.Vec3]]]]  
                           = None, estimate: str = '5-p', dxfattribs=None) →  
          eздxf.entities.spline.Spline
```

Add a `Spline` entity passing through the given fit points. This method tries to create the same curve as CAD applications do. To understand the limitations and for more information see function `ezdxf.math.fit_points_to_cad_cv()`.

#### Parameters

- **fit\_points** – iterable of fit points as (x, y[, z]) in `WCS`
- **tangents** – start- and end tangent, default is autodetect
- **estimate** – tangent direction estimation method
- **dxfattribs** – additional DXF attributes

```
add_spline_control_frame(fit_points: Iterable[Union[Sequence[float],  
          eздxf.math._vector.Vec2, eздxf.math._vector.Vec3]], degree:  
                           int = 3, method: str = 'chord', dxfattribs=None) →  
          eздxf.entities.spline.Spline
```

Add a `Spline` entity passing through the given `fit_points`, the control points are calculated by a global curve interpolation without start- and end tangent constrains. The new SPLINE entity is defined by control points and not by the fit points, therefore the SPLINE looks always the same, no matter which CAD application renders the SPLINE.

- “uniform”: creates a uniform t vector, from 0 to 1 evenly spaced, see `uniform` method
- “distance”, “chord”: creates a t vector with values proportional to the fit point distances, see `chord length` method
- “centripetal”, “sqrt\_chord”: creates a t vector with values proportional to the fit point sqrt(distances), see `centripetal` method
- “arc”: creates a t vector with values proportional to the arc length between fit points.

Use function `add_cad_spline_control_frame()` to create SPLINE entities from fit points similar to CAD application including start- and end tangent constraints.

#### Parameters

- **fit\_points** – iterable of fit points as (x, y[, z]) in `WCS`
- **degree** – degree of B-spline, max. degree supported by AutoCAD is 11
- **method** – calculation method for parameter vector t
- **dxfattribs** – additional DXF attributes

---

```
add_open_spline(control_points: Iterable[Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3]], degree: int = 3, knots: Optional[Iterable[float]] = None, dxfattribs=None) → ezdxf.entities.spline.Spline
```

Add an open uniform [Spline](#) defined by *control\_points*. (requires DXF R2000)

Open uniform B-splines start and end at your first and last control point.

#### Parameters

- **control\_points** – iterable of 3D points in [WCS](#)
- **degree** – degree of B-spline, max. degree supported by AutoCAD is 11
- **knots** – knot values as iterable of floats
- **dfattribs** – additional DXF attributes

```
add_rational_spline(control_points: Iterable[Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3]], weights: Sequence[float], degree: int = 3, knots: Optional[Iterable[float]] = None, dxfattribs=None) → ezdxf.entities.spline.Spline
```

Add an open rational uniform [Spline](#) defined by *control\_points*. (requires DXF R2000)

*weights* has to be an iterable of floats, which defines the influence of the associated control point to the shape of the B-spline, therefore for each control point is one weight value required.

Open rational uniform B-splines start and end at the first and last control point.

#### Parameters

- **control\_points** – iterable of 3D points in [WCS](#)
- **weights** – weight values as iterable of floats
- **degree** – degree of B-spline, max. degree supported by AutoCAD is 11
- **knots** – knot values as iterable of floats
- **dfattribs** – additional DXF attributes

```
add_hatch(color: int = 7, dxfattribs=None) → Hatch
```

Add a [Hatch](#) entity. (requires DXF R2000)

#### Parameters

- **color** – fill color as :ref:`ACI`, default is 7 (black/white).
- **dfattribs** – additional DXF attributes

```
add_helix(radius: float, pitch: float, turns: float, ccw=True, dxfattribs=None) → Helix
```

Add a [Helix](#) entity.

The center of the helix is always (0, 0, 0) and the helix axis direction is the +z-axis.

Transform the new HELIX by the [transform\(\)](#) method to your needs.

#### Parameters

- **radius** – helix radius
- **pitch** – the height of one complete helix turn
- **turns** – count of turns
- **ccw** – creates a counter-clockwise turning (right-handed) helix if True
- **dfattribs** – additional DXF attributes

New in version 0.18.

**add\_mpolygon** (*color: int = 256, fill\_color: Optional[int] = None, dxfattribs=None*) → MPolygon  
Add a [MPolygon](#) entity. (requires DXF R2000)

The MPOLYGON entity is not a core DXF entity and is not supported by every CAD application or DXF library.

DXF version R2004+ is required to use a fill color different from BYLAYER. For R2000 the fill color is always BYLAYER, set any ACI value to create a filled MPOLYGON entity.

#### Parameters

- **color** – boundary color as *AutoCAD Color Index (ACI)*, default is BYLAYER.
- **fill\_color** – fill color as *AutoCAD Color Index (ACI)*, default is None
- **dfattribs** – additional DXF attributes

**add\_mesh** (*dfattribs=None*) → Mesh

Add a [Mesh](#) entity. (requires DXF R2007)

#### Parameters **dfattribs** – additional DXF attributes

**add\_image** (*image\_def: ImageDef, insert: Union[Sequence[float], ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3], size\_in\_units: Tuple[float, float], rotation: float = 0.0, dfattribs=None*) → Image

Add an [Image](#) entity, requires a [ImageDef](#) entity, see [Tutorial for Image and ImageDef](#). (requires DXF R2000)

#### Parameters

- **image\_def** – required image definition as [ImageDef](#)
- **insert** – insertion point as 3D point in [WCS](#)
- **size\_in\_units** – size as (x, y) tuple in drawing units
- **rotation** – rotation angle around the extrusion axis, default is the z-axis, in degrees
- **dfattribs** – additional DXF attributes

**add\_wipeout** (*vertices: Iterable[Union[Sequence[float], ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3]], dfattribs=None*) → Wipeout

Add a [ezdxf.entities.Wipeout](#) entity, the masking area is defined by WCS *vertices*.

This method creates only a 2D entity in the xy-plane of the layout, the z-axis of the input vertices are ignored.

**add\_underlay** (*underlay\_def: UnderlayDefinition, insert: Union[Sequence[float], ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3] = (0, 0, 0), scale=(1, 1, 1), rotation: float = 0.0, dfattribs=None*) → Underlay

Add an [Underlay](#) entity, requires a [UnderlayDefinition](#) entity, see [Tutorial for Underlay and UnderlayDefinition](#). (requires DXF R2000)

#### Parameters

- **underlay\_def** – required underlay definition as [UnderlayDefinition](#)
- **insert** – insertion point as 3D point in [WCS](#)
- **scale** – underlay scaling factor as (x, y, z) tuple or as single value for uniform scaling for x, y and z
- **rotation** – rotation angle around the extrusion axis, default is the z-axis, in degrees
- **dfattribs** – additional DXF attributes

```
add_linear_dim(base: Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3],
               p1: Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3], p2:
               Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3], location:
               Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3,
               None] = None, text: str = '<>', angle: float = 0, text_rotation: Optional[float]
               = None, dimstyle: str = 'EZDXF', override: Optional[Dict[KT, VT]] = None, dx-
               fattribs=None) → DimStyleOverride
```

Add horizontal, vertical and rotated [Dimension](#) line. If an [UCS](#) is used for dimension line rendering, all point definitions in UCS coordinates, translation into [WCS](#) and [OCS](#) is done by the rendering function. Extrusion vector is defined by UCS or (0, 0, 1) by default. See also: [Tutorial for Linear Dimensions](#)

This method returns a [DimStyleOverride](#) object - to create the necessary dimension geometry, you have to call [render\(\)](#) manually, this two step process allows additional processing steps on the [Dimension](#) entity between creation and rendering.

---

**Note:** *Ezdx*f does not consider all DIMSTYLE variables, so the rendering results are different from CAD applications.

---

### Parameters

- **base** – location of dimension line, any point on the dimension line or its extension will do (in UCS)
- **p1** – measurement point 1 and start point of extension line 1 (in UCS)
- **p2** – measurement point 2 and start point of extension line 2 (in UCS)
- **location** – user defined location for text mid point (in UCS)
- **text** – None or “<>” the measurement is drawn as text, ” ” (a single space) suppresses the dimension text, everything else *text* is drawn as dimension text
- **dimstyle** – dimension style name ([DimStyle](#) table entry), default is “EZDXF”
- **angle** – angle from ucs/wcs x-axis to dimension line in degrees
- **text\_rotation** – rotation angle of the dimension text as absolute angle (x-axis=0, y-axis=90) in degrees
- **override** – [DimStyleOverride](#) attributes
- **dxfattribs** – additional DXF attributes for the DIMENSION entity

Returns: [DimStyleOverride](#)

```
add_multi_point_linear_dim(base: Union[Sequence[float], ezdxf.math._vector.Vec2,
                                         ezdxf.math._vector.Vec3], points: Iterable[Union[Sequence[float],
                                         ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3]], angle: float = 0, ucs: Optional[UCS]
                                         = None, avoid_double_rendering: bool = True, dimstyle: str = 'EZDXF', override: Optional[Dict[KT, VT]] = None,
                                         dxfattribs=None, discard=False) → None
```

Add multiple linear dimensions for iterable *points*. If an [UCS](#) is used for dimension line rendering, all point definitions in UCS coordinates, translation into [WCS](#) and [OCS](#) is done by the rendering function. Extrusion vector is defined by UCS or (0, 0, 1) by default. See also: [Tutorial for Linear Dimensions](#)

This method sets many design decisions by itself, the necessary geometry will be generated automatically, no required nor possible [render\(\)](#) call. This method is easy to use but you get what you get.

---

**Note:** *Ezdx*f does not consider all DIMSTYLE variables, so the rendering results are different from CAD applications.

---

### Parameters

- **base** – location of dimension line, any point on the dimension line or its extension will do (in UCS)
- **points** – iterable of measurement points (in UCS)
- **angle** – angle from ucs/wcs x-axis to dimension line in degrees (0 = horizontal, 90 = vertical)
- **ucs** – user defined coordinate system
- **avoid\_double\_rendering** – suppresses the first extension line and the first arrow if possible for continued dimension entities
- **dimstyle** – dimension style name (DimStyle table entry), default is “EZDXF”
- **override** – *DimStyleOverride* attributes
- **dxfattribs** – additional DXF attributes for the DIMENSION entity
- **discard** – discard rendering result for friendly CAD applications like BricsCAD to get a native and likely better rendering result. (does not work with AutoCAD)

```
add_aligned_dim(p1: Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3],  
                p2: Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3],  
                distance: float, text: str = '<>', dimstyle: str = 'EZDXF', override: Optional[Dict[KT, VT]] = None, dxfattribs=None) → DimStyleOverride
```

Add linear dimension aligned with measurement points *p1* and *p2*. If an *UCS* is used for dimension line rendering, all point definitions in UCS coordinates, translation into *WCS* and *OCS* is done by the rendering function. Extrusion vector is defined by UCS or (0, 0, 1) by default. See also: [Tutorial for Linear Dimensions](#)

This method returns a *DimStyleOverride* object, to create the necessary dimension geometry, you have to call *DimStyleOverride.render()* manually, this two step process allows additional processing steps on the *Dimension* entity between creation and rendering.

---

**Note:** *Ezdx*f does not consider all DIMSTYLE variables, so the rendering results are different from CAD applications.

---

### Parameters

- **p1** – measurement point 1 and start point of extension line 1 (in UCS)
- **p2** – measurement point 2 and start point of extension line 2 (in UCS)
- **distance** – distance of dimension line from measurement points
- **text** – `None` or “<>” the measurement is drawn as text, “ ” (a single space) suppresses the dimension text, everything else *text* is drawn as dimension text
- **dimstyle** – dimension style name (*DimStyle* table entry), default is “EZDXF”
- **override** – *DimStyleOverride* attributes
- **dxfattribs** – additional DXF attributes for the DIMENSION entity

Returns: `DimStyleOverride`

```
add_radius_dim(center: Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3],
    mpoint: Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3,
    None] = None, radius: Optional[float] = None, angle: Optional[float]
    = None, *, location: Union[Sequence[float], ezdxf.math._vector.Vec2,
    ezdxf.math._vector.Vec3, None] = None, text: str = '<>', dimstyle: str =
    'EZ_RADIUS', override: Optional[Dict[KT, VT]] = None, dxftattribs=None) →
DimStyleOverride
```

Add a radius `Dimension` line. The radius dimension line requires a `center` point and a point `mpoint` on the circle or as an alternative a `radius` and a dimension line `angle` in degrees. See also: [Tutorial for Radius Dimensions](#)

If an `UCS` is used for dimension line rendering, all point definitions in UCS coordinates, translation into `WCS` and `OCS` is done by the rendering function. Extrusion vector is defined by UCS or (0, 0, 1) by default.

This method returns a `DimStyleOverride` object - to create the necessary dimension geometry, you have to call `render()` manually, this two step process allows additional processing steps on the `Dimension` entity between creation and rendering.

Following render types are supported:

- Default text location outside: text aligned with dimension line; dimension style: “EZ\_RADIUS”
- Default text location outside horizontal: “EZ\_RADIUS” + dimtoh=1
- Default text location inside: text aligned with dimension line; dimension style: “EZ\_RADIUS\_INSIDE”
- Default text location inside horizontal: “EZ\_RADIUS\_INSIDE” + dimtih=1
- User defined text location: argument `location` != `None`, text aligned with dimension line; dimension style: “EZ\_RADIUS”
- User defined text location horizontal: argument `location` != `None`, “EZ\_RADIUS” + dimtoh=1 for text outside horizontal, “EZ\_RADIUS” + dimtih=1 for text inside horizontal

Placing the dimension text at a user defined `location`, overrides the `mpoint` and the `angle` argument, but requires a given `radius` argument. The `location` argument does not define the exact text location, instead it defines the dimension line starting at `center` and the measurement text midpoint projected on this dimension line going through `location`, if text is aligned to the dimension line. If text is horizontal, `location` is the kink point of the dimension line from radial to horizontal direction.

---

**Note:** Ezdxf does not consider all DIMSTYLE variables, so the rendering results are different from CAD applications.

---

## Parameters

- `center` – center point of the circle (in UCS)
- `mpoint` – measurement point on the circle, overrides `angle` and `radius` (in UCS)
- `radius` – radius in drawing units, requires argument `angle`
- `angle` – specify angle of dimension line in degrees, requires argument `radius`
- `location` – user defined dimension text location, overrides `mpoint` and `angle`, but requires `radius` (in UCS)
- `text` – `None` or “<>” the measurement is drawn as text, “ ” (a single space) suppresses the dimension text, everything else `text` is drawn as dimension text

- **dimstyle** – dimension style name (*DimStyle* table entry), default is “EZ\_RADIUS”
- **override** – *DimStyleOverride* attributes
- **dxfattribs** – additional DXF attributes for the DIMENSION entity

Returns: *DimStyleOverride*

```
add_radius_dim_2p (center: Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3], mpoint: Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3], *, text: str = '<>', dimstyle: str = 'EZ_RADIUS', override: Optional[Dict[KT, VT]] = None, dxfattribs=None) → DimStyleOverride
```

Shortcut method to create a radius dimension by center point, measurement point on the circle and the measurement text at the default location defined by the associated *dimstyle*, for further information see general method [add\\_radius\\_dim\(\)](#).

- dimstyle “EZ\_RADIUS”: places the dimension text outside
- dimstyle “EZ\_RADIUS\_INSIDE”: places the dimension text inside

#### Parameters

- **center** – center point of the circle (in UCS)
- **mpoint** – measurement point on the circle (in UCS)
- **text** – None or “<>” the measurement is drawn as text, “ ” (a single space) suppresses the dimension text, everything else *text* is drawn as dimension text
- **dimstyle** – dimension style name (*DimStyle* table entry), default is “EZ\_RADIUS”
- **override** – *DimStyleOverride* attributes
- **dxfattribs** – additional DXF attributes for the DIMENSION entity

Returns: *DimStyleOverride*

```
add_radius_dim_cra (center: Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3], radius: float, angle: float, *, text: str = '<>', dimstyle: str = 'EZ_RADIUS', override: Optional[Dict[KT, VT]] = None, dxfattribs=None) → DimStyleOverride
```

Shortcut method to create a radius dimension by (c)enter point, (r)adius and (a)ngle, the measurement text is placed at the default location defined by the associated *dimstyle*, for further information see general method [add\\_radius\\_dim\(\)](#).

- dimstyle “EZ\_RADIUS”: places the dimension text outside
- dimstyle “EZ\_RADIUS\_INSIDE”: places the dimension text inside

#### Parameters

- **center** – center point of the circle (in UCS)
- **radius** – radius in drawing units
- **angle** – angle of dimension line in degrees
- **text** – None or “<>” the measurement is drawn as text, “ ” (a single space) suppresses the dimension text, everything else *text* is drawn as dimension text
- **dimstyle** – dimension style name (*DimStyle* table entry), default is “EZ\_RADIUS”
- **override** – *DimStyleOverride* attributes

- **dxfattribs** – additional DXF attributes for the DIMENSION entity

Returns: `DimStyleOverride`

```
add_diameter_dim(center: Union[Sequence[float], ezdxf.math._vector.Vector[Vec2, Vec3]], mpoint: Union[Sequence[float], ezdxf.math._vector.Vector[Vec2, Vec3, None]], radius: Optional[float] = None, angle: Optional[float] = None, *, location: Union[Sequence[float], ezdxf.math._vector.Vector[Vec2, Vec3, None]], text: str = '<>', dimstyle: str = 'EZ_RADIUS', override: Optional[Dict[KT, VT]] = None, dxfattribs=None) → DimStyleOverride
```

Add a diameter `Dimension` line. The diameter dimension line requires a `center` point and a point `mpoint` on the circle or as an alternative a `radius` and a dimension line `angle` in degrees.

If an `UCS` is used for dimension line rendering, all point definitions in UCS coordinates, translation into `WCS` and `OCS` is done by the rendering function. Extrusion vector is defined by UCS or (0, 0, 1) by default.

This method returns a `DimStyleOverride` object - to create the necessary dimension geometry, you have to call `render()` manually, this two step process allows additional processing steps on the `Dimension` entity between creation and rendering.

---

**Note:** Ezdxf does not consider all DIMSTYLE variables, so the rendering results are different from CAD applications.

---

## Parameters

- **center** – specifies the center of the circle (in UCS)
- **mpoint** – specifies the measurement point on the circle (in UCS)
- **radius** – specify radius, requires argument `angle`, overrides `p1` argument
- **angle** – specify angle of dimension line in degrees, requires argument `radius`, overrides `p1` argument
- **location** – user defined location for text mid point (in UCS)
- **text** – `None` or "`<>`" the measurement is drawn as text, " " (a single space) suppresses the dimension text, everything else `text` is drawn as dimension text
- **dimstyle** – dimension style name (`DimStyle` table entry), default is "EZ\_RADIUS"
- **override** – `DimStyleOverride` attributes
- **dfattribs** – additional DXF attributes for the DIMENSION entity

Returns: `DimStyleOverride`

```
add_diameter_dim_2p(p1: Union[Sequence[float], ezdxf.math._vector.Vector[Vec2, Vec3]], p2: Union[Sequence[float], ezdxf.math._vector.Vector[Vec2, Vec3]], text: str = '<>', dimstyle: str = 'EZ_RADIUS', override: Optional[Dict[KT, VT]] = None, dfattribs=None) → DimStyleOverride
```

Shortcut method to create a diameter dimension by two points on the circle and the measurement text at the default location defined by the associated `dimstyle`, for further information see general method `add_diameter_dim()`. Center point of the virtual circle is the mid point between `p1` and `p2`.

- dimstyle "EZ\_RADIUS": places the dimension text outside
- dimstyle "EZ\_RADIUS\_INSIDE": places the dimension text inside

## Parameters

- **p1** – first point of the circle (in UCS)
- **p2** – second point on the opposite side of the center point of the circle (in UCS)
- **text** – None or “<>” the measurement is drawn as text, ” ” (a single space) suppresses the dimension text, everything else *text* is drawn as dimension text
- **dimstyle** – dimension style name (*DimStyle* table entry), default is “EZ\_RADIUS”
- **override** – *DimStyleOverride* attributes
- **dxfattribs** – additional DXF attributes for the DIMENSION entity

Returns: *DimStyleOverride*

```
add_angular_dim_2l(base: Union[Sequence[float], ezdxf.math._vector.Vec2,
                                ezdxf.math._vector.Vec3], line1: Tuple[Union[Sequence[float],
                                ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3], Union[Sequence[float],
                                ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3]], line2:
                                Tuple[Union[Sequence[float], ezdxf.math._vector.Vec2,
                                ezdxf.math._vector.Vec3], Union[Sequence[float], ezdxf.math._vector.Vec2,
                                ezdxf.math._vector.Vec3]], *, location: Union[Sequence[float],
                                ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3, None] = None, text: str =
                                '<>', text_rotation: Optional[float] = None, dimstyle: str = 'EZ_CURVED',
                                override: Optional[Dict[KT, VT]] = None, dxfattribs=None) → Dim-
                                StyleOverride
```

Add angular *Dimension* from 2 lines. The measurement is always done from *line1* to *line2* in counter clockwise orientation. This does not always match the result in CAD applications!

If an *UCS* is used for angular dimension rendering, all point definitions in UCS coordinates, translation into *WCS* and *OCS* is done by the rendering function. Extrusion vector is defined by UCS or (0, 0, 1) by default.

This method returns a *DimStyleOverride* object - to create the necessary dimension geometry, you have to call *render()* manually, this two step process allows additional processing steps on the *Dimension* entity between creation and rendering.

---

**Note:** Ezdxf does not consider all DIMSTYLE variables, so the rendering results are different from CAD applications.

---

## Parameters

- **base** – location of dimension line, any point on the dimension line or its extension is valid (in UCS)
- **line1** – specifies start leg of the angle (start point, end point) and determines extension line 1 (in UCS)
- **line2** – specifies end leg of the angle (start point, end point) and determines extension line 2 (in UCS)
- **location** – user defined location for text mid point (in UCS)
- **text** – None or “<>” the measurement is drawn as text, ” ” (a single space) suppresses the dimension text, everything else *text* is drawn as dimension text
- **text\_rotation** – rotation angle of the dimension text as absolute angle (x-axis=0, y-axis=90) in degrees

- **dimstyle** – dimension style name ([DimStyle](#) table entry), default is “EZ\_CURVED”
- **override** – [DimStyleOverride](#) attributes
- **dxfattribs** – additional DXF attributes for the DIMENSION entity

Returns: [DimStyleOverride](#)

New in version v0.18.

```
add_angular_dim_3p(base: Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3], center: Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3], p1: Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3], p2: Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3], *, location: Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3, None] = None, text: str = '<>', text_rotation: Optional[float] = None, dimstyle: str = 'EZ_CURVED', override: Optional[Dict[KT, VT]] = None, dxfattribs=None) → DimStyleOverride
```

Add angular [Dimension](#) from 3 points (center, p1, p2). The measurement is always done from p1 to p2 in counter clockwise orientation. This does not always match the result in CAD applications!

If an [UCS](#) is used for angular dimension rendering, all point definitions in UCS coordinates, translation into [WCS](#) and [OCS](#) is done by the rendering function. Extrusion vector is defined by UCS or (0, 0, 1) by default.

This method returns a [DimStyleOverride](#) object - to create the necessary dimension geometry, you have to call [render\(\)](#) manually, this two step process allows additional processing steps on the [Dimension](#) entity between creation and rendering.

---

**Note:** Ezdxf does not consider all DIMSTYLE variables, so the rendering results are different from CAD applications.

---

## Parameters

- **base** – location of dimension line, any point on the dimension line or its extension is valid (in UCS)
- **center** – specifies the vertex of the angle
- **p1** – specifies start leg of the angle (center -> p1) and end point of extension line 1 (in UCS)
- **p2** – specifies end leg of the angle (center -> p2) and end point of extension line 2 (in UCS)
- **location** – user defined location for text mid point (in UCS)
- **text** – None or “<>” the measurement is drawn as text, ” ” (a single space) suppresses the dimension text, everything else *text* is drawn as dimension text
- **text\_rotation** – rotation angle of the dimension text as absolute angle (x-axis=0, y-axis=90) in degrees
- **dimstyle** – dimension style name ([DimStyle](#) table entry), default is “EZ\_CURVED”
- **override** – [DimStyleOverride](#) attributes
- **dxfattribs** – additional DXF attributes for the DIMENSION entity

Returns: *DimStyleOverride*

New in version v0.18.

```
add_angular_dim_cra(center: Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3], radius: float, start_angle: float, end_angle: float, distance: float, *, location: Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3, None] = None, text: str = '<>', text_rotation: Optional[float] = None, dimstyle: str = 'EZ_CURVED', override: Optional[Dict[KT, VT]] = None, dxfattribs=None) → DimStyleOverride
```

Shortcut method to create an angular dimension by (c)enter point, (r)adius and start- and end (a)ngles, the measurement text is placed at the default location defined by the associated *dimstyle*. The measurement is always done from *start\_angle* to *end\_angle* in counter clockwise orientation. This does not always match the result in CAD applications! For further information see the more generic factory method *add\_angular\_dim\_3p()*.

#### Parameters

- **center** – center point of the angle (in UCS)
- **radius** – the distance from *center* to the start of the extension lines in drawing units
- **start\_angle** – start angle in degrees (in UCS)
- **end\_angle** – end angle in degrees (in UCS)
- **distance** – distance from start of the extension lines to the dimension line in drawing units
- **location** – user defined location for text mid point (in UCS)
- **text** – None or “<>” the measurement is drawn as text, ” ” (a single space) suppresses the dimension text, everything else *text* is drawn as dimension text
- **text\_rotation** – rotation angle of the dimension text as absolute angle (x-axis=0, y-axis=90) in degrees
- **dimstyle** – dimension style name (*DimStyle* table entry), default is “EZ\_CURVED”
- **override** – *DimStyleOverride* attributes
- **dxfattribs** – additional DXF attributes for the DIMENSION entity

Returns: *DimStyleOverride*

New in version v0.18.

```
add_angular_dim_arc(arc: ezdxf.math.arc.ConstructionArc, distance: float, *, location: Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3, None] = None, text: str = '<>', text_rotation: Optional[float] = None, dimstyle: str = 'EZ_CURVED', override: Optional[Dict[KT, VT]] = None, dxfattribs=None) → DimStyleOverride
```

Shortcut method to create an angular dimension from a *ConstructionArc*. This construction tool can be created from ARC entities and the tool itself provides various construction class methods. The measurement text is placed at the default location defined by the associated *dimstyle*. The measurement is always done from *start\_angle* to *end\_angle* of the arc in counter clockwise orientation. This does not always match the result in CAD applications! For further information see the more generic factory method *add\_angular\_dim\_3p()*.

#### Parameters

- **arc** – *ConstructionArc*

- **distance** – distance from start of the extension lines to the dimension line in drawing units
- **location** – user defined location for text mid point (in UCS)
- **text** – None or “<>” the measurement is drawn as text, ” ” (a single space) suppresses the dimension text, everything else *text* is drawn as dimension text
- **text\_rotation** – rotation angle of the dimension text as absolute angle (x-axis=0, y-axis=90) in degrees
- **dimstyle** – dimension style name (*DimStyle* table entry), default is “EZ\_CURVED”
- **override** – *DimStyleOverride* attributes
- **dxfattribs** – additional DXF attributes for the DIMENSION entity

Returns: *DimStyleOverride*

New in version v0.18.

```
add_arc_dim_3p(base: Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3],  
center: Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3],  
p1: Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3], p2:  
Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3], *,  
location: Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3,  
None] = None, text: str = '<>', text_rotation: Optional[float] = None, dimstyle:  
str = 'EZ_CURVED', override: Optional[Dict[KT, VT]] = None, dxfattribs=None)  
→ DimStyleOverride
```

Add *ArcDimension* from 3 points (center, p1, p2). Point *p1* defines the radius and the start angle of the arc, point *p2* only defines the end angle of the arc.

If an *UCS* is used for arc dimension rendering, all point definitions in UCS coordinates, translation into *WCS* and *OCS* is done by the rendering function. Extrusion vector is defined by UCS or (0, 0, 1) by default.

This method returns a *DimStyleOverride* object - to create the necessary dimension geometry, you have to call *render()* manually, this two step process allows additional processing steps on the *ArcDimension* entity between creation and rendering.

---

**Note:** Ezdxf does not render the arc dimension like CAD applications and does not consider all DIMSTYLE variables, so the rendering results are **very** different from CAD applications.

---

## Parameters

- **base** – location of dimension line, any point on the dimension line or its extension is valid (in UCS)
- **center** – specifies the vertex of the angle
- **p1** – specifies the radius (center -> p1) and the star angle of the arc, this is also the start point for the 1st extension line (in UCS)
- **p2** – specifies the end angle of the arc. The start 2nd extension line is defined by this angle and the radius defined by p1 (in UCS)
- **location** – user defined location for text mid point (in UCS)
- **text** – None or “<>” the measurement is drawn as text, ” ” (a single space) suppresses the dimension text, everything else *text* is drawn as dimension text
- **text\_rotation** – rotation angle of the dimension text as absolute angle (x-axis=0, y-axis=90) in degrees

- **dimstyle** – dimension style name (*DimStyle* table entry), default is “EZ\_CURVED”
- **override** – *DimStyleOverride* attributes
- **dxftattribs** – additional DXF attributes for the DIMENSION entity

Returns: *DimStyleOverride*

New in version v0.18.

```
add_arc_dim_cra(center: Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3], radius: float, start_angle: float, end_angle: float, distance: float, *, location: Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3, None] = None, text: str = '<>', text_rotation: Optional[float] = None, dimstyle: str = 'EZ_CURVED', override: Optional[Dict[KT, VT]] = None, dxftattribs=None) → DimStyleOverride
```

Shortcut method to create an arc dimension by (c)enter point, (r)adius and start- and end (a)ngles, the measurement text is placed at the default location defined by the associated *dimstyle*.

---

**Note:** *Ezdx*f does not render the arc dimension like CAD applications and does not consider all DIMSTYLE variables, so the rendering results are **very** different from CAD applications.

---

### Parameters

- **center** – center point of the angle (in UCS)
- **radius** – the distance from *center* to the start of the extension lines in drawing units
- **start\_angle** – start angle in degrees (in UCS)
- **end\_angle** – end angle in degrees (in UCS)
- **distance** – distance from start of the extension lines to the dimension line in drawing units
- **location** – user defined location for text mid point (in UCS)
- **text** – None or “<>” the measurement is drawn as text, ” ” (a single space) suppresses the dimension text, everything else *text* is drawn as dimension text
- **text\_rotation** – rotation angle of the dimension text as absolute angle (x-axis=0, y-axis=90) in degrees
- **dimstyle** – dimension style name (*DimStyle* table entry), default is “EZ\_CURVED”
- **override** – *DimStyleOverride* attributes
- **dxftattribs** – additional DXF attributes for the DIMENSION entity

Returns: *DimStyleOverride*

New in version v0.18.

```
add_arc_dim_arc(arc: ezdxf.math.arc.ConstructionArc, distance: float, *, location: Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3, None] = None, text: str = '<>', text_rotation: Optional[float] = None, dimstyle: str = 'EZ_CURVED', override: Optional[Dict[KT, VT]] = None, dxftattribs=None) → DimStyleOverride
```

Shortcut method to create an arc dimension from a *ConstructionArc*. This construction tool can be created from ARC entities and the tool itself provides various construction class methods. The measurement text is placed at the default location defined by the associated *dimstyle*.

---

**Note:** *Ezdx*f does not render the arc dimension like CAD applications and does not consider all DIMSTYLE variables, so the rendering results are **very** different from CAD applications.

---

### Parameters

- **arc** – *ConstructionArc*
- **distance** – distance from start of the extension lines to the dimension line in drawing units
- **location** – user defined location for text mid point (in UCS)
- **text** – None or “<>” the measurement is drawn as text, “ ” (a single space) suppresses the dimension text, everything else *text* is drawn as dimension text
- **text\_rotation** – rotation angle of the dimension text as absolute angle (x-axis=0, y-axis=90) in degrees
- **dimstyle** – dimension style name (*DimStyle* table entry), default is “EZ\_CURVED”
- **override** – *DimStyleOverride* attributes
- **dxfattribs** – additional DXF attributes for the DIMENSION entity

Returns: *DimStyleOverride*

New in version v0.18.

```
add_ordinate_dim(feature_location: Union[Sequence[float], ezdxf.math._vector.Vec2,
                                         ezdxf.math._vector.Vec3], offset: Union[Sequence[float],
                                         ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3], dtype: int, *, origin:
                                         Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3] =
                                         Vec3(0.0, 0.0, 0.0), rotation: float = 0.0, text: str = '<>', dimstyle: str =
                                         'EZDXF', override: Optional[Dict[KT, VT]] = None, dxfattribs=None) →
                                         ezdxf.entities.dimstyleoverride.DimStyleOverride
```

Add an ordinate type *Dimension* line. The feature location is defined in the global coordinate system, which is set as render UCS, which is the *WCS* by default.

If an *UCS* is used for dimension line rendering, all point definitions in UCS coordinates, translation into *WCS* and *OCS* is done by the rendering function. Extrusion vector is defined by UCS or (0, 0, 1) by default.

This method returns a *DimStyleOverride* object - to create the necessary dimension geometry, you have to call *render()* manually, this two step process allows additional processing steps on the *Dimension* entity between creation and rendering.

---

**Note:** *Ezdx*f does not consider all DIMSTYLE variables, so the rendering results are different from CAD applications.

---

### Parameters

- **feature\_location** – feature location in the global coordinate system (UCS)
- **offset** – offset vector of leader end point from the feature location in the local coordinate system
- **dtype** – 1 = x-type, 0 = y-type
- **origin** – specifies the origin (0, 0) of the local coordinate system in UCS

- **rotation** – rotation angle of the local coordinate system in degrees
- **text** – `None` or “`<>`” the measurement is drawn as text, “ ” (a single space) suppresses the dimension text, everything else `text` is drawn as dimension text
- **dimstyle** – dimension style name (`DimStyle` table entry), default is “EZDXF”
- **override** – `DimStyleOverride` attributes
- **dxfattribs** – additional DXF attributes for the DIMENSION entity

Returns: `DimStyleOverride`

New in version v0.18.

```
add_ordinate_x_dim(feature_location: Union[Sequence[float], ezdxf.math._vector.Vec2,
                                             ezdxf.math._vector.Vec3], offset: Union[Sequence[float],
                                             ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3], *, origin:
                                             Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3] =
                                             Vec3(0.0, 0.0, 0.0), rotation: float = 0.0, text: str = '<>', dimstyle: str =
                                             'EZDXF', override: Optional[Dict[KT, VT]] = None, dxfattribs=None) →
                                             ezdxf.entities.dimstyleoverride.DimStyleOverride
```

Shortcut to add a x-type feature ordinate DIMENSION, for more information see `add_ordinate_dim()`.

New in version v0.18.

```
add_ordinate_y_dim(feature_location: Union[Sequence[float], ezdxf.math._vector.Vec2,
                                             ezdxf.math._vector.Vec3], offset: Union[Sequence[float],
                                             ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3], *, origin:
                                             Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3] =
                                             Vec3(0.0, 0.0, 0.0), rotation: float = 0.0, text: str = '<>', dimstyle: str =
                                             'EZDXF', override: Optional[Dict[KT, VT]] = None, dxfattribs=None) →
                                             ezdxf.entities.dimstyleoverride.DimStyleOverride
```

Shortcut to add a y-type feature ordinate DIMENSION, for more information see `add_ordinate_dim()`.

New in version v0.18.

```
add_leader(vertices: Iterable[Union[Sequence[float], ezdxf.math._vector.Vec2,
                                         ezdxf.math._vector.Vec3]], dimstyle: str = 'EZDXF', override: Optional[Dict[KT,
                                         VT]] = None, dxfattribs=None) → Leader
```

The `Leader` entity represents an arrow, made up of one or more vertices (or spline fit points) and an arrowhead. The label or other content to which the `Leader` is attached is stored as a separate entity, and is not part of the `Leader` itself. (requires DXF R2000)

`Leader` shares its styling infrastructure with `Dimension`.

By default a `Leader` without any annotation is created. For creating more fancy leaders and annotations see documentation provided by Autodesk or [Demystifying DXF: LEADER and MULTILEADER implementation notes](#).

### Parameters

- **vertices** – leader vertices (in WCS)
- **dimstyle** – dimension style name (`DimStyle` table entry), default is “EZDXF”
- **override** – override `DimStyleOverride` attributes
- **dxfattribs** – additional DXF attributes

---

**add\_multileader\_mtext** (*style: str = 'Standard'*, *dxfattribs=None*) → MultiLeaderMTextBuilder  
Add a *MultiLeader* entity but returns a *MultiLeaderMTextBuilder*.

New in version 0.18.

**add\_multileader\_block** (*style: str = 'Standard'*, *dxfattribs=None*) → MultiLeaderBlockBuilder  
Add a *MultiLeader* entity but returns a *MultiLeaderBlockBuilder*.

New in version 0.18.

**add\_body** (*dxfattribs=None*) → Body  
Add a *Body* entity. (requires DXF R2000 or later)

The ACIS data has to be set as *SAT* or *SAB*.

**add\_region** (*dxfattribs=None*) → Region  
Add a *Region* entity. (requires DXF R2000 or later)

The ACIS data has to be set as *SAT* or *SAB*.

**add\_3dsolid** (*dxfattribs=None*) → Solid3d  
Add a *3DSOLID* entity (*Solid3d*). (requires DXF R2000 or later)

The ACIS data has to be set as *SAT* or *SAB*.

**add\_surface** (*dxfattribs=None*) → Surface  
Add a *Surface* entity. (requires DXF R2007 or later)

The ACIS data has to be set as *SAT* or *SAB*.

**add\_extruded\_surface** (*dxfattribs=None*) → ExtrudedSurface  
Add a *ExtrudedSurface* entity. (requires DXF R2007 or later)

The ACIS data has to be set as *SAT* or *SAB*.

**add\_lofted\_surface** (*dxfattribs=None*) → LoftedSurface  
Add a *LoftedSurface* entity. (requires DXF R2007 or later)

The ACIS data has to be set as *SAT* or *SAB*.

**add\_revolved\_surface** (*dxfattribs=None*) → RevolvedSurface  
Add a *RevolvedSurface* entity. (requires DXF R2007 or later)

The ACIS data has to be set as *SAT* or *SAB*.

**add\_swept\_surface** (*dxfattribs=None*) → SweptSurface  
Add a *SweptSurface* entity. (requires DXF R2007 or later)

The ACIS data has to be set as *SAT* or *SAB*.

## Layout

**class** ezdxf.layouts.Layout

*Layout* is a subclass of *BaseLayout* and common base class of *Modelspace* and *Paperspace*.

**name**

Layout name as shown in tabs of *CAD* applications.

**dxf**

Returns the DXF name space attribute of the associated *DXFLayout* object.

This enables direct access to the underlying LAYOUT entity, e.g. `Layout.dxf.layout_flags`

`__contains__(entity: Union[DXFGraphic, str]) → bool`

Returns True if `entity` is stored in this layout.

**Parameters** `entity` – DXFGraphic object or handle as hex string

`reset_extents(extmin=(1e+20, 1e+20, 1e+20), extmax=(-1e+20, -1e+20, -1e+20)) → None`

Reset `extents` to given values or the AutoCAD default values.

“Drawing extents are the bounds of the area occupied by objects.” (Quote Autodesk Knowledge Network)

**Parameters**

- `extmin` – minimum extents or (1e20, 1e20, 1e20) as default value
- `extmax` – maximum extents or (-1e20, -1e20, -1e20) as default value

`reset_limits(limmin=None, limmax=None) → None`

Reset `limits` to given values or the AutoCAD default values.

“Sets an invisible rectangular boundary in the drawing area that can limit the grid display and limit clicking or entering point locations.” (Quote Autodesk Knowledge Network)

The `Paperspace` class has an additional method `reset_paper_limits()` to deduce the default limits from the paper size settings.

**Parameters**

- `extmin` – minimum extents or (0, 0) as default
- `extmax` – maximum extents or (paper width, paper height) as default value

`set_plot_type(value: int = 5) → None`

0	last screen display
1	drawing extents
2	drawing limits
3	view specific (defined by <code>Layout.dxf.plot_view_name</code> )
4	window specific (defined by <code>Layout.set_plot_window_limits()</code> )
5	layout information (default)

**Parameters** `value` – plot type

**Raises** DXFValueError – for `value` out of range

`set_plot_style(name: str = 'ezdxf.ctb', show: bool = False) → None`

Set plot style file of type `.ctb`.

**Parameters**

- `name` – plot style filename
- `show` – show plot style effect in preview? (AutoCAD specific attribute)

`set_plot_window(lower_left: Tuple[float, float] = (0, 0), upper_right: Tuple[float, float] = (0, 0))`

Set plot window size in (scaled) paper space units.  
→ None

**Parameters**

- `lower_left` – lower left corner as 2D point
- `upper_right` – upper right corner as 2D point

**set\_redraw\_order** (*handles*: Union[Dict[KT, VT], Iterable[Tuple[str, str]]]) → None

If the header variable \$SORTENTS Regen flag (bit-code value 16) is set, AutoCAD regenerates entities in ascending handles order.

To change redraw order associate a different sort handle to entities, this redefines the order in which the entities are regenerated. *handles* can be a dict of entity\_handle and sort\_handle as (k, v) pairs, or an iterable of (entity\_handle, sort\_handle) tuples.

The sort\_handle doesn't have to be unique, some or all entities can share the same sort handle and a sort handle can be an existing handle.

The “0” handle can be used, but this sort handle will be drawn as latest (on top of all other entities) and not as first as expected.

**Parameters** **handles** – iterable or dict of handle associations; an iterable of 2-tuples (entity\_handle, sort\_handle) or a dict (k, v) association as (entity\_handle, sort\_handle)

**get\_redraw\_order** () → Iterable[Tuple[str, str]]

Returns iterable for all existing table entries as (entity\_handle, sort\_handle) pairs, see also [set\\_redraw\\_order\(\)](#).

**plot\_viewport\_borders** (*state*: bool = True) → None

**show\_plot\_styles** (*state*: bool = True) → None

**plot\_centered** (*state*: bool = True) → None

**plot\_hidden** (*state*: bool = True) → None

**use\_standard\_scale** (*state*: bool = True) → None

**use\_plot\_styles** (*state*: bool = True) → None

**scale\_lineweights** (*state*: bool = True) → None

**print\_lineweights** (*state*: bool = True) → None

**draw\_viewports\_first** (*state*: bool = True) → None

**model\_type** (*state*: bool = True) → None

**update\_paper** (*state*: bool = True) → None

**zoom\_to\_paper\_on\_update** (*state*: bool = True) → None

**plot\_flags\_initializing** (*state*: bool = True) → None

**prev\_plot\_init** (*state*: bool = True) → None

**set\_plot\_flags** (*flag*, *state*: bool = True) → None

## Modelspace

**class** ezdxf.layouts.**Modelspace**

*Modelspace* is a subclass of [Layout](#).

The modelspace contains the “real” world representation of the drawing subjects in real world units.

**name**

Name of modelspace is fixed as “Model”.

**new\_geodata** (*dxfattribs*: Optional[dict] = None) → GeoData

Creates a new GeoData entity and replaces existing ones. The GEODATA entity resides in the OBJECTS

section and not in the modelspace, it is linked to the modelspace by an ExtensionDict located in BLOCK\_RECORD of the modelspace.

The GEODATA entity requires DXF R2010. The DXF reference does not document if other layouts than the modelspace supports geo referencing, so I assume getting/setting geo data may only make sense for the modelspace.

**Parameters** `dxffattribs` – DXF attributes for `GeoData` entity

`get_geodata()` → Optional[`GeoData`]

Returns the `GeoData` entity associated to the modelspace or `None`.

## Paperspace

**class** `ezdxf.layouts.Paperspace`

`Paperspace` is a subclass of `Layout`.

Paperspace layouts are used to create different drawing sheets of the modelspace subjects for printing or PDF export.

**name**

Layout name as shown in tabs of `CAD` applications.

`page_setup(size=(297, 210), margins=(10, 15, 10, 15), units='mm', offset=(0, 0), rotation=0, scale=16, name='ezdxf', device='DWG to PDF.pc3')`

Setup plot settings and paper size and reset viewports. All parameters in given `units` (mm or inch).

Reset paper limits, extents and viewports.

**Parameters**

- `size` – paper size as (width, height) tuple
- `margins` – (top, right, bottom, left) hint: clockwise
- `units` – “mm” or “inch”
- `offset` – plot origin offset is 2D point
- `rotation` – see table Rotation
- `scale` – integer in range [0, 32] defines a standard scale type or as tuple(numerator, denominator) e.g. (1, 50) for scale 1:50
- `name` – paper name prefix “{name}\_(width)\_x\_(height)\_{unit})”
- `device` – device .pc3 configuration file or system printer name

int	Rotation
0	no rotation
1	90 degrees counter-clockwise
2	upside-down
3	90 degrees clockwise

`viewports()` → List[`Viewport`]

Get all VIEWPORT entities defined in this paperspace layout. Returns a list of `Viewport` objects, sorted by id, the first entity is always the main viewport with an id of 1.

`main_viewport()` → Optional[`Viewport`]

Returns the main viewport of this paper space layout, or `None` if no main viewport exist.

---

```
add_viewport(center: Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3],
              size: Tuple[float, float], view_center_point: Union[Sequence[float],
              ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3], view_height: float, dxfaattribs:
              Optional[dict] = None) → Viewport
```

Add a new [Viewport](#) entity.

```
reset_viewports() → None
```

Delete all existing viewports, and create a new main viewport.

```
reset_main_viewport(center: Union[Sequence[float], ezdxf.math._vector.Vec2,
                                     ezdxf.math._vector.Vec3, None] = None, size: Union[Sequence[float],
                                     ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3, None] = None) →
Viewport
```

Reset the main viewport of this paper space layout to the given values, or reset them to the default values, deduced from the paper settings. Creates a new main viewport if none exist.

Ezdx does not create a main viewport by default, because CAD applications don't require one.

#### Parameters

- **center** – center of the viewport in paper space units
- **size** – viewport size as (width, height) tuple in paper space units

```
reset_paper_limits() → None
```

Set paper limits to default values, all values in paperspace units but without plot scale (?).

```
get_paper_limits() → Tuple[ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec2]
```

Returns paper limits in plot paper units, relative to the plot origin.

plot origin = lower left corner of printable area + plot origin offset

**Returns** tuple (Vec2(x1, y1), Vec2(x2, y2)), lower left corner is (x1, y1), upper right corner is (x2, y2).

## BlockLayout

```
class ezdxf.layouts.BlockLayout
```

[BlockLayout](#) is a subclass of [BaseLayout](#).

Block layouts are reusable sets of graphical entities, which can be referenced by multiple [Insert](#) entities. Each reference can be placed, scaled and rotated individually and can have its own set of DXF [Attrib](#) entities attached.

```
__contains__(entity) → bool
```

Returns True if block contains *entity*.

**Parameters** **entity** – DXFGraphic object or handle as hex string

```
attdefs() → Iterable[ezdxf.entities.attrib.AttDef]
```

Returns iterable of all Attdef entities.

```
has_attdef(tag: str) → bool
```

Returns True if an Attdef for *tag* exist.

```
get_attdef(tag: str) → Optional[ezdxf.entities.dxfgfx.DXFGraphic]
```

Returns attached Attdef entity by *tag* name.

```
get_attdef_text(tag: str, default: str = "") → str
```

Returns text content for Attdef *tag* as string or returns *default* if no Attdef for *tag* exist.

#### Parameters

- **tag** – name of tag
- **default** – default value if *tag* not exist

## Groups

A group is just a bunch of DXF entities tied together. All entities of a group has to be on the same layout (modelspace or any paper layout but not block). Groups can be named or unnamed, but in reality an unnamed groups has just a special name like “\*Annnn”. The name of a group has to be unique in the drawing. Groups are organized in the main group table, which is stored as attribute *groups* in the *Drawing* object.

Group entities have to be in modelspace or any paperspace layout but not in a block definition!

## DXFGroup

**class** ezdxf.entities.dxfgroups.**DXFGroup**

The group name is not stored in the GROUP entity, it is stored in the *GroupCollection* object.

**dxfs.description**

group description (string)

**dxfs.unnamed**

1 for unnamed, 0 for named group (int)

**dxfs.selectable**

1 for selectable, 0 for not selectable group (int)

**\_\_iter\_\_** () → Iterator[ezdxf.entities.dxfentity.DXFEntity]

Iterate over all DXF entities in *DXFGroup* as instances of *DXFGraphic* or inherited (LINE, CIRCLE, ...).

**\_\_len\_\_** () → int

Returns the count of DXF entities in *DXFGroup*.

**\_\_getitem\_\_** (item)

Returns entities by standard Python indexing and slicing.

**\_\_contains\_\_** (item: Union[str, ezdxf.entities.dxfentity.DXFEntity]) → bool

Returns True if item is in *DXFGroup*. item has to be a handle string or an object of type *DXFEntity* or inherited.

**handles** () → Iterable[str]

Iterable of handles of all DXF entities in *DXFGroup*.

**edit\_data** () → List[ezdxf.entities.dxfentity.DXFEntity]

Context manager which yields all the group entities as standard Python list:

```
with group.edit_data() as data:  
    # add new entities to a group  
    data.append(modelspace.add_line((0, 0), (3, 0)))  
    # remove last entity from a group  
    data.pop()
```

**set\_data** (entities: Iterable[ezdxf.entities.dxfentity.DXFEntity]) → None

Set *entities* as new group content, entities should be an iterable *DXFGraphic* or inherited (LINE, CIRCLE, ...). Raises *DXFValueError* if not all entities be on the same layout (modelspace or any paperspace layout but not block)

**extend** (*entities*: Iterable[ezdxf.entities.dxentity.DXFEntity]) → None

Add *entities* to *DXFGroup* without immediate verification!

Validation at DXF export may raise a *DXFStructureError*!

**clear** () → None

Remove all entities from *DXFGroup*, does not delete any drawing entities referenced by this group.

**audit** (*auditor*: Auditor) → None

Remove invalid entities from *DXFGroup*.

Invalid entities are:

- deleted entities
- all entities which do not reside in model- or paper space
- all entities if they do not reside in the same layout

## GroupCollection

Each *Drawing* has one group table, which is accessible by the attribute *groups*.

**class** ezdxf.entities.dxfgroups.GroupCollection

Manages all *DXFGroup* objects of a *Drawing*.

**\_\_len\_\_** ()

Returns the count of DXF groups.

**\_\_iter\_\_** ()

Iterate over all existing groups as (*name*, *group*) tuples. *name* is the name of the group as string and *group* is an *DXFGroup* object.

**\_\_contains\_\_** ()

Returns True if a group *name* exist.

**get** (*name*: str) → DXFGroup

Returns the group *name*. Raises *DXFKeyError* if group *name* does not exist.

**groups** () → Iterable[ezdxf.entities.dxfgroups.DXFGroup]

Iterable of all existing groups.

**new** (*name*: str = None, *description*: str = "", *selectable*: bool = True) → ezdxf.entities.dxfgroups.DXFGroup

Creates a new group. If *name* is None an unnamed group is created, which has an automatically generated name like “\*Annnn”. Group names are case insensitive.

### Parameters

- **name** – group name as string
- **description** – group description as string
- **selectable** – group is selectable if True

**delete** (*group*: Union[ezdxf.entities.dxfgroups.DXFGroup, str]) → None

Delete *group*, *group* can be an object of type *DXFGroup* or a group name as string.

**clear** ()

Delete all groups.

**audit** (*auditor*: Auditor) → None

Removes empty groups and invalid handles from all groups.

## DXF Entities

All DXF entities can only reside in the `BaseLayout` and inherited classes like `Modelspace`, `Paperspace` and `BlockLayout`.

**Warning:** Do not instantiate entity classes by yourself - always use the provided factory functions!

### DXF Entity Base Class

Common base class for all DXF entities and objects.

**Warning:** Do not instantiate entity classes by yourself - always use the provided factory functions!

```
class ezdxf.entities.DXFEntity
```

#### dx<sup>f</sup>

The DXF attributes namespace:

```
# set attribute value
entity.dxf.layer = 'MyLayer'

# get attribute value
linetype = entity.dxf.linetype

# delete attribute
del entity.dxf.linetype
```

#### dx<sup>f</sup>.handle

DXF *handle* is a unique identifier as plain hex string like F000. (feature for experts)

#### dx<sup>f</sup>.owner

Handle to *owner* as plain hex string like F000. (feature for experts)

#### doc

Get the associated `Drawing` instance.

#### dx<sup>f</sup>type() → str

Get DXF type as string, like `LINE` for the line entity.

#### \_\_str\_\_() → str

Returns a simple string representation.

#### \_\_repr\_\_() → str

Returns a simple string representation including the class.

#### has\_dxf\_attrib(key: str) → bool

Returns True if DXF attribute *key* really exist.

Raises `DXFAttributeError` if *key* is not an supported DXF attribute.

#### is\_supported\_dxf\_attrib(key: str) → bool

Returns True if DXF attrib *key* is supported by this entity. Does not grant that attribute *key* really exist.

**get\_dxf\_attrib** (*key: str, default: Any = None*) → Any

Get DXF attribute *key*, returns *default* if key doesn't exist, or raise `DXFValueError` if *default* is `DXFValueError` and no DXF default value is defined:

```
layer = entity.get_dxf_attrib("layer")
# same as
layer = entity.dxf.layer
```

Raises `DXFAttributeError` if *key* is not an supported DXF attribute.

**set\_dxf\_attrib** (*key: str, value: Any*) → None

Set new *value* for DXF attribute *key*:

```
entity.set_dxf_attrib("layer", "MyLayer")
# same as
entity.dxf.layer = "MyLayer"
```

Raises `DXFAttributeError` if *key* is not an supported DXF attribute.

**del\_dxf\_attrib** (*key: str*) → None

Delete DXF attribute *key*, does not raise an error if attribute is supported but not present.

Raises `DXFAttributeError` if *key* is not an supported DXF attribute.

**dxfattribs** (*drop: Set[str] = None*) → Dict[KT, VT]

Returns a dict with all existing DXF attributes and their values and exclude all DXF attributes listed in set *drop*.

**update\_dxf\_attribs** (*dxfattribs: Dict[KT, VT]*) → None

Set DXF attributes by a dict like `{'layer': 'test', 'color': 4}`.

**set\_flag\_state** (*flag: int, state: bool = True, name: str = 'flags'*) → None

Set binary coded *flag* of DXF attribute *name* to 1 (on) if *state* is True, set *flag* to 0 (off) if *state* is False.

**get\_flag\_state** (*flag: int, name: str = 'flags'*) → bool

Returns True if any *flag* of DXF attribute is 1 (on), else False. Always check only one flag state at the time.

**has\_extension\_dict**

Returns True if entity has an attached `ExtensionDict` instance.

**get\_extension\_dict** () → ezdxf.entities.xdict.ExtensionDict

Returns the existing `ExtensionDict` instance.

**Raises** `AttributeError` – extension dict does not exist

**new\_extension\_dict** () → ezdxf.entities.xdict.ExtensionDict

Create a new `ExtensionDict` instance .

**discard\_extension\_dict** () → None

Delete `ExtensionDict` instance .

**has\_app\_data** (*appid: str*) → bool

Returns True if application defined data for *appid* exist.

**get\_app\_data** (*appid: str*) → ezdxf.lldxf.tags.Tags

Returns application defined data for *appid*.

**Parameters** *appid* – application name as defined in the APPID table.

**Raises** `DXFValueError` – no data for *appid* found

**set\_app\_data** (*appid*: str, *tags*: Iterable[T\_co]) → None

Set application defined data for *appid* as iterable of tags.

#### Parameters

- **appid** – application name as defined in the APPID table.
- **tags** – iterable of (code, value) tuples or *DXFTag*

**discard\_app\_data** (*appid*: str)

Discard application defined data for *appid*. Does not raise an exception if no data for *appid* exist.

**has\_xdata** (*appid*: str) → bool

Returns True if extended data for *appid* exist.

**get\_xdata** (*appid*: str) → ezdxf.lldxf.tags.Tags

Returns extended data for *appid*.

**Parameters** **appid** – application name as defined in the APPID table.

**Raises** DXFValueError – no extended data for *appid* found

**set\_xdata** (*appid*: str, *tags*: Iterable[T\_co]) → None

Set extended data for *appid* as iterable of tags.

#### Parameters

- **appid** – application name as defined in the APPID table.
- **tags** – iterable of (code, value) tuples or *DXFTag*

**discard\_xdata** (*appid*: str) → None

Discard extended data for *appid*. Does not raise an exception if no extended data for *appid* exist.

**has\_xdata\_list** (*appid*: str, *name*: str) → bool

Returns True if a tag list *name* for extended data *appid* exist.

**get\_xdata\_list** (*appid*: str, *name*: str) → ezdxf.lldxf.tags.Tags

Returns tag list *name* for extended data *appid*.

#### Parameters

- **appid** – application name as defined in the APPID table.
- **name** – extended data list name

**Raises** DXFValueError – no extended data for *appid* found or no data list *name* not found

**set\_xdata\_list** (*appid*: str, *name*: str, *tags*: Iterable[T\_co]) → None

Set tag list *name* for extended data *appid* as iterable of tags.

#### Parameters

- **appid** – application name as defined in the APPID table.
- **name** – extended data list name
- **tags** – iterable of (code, value) tuples or *DXFTag*

**discard\_xdata\_list** (*appid*: str, *name*: str) → None

Discard tag list *name* for extended data *appid*. Does not raise an exception if no extended data for *appid* or no tag list *name* exist.

**replace\_xdata\_list** (*appid*: str, *name*: str, *tags*: Iterable[T\_co]) → None

Replaces tag list *name* for existing extended data *appid* by *tags*. Appends new list if tag list *name* do not exist, but raises DXFValueError if extended data *appid* do not exist.

## Parameters

- **appid** – application name as defined in the APPID table.
- **name** – extended data list name
- **tags** – iterable of (code, value) tuples or *DXFTag*

**Raises** `DXFValueError` – no extended data for *appid* found

**has\_reactors()** → bool

Returns True if entity has reactors.

**get\_reactors()** → List[str]

Returns associated reactors as list of handles.

**set\_reactors(handles: Iterable[str])** → None

Set reactors as list of handles.

**append\_reactor\_handle(handle: str)** → None

Append *handle* to reactors.

**discard\_reactor\_handle(handle: str)** → None

Discard *handle* from reactors. Does not raise an exception if *handle* does not exist.

## DXF Graphic Entity Base Class

Common base class for all graphical DXF entities.

This entities resides in entity spaces like *Modelspace*, any *Paperspace* or *BlockLayout*.

Subclass of	<code>ezdxf.entities.DXFEntity</code>
-------------	---------------------------------------

**Warning:** Do not instantiate entity classes by yourself - always use the provided factory functions!

**class** `ezdxf.entities.DXFGraphic`

### rgb

Get/set DXF attribute `dxf.true_color` as (r, g, b) tuple, returns None if attribute `dxf.true_color` is not set.

<pre>entity.rgb = (30, 40, 50) r, g, b = entity.rgb</pre>
---

This is the recommend method to get/set RGB values, when ever possible do not use the DXF low level attribute `dxf.true_color`.

### transparency

Get/set transparency value as float. Value range 0 to 1, where 0 means entity is opaque and 1 means entity is 100% transparent (invisible). This is the recommend method to get/set transparency values, when ever possible do not use the DXF low level attribute `DXFGraphic.dxf.transparency`

This attribute requires DXF R2004 or later, returns 0 for prior DXF versions and raises `DXFAttributeError` for setting *transparency* in older DXF versions.

**ocs()** → ezdxf.math.ucs.OCS

Returns object coordinate system (*OCS*) for 2D entities like *Text* or *Circle*, returns a pass-through OCS for entities without OCS support.

**get\_layout()** → Optional[BaseLayout]

Returns the owner layout or returns `None` if entity is not assigned to any layout.

**unlink\_from\_layout()** → None

Unlink entity from associated layout. Does nothing if entity is already unlinked.

It is more efficient to call the `unlink_entity()` method of the associated layout, especially if you have to unlink more than one entity.

**copy\_to\_layout(layout: BaseLayout)** → DXFEntity

Copy entity to another *layout*, returns new created entity as *DXFEntity* object. Copying between different DXF drawings is not supported.

**Parameters** `layout` – any layout (model space, paper space, block)

**Raises** `DXFStructureError` – for copying between different DXF drawings

**move\_to\_layout(layout: BaseLayout, source: BaseLayout = None)** → None

Move entity from model space or a paper space layout to another layout. For block layout as source, the block layout has to be specified. Moving between different DXF drawings is not supported.

**Parameters**

- `layout` – any layout (model space, paper space, block)
- `source` – provide source layout, faster for DXF R12, if entity is in a block layout

**Raises** `DXFStructureError` – for moving between different DXF drawings

**graphic\_properties()** → Dict[KT, VT]

Returns the important common properties layer, color, linetype, linewidth, Itscale, true\_color and color\_name as *dxfattribs* dict.

**has\_hyperlink()** → bool

Returns `True` if entity has an attached hyperlink.

**get\_hyperlink()** → Tuple[str, str, str]

Returns hyperlink, description and location.

**set\_hyperlink(link: str, description: Optional[str] = None, location: Optional[str] = None)**

Set hyperlink of an entity.

**transform(m: ezdxf.math.\_matrix44.Matrix44)** → ezdxf.entities.dxfgfx.DXFGraphic

Inplace transformation interface, returns `self` (floating interface).

**Parameters** `m` – 4x4 transformation matrix (`ezdxf.math.Matrix44`)

**translate(dx: float, dy: float, dz: float)** → ezdxf.entities.dxfgfx.DXFGraphic

Translate entity inplace about *dx* in x-axis, *dy* in y-axis and *dz* in z-axis, returns `self` (floating interface).

Basic implementation uses the `transform()` interface, subclasses may have faster implementations.

**scale(sx: float, sy: float, sz: float)** → ezdxf.entities.dxfgfx.DXFGraphic

Scale entity inplace about *dx* in x-axis, *dy* in y-axis and *dz* in z-axis, returns `self` (floating interface).

**scale\_uniform(s: float)** → DXFGraphic

Scale entity inplace uniform about *s* in x-axis, y-axis and z-axis, returns `self` (floating interface).

**rotate\_x(angle: float)** → ezdxf.entities.dxfgfx.DXFGraphic

Rotate entity inplace about x-axis, returns `self` (floating interface).

**Parameters** `angle` – rotation angle in radians

`rotate_y(angle: float) → ezdxf.entities.dxfgfx.DXFGraphic`

Rotate entity inplace about y-axis, returns `self` (floating interface).

**Parameters** `angle` – rotation angle in radians

`rotate_z(angle: float) → ezdxf.entities.dxfgfx.DXFGraphic`

Rotate entity inplace about z-axis, returns `self` (floating interface).

**Parameters** `angle` – rotation angle in radians

`rotate_axis(axis: Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3], angle: float) → ezdxf.entities.dxfgfx.DXFGraphic`

Rotate entity inplace about vector `axis`, returns `self` (floating interface).

**Parameters**

- `axis` – rotation axis as tuple or `Vec3`

- `angle` – rotation angle in radians

## Common graphical DXF attributes

`DXFGraphic.dxf.layer`

Layer name as string; default = '0'

`DXFGraphic.dxf.linetype`

Linetype as string, special names 'BYLAYER', 'BYBLOCK'; default value is 'BYLAYER'

`DXFGraphic.dxf.color`

*AutoCAD Color Index (ACI)*, default = 256

Constants defined in `ezdxf.lldxf.const`

0	BYBLOCK
256	BYLAYER
257	BYOBJECT

`DXFGraphic.dxf.lineweight`

Line weight in mm times 100 (e.g. 0.13mm = 13). There are fixed valid lineweights which are accepted by AutoCAD, other values prevents AutoCAD from loading the DXF document, BricsCAD isn't that picky. (requires DXF R2000)

Constants defined in `ezdxf.lldxf.const`

-1	LINEWEIGHT_BYLAYER
-2	LINEWEIGHT_BYBLOCK
-3	LINEWEIGHT_DEFAULT

Valid DXF lineweights stored in `VALID_DXF_LINEWEIGHTS`: 0, 5, 9, 13, 15, 18, 20, 25, 30, 35, 40, 50, 53, 60, 70, 80, 90, 100, 106, 120, 140, 158, 200, 211

`DXFGraphic.dxf.ltscale`

Line type scale as float; default = 1.0 (requires DXF R2000)

`DXFGraphic.dxf.invisible`

1 for invisible, 0 for visible; default = 0 (requires DXF R2000)

**DXFGraphic.dxf.paperspace**

0 for entity resides in modelspace or a block, 1 for paperspace, this attribute is set automatically by adding an entity to a layout (feature for experts); default = 0

**DXFGraphic.dxf.extrusion**

Extrusion direction as 3D vector; default = (0, 0, 1)

**DXFGraphic.dxf.thickness**

Entity thickness as float; default = 0.0 (requires DXF R2000)

**DXFGraphic.dxf.true\_color**

True color value as int 0x00RRGGBB, use `DXFGraphic.rgb` to get/set true color values as (r, g, b) tuples. (requires DXF R2004)

**DXFGraphic.dxf.color\_name**

Color name as string. (requires DXF R2004)

**DXFGraphic.dxf.transparency**

Transparency value as int, 0x020000TT 0x00 = 100% transparent / 0xFF = opaque, special value 0x01000000 means transparency by block. An unset transparency value means transparency by layer. Use `DXFGraphic.transparency` to get/set transparency as float value, and the properties `DXFGraphic.is_transparency_by_block` and `DXFGraphic.is_transparency_by_layer` to check special cases.

(requires DXF R2004)

**DXFGraphic.dxf.shadow\_mode**

0	casts and receives shadows
1	casts shadows
2	receives shadows
3	ignores shadows

(requires DXF R2007)

## Face3d

A 3DFACE ([DXF Reference](#)) is real 3D solid filled triangle or quadrilateral. Access vertices by name (`entity.dxf.vtx0 = (1.7, 2.3)`) or by index (`entity[0] = (1.7, 2.3)`).

Subclass of	<code>ezdxf.entities.DXFGraphic</code>
DXF type	'3DFACE'
Factory function	<code>ezdxf.layouts.BaseLayout.add_3dface()</code>
Inherited DXF attributes	<i>Common graphical DXF attributes</i>

**Warning:** Do not instantiate entity classes by yourself - always use the provided factory functions!

**class ezdxf.entities.Face3d**

*Face3d* because 3dface is not a valid Python class name.

**dxfs.vtx0**

Location of 1. vertex (3D Point in [WCS](#))

**dx<sub>f</sub>.vtx1**

Location of 2. vertex (3D Point in WCS)

**dx<sub>f</sub>.vtx2**

Location of 3. vertex (3D Point in WCS)

**dx<sub>f</sub>.vtx3**

Location of 4. vertex (3D Point in WCS)

**dx<sub>f</sub>.invisible\_edge**

invisible edge flag (int, default=0)

1	first edge is invisible
2	second edge is invisible
4	third edge is invisible
8	fourth edge is invisible

Combine values by adding them, e.g. 1+4 = first and third edge is invisible.

**transform**(*m*: ezdxf.math.\_matrix44.Matrix44) → ezdxf.entities.solid.Face3dTransform the 3DFACE entity by transformation matrix *m* inplace.**wcs\_vertices**(*close*: bool = False) → List[ezdxf.math.\_vector.Vec3]Returns WCS vertices, if argument *close* is True, last vertex == first vertex.

returns 4 vertices when close=False and 5 vertices when close=True. Some edges may have 0 length.

Compatibility interface to SOLID and TRACE. The 3DFACE entity returns already WCS vertices.

**Solid3d**3DSOLID ([DXF Reference](#)) created by an ACIS geometry kernel provided by the [Spatial Corp.](#)**See also:***Ezdx<sub>f</sub>* has only very limited support for ACIS based entities, for more information see the FAQ: *How to add/edit ACIS based entities like 3DSOLID, REGION or SURFACE?*

Subclass of	<i>ezdxf.entities.Body</i>
DXF type	'3DSOLID'
Factory function	<i>ezdxf.layouts.BaseLayout.add_3dsolid()</i>
Inherited DXF attributes	<a href="#">Common graphical DXF attributes</a>
Required DXF version	DXF R2000 ('AC1015')

**Warning:** Do not instantiate entity classes by yourself - always use the provided factory functions!**class** ezdxf.entities.Solid3dSame attributes and methods as parent class *Body*.**dx<sub>f</sub>.history\_handle**

Handle to history object.

## Arc

ARC (DXF Reference) center at location `dxf.center` and radius of `dxf.radius` from `dxf.start_angle` to `dxf.end_angle`. ARC goes always from `dxf.start_angle` to `dxf.end_angle` in counter clockwise orientation around the `dxf.extrusion` vector, which is  $(0, 0, 1)$  by default and the usual case for 2D arcs.

Subclass of	<code>ezdxf.entities.Circle</code>
DXF type	'ARC'
Factory function	<code>ezdxf.layouts.BaseLayout.add_arc()</code>
Inherited DXF attributes	<i>Common graphical DXF attributes</i>

**Warning:** Do not instantiate entity classes by yourself - always use the provided factory functions!

```
class eздxf.entities.Arc
```

**dxf.center**  
Center point of arc (2D/3D Point in *OCS*)

**dxf.radius**  
Radius of arc (float)

**dxf.start\_angle**  
Start angle in degrees (float)

**dxf.end\_angle**  
End angle in degrees (float)

**start\_point**  
Returns the start point of the arc in WCS, takes OCS into account.

**end\_point**  
Returns the end point of the arc in WCS, takes OCS into account.

**angles** (num: int) → Iterable[float]  
Returns num angles from start- to end angle in degrees in counter clockwise order.  
All angles are normalized in the range from [0, 360].

**flattening** (sagitta: float) → Iterator[ezdxf.math.\_vector.Vec3]  
Approximate the arc by vertices in WCS, argument *segment* is the max. distance from the center of an arc segment to the center of its chord.

**transform** (m: eздxf.math.\_matrix44.Matrix44) → eздxf.entities.arc.Arc  
Transform ARC entity by transformation matrix *m* inplace.  
Raises NonUniformScalingError() for non uniform scaling.

**to\_ellipse** (replace=True) → Ellipse  
Convert CIRCLE/ARC to an *Ellipse* entity.  
Adds the new ELLIPSE entity to the entity database and to the same layout as the source entity.  
**Parameters replace** – replace (delete) source entity by ELLIPSE entity if True

**to\_spline** (replace=True) → Spline  
Convert CIRCLE/ARC to a *Spline* entity.  
Adds the new SPLINE entity to the entity database and to the same layout as the source entity.

**Parameters** `replace` – replace (delete) source entity by SPLINE entity if `True`

`construction_tool ()` → `ezdxf.math.arc.ConstructionArc`  
 Returns 2D construction tool `ezdxf.math.ConstructionArc`, ignoring the extrusion vector.

`apply_construction_tool (arc: ezdxf.math.arc.ConstructionArc)` → `ezdxf.entities.arc.Arc`  
 Set ARC data from construction tool `ezdxf.math.ConstructionArc`, will not change the extrusion vector.

## Body

BODY (DXF Reference) created by an ACIS geometry kernel provided by the Spatial Corp.

### See also:

*Ezdx*f has only very limited support for ACIS based entities, for more information see the FAQ: [How to add/edit ACIS based entities like 3DSOLID, REGION or SURFACE?](#)

Subclass of	<code>ezdxf.entities.DXFGraphic</code>
DXF type	'BODY'
Factory function	<code>ezdxf.layouts.BaseLayout.add_body()</code>
Inherited DXF attributes	<a href="#">Common graphical DXF attributes</a>
Required DXF version	DXF R2000 ('AC1015')

**Warning:** Do not instantiate entity classes by yourself - always use the provided factory functions!

## class `ezdxf.entities.Body`

`dxf.version`  
 Modeler format version number, default value is 1

`dxf.flags`  
 Require DXF R2013.

`dxf.uid`  
 Require DXF R2013.

`tostring ()` → str  
 Returns ACIS `SAT` data as a single string if the entity has SAT data.

## Circle

CIRCLE (DXF Reference) center at location `dxf.center` and radius of `dxf.radius`.

Subclass of	<code>ezdxf.entities.DXFGraphic</code>
DXF type	'CIRCLE'
Factory function	<code>ezdxf.layouts.BaseLayout.add_circle()</code>
Inherited DXF attributes	<a href="#">Common graphical DXF attributes</a>

**Warning:** Do not instantiate entity classes by yourself - always use the provided factory functions!

```
class ezdxf.entities.Circle

    dxf.center
        Center point of circle (2D/3D Point in OCS)

    dxf.radius
        Radius of circle (float)

    vertices (angles: Iterable[float]) → Iterable[ezdxf.math._vector.Vec3]
        Yields vertices of the circle for iterable angles in WCS.

            Parameters angles – iterable of angles in OCS as degrees, angle goes counter clockwise
                around the extrusion vector, OCS x-axis = 0 deg.

    flattening (sagitta: float) → Iterable[ezdxf.math._vector.Vec3]
        Approximate the circle by vertices in WCS, argument sagitta is the max. distance from the center of an
        arc segment to the center of its chord. Returns a closed polygon: start vertex == end vertex!

        Yields always Vec3 objects.

        New in version 0.15.

    transform (m: ezdxf.math._matrix44.Matrix44) → ezdxf.entities.circle.Circle
        Transform the CIRCLE entity by transformation matrix m inplace.

        Raises NonUniformScalingError () for non uniform scaling.

    translate (dx: float, dy: float, dz: float) → ezdxf.entities.circle.Circle
        Optimized CIRCLE/ARC translation about dx in x-axis, dy in y-axis and dz in z-axis, returns self (floating
        interface).

    to_ellipse (replace=True) → Ellipse
        Convert CIRCLE/ARC to an Ellipse entity.

        Adds the new ELLIPSE entity to the entity database and to the same layout as the source entity.

            Parameters replace – replace (delete) source entity by ELLIPSE entity if True

    to_spline (replace=True) → Spline
        Convert CIRCLE/ARC to a Spline entity.

        Adds the new SPLINE entity to the entity database and to the same layout as the source entity.

            Parameters replace – replace (delete) source entity by SPLINE entity if True
```

## Dimension

The DIMENSION entity ([DXF Reference](#)) represents several types of dimensions in many orientations and alignments. The basic types of dimensioning are linear, radial, angular, ordinate, and arc length.

For more information about dimensions see the online help from AutoDesk: [About the Types of Dimensions](#)

---

**Important:** The DIMENSION entity is reused to create dimensional constraints, such entities do not have an associated geometrical block nor a dimension type group code (2) and reside on layer \*ADSK\_CONSTRAINTS. Use property `Dimension.is_dimensional_constraint` to check for this objects. Dimensional constraints are not documented in the DXF reference and not supported by *ezdxf*.

---

**See also:**

- [Tutorial for Linear Dimensions](#)
- [Tutorial for Radius Dimensions](#)
- [Tutorial for Diameter Dimensions](#)
- [Tutorial for Angular Dimensions](#)
- [Tutorial for Ordinate Dimensions](#)

Subclass of	<code>ezdxf.entities.DXFGraphic</code>
DXF type	'DIMENSION'
factory function	see table below
Inherited DXF attributes	<a href="#">Common graphical DXF attributes</a>

**Factory Functions**

Linear and Rotated Dimension (DXF)	<code>add_linear_dim()</code>
Aligned Dimension (DXF)	<code>add_aligned_dim()</code>
Angular Dimension (DXF)	<code>add_angular_dim_21()</code>
Angular 3P Dimension (DXF)	<code>add_angular_dim_3p()</code>
Angular Dimension by center, radius, angles	<code>add_angular_dim_cra()</code>
Angular Dimension by ConstructionArc	<code>add_angular_dim_arc()</code>
Diameter Dimension (DXF)	<code>add_diameter_dim()</code>
Radius Dimension (DXF)	<code>add_radius_dim()</code>
Ordinate Dimension (DXF)	<code>add_ordinate_dim()</code> (not implemented)

**Warning:** Do not instantiate entity classes by yourself - always use the provided factory functions!

**class** `ezdxf.entities.Dimension`

There is only one `Dimension` class to represent all different dimension types.

**dxfs.version**

Version number: 0 = R2010. (int, DXF R2010)

**dxfs.geometry**

Name of the BLOCK that contains the entities that make up the dimension picture.

For AutoCAD this graphical representation is mandatory, else AutoCAD will not open the DXF drawing. BricsCAD will render the DIMENSION entity by itself, if the graphical representation is not present, but uses the BLOCK instead of rendering, if it is present.

**dxfs.dimstyle**

Dimension style (`DimStyle`) name as string.

**dxfs.dimtype**

Values 0-6 are integer values that represent the dimension type. Values 32, 64, and 128 are bit values, which are added to the integer values.

0	Linear and Rotated Dimension (DXF)
1	Aligned Dimension (DXF)
2	Angular Dimension (DXF)
3	Diameter Dimension (DXF)
4	Radius Dimension (DXF)
5	Angular 3P Dimension (DXF)
6	Ordinate Dimension (DXF)
8	subclass <code>ezdxf.entities.ArcDimension</code> introduced in DXF R2004
32	Indicates that graphical representation geometry is referenced by this dimension only. (always set in DXF R13 and later)
64	Ordinate type. This is a bit value (bit 7) used only with integer value 6. If set, ordinate is <i>X-type</i> ; if not set, ordinate is <i>Y-type</i>
128	This is a bit value (bit 8) added to the other dimtype values if the dimension text has been positioned at a user-defined location rather than at the default location

**dx.f.`defpoint`**

Definition point for all dimension types. (3D Point in [WCS](#))

Linear and rotated dimension: `dx.f.defpoint` specifies the dimension line location.

Arc and angular dimension: `dx.f.defpoint` and `dx.f.defpoint4` specify the endpoints of the line used to determine the second extension line.

**dx.f.`defpoint2`**

Definition point for linear and angular dimensions. (3D Point in [WCS](#))

Linear and rotated dimension: The `dx.f.defpoint2` specifies the start point of the first extension line.

Arc and angular dimension: The `dx.f.defpoint2` and `dx.f.defpoint3` specify the endpoints of the line used to determine the first extension line.

**dx.f.`defpoint3`**

Definition point for linear and angular dimensions. (3D Point in [WCS](#))

Linear and rotated dimension: The `dx.f.defpoint3` specifies the start point of the second extension line.

Arc and angular dimension: The `dx.f.defpoint2` and `dx.f.defpoint3` specify the endpoints of the line used to determine the first extension line.

**dx.f.`defpoint4`**

Definition point for diameter, radius, and angular dimensions. (3D Point in [WCS](#))

Arc and angular dimension: `dx.f.defpoint` and `dx.f.defpoint4` specify the endpoints of the line used to determine the second extension line.

**dx.f.`defpoint5`**

Point defining dimension arc for angular dimensions, specifies the location of the dimension line arc. (3D Point in [OCS](#))

**dx.f.`angle`**

Angle of linear and rotated dimensions in degrees. (float)

**dx.f.`leader_length`**

Leader length for radius and diameter dimensions. (float)

**dx.f.`text_midpoint`**

Middle point of dimension text. (3D Point in [OCS](#))

**dx<sub>f</sub>.insert**

Insertion point for clones of a linear dimensions. (3D Point in *OCS*)

This value translates the content of the associated anonymous block for cloned linear dimensions, similar to the `insert` attribute of the [Insert](#) entity.

**dx<sub>f</sub>.attachment\_point**

Text attachment point (int, DXF R2000), default value is 5.

1	Top left
2	Top center
3	Top right
4	Middle left
5	Middle center
6	Middle right
7	Bottom left
8	Bottom center
9	Bottom right

**dx<sub>f</sub>.line\_spacing\_style**

Dimension text line-spacing style (int, DXF R2000), default value is 1.

1	At least (taller characters will override)
2	Exact (taller characters will not override)

**dx<sub>f</sub>.line\_spacing\_factor**

Dimension text-line spacing factor. (float, DXF R2000)

Percentage of default (3-on-5) line spacing to be applied. Valid values range from 0.25 to 4.00.

**dx<sub>f</sub>.actual\_measurement**

Actual measurement (float, DXF R2000), this is an optional attribute and often not present. (read-only value)

**dx<sub>f</sub>.text**

Dimension text explicitly entered by the user (str), default value is an empty string.

If empty string or '`<>`', the dimension measurement is drawn as the text, if ' ' (one blank space), the text is suppressed. Anything else is drawn as the text.

**dx<sub>f</sub>.oblique\_angle**

Linear dimension types with an oblique angle have an optional `dxf.oblique_angle`.

When added to the rotation `dxf.angle` of the linear dimension, it gives the angle of the extension lines.

**dx<sub>f</sub>.text\_rotation**

Defines is the rotation angle of the dimension text away from its default orientation (the direction of the dimension line). (float)

**dx<sub>f</sub>.horizontal\_direction**

Indicates the horizontal direction for the dimension entity (float).

This attribute determines the orientation of dimension text and lines for horizontal, vertical, and rotated linear dimensions. This value is the negative of the angle in the OCS xy-plane between the dimension line and the OCS x-axis.

**get\_dim\_style() → DimStyle**

Returns the associated [DimStyle](#) entity.

**get\_geometry\_block()** → Optional[BlockLayout]  
Returns *BlockLayout* of associated anonymous dimension block, which contains the entities that make up the dimension picture. Returns None if block name is not set or the BLOCK itself does not exist

**get\_measurement()** → Union[float, ezdxf.math.\_vector.Vec3]  
Returns the actual dimension measurement in *WCS* units, no scaling applied for linear dimensions. Returns angle in degrees for angular dimension from 2 lines and angular dimension from 3 points. Returns vector from origin to feature location for ordinate dimensions.

**override()** → ezdxf.entities.dimstyleoverride.DimStyleOverride  
Returns the *DimStyleOverride* object.

**render()** → None  
Render graphical representation as anonymous block.

**transform(m: ezdxf.math.\_matrix44.Matrix44)** → ezdxf.entities.dimension.Dimension  
Transform the DIMENSION entity by transformation matrix *m* inplace.  
Raises NonUniformScalingError() for non uniform scaling.

**virtual\_entities()** → Iterable[ezdxf.entities.dxfgfx.DXFGraphic]  
Yields ‘virtual’ parts of DIMENSION as basic DXF entities like LINE, ARC or TEXT.  
This entities are located at the original positions, but are not stored in the entity database, have no handle and are not assigned to any layout.

**explode(target\_layout: BaseLayout = None)** → EntityQuery  
Explode parts of DIMENSION as basic DXF entities like LINE, ARC or TEXT into target layout, if target layout is None, the target layout is the layout of the DIMENSION.  
Returns an *EntityQuery* container with all DXF primitives.

**Parameters** **target\_layout** – target layout for DXF parts, None for same layout as source entity.

## DimStyleOverride

All of the *DimStyle* attributes can be overridden for each *Dimension* entity individually.

The *DimStyleOverride* class manages all the complex dependencies between *DimStyle* and *Dimension*, the different features of all DXF versions and the rendering process to create the *Dimension* picture as BLOCK, which is required for AutoCAD.

```
class ezdxf.entities.DimStyleOverride

    dimension
        Base Dimension entity.

    dimstyle
        By dimension referenced DimStyle entity.

    dimstyle_attribs
        Contains all overridden attributes of dimension, as a dict with DimStyle attribute names as keys.

    __getitem__(key: str) → Any
        Returns DIMSTYLE attribute key, see also get ().

    __setitem__(key: str, value: Any) → None
        Set DIMSTYLE attribute key in dimstyle_attribs.
```

---

**\_\_delitem\_\_** (*key: str*) → None  
 Deletes DIMSTYLE attribute *key* from *dimstyle\_attrs*, ignores KeyErrors silently.

**get** (*attribute: str, default: Optional[Any] = None*) → Any  
 Returns DIMSTYLE attribute from override dict *dimstyle\_attrs* or base *DimStyle*.  
 Returns *default* value for attributes not supported by DXF R12. This is a hack to use the same algorithm to render DXF R2000 and DXF R12 DIMENSION entities. But the DXF R2000 attributes are not stored in the DXF R12 file! Does not catch invalid attributes names! Look into debug log for ignored DIMSTYLE attributes.

**pop** (*attribute: str, default: Optional[Any] = None*) → Any  
 Returns DIMSTYLE attribute from override dict *dimstyle\_attrs* and removes this *attribute* from override dict.

**update** (*attribs: dict*) → None  
 Update override dict *dimstyle\_attrs*.

**Parameters attribs** – dict of DIMSTYLE attributes

**commit** () → None  
 Writes overridden DIMSTYLE attributes into ACAD:DSTYLE section of XDATA of the DIMENSION entity.

**get\_arrow\_names** () → Tuple[str, str]  
 Get arrow names as strings like 'ARCHTICK'.  
**Returns** tuple of [dimblk1, dimblk2]  
**Return type** Tuple[str, str]

**set\_arrows** (*blk: Optional[str] = None, blk1: Optional[str] = None, blk2: Optional[str] = None, ldrblk: Optional[str] = None, size: Optional[float] = None*) → None  
 Set arrows or user defined blocks and disable oblique stroke as tick.  
**Parameters**

- **blk** – defines both arrows at once as name str or user defined block
- **blk1** – defines left arrow as name str or as user defined block
- **blk2** – defines right arrow as name str or as user defined block
- **ldrblk** – defines leader arrow as name str or as user defined block
- **size** – arrow size in drawing units

**set\_tick** (*size: float = 1*) → None  
 Use oblique stroke as tick, disables arrows.  
**Parameters size** – arrow size in drawing units

**set\_text\_align** (*halign: Optional[str] = None, valign: Optional[str] = None, vshift: Optional[float] = None*) → None  
 Set measurement text alignment, *halign* defines the horizontal alignment, *valign* defines the vertical alignment, *above1* and *above2* means above extension line 1 or 2 and aligned with extension line.  
**Parameters**

- **halign** – *left, right, center, above1, above2*, requires DXF R2000+
- **valign** – *above, center, below*
- **vshift** – vertical text shift, if *valign* is *center*; >0 shift upward, <0 shift downwards

**set\_tolerance** (*upper: float, lower: Optional[float] = None, hfactor: Optional[float] = None, align: Optional[ezdxf.enums.MTextLineAlignment] = None, dec: Optional[int] = None, leading\_zeros: Optional[bool] = None, trailing\_zeros: Optional[bool] = None*) → None

Set tolerance text format, upper and lower value, text height factor, number of decimal places or leading and trailing zero suppression.

#### Parameters

- **upper** – upper tolerance value
- **lower** – lower tolerance value, if None same as upper
- **hfactor** – tolerance text height factor in relation to the dimension text height
- **align** – tolerance text alignment enum `ezdxf.enums.MTextLineAlignment`
- **dec** – Sets the number of decimal places displayed
- **leading\_zeros** – suppress leading zeros for decimal dimensions if False
- **trailing\_zeros** – suppress trailing zeros for decimal dimensions if False

Changed in version 0.17.2: argument `align` as enum `ezdxf.enums.MTextLineAlignment`

**set\_limits** (*upper: float, lower: float, hfactor: Optional[float] = None, dec: Optional[int] = None, leading\_zeros: Optional[bool] = None, trailing\_zeros: Optional[bool] = None*) → None

Set limits text format, upper and lower limit values, text height factor, number of decimal places or leading and trailing zero suppression.

#### Parameters

- **upper** – upper limit value added to measurement value
- **lower** – lower lower value subtracted from measurement value
- **hfactor** – limit text height factor in relation to the dimension text height
- **dec** – Sets the number of decimal places displayed, required DXF R2000+
- **leading\_zeros** – suppress leading zeros for decimal dimensions if False, required DXF R2000+
- **trailing\_zeros** – suppress trailing zeros for decimal dimensions if False, required DXF R2000+

**set\_text\_format** (*prefix: str = "", postfix: str = "", rnd: Optional[float] = None, dec: Optional[int] = None, sep: Optional[str] = None, leading\_zeros: Optional[bool] = None, trailing\_zeros: Optional[bool] = None*) → None

Set dimension text format, like prefix and postfix string, rounding rule and number of decimal places.

#### Parameters

- **prefix** – dimension text prefix text as string
- **postfix** – dimension text postfix text as string
- **rnd** – Rounds all dimensioning distances to the specified value, for instance, if DIMRND is set to 0.25, all distances round to the nearest 0.25 unit. If you set DIMRND to 1.0, all distances round to the nearest integer.
- **dec** – Sets the number of decimal places displayed for the primary units of a dimension. requires DXF R2000+
- **sep** – “.” or “,” as decimal separator
- **leading\_zeros** – suppress leading zeros for decimal dimensions if False

- **trailing\_zeros** – suppress trailing zeros for decimal dimensions if False

**set\_dimline\_format** (*color: Optional[int] = None, linetype: Optional[str] = None, linewidth: Optional[int] = None, extension: Optional[float] = None, disable1: Optional[bool] = None, disable2: Optional[bool] = None*)

Set dimension line properties

#### Parameters

- **color** – color index
- **linetype** – linetype as string
- **linewidth** – line weight as int, 13 = 0.13mm, 200 = 2.00mm
- **extension** – extension length
- **disable1** – True to suppress first part of dimension line
- **disable2** – True to suppress second part of dimension line

**set\_extline\_format** (*color: Optional[int] = None, linewidth: Optional[int] = None, extension: Optional[float] = None, offset: Optional[float] = None, fixed\_length: Optional[float] = None*)

Set common extension line attributes.

#### Parameters

- **color** – color index
- **linewidth** – line weight as int, 13 = 0.13mm, 200 = 2.00mm
- **extension** – extension length above dimension line
- **offset** – offset from measurement point
- **fixed\_length** – set fixed length extension line, length below the dimension line

**set\_extline1** (*linetype: Optional[str] = None, disable=False*)

Set extension line 1 attributes.

#### Parameters

- **linetype** – linetype for extension line 1
- **disable** – disable extension line 1 if True

**set\_extline2** (*linetype: Optional[str] = None, disable=False*)

Set extension line 2 attributes.

#### Parameters

- **linetype** – linetype for extension line 2
- **disable** – disable extension line 2 if True

**set\_text** (*text: str = '<>'*) → None

Set dimension text.

- *text* = “” to suppress dimension text
- *text* = “” or “<>” to use measured distance as dimension text
- else use “text” literally

**shift\_text** (*dh: float, dv: float*) → None

Set relative text movement, implemented as user location override without leader.

#### Parameters

- **dh** – shift text in text direction
- **dv** – shift text perpendicular to text direction

**set\_location** (*location: Union[Sequence[float], ezdxf.math.\_vector.Vector2, ezdxf.math.\_vector.Vector3], leader=False, relative=False*) → None

Set text location by user, special version for linear dimensions, behaves for other dimension types like [user\\_location\\_override\(\)](#).

#### Parameters

- **location** – user defined text location
- **leader** – create leader from text to dimension line
- **relative** – *location* is relative to default location.

**user\_location\_override** (*location: Union[Sequence[float], ezdxf.math.\_vector.Vector2, ezdxf.math.\_vector.Vector3]*) → None

Set text location by user, *location* is relative to the origin of the UCS defined in the [render\(\)](#) method or WCS if the *ucs* argument is None.

**render** (*ucs: 'UCS' = None, discard=False*) → BaseDimensionRenderer

Initiate dimension line rendering process and also writes overridden dimension style attributes into the DSTYLE XDATA section.

For a friendly CAD applications like BricsCAD you can discard the dimension line rendering, because it is done automatically by BricsCAD, if no dimension rendering BLOCK is available and it is likely to get better results as by *ezdxf*.

AutoCAD does not render DIMENSION entities automatically, so I rate AutoCAD as an unfriendly CAD application.

#### Parameters

- **ucs** – user coordinate system
- **discard** – discard rendering done by *ezdxf* (works with BricsCAD, but not tolerated by AutoCAD)

**Returns** Rendering object used to render the DIMENSION entity for analytics

**Return type** BaseDimensionRenderer

## ArcDimension

The ARC\_DIMENSION entity was introduced in DXF R2004 and is **not** documented in the DXF reference.

**See also:**

[Tutorial for Arc Dimensions](#)

Subclass of	<i>ezdxf.entities.Dimension</i>
DXF type	'ARC_DIMENSION'
factory function	<ul style="list-style-type: none"><li>• <i>add_arc_dim_3p()</i></li><li>• <i>add_arc_dim_cra()</i></li><li>• <i>add_arc_dim_arc()</i></li></ul>
Inherited DXF attributes	<a href="#">Common graphical DXF attributes</a>
Required DXF version	R2004 / AC1018

**Warning:** Do not instantiate entity classes by yourself - always use the provided factory functions!

```
class ezdxf.entities.ArcDimension

    dxf.defpoint2
        start point of first extension line in OCS

    dxf.defpoint3
        start point of second extension line in OCS

    dxf.defpoint4
        center point of arc in OCS

    dxf.start_angle
    dxf.end_angle
    dxf.is_partial
    dxf.has_leader
    dxf.leader_point1
    dxf.leader_point2

    dimtype
        Returns always 8.
```

## Ellipse

ELLIPSE ([DXF Reference](#)) with center point at location `dxf.center` and a major axis `dxf.major_axis` as vector. `dxf.ratio` is the ratio of minor axis to major axis. `dxf.start_param` and `dxf.end_param` defines the starting- and the end point of the ellipse, a full ellipse goes from 0 to  $2\pi$ . The ellipse goes from starting- to end param in counter clockwise direction.

`dxf.extrusion` is supported, but does not establish an *OCS*, but creates an 3D entity by extruding the base ellipse in direction of the `dxf.extrusion` vector.

Subclass of	<code>ezdxf.entities.DXFGraphic</code>
DXF type	'ELLIPSE'
factory function	<code>add_ellipse()</code>
Inherited DXF attributes	<a href="#">Common graphical DXF attributes</a>
Required DXF version	DXF R2000 ('AC1015')

```
class ezdxf.entities.Ellipse

    dxf.center
        Center point of circle (2D/3D Point in WCS)

    dxf.major_axis
        Endpoint of major axis, relative to the dxf.center (Vec3), default value is (1, 0, 0).

    dxf.ratio
        Ratio of minor axis to major axis (float), has to be in range from 0.000001 to 1, default value is 1.
```

**dx<sub>f</sub>.start\_param**

Start parameter (float), default value is 0.

**dx<sub>f</sub>.end\_param**

End parameter (float), default value is 2\*pi.

**start\_point**

Returns the start point of the ellipse in WCS.

**end\_point**

Returns the end point of the ellipse in WCS.

**minor\_axis**

Returns the minor axis of the ellipse as Vec3 in WCS.

**construction\_tool()** → ezdxf.math.ellipse.ConstructionEllipse

Returns construction tool `ezdxf.math.ConstructionEllipse`.

**apply\_construction\_tool(*e*:** ez<sub>dxf</sub>.math.ellipse.ConstructionEllipse)

ezdxf.entities.ellipse.Ellipse

Set ELLIPSE data from construction tool `ezdxf.math.ConstructionEllipse`.

**vertices(*params*: Iterable[float])** → Iterable[ezdxf.math.\_vector.Vec3]

Yields vertices on ellipse for iterable *params* in WCS.

**Parameters** **params** – param values in the range from 0 to 2\*pi in radians, param goes counter clockwise around the extrusion vector, major\_axis = local x-axis = 0 rad.

**flattening(*distance*: float, *segments*: int = 8)** → Iterable[ezdxf.math.\_vector.Vec3]

Adaptive recursive flattening. The argument *segments* is the minimum count of approximation segments, if the distance from the center of the approximation segment to the curve is bigger than *distance* the segment will be subdivided. Returns a closed polygon for a full ellipse: start vertex == end vertex.

**Parameters**

- **distance** – maximum distance from the projected curve point onto the segment chord.
- **segments** – minimum segment count

New in version 0.15.

**params(*num*: int)** → Iterable[float]

Returns *num* params from start- to end param in counter clockwise order.

All params are normalized in the range from [0, 2pi).

**transform(*m*: ezdxf.math.\_matrix44.Matrix44)** → ezdxf.entities.ellipse.Ellipse

Transform the ELLIPSE entity by transformation matrix *m* inplace.

**translate(*dx*: float, *dy*: float, *dz*: float)** → ezdxf.entities.ellipse.Ellipse

Optimized ELLIPSE translation about *dx* in x-axis, *dy* in y-axis and *dz* in z-axis, returns *self* (floating interface).

**to\_spline(*replace*=True)** → Spline

Convert ELLIPSE to a `Spline` entity.

Adds the new SPLINE entity to the entity database and to the same layout as the source entity.

**Parameters** **replace** – replace (delete) source entity by SPLINE entity if True

**classmethod from\_arc(*entity*: ezdxf.entities.dxgfd.DXFGraphic)** → ezdxf.entities.ellipse.Ellipse

Create a new ELLIPSE entity from ARC or CIRCLE entity.

The new SPLINE entity has no owner, no handle, is not stored in the entity database nor assigned to any layout!

## Hatch

The HATCH entity ([DXF Reference](#)) fills an enclosed area defined by one or more boundary paths with a hatch pattern, solid fill, or gradient fill.

All points in *OCS* as (x, y) tuples (*Hatch.dxf.elevation* is the z-axis value).

There are two different hatch pattern default scaling, depending on the HEADER variable \$MEASUREMENT, one for ISO measurement (m, cm, mm, ...) and one for imperial measurement (in, ft, yd, ...).

Starting with *ezdxf* v0.15 the default scaling for predefined hatch pattern will be chosen according this measurement setting in the HEADER section, this replicates the behavior of BricsCAD and other CAD applications. *ezdxf* uses the ISO pattern definitions as a base line and scales this pattern down by factor 1/25.6 for imperial measurement usage. The pattern scaling is independent from the drawing units of the document defined by the HEADER variable \$INSUNITS.

Prior to *ezdxf* v0.15 the default scaling was always the ISO measurement scaling, no matter which value \$MEASUREMENT had.

### See also:

[Tutorial for Hatch](#) and [DXF Units](#)

Subclass of	<code>ezdxf.entities.DXFGraphic</code>
DXF type	'HATCH'
Factory function	<code>ezdxf.layouts.BaseLayout.add_hatch()</code>
Inherited DXF attributes	<a href="#">Common graphical DXF attributes</a>
Required DXF version	DXF R2000 ('AC1015')

## Boundary paths helper classes

Path manager: `BoundaryPaths`

- `PolylinePath`
- `EdgePath`
  - `LineEdge`
  - `ArcEdge`
  - `EllipseEdge`
  - `SplineEdge`

## Pattern and gradient helper classes

- `Pattern`
- `PatternLine`
- `Gradient`

```
class ezdxf.entities.Hatch
```

```
    dxf.pattern_name
        Pattern name as string
```

**dx<sub>f</sub>.solid\_fill**

1	solid fill, better use: <i>Hatch.set_solid_fill()</i>
0	pattern fill, better use: <i>Hatch.set_pattern_fill()</i>

**dx<sub>f</sub>.associative**

1	associative hatch
0	not associative hatch

Associations not handled by *ezdxf*, you have to set the handles to the associated DXF entities by yourself.

**dx<sub>f</sub>.hatch\_style**

0	normal
1	outer
2	ignore

(search AutoCAD help for more information)

**dx<sub>f</sub>.pattern\_type**

0	user
1	predefined
2	custom

**dx<sub>f</sub>.pattern\_angle**

Actual pattern angle in degrees (float). Changing this value does not rotate the pattern, use *set\_pattern\_angle()* for this task.

**dx<sub>f</sub>.pattern\_scale**

Actual pattern scaling factor (float). Changing this value does not scale the pattern use *set\_pattern\_scale()* for this task.

**dx<sub>f</sub>.pattern\_double**

1 = double pattern size else 0. (int)

**dx<sub>f</sub>.n\_seed\_points**

Count of seed points (better user: *get\_seed\_points()*)

**dx<sub>f</sub>.elevation**

Z value represents the elevation height of the *OCS*. (float)

**paths**

*BoundaryPaths* object.

**pattern**

*Pattern* object.

**gradient**

*Gradient* object.

**seeds**

List of (x, y) tuples.

**set\_pattern\_definition**(*lines*: Sequence[T\_co], *factor*: float = 1, *angle*: float = 0) → None

Setup pattern definition by a list of definition lines and a definition line is a 4-tuple (angle, base\_point, offset, dash\_length\_items), the pattern definition should be designed for scaling factor 1 and angle 0.

- **angle**: line angle in degrees
- **base-point**: 2-tuple (x, y)
- **offset**: 2-tuple (dx, dy)
- **dash\_length\_items**: list of dash items (item > 0 is a line, item < 0 is a gap and item == 0.0 is a point)

**Parameters**

- **lines** – list of definition lines
- **factor** – pattern scaling factor
- **angle** – rotation angle in degrees

**set\_pattern\_scale**(*scale*: float) → None

Set scaling of pattern definition to *scale*.

Starts always from the original base scaling, `set_pattern_scale(1)` reset the pattern scaling to the original appearance as defined by the pattern designer, but only if the the pattern attribute `dxfl.pattern_scale` represents the actual scaling, it is not possible to recreate the original pattern scaling from the pattern definition itself.

**Parameters** `scale` – pattern scaling factor

**set\_pattern\_angle**(*angle*: float) → None

Set rotation of pattern definition to *angle* in degrees.

Starts always from the original base rotation 0, `set_pattern_angle(0)` reset the pattern rotation to the original appearance as defined by the pattern designer, but only if the the pattern attribute `dxfl.pattern_angle` represents the actual rotation, it is not possible to recreate the original rotation from the pattern definition itself.

**Parameters** `angle` – rotation angle in degrees

**set\_solid\_fill**(*color*: int = 7, *style*: int = 1, *rgb*: RGB = None)

Set `Hatch` to solid fill mode and removes all gradient and pattern fill related data.

**Parameters**

- **color** – [AutoCAD Color Index \(ACI\)](#), (0 = BYBLOCK; 256 = BYLAYER)
- **style** – hatch style (0 = normal; 1 = outer; 2 = ignore)
- **rgb** – true color value as (r, g, b)-tuple - has higher priority than *color*. True color support requires DXF R2000.

**set\_pattern\_fill**(*name*: str, *color*: int = 7, *angle*: float = 0.0, *scale*: float = 1.0, *double*: int = 0, *style*: int = 1, *pattern\_type*: int = 1, *definition*=None) → None

Set `Hatch` and `MPolygon` to pattern fill mode. Removes all gradient related data. The pattern definition should be designed for scaling factor 1. Predefined hatch pattern like “ANSI33” are scaled according to the HEADER variable \$MEASUREMENT for ISO measurement (m, cm, ... ), or imperial units (in, ft, ... ), this replicates the behavior of BricsCAD.

**Parameters**

- **name** – pattern name as string

- **color** – pattern color as *AutoCAD Color Index (ACI)*
- **angle** – angle of pattern fill in degrees
- **scale** – pattern scaling as float
- **double** – double size flag
- **style** – hatch style (0 = normal; 1 = outer; 2 = ignore)
- **pattern\_type** – pattern type (0 = user-defined; 1 = predefined; 2 = custom)
- **definition** – list of definition lines and a definition line is a 4-tuple [angle, base\_point, offset, dash\_length\_items], see [set\\_pattern\\_definition\(\)](#)

**set\_gradient** (*color1*: *Tuple[int, int, int]* = (0, 0, 0), *color2*: *Tuple[int, int, int]* = (255, 255, 255),  
*rotation*: *float* = 0.0, *centered*: *float* = 0.0, *one\_color*: *int* = 0, *tint*: *float* = 0.0, *name*:  
*str* = 'LINEAR') → None

Set *Hatch* and *MPolygon* to gradient fill mode and removes all pattern fill related data. Gradient support requires DXF R2004+. A gradient filled hatch is also a solid filled hatch.

Valid gradient type names are:

- 'LINEAR'
- 'CYLINDER'
- 'INVCYLINDER'
- 'SPHERICAL'
- 'INVSPHERICAL'
- 'HEMISPHERICAL'
- 'INVHEMISPHERICAL'
- 'CURVED'
- 'INVCURVED'

### Parameters

- **color1** – (r, g, b)-tuple for first color, rgb values as int in the range [0, 255]
- **color2** – (r, g, b)-tuple for second color, rgb values as int in the range [0, 255]
- **rotation** – rotation angle in degrees
- **centered** – determines whether the gradient is centered or not
- **one\_color** – 1 for gradient from *color1* to tinted *color1*
- **tint** – determines the tinted target *color1* for a one color gradient. (valid range 0.0 to 1.0)
- **name** – name of gradient type, default "LINEAR"

**set\_seed\_points** (*points*: *Iterable[Tuple[float, float]]*) → None

Set seed points, *points* is an iterable of (x, y)-tuples. I don't know why there can be more than one seed point. All points in *OCS* (*Hatch.dxf.elevation* is the Z value)

**transform** (*m*: *Matrix44*) → Hatch

Transform entity by transformation matrix *m* inplace.

---

```
associate (path: ezdxf.entities.boundary_paths.AbstractBoundaryPath, entities: Iterable[DXFEntity])
```

Set association from hatch boundary *path* to DXF geometry *entities*.

A HATCH entity can be associative to a base geometry, this association is **not** maintained nor verified by *ezdxf*, so if you modify the base geometry the geometry of the boundary path is not updated and no verification is done to check if the associated geometry matches the boundary path, this opens many possibilities to create invalid DXF files: USE WITH CARE!

```
remove_association()
```

Remove associated path elements.

## Boundary Paths

The hatch entity is build by different functional path types, this are filter flags for the *Hatch.dxf.hatch\_style*:

- EXTERNAL: defines the outer boundary of the hatch
- OUTERMOST: defines the first tier of inner hatch boundaries
- DEFAULT: default boundary path

As you will learn in the next sections, these are more the recommended usage type for the flags, but the fill algorithm doesn't care much about that, for instance an OUTERMOST path doesn't have to be inside the EXTERNAL path.

## Island Detection

In general the island detection algorithm works always from outside to inside and alternates filled and unfilled areas. The area between then 1st and the 2nd boundary is filled, the area between the 2nd and the 3rd boundary is unfilled and so on. The different hatch styles defined by the *Hatch.dxf.hatch\_style* attribute are created by filtering some boundary path types.

## Hatch Style

- HATCH\_STYLE\_IGNORE: Ignores all paths except the paths marked as EXTERNAL, if there are more than one path marked as EXTERNAL, they are filled in NESTED style. Creates no hatch if no path is marked as EXTERNAL.
- HATCH\_STYLE\_OUTERMOST: Ignores all paths marked as DEFAULT, remaining EXTERNAL and OUTERMOST paths are filled in NESTED style. Creates no hatch if no path is marked as EXTERNAL or OUTERMOST.
- HATCH\_STYLE\_NESTED: Use all existing paths.

## Hatch Boundary Helper Classes

```
class ezdxf.entities.BoundaryPaths
```

Defines the borders of the hatch, a hatch can consist of more than one path.

```
paths
```

List of all boundary paths. Contains *PolylinePath* and *EdgePath* objects. (read/write)

```
external_paths () → Iterable[ezdxf.entities.boundary_paths.AbstractBoundaryPath]
```

Iterable of external paths, could be empty.

**outermost\_paths** () → Iterable[ezdxf.entities.boundary\_paths.AbstractBoundaryPath]

Iterable of outermost paths, could be empty.

**default\_paths** () → Iterable[ezdxf.entities.boundary\_paths.AbstractBoundaryPath]

Iterable of default paths, could be empty.

**rendering\_paths** (hatch\_style: int = 0) → Iterable[ezdxf.entities.boundary\_paths.AbstractBoundaryPath]

Iterable of paths to process for rendering, filters unused boundary paths according to the given hatch style:

- NESTED: use all boundary paths
- OUTERMOST: use EXTERNAL and OUTERMOST boundary paths
- IGNORE: ignore all paths except EXTERNAL boundary paths

Yields paths in order of EXTERNAL, OUTERMOST and DEFAULT.

**add\_polyline\_path** (path\_vertices: Iterable[Tuple[float, ...]], is\_closed: bool = True, flags: int =

1) → eздxf.entities.boundary\_paths.PolylinePath

Create and add a new [PolylinePath](#) object.

#### Parameters

- **path\_vertices** – iterable of polyline vertices as (x, y) or (x, y, bulge)-tuples.
- **is\_closed** – 1 for a closed polyline else 0
- **flags** – external(1) or outermost(16) or default (0)

**add\_edge\_path** (flags: int = 1) → eздxf.entities.boundary\_paths.EdgePath

Create and add a new [EdgePath](#) object.

#### Parameters **flags** – external(1) or outermost(16) or default (0)

**polyline\_to\_edge\_paths** (just\_with\_bulge=True) → None

Convert polyline paths including bulge values to line- and arc edges.

#### Parameters **just\_with\_bulge** – convert only polyline paths including bulge values if True

**edge\_to\_polyline\_paths** (distance: float, segments: int = 16)

Convert all edge paths to simple polyline paths without bulges.

#### Parameters

- **distance** – maximum distance from the center of the curve to the center of the line segment between two approximation points to determine if a segment should be subdivided.
- **segments** – minimum segment count per curve

**arc\_edges\_to\_ellipse\_edges** () → None

Convert all arc edges to ellipse edges.

**ellipse\_edges\_to\_spline\_edges** (num: int = 32) → None

Convert all ellipse edges to spline edges (approximation).

#### Parameters **num** – count of control points for a **full** ellipse, partial ellipses have proportional fewer control points but at least 3.

**spline\_edges\_to\_line\_edges** (factor: int = 8) → None

Convert all spline edges to line edges (approximation).

#### Parameters **factor** – count of approximation segments = count of control points x factor

**all\_to\_spline\_edges** (num: int = 64) → None

Convert all bulge, arc and ellipse edges to spline edges (approximation).

**Parameters** `num` – count of control points for a **full** circle/ellipse, partial circles/ellipses have proportional fewer control points but at least 3.

**all\_to\_line\_edges** (`num: int = 64, spline_factor: int = 8`) → None

Convert all bulge, arc and ellipse edges to spline edges and approximate this splines by line edges.

#### Parameters

- `num` – count of control points for a **full** circle/ellipse, partial circles/ellipses have proportional fewer control points but at least 3.
- `spline_factor` – count of spline approximation segments = count of control points x `spline_factor`

**clear()** → None

Remove all boundary paths.

**class** `ezdxf.entities.BoundaryPathType`

#### POLYLINE

polyline path type

#### EDGE

edge path type

**class** `ezdxf.entities.PolylinePath`

A polyline as hatch boundary path.

#### type

Path type as `BoundaryPathType.POLYLINE` enum

#### path\_type\_flags

(bit coded flags)

0	default
1	external
2	polyline, will be set by <code>ezdxf</code>
16	outermost

My interpretation of the `path_type_flags`, see also [Tutorial for Hatch](#):

- external - path is part of the hatch outer border
- outermost - path is completely inside of one or more external paths
- default - path is completely inside of one or more outermost paths

If there are troubles with AutoCAD, maybe the hatch entity has the `Hatch.dxf.pixel_size` attribute set - delete it del `hatch.dxf.pixel_size` and maybe the problem is solved. `ezdxf` does not use the `Hatch.dxf.pixel_size` attribute, but it can occur in DXF files created by other applications.

#### is\_closed

True if polyline path is closed.

#### vertices

List of path vertices as (x, y, bulge)-tuples. (read/write)

#### source\_boundary\_objects

List of handles of the associated DXF entities for associative hatches. There is no support for associative hatches by `ezdxf`, you have to do it all by yourself. (read/write)

**set\_vertices** (*vertices*: *Iterable[Sequence[float]]*, *is\_closed*: *bool* = *True*) → None  
Set new *vertices* as new polyline path, a vertex has to be a (x, y) or a (x, y, bulge)-tuple.

**clear()** → None  
Removes all vertices and all handles to associated DXF objects (*source\_boundary\_objects*).

**class** `ezdxf.entities.EdgePath`

Boundary path build by edges. There are four different edge types: *LineEdge*, *ArcEdge*, *EllipseEdge* or *SplineEdge*. Make sure there are no gaps between edges and the edge path must be closed to be recognized as path. AutoCAD is very picky in this regard. *Ezdx*f performs no checks on gaps between the edges and does not prevent creating open loops.

---

**Note:** *ArcEdge* and *EllipseEdge* are ALWAYS represented in counter-clockwise orientation, even if an clockwise oriented edge is required to build a closed loop. To add a clockwise oriented curve swap start- and end angles and set the *ccw* flag to *False* and *ezdxf* will export a correct clockwise orientated curve.

---

**type**

Path type as *BoundaryPathType.EDGE* enum

**path\_type\_flags**

(bit coded flags)

0	default
1	external
16	outermost

see *PolylinePath.path\_type\_flags*

**edges**

List of boundary edges of type *LineEdge*, *ArcEdge*, *EllipseEdge* or *SplineEdge*

**source\_boundary\_objects**

Required for associative hatches, list of handles to the associated DXF entities.

**clear()** → None

Delete all edges.

**add\_line** (*start*: *Union[Sequence[float], ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3]*, *end*: *Union[Sequence[float], ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3]*) → *LineEdge*  
Add a *LineEdge* from *start* to *end*.

#### Parameters

- **start** – start point of line, (x, y)-tuple
- **end** – end point of line, (x, y)-tuple

**add\_arc** (*center*: *Union[Sequence[float], ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3]*, *radius*: *float* = *1.0*, *start\_angle*: *float* = *0.0*, *end\_angle*: *float* = *360.0*, *ccw*: *bool* = *True*) → *ArcEdge*  
Add an *ArcEdge*.

#### Adding Clockwise Oriented Arcs:

Clockwise oriented *ArcEdge* objects are sometimes necessary to build closed loops, but the *ArcEdge* objects are always represented in counter-clockwise orientation. To add a clockwise oriented *ArcEdge* you have to swap the start- and end angle and set the *ccw* flag to *False*, e.g. to add a clockwise oriented *ArcEdge* from 180 to 90 degree, add the *ArcEdge* in counter-clockwise orientation with swapped angles:

```
edge_path.add_arc(center, radius, start_angle=90, end_angle=180, ccw=False)
```

### Parameters

- **center** – center point of arc, (x, y)-tuple
- **radius** – radius of circle
- **start\_angle** – start angle of arc in degrees (*end\_angle* for a clockwise oriented arc)
- **end\_angle** – end angle of arc in degrees (*start\_angle* for a clockwise oriented arc)
- **ccw** – True for counter clockwise False for clockwise orientation

```
add_ellipse(center: Union[Sequence[float], ezdxf.math._vector.Vector2, ezdxf.math._vector.Vector3], major_axis: Union[Sequence[float], ezdxf.math._vector.Vector2, ezdxf.math._vector.Vector3] = (1.0, 0.0), ratio: float = 1.0, start_angle: float = 0.0, end_angle: float = 360.0, ccw: bool = True) → ezdxf.entities.boundary_paths.EllipseEdge
```

Add an [EllipseEdge](#).

### Adding Clockwise Oriented Ellipses:

Clockwise oriented [EllipseEdge](#) objects are sometimes necessary to build closed loops, but the [EllipseEdge](#) objects are always represented in counter-clockwise orientation. To add a clockwise oriented [EllipseEdge](#) you have to swap the start- and end angle and set the *ccw* flag to `False`, e.g. to add a clockwise oriented [EllipseEdge](#) from 180 to 90 degree, add the [EllipseEdge](#) in counter-clockwise orientation with swapped angles:

```
edge_path.add_ellipse(center, major_axis, ratio, start_angle=90, end_angle=180, ccw=False)
```

### Parameters

- **center** – center point of ellipse, (x, y)-tuple
- **major\_axis** – vector of major axis as (x, y)-tuple
- **ratio** – ratio of minor axis to major axis as float
- **start\_angle** – start angle of ellipse in degrees (*end\_angle* for a clockwise oriented ellipse)
- **end\_angle** – end angle of ellipse in degrees (*start\_angle* for a clockwise oriented ellipse)
- **ccw** – True for counter clockwise False for clockwise orientation

```
add_spline(fit_points: Optional[Iterable[Union[Sequence[float], ezdxf.math._vector.Vector2, ezdxf.math._vector.Vector3]]] = None, control_points: Optional[Iterable[Union[Sequence[float], ezdxf.math._vector.Vector2, ezdxf.math._vector.Vector3]]] = None, knot_values: Optional[Iterable[float]] = None, weights: Optional[Iterable[float]] = None, degree: int = 3, periodic: int = 0, start_tangent: Union[Sequence[float], ezdxf.math._vector.Vector2, ezdxf.math._vector.Vector3, None] = None, end_tangent: Union[Sequence[float], ezdxf.math._vector.Vector2, ezdxf.math._vector.Vector3, None] = None) → ezdxf.entities.boundary_paths.SplineEdge
```

Add a [SplineEdge](#).

### Parameters

- **fit\_points** – points through which the spline must go, at least 3 fit points are required. list of (x, y)-tuples

- **control\_points** – affects the shape of the spline, mandatory and AutoCAD crashes on invalid data. list of (x, y)-tuples
- **knot\_values** – (knot vector) mandatory and AutoCAD crashes on invalid data. list of floats; `ezdxf` provides two tool functions to calculate valid knot values: `ezdxf.math.uniform_knot_vector()`, `ezdxf.math.open_uniform_knot_vector()` (default if None)
- **weights** – weight of control point, not mandatory, list of floats.
- **degree** – degree of spline (int)
- **periodic** – 1 for periodic spline, 0 for none periodic spline
- **start\_tangent** – start\_tangent as 2d vector, optional
- **end\_tangent** – end\_tangent as 2d vector, optional

**Warning:** Unlike for the spline entity AutoCAD does not calculate the necessary *knot\_values* for the spline edge itself. On the contrary, if the *knot\_values* in the spline edge are missing or invalid AutoCAD **crashes**.

```
class ezdxf.entities.EdgeType
```

**LINE**

**ARC**

**ELLIPSE**

**SPLINE**

```
class ezdxf.entities.LineEdge
```

Straight boundary edge.

**type**

Edge type as `EdgeType.LINE` enum

**start**

Start point as (x, y)-tuple. (read/write)

**end**

End point as (x, y)-tuple. (read/write)

```
class ezdxf.entities.ArcEdge
```

Arc as boundary edge in counter-clockwise orientation, see `EdgePath.add_arc()`.

**type**

Edge type as `EdgeType.ARC` enum

**center**

Center point of arc as (x, y)-tuple. (read/write)

**radius**

Arc radius as float. (read/write)

**start\_angle**

Arc start angle in counter-clockwise orientation in degrees. (read/write)

**end\_angle**

Arc end angle in counter-clockwise orientation in degrees. (read/write)

---

```

ccw
    True for counter clockwise arc else False. (read/write)

class ezdxf.entities.EllipseEdge
    Elliptic arc as boundary edge in counter-clockwise orientation, see EdgePath.add\_ellipse\(\).

type
    Edge type as EdgeType.ELLIPSE enum

major_axis_vector
    Ellipse major axis vector as (x, y)-tuple. (read/write)

minor_axis_length
    Ellipse minor axis length as float. (read/write)

radius
    Ellipse radius as float. (read/write)

start_angle
    Ellipse start angle in counter-clockwise orientation in degrees. (read/write)

end_angle
    Ellipse end angle in counter-clockwise orientation in degrees. (read/write)

ccw
    True for counter clockwise ellipse else False. (read/write)

class ezdxf.entities.SplineEdge
    Spline as boundary edge.

type
    Edge type as EdgeType.SPLINE enum

degree
    Spline degree as int. (read/write)

rational
    1 for rational spline else 0. (read/write)

periodic
    1 for periodic spline else 0. (read/write)

knot_values
    List of knot values as floats. (read/write)

control_points
    List of control points as (x, y)-tuples. (read/write)

fit_points
    List of fit points as (x, y)-tuples. (read/write)

weights
    List of weights (of control points) as floats. (read/write)

start_tangent
    Spline start tangent (vector) as (x, y)-tuple. (read/write)

end_tangent
    Spline end tangent (vector) as (x, y)-tuple. (read/write)

```

## Hatch Pattern Definition Helper Classes

**class** ezdxf.entities.Pattern

### lines

List of pattern definition lines (read/write). see [PatternLine](#)

**add\_line**(angle: float = 0, base\_point: Union[Sequence[float], ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3] = (0, 0), offset: Union[Sequence[float], ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3] = (0, 0), dash\_length\_items: Optional[Iterable[float]] = None) → None

Create a new pattern definition line and add the line to the [Pattern.lines](#) attribute.

**clear()** → None

Delete all pattern definition lines.

**scale**(factor: float = 1, angle: float = 0) → None

Scale and rotate pattern.

Be careful, this changes the base pattern definition, maybe better use [Hatch.set\\_pattern\\_scale\(\)](#) or [Hatch.set\\_pattern\\_angle\(\)](#).

### Parameters

- **factor** – scaling factor
- **angle** – rotation angle in degrees

**class** ezdxf.entities.PatternLine

Represents a pattern definition line, use factory function [Pattern.add\\_line\(\)](#) to create new pattern definition lines.

### angle

Line angle in degrees. (read/write)

### base\_point

Base point as (x, y)-tuple. (read/write)

### offset

Offset as (x, y)-tuple. (read/write)

### dash\_length\_items

List of dash length items (item > 0 is line, < 0 is gap, 0.0 = dot). (read/write)

## Hatch Gradient Fill Helper Classes

**class** ezdxf.entities.Gradient

### color1

First rgb color as (r, g, b)-tuple, rgb values in range 0 to 255. (read/write)

### color2

Second rgb color as (r, g, b)-tuple, rgb values in range 0 to 255. (read/write)

### one\_color

If [one\\_color](#) is 1 - the hatch is filled with a smooth transition between [color1](#) and a specified [tint](#) of [color1](#). (read/write)

**rotation**

Gradient rotation in degrees. (read/write)

**centered**

Specifies a symmetrical gradient configuration. If this option is not selected, the gradient fill is shifted up and to the left, creating the illusion of a light source to the left of the object. (read/write)

**tint**

Specifies the tint (`color1` mixed with white) of a color to be used for a gradient fill of one color. (read/write)

**See also:**

*Tutorial for Hatch Pattern Definition*

**Helix**

HELIX curve (DXF Reference).

The helix curve is represented by a cubic B-spline curve, therefore the HELIX entity is also derived from the SPLINE entity.

New in version 0.18.

**See also:**

- [Wikipedia](#) article about the helix shape

Subclass of	<code>ezdxf.entities.Spline</code>
DXF type	'HELIX'
Factory function	<code>ezdxf.layouts.BaseLayout.add_helix()</code>
Inherited DXF attributes	<i>Common graphical DXF attributes</i>
Required DXF version	DXF R2000 ('AC1015')

**class ezdxf.entities.Helix**

All points in `WCS` as (x, y, z) tuples

**dxfs.axis\_base\_point**

The base point of the helix axis (Vec3).

**dxfs.start\_point**

The starting point of the helix curve (Vec3). This also defines the base radius as the distance from the start point to the axis base point.

**dxfs.axis\_vector**

Defines the direction of the helix axis (Vec3).

**dxfs.radius**

Defines the top radius of the helix (float).

**dxfs.turn\_height**

Defines the pitch (height if one helix turn) of the helix (float).

**dxfs.turns**

The count of helix turns (float).

**dxfs.handedness**

Helix orientation (int).

0	clock wise (left handed)
1	counter clockwise (right handed)

`dxfs.constrain`

0	constrain turn height (pitch)
1	constrain count of turns
2	constrain total height

## Image

Add a raster IMAGE ([DXF Reference](#)) to the DXF file, the file itself is not embedded into the DXF file, it is always a separated file. The IMAGE entity is like a block reference, you can use it multiple times to add the image on different locations with different scales and rotations. But therefore you need also a IMAGEDEF entity, see [\*ImageDef\*](#). `ezdxf` creates only images in the xy-plan, you can place images in the 3D space too, but then you have to set the `Image.dxf.u_pixel` and the `Image.dxf.v_pixel` vectors by yourself.

Subclass of	<code>ezdxf.entities.DXFGraphic</code>
DXF type	'IMAGE'
Factory function	<code>ezdxf.layouts.BaseLayout.add_image()</code>
Inherited DXF attributes	<i>Common graphical DXF attributes</i>
Required DXF version	DXF R2000 ('AC1015')

**Warning:** Do not instantiate entity classes by yourself - always use the provided factory functions!

`class ezdxf.entities.Image`

`dxfs.insert`

Insertion point, lower left corner of the image (3D Point in [WCS](#)).

`dxfs.u_pixel`

U-vector of a single pixel (points along the visual bottom of the image, starting at the insertion point) as (x, y, z) tuple

`dxfs.v_pixel`

V-vector of a single pixel (points along the visual left side of the image, starting at the insertion point) as (x, y, z) tuple

`dxfs.image_size`

Image size in pixels as (x, y) tuple

`dxfs.image_def_handle`

Handle to the image definition entity, see [\*ImageDef\*](#)

`dxfs.flags`

<i>Image.dxf.flags</i>	Value	Description
Image.SHOW_IMAGE	1	Show image
Image.SHOW_WHEN_NOT_ALIGNED	2	Show image when not aligned with screen
Image.USE_CLIPPING_BOUNDARY	4	Use clipping boundary
Image.USE_TRANSPARENCY	8	Transparency is on

**dx.dxf.clipping**

Clipping state:

0	clipping off
1	clipping on

**dx.dxf.brightness**

Brightness value (0-100; default = 50)

**dx.dxf.contrast**

Contrast value (0-100; default = 50)

**dx.dxf.fade**

Fade value (0-100; default = 0)

**dx.dxf.clipping\_boundary\_type**

Clipping boundary type:

1	Rectangular
2	Polygonal

**dx.dxf.count\_boundary\_points**Number of clip boundary vertices, maintained by *ezdxf*.**dx.dxf.clip\_mode**

Clip mode (DXF R2010):

0	Outside
1	Inside

**boundary\_path**

A list of vertices as pixel coordinates, Two vertices describe a rectangle, lower left corner is (-0.5, -0.5) and upper right corner is (ImageSizeX-0.5, ImageSizeY-0.5), more than two vertices is a polygon as clipping path. All vertices as pixel coordinates. (read/write)

**image\_def**Returns the associated IMAGEDEF entity, see [ImageDef](#).**reset\_boundary\_path () → None**

Reset boundary path to the default rectangle [(-0.5, -0.5), (ImageSizeX-0.5, ImageSizeY-0.5)].

**set\_boundary\_path (vertices: Iterable[Union[Sequence[float], ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3]]) → None**Set boundary path to *vertices*. Two vertices describe a rectangle (lower left and upper right corner), more than two vertices is a polygon as clipping path.**boundary\_path\_wcs () → List[ezdxf.math.\_vector.Vec3]**

Returns the boundary/clipping path in WCS coordinates.

New in version 0.14.

Since version 0.16 it's recommended to create the clipping path as `Path` object by the `make_path()` function:

```
form ezdxf.path import make_path

image = ... # get image entity
clipping_path = make_path(image)
```

### `transform(m: Matrix44) → ImageBase`

Transform IMAGE entity by transformation matrix *m* inplace.

## Leader

The LEADER entity ([DXF Reference](#)) represents an arrow, made up of one or more vertices (or spline fit points) and an arrowhead. The label or other content to which the `Leader` is attached is stored as a separate entity, and is not part of the `Leader` itself.

`Leader` shares its styling infrastructure with `Dimension`.

By default a `Leader` without any annotation is created. For creating more fancy leaders and annotations see documentation provided by Autodesk or [Demystifying DXF: LEADER and MULTILEADER implementation notes](#).

Subclass of	<code>ezdxf.entities.DXFGraphic</code>
DXF type	'LEADER'
Factory function	<code>ezdxf.layouts.BaseLayout.add_leader()</code>
Inherited DXF attributes	<i>Common graphical DXF attributes</i>
Required DXF version	DXF R2000 ('AC1015')

### `class ezdxf.entities.Leader`

#### `dxf.dimstyle`

Name of Dimstyle as string.

#### `dxf.has_arrowhead`

0	Disabled
1	Enabled

#### `dxf.path_type`

Leader path type:

0	Straight line segments
1	Spline

#### `dxf.annotation_type`

0	Created with text annotation
1	Created with tolerance annotation
2	Created with block reference annotation
3	Created without any annotation (default)

**dx.f.hookline\_direction**

Hook line direction flag:

0	Hookline (or end of tangent for a splined leader) is the opposite direction from the horizontal vector
1	Hookline (or end of tangent for a splined leader) is the same direction as horizontal vector (see <code>has_hook_line</code> )

**dx.f.has\_hookline**

0	No hookline
1	Has a hookline

**dx.f.text\_height**

Text annotation height in drawing units.

**dx.f.text\_width**

Text annotation width.

**dx.f.block\_color**

Color to use if leader's DIMCLRD = BYBLOCK

**dx.f.annotation\_handle**

Hard reference (handle) to associated annotation (`MText`, Tolerance, or `Insert` entity)

**dx.f.normal\_vector**

Extrusion vector? default = (0, 0, 1).

**.dx.f.horizontal\_direction**

Horizontal direction for leader, default = (1, 0, 0).

**dx.f.leader\_offset\_block\_ref**

Offset of last leader vertex from block reference insertion point, default = (0, 0, 0).

**dx.f.leader\_offset\_annotation\_placement**

Offset of last leader vertex from annotation placement point, default = (0, 0, 0).

**vertices**

List of `Vec3` objects, representing the vertices of the leader (3D Point in `WCS`).

**set\_vertices**(vertices: *Iterable[Union[Sequence[float], ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3]]*)

Set vertices of the leader, vertices is an iterable of (x, y [,z]) tuples or `Vec3`.

**transform**(m: `Matrix44`) → Leader

Transform LEADER entity by transformation matrix *m* inplace.

**virtual\_entities**() → Iterable[ezdxf.entities.dxfgfx.DXFGraphic]

Yields ‘virtual’ parts of LEADER as DXF primitives.

This entities are located at the original positions, but are not stored in the entity database, have no handle and are not assigned to any layout.

**explode**(target\_layout: `BaseLayout` = `None`) → EntityQuery

Explode parts of LEADER as DXF primitives into target layout, if target layout is `None`, the target layout is the layout of the LEADER.

Returns an `EntityQuery` container with all DXF parts.

**Parameters** `target_layout` – target layout for DXF parts, `None` for same layout as source entity.

New in version 0.14.

## Line

LINE (DXF Reference) entity is a 3D line from `Line.dxf.start` to `Line.dxf.end`.

Subclass of	<code>ezdxf.entities.DXFGraphic</code>
DXF type	'LINE'
Factory function	<code>ezdxf.layouts.BaseLayout.add_line()</code>
Inherited DXF Attributes	<i>Common graphical DXF attributes</i>

**Warning:** Do not instantiate entity classes by yourself - always use the provided factory functions!

```
class ezdxf.entities.Line

    dxf.start
        start point of line (2D/3D Point in WCS)

    dxf.end
        end point of line (2D/3D Point in WCS)

    dxf.thickness
        Line thickness in 3D space in direction extrusion, default value is 0. This value should not be confused with the lineweight value.

    dxf.extrusion
        extrusion vector, default value is (0, 0, 1)

    transform(m: ezdxf.math._matrix44.Matrix44) → ezdxf.entities.line.Line
        Transform the LINE entity by transformation matrix m inplace.

    translate(dx: float, dy: float, dz: float) → ezdxf.entities.line.Line
        Optimized LINE translation about dx in x-axis, dy in y-axis and dz in z-axis.
```

## LWPolyline

The LWPOLYLINE entity (Lightweight POLYLINE, DXF Reference) is defined as a single graphic entity, which differs from the old-style `Polyline` entity, which is defined as a group of sub-entities. `LWPolyline` display faster (in AutoCAD) and consume less disk space, it is a planar element, therefore all points are located in the `OCS` as (x, y)-tuples (`LWPolyline.dxf.elevation` is the z-axis value).

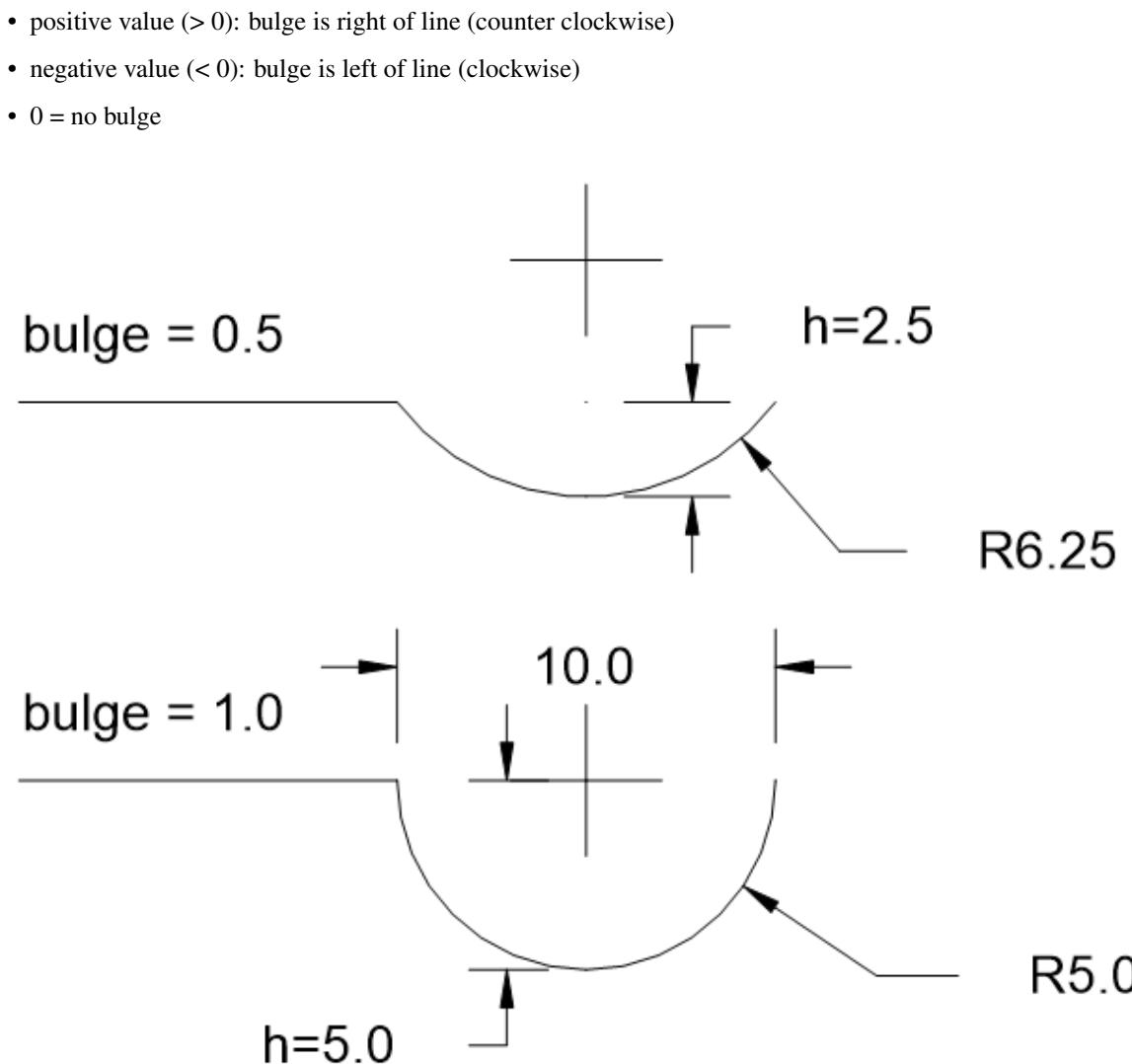
Changed in version 0.8.9: `LWPolyline` stores point data as packed data (`array.array`).

Subclass of	<code>ezdxf.entities.DXFGraphic</code>
DXF type	'LWPOLYLINE'
factory function	<code>add_lwpolyline()</code>
Inherited DXF attributes	<i>Common graphical DXF attributes</i>
Required DXF version	DXF R2000 ('AC1015')

## Bulge value

The bulge value is used to create arc shaped line segments for `Polyline` and `LWPolyline` entities. The arc starts at the vertex which includes the bulge value and ends at the following vertex. The bulge value defines the ratio of the arc sagitta (versine) to half line segment length, a bulge value of 1 defines a semicircle.

The sign of the bulge value defines the side of the bulge:



## Start- and end width

The start width and end width values defines the width in drawing units for the following line segment. To use the default width value for a line segment set value to 0.

## Width and bulge values at last point

The width and bulge values of the last point has only a meaning if the polyline is closed, and they apply to the last line segment from the last to the first point.

**See also:**

*Tutorial for LWPolyline* and *Bulge Related Functions*

**User Defined Point Format Codes**

Code	Point Component
x	x-coordinate
y	y-coordinate
s	start width
e	end width
b	bulge value
v	(x, y [, z]) as tuple

`class ezdxf.entities.LWPolyline`

`dx.dxf.elevation`

*OCS* z-axis value for all polyline points, default=0

`dx.dxf.flags`

Constants defined in `ezdxf.lldxf.const`:

dx.dxf.flags	Value	Description
LWPOLYLINE_CLOSED	1	polyline is closed
LWPOLYLINE_PLINEGEN	128	???

`dx.dxf.const_width`

Constant line width (float), default value is 0.

`dx.dxf.count`

Count of polyline points (read only), same as `len(polyline)`

`close(state: bool = True) → None`

Get/set closed state of LWPOLYLINE. Compatibility interface to `Polyline`

`__len__() → int`

Returns count of polyline points.

`__getitem__(index: int) → Tuple[float, float, float, float, float]`

Returns point at position `index` as (x, y, start\_width, end\_width, bulge) tuple. start\_width, end\_width and bulge is 0 if not present, supports extended slicing. Point format is fixed as 'xyseb'.

All coordinates in *OCS*.

`__setitem__(index: int, value: Sequence[float]) → None`

Set point at position `index` as (x, y, [start\_width, [end\_width, [bulge]]]) tuple. If start\_width or end\_width is 0 or left off the default value is used. If the bulge value is left off, bulge is 0 by default (straight line). Does NOT support extend slicing. Point format is fixed as 'xyseb'.

All coordinates in *OCS*.

**Parameters**

- **index** – point index
- **value** – point value as (x, y, [start\_width, [end\_width, [bulge]]]) tuple

---

**`__delitem__(index: int) → None`**  
Delete point at position `index`, supports extended slicing.

**`__iter__() → Iterator[Tuple[float, float, float, float]]`**  
Returns iterable of tuples (x, y, start\_width, end\_width, bulge).

**`vertices() → Iterator[Tuple[float, float]]`**  
Returns iterable of all polyline points as (x, y) tuples in *OCS* (`dx.dxf.elevation` is the z-axis value).

**`vertices_in_wcs() → Iterable[ezdxf.math._vector.Vec3]`**  
Returns iterable of all polyline points as Vec3(x, y, z) in *WCS*.

**`append(point: Sequence[float], format: str = 'xyseb') → None`**  
Append `point` to polyline, `format` specifies a user defined point format.  
All coordinates in *OCS*.

#### Parameters

- **point** – (x, y, [start\_width, [end\_width, [bulge]]]) tuple
- **format** – format string, default is 'xyseb', see: [format codes](#)

**`append_points(points: Iterable[Sequence[float]], format: str = 'xyseb') → None`**  
Append new `points` to polyline, `format` specifies a user defined point format.  
All coordinates in *OCS*.

#### Parameters

- **points** – iterable of point, point is (x, y, [start\_width, [end\_width, [bulge]]]) tuple
- **format** – format string, default is 'xyseb', see: [format codes](#)

**`insert(pos: int, point: Sequence[float], format: str = 'xyseb') → None`**  
Insert new point in front of positions `pos`, `format` specifies a user defined point format.  
All coordinates in *OCS*.

#### Parameters

- **pos** – insert position
- **point** – point data
- **format** – format string, default is 'xyseb', see: [format codes](#)

**`clear() → None`**  
Remove all points.

**`get_points(format: str = 'xyseb') → List[Sequence[float]]`**  
Returns all points as list of tuples, `format` specifies a user defined point format.  
All points in *OCS* as (x, y) tuples (`dx.dxf.elevation` is the z-axis value).

**Parameters** `format` – format string, default is 'xyseb', see [format codes](#)

**`set_points(points: Iterable[Sequence[float]], format: str = 'xyseb') → None`**  
Remove all points and append new `points`.  
All coordinates in *OCS*.

#### Parameters

- **points** – iterable of point, point is (x, y, [start\_width, [end\_width, [bulge]]]) tuple
- **format** – format string, default is 'xyseb', see [format codes](#)

**points** (*format: str = 'xyseb'*) → Iterator[List[Sequence[float]]]

Context manager for polyline points. Returns a standard Python list of points, according to the format string.

All coordinates in *OCS*.

**Parameters** **format** – format string, see *format codes*

**transform** (*m: ezdxf.math.\_matrix44.Matrix44*) → ezdxf.entities.lwpolyline.LWPolyline

Transform the LWPOLYLINE entity by transformation matrix *m* inplace.

A non-uniform scaling is not supported if the entity contains circular arc segments (bulges).

**Parameters** **m** – transformation *Matrix44*

**Raises** NonUniformScalingError – for non uniform scaling of entity containing circular arc segments (bulges)

**virtual\_entities** () → Iterable[Union[Line, Arc]]

Yields the graphical representation of LWPOLYLINE as virtual DXF primitives (LINE or ARC).

These virtual entities are located at the original location, but are not stored in the entity database, have no handle and are not assigned to any layout.

**explode** (*target\_layout: BaseLayout = None*) → EntityQuery

Explode the LWPOLYLINE entity as DXF primitives (LINE or ARC) into the target layout, if the target layout is *None*, the target layout is the layout of the source entity.

Returns an *EntityQuery* container of all DXF primitives.

**Parameters** **target\_layout** – target layout for the DXF primitives, *None* for same layout as the source entity.

## MLine

The MLINE entity ([DXF Reference](#)).

Subclass of	<i>ezdxf.entities.DXFGraphic</i>
DXF type	'MLINE'
factory function	<i>add_mline()</i>
Inherited DXF attributes	<a href="#">Common graphical DXF attributes</a>
Required DXF version	DXF R2000 ('AC1015')

**class** ezdxf.entities.MLine

**dxfs.style\_name**

*MLineStyle* name stored in Drawing.mline\_styles dictionary, use *set\_style()* to change the MLINESTYLE and update geometry accordingly.

**dxfs.style\_handle**

Handle of *MLineStyle*, use *set\_style()* to change the MLINESTYLE and update geometry accordingly.

**dxfs.scale\_factor**

MLINE scaling factor, use method *set\_scale\_factor()* to change the scaling factor and update geometry accordingly.

**dx.dxf.justification**

Justification defines the location of the MLINE in relation to the reference line, use method `set_justification()` to change the justification and update geometry accordingly.

Constants defined in `ezdxf.lldxf.const`:

dx.dxf.justification	Value
MLINE_TOP	0
MLINE_ZERO	1
MLINE_BOTTOM	2
MLINE_RIGHT (alias)	0
MLINE_CENTER (alias)	1
MLINE_LEFT (alias)	2

**dx.dxf.flags**

Use method `close()` and the properties `start_caps` and `end_caps` to change these flags.

Constants defined in `ezdxf.lldxf.const`:

dx.dxf.flags	Value
MLINE_HAS_VERTEX	1
MLINE_CLOSED	2
MLINE_SUPPRESS_START_CAPS	4
MLINE_SUPPRESS_END_CAPS	8

**dx.dxf.start\_location**

Start location of the reference line. (read only)

**dx.dxf.count**

Count of MLINE vertices. (read only)

**dx.dxf.style\_element\_count**

Count of elements in `MLineStyle` definition. (read only)

**dx.dxf.extrusion**

Normal vector of the entity plane, but MLINE is not an OCS entity, all vertices of the reference line are WCS! (read only)

**vertices**

MLINE vertices as `MLineVertex` objects, stored in a regular Python list.

**set\_style(name: str) → None**

Set MLINESTYLE by name and update geometry accordingly. The MLINESTYLE definition must exist.

**set\_scale\_factor(value: float) → None**

Set the scale factor and update geometry accordingly.

**set\_justification(value: int) → None**

Set MLINE justification and update geometry accordingly. See `dx.dxf.justification` for valid settings.

**close(state: bool = True) → None**

Get/set closed state of MLINE and update geometry accordingly. Compatibility interface to `Polyline`

**\_\_len\_\_()**

Count of MLINE vertices.

**start\_location() → ezdxf.math.\_vector.Vec3**

Returns the start location of the reference line. Callback function for `dx.dxf.start_location`.

**get\_locations()** → List[ezdxf.math.\_vector.Vec3]

Returns the vertices of the reference line.

**extend(vertices: Iterable[Union[Sequence[float], ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3]])**

→ None

Append multiple vertices to the reference line.

It is possible to work with 3D vertices, but all vertices have to be in the same plane and the normal vector of this plan is stored as extrusion vector in the MLINE entity.

**clear()** → None

Remove all MLINE vertices.

**update\_geometry()** → None

Regenerate the MLINE geometry based on current settings.

**generate\_geometry(vertices: List[ezdxf.math.\_vector.Vec3])** → None

Regenerate the MLINE geometry for new reference line defined by *vertices*.

**transform(m: Matrix44)** → DXFGraphic

Transform MLINE entity by transformation matrix *m* inplace.

**virtual\_entities()** → Iterator[ezdxf.entities.dxfgfx.DXFGraphic]

Yields ‘virtual’ parts of MLINE as LINE, ARC and HATCH entities.

This entities are located at the original positions, but are not stored in the entity database, have no handle and are not assigned to any layout.

**explode(target\_layout: BaseLayout = None)** → EntityQuery

Explode parts of MLINE as LINE, ARC and HATCH entities into target layout, if target layout is None, the target layout is the layout of the MLINE.

Returns an *EntityQuery* container with all DXF parts.

**Parameters** **target\_layout** – target layout for DXF parts, None for same layout as source entity.

**class** eздxf.entities.MLineVertex

**location**

Reference line vertex location.

**line\_direction**

Reference line direction.

**miter\_direction**

**line\_params**

The line parameterization is a list of float values. The list may contain zero or more items.

The first value (miter-offset) is the distance from the vertex *location* along the *miter\_direction* vector to the point where the line element’s path intersects the miter vector.

The next value (line-start-offset) is the distance along the *line\_direction* from the miter/line path intersection point to the actual start of the line element.

The next value (dash-length) is the distance from the start of the line element (dash) to the first break (gap) in the line element. The successive values continue to list the start and stop points of the line element in this segment of the mline.

**fill\_params**

The fill parameterization is also a list of float values. Similar to the line parameterization, it describes the parameterization of the fill area for this mline segment. The values are interpreted identically to the line

parameters and when taken as a whole for all line elements in the mline segment, they define the boundary of the fill area for the mline segment.

### `class ezdxf.entities.MLineStyle`

The `MLineStyle` stores the style properties for the MLINE entity.

`dxfs.name`

`dxfs.description`

`dxfs.flags`

`dxfs.fill_color`

*AutoCAD Color Index (ACI)* value of the fill color

`dxfs.start_angle`

`dxfs.end_angle`

`elements`

*MLineStyleElements* object

`update_all()`

Update all MLINE entities using this MLINESTYLE.

The update is required if elements were added or removed or the offset of any element was changed.

### `class ezdxf.entities.mline.MLineStyleElements`

`elements`

List of `MLineStyleElement` objects, one for each line element.

`MLineStyleElements.__len__()`

`MLineStyleElements.__getitem__(item)`

`MLineStyleElements.append(offset: float, color: int = 0, linetype: str = 'BYLAYER') → None`

Append a new line element.

#### Parameters

- `offset` – normal offset from the reference line: if justification is `MLINE_ZERO`, positive values are above and negative values are below the reference line.
- `color` – *AutoCAD Color Index (ACI)* value
- `linetype` – linetype name

### `class ezdxf.entities.mline.MLineStyleElement`

Named tuple to store properties of a line element.

`offset`

Normal offset from the reference line: if justification is `MLINE_ZERO`, positive values are above and negative values are below the reference line.

`color`

*AutoCAD Color Index (ACI)* value

`linetype`

Linetype name

## Mesh

The MESH entity ([DXF Reference](#)) is a 3D mesh similar to the [Polyface](#) entity.

All vertices in [WCS](#) as (x, y, z) tuples

Changed in version 0.8.9: [Mesh](#) stores vertices, edges, faces and creases as packed data.

Subclass of	<code>ezdxf.entities.DXFGraphic</code>
DXF type	'MESH'
Factory function	<code>ezdxf.layouts.BaseLayout.add_mesh()</code>
Inherited DXF attributes	<a href="#">Common graphical DXF attributes</a>
Required DXF version	DXF R2000 ('AC1015')

### See also:

[Tutorial for Mesh](#) and helper classes: [MeshBuilder](#), [MeshVertexMerger](#)

**class** `ezdxf.entities.Mesh`

**dxdf.version**

**dxdf.blend\_creature**

0 = off, 1 = on

**dxdf.subdivision\_levels**

0 for no smoothing else integer greater than 0.

**vertices**

Vertices as list like [VertexArray](#). (read/write)

**edges**

Edges as list like [TagArray](#). (read/write)

**faces**

Faces as list like [TagList](#). (read/write)

**creases**

Creases as `array.array`. (read/write)

**edit\_data()** → `Iterator[ezdxf.entities.mesh.MeshData]`

Context manager various mesh data, returns [MeshData](#).

Despite that vertices, edge and faces since `ezdxf` v0.8.9 are accessible as packed data types, the usage of [MeshData](#) by context manager `edit_data()` is still recommended.

**transform**(*m*: `ezdxf.math._matrix44.Matrix44`) → `ezdxf.entities.mesh.Mesh`

Transform the MESH entity by transformation matrix *m* inplace.

## MeshData

**class** `ezdxf.entities.MeshData`

**vertices**

A standard Python list with (x, y, z) tuples (read/write)

**faces**

A standard Python list with (v1, v2, v3,...) tuples (read/write)

Each face consist of a list of vertex indices (= index in `vertices`).

**edges**

A standard Python list with (v1, v2) tuples (read/write). These list represents the edges to which the `edge_creature_values` values will be applied. Each edge consist of exact two vertex indices (= index in `vertices`).

**edge\_creature\_values**

A standard Python list of float values, one value for each edge. (read/write)

`add_face(vertices: Iterable[Union[Sequence[float], ezdxf.math._vector.Vec2,`

`ezdxf.math._vector.Vec3]]) → Sequence[int]`

Add a face by coordinates, vertices is a list of (x, y, z) tuples.

`add_edge_creature(v1: int, v2: int, creature: float)`

Add an edge creature value, the edge is defined by the vertex indices `v1` and `v2`. The creature value defines the amount of subdivision that will be applied to this edge. A creature value of the subdivision level prevents the edge from deformation and a value of 0.0 means no protection from subdividing.

`optimize(precision: int = 6)`

Try to reduce vertex count by merging near vertices. `precision` defines the decimal places for coordinate be equal to merge two vertices.

## MPolygon

The MPOLYGON entity is not a core DXF entity and is not supported by every CAD application or DXF library.

The `MPolygon` class is very similar to the `Hatch` class with small differences in supported DXF attributes and features.

The boundary paths of the MPOLYGON are visible and use the graphical DXF attributes of the main entity like `dxf.color`, `dxf.linetype` and so on. The solid filling is only visible if the attribute `dxf.solid_fill` is 1, the color of the solid fill is defined by `dxf.fill_color` as [AutoCAD Color Index \(ACI\)](#).

MPOLYGON supports `ezdxf.entities.Gradient` settings like HATCH for DXF R2004+. This feature is used by method `MPolygon.set_solid_fill()` to set a solid RGB fill color as linear gradient, this disables pattern fill automatically.

The MPOLYGON does not support associated source path entities, because the MPOLYGON also represents the boundary paths as visible graphical objects.

Hatch patterns are supported, but the hatch style tag is not supported, the default hatch style is `ezdxf.const.HATCH_STYLE_NESTED` and the style flags of the boundary paths are ignored.

Background color for pattern fillings is supported, set background color by property `MPolygon.bgcolor` as RGB tuple.

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**Note:** Background RGB fill color for solid fill and pattern fill is set differently!

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Autodesk products do support polyline paths including bulges. An example for edge paths as boundary paths is not available or edge paths are not supported. `Ezdx` does **not** export MPOLYGON entities including edge paths! The `BoundaryPaths.edge_to_polyline_paths()` method converts all edge paths to simple polyline paths with approximated curves, this conversion has to be done explicit.

**See also:**

For more information see the `ezdxf.entities.Hatch` documentation.

Subclass of	<code>ezdxf.entities.DXFGraphic</code>
DXF type	'MPOLYGON'
Factory function	<code>ezdxf.layouts.BaseLayout.add_mpolygon()</code>
Inherited DXF attributes	<i>Common graphical DXF attributes</i>
Required DXF version	DXF R2000 ('AC1015')

**class** `ezdxf.entities.MPolygon`

`dxfs.pattern_name`  
Pattern name as string

`dxfs.solid_fill`

1	solid fill, better use: <code>MPolygon.set_solid_fill()</code>
0	pattern fill, better use: <code>MPolygon.set_pattern_fill()</code>

(search AutoCAD help for more information)

`dxfs.pattern_type`

0	user
1	predefined
2	custom

`dxfs.pattern_angle`

Actual pattern angle in degrees (float). Changing this value does not rotate the pattern, use `set_pattern_angle()` for this task.

`dxfs.pattern_scale`

Actual pattern scaling factor (float). Changing this value does not scale the pattern use `set_pattern_scale()` for this task.

`dxfs.pattern_double`

1 = double pattern size else 0. (int)

`dxfs.elevation`

Z value represents the elevation height of the *OCS*. (float)

**paths**

*BoundaryPaths* object.

**pattern**

*Pattern* object.

**gradient**

*Gradient* object.

**set\_pattern\_definition** (*lines: Sequence[T\_co]*, *factor: float = 1*, *angle: float = 0*) → None

Setup pattern definition by a list of definition lines and a definition line is a 4-tuple (angle, base\_point, offset, dash\_length\_items), the pattern definition should be designed for scaling factor 1 and angle 0.

- angle: line angle in degrees

- base-point: 2-tuple (x, y)
- offset: 2-tuple (dx, dy)
- dash\_length\_items: list of dash items (item > 0 is a line, item < 0 is a gap and item == 0.0 is a point)

#### Parameters

- **lines** – list of definition lines
- **factor** – pattern scaling factor
- **angle** – rotation angle in degrees

**set\_pattern\_scale** (*scale*: float) → None

Set scaling of pattern definition to *scale*.

Starts always from the original base scaling, `set_pattern_scale(1)` reset the pattern scaling to the original appearance as defined by the pattern designer, but only if the the pattern attribute `dxf.pattern_scale` represents the actual scaling, it is not possible to recreate the original pattern scaling from the pattern definition itself.

#### Parameters **scale** – pattern scaling factor

**set\_pattern\_angle** (*angle*: float) → None

Set rotation of pattern definition to *angle* in degrees.

Starts always from the original base rotation 0, `set_pattern_angle(0)` reset the pattern rotation to the original appearance as defined by the pattern designer, but only if the the pattern attribute `dxf.pattern_angle` represents the actual rotation, it is not possible to recreate the original rotation from the pattern definition itself.

#### Parameters **angle** – rotation angle in degrees

**set\_solid\_fill** (*color*: int = 7, *style*: int = 1, *rgb*: RGB = None)

Set `MPolygon` to solid fill mode and removes all gradient and pattern fill related data.

#### Parameters

- **color** – [AutoCAD Color Index \(ACI\)](#), (0 = BYBLOCK; 256 = BYLAYER)
- **style** – hatch style is not supported by MPOLYGON, just for symmetry to HATCH
- **rgb** – true color value as (r, g, b)-tuple - has higher priority than *color*. True color support requires DXF R2004+

**set\_pattern\_fill** (*name*: str, *color*: int = 7, *angle*: float = 0.0, *scale*: float = 1.0, *double*: int = 0, *style*: int = 1, *pattern\_type*: int = 1, *definition*=None) → None

Set `Hatch` and `MPolygon` to pattern fill mode. Removes all gradient related data. The pattern definition should be designed for scaling factor 1. Predefined hatch pattern like “ANSI33” are scaled according to the HEADER variable \$MEASUREMENT for ISO measurement (m, cm, ...), or imperial units (in, ft, ...), this replicates the behavior of BricsCAD.

#### Parameters

- **name** – pattern name as string
- **color** – pattern color as [AutoCAD Color Index \(ACI\)](#)
- **angle** – angle of pattern fill in degrees
- **scale** – pattern scaling as float
- **double** – double size flag
- **style** – hatch style (0 = normal; 1 = outer; 2 = ignore)

- **pattern\_type** – pattern type (0 = user-defined; 1 = predefined; 2 = custom)
- **definition** – list of definition lines and a definition line is a 4-tuple [angle, base\_point, offset, dash\_length\_items], see `set_pattern_definition()`

**set\_gradient** (`color1: Tuple[int, int, int] = (0, 0, 0), color2: Tuple[int, int, int] = (255, 255, 255), rotation: float = 0.0, centered: float = 0.0, one_color: int = 0, tint: float = 0.0, name: str = 'LINEAR'`) → None

Set `Hatch` and `MPolygon` to gradient fill mode and removes all pattern fill related data. Gradient support requires DXF R2004+. A gradient filled hatch is also a solid filled hatch.

Valid gradient type names are:

- 'LINEAR'
- 'CYLINDER'
- 'INVCYLINDER'
- 'SPHERICAL'
- 'INVSPHERICAL'
- 'HEMISPHERICAL'
- 'INVHEMISPHERICAL'
- 'CURVED'
- 'INVCURVED'

### Parameters

- **color1** – (r, g, b)-tuple for first color, rgb values as int in the range [0, 255]
- **color2** – (r, g, b)-tuple for second color, rgb values as int in the range [0, 255]
- **rotation** – rotation angle in degrees
- **centered** – determines whether the gradient is centered or not
- **one\_color** – 1 for gradient from `color1` to tinted `color1`
- **tint** – determines the tinted target `color1` for a one color gradient. (valid range 0.0 to 1.0)
- **name** – name of gradient type, default “LINEAR”

**transform** (`m: ezdxf.math._matrix44.Matrix44`) → `ezdxf.entities.polygon.DXFPolygon`

Transform entity by transformation matrix `m` inplace.

## MText

The MTEXT entity ([DXF Reference](#)) fits a multiline text in a specified width but can extend vertically to an indefinite length. You can format individual words or characters within the `MText`.

### See also:

[Tutorial for MText and MTextEditor](#)

Subclass of	<code>ezdxf.entities.DXFGraphic</code>
DXF type	'MTEXT'
Factory function	<code>ezdxf.layouts.BaseLayout.add_mtext()</code>
Inherited DXF attributes	<i>Common graphical DXF attributes</i>
Required DXF version	DXF R2000 ('AC1015')

`class ezdxf.entities.MText`

`dx.dxf.insert`

Insertion point (3D Point in *OCS*)

`dx.dxf.char_height`

Initial text height (float); default=1.0

`dx.dxf.width`

Reference text width (float), forces text wrapping at given width.

`dx.dxf.attachment_point`

Constants defined in `ezdxf.lldxf.const`:

<code>MText.dxf.attachment_point</code>	Value
<code>MTEXT_TOP_LEFT</code>	1
<code>MTEXT_TOP_CENTER</code>	2
<code>MTEXT_TOP_RIGHT</code>	3
<code>MTEXT_MIDDLE_LEFT</code>	4
<code>MTEXT_MIDDLE_CENTER</code>	5
<code>MTEXT_MIDDLE_RIGHT</code>	6
<code>MTEXT_BOTTOM_LEFT</code>	7
<code>MTEXT_BOTTOM_CENTER</code>	8
<code>MTEXT_BOTTOM_RIGHT</code>	9

`dx.dxf.flow_direction`

Constants defined in `ezdxf.const`:

<code>MText.dxf.flow_direction</code>	Value	Description
<code>MTEXT_LEFT_TO_RIGHT</code>	1	left to right
<code>MTEXT_TOP_TO_BOTTOM</code>	3	top to bottom
<code>MTEXT_BY_STYLE</code>	5	by style (the flow direction is inherited from the associated text style)

`dx.dxf.style`

Text style (string); default = 'STANDARD'

`dx.dxf.text_direction`

X-axis direction vector in *WCS* (3D Point); default value is (1, 0, 0); if `dx.dxf.rotation` and `dx.dxf.text_direction` are present, `dx.dxf.text_direction` wins.

`dx.dxf.rotation`

Text rotation in degrees (float); default = 0

`dx.dxf.line_spacing_style`

Line spacing style (int), see table below

**dx.dxf.line\_spacing\_factor**

Percentage of default (3-on-5) line spacing to be applied. Valid values range from 0.25 to 4.00 (float).

Constants defined in `ezdxf.lldxf.const`:

MText.dxf.line_spacing_style	Value	Description
MTEXT_AT_LEAST	1	taller characters will override
MTEXT_EXACT	2	taller characters will not override

**dx.dxf.bg\_fill**

Defines the background fill type. (DXF R2007)

MText.dxf.bg_fill	Value	Description
MTEXT_BG_OFF	0	no background color
MTEXT_BG_COLOR	1	use specified color
MTEXT_BG_WINDOW_COLOR	2	use window color (?)
MTEXT_BG_CANVAS_COLOR	3	use canvas background color

**dx.dxf.box\_fill\_scale**

Determines how much border there is around the text. (DXF R2007)

Requires: `bg_fill`, `bg_fill_color` else AutoCAD complains

Better use `set_bg_color()`

**dx.dxf.bg\_fill\_color**

Background fill color as *AutoCAD Color Index (ACI)* (DXF R2007)

Better use `set_bg_color()`

**dx.dxf.bg\_fill\_true\_color**

Background fill color as true color value (DXF R2007), also `dx.dxf.bg_fill_color` must be present, else AutoCAD complains.

Better use `set_bg_color()`

**dx.dxf.bg\_fill\_color\_name**

Background fill color as name string (?) (DXF R2007), also `dx.dxf.bg_fill_color` must be present, else AutoCAD complains.

Better use `set_bg_color()`

**dx.dxf.transparency**

Transparency of background fill color (DXF R2007), not supported by AutoCAD or BricsCAD.

**text**

MTEXT content as string (read/write).

Line endings `\n` will be replaced by the MTEXT line endings `\P` at DXF export, but **not** vice versa `\P` by `\n` at DXF file loading.

**set\_location** (`insert: Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3]`, `rotation: Optional[float] = None`, `attachment_point: Optional[int] = None`) → ezdxf.entities.mtext.MText

Set attributes `dx.dxf.insert`, `dx.dxf.rotation` and `dx.dxf.attachment_point`, `None` for `dx.dxf.rotation` or `dx.dxf.attachment_point` preserves the existing value.

**get\_rotation() → float**

Get text rotation in degrees, independent if it is defined by `dx.dxf.rotation` or `dx.dxf.text_direction`.

**set\_rotation** (*angle: float*) → ezdxf.entities.mtext.MText  
Set attribute *rotation* to *angle* (in degrees) and deletes *dxf.text\_direction* if present.

**get\_text\_direction** () → ezdxf.math.\_vector.Vec3  
Returns the horizontal text direction as *Vec3* object, even if only the text rotation is defined.

**set\_bg\_color** (*color: Union[int, str, Tuple[int, int, int], None], scale: float = 1.5, text\_frame=False*)  
Set background color as *AutoCAD Color Index (ACI)* value or as name string or as RGB tuple (r, g, b).  
Use special color name *canvas*, to set background color to canvas background color.  
Use *color = None* to remove the background filling.  
Setting only a text border is supported (*color='None'*), but in this case the scaling is always 1.5.

**Parameters**

- **color** – color as *AutoCAD Color Index (ACI)*, string, RGB tuple or *None*
- **scale** – determines how much border there is around the text, the value is based on the text height, and should be in the range of [1, 5], where 1 fits exact the MText entity.
- **text\_frame** – draw a text frame in text color if *True*

**\_\_iadd\_\_** (*text: str*) → MText  
Append *text* to existing content (*text* attribute).

**append** (*text: str*) → MText  
Append *text* to existing content (*text* attribute).

**plain\_text** (*split=False, fast=True*) → Union[List[str], str]  
Returns the text content without inline formatting codes.

The “fast” mode is accurate if the DXF content was created by reliable (and newer) CAD applications like AutoCAD or BricsCAD. The “accurate” mode is for some rare cases where the content was created by older CAD applications or unreliable DXF libraries and CAD applications.

**Parameters**

- **split** – split content text at line breaks if *True* and returns a list of strings without line endings
- **fast** – uses the “fast” mode to extract the plain MTEXT content if *True* or the “accurate” mode if set to *False*

New in version 0.16.6: *fast* argument

**all\_columns\_plain\_text** (*split=False*) → Union[List[str], str]  
Returns the text content of all columns without inline formatting codes.

**Parameters** **split** – split content text at line breaks if *True* and returns a list of strings without line endings

New in version 0.17.

**all\_columns\_raw\_content** () → str  
Returns the text content of all columns as a single string including the inline formatting codes.

New in version 0.17.

**transform** (*m: ezdxf.math.\_matrix44.Matrix44*) → ezdxf.entities.mtext.MText  
Transform the MTEXT entity by transformation matrix *m* inplace.

**ucs()** → ezdxf.math.UCS

Returns the *UCS* of the *MText* entity, defined by the insert location (origin), the text direction or rotation (x-axis) and the extrusion vector (z-axis).

**MText Inline Codes**

Code	Description
\U	Start underline
\V	Stop underline
\O	Start overline
\o	Stop overline
\K	Start strike-through
\k	Stop strike-through
\P	New paragraph (new line)
\p	Paragraphs properties: indentation, alignment, tabulator stops
\X	Paragraph wrap on the dimension line (only in dimensions)
\Q	Slanting (oblique) text by angle - e.g. \Q30;
\H	Text height - e.g. relative \H3x; absolut \H3;
\W	Text width - e.g. relative \W0.8x; absolut \W0.8;
\T	Tracking, character spacing - e.g. relative \T0.5x; absolut \T2;
\F	Font selection e.g. \Fgdt;o - GDT-tolerance
\S	Stacking, fractions e.g. \SA^ B; space after “^” is required to avoid caret decoding, \SX/Y; \S1#4;
\A	Alignment <ul style="list-style-type: none"> <li>• \A0; = bottom</li> <li>• \A1; = center</li> <li>• \A2; = top</li> </ul>
\C	Color change <ul style="list-style-type: none"> <li>• \C1; = red</li> <li>• \C2; = yellow</li> <li>• \C3; = green</li> <li>• \C4; = cyan</li> <li>• \C5; = blue</li> <li>• \C6; = magenta</li> <li>• \C7; = white</li> </ul>
\~	Non breaking space
{}	Braces - define the text area influenced by the code, codes and braces can be nested up to 8 levels deep
\	Escape character - e.g. \{ = “{”

## Convenient constants defined in MTextEditor:

Constant	Description
UNDERLINE_START	start underline text
UNDERLINE_STOP	stop underline text
OVERSTRIKE_START	start overline
OVERSTRIKE_STOP	stop overline
STRIKE_START	start strike trough
STRIKE_STOP	stop strike trough
GROUP_START	start of group
GROUP_END	end of group
NEW_LINE	start in new line
NBSP	none breaking space

## MultiLeader

New in version 0.18.

The MULTILEADER entity ([DXF Reference](#)) represents one or more leaders, made up of one or more vertices (or spline fit points) and an arrowhead. In contrast to the [Leader](#) entity the text- or block content is part of the MULTILEADER entity.

AutoCAD, BricsCAD and maybe other CAD applications do accept 'MLEADER' as type string but they always create entities with 'MULTILEADER' as type string.

Because of the complexity of the MULTILEADER entity, the factory method `add_multileader_mtext()` returns a `MultiLeaderMTextBuilder` instance to build a new entity and the factory method `add_multileader_block()` returns a `MultiLeaderBlockBuilder` instance.

The visual design is based on an associated `MLeaderStyle`, but almost all attributes are also stored in the MULTILEADER entity itself.

The attribute `MultiLeader.dxf.property_override_flags` should indicate which MLEADERSTYLE attributes are overridden by MULTILEADER attributes, but these flags do not always reflect the state of overridden attributes. The `ezdxf` MULTILEADER renderer uses always the attributes from the MULTILEADER entity and ignores the override flags.

All vertices are WCS coordinates, even those for BLOCK entities which are OCS coordinates in the usual case.

### See also:

- `ezdxf.entities.MLeaderStyle`
- `ezdxf.render.MultiLeaderBuilder`
- [Tutorial for MultiLeader](#)
- [MULTILEADER Internals](#)

Subclass of	<code>ezdxf.entities.DXFGraphic</code>
DXF type	'MULTILEADER'
Factory functions	<ul style="list-style-type: none"> <li><code>ezdxf.layouts.BaseLayout.add_multileader_mtext()</code></li> <li><code>ezdxf.layouts.BaseLayout.add_multileader_block()</code></li> </ul>
Inherited DXF attributes	<a href="#">Common graphical DXF attributes</a>
Required DXF version	DXF R2000 ('AC1015')

`class ezdxf.entities.Multileader`

`dx.dxf.arrow_head_handle`

handle of the arrow head, see also `ezdxf.render.arrows` module, “closed filled” arrow if not set

`dx.dxf.arrow_head_size`

arrow head size in drawing units

`dx.dxf.block_color`

block color as `raw color` value, default is BY\_BLOCK\_RAW\_VALUE

`dx.dxf.block_connection_type`

0	center extents
1	insertion point

`dx.dxf.block_record_handle`

handle to block record of the BLOCK content

`dx.dxf.block_rotation`

BLOCK rotation in radians

`dx.dxf.block_scale_vector`

`Vec3` object which stores the scaling factors for the x-, y- and z-axis

`dx.dxf.content_type`

0	none
1	BLOCK
2	MTEXT
3	TOLERANCE

`dx.dxf.dogleg_length`

dogleg length in drawing units

`dx.dxf.has_dogleg`

`dx.dxf.has_landing`

`dx.dxf.has_text_frame`

`dx.dxf.is_annotation`

`dx.dxf.is_text_direction_negative`

`dxf.leader_extend_to_text`  
`dxf.leader_line_color`  
     leader line color as *raw color* value  
`dxf.leader_linetype_handle`  
     handle of the leader linetype, “CONTINUOUS” if not set  
`dxf.leader_lineweight`  
`dxf.leader_type`

0	invisible
1	straight line leader
2	spline leader

`dxf.property_override_flags`  
     Each bit shows if the MLEADERSTYLE is overridden by the value in the MULTILEADER entity, but this is not always the case for all values, it seems to be save to always use the value from the MULTILEADER entity.  
`dxf.scale`  
     overall scaling factor  
`dxf.style_handle`  
     handle to the associated MLEADERSTYLE object  
`dxf.text_IPE_align`  
     unknown meaning  
`dxf.text_alignment_type`  
     unknown meaning - its not the MTEXT attachment point!  
`dxf.text_angle_type`

0	text angle is equal to last leader line segment angle
1	text is horizontal
2	text angle is equal to last leader line segment angle, but potentially rotated by 180 degrees so the right side is up for readability.

`dxf.text_attachment_direction`  
     defines whether the leaders attach to the left & right of the content BLOCK/MTEXT or attach to the top & bottom:

0	horizontal - left & right of content
1	vertical - top & bottom of content

`dxf.text_attachment_point`  
     MTEXT attachment point

1	top left
2	top center
3	top right

**dx<sub>f</sub>.text\_bottom\_attachment\_type**

9	center
10	overline and center

**dx<sub>f</sub>.text\_color**MTEXT color as *raw color* value**dx<sub>f</sub>.text\_left\_attachment\_type**

0	top of top MTEXT line
1	middle of top MTEXT line
2	middle of whole MTEXT
3	middle of bottom MTEXT line
4	bottom of bottom MTEXT line
5	bottom of bottom MTEXT line & underline bottom MTEXT line
6	bottom of top MTEXT line & underline top MTEXT line
7	bottom of top MTEXT line
8	bottom of top MTEXT line & underline all MTEXT lines

**dx<sub>f</sub>.text\_right\_attachment\_type**

0	top of top MTEXT line
1	middle of top MTEXT line
2	middle of whole MTEXT
3	middle of bottom MTEXT line
4	bottom of bottom MTEXT line
5	bottom of bottom MTEXT line & underline bottom MTEXT line
6	bottom of top MTEXT line & underline top MTEXT line
7	bottom of top MTEXT line
8	bottom of top MTEXT line & underline all MTEXT lines

**dx<sub>f</sub>.text\_style\_handle**

handle of the MTEXT text style, “Standard” if not set

**dx<sub>f</sub>.text\_top\_attachment\_type**

9	center
10	overline and center

**dx<sub>f</sub>.version**

always 2?

**context***MLeaderContext* instance**arrow\_heads**list of *ArrowHeadData*

**block\_attributes**list of [AttribData](#)**virtual\_entities()** → Iterable[ezdxf.entities.dxfgfx.DXFGraphic]

Yields the graphical representation of MULTILEADER as virtual DXF primitives.

This entities are located at the original location, but are not stored in the entity database, have no handle and are not assigned to any layout.

**explode(target\_layout: BaseLayout = None)** → EntityQuery

Explode MULTILEADER as DXF primitives into target layout, if target layout is `None`, the target layout is the layout of the source entity.

Returns an [EntityQuery](#) container with all DXF primitives.

**Parameters** `target_layout` – target layout for the DXF primitives, `None` for same layout as the source entity.

**transform(m: ezdxf.math.\_matrix44.Matrix44)** → ezdxf.entities.mleader.MultiLeader

Transform the MULTILEADER entity by transformation matrix `m` inplace.

Non uniform scaling is not supported.

**Parameters** `m` – transformation [Matrix44](#)

**Raises** `NonUniformScalingError` – for non uniform scaling

**class ezdxf.entities.MLeaderContext****leaders**list of [LeaderData](#) objects**scale**redundant data: `MultiLeader.dxf.scale`**base\_point**

insert location as Vec3 of the MTEXT or the BLOCK entity?

**char\_height**

MTEXT char height, already scaled

**arrow\_head\_size**redundant data: `MultiLeader.dxf.arrow_head_size`**landing\_gap\_size****left\_attachment**redundant data: `MultiLeader.dxf.text_left_attachment_type`**right\_attachment**redundant data: `MultiLeader.dxf.text_right_attachment_type`**text\_align\_type**redundant data: `MultiLeader.dxf.text_attachment_point`**attachment\_type**

BLOCK alignment?

0	content extents
1	insertion point

```
mtext
    instance of MTextData if content is MTEXT otherwise None

block
    instance of BlockData if content is BLOCK otherwise None

plane_origin
    Vec3

plane_x_axis
    Vec3

plane_y_axis
    Vec3

plane_normal_reversed
    the plan normal is x-axis “cross” y-axis (right-hand-rule), this flag indicates to invert this plan normal

top_attachment
    redundant data: MultiLeader.dxf.text\_top\_attachment\_type

bottom_attachment
    redundant data: MultiLeader.dxf.text\_bottom\_attachment\_type

class ezdxf.entities.LeaderData

lines
    list of LeaderLine

has_last_leader_line
    unknown meaning

has_dogleg_vector

last_leader_point
    WCS point as Vec3

dogleg_vector
    WCS direction as Vec3

dogleg_length
    redundant data: MultiLeader.dxf.dogleg\_length

index
    leader index?

attachment_direction
    redundant data: MultiLeader.dxf.text\_attachment\_direction

breaks
    list of break vertices as Vec3 objects

class ezdxf.entities.LeaderLine

vertices
    list of WCS coordinates as Vec3

breaks
    mixed list of mixed integer indices and break coordinates or None leader lines without breaks in it

index
    leader line index?
```

---

```

color
    leader line color override, ignore override value if BY_BLOCK_RAW_VALUE

class ezdxf.entities.ArrowHeadData

index
    arrow head index?

handle
    handle to arrow head block

class ezdxf.entities.AttribData

handle
    handle to Attdef entity in the BLOCK definition

index
    unknown meaning

width
    text width factor?

text
    Attrib content

class ezdxf.entities.MTextData
    stores the content and attributes of the MTEXT entity

default_content
    content as string

extrusion
    extrusion vector of the MTEXT entity but MTEXT is not an OCS entity!

style_handle
    redundant data: MLeader.dxf.text_style_handle

insert
    insert location in WCS coordinates, same as MLeaderContext.base_point?

text_direction
    “horizontal” text direction vector in WCS

rotation
    rotation angle in radians (!) around the extrusion vector, calculated as it were an OCS entity

width
    unscaled column width

defined_height
    unscaled defined column height

line_spacing_factor
    see MText.dxf.line_spacing_factor

line_spacing_style
    see MText.dxf.line_spacing_style

color
    redundant data: MLeader.dxf.text_color
```

**alignment**redundant data: *MultiLeader.dxf.text\_attachment\_point***flow\_direction**

1	horizontal
3	vertical
6	by text style

**bg\_color**background color as *raw color* value**bg\_scale\_factor**see *MText.dxf.box\_fill\_scale***bg\_transparency**

background transparency value

**use\_window\_bg\_color****has\_bg\_fill****column\_type**

unknown meaning - most likely:

0	none
1	static
2	dynamic

**use\_auto\_height****column\_width**unscaled column width, redundant data *width***column\_gutter\_width**

unscaled column gutter width

**column\_flow\_reversed****column\_sizes**

list of unscaled columns heights for dynamic column with manual heights

**use\_word\_break****class ezdxf.entities.BlockData**stores the attributes for the *Insert* entity**block\_record\_handle**redundant data: *MultiLeader.dxf.block\_record\_handle***extrusion**

extrusion vector in WCS

**insert**insertion location in WCS as Vec3, same as *MLeaderContext.base\_point?***scale**redundant data: *MultiLeader.dxf.block\_scale\_vector*

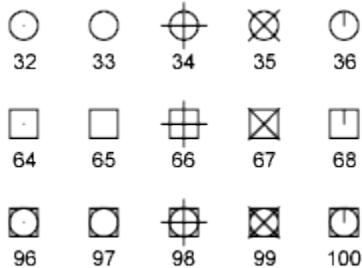
**rotation**redundant data: `MultiLeader.dxf.block_rotation`**color**redundant data: `MultiLeader.dxf.block_color`**Point**POINT (DXF Reference) at location `dxf.location`.

The POINT styling is a global setting, stored as header variable `$PDMODE`, this also means **all** POINT entities in a DXF document have the same styling:

0	center dot (.)
1	none ()
2	cross (+)
3	x-cross (x)
4	tick (*)

Combined with these bit values

32	circle
64	Square

e.g. circle + square + center dot =  $32 + 64 + 0 = 96$ The size of the points is defined by the header variable `$PDSIZE`:

0	5% of draw area height
<0	Specifies a percentage of the viewport size
>0	Specifies an absolute size

Subclass of	<code>ezdxf.entities.DXFGraphic</code>
DXF type	'POINT'
Factory function	<code>ezdxf.layouts.BaseLayout.add_point()</code>
Inherited DXF attributes	<code>Common graphical DXF attributes</code>

**Warning:** Do not instantiate entity classes by yourself - always use the provided factory functions!

```
class ezdxf.entities.Point

    dxf.location
        Location of the point (2D/3D Point in WCS)

    dxf.angle
        Angle in degrees of the x-axis for the UCS in effect when POINT was drawn (float); used when PDMODE is nonzero.

    transform(m: ezdxf.math._matrix44.Matrix44) → ezdxf.entities.point.Point
        Transform the POINT entity by transformation matrix m inplace.

    translate(dx: float, dy: float, dz: float) → ezdxf.entities.point.Point
        Optimized POINT translation about dx in x-axis, dy in y-axis and dz in z-axis.

    virtual_entities(pdszie: float = 1, pdmode: int = 0) → Iterable[ezdxf.entities.dxfgfx.DXFGraphic]
        Yields point graphic as DXF primitives LINE and CIRCLE entities. The dimensionless point is rendered as zero-length line!
```

Check for this condition:

```
e.dxfertype() == 'LINE' and e.dxf.start.isclose(e.dxf.end)
```

if the rendering engine can't handle zero-length lines.

#### Parameters

- **pdszie** – point size in drawing units
- **pdmode** – point styling mode

## Polyline

The POLYLINE entity ([POLYLINE DXF Reference](#)) is very complex, it's used to build 2D/3D polylines, 3D meshes and 3D polyfaces. For every type exists a different wrapper class but they all have the same dxftype of 'POLYLINE'. Detect POLYLINE type by `Polyline.get_mode()`.

POLYLINE types returned by `Polyline.get_mode()`:

- 'AcDb2dPolyline' for 2D *Polyline*
- 'AcDb3dPolyline' for 3D *Polyline*
- 'AcDbPolygonMesh' for *Polymesh*
- 'AcDbPolyFaceMesh' for *Polyface*

For 2D entities all vertices in *OCS*.

For 3D entities all vertices in *WCS*.

Subclass of	<code>ezdxf.entities.DXFGraphic</code>
DXF type	'POLYLINE'
2D factory function	<code>ezdxf.layouts.BaseLayout.add_polyline2d()</code>
3D factory function	<code>ezdxf.layouts.BaseLayout.add_polyline3d()</code>
Inherited DXF attributes	<a href="#">Common graphical DXF attributes</a>

**Warning:** Do not instantiate entity classes by yourself - always use the provided factory functions!

### `class ezdxf.entities.Polyline`

`Vertex` entities are stored in a standard Python list `Polyline.vertices`. Vertices can be retrieved and deleted by direct access to `Polyline.vertices` attribute:

```
# delete first and second vertex
del polyline.vertices[:2]
```

#### `dxf.elevation`

Elevation point, the X and Y values are always 0, and the Z value is the polyline's elevation (3D Point in `OCS` when 2D, `WCS` when 3D).

#### `dxf.flags`

Constants defined in `ezdxf.lldxf.const`:

<code>Polyline.dxf.flags</code>	Value	Description
<code>POLYLINE_CLOSED</code>	1	This is a closed Polyline (or a polygon mesh closed in the M direction)
<code>POLYLINE_MESH_CLOSED_M_DIRECTION</code>	1	equals <code>POLYLINE_CLOSED</code>
<code>POLYLINE_CURVE_FIT_VERTICES_ADDED</code>	2	Curve-fit vertices have been added
<code>POLYLINE_SPLINE_FIT_VERTICES_ADDED</code>	4	Spline-fit vertices have been added
<code>POLYLINE_3D_POLYLINE</code>	8	This is a 3D Polyline
<code>POLYLINE_3D_POLYMESH</code>	16	This is a 3D polygon mesh
<code>POLYLINE_MESH_CLOSED_N_DIRECTION</code>	32	The polygon mesh is closed in the N direction
<code>POLYFACE_MESH</code>	64	This Polyline is a polyface mesh
<code>POLYLINE_GENERATE_LINETYPE_PATTERN</code>	128	The linetype pattern is generated continuously around the vertices of this Polyline

#### `dxf.default_start_width`

Default line start width (float); default = 0

#### `dxf.default_end_width`

Default line end width (float); default = 0

#### `dxf.m_count`

Polymesh M vertex count (int); default = 1

#### `dxf.n_count`

Polymesh N vertex count (int); default = 1

#### `dxf.m_smooth_density`

Smooth surface M density (int); default = 0

#### `dxf.n_smooth_density`

Smooth surface N density (int); default = 0

#### `dxf.smooth_type`

Curves and smooth surface type (int); default=0, see table below

Constants for `smooth_type` defined in `ezdxf.lldxf.const`:

<i>Polyline.dxf.smooth_type</i>	Value	Description
POLYMESH_NO_SMOOTH	0	no smooth surface fitted
POLYMESH_QUADRATIC_BSPLINE	5	quadratic B-spline surface
POLYMESH_CUBIC_BSPLINE	6	cubic B-spline surface
POLYMESH_BEZIER_SURFACE	8	Bezier surface

**vertices**

List of *Vertex* entities.

**is\_2d\_polyline**

True if POLYLINE is a 2D polyline.

**is\_3d\_polyline**

True if POLYLINE is a 3D polyline.

**is\_polygon\_mesh**

True if POLYLINE is a polygon mesh, see *Polymesh*

**is\_poly\_face\_mesh**

True if POLYLINE is a poly face mesh, see *Polyface*

**is\_closed**

True if POLYLINE is closed.

**is\_m\_closed**

True if POLYLINE (as *Polymesh*) is closed in m direction.

**is\_n\_closed**

True if POLYLINE (as *Polymesh*) is closed in n direction.

**has\_arc**

Returns True if 2D POLYLINE has an arc segment.

**has\_width**

Returns True if 2D POLYLINE has default width values or any segment with width attributes.

New in version 0.14.

**get\_mode () → str**

Returns POLYLINE type as string:

- ‘AcDb2dPolyline’
- ‘AcDb3dPolyline’
- ‘AcDbPolygonMesh’
- ‘AcDbPolyFaceMesh’

**m\_close (status=True) → None**

Close POLYMESH in m direction if *status* is True (also closes POLYLINE), clears closed state if *status* is False.

**n\_close (status=True) → None**

Close POLYMESH in n direction if *status* is True, clears closed state if *status* is False.

**close (m\_close=True, n\_close=False) → None**

Set closed state of POLYMESH and POLYLINE in m direction and n direction. True set closed flag, False clears closed flag.

**\_\_len\_\_ () → int**

Returns count of *Vertex* entities.

**\_\_getitem\_\_(pos)** → ezdxf.entities.polyline.DXFVertex  
Get `Vertex` entity at position `pos`, supports list slicing.

**points()** → Iterator[ezdxf.math.\_vector.Vec3]

Returns iterable of all polyline vertices as (x, y, z) tuples, not as `Vertex` objects.

**append\_vertex(point: Union[Sequence[float], ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3], dxfattribs=None)** → None

Append a single `Vertex` entity at location `point`.

#### Parameters

- **point** – as (x, y[, z]) tuple
- **dxfattribs** – dict of DXF attributes for `Vertex` class

**append\_vertices(points: Iterable[Union[Sequence[float], ezdxf.math.\_vector.Vec3]], dxfattribs=None)** → None

Append multiple `Vertex` entities at location `points`.

#### Parameters

- **points** – iterable of (x, y[, z]) tuples
- **dxfattribs** – dict of DXF attributes for the VERTEX objects

**append\_formatted\_vertices(points: Iterable[Union[Sequence[float], ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3]], format: str = 'xy', dxfattribs=None)** → None

Append multiple `Vertex` entities at location `points`.

#### Parameters

- **points** – iterable of (x, y, [start\_width, [end\_width, [bulge]]]) tuple
- **format** – format string, default is 'xy', see: [User Defined Point Format Codes](#)
- **dxfattribs** – dict of DXF attributes for the VERTEX objects

**insert\_vertices(pos: int, points: Iterable[Union[Sequence[float], ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3]], dxfattribs=None)** → None

Insert vertices `points` into `Polyline.vertices` list at insertion location `pos`.

#### Parameters

- **pos** – insertion position of list `Polyline.vertices`
- **points** – list of (x, y[, z]) tuples
- **dxfattribs** – dict of DXF attributes for `Vertex` class

**transform(m: ezdxf.math.\_matrix44.Matrix44)** → ezdxf.entities.polyline.Polyline

Transform the POLYLINE entity by transformation matrix `m` inplace.

A non-uniform scaling is not supported if a 2D POLYLINE contains circular arc segments (bulges).

#### Parameters `m` – transformation `Matrix44`

**Raises NonUniformScalingError** – for non-uniform scaling of 2D POLYLINE containing circular arc segments (bulges)

**virtual\_entities()** → Iterator[Union[Line, Arc, Face3d]]

Yields the graphical representation of POLYLINE as virtual DXF primitives (LINE, ARC or 3DFACE).

These virtual entities are located at the original location, but are not stored in the entity database, have no handle and are not assigned to any layout.

**explode** (*target\_layout: BaseLayout = None*) → EntityQuery

Explode the POLYLINE entity as DXF primitives (LINE, ARC or 3DFACE) into the target layout, if the target layout is None, the target layout is the layout of the POLYLINE entity.

Returns an *EntityQuery* container of all DXF primitives.

**Parameters** **target\_layout** – target layout for DXF primitives, None for same layout as source entity.

## Vertex

A VERTEX (VERTEX DXF Reference) represents a polyline/mesh vertex.

Subclass of	<code>ezdxf.entities.DXFGraphic</code>
DXF type	'VERTEX'
Factory function	<code>Polyline.append_vertex()</code>
Factory function	<code>Polyline.extend()</code>
Factory function	<code>Polyline.insert_vertices()</code>
Inherited DXF Attributes	<i>Common graphical DXF attributes</i>

**class** `ezdxf.entities.Vertex`

**dx.f.location**

Vertex location (2D/3D Point *OCS* when 2D, *WCS* when 3D)

**dx.f.start\_width**

Line segment start width (float); default = 0

**dx.f.end\_width**

Line segment end width (float); default = 0

**dx.f.bulge**

*Bulge value* (float); default = 0.

The bulge value is used to create arc shaped line segments.

**dx.f.flags**

Constants defined in `ezdxf.lldxf.const`:

Vertex.dxf.flags	Value Description
VTX_EXTRA_VERTEX	vertex created by curve-fitting
VTX_CURVE_FIT_TANGENT	tangent defined for this vertex. A curve-fit tangent direction of 0 may be omitted from the DXF output, but is significant if this bit is set.
VTX_SPLINE_VERTEX	vertex created by spline-fitting
VTX_SPLINE_FRAME_CONTROL_POINT	control point
VTX_3D_POLYLINE_VERTEX	3D polyline vertex
VTX_3D_POLYGON_MESH_VERTEX	mesh vertex
VTX_3D_POLYFACE_MESH_VERTEX	mesh vertex

**dx.f.tangent**

Curve fit tangent direction (float), used for 2D spline in DXF R12.

**dx.f.vtx1**

Index of 1st vertex, if used as face (feature for experts)

`dxf.vtx2`  
Index of 2nd vertex, if used as face (feature for experts)

`dxf.vtx3`  
Index of 3rd vertex, if used as face (feature for experts)

`dxf.vtx4`  
Index of 4th vertex, if used as face (feature for experts)

`is_2d_polyline_vertex`  
`is_3d_polyline_vertex`  
`is_polygon_mesh_vertex`  
`is_poly_face_mesh_vertex`  
`is_face_record`

`format(format='xyz')` → Sequence  
Return formatted vertex components as tuple.

Format codes:

- “x” = x-coordinate
- “y” = y-coordinate
- “z” = z-coordinate
- “s” = start width
- “e” = end width
- “b” = bulge value
- “v” = (x, y, z) as tuple

**Args:** format: format string, default is “xyz”

New in version 0.14.

## Polymesh

Subclass of	<code>ezdxf.entities.Polyline</code>
DXF type	'POLYLINE'
Factory function	<code>ezdxf.layouts.BaseLayout.add_polymesh()</code>
Inherited DXF Attributes	<i>Common graphical DXF attributes</i>

### `class ezdxf.entities.Polymesh`

A polymesh is a grid of m\_count x n\_count vertices, every vertex has its own (x, y, z) location. The `Polymesh` is a subclass of `Polyline`, DXF type is also 'POLYLINE' but get\_mode() returns 'AcDbPolygonMesh'.

`get_mesh_vertex(pos: Tuple[int, int])` → `ezdxf.entities.polyline.DXFVertex`  
Get location of a single mesh vertex.

**Parameters** pos – 0-based (row, col) tuple, position of mesh vertex

`set_mesh_vertex(pos: Tuple[int, int], point: Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3], dxfattribs=None)`  
Set location and DXF attributes of a single mesh vertex.

## Parameters

- **pos** – 0-based (row, col)-tuple, position of mesh vertex
- **point** – (x, y, z)-tuple, new 3D coordinates of the mesh vertex
- **dxfattribs** – dict of DXF attributes

**get\_mesh\_vertex\_cache ()** → ezdxf.entities.MeshVertexCache

Get a [MeshVertexCache](#) object for this POLYMESH. The caching object provides fast access to the location attribute of mesh vertices.

## MeshVertexCache

**class** ezdxf.entities.MeshVertexCache

Cache mesh vertices in a dict, keys are 0-based (row, col) tuples.

Set vertex location: cache[row, col] = (x, y, z)

Get vertex location: x, y, z = cache[row, col]

### vertices

Dict of mesh vertices, keys are 0-based (row, col) tuples.

**\_\_getitem\_\_** (pos: Tuple[int, int]) → Union[Sequence[float], ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3]

Get mesh vertex location as (x, y, z)-tuple.

**Parameters** pos – 0-based (row, col)-tuple.

**\_\_setitem\_\_** (pos: Tuple[int, int], location: Union[Sequence[float], ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3]) → None

Get mesh vertex location as (x, y, z)-tuple.

**Parameters**

- **pos** – 0-based (row, col)-tuple.

- **location** – (x, y, z)-tuple

## Polyface

Subclass of	<a href="#">ezdxf.entities.Polyline</a>
DXF type	'POLYLINE'
Factory function	<a href="#">ezdxf.layouts.BaseLayout.add_polyface()</a>
Inherited DXF Attributes	<a href="#">Common graphical DXF attributes</a>

### See also:

[Tutorial for Polyface](#)

**class** ezdxf.entities.Polyface

A polyface consist of multiple location independent 3D areas called faces. The [Polyface](#) is a subclass of [Polyline](#), DXF type is also 'POLYLINE' but [get\\_mode\(\)](#) returns 'AcDbPolyFaceMesh'.

**append\_face** (face: FaceType, dxfattribs=None) → None

Append a single face. A *face* is a list of (x, y, z) tuples.

**Parameters**

- **face** – List[ $(x, y, z)$  tuples]
- **dxfattribs** – dict of DXF attributes for VERTEX objects

**append\_faces** (*faces*: Iterable[FaceType], *dxfattribs*=None) → None

Append multiple *faces.faces* is a list of single faces and a single face is a list of  $(x, y, z)$  tuples.

#### Parameters

- **faces** – list of List[ $(x, y, z)$  tuples]
- **dxfattribs** – dict of DXF attributes for teh VERTEX objects

**faces()** → Iterator[List[ezdxf.entities.polyline.DXFVertex]]

Iterable of all faces, a face is a tuple of vertices.

**Returns** [vertex, vertex, vertex, [vertex,] face\_record]

**Return type** list

**optimize** (*precision*: int = 6) → None

Rebuilds *Polyface* including vertex optimization by merging vertices with nearly same vertex locations.

**Parameters** **precision** – floating point precision for determining identical vertex locations

## Ray

RAY entity ([DXF Reference](#)) starts at Ray.dxf.point and continues to infinity (construction line).

Subclass of	<code>ezdxf.entities.XLine</code>
DXF type	'RAY'
Factory function	<code>ezdxf.layouts.BaseLayout.add_ray()</code>
Inherited DXF attributes	<i>Common graphical DXF attributes</i>
Required DXF version	DXF R2000 ('AC1015')

**class** ezdxf.entities.Ray

**dxf.start**

Start point as (3D Point in [WCS](#))

**dxf.unit\_vector**

Unit direction vector as (3D Point in [WCS](#))

**transform** (*m*: `ezdxf.math._matrix44.Matrix44`) → ezdxf.entities.xline.XLine

Transform the XLINE/RAY entity by transformation matrix *m* inplace.

**translate** (*dx*: float, *dy*: float, *dz*: float) → ezdxf.entities.xline.XLine

Optimized XLINE/RAY translation about *dx* in x-axis, *dy* in y-axis and *dz* in z-axis.

## Region

REGION ([DXF Reference](#)) created by an ACIS geometry kernel provided by the [Spatial Corp.](#)

#### See also:

*Ezdx*f has only very limited support for ACIS based entities, for more information see the FAQ: [How to add/edit ACIS based entities like 3DSOLID, REGION or SURFACE?](#)

Subclass of	<code>ezdxf.entities.Body</code>
DXF type	'REGION'
Factory function	<code>ezdxf.layouts.BaseLayout.add_region()</code>
Inherited DXF attributes	<a href="#">Common graphical DXF attributes</a>
Required DXF version	DXF R2000 ('AC1015')

**Warning:** Do not instantiate entity classes by yourself - always use the provided factory functions!

**class** `ezdxf.entities.Region`

Same attributes and methods as parent class [`Body`](#).

**Shape**

SHAPES ([DXF Reference](#)) are objects that are used like block references, each SHAPE reference can be scaled and rotated individually. The SHAPE definitions are stored in external shape files (\*.SHX), and `ezdxf` can not create this shape files.

Subclass of	<code>ezdxf.entities.DXFGraphic</code>
DXF type	'SHAPE'
Factory function	<code>ezdxf.layouts.BaseLayout.add_shape()</code>
Inherited DXF attributes	<a href="#">Common graphical DXF attributes</a>

**Warning:** Do not instantiate entity classes by yourself - always use the provided factory functions!

**class** `ezdxf.entities.Shape`**dx.f.insert**

Insertion location as (2D/3D Point in [`WCS`](#))

**dx.f.name**

Shape name (str)

**dx.f.size**

Shape size (float)

**dx.f.rotation**

Rotation angle in degrees; default value is 0

**dx.f.xscale**

Relative X scale factor (float); default value is 1

**dx.f.oblique**

Oblique angle in degrees (float); default value is 0

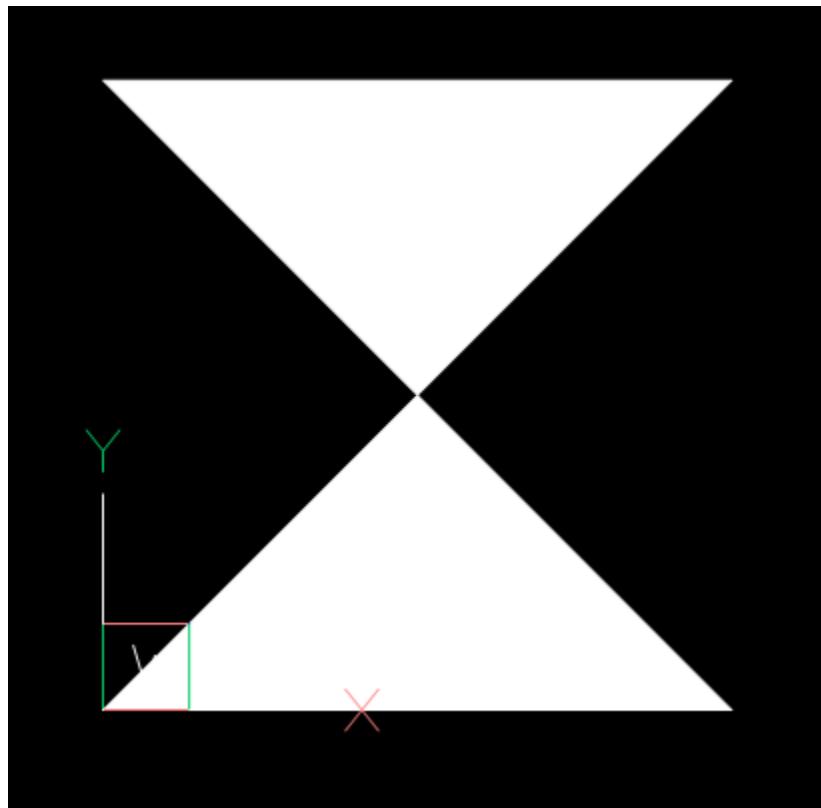
**transform**(*m*: `Matrix44`) → Shape

Transform the SHAPE entity by transformation matrix *m* inplace.

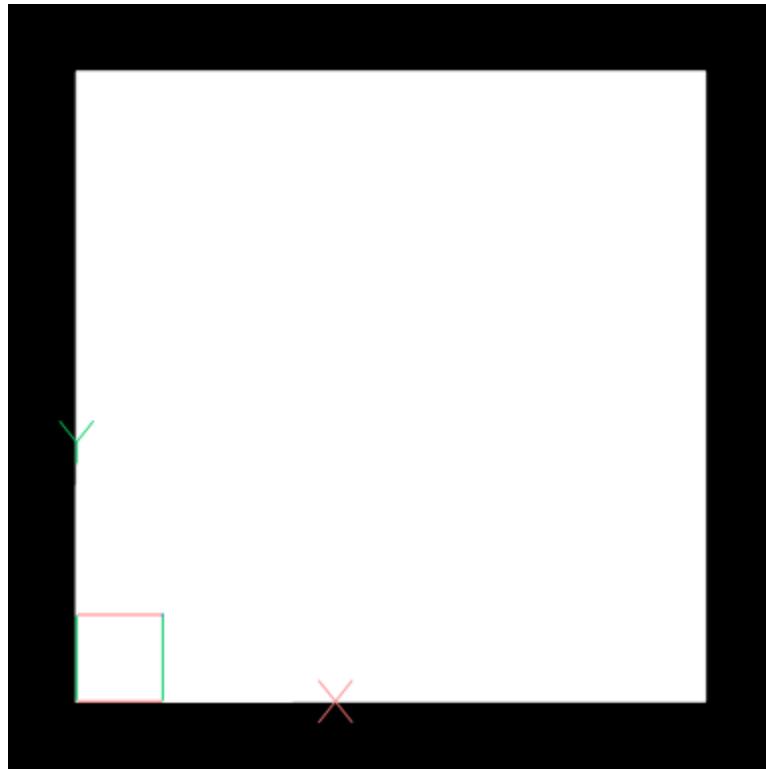
## Solid

SOLID ([DXF Reference](#)) is a filled triangle or quadrilateral. Access vertices by name (`entity.dxf.vtx0 = (1.7, 2.3)`) or by index (`entity[0] = (1.7, 2.3)`). If only 3 vertices are provided the last (3rd) vertex will be repeated in the DXF file.

The SOLID entity stores the vertices in an unusual way, the last two vertices are reversed. The coordinates `[(0, 0), (1, 0), (1, 1), (0, 1)]` do not create a square as you would expect:



Reverse the last two vertices to get the *expected* square: `[(0, 0), (1, 0), (0, 1), (1, 1)]`



---

**Note:** The `Solid.vertices()` and `Solid.wcs_vertices()` methods return the vertices in the *expected* (reversed) order.

---

Subclass of	<code>ezdxf.entities.DXFGraphic</code>
DXF type	'SOLID'
Factory function	<code>ezdxf.layouts.BaseLayout.add_solid()</code>
Inherited DXF attributes	<code>Common graphical DXF attributes</code>

**Warning:** Do not instantiate entity classes by yourself - always use the provided factory functions!

```
class ezdxf.entities.Solid

    dxfl.vtx0
        Location of 1. vertex (2D/3D Point in OCS)
    dxfl.vtx1
        Location of 2. vertex (2D/3D Point in OCS)
    dxfl.vtx2
        Location of 3. vertex (2D/3D Point in OCS)
    dxfl.vtx3
        Location of 4. vertex (2D/3D Point in OCS)
    transform(m: ezdxf.math._matrix44.Matrix44) → ezdxf.entities.solid.Solid
        Transform the SOLID/TRACE entity by transformation matrix m inplace.
```

**vertices** (*close: bool = False*) → List[ezdxf.math.\_vector.Vec3]

Returns OCS vertices in correct order, if argument *close* is True, last vertex == first vertex. Does **not** return duplicated last vertex if represents a triangle.

New in version 0.15.

**wcs\_vertices** (*close: bool = False*) → List[ezdxf.math.\_vector.Vec3]

Returns WCS vertices in correct order, if argument *close* is True, last vertex == first vertex. Does **not** return duplicated last vertex if represents a triangle.

New in version 0.15.

## Spline

SPLINE curve (DXF Reference), all coordinates have to be 3D coordinates even the spline is only a 2D planar curve.

The spline curve is defined by control points, knot values and weights. The control points establish the spline, the various types of knot vector determines the shape of the curve and the weights of rational splines define how strong a control point influences the shape.

To create a *Spline* curve you just need a bunch of fit points - knot values and weights are optional (tested with AutoCAD 2010). If you add additional data, be sure that you know what you do.

New in version 0.16: The function `ezdxf.math.fit_points_to_cad_cv()` calculates control vertices from given fit points. This control vertices define a cubic B-spline which matches visually the SPLINE entities created by BricsCAD and AutoCAD from fit points.

### See also:

- Wikipedia article about B\_splines
- Department of Computer Science and Technology at the Cambridge University
- *Tutorial for Spline*

Subclass of	<code>ezdxf.entities.DXFGraphic</code>
DXF type	'SPLINE'
Factory function	see table below
Inherited DXF attributes	<i>Common graphical DXF attributes</i>
Required DXF version	DXF R2000 ('AC1015')

## Factory Functions

Basic spline entity	<code>add_spline()</code>
Spline control frame from fit points	<code>add_spline_control_frame()</code>
Open uniform spline	<code>add_open_spline()</code>
Closed uniform spline	<code>add_closed_spline()</code>
Open rational uniform spline	<code>add_rational_spline()</code>
Closed rational uniform spline	<code>add_closed_rational_spline()</code>

**class** `ezdxf.entities.Spline`

All points in *WCS* as (x, y, z) tuples

`dxf.degree`

Degree of the spline curve (int).

**dx<sub>f</sub>.flags**

Bit coded option flags, constants defined in `ezdxf.lldxf.const`:

dx <sub>f</sub> .flags	Value	Description
CLOSED_SPLINE	1	Spline is closed
PERIODIC_SPLINE	2	
RATIONAL_SPLINE	4	
PLANAR_SPLINE	8	
LINEAR_SPLINE	16	planar bit is also set

**dx<sub>f</sub>.n\_knots**

Count of knot values (int), automatically set by `ezdxf` (read only)

**dx<sub>f</sub>.n\_fit\_points**

Count of fit points (int), automatically set by `ezdxf` (read only)

**dx<sub>f</sub>.n\_control\_points**

Count of control points (int), automatically set by `ezdxf` (read only)

**dx<sub>f</sub>.knot\_tolerance**

Knot tolerance (float); default =  $1e-10$

**dx<sub>f</sub>.fit\_tolerance**

Fit tolerance (float); default =  $1e-10$

**dx<sub>f</sub>.control\_point\_tolerance**

Control point tolerance (float); default =  $1e-10$

**dx<sub>f</sub>.start\_tangent**

Start tangent vector as (3D vector in `WCS`)

**dx<sub>f</sub>.end\_tangent**

End tangent vector as (3D vector in `WCS`)

**closed**

True if spline is closed. A closed spline has a connection from the last control point to the first control point. (read/write)

**control\_points**

`VertexArray` of control points in `WCS`.

**fit\_points**

`VertexArray` of fit points in `WCS`.

**knots**

Knot values as `array.array('d')`.

**weights**

Control point weights as `array.array('d')`.

**control\_point\_count () → int**

Count of control points.

**fit\_point\_count () → int**

Count of fit points.

**knot\_count () → int**

Count of knot values.

**construction\_tool () → ezdxf.math.BSpline**

Returns the construction tool `ezdxf.math.BSpline`.

**apply\_construction\_tool**(*s*) → ezdxf.entities.spline.Spline

Apply SPLINE data from a *BSpine* construction tool or from a geomdl.BSpline.Curve object.

**flattening**(*distance*: float, *segments*: int = 4) → Iterator[ezdxf.math.\_vector.Vec3]

Adaptive recursive flattening. The argument *segments* is the minimum count of approximation segments between two knots, if the distance from the center of the approximation segment to the curve is bigger than *distance* the segment will be subdivided.

### Parameters

- **distance** – maximum distance from the projected curve point onto the segment chord.
- **segments** – minimum segment count between two knots

New in version 0.15.

**set\_open\_uniform**(*control\_points*: Sequence[Union[Sequence[float], ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3]], *degree*: int = 3) → None

Open B-spline with uniform knot vector, start and end at your first and last control points.

**set\_uniform**(*control\_points*: Sequence[Union[Sequence[float], ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3]], *degree*: int = 3) → None

B-spline with a uniform knot vector, does NOT start and end at your first and last control points.

**set\_closed**(*control\_points*: Sequence[Union[Sequence[float], ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3]], *degree*=3) → None

Closed B-spline with uniform knot vector, start and end at your first control point.

**set\_open\_rational**(*control\_points*: Sequence[Union[Sequence[float], ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3]], *weights*: Sequence[float], *degree*: int = 3) → None

Open rational B-spline with a uniform knot vector, start and end at your first and last control points, and has additional control possibilities by weighting each control point.

**set\_uniform\_rational**(*control\_points*: Sequence[Union[Sequence[float], ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3]], *weights*: Sequence[float], *degree*: int = 3) → None

Rational B-spline with a uniform knot vector, does NOT start and end at your first and last control points, and has additional control possibilities by weighting each control point.

**set\_closed\_rational**(*control\_points*: Sequence[Union[Sequence[float], ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3]], *weights*: Sequence[float], *degree*: int = 3) → None

Closed rational B-spline with a uniform knot vector, start and end at your first control point, and has additional control possibilities by weighting each control point.

**transform**(*m*: ezdxf.math.\_matrix44.Matrix44) → ezdxf.entities.spline.Spline

Transform the SPLINE entity by transformation matrix *m* inplace.

**classmethod from\_arc**(*entity*: ezdxf.entities.dxfgfx.DXFGraphic) → ezdxf.entities.spline.Spline

Create a new SPLINE entity from a CIRCLE, ARC or ELLIPSE entity.

The new SPLINE entity has no owner, no handle, is not stored in the entity database nor assigned to any layout!

## Surface

SURFACE ([DXF Reference](#)) created by an ACIS geometry kernel provided by the [Spatial Corp](#).

### See also:

Ezdx has only very limited support for ACIS based entities, for more information see the FAQ: [How to add/edit ACIS based entities like 3DSOLID, REGION or SURFACE?](#)

Subclass of	<code>ezdxf.entities.Body</code>
DXF type	'SURFACE'
Factory function	<code>ezdxf.layouts.BaseLayout.add_surface()</code>
Inherited DXF attributes	<i>Common graphical DXF attributes</i>
Required DXF version	DXF R2000 ('AC1015')

**Warning:** Do not instantiate entity classes by yourself - always use the provided factory functions!

### `class ezdxf.entities.Surface`

Same attributes and methods as parent class `Body`.

#### `dxf.u_count`

Number of U isolines.

#### `dxf.v_count`

Number of V2 isolines.

## ExtrudedSurface

(DXF Reference)

Subclass of	<code>ezdxf.entities.Surface</code>
DXF type	'EXTRUDEDSURFACE'
Factory function	<code>ezdxf.layouts.BaseLayout.add_extruded_surface()</code>
Inherited DXF attributes	<i>Common graphical DXF attributes</i>
Required DXF version	DXF R2007 ('AC1021')

### `class ezdxf.entities.ExtrudedSurface`

Same attributes and methods as parent class `Surface`.

#### `dxf.class_id`

#### `dxf.sweep_vector`

#### `dxf.draft_angle`

#### `dxf.draft_start_distance`

#### `dxf.draft_end_distance`

#### `dxf.twist_angle`

#### `dxf.scale_factor`

#### `dxf.align_angle`

#### `dxf.solid`

#### `dxf.sweep_alignment_flags`

0	No alignment
1	Align sweep entity to path
2	Translate sweep entity to path
3	Translate path to sweep entity

```

dxf.align_start
dxf.bank
dxf.base_point_set
dxf.sweep_entity_transform_computed
dxf.path_entity_transform_computed
dxf.reference_vector_for_controlling_twist
transformation_matrix_extruded_entity
    type: Matrix44
sweep_entity_transformation_matrix
    type: Matrix44
path_entity_transformation_matrix
    type: Matrix44

```

## LoftedSurface

(DXF Reference)

Subclass of	<code>ezdxf.entities.Surface</code>
DXF type	'LOFTEDSURFACE'
Factory function	<code>ezdxf.layouts.BaseLayout.add_lofted_surface()</code>
Inherited DXF attributes	<i>Common graphical DXF attributes</i>
Required DXF version	DXF R2007 ('AC1021')

```

class ezdxf.entities.LoftedSurface
    Same attributes and methods as parent class Surface.
    dxf.plane_normal_lofting_type
    dxf.start_draft_angle
    dxf.end_draft_angle
    dxf.start_draft_magnitude
    dxf.end_draft_magnitude
    dxf.arc_length_parameterization
    dxf.no_twist
    dxf.align_direction
    dxf.simple_surfaces
    dxf.closed_surfaces
    dxf.solid
    dxf.ruled_surface
    dxf.virtual_guide
    set_transformation_matrix_lofted_entity
        type: Matrix44

```

## RevolvedSurface

(DXF Reference)

Subclass of	<code>ezdxf.entities.Surface</code>
DXF type	'REVOLVEDSURFACE'
Factory function	<code>ezdxf.layouts.BaseLayout.add_revolved_surface()</code>
Inherited DXF attributes	<a href="#">Common graphical DXF attributes</a>
Required DXF version	DXF R2007 ('AC1021')

```
class ezdxf.entities.RevolvedSurface
    Same attributes and methods as parent class Surface.
    dxf.class_id
    dxf.axis_point
    dxf.axis_vector
    dxf.revolve_angle
    dxf.start_angle
    dxf.draft_angle
    dxf.start_draft_distance
    dxf.end_draft_distance
    dxf.twist_angle
    dxf.solid
    dxf.close_to_axis
    transformation_matrix_revolved_entity
        type: Matrix44
```

## SweptSurface

(DXF Reference)

Subclass of	<code>ezdxf.entities.Surface</code>
DXF type	'SWEPTSURFACE'
Factory function	<code>ezdxf.layouts.BaseLayout.add_swept_surface()</code>
Inherited DXF attributes	<a href="#">Common graphical DXF attributes</a>
Required DXF version	DXF R2007 ('AC1021')

```
class ezdxf.entities.SweptSurface
    Same attributes and methods as parent class Surface.
    dxf.swept_entity_id
    dxf.path_entity_id
    dxf.draft_angle
    draft_start_distance
    dxf.draft_end_distance
```

```

dx.f.twist_angle
dx.f.scale_factor
dx.f.align_angle
dx.f.solid
dx.f.sweep_alignment
dx.f.align_start
dx.f.bank
dx.f.base_point_set
dx.f.sweep_entity_transform_computed
dx.f.path_entity_transform_computed
dx.f.reference_vector_for_controlling_twist
transformation_matrix_sweep_entity
    type: Matrix44
transformation_matrix_path_entity()
    type: Matrix44
sweep_entity_transformation_matrix()
    type: Matrix44
path_entity_transformation_matrix()
    type: Matrix44

```

## Text

The single line TEXT entity ([DXF Reference](#)). The `style` attribute stores the associated `Textstyle` entity as string, which defines the basic font properties. The text size is stored as cap height in the `height` attribute in drawing units. Text alignments are defined as enums of type `ezdxf.enums.TextEntityAlignment`.

### See also:

See the documentation for the `Textstyle` class to understand the limitations of text representation in the DXF format.

*Tutorial for Text*

Subclass of	<code>ezdxf.entities.DXFGraphic</code>
DXF type	'TEXT'
Factory function	<code>ezdxf.layouts.BaseLayout.add_text()</code>
Inherited DXF attributes	<i>Common graphical DXF attributes</i>

**Warning:** Do not instantiate entity classes by yourself - always use the provided factory functions!

```
class eздxf.entities.Text
```

```
dx.f.text
Text content as string.
```

**dx<sub>f</sub>.insert**

First alignment point of text (2D/3D Point in *OCS*), relevant for the adjustments LEFT, ALIGNED and FIT.

**dx<sub>f</sub>.align\_point**

The main alignment point of text (2D/3D Point in *OCS*), if the alignment is anything else than LEFT, or the second alignment point for the ALIGNED and FIT alignments.

**dx<sub>f</sub>.height**

Text height in drawing units as float value, the default value is 1.

**dx<sub>f</sub>.rotation**

Text rotation in degrees as float value, the default value is 0.

**dx<sub>f</sub>.oblique**

Text oblique angle (slanting) in degrees as float value, the default value is 0 (straight vertical text).

**dx<sub>f</sub>.style**

*Textstyle* name as case insensitive string, the default value is “Standard”

**dx<sub>f</sub>.width**

Width scale factor as float value, the default value is 1.

**dx<sub>f</sub>.halign**

Horizontal alignment flag as int value, use the *set\_placement()* and *get\_align\_enum()* methods to handle text alignment, the default value is 0.

0	Left
2	Right
3	Aligned (if vertical alignment = 0)
4	Middle (if vertical alignment = 0)
5	Fit (if vertical alignment = 0)

**dx<sub>f</sub>.valign**

Vertical alignment flag as int value, use the *set\_placement()* and *get\_align\_enum()* methods to handle text alignment, the default value is 0.

0	Baseline
1	Bottom
2	Middle
3	Top

**dx<sub>f</sub>.text\_generation\_flag**

Text generation flags as int value, use the *is\_backward* and *is\_upside\_down* attributes to handle this flags.

2	text is backward (mirrored in X)
4	text is upside down (mirrored in Y)

**set\_placement** (*p1: Union[Sequence[float], ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3], p2: Union[Sequence[float], ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3, None] = None, align: Optional[ezdxf.enums.TextEntityAlignment] = None*) → ezdxf.entities.text.Text  
Set text alignment and location.

The alignments ALIGNED and FIT are special, they require a second alignment point, the text is aligned on the virtual line between these two points and sits vertically at the baseline.

- **ALIGNED**: Text is stretched or compressed to fit exactly between  $p1$  and  $p2$  and the text height is also adjusted to preserve height/width ratio.
- **FIT**: Text is stretched or compressed to fit exactly between  $p1$  and  $p2$  but only the text width is adjusted, the text height is fixed by the `dxf.height` attribute.
- **MIDDLE**: also a special adjustment, centered text like `MIDDLE_CENTER`, but vertically centred at the total height of the text.

### Parameters

- **p1** – first alignment point as  $(x, y[, z])$
- **p2** – second alignment point as  $(x, y[, z])$ , required for `ALIGNED` and `FIT` else ignored
- **align** – new alignment as enum `TextEntityAlignment`, `None` to preserve the existing alignment.

**set\_pos** ( $p1: Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3]$ ,  $p2: Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3, None] = None$ ,  $align: Optional[str] = None$ ) → `ezdxf.entities.text.Text`  
Set text alignment and location. (deprecated)

The alignments “`ALIGNED`” and “`FIT`” are special, they require a second alignment point, the text is aligned on the virtual line between these two points and sits vertically at the base line.

- “`ALIGNED`”: Text is stretched or compressed to fit exactly between  $p1$  and  $p2$  and the text height is also adjusted to preserve height/width ratio.
- “`FIT`”: Text is stretched or compressed to fit exactly between  $p1$  and  $p2$  but only the text width is adjusted, the text height is fixed by the `dxf.height` attribute.
- “`MIDDLE`”: also a special adjustment, centered text like “`MIDDLE_CENTER`”, but vertically centred at the total height of the text.

**Warning:** Will be removed in v1.0.0, use `set_placement()`

### Parameters

- **p1** – first alignment point as  $(x, y[, z])$
- **p2** – second alignment point as  $(x, y[, z])$ , required for “`ALIGNED`” and “`FIT`” else ignored
- **align** – new alignment as string or `None` to preserve the existing alignment.

**get\_placement()** → `Tuple[ezdxf.enums.TextEntityAlignment, ezdxf.math._vector.Vec3, Optional[ezdxf.math._vector.Vec3]]`

Returns a tuple ( $align, p1, p2$ ),  $align$  is the alignment enum `TextEntityAlignment`,  $p1$  is the alignment point,  $p2$  is only relevant if  $align$  is `ALIGNED` or `FIT`, otherwise it is `None`.

**get\_pos()** → `Tuple[str, ezdxf.math._vector.Vec3, Optional[ezdxf.math._vector.Vec3]]`

Returns a tuple ( $align, p1, p2$ ),  $align$  is the alignment method,  $p1$  is the alignment point,  $p2$  is only relevant if  $align$  is “`ALIGNED`” or “`FIT`”, otherwise it is `None` (deprecated).

**Warning:** Will be removed in v1.0.0, use `get_placement()`

**get\_align\_enum()** → ezdxf.enums.TextEntityAlignment

Returns the current text alignment as *TextEntityAlignment*, see also *set\_placement()*.

**get\_align()** → str

Returns the current text alignment as string (deprecated).

**Warning:** Will be removed in v1.0.0, use *get\_align\_enum()*

**set\_align\_enum(*align*=<TextEntityAlignment.LEFT: 1>)** → ezdxf.entities.text.Text

Just for experts: Sets the text alignment without setting the alignment points, set adjustment points attr:*dxf.insert* and *dxf.align\_point* manually.

Parameters **align** – *TextEntityAlignment*

**set\_align(*align*: str = 'LEFT')** → ezdxf.entities.text.Text

Set the text alignment as string (deprecated)

**Warning:** Will be removed in v1.0.0, use *set\_align\_enum()*

**transform(*m*: ezdxf.math.\_matrix44.Matrix44)** → ezdxf.entities.text.Text

Transform the TEXT entity by transformation matrix *m* inplace.

**translate(*dx*: float, *dy*: float, *dz*: float)** → ezdxf.entities.text.Text

Optimized TEXT/ATTRIB/ATTDEF translation about *dx* in x-axis, *dy* in y-axis and *dz* in z-axis, returns *self*.

**plain\_text()** → str

Returns text content without formatting codes.

**font\_name()** → str

Returns the font name of the associated *Textstyle*.

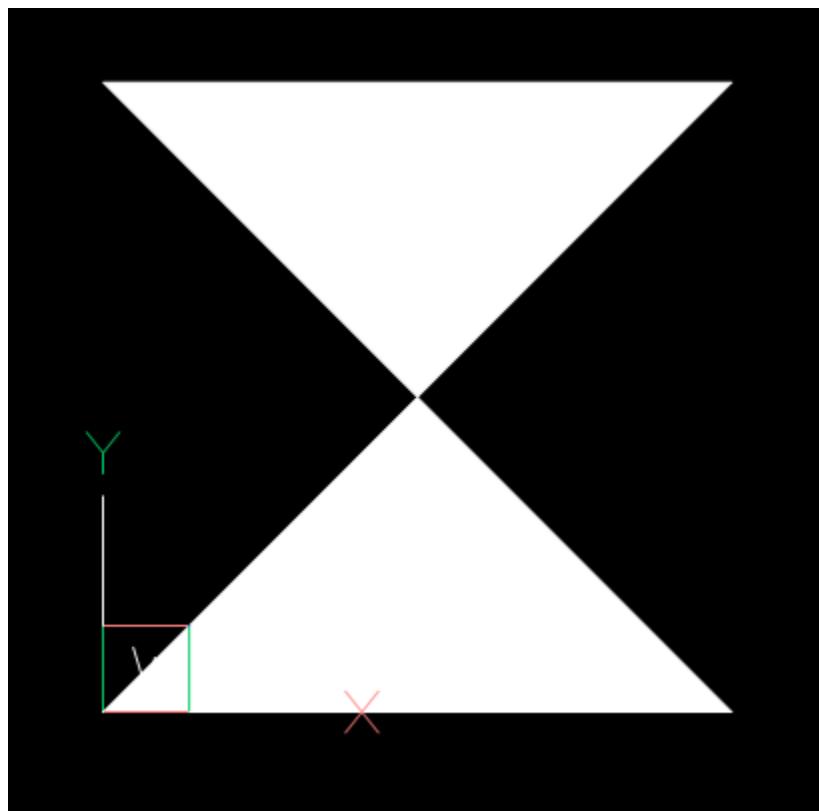
**fit\_length()** → float

Returns the text length for alignments *TextEntityAlignment.FIT* and *TextEntityAlignment.AIGNED*, defined by the distance from the insertion point to the align point or 0 for all other alignments.

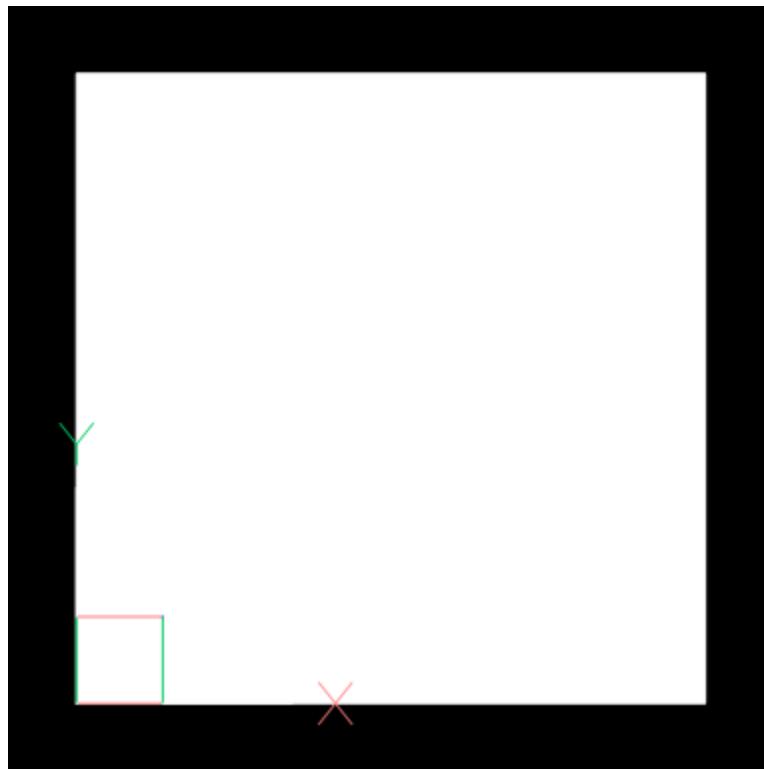
## Trace

TRACE entity (DXF Reference) is solid filled triangle or quadrilateral. Access vertices by name (*entity.dxf.vtx0* = (1.7, 2.3)) or by index (*entity[0]* = (1.7, 2.3)). If only 3 vertices are provided the last (3rd) vertex will be repeated in the DXF file.

The TRACE entity stores the vertices in an unusual way, the last two vertices are reversed. The coordinates [(0, 0), (1, 0), (1, 1), (0, 1)] do not create a square as you would expect:



Reverse the last two vertices to get the *expected* square: `[(0, 0), (1, 0), (0, 1), (1, 1)]`



**Note:** The `Trace.vertices()` and `Trace.wcs_vertices()` methods return the vertices in the *expected*

(reversed) order.

Subclass of	<code>ezdxf.entities.DXFGraphic</code>
DXF type	'TRACE'
Factory function	<code>ezdxf.layouts.BaseLayout.add_trace()</code>
Inherited DXF attributes	<i>Common graphical DXF attributes</i>

**Warning:** Do not instantiate entity classes by yourself - always use the provided factory functions!

**class** `ezdxf.entities.Trace`

`dxfs.vtx0`

Location of 1. vertex (2D/3D Point in *OCS*)

`dxfs.vtx1`

Location of 2. vertex (2D/3D Point in *OCS*)

`dxfs.vtx2`

Location of 3. vertex (2D/3D Point in *OCS*)

`dxfs.vtx3`

Location of 4. vertex (2D/3D Point in *OCS*)

`transform(m: ezdxf.math._matrix44.Matrix44)` → `ezdxf.entities.solid.Solid`

Transform the SOLID/TRACE entity by transformation matrix *m* inplace.

`vertices(close: bool = False)` → `List[ezdxf.math._vector.Vec3]`

Returns OCS vertices in correct order, if argument *close* is True, last vertex == first vertex. Does **not** return duplicated last vertex if represents a triangle.

New in version 0.15.

`wcs_vertices(close: bool = False)` → `List[ezdxf.math._vector.Vec3]`

Returns WCS vertices in correct order, if argument *close* is True, last vertex == first vertex. Does **not** return duplicated last vertex if represents a triangle.

New in version 0.15.

## Underlay

UNDERLAY entity ([DXF Reference](#)) links an underlay file to the DXF file, the file itself is not embedded into the DXF file, it is always a separated file. The (PDF)UNDERLAY entity is like a block reference, you can use it multiple times to add the underlay on different locations with different scales and rotations. But therefore you need a also a (PDF)DEFINITION entity, see [UnderlayDefinition](#).

The DXF standard supports three different file formats: PDF, DWF (DWFX) and DGN. An Underlay can be clipped by a rectangle or a polygon path. The clipping coordinates are 2D *OCS* coordinates in drawing units but without scaling.

Subclass of	<code>ezdxf.entities.DXFGraphic</code>
DXF type	internal base class
Factory function	<code>ezdxf.layouts.BaseLayout.add_underlay()</code>
Inherited DXF attributes	<i>Common graphical DXF attributes</i>
Required DXF version	DXF R2000 ('AC1015')

---

```
class ezdxf.entities.Underlay
    Base class of PdfUnderlay, DwfUnderlay and DgnUnderlay

    dxfs.insert
        Insertion point, lower left corner of the image in OCS.

    dxfs.scale_x
        Scaling factor in x-direction (float)

    dxfs.scale_y
        Scaling factor in y-direction (float)

    dxfs.scale_z
        Scaling factor in z-direction (float)

    dxfs.rotation
        ccw rotation in degrees around the extrusion vector (float)

    dxfs.extrusion
        extrusion vector, default = (0, 0, 1)

    dxfs.underlay_def_handle
        Handle to the underlay definition entity, see UnderlayDefinition

    dxfs.flags
```

dxfs.flags	Value	Description
UNDERLAY_CLIPPING	1	clipping is on/off
UNDERLAY_ON	2	underlay is on/off
UNDERLAY_MONOCHROME	4	Monochrome
UNDERLAY_ADJUST_FOR_BACKGROUND	8	Adjust for background

```
dxfs.contrast
    Contrast value (20 - 100; default = 100)

dxfs.fade
    Fade value (0 - 80; default = 0)

clipping
    True or False (read/write)

on
    True or False (read/write)

monochrome
    True or False (read/write)

adjust_for_background
    True or False (read/write)

scale
    Scaling (x, y, z) tuple (read/write)

boundary_path
    Boundary path as list of vertices (read/write).

    Two vertices describe a rectangle (lower left and upper right corner), more than two vertices is a polygon as clipping path.

get_underlay_def()
    Returns the associated DEFINITION entity. see UnderlayDefinition.
```

```
set_underlay_def()
```

Set the associated DEFINITION entity. see *UnderlayDefinition*.

```
reset_boundary_path() → None
```

Removes the clipping path.

## PdfUnderlay

Subclass of	<i>ezdxf.entities.Underlay</i>
DXF type	'PDFUNDERLAY'
Factory function	<i>ezdxf.layouts.BaseLayout.add_underlay()</i>
Inherited DXF attributes	<i>Common graphical DXF attributes</i>
Required DXF version	DXF R2000 ('AC1015')

```
class ezdxf.entities.PdfUnderlay
```

PDF underlay.

## DwfUnderlay

Subclass of	<i>ezdxf.entities.Underlay</i>
DXF type	'DWFUNDERLAY'
Factory function	<i>ezdxf.layouts.BaseLayout.add_underlay()</i>
Inherited DXF attributes	<i>Common graphical DXF attributes</i>
Required DXF version	DXF R2000 ('AC1015')

```
class ezdxf.entities.DwfUnderlay
```

DWF underlay.

## DgnUnderlay

Subclass of	<i>ezdxf.entities.Underlay</i>
DXF type	'DGNUNDERLAY'
Factory function	<i>ezdxf.layouts.BaseLayout.add_underlay()</i>
Inherited DXF attributes	<i>Common graphical DXF attributes</i>
Required DXF version	DXF R2000 ('AC1015')

```
class ezdxf.entities.DgnUnderlay
```

DGN underlay.

## Viewport

The VIEWPORT (DXF Reference) entity is a window from a paperspace layout to the modelspace.

Subclass of	<i>ezdxf.entities.DXFGraphic</i>
DXF type	'VIEWPORT'
Factory function	<i>ezdxf.layouts.Paperspace.add_viewport()</i>
Inherited DXF attributes	<i>Common graphical DXF attributes</i>

**Warning:** Do not instantiate entity classes by yourself - always use the provided factory functions!

### `class ezdxf.entities.Viewport`

#### `dxfs.center`

Center point of the viewport located in the paper space layout in paper space units stored as 3D point.  
(Error in the DXF reference)

#### `dxfs.width`

Viewport width in paperspace units (float)

#### `dxfs.height`

Viewport height in paperspace units (float)

#### `dxfs.status`

Viewport status field (int)

-1	On, but is fully off screen, or is one of the viewports that is not active because the \$MAXACTVP count is currently being exceeded.
0	Off
>0	On and active. The value indicates the order of stacking for the viewports, where 1 is the active viewport, 2 is the next, and so forth

#### `dxfs.id`

Viewport id (int)

#### `dxfs.view_center_point`

View center point in modelspace stored as 2D point, but represents a [WCS](#) point. (Error in the DXF reference)

#### `dxfs.snap_base_point`

#### `dxfs.snap_spacing`

#### `dxfs.snap_angle`

#### `dxfs.grid_spacing`

#### `dxfs.view_direction_vector`

View direction (3D vector in [WCS](#)).

#### `dxfs.view_target_point`

View target point (3D point in [WCS](#)).

#### `dxfs.perspective_lens_length`

Lens focal length in mm as 35mm film equivalent.

#### `dxfs.front_clip_plane_z_value`

#### `dxfs.back_clip_plane_z_value`

#### `dxfs.view_height`

View height in [WCS](#).

#### `dxfs.view_twist_angle`

#### `dxfs.circle_zoom`

#### `dxfs.flags`

Viewport status bit-coded flags:

Bit value	Constant in ezdxf.const	Description
1 (0x1)	VSF_PERSPECTIVE_MODE	perspective mode
2 (0x2)	VSF_FRONT_CLIPPING	Enables front clipping
4 (0x4)	VSF_BACK_CLIPPING	Enables back clipping
8 (0x8)	VSF_UCS_FOLLOW	Enables UCS follow
16 (0x10)	VSF_FRONT_CLIPPING_AT_EYE	Front clipping at eye
32 (0x20)	VSF_UCS_ICON_VISIBILITY	UCS icon visibility
64 (0x40)	VSF_UCS_ICON_AT_ORIGIN	UCS icon at origin
128 (0x80)	VSF_FAST_ZOOM	Enables fast zoom
256 (0x100)	VSF_SNAP_MODE	Enables snap mode
512 (0x200)	VSF_GRID_MODE	Enables grid mode
1024 (0x400)	VSF_ISOMETRIC_SNAP_STYLE	Isometric snap style
2048 (0x800)	VSF_HIDE_PLOT_MODE	Hides plot mode
4096 (0x1000)	VSF_KISOPAIR_TOP	kIsoPairTop. If set and kIsoPairRight is not set, then isopair top is enabled. If both kIsoPairTop and kIsoPairRight are set, then isopair left is enabled
8192 (0x2000)	VSF_KISOPAIR_RIGHT	kIsoPairRight. If set and kIsoPairTop is not set, then isopair right is enabled
16384 (0x4000)	VSF_LOCK_ZOOM	Enables viewport zoom locking
32768 (0x8000)	VSF_CURRENTLY_ALWAYS_ENABLED	Always enabled
65536 (0x10000)	VSF_NON_RECTANGULAR_CLIPPING	Non rectangular clipping
131072 (0x20000)	VSF_TURN_VIEWPORT_OFF	Viewport off
262144 (0x40000)	VSF_NO_GRID_LIMITS	Hides the display of the grid beyond the drawing limits
524288 (0x80000)	VSF_ADAPTIVE_GRID_DISPLAY	Adaptive grid display
1048576 (0x100000)	VSF_SUBDIVIDE_GRID	Subdivision of the grid below the set grid spacing when the grid display is adaptive
2097152 (0x200000)	VSF_GRID_FOLLOW_WORKPLANE	Workplane switching

Use helper method `set_flag_state()` to set and clear viewport flags, e.g. lock viewport:

```
vp.set_flag_state(ezdx.dxf.const.VSF_LOCK_ZOOM, True)
```

```
dx.dxf.clipping_boundary_handle
dx.dxf.plot_style_name
dx.dxf.render_mode
```

0	2D Optimized (classic 2D)
1	Wireframe
2	Hidden line
3	Flat shaded
4	Gouraud shaded
5	Flat shaded with wireframe
6	Gouraud shaded with wireframe

**dx.dxf.ucs\_per\_viewport****dx.dxf.ucs\_icon****dx.dxf.ucs\_origin**

UCS origin as 3D point.

**dx.dxf.ucs\_x\_axis**

UCS x-axis as 3D vector.

**dx.dxf.ucs\_y\_axis**

UCS y-axis as 3D vector.

**dx.dxf.ucs\_handle**

Handle of UCSTable if UCS is a named UCS. If not present, then UCS is unnamed.

**dx.dxf.ucs\_ortho\_type**

0	not orthographic
1	Top
2	Bottom
3	Front
4	Back
5	Left
6	Right

**dx.dxf.ucs\_base\_handle**Handle of UCSTable of base UCS if UCS is orthographic (`Viewport.dx.dxf.ucs_ortho_type` is non-zero). If not present and `Viewport.dx.dxf.ucs_ortho_type` is non-zero, then base UCS is taken to be WORLD.**dx.dxf.elevation****dx.dxf.shade\_plot\_mode**

(DXF R2004)

0	As Displayed
1	Wireframe
2	Hidden
3	Rendered

**dx.dxf.grid\_frequency**

Frequency of major grid lines compared to minor grid lines. (DXF R2007)

**dx.dxf.background\_handle****dx.dxf.shade\_plot\_handle**

```
dxf.visual_style_handle  
dxf.default_lighting_flag  
dxf.default_lighting_style
```

0	One distant light
1	Two distant lights

```
dxf.view_brightness  
dxf.view_contrast  
dxf.ambient_light_color_1  
    as AutoCAD Color Index (ACI)  
dxf.ambient_light_color_2  
    as true color value  
dxf.ambient_light_color_3  
    as true color value  
dxf.sun_handle  
dxf.ref_vp_object_1  
dxf.ref_vp_object_2  
dxf.ref_vp_object_3  
dxf.ref_vp_object_4  
frozen_layers  
    Set/get frozen layers as list of layer names.  
is_frozen (layer_name: str) → bool  
    Returns True if layer_name is frozen in this viewport.  
freeze (layer_name: str) → None  
    Freeze layer_name in this viewport.  
thaw (layer_name: str) → None  
    Thaw layer_name in this viewport.
```

## Wipeout

THE WIPEOUT ([DXF Reference](#)) entity is a polygonal area that masks underlying objects with the current background color. The WIPEOUT entity is based on the IMAGE entity, but usage does not require any knowledge about the IMAGE entity.

The handles to the support entities *ImageDef* and *ImageDefReactor* are always “0”, both are not needed by the WIPEOUT entity.

Subclass of	<i>ezdxf.entities.Image</i>
DXF type	'WIPEOUT'
Factory function	<i>ezdxf.layouts.BaseLayout.add_wipeout()</i>
Inherited DXF attributes	<a href="#">Common graphical DXF attributes</a>
Required DXF version	DXF R2000 ('AC1015')

**Warning:** Do not instantiate entity classes by yourself - always use the provided factory functions!

### `class ezdxf.entities.Wipeout`

`set_masking_area(vertices: Iterable[Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3]]) → None`  
Set a new masking area, the area is placed in the layout xy-plane.

## XLine

XLINE entity ([DXF Reference](#)) is a construction line that extents to infinity in both directions.

Subclass of	<code>ezdxf.entities.DXFGraphic</code>
DXF type	'XLINE'
Factory function	<code>ezdxf.layouts.BaseLayout.add_xline()</code>
Inherited DXF attributes	<a href="#">Common graphical DXF attributes</a>
Required DXF version	DXF R2000 ('AC1015')

### `class ezdxf.entities.XLine`

#### `dxfl.start`

Location point of line as (3D Point in [WCS](#))

#### `dxfl.unit_vector`

Unit direction vector as (3D Point in [WCS](#))

`transform(m: ezdxf.math._matrix44.Matrix44) → ezdxf.entities.xline.XLine`  
Transform the XLINE/RAY entity by transformation matrix *m* inplace.

`translate(dx: float, dy: float, dz: float) → ezdxf.entities.xline.XLine`  
Optimized XLINE/RAY translation about *dx* in x-axis, *dy* in y-axis and *dz* in z-axis.

## DXF Objects

All DXF objects can only reside in the OBJECTS section of a DXF document.

## Dictionary

The [DICTIONARY](#) is a general storage entity.

AutoCAD maintains items such as MLINE\_STYLES and GROUP definitions as objects in dictionaries. Other applications are free to create and use their own dictionaries as they see fit. The prefix '[ACAD\\_](#)' is reserved for use by AutoCAD applications.

Dictionary entries are (key, [DXFEntity](#)) pairs for fully loaded or new created DXF documents. The referenced entities are owned by the dictionary and cannot be graphical entities that always belong to the layout in which they are located.

Loading DXF files is done in two passes, because at the first loading stage not all referenced objects are already stored in the entity database. Therefore the entities are stored as handles strings at the first loading stage and have to be

replaced by the real entity at the second loading stage. If the entity is still a handle string after the second loading stage, the entity does not exist.

Dictionary keys are handled case insensitive by AutoCAD, but not by *ezdxf*, in doubt use an uppercase key. AutoCAD stores all keys in uppercase.

Subclass of	<code>ezdxf.entities.DXFObject</code>
DXF type	'DICTIONARY'
Factory function	<code>ezdxf.sections.objects.ObjectsSection.add_dictionary()</code>

**Warning:** Do not instantiate object classes by yourself - always use the provided factory functions!

`class ezdxf.entities.Dictionary`

`dxfs.hard_owned`

If set to 1, indicates that elements of the dictionary are to be treated as hard-owned.

`dxfs.cloning`

Duplicate record cloning flag (determines how to merge duplicate entries, ignored by *ezdxf*):

0	not applicable
1	keep existing
2	use clone
3	<xref>\$0\$<name>
4	\$0\$<name>
5	Unmangle name

`is_hard_owner`

Returns True if the dictionary is hard owner of entities. Hard owned entities will be destroyed by deleting the dictionary.

`__len__ () → int`

Returns count of dictionary entries.

`__contains__ (key: str) → bool`

Returns `key` in self.

`__getitem__ (key: str) → ezdxf.entities.dxfentity.DXFEntity`

Return `self[key]`.

The returned value can be a handle string if the entity does not exist.

**Raises** `DXFKeyError` – `key` does not exist

`__setitem__ (key: str, entity: ezdxf.entities.dxfobj.DXFObject) → None`

Set `self[key] = entity`.

Only DXF objects stored in the OBJECTS section are allowed as content of `Dictionary` objects. DXF entities stored in layouts are not allowed.

**Raises** `DXFTypeError` – invalid DXF type

`__delitem__ (key: str) → None`

Delete `self[key]`.

**Raises** `DXFKeyError` – `key` does not exist

**keys ()**

Returns a KeysView of all dictionary keys.

**items ()**

Returns an ItemsView for all dictionary entries as (key, entity) pairs. An entity can be a handle string if the entity does not exist.

**count () → int**

Returns count of dictionary entries.

**get (key: str, default: Optional[ezdxf.entities.dxfobj.DXFObject] = None) → Op-tional[ezdxf.entities.dxfobj.DXFObject]**

Returns the *DXFEntity* for *key*, if *key* exist else *default*. An entity can be a handle string if the entity does not exist.

**add (key: str, entity: ezdxf.entities.dxfobj.DXFObject) → None**  
Add entry (key, value).**Raises**

- DXFValueError – invalid entity handle
- DXFTypError – invalid DXF type

**remove (key: str) → None**

Delete entry *key*. Raises DXFKeyError, if *key* does not exist. Destroys hard owned DXF entities.

**discard (key: str) → None**

Delete entry *key* if exists. Does not raise an exception if *key* doesn't exist and does not destroy hard owned DXF entities.

**clear () → None**

Delete all entries from the dictionary and destroys hard owned DXF entities.

**add\_new\_dict (key: str, hard\_owned: bool = False) → ezdxf.entities.dictionary.Dictionary**  
Create a new sub-dictionary of type *Dictionary*.**Parameters**

- **key** – name of the sub-dictionary
- **hard\_owned** – entries of the new dictionary are hard owned

**get\_required\_dict (key: str, hard\_owned=False) → ezdxf.entities.dictionary.Dictionary**  
Get entry *key* or create a new *Dictionary*, if *Key* not exist.**add\_dict\_var (key: str, value: str) → ezdxf.entities.dictionary.DictionaryVar**  
Add a new *DictionaryVar*.**Parameters**

- **key** – entry name as string
- **value** – entry value as string

**add\_xrecord (key: str) → XRecord**

Add a new *XRecord*.

**Parameters key** – entry name as string**link\_dxf\_object (name: str, obj: ezdxf.entities.dxfobj.DXFObject) → None**  
Add *obj* and set owner of *obj* to this dictionary.

Graphical DXF entities have to reside in a layout and therefore can not be owned by a *Dictionary*.

**Raises** DXFTypError – *obj* has invalid DXF type

## DictionaryWithDefault

Subclass of	<code>ezdxf.entities.Dictionary</code>
DXF type	'ACDBDICTIONARYWDFLT'
Factory function	<code>ezdxf.sections.objects.ObjectsSection.add_dictionary_with_default()</code>

```
class ezdxf.entities.DictionaryWithDefault
```

### `dxfl.default`

Handle to default entry as hex string like FF00.

**get** (`key: str, default: Optional[ezdxf.entities.dxfo.DXFObject] = None`) → `Optional[ezdxf.entities.dxfo.DXFObject]`  
Returns `DXFEntity` for `key` or the predefined dictionary wide `dxfl.default` entity if `key` does not exist or `None` if default value also not exist.

**set\_default** (`default: ezdxf.entities.dxfo.DXFObject`) → `None`  
Set dictionary wide default entry.

**Parameters** `default` – default entry as `DXFEntity`

## DictionaryVar

Subclass of	<code>ezdxf.entities.DXFObject</code>
DXF type	'DICTIONARYVAR'
Factory function	<code>ezdxf.entities.Dictionary.add_dict_var()</code>

```
class ezdxf.entities.DictionaryVar
```

### `dxfl.schema`

Object schema number (currently set to 0)

### `dxfl.value`

Value as string.

## DXFLayout

`LAYOUT` entity is part of a modelspace or paperspace layout definitions.

Subclass of	<code>ezdxf.entities.PlotSettings</code>
DXF type	'LAYOUT'
Factory function	internal data structure, use <code>Layouts</code> to manage layout objects.

```
class ezdxf.entities.DXFLLayout
```

### `dxfl.name`

Layout name as shown in tabs by `CAD` applications

TODO

## DXFObject

Common base class for all non-graphical DXF objects.

**class** `ezdxf.entities.DXFObject`

A class hierarchy marker class and subclass of `ezdxf.entities.DXFEntity`

## GeoData

The **GEODATA** entity is associated to the `Modelspace` object. The **GEODATA** entity is supported since the DXF version R2000, but was officially documented the first time in the DXF reference for version R2009.

Subclass of	<code>ezdxf.entities.DXFObject</code>
DXF type	'GEODATA'
Factory function	<code>ezdxf.layouts.Modelspace.new_geodata()</code>
Required DXF version	R2010 ('AC1024')

**See also:**

`using_geodata.py`

**Warning:** Do not instantiate object classes by yourself - always use the provided factory functions!

**class** `ezdxf.entities.GeoData`

`dxf.version`

1	R2009
2	R2010

`dxf.coordinate_type`

0	unknown
1	local grid
2	projected grid
3	geographic (latitude/longitude)

`dxf.block_record_handle`

Handle of host BLOCK\_RECORD table entry, in general the `Modelspace`.

Changed in version 0.10: renamed from `dxf.block_record`

`dxf.design_point`

Reference point in `WCS` coordinates.

`dxf.reference_point`

Reference point in geo coordinates, valid only when coordinate type is *local grid*. The difference between `dxf.design_point` and `dxf.reference_point` defines the translation from WCS coordinates to geo-coordinates.

**dx<sub>f</sub>.north\_direction**

North direction as 2D vector. Defines the rotation (about the *dx<sub>f</sub>.design\_point*) to transform from WCS coordinates to geo-coordinates

**dx<sub>f</sub>.horizontal\_unit\_scale**

Horizontal unit scale, factor which converts horizontal design coordinates to meters by multiplication.

**dx<sub>f</sub>.vertical\_unit\_scale**

Vertical unit scale, factor which converts vertical design coordinates to meters by multiplication.

**dx<sub>f</sub>.horizontal\_units**

Horizontal units (see *BlockRecord*). Will be 0 (Unitless) if units specified by horizontal unit scale is not supported by AutoCAD enumeration.

**dx<sub>f</sub>.vertical\_units**

Vertical units (see *BlockRecord*). Will be 0 (Unitless) if units specified by vertical unit scale is not supported by AutoCAD enumeration.

**dx<sub>f</sub>.up\_direction**

Up direction as 3D vector.

**dx<sub>f</sub>.scale\_estimation\_method**

1	none
2	user specified scale factor
3	grid scale at reference point
4	prismoidal

**dx<sub>f</sub>.sea\_level\_correction**

Bool flag specifying whether to do sea level correction.

**dx<sub>f</sub>.user\_scale\_factor****dx<sub>f</sub>.sea\_level\_elevation****dx<sub>f</sub>.coordinate\_projection\_radius****dx<sub>f</sub>.geo\_rss\_tag****dx<sub>f</sub>.observation\_from\_tag****dx<sub>f</sub>.observation\_to\_tag****dx<sub>f</sub>.mesh\_faces\_count****source\_vertices**

2D source vertices in the CRS of the GeoData as *VertexArray*. Used together with *target\_vertices* to define the transformation from the CRS of the GeoData to WGS84.

**target\_vertices**

2D target vertices in WGS84 (EPSG:4326) as *VertexArray*. Used together with *source\_vertices* to define the transformation from the CRS of the geoData to WGS84.

**faces**

List of face definition tuples, each face entry is a 3-tuple of vertex indices (0-based).

**coordinate\_system\_definition**

The coordinate system definition string. Stored as XML. Defines the CRS used by the GeoData. The EPSG number and other details like the axis-ordering of the CRS is stored.

`get_crs() → Tuple[int, bool]`

Returns the EPSG index and axis-ordering, axis-ordering is True if first axis is labeled “E” or “W” and False if first axis is labeled “N” or “S”.

If axis-ordering is False the CRS is not compatible with the `__geo_interface__` or GeoJSON (see chapter 3.1.1).

**Raises** `InvalidGeoDataException` – for invalid or unknown XML data

The EPSG number is stored in a tag like:

```
<Alias id="27700" type="CoordinateSystem">
    <ObjectId>OSGB1936.NationalGrid</ObjectId>
    <Namespace>EPSG Code</Namespace>
</Alias>
```

The axis-ordering is stored in a tag like:

```
<Axis uom="METER">
    <CoordinateSystemAxis>
        <AxisOrder>1</AxisOrder>
        <AxisName>Easting</AxisName>
        <AxisAbbreviation>E</AxisAbbreviation>
        <AxisDirection>east</AxisDirection>
    </CoordinateSystemAxis>
    <CoordinateSystemAxis>
        <AxisOrder>2</AxisOrder>
        <AxisName>Northing</AxisName>
        <AxisAbbreviation>N</AxisAbbreviation>
        <AxisDirection>north</AxisDirection>
    </CoordinateSystemAxis>
</Axis>
```

`get_crs_transformation(*, no_checks: bool = False) → Tuple[ezdxf.math._matrix44.Matrix44, int]`

Returns the transformation matrix and the EPSG index to transform WCS coordinates into CRS coordinates. Because of the lack of proper documentation this method works only for tested configurations, set argument `no_checks` to True to use the method for untested geodata configurations, but the results may be incorrect.

Supports only “Local Grid” transformation!

**Raises** `InvalidGeoDataException` – for untested geodata configurations

```
setup_local_grid(*,    design_point:      Union[Sequence[float],      eздxf.math._vector.Vec2,
                                                eздxf.math._vector.Vec3],    reference_point:      Union[Sequence[float],
                                                eздxf.math._vector.Vec2,      eздxf.math._vector.Vec3],    north_direction:
                                                Union[Sequence[float],      eздxf.math._vector.Vec2,      eздxf.math._vector.Vec3]
                                                = (0, 1),    crs:      str = '<?xml version="1.0" encoding="UTF-
                                                16" standalone="no" ?>\n<Dictionary version="1.0"
                                                xmlns="http://www.osgeo.org/mapguide/coordinatesystem">\n\n<ProjectedCoordinateSystem
                                                id="WORLD-MERCATOR">\n<Name>WORLD-
                                                MERCATOR</Name>\n<AdditionalInformation>\n<ParameterItem
                                                type="CsMap">\n<Key>CSQuadrantSimplified</Key>\n<IntegerValue>1</IntegerValue>\n</Param
                                                180.75</WestBoundLongitude>\n<EastBoundLongitude>180.75</EastBoundLongitude>\n<SouthBound
                                                80.75</SouthBoundLatitude>\n<NorthBoundLatitude>84.75</NorthBoundLatitude>\n</GeographicE
                                                uom="Meter">\n<CoordinateSystemAxis>\n<AxisOrder>1</AxisOrder>\n<AxisName>Easting</Axis
                                                (variant B)</OperationMethodId>\n<ParameterValue><OperationParameterId>Longitude
                                                of natural origin</OperationParameterId><Value
                                                uom="degree">0</Value></ParameterValue>\n<ParameterValue><OperationParameterId>Standard
                                                Parallel</OperationParameterId><Value uom="degree">0</Value></ParameterValue>\n<Parameter
                                                factor for coord differences</OperationParameterId><Value
                                                uom="unity">1</Value></ParameterValue>\n<ParameterValue><OperationParameterId>False
                                                easting</OperationParameterId><Value uom="Meter">0</Value></ParameterValue>\n<ParameterV
                                                northing</OperationParameterId><Value uom="Meter">0</Value></ParameterValue>\n</Projection
                                                id="3395" type="CoordinateSystem">\n<ObjectID>WORLD-
                                                MERCATOR</ObjectID>\n<Namespace>EPSG
                                                Code</Namespace>\n<Alias>\n\n<GeodeticDatum
                                                id="WGS84">\n<Name>WGS84</Name>\n<PrimeMeridianId>Greenwich</PrimeMeridianId>\n<E
                                                id="6326" type="Datum">\n<ObjectID>WGS84</ObjectID>\n<Namespace>EPSG
                                                Code</Namespace>\n<Alias>\n\n<Ellipsoid id="WGS84">\n<Name>WGS84</Name>\n<SemiMajor
                                                uom="meter">6.37814e+06</SemiMajorAxis>\n<SecondDefiningParameter>\n<SemiMinorAxis
                                                uom="meter">6.35675e+06</SemiMinorAxis>\n<SecondDefiningParameter>\n</Ellipsoid>\n<Alias
                                                id="7030" type="Ellipsoid">\n<ObjectID>WGS84</ObjectID>\n<Namespace>EPSG
                                                Code</Namespace>\n<Alias>\n\n</Dictionary>\n') → None
```

Setup local grid coordinate system. This method is designed to setup CRS similar to *EPSG:3395 World Mercator*, the basic features of the CRS should fulfill these assumptions:

- base unit of reference coordinates is 1 meter
- right-handed coordinate system: +Y=north/+X=east/+Z=up

The CRS string is not validated nor interpreted!

---

**Hint:** The reference point must be a 2D cartesian map coordinate and not a globe (lon/lat) coordinate like stored in GeoJSON or GPS data.

---

## Parameters

- **design\_point** – WCS coordinates of the CRS reference point
- **reference\_point** – CRS reference point in 2D cartesian coordinates
- **north\_direction** – north direction a 2D vertex, default is (0, 1)
- **crs** – Coordinate Reference System definition XML string, default is the definition string for *EPSG:3395 World Mercator*

## ImageDef

**IMAGEDEF** entity defines an image file, which can be placed by the *Image* entity.

Subclass of	<code>ezdxf.entities.DXFObject</code>
DXF type	' IMAGEDEF '
Factory function (1)	<code>ezdxf.document.Drawing.add_image_def()</code>
Factory function (2)	<code>ezdxf.sections.objects.ObjectsSection.add_image_def()</code>

**Warning:** Do not instantiate object classes by yourself - always use the provided factory functions!

```
class eздxf.entities.ImageDef
```

`dxfs.class_version`

Current version is 0.

`dxfs.filename`

Relative (to the DXF file) or absolute path to the image file as string.

`dxfs.image_size`

Image size in pixel as (x, y) tuple.

`dxfs.pixel_size`

Default size of one pixel in drawing units as (x, y) tuple.

`dxfs.loaded`

0 = unloaded; 1 = loaded, default = 1

`dxfs.resolution_units`

0	No units
2	Centimeters
5	Inch

Default = 0

## ImageDefReactor

```
class eздxf.entities.ImageDefReactor
```

`dxfs.class_version`

`dxfs.image_handle`

## MLeaderStyle

The MLEADERSTYLE object ([DXF Reference](#)) store all attributes required to create new *MultiLeader* entities. The meaning of these attributes are not really documented in the [DXF Reference](#). The default style “Standard” always exist.

**See also:**

- `ezdxf.entities.MultiLeader`
- `ezdxf.render.MultiLeaderBuilder`
- `Tutorial for MultiLeader`

Create a new `MLeaderStyle`:

```
import ezdxf

doc = ezdxf.new()
new_style = doc.mleader_styles.new("NewStyle")
```

Duplicate an existing style:

```
duplicated_style = doc.mleader_styles.duplicate_entry("Standard", "DuplicatedStyle")
```

Subclass of	<code>ezdxf.entities.DXFObject</code>
DXF type	'MLEADERSTYLE'
Factory function	<code>ezdxf.document.Drawing.mleader_styles.new()</code>

`class ezdxf.entities.MLeaderStyle`

`dx.dxf.align_space`

unknown meaning

`dx.dxf.arrow_head_handle`

handle of default arrow head, see also `ezdxf.render.arrows` module, by default no handle is set, which mean default arrow “closed filled”

`dx.dxf.arrow_head_size`

default arrow head size in drawing units, default is 4.0

`dx.dxf.block_color`

default block color as ;term:raw color value, default is BY\_BLOCK\_RAW\_VALUE

`dx.dxf.block_connection_type`

0	center extents
1	insertion point

`dx.dxf.block_record_handle`

handle to block record of the BLOCK content, not set by default

`dx.dxf.block_rotation`

default BLOCK rotation in radians, default is 0.0

`dx.dxf.block_scale_x`

default block x-axis scale factor, default is 1.0

`dx.dxf.block_scale_y`

default block y-axis scale factor, default is 1.0

`dx.dxf.block_scale_z`

default block z-axis scale factor, default is 1.0

---

`dxf.break_gap_size`  
default break gap size, default is 3.75

`dxf.char_height`  
default MTEXT char height, default is 4.0

`dxf.content_type`

0	none
1	BLOCK
2	MTEXT
3	TOLERANCE

default is MTEXT (2)

`dxf.default_text_content`  
default MTEXT content as string, default is ""

`dxf.dogleg_length`  
default dogleg length, default is 8.0

`dxf.draw_leader_order_type`  
unknown meaning

`dxf.draw_mleader_order_type`  
unknown meaning

`dxf.first_segment_angle_constraint`  
angle of fist leader segment in radians, default is 0.0

`dxf.has_block_rotation`

`dxf.has_block_scaling`

`dxf.has_dogleg`  
default is 1

`dxf.has_landing`  
default is 1

`dxf.is_annotation`  
default is 0

`dxf.landing_gap`  
default landing gap size, default is 2.0

`dxf.leader_line_color`  
default leader line color as *raw color* value, default is BY\_BLOCK\_RAW\_VALUE

`dxf.leader_linetype_handle`  
handle of default leader linetype

`dxf.leader_lineweight`  
default leader linewidth, default is LINEWEIGHT\_BYBLOCK

`dxf.leader_type`

0	invisible
1	straight line leader
2	spline leader

default is 1

`dxf.max_leader_segments_points`  
max count of leader segments, default is 2

`dxf.name`  
MLEADERSTYLE name

`dxf.overwrite_property_value`  
unknown meaning

`dxf.scale`  
overall scaling factor, default is 1.0

`dxf.second_segment_angle_constraint`  
angle of fist leader segment in radians, default is 0.0

`dxf.text_align_always_left`  
use always left side to attach leaders, default is 0

`dxf.text_alignment_type`  
unknown meaning - its not the MTEXT attachment point!

`dxf.text_angle_type`

0	text angle is equal to last leader line segment angle
1	text is horizontal
2	text angle is equal to last leader line segment angle, but potentially rotated by 180 degrees so the right side is up for readability.

default is 1

`dxf.text_attachment_direction`

defines whether the leaders attach to the left & right of the content BLOCK/MTEXT or attach to the top & bottom:

0	horizontal - left & right of content
1	vertical - top & bottom of content

default is 0

`dxf.text_bottom_attachment_type`

9	center
10	overline and center

default is 9

`dxf.text_color`  
default MTEXT color as *raw color* value, default is BY\_BLOCK\_RAW\_VALUE

`dxf.text_left_attachment_type`

0	top of top MTEXT line
1	middle of top MTEXT line
2	middle of whole MTEXT
3	middle of bottom MTEXT line
4	bottom of bottom MTEXT line
5	bottom of bottom MTEXT line & underline bottom MTEXT line
6	bottom of top MTEXT line & underline top MTEXT line
7	bottom of top MTEXT line
8	bottom of top MTEXT line & underline all MTEXT lines

`dxf.text_right_attachment_type`

0	top of top MTEXT line
1	middle of top MTEXT line
2	middle of whole MTEXT
3	middle of bottom MTEXT line
4	bottom of bottom MTEXT line
5	bottom of bottom MTEXT line & underline bottom MTEXT line
6	bottom of top MTEXT line & underline top MTEXT line
7	bottom of top MTEXT line
8	bottom of top MTEXT line & underline all MTEXT lines

`dxf.text_style_handle`

handle of the default MTEXT text style, not set by default, which means “Standard”

`dxf.text_top_attachment_type`

9	center
10	overline and center

## Placeholder

The `ACDBPLACEHOLDER` object for internal usage.

Subclass of	<code>ezdxf.entities.DXFObject</code>
DXF type	<code>'ACDBPLACEHOLDER'</code>
Factory function	<code>ezdxf.sections.objects.ObjectsSection.add_placeholder()</code>

**Warning:** Do not instantiate object classes by yourself - always use the provided factory functions!

`class ezdxf.entities.Placeholder`

## PlotSettings

All `PLOTSETTINGS` attributes are part of the `DXFLayout` entity, I don't know if this entity also appears as stand-alone entity.

Subclass of	<code>ezdxf.entities.DXFObject</code>
DXF type	'PLOTSETTINGS'
Factory function	internal data structure

```
class ezdxf.entities.PlotSettings
```

`dxfs.page_setup_name`  
Page setup name

TODO

## Sun

SUN entity defines properties of the sun.

Subclass of	<code>ezdxf.entities.DXFObject</code>
DXF type	'SUN'
Factory function	creating a new SUN entity is not supported

```
class ezdxf.entities.Sun
```

`dxfs.version`  
Current version is 1.

`dxfs.status`  
on = 1 or off = 0

`dxfs.color`  
*AutoCAD Color Index (ACI)* value of the sun.

`dxfs.true_color`  
*true color* value of the sun.

`dxfs.intensity`  
Intensity value in the range of 0 to 1. (float)

`dxfs.julian_day`  
use `calendardate()` to convert `dxfs.julian_day` to `datetime.datetime` object.

`dxfs.time`  
Day time in seconds past midnight. (int)

`dxfs.daylight_savings_time`

`dxfs.shadows`

0	Sun do not cast shadows
1	Sun do cast shadows

`dxfs.shadow_type`

`dxfs.shadow_map_size`

`dxfs.shadow_softness`

## UnderlayDefinition

*UnderlayDefinition* (DXF Reference) defines an underlay file, which can be placed by the *Underlay* entity.

Subclass of	<code>ezdxf.entities.DXFObject</code>
DXF type	internal base class
Factory function (1)	<code>ezdxf.document.Drawing.add_underlay_def()</code>
Factory function (2)	<code>ezdxf.sections.objects.ObjectsSection.add_underlay_def()</code>

```
class ezdxf.entities.UnderlayDefinition
    Base class of PdfDefinition, DwfDefinition and DgnDefinition
```

`dxfs.filename`

Relative (to the DXF file) or absolute path to the underlay file as string.

`dxfs.name`

Defines which part of the underlay file to display.

'pdf'	PDF page number
'dgn'	always 'default'
'dwf'	?

**Warning:** Do not instantiate object classes by yourself - always use the provided factory functions!

## PdfDefinition

Subclass of	<code>ezdxf.entities.UnderlayDefinition</code>
DXF type	'PDFDEFINITION'
Factory function (1)	<code>ezdxf.document.Drawing.add_underlay_def()</code>
Factory function (2)	<code>ezdxf.sections.objects.ObjectsSection.add_underlay_def()</code>

```
class ezdxf.entities.PdfDefinition
```

PDF underlay file.

## DwfDefinition

Subclass of	<code>ezdxf.entities.UnderlayDefinition</code>
DXF type	'DWFDEFINITION'
Factory function (1)	<code>ezdxf.document.Drawing.add_underlay_def()</code>
Factory function (2)	<code>ezdxf.sections.objects.ObjectsSection.add_underlay_def()</code>

```
class ezdxf.entities.DwfDefinition
```

DWF underlay file.

## DgnDefinition

Subclass of	<code>ezdxf.entities.UnderlayDefinition</code>
DXF type	'DGNDEFINITION'
Factory function (1)	<code>ezdxf.document.Drawing.add_underlay_def()</code>
Factory function (2)	<code>ezdxf.sections.objects.ObjectsSection.add_underlay_def()</code>

```
class ezdxf.entities.DgnDefinition  
    DGN underlay file.
```

## XRecord

Important class for storing application defined data in DXF files.

XRECORD objects are used to store and manage arbitrary data. They are composed of DXF group codes ranging from 1 through 369. This object is similar in concept to XDATA but is not limited by size or order.

To reference a XRECORD by an DXF entity, store the handle of the XRECORD in the XDATA section, application defined data or the ExtensionDict of the DXF entity.

### See also:

- *Extended Data (XDATA)*
- *Extension Dictionary*
- *Storing Custom Data in DXF Files*

Subclass of	<code>ezdxf.entities.DXFObject</code>
DXF type	'XRECORD'
Factory function	<code>ezdxf.sections.objects.ObjectsSection.add_xrecord()</code>

**Warning:** Do not instantiate object classes by yourself - always use the provided factory functions!

```
class ezdxf.entities.XRecord
```

### dxfs.cloning

Duplicate record cloning flag (determines how to merge duplicate entries, ignored by *ezdxf*):

0	not applicable
1	keep existing
2	use clone
3	<xref>\$0\$<name>
4	\$0\$<name>
5	Unmangle name

### tags

Raw DXF tag container *Tags*. Be careful *ezdxf* does not validate the content of XRECORDS.

### clear() → None

Remove all DXF tags.

**reset** (*tags: Iterable[Union[ezdxf.lldxf.types.DXFTag, Tuple[int, Any]]]*) → None  
 Reset DXF tags.

**extend** (*tags: Iterable[Union[ezdxf.lldxf.types.DXFTag, Tuple[int, Any]]]*) → None  
 Extend DXF tags.

## Extended Data (XDATA)

Extended data (XDATA) is a DXF tags structure to store arbitrary data in DXF entities. The XDATA is associated to an *AppID* and only one tag list is supported for each AppID per entity.

**Warning:** Low level usage of XDATA is an advanced feature, it is the responsibility of the programmer to create valid XDATA structures. Any errors can invalidate the DXF file!

This section shows how to store DXF tags directly in DXF entity but there is also a more user friendly and safer way to store custom XDATA in DXF entities:

- *XDataUserList*
- *XDataUserDict*

Use the high level methods of *DXFEntity* to manage XDATA tags.

- *has\_xdata()*
- *get\_xdata()*
- *set\_xdata()*

Get XDATA tags as a *ezdxf.lldxf.tags.Tags* data structure, **without** the mandatory first tag (1001, AppID):

```
if entity.has_xdata("EZDXF"):
    tags = entity.get_xdata("EZDXF")

# or use alternatively:
try:
    tags = entity.get_xdata("EZDXF")
except DXFValueError:
    # XDATA for "EZDXF" does not exist
    ...
```

Set DXF tags as list of (group code, value) tuples or as *ezdxf.lldxf.tags.Tags* data structure, valid DXF tags for XDATA are documented in the section about the *Extended Data* internals. The mandatory first tag (1001, AppID) is inserted automatically if not present.

Set only new XDATA tags:

```
if not entity.has_xdata("EZDXF"):
    entity.set_xdata("EZDXF", [(1000, "MyString")])
```

Replace or set new XDATA tags:

```
entity.set_xdata("EZDXF", [(1000, "MyString")])
```

See also:

- Tutorial: *Storing Custom Data in DXF Files*
- Internals about *Extended Data* tags

- Internal XDATA management class: [XData](#)
- DXF R2018 Reference

## Application-Defined Data (AppData)

The application-defined data feature is not very well documented in the DXF reference, so usage as custom data store is not recommended. AutoCAD uses these feature to store the handle to the extension dictionary ([ExtensionDict](#)) of a DXF entity and the handles to the persistent reactors ([Reactors](#)) of a DXF entity.

Use the high level methods of [DXFEntity](#) to manage application-defined data tags.

- [has\\_app\\_data\(\)](#)
- [get\\_app\\_data\(\)](#)
- [set\\_app\\_data\(\)](#)
- [discard\\_app\\_data\(\)](#)

---

**Hint:** Ezdxf uses special classes to manage the extension dictionary and the reactor handles. These features cannot be accessed by the methods above.

---

Set application-defined data:

```
entity.set_app_data("YOURAPPID", [(1, "DataString")])
```

Setting the content tags can contain the opening structure tag (102, “{YOURAPPID”) and the closing tag (102, “}”), but doesn’t have to. The returned [Tags](#) objects does not contain these structure tags. Which tags are valid for application-defined data is not documented.

The AppID has to have an entry in the AppID table.

Get application-defined data:

```
if entity.has_app_data("YOURAPPID"):
    tags = entity.get_app_data("YOURAPPID")

# tags content is [DXFTag(1, 'DataString')]
```

See also:

- Internals about [Application-Defined Codes](#)
- Internal AppData management class: [AppData](#)

## Extension Dictionary

Every entity can have an extension dictionary, which can reference arbitrary DXF objects from the OBJECTS section but not graphical entities. Using this mechanism, several applications can attach data to the same entity. The usage of extension dictionaries is more complex than [Extended Data \(XDATA\)](#) but also more flexible with higher capacity for adding data.

Use the high level methods of [DXFEntity](#) to manage extension dictionaries.

- [has\\_extension\\_dict\(\)](#)
- [get\\_extension\\_dict\(\)](#)

- `new_extension_dict()`
- `discard_extension_dict()`

The main data storage objects referenced by extension dictionaries are:

- `Dictionary`, structural container
- `DictionaryVar`, stores a single string
- `XRecord`, stores arbitrary data

#### See also:

- Tutorial: [Storing Custom Data in DXF Files](#)

**class** `ezdxf.entities.xdict.ExtensionDict`  
Internal management class for extension dictionaries.

#### See also:

- Underlying DXF `Dictionary` class
- DXF Internals: [Extension Dictionary](#)
- [DXF R2018 Reference](#)

`__contains__(key: str)`  
Return `key` in self.

`__getitem__(key: str)`  
Get `self[key]`.

`__setitem__(key: str, value)`  
Set `self[key]` to `value`.

Only DXF objects stored in the OBJECTS section are allowed as content of the extension dictionary. DXF entities stored in layouts are not allowed.

**Raises** `DXFTypeError` – invalid DXF type

`__delitem__(key: str)`  
Delete `self[key]`, destroys referenced entity.

`__len__()`  
Returns count of extension dictionary entries.

`get(key: str, default=None) → Optional[DXFEntity]`  
Return extension dictionary entry `key`.

`keys()`  
Returns a `KeysView` of all extension dictionary keys.

`items()`  
Returns an `ItemsView` for all extension dictionary entries as (key, entity) pairs. An entity can be a handle string if the entity does not exist.

`discard(key: str) → None`  
Discard extension dictionary entry `key`.

`add_dictionary(name: str, hard_owned: bool = True) → Dictionary`  
Create a new `Dictionary` object as extension dictionary entry `name`.

`add_dictionary_var(name: str, value: str) → DictionaryVar`  
Create a new `DictionaryVar` object as extension dictionary entry `name`.

**add\_xrecord** (*name: str*) → XRecord

Create a new *XRecord* object as extension dictionary entry *name*.

**link\_dxf\_object** (*name: str, obj: DXFObject*) → None

Link *obj* to the extension dictionary as entry *name*.

Linked objects are owned by the extensions dictionary and therefore cannot be a graphical entity, which have to be owned by a *BaseLayout*.

**Raises** DXFTypeError – *obj* has invalid DXF type

**destroy()**

Destroy the underlying *Dictionary* object.

## Reactors

Persistent reactors are optional object handles of objects registering themselves as reactors on an object. Any DXF object or DXF entity may have reactors.

Use the high level methods of *DXFEntity* to manage persistent reactor handles.

- *has\_reactors()*
- *get\_reactors()*
- *set\_reactors()*
- *append\_reactor\_handle()*
- *discard\_reactor\_handle()*

*Ezdx*f keeps these reactors only up to date, if this is absolute necessary according to the DXF reference.

**See also:**

- Internals about *Persistent Reactors*
- Internal Reactors management class: *Reactors*

## Block Reference Management

The package *ezdxf* is not designed as a CAD library and does not automatically monitor all internal changes. This enables faster entity processing at the cost of an unknown state of the DXF document.

In order to carry out precise BLOCK reference management, i.e. to handle dependencies or to delete unused BLOCK definition, the block reference status (counter) must be acquired explicitly by the package user. All block reference management structures must be explicitly recreated each time the document content is changed. This is not very efficient, but it is safe.

**Warning:** And even with all this careful approach, it is always possible to destroy a DXF document by deleting an absolutely necessary block definition.

Always remember that *ezdxf* is not intended or suitable as a basis for a CAD application!

New in version 0.18.

**class** ezdxf.blkrefs.**BlockDefinitionIndex** (*doc: Drawing*)

Index of all *BlockRecord* entities representing real BLOCK definitions, excluding all *BlockRecord* entities defining model space or paper space layouts. External references (XREF) and XREF overlays are included.

**rebuild()**

Rebuild index from scratch.

**has\_handle(handle: str) → bool**

Returns True if a *BlockRecord* for the given block record handle exist.

**by\_handle(handle: str) → Optional[BlockRecord]**

Returns the *BlockRecord* for the given block record handle or None.

**has\_name(name: str) → bool**

Returns True if a *BlockRecord* for the given block name exist.

**by\_name(name: str) → Optional[BlockRecord]**

Returns *BlockRecord* for the given block name or None.

```
class ezdxf.blkrefs.BlockReferenceCounter(doc: Drawing, index: ezdxf.blkrefs.BlockDefinitionIndex = None)
```

Counts all block references in a DXF document.

Check if a block is referenced by any entity or any resource (DIMSYTLE, MLEADERSTYLE) in a DXF document:

```
import ezdxf
from ezdxf.blkrefs import BlockReferenceCounter

doc = ezdxf.readfile("your.dxf")
counter = BlockReferenceCounter(doc)
count = counter.by_name("XYZ")
print(f"Block 'XYZ' is referenced {count} times.")
```

**by\_handle(handle: str) → int**

Returns the block reference count for a given *BlockRecord* handle.

**by\_name(block\_name: str) → int**

Returns the block reference count for a given block name.

## Const

The module `ezdxf.lldxdf.const`, is also accessible from the `ezdxf` namespace:

```
from ezdxf.lldxdf.const import DXF12
import ezdxf

print(DXF12)
print(ezdxf.const.DXF12)
```

## DXF Version Strings

Name	Version	Alias
DXF9	“AC1004”	“R9”
DXF10	“AC1006”	“R10”
DXF12	“AC1009”	“R12”
DXF13	“AC1012”	“R13”
DXF14	“AC1014”	“R14”
DXF2000	“AC1015”	“R2000”
DXF2004	“AC1018”	“R2004”
DXF2007	“AC1021”	“R2007”
DXF2010	“AC1024”	“R2010”
DXF2013	“AC1027”	“R2013”
DXF2018	“AC1032”	“R2018”

## Exceptions

```
class ezdxf.lldxf.const.DXFError
    Base exception for all ezdxf exceptions.

class ezdxf.lldxf.const.DXFStructureError(DXFError)

class ezdxf.lldxf.const.DXFVersionError(DXFError)
    Errors related to features not supported by the chosen DXF Version

class ezdxf.lldxf.const.DXFValueError(DXFError)

class ezdxf.lldxf.const.DXFInvalidLineType(DXFValueError)

class ezdxf.lldxf.const.DXFBlockInUseError(DXFValueError)

class ezdxf.lldxf.const.DXFKeyError(DXFError)

class ezdxf.lldxf.const.DXFUndefinedBlockError(DXFKeyError)

class ezdxf.lldxf.const.DXFAttributeError(DXFError)

class ezdxf.lldxf.const.DXFIndexError(DXFError)

class ezdxf.lldxf.const.DXFTypeError(DXFError)

class ezdxf.lldxf.const.DXFTableEntryError(DXFValueError)
```

### 6.8.3 DXF Entity Creation

#### Layout Factory Methods

Recommended way to create DXF entities.

For all supported entities exist at least one factory method in the `ezdxf.layouts.BaseLayout` class. All factory methods have the prefix: `add_...`

```
import ezdxf

doc = ezdxf.new()
```

(continues on next page)

(continued from previous page)

```
msp = doc.modelspace()
msp.add_line((0, 0, 0), (3, 0, 0), dxftattribs={"color": 2})
```

## Thematic Index of Layout Factory Methods

### DXF Primitives

- `add_3dface()`
- `add_arc()`
- `add_circle()`
- `add_ellipse()`
- `add_hatch()`
- `add_helix()`
- `add_image()`
- `add_leader()`
- `add_line()`
- `add_lwpolyline()`
- `add_mesh()`
- `add_mline()`
- `add_mpolygon()`
- `add_multileader_mtext()`
- `add_multileader_block()`
- `add_point()`
- `add_polyface()`
- `add_polyline2d()`
- `add_polyline3d()`
- `add_polymesh()`
- `add_ray()`
- `add_shape()`
- `add_solid()`
- `add_trace()`
- `add_wipeout()`
- `add_xline()`

## Text Entities

- `add_attdef()`
- `add_mtext_dynamic_auto_height_columns()`
- `add_mtext_dynamic_manual_height_columns()`
- `add_mtext_static_columns()`
- `add_mtext()`
- `add_text()`

## Spline Entity

- `add_cad_spline_control_frame()`
- `add_open_spline()`
- `add_rational_spline()`
- `add_spline_control_frame()`
- `add_spline()`

## Block References and Underlays

- `add_arrow_blockref()`
- `add_auto_blockref()`
- `add_blockref()`
- `add_underlay()`

## Viewport Entity

Only available in paper space layouts.

- `add_viewport()`

## Dimension Entities

### Linear Dimension

- `add_aligned_dim()`
- `add_linear_dim()`
- `add_multi_point_linear_dim()`

### Radius and Diameter Dimension

- `add_diameter_dim_2p()`
- `add_diameter_dim()`
- `add_radius_dim_2p()`

- `add_radius_dim_cra()`
- `add_radius_dim()`

#### Angular Dimension

- `add_angular_dim_2l()`
- `add_angular_dim_3p()`
- `add_angular_dim_arc()`
- `add_angular_dim_cra()`

#### Arc Dimension

- `add_arc_dim_3p()`
- `add_arc_dim_arc()`
- `add_arc_dim_cra()`

#### Ordinate Dimension

- `add_ordinate_dim()`
- `add_ordinate_x_dim()`
- `add_ordinate_y_dim()`

## Miscellaneous

- `add_entity()`
- `add_foreign_entity()`
- `add_arrow()`

## ACIS Entities

The creation of the required *ACIS* data has do be done by an external library!

- `add_3dsolid()`
- `add_body()`
- `add_extruded_surface()`
- `add_lofted_surface()`
- `add_region()`
- `add_revolved_surface()`
- `add_surface()`
- `add_swept_surface()`

#### See also:

Layout base class: `BaseLayout`

## Factory Functions

Alternative way to create DXF entities for advanced *ezdxf* users.

The `ezdxf.entities.factory` module provides the `new()` function to create new DXF entities by their DXF name and a dictionary of DXF attributes. This will bypass the validity checks in the factory methods of the `BaseLayout` class.

This new created entities are virtual entities which are not assigned to any DXF document nor to any layout. Add the entity to a layout (and document) by the layout method `add_entity()`.

```
import eздxf
from eздxf.entities import factory

doc = eздxf.new()
msp = doc.modelspace()
line = factory.new(
    "LINE",
    dxftattribs={
        "start": (0, 0, 0),
        "end": (3, 0, 0),
        "color": 2,
    },
)
msp.add_entity(line)
```

## Direct Object Instantiation

For advanced developers with knowledge about the internal design of *ezdxf*.

Import the entity classes from sub-package `ezdxf.entities` and instantiate them. This will bypass the validity checks in the factory methods of the `BaseLayout` class and maybe additional required setup procedures for some entities - **study the source code!**.

**Warning:** A refactoring of the internal *ezdxf* structures will break your code.

This new created entities are virtual entities which are not assigned to any DXF document nor to any layout. Add the entity to a layout (and document) by the layout method `add_entity()`.

```
import eздxf
from eздxf.entities import Line

doc = eздxf.new()
msp = doc.modelspace()
line = Line.new(
    dxftattribs={
        "start": (0, 0, 0),
        "end": (3, 0, 0),
        "color": 2,
    }
)
msp.add_entity(line)
```

## 6.8.4 Enums

### TextEntityAlignment

```
class ezdxf.enums.TextEntityAlignment
    Text alignment enum for the Text, Attrib and AttDef entities.

    LEFT
    CENTER
    RIGHT
    ALIGNED
    MIDDLE
    FIT
    BOTTOM_LEFT
    BOTTOM_CENTER
    BOTTOM_RIGHT
    MIDDLE_LEFT
    MIDDLE_CENTER
    MIDDLE_RIGHT
    TOP_LEFT
    TOP_CENTER
    TOP_RIGHT
```

### MTextEntityAlignment

```
class ezdxf.enums.MTextEntityAlignment
    Text alignment enum for the MText entity.

    TOP_LEFT
    TOP_CENTER
    TOP_RIGHT
    MIDDLE_LEFT
    MIDDLE_CENTER
    MIDDLE_RIGHT
    BOTTOM_LEFT
    BOTTOM_CENTER
    BOTTOM_RIGHT
```

## MTextParagraphAlignment

```
class eздxf.enums.MTextParagraphAlignment
    An enumeration.

    DEFAULT
    LEFT
    RIGHT
    CENTER
    JUSTIFIED
    DISTRIBUTED
```

## MTextFlowDirection

```
class eздxf.enums.MTextFlowDirection
    An enumeration.

    LEFT_TO_RIGHT
    TOP_TO_BOTTOM
    BY_STYLE
```

## MTextLineAlignment

```
class eздxf.enums.MTextLineAlignment
    An enumeration.

    BOTTOM
    MIDDLE
    TOP
```

## MTextStroke

```
class eздxf.enums.MTextStroke
    Combination of flags is supported: UNDERLINE + STRIKE_THROUGH

    UNDERLINE
    STRIKE_THROUGH
    OVERLINE
```

## MTextLineSpacing

```
class eздxf.enums.MTextLineSpacing
    An enumeration.

    AT_LEAST
    EXACT
```

## MTextBackgroundColor

```
class ezdxf.enums.MTextBackgroundColor
    An enumeration.

    OFF
    COLOR
    WINDOW
    CANVAS
```

## InsertUnits

```
class ezdxf.enums.InsertUnits
    An enumeration.

    Unitless
    Inches
    Feet
    Miles
    Millimeters
    Centimeters
    Meters
    Kilometers
    Microinches
    Mils
    Yards
    Angstroms
    Nanometers
    Microns
    Decimeters
    Decameters
    Hectometers
    Gigameters
    AstronomicalUnits
    Lightyears
    Parsecs
    USSurveyFeet
    USSurveyInch
    USSurveyYard
    USSurveyMile
```

## Measurement

```
class ezdxf.enums.Measurement
    An enumeration.

    Imperial
    Metric
```

## LengthUnits

```
class ezdxf.enums.LengthUnits
    An enumeration.

    Scientific
    Decimal
    Engineering
    Architectural
    Fractional
```

## AngularUnits

```
class ezdxf.enums.AngularUnits
    An enumeration.

    DecimalDegrees
    DegreesMinutesSeconds
    Grad
    Radians
```

## SortEntities

```
class ezdxf.enums.SortEntities
    An enumeration.

    DISABLE
    SELECTION
        Sorts for object selection
    SNAP
        Sorts for object snap
    REDRAW
        Sorts for redraws; obsolete
    MSLIDE
        Sorts for MSLIDE command slide creation; obsolete
    REGEN
        Sorts for REGEN commands
    PLOT
        Sorts for plotting
```

**POSTSCRIPT**

Sorts for PostScript output; obsolete

**ACI**

```
class ezdxf.enums.ACIM
```

AutoCAD Color Index

**BYBLOCK**

**BYLAYER**

**BYOBJECT**

**RED**

**YELLOW**

**GREEN**

**CYAN**

**BLUE**

**MAGENTA**

**BLACK**

**WHITE**

## 6.8.5 Colors

### Colors Module

This module provides functions and constants to manage all kinds of colors in DXF documents.

#### Converter Functions

```
ezdxf.colors.rgb2int (rgb: Tuple[int, int, int]) → int
```

Combined integer value from (r, g, b) tuple.

```
ezdxf.colors.int2rgb (value: int) → Tuple[int, int, int]
```

Split RGB integer *value* into (r, g, b) tuple.

```
ezdxf.colors.aci2rgb (index: int) → Tuple[int, int, int]
```

Convert *AutoCAD Color Index (ACI)* into (r, g, b) tuple, based on default AutoCAD colors.

```
ezdxf.colors.luminance (color: Tuple[int, int, int]) → float
```

Returns perceived luminance for a RGB color in the range [0.0, 1.0] from dark to light.

```
ezdxf.colors.decode_raw_color (value: int) → Tuple[int, Union[int, Tuple[int, int, int]]]
```

Decode *raw color* value as tuple(type, Union[aci, (r, g, b)]), the true color value is a (r, g, b) tuple.

```
ezdxf.colors.decode_raw_color_int (value: int) → Tuple[int, int]
```

Decode *raw color* value as tuple(type, int), the true color value is a 24-bit int value.

```
ezdxf.colors.encode_raw_color (value: Union[int, Tuple[int, int, int]]) → int
```

Encode *true color* value or *AutoCAD Color Index (ACI)* color value into a :term: raw color value.

```
ezdxf.colors.transparency2float (value: int) → float
```

Returns transparency value as float from 0 to 1, 0 for no transparency (opaque) and 1 for 100% transparency.

**Parameters** `value` – DXF integer transparency value, 0 for 100% transparency and 255 for opaque

`ezdxf.colors.float2transparency(value: float) → int`

Returns DXF transparency value as integer in the range from 0 to 255, where 0 is 100% transparent and 255 is opaque.

**Parameters** `value` – transparency value as float in the range from 0 to 1, where 0 is opaque and 1 is 100% transparent.

## ACI Color Values

Common *AutoCAD Color Index (ACI)* values, also accessible as IntEnum `ezdxf.enums.ACI`

BYBLOCK	0
BYLAYER	256
BYOBJECT	257
RED	1
YELLOW	2
GREEN	3
CYAN	4
BLUE	5
MAGENTA	6
BLACK (on light background)	7
WHITE (on dark background)	7

## Default Palettes

Default color mappings from *AutoCAD Color Index (ACI)* to *true color* values.

model space	DXF_DEFAULT_COLORS
paper space	DXF_DEFAULT_PAPERSPACE_COLORS

## Raw Color Types

COLOR_TYPE_BY_LAYER	0xC0
COLOR_TYPE_BY_BLOCK	0xC1
COLOR_TYPE_RGB	0xC2
COLOR_TYPE_ACI	0xC3
COLOR_TYPE_WINDOW_BG	0xC8

## Raw Color Vales

BY_LAYER_RAW_VALUE	-1073741824
BY_BLOCK_RAW_VALUE	-1056964608
WINDOW_BG_RAW_VALUE	-939524096

## Transparency Values

OPAQUE	0x20000FF
TRANSPARENCY_10	0x20000E5
TRANSPARENCY_20	0x20000CC
TRANSPARENCY_30	0x20000B2
TRANSPARENCY_40	0x2000099
TRANSPARENCY_50	0x200007F
TRANSPARENCY_60	0x2000066
TRANSPARENCY_70	0x200004C
TRANSPARENCY_80	0x2000032
TRANSPARENCY_90	0x2000019
TRANSPARENCY_BYBLOCK	0x1000000

## 6.8.6 Data Query

### See also:

For usage of the query features see the tutorial: [Tutorial for getting data from DXF files](#)

### Entity Query String

The query string is the combination of two queries, first the required entity query and second the optional attribute query, enclosed in square brackets, append 'i' after the closing square bracket to ignore case for strings.

### Entity Query

The entity query is a whitespace separated list of DXF entity names or the special name '\*'. Where '\*' means all DXF entities, exclude some entity types by appending their names with a preceding ! (e.g. all entities except LINE = '\* !LINE'). All DXF names have to be uppercase.

### Attribute Query

The *optional* attribute query is a boolean expression, supported operators are:

- not (!): !term is true, if term is false
- and (&): term & term is true, if both terms are true
- or (|): term | term is true, if one term is true
- and arbitrary nested round brackets
- append (i) after the closing square bracket to ignore case for strings

Attribute selection is a term: "name comparator value", where name is a DXF entity attribute in lowercase, value is a integer, float or double quoted string, valid comparators are:

- == equal "value"
- != not equal "value"
- < lower than "value"

- <= lower or equal than “value”
- > greater than “value”
- >= greater or equal than “value”
- ? match regular expression “value”
- ! ? does not match regular expression “value”

## Query Result

The `EntityQuery` class is the return type of all `query()` methods. `EntityQuery` contains all DXF entities of the source collection, which matches one name of the entity query AND the whole attribute query. If a DXF entity does not have or support a required attribute, the corresponding attribute search term is `False`.

examples:

- `LINE [text ? ".*"]`: always empty, because the LINE entity has no text attribute.
- `LINE CIRCLE[layer=="construction"]`: all LINE and CIRCLE entities with layer == "construction"
- `*[!(layer=="construction" & color<7)]`: all entities except those with layer == "construction" and color < 7
- `*[layer=="construction"]i`, (ignore case) all entities with layer == "construction" | "Construction" | "ConStruction" ...

## EntityQuery Class

```
class ezdxf.query.EntityQuery
```

The `EntityQuery` class is a result container, which is filled with DXF entities matching the query string. It is possible to add entities to the container (extend), remove entities from the container and to filter the container. Supports the standard Python Sequence methods and protocols. Does not remove automatically destroyed entities (entities deleted by calling method `destroy()`), the method `purge()` has to be called explicit to remove the destroyed entities.

**first**

First entity or None.

**last**

Last entity or None.

**\_\_len\_\_()** → int

Returns count of DXF entities.

**\_\_getitem\_\_(item)**

Returns DXFEntity at index `item`, supports negative indices and slicing. Returns all entities which support a specific DXF attribute, if `item` is a DXF attribute name as string.

Changed in version 0.18: support DXF attribute name as argument

**\_\_setitem\_\_(key, value)**

Set the DXF attribute `key` for all supported DXF entities to `value`.

New in version 0.18.

**\_\_delitem\_\_(key)**

Discard the DXF attribute `key` from all supported DXF entities.

New in version 0.18.

**\_\_eq\_\_(other)**

Equal selector (`self == other`). Returns all entities where the selected DXF attribute is equal to `other`.

New in version 0.18.

**\_\_ne\_\_(other)**

Not equal selector (`self != other`). Returns all entities where the selected DXF attribute is not equal to `other`.

New in version 0.18.

**\_\_lt\_\_(other)**

Less than selector (`self < other`). Returns all entities where the selected DXF attribute is less than `other`.

**Raises** `TypeError` – for vector based attributes like `center` or `insert`

New in version 0.18.

**\_\_le\_\_(other)**

Less equal selector (`self <= other`). Returns all entities where the selected DXF attribute is less or equal `other`.

**Raises** `TypeError` – for vector based attributes like `center` or `insert`

New in version 0.18.

**\_\_gt\_\_(other)**

Greater than selector (`self > other`). Returns all entities where the selected DXF attribute is greater than `other`.

**Raises** `TypeError` – for vector based attributes like `center` or `insert`

New in version 0.18.

**\_\_ge\_\_(other)**

Greater equal selector (`self >= other`). Returns all entities where the selected DXF attribute is greater or equal `other`.

**Raises** `TypeError` – for vector based attributes like `center` or `insert`

New in version 0.18.

**match(pattern: str) → ezdxf.query.EntityQuery**

Returns all entities where the selected DXF attribute matches the regular expression `pattern`.

**Raises** `TypeError` – for non-string based attributes

New in version 0.18.

**\_\_or\_\_(other)**

Union operator, see `union()`.

New in version 0.18.

**\_\_and\_\_(other)**

Intersection operator, see `intersection()`.

New in version 0.18.

**\_\_sub\_\_(other)**

Difference operator, see `difference()`.

New in version 0.18.

**\_\_xor\_\_(other)**

Symmetric difference operator, see [symmetric\\_difference\(\)](#).

New in version 0.18.

**\_\_iter\_\_() → Iterator[ezdxf.entities.dxfentity.DXFEntity]**

Returns iterable of DXFEntity objects.

**purge() → ezdxf.query.EntityQuery**

Remove destroyed entities.

**extend(entities: Iterable[ezdxf.entities.dxfentity.DXFEntity], query: str = '\*') → ezdxf.query.EntityQuery**

Extent the [EntityQuery](#) container by entities matching an additional query.

**remove(query: str = '\*') → ezdxf.query.EntityQuery**

Remove all entities from [EntityQuery](#) container matching this additional query.

**query(query: str = '\*') → ezdxf.query.EntityQuery**

Returns a new [EntityQuery](#) container with all entities matching this additional query.

**Raises** pyparsing.ParseException – query string parsing error

**groupby(dxattrib: str = "", key: Callable[[ezdxf.entities.dxfentity.DXFEntity], Hashable] = None) → Dict[Hashable, List[ezdxf.entities.dxfentity.DXFEntity]]**

Returns a dict of entity lists, where entities are grouped by a DXF attribute or a key function.

**Parameters**

- **dxattrib** – grouping DXF attribute as string like 'layer'
- **key** – key function, which accepts a DXFEntity as argument, returns grouping key of this entity or `None` for ignore this object. Reason for ignoring: a queried DXF attribute is not supported by this entity

**filter(func: Callable[[ezdxf.entities.dxfentity.DXFEntity], bool]) → ezdxf.query.EntityQuery**

Returns a new [EntityQuery](#) with all entities from this container for which the callable `func` returns True.

Build your own operator to filter by attributes which are not DXF attributes or to build complex queries:

```
result = msp.query().filter(  
    lambda e: hasattr(e, "rgb") and e.rgb == (0, 0, 0)  
)
```

New in version 0.18.

**union(other: ezdxf.query.EntityQuery) → ezdxf.query.EntityQuery**

Returns a new [EntityQuery](#) with entities from `self` and `other`. All entities are unique - no duplicates.

New in version 0.18.

**intersection(other: ezdxf.query.EntityQuery) → ezdxf.query.EntityQuery**

Returns a new [EntityQuery](#) with entities common to `self` and `other`.

New in version 0.18.

**difference(other: ezdxf.query.EntityQuery) → ezdxf.query.EntityQuery**

Returns a new [EntityQuery](#) with all entities from `self` that are not in `other`.

New in version 0.18.

**symmetric\_difference(other: ezdxf.query.EntityQuery) → ezdxf.query.EntityQuery**

Returns a new [EntityQuery](#) with entities in either `self` or `other` but not both.

New in version 0.18.

## Extended EntityQuery Features

New in version 0.18.

The `[]` operator got extended features in version 0.18, until then the `EntityQuery` implemented the `__getitem__()` interface like a sequence to get entities from the container:

```
result = msp.query(...)
first = result[0]
last = result[-1]
sequence = result[1:-2] # returns not an EntityQuery container!
```

Now the `__getitem__()` function accepts also a DXF attribute name and returns all entities which support this attribute, this is the base for supporting queries by relational operators. More on that later.

The `__setitem__()` method assigns a DXF attribute to all supported entities in the `EntityQuery` container:

```
result = msp.query(...)
result["layer"] = "MyLayer"
```

Entities which do not support an attribute are silently ignored:

```
result = msp.query(...)
result["center"] = (0, 0) # set center only of CIRCLE and ARC entities
```

The `__delitem__()` method discards DXF attributes from all entities in the `EntityQuery` container:

```
result = msp.query(...)
# reset the layer attribute from all entities in container result to the
# default layer "0"
del result["layer"]
```

## Descriptors for DXF Attributes

New in version 0.18.

For some basic DXF attributes exist descriptors in the `EntityQuery` class:

- `layer`: layer name as string
- `color`: *AutoCAD Color Index (ACI)*, see `ezdxf.colors`
- `linetype`: linetype as string
- `ltscale`: linetype scaling factor as float value
- `lineweight`: *Lineweights*
- `invisible`: 0 if visible 1 if invisible, 0 is the default value
- `true_color`: true color as int value, see `ezdxf.colors`, has no default value
- `transparency`: transparency as int value, see `ezdxf.colors`, has no default value

A descriptor simplifies the attribute access through the `EntityQuery` container and has auto-completion support from IDEs:

```
result = msp.query(...)  
# set attribute of all entities in result  
result.layer = "MyLayer"  
# delete attribute from all entities in result  
del result.layer  
# and for selector usage, see following section  
assert len(result.layer) == 1
```

## Relational Selection Operators

New in version 0.18.

The attribute selection by `__getitem__()` allows further selections by relational operators:

```
msp.add_line((0, 0), (1, 0), dxffattribs={"layer": "MyLayer"})  
lines = msp.query("LINE")  
# select all entities on layer "MyLayer"  
entities = lines["layer"] == "MyLayer"  
assert len(entities) == 1  
  
# or select all entities except the entities on layer "MyLayer"  
entities = lines["layer"] != "MyLayer"
```

These operators work only with real DXF attributes, for instance the `rgb` attribute of graphical entities is not a real DXF attribute either the `vertices` of the `LWPOLYLINE` entity.

The selection by relational operators is case insensitive by default, because all names of DXF table entries are handled case insensitive. But if required the selection mode can be set to case sensitive:

```
lines = msp.query("LINE")  
# use case sensitive selection: "MyLayer" != "MYLAYER"  
lines.ignore_case = False  
entities = lines["layer"] == "MYLAYER"  
assert len(entities) == 0  
  
# the result container has the default setting:  
assert entities.ignore_case is True
```

Supported selection operators are:

- `==` equal “value”
- `!=` not equal “value”
- `<` lower than “value”
- `<=` lower or equal than “value”
- `>` greater than “value”
- `>=` greater or equal than “value”

The relational operators `<`, `>`, `<=` and `>=` are not supported for vector-based attributes such as `center` or `insert` and raise a `TypeError`.

---

**Note:** These operators are selection operators and not logic operators, therefore the logic operators `and`, `or` and `not` are **not** applicable. The methods `union()`, `intersection()`, `difference()` and

`symmetric_difference()` can be used to combine selection. See section [Query Set Operators](#) and [Build Own Filters](#).

## Regular Expression Selection

The `EntityQuery.match()` method returns all entities where the selected DXF attribute matches the given regular expression. This methods work only on string based attributes, raises `TypeError` otherwise.

From here on I use only descriptors for attribute selection if possible.

```
msp.add_line((0, 0), (1, 0), dxftattribs={"layer": "Lay1"})
msp.add_line((0, 0), (1, 0), dxftattribs={"layer": "Lay2"})
lines = msp.query("LINE")

# select all entities at layers starting with "Lay",
# selection is also case insensitive by default:
assert len(lines.layer.match("^\u00d7Lay.*")) == 2
```

## Build Own Filters

The method `EntityQuery.filter` can be used to build operators for none-DXF attributes or for complex logic expressions.

Find all MTEXT entities in modelspace containing “SearchText”. All `MText` entities have a `text` attribute, no need for a safety check:

```
mtext = msp.query("MTEXT").filter(lambda e: "SearchText" in e.text)
```

This filter checks the non-DXF attribute `rgb`. The filter has to check if the `rgb` attributes exist to avoid exceptions, because not all entities in modelspace may have the `rgb` attribute e.g. the `DXFTagStorage` entities which preserve unknown DXF entities:

```
result = msp.query().filter(
    lambda e: hasattr(e, "rgb") and e.rgb == (0, 0, 0)
)
```

Build 1-pass logic filters for complex queries, which would require otherwise multiple passes:

```
result = msp.query().filter(lambda e: e.dxf.color < 7 and e.dxf.layer == "0")
```

Combine filters for more complex operations. The first filter passes only valid entities and the second filter does the actual check:

```
def validator(entity):
    return True # if entity is valid and has all required attributes

def check(entity):
    return True # if entity passes the attribute checks

result = msp.query().filter(validator).filter(check)
```

## Query Set Operators

The `|` operator or `EntityQuery.union()` returns a new `EntityQuery` with all entities from both queries. All entities are unique - no duplicates. This operator acts like the logical `or` operator.

```
entities = msp.query()
# select all entities with color < 2 or color > 7
result = (entities.color < 2) | (entities.color > 7)
```

The `&` operator or `EntityQuery.intersection()` returns a new `EntityQuery` with entities common to `self` and `other`. This operator acts like the logical `and` operator.

```
entities = msp.query()
# select all entities with color > 1 and color < 7
result = (entities.color > 1) & (entities.color < 7)
```

The `-` operator or `EntityQuery.difference()` returns a new `EntityQuery` with all entities from `self` that are not in `other`.

```
entities = msp.query()
# select all entities with color > 1 and not layer == "MyLayer"
result = (entities.color > 1) - (entities.layer != "MyLayer")
```

The `^` operator or `EntityQuery.symmetric_difference()` returns a new `EntityQuery` with entities in either `self` or `other` but not both.

```
entities = msp.query()
# select all entities with color > 1 or layer == "MyLayer", exclusive
# entities with color > 1 and layer == "MyLayer"
result = (entities.color > 1) ^ (entities.layer == "MyLayer")
```

## The `new()` Function

`ezdxf.query.new(entities: Iterable[ezdxf.entities.dxfentity.DXFEntity] = None, query: str = '*') → ezdxf.query.EntityQuery`

Start a new query based on sequence `entities`. The `entities` argument has to be an iterable of `DXFEntity` or inherited objects and returns an `EntityQuery` object.

### See also:

For usage of the groupby features see the tutorial: [Retrieve entities by groupby\(\) function](#)

## Groupby Function

`ezdxf.groupby.groupby(entities: Iterable[DXFEntity], dxfattrib: str = "", key: KeyFunc = None) → Dict[Hashable, List[DXFEntity]]`

Groups a sequence of DXF entities by a DXF attribute like `'layer'`, returns a dict with `dxfattrib` values as key and a list of entities matching this `dxfattrib`. A `key` function can be used to combine some DXF attributes (e.g. layer and color) and should return a hashable data type like a tuple of strings, integers or floats, `key` function example:

```
def group_key(entity: DXFEntity):
    return entity.dxf.layer, entity.dxf.color
```

For not suitable DXF entities return `None` to exclude this entity, in this case it's not required, because `groupby()` catches `DXFAttributeError` exceptions to exclude entities, which do not provide layer and/or color attributes, automatically.

Result dict for `dxffattrib = 'layer'` may look like this:

```
{
    '0': [ ... list of entities ],
    'ExampleLayer1': [ ... ],
    'ExampleLayer2': [ ... ],
    ...
}
```

Result dict for `key = group_key`, which returns a `(layer, color)` tuple, may look like this:

```
{
    ('0', 1): [ ... list of entities ],
    ('0', 3): [ ... ],
    ('0', 7): [ ... ],
    ('ExampleLayer1', 1): [ ... ],
    ('ExampleLayer1', 2): [ ... ],
    ('ExampleLayer1', 5): [ ... ],
    ('ExampleLayer2', 7): [ ... ],
    ...
}
```

All entity containers (modelspace, paperspace layouts and blocks) and the `EntityQuery` object have a dedicated `groupby()` method.

### Parameters

- **entities** – sequence of DXF entities to group by a DXF attribute or a `key` function
- **dxffattrib** – grouping DXF attribute like `'layer'`
- **key** – key function, which accepts a `DXFEntity` as argument and returns a hashable grouping key or `None` to ignore this entity

## 6.8.7 Math

### Core

Math core module: `ezdxf.math`

These are the core math functions and classes which should be imported from `ezdxf.math`.

### Functions

```
ezdxf.math.closest_point(base: Union[Sequence[float], ezdxf.math._vector.Vec2,
                                         ezdxf.math._vector.Vec3], points: Iterable[Union[Sequence[float],
                                         ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3]]) → Vec3
```

Returns the closest point to `base`.

### Parameters

- **base** – base point as `Vec3` compatible object
- **points** – iterable of points as `Vec3` compatible object

`ezdxf.math.uniform_knot_vector(count: int, order: int, normalize=False) → List[float]`

Returns an uniform knot vector for a B-spline of *order* and *count* control points.

*order* = degree + 1

#### Parameters

- **count** – count of control points
- **order** – spline order
- **normalize** – normalize values in range [0, 1] if True

`ezdxf.math.open_uniform_knot_vector(count: int, order: int, normalize=False) → List[float]`

Returns an open (clamped) uniform knot vector for a B-spline of *order* and *count* control points.

*order* = degree + 1

#### Parameters

- **count** – count of control points
- **order** – spline order
- **normalize** – normalize values in range [0, 1] if True

`ezdxf.math.required_knot_values(count: int, order: int) → int`

Returns the count of required knot values for a B-spline of *order* and *count* control points.

#### Parameters

- **count** – count of control points, in text-books referred as “n + 1”
- **order** – order of B-Spline, in text-books referred as “k”

Relationship:

“p” is the degree of the B-spline, text-book notation.

- $k = p + 1$
- $2 \leq k \leq n + 1$

`ezdxf.math.xround(value: float, rounding: float = 0.0) → float`

Extended rounding function, argument *rounding* defines the rounding limit:

0	remove fraction
0.1	round next to x.1, x.2, ... x.0
0.25	round next to x.25, x.50, x.75 or x.00
0.5	round next to x.5 or x.0
1.0	round to a multiple of 1: remove fraction
2.0	round to a multiple of 2: xxx2, xxx4, xxx6 ...
5.0	round to a multiple of 5: xxx5 or xxx0
10.0	round to a multiple of 10: xx10, xx20, ...

#### Parameters

- **value** – float value to round
- **rounding** – rounding limit

`ezdxf.math.linspace(start: float, stop: float, num: int, endpoint=True) → Iterable[float]`

Return evenly spaced numbers over a specified interval, like `numpy.linspace()`.

Returns *num* evenly spaced samples, calculated over the interval [start, stop]. The endpoint of the interval can optionally be excluded.

`ezdxf.math.area(vertices: Iterable[Union[Sequence[float],  
ezdxf.math._vector.Vector3]]) → float`

Returns the area of a polygon, returns the projected area in the xy-plane for any vertices (z-axis will be ignored).

`ezdxf.math.arc_angle_span_deg(start: float, end: float) → float`

Returns the counter-clockwise angle span from *start* to *end* in degrees.

Returns the angle span in the range of [0, 360], 360 is a full circle. Full circle handling is a special case, because normalization of angles which describe a full circle would return 0 if treated as regular angles. e.g. (0, 360) → 360, (0, -360) → 360, (180, -180) → 360. Input angles with the same value always return 0 by definition: (0, 0) → 0, (-180, -180) → 0, (360, 360) → 0.

`ezdxf.math.arc_angle_span_rad(start: float, end: float) → float`

Returns the counter-clockwise angle span from *start* to *end* in radians.

Returns the angle span in the range of [0,  $2\pi$ ],  $2\pi$  is a full circle. Full circle handling is a special case, because normalization of angles which describe a full circle would return 0 if treated as regular angles. e.g. (0,  $2\pi$ ) →  $2\pi$ , (0,  $-2\pi$ ) →  $2\pi$ , ( $\pi$ ,  $-\pi$ ) →  $2\pi$ . Input angles with the same value always return 0 by definition: (0, 0) → 0, ( $-\pi$ ,  $-\pi$ ) → 0, ( $2\pi$ ,  $2\pi$ ) → 0.

`ezdxf.math.arc_segment_count(radius: float, angle: float, sagitta: float) → int`

Returns the count of required segments for the approximation of an arc for a given maximum *sagitta*.

#### Parameters

- **radius** – arc radius
- **angle** – angle span of the arc in radians
- **sagitta** – max. distance from the center of an arc segment to the center of its chord

`ezdxf.math.arc_chord_length(radius: float, sagitta: float) → float`

Returns the chord length for an arc defined by *radius* and the *sagitta*.

#### Parameters

- **radius** – arc radius
- **sagitta** – distance from the center of the arc to the center of its base

`ezdxf.math.ellipse_param_span(start_param: float, end_param: float) → float`

Returns the counter-clockwise params span of an elliptic arc from start- to end param.

Returns the param span in the range [0,  $2\pi$ ],  $2\pi$  is a full ellipse. Full ellipse handling is a special case, because normalization of params which describe a full ellipse would return 0 if treated as regular params. e.g. (0,  $2\pi$ ) →  $2\pi$ , (0,  $-2\pi$ ) →  $2\pi$ , ( $\pi$ ,  $-\pi$ ) →  $2\pi$ . Input params with the same value always return 0 by definition: (0, 0) → 0, ( $-\pi$ ,  $-\pi$ ) → 0, ( $2\pi$ ,  $2\pi$ ) → 0.

Alias to function: `ezdxf.math.arc_angle_span_rad()`

`ezdxf.math.has_matrix_2d_stretching(m: ezdxf.math._matrix44.Matrix44) → bool`

Returns True if matrix *m* performs a non-uniform xy-scaling. Uniform scaling is not stretching in this context.

Does not check if the target system is a cartesian coordinate system, use the `Matrix44` property `is_cartesian` for that.

`ezdxf.math.has_matrix_3d_stretching(m: ezdxf.math._matrix44.Matrix44) → bool`

Returns True if matrix *m* performs a non-uniform xyz-scaling. Uniform scaling is not stretching in this context.

Does not check if the target system is a cartesian coordinate system, use the `Matrix44` property `is_cartesian` for that.

## Bulge Related Functions

### See also:

Description of the *Bulge value*.

```
ezdxf.math.arc_to_bulge (center: Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3], start_angle: float, end_angle: float, radius: float) → Tuple[Vec2, Vec2, float]
```

Returns bulge parameters from arc parameters.

#### Parameters

- **center** – circle center point as *Vec2* compatible object
- **start\_angle** – start angle in radians
- **end\_angle** – end angle in radians
- **radius** – circle radius

**Returns** (start\_point, end\_point, bulge)

#### Return type tuple

```
ezdxf.math.bulge_3_points (start_point: Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3], end_point: Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3], point: Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3]) → float
```

Returns bulge value defined by three points.

Based on 3-Points to Bulge by [Lee Mac](#).

#### Parameters

- **start\_point** – start point as *Vec2* compatible object
- **end\_point** – end point as *Vec2* compatible object
- **point** – arbitrary point as *Vec2* compatible object

```
ezdxf.math.bulge_center (start_point: Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3], end_point: Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3], bulge: float) → Vec2
```

Returns center of arc described by the given bulge parameters.

Based on Bulge Center by [Lee Mac](#).

#### Parameters

- **start\_point** – start point as *Vec2* compatible object
- **end\_point** – end point as *Vec2* compatible object
- **bulge** – bulge value as float

```
ezdxf.math.bulge_radius (start_point: Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3], end_point: Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3], bulge: float) → float
```

Returns radius of arc defined by the given bulge parameters.

Based on Bulge Radius by [Lee Mac](#)

#### Parameters

- **start\_point** – start point as `Vec2` compatible object
- **end\_point** – end point as `Vec2` compatible object
- **bulge** – bulge value

```
ezdxf.math.bulge_to_arc(start_point: Union[Sequence[float], ezdxf.math._vector.Vector[Vec2, ezdxf.math._vector.Vector[Vec3]]], end_point: Union[Sequence[float], ezdxf.math._vector.Vector[Vec2, ezdxf.math._vector.Vector[Vec3]]], bulge: float) → Tuple[Vec2, float, float, float]
```

Returns arc parameters from bulge parameters.

The arcs defined by bulge values of `LWPolyline` and 2D `Polyline` entities start at the vertex which includes the bulge value and ends at the following vertex.

Based on Bulge to Arc by [Lee Mac](#).

#### Parameters

- **start\_point** – start vertex as `Vec2` compatible object
- **end\_point** – end vertex as `Vec2` compatible object
- **bulge** – bulge value

**Returns** (center, start\_angle, end\_angle, radius)

**Return type** Tuple

## 2D Graphic Functions

```
ezdxf.math.convex_hull_2d(points: Iterable[Union[Sequence[float], ezdxf.math._vector.Vector[Vec2, ezdxf.math._vector.Vector[Vec3]]]]) → List[ezdxf.math._vector.Vector[Vec2]]
```

Returns 2D convex hull for `points` as list of `Vec2`. Returns a closed polyline, first vertex == last vertex.

**Parameters** `points` – iterable of points, z-axis is ignored

```
ezdxf.math.distance_point_line_2d(point: ezdxf.math._vector.Vector[Vec2], start: ezdxf.math._vector.Vector[Vec2], end: ezdxf.math._vector.Vector[Vec2]) → float
```

Returns the normal distance from `point` to 2D line defined by `start-` and `end` point.

```
ezdxf.math.intersect_polylines_2d(p1: Sequence[ezdxf.math._vector.Vector[Vec2]], p2: Sequence[ezdxf.math._vector.Vector[Vec2]], abs_tol=1e-10) → List[ezdxf.math._vector.Vector[Vec2]]
```

Returns the intersection points for two polylines as list of `Vec2` objects, the list is empty if no intersection points exist. Does not return self intersection points of `p1` or `p2`. Duplicate intersection points are removed from the result list, but the list does not have a particular order! You can sort the result list by `result.sort()` to introduce an order.

#### Parameters

- **p1** – first polyline as sequence of `Vec2` objects
- **p2** – second polyline as sequence of `Vec2` objects
- **abs\_tol** – absolute tolerance for comparisons

New in version 0.17.2.

```
ezdxf.math.intersection_line_line_2d(line1: Sequence[ezdxf.math._vector.Vector[Vec2]], line2: Sequence[ezdxf.math._vector.Vector[Vec2]], virtual=True, abs_tol=1e-10) → Optional[ezdxf.math._vector.Vector[Vec2]]
```

Compute the intersection of two lines in the xy-plane.

### Parameters

- **line1** – start- and end point of first line to test e.g. ((x1, y1), (x2, y2)).
- **line2** – start- and end point of second line to test e.g. ((x3, y3), (x4, y4)).
- **virtual** – True returns any intersection point, False returns only real intersection points.
- **abs\_tol** – tolerance for intersection test.

**Returns** None if there is no intersection point (parallel lines) or intersection point as `Vec2`

```
ezdxf.math.is_convex_polygon_2d(polygon: List[ezdxf.math._vector.Vec2], *, strict=False, epsilon=1e-06) → bool
```

Returns True if the 2D *polygon* is convex. This function works with open and closed polygons and clockwise or counter-clockwise vertex orientation. Coincident vertices will always be skipped and if argument *strict* is True, polygons with collinear vertices are not considered as convex.

This solution works only for simple non-self-intersecting polygons!

```
ezdxf.math.is_point_in_polygon_2d(point: ezdxf.math._vector.Vec2, polygon: Sequence[ezdxf.math._vector.Vec2], abs_tol=1e-10) → int
```

Test if *point* is inside *polygon*. Returns -1 (for outside) if the polygon is degenerated, no exception will be raised.

### Parameters

- **point** – 2D point to test as `Vec2`
- **polygon** – sequence of 2D points as `Vec2`
- **abs\_tol** – tolerance for distance check

**Returns** +1 for inside, 0 for on boundary line, -1 for outside

```
ezdxf.math.is_point_left_of_line(point: ezdxf.math._vector.Vec2, start: ezdxf.math._vector.Vec2, end: ezdxf.math._vector.Vec2, colinear=False) → bool
```

Returns True if *point* is “left of line” defined by *start*- and *end* point, a colinear point is also “left of line” if argument *colinear* is True.

### Parameters

- **point** – 2D point to test as `Vec2`
- **start** – line definition point as `Vec2`
- **end** – line definition point as `Vec2`
- **colinear** – a colinear point is also “left of line” if True

```
ezdxf.math.is_point_on_line_2d(point: ezdxf.math._vector.Vec2, start: ezdxf.math._vector.Vec2, end: ezdxf.math._vector.Vec2, ray=True, abs_tol=1e-10) → bool
```

Returns True if *point* is on *line*.

### Parameters

- **point** – 2D point to test as `Vec2`
- **start** – line definition point as `Vec2`
- **end** – line definition point as `Vec2`

- **ray** – if True point has to be on the infinite ray, if False point has to be on the line segment
- **abs\_tol** – tolerance for on the line test

```
ezdxf.math.offset_vertices_2d(vertices: Iterable[Union[Sequence[float],  
ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3]]], offset:  
float, closed: bool = False) → Iterable[ezdxf.math._vector.Vec2]
```

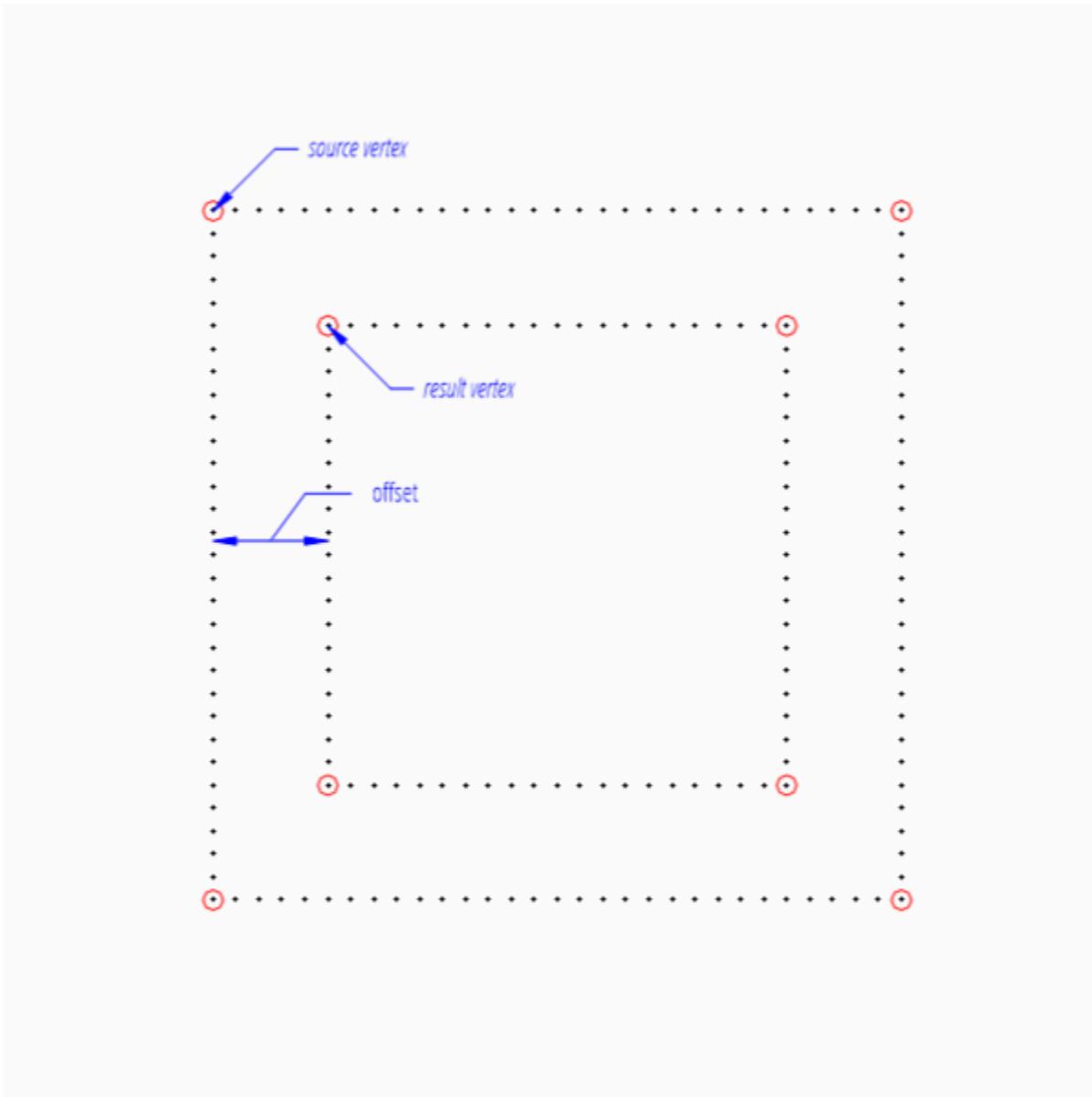
Yields vertices of the offset line to the shape defined by *vertices*. The source shape consist of straight segments and is located in the xy-plane, the z-axis of input vertices is ignored. Takes closed shapes into account if argument *closed* is True, which yields intersection of first and last offset segment as first vertex for a closed shape. For closed shapes the first and last vertex can be equal, else an implicit closing segment from last to first vertex is added. A shape with equal first and last vertex is not handled automatically as closed shape.

**Warning:** Adjacent collinear segments in *opposite* directions, same as a turn by 180 degree (U-turn), leads to unexpected results.

### Parameters

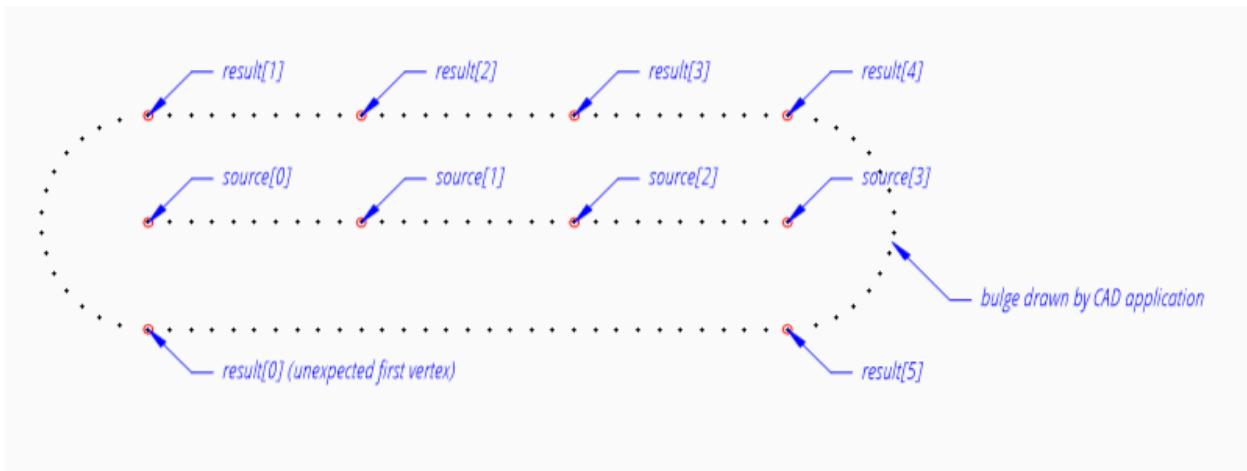
- **vertices** – source shape defined by vertices
- **offset** – line offset perpendicular to direction of shape segments defined by vertices order, offset > 0 is ‘left’ of line segment, offset < 0 is ‘right’ of line segment
- **closed** – True to handle as closed shape

```
source = [(0, 0), (3, 0), (3, 3), (0, 3)]  
result = list(offset_vertices_2d(source, offset=0.5, closed=True))
```



Example for a closed collinear shape, which creates 2 additional vertices and the first one has an unexpected location:

```
source = [(0, 0), (0, 1), (0, 2), (0, 3)]
result = list(offset_vertices_2d(source, offset=0.5, closed=True))
```



```
ezdxf.math.point_to_line_relation(point: ezdxf.math._vector.Vec2, start:
                                     ezdxf.math._vector.Vec2, end: ezdxf.math._vector.Vec2,
                                     abs_tol=1e-10) → int
```

Returns  $-1$  if *point* is left *line*,  $+1$  if *point* is right of *line* and  $0$  if *point* is on the *line*. The *line* is defined by two vertices given as arguments *start* and *end*.

#### Parameters

- **point** – 2D point to test as *Vec2*
- **start** – line definition point as *Vec2*
- **end** – line definition point as *Vec2*
- **abs\_tol** – tolerance for minimum distance to line

```
ezdxf.math.rytz_axis_construction(d1: ezdxf.math._vector.Vec3, d2: ezdxf.math._vector.Vec3)
                                   → Tuple[ezdxf.math._vector.Vec3,
                                          ezdxf.math._vector.Vec3, float]
```

The Rytz's axis construction is a basic method of descriptive Geometry to find the axes, the semi-major axis and semi-minor axis, starting from two conjugated half-diameters.

Source: [Wikipedia](#)

Given conjugated diameter *d1* is the vector from center C to point P and the given conjugated diameter *d2* is the vector from center C to point Q. Center of ellipse is always  $(0, 0, 0)$ . This algorithm works for 2D/3D vectors.

#### Parameters

- **d1** – conjugated semi-major axis as *Vec3*
- **d2** – conjugated semi-minor axis as *Vec3*

**Returns** Tuple of (major axis, minor axis, ratio)

## 3D Graphic Functions

### See also:

The free online book [3D Math Primer for Graphics and Game Development](#) is a very good resource for learning vector math and other graphic related topics, it is easy to read for beginners and especially targeted to programmers.

```
ezdxf.math.basic_transformation(move: Union[Sequence[float], eздxf.math._vector.Vec2,
                                             eздxf.math._vector.Vec3] = (0, 0, 0), scale:
                                             Union[Sequence[float], eздxf.math._vector.Vec2,
                                             eздxf.math._vector.Vec3] = (1, 1, 1), z_rotation: float =
                                             0) → eздxf.math._matrix44.Matrix44
```

Returns a combined transformation matrix for translation, scaling and rotation about the z-axis.

#### Parameters

- **move** – translation vector
- **scale** – x-, y- and z-axis scaling as float triplet, e.g. (2, 2, 1)
- **z\_rotation** – rotation angle about the z-axis in radians

```
ezdxf.math.best_fit_normal(vertices: Iterable[Union[Sequence[float], eздxf.math._vector.Vec2,
                                                    eздxf.math._vector.Vec3]]) → eздxf.math._vector.Vec3
```

Returns the “best fit” normal for a plane defined by three or more vertices. This function tolerates imperfect plane vertices. Safe function to detect the extrusion vector of flat arbitrary polygons.

```
ezdxf.math.bezier_to_bspline(curves: Iterable[Union[eздxf.math._bezier3p.Bezier3P,
                                                    eздxf.math._bezier4p.Bezier4P]]) → eздxf.math.bspline.BSpline
```

Convert multiple quadratic or cubic Bézier curves into a single cubic B-spline ([eздxf.math.BSpline](#)). For good results the curves must be lined up seamlessly, i.e. the starting point of the following curve must be the same as the end point of the previous curve. G1 continuity or better at the connection points of the Bézier curves is required to get best results.

New in version 0.16.

```
ezdxf.math.closed_uniform_bspline(control_points: Iterable[Union[Sequence[float],
                                                               eздxf.math._vector.Vec2, eздxf.math._vector.Vec3]], order: int = 4, weights: Optional[Iterable[float]] = None) → eздxf.math.bspline.BSpline
```

Creates an closed uniform (periodic) B-spline curve ([open curve](#)).

This B-spline does not pass any of the control points.

#### Parameters

- **control\_points** – iterable of control points as [Vec3](#) compatible objects
- **order** – spline order (degree + 1)
- **weights** – iterable of weight values

```
ezdxf.math.cubic_bezier_bbox(curve: eздxf.math._bezier4p.Bezier4P, *, abs_tol=1e-12) → eздxf.math.bbox.BoundingBox
```

Returns the [BoundingBox](#) of a cubic Bézier curve of type [Bezier4P](#).

New in version 0.18.

```
ezdxf.math.cubic_bezier_from_3p(p1: Union[Sequence[float], eздxf.math._vector.Vec2,
                                             eздxf.math._vector.Vec3], p2: Union[Sequence[float],
                                             eздxf.math._vector.Vec2, eздxf.math._vector.Vec3],
                                             p3: Union[Sequence[float], e Zukxf.math._vector.Vec2,
                                             e Zukxf.math._vector.Vec3]) → e Zukxf.math._bezier4p.Bezier4P
```

Returns a cubic Bézier curve [Bezier4P](#) from three points. The curve starts at *p1*, goes through *p2* and ends at *p3*. (source: [pomax-2](#))

New in version 0.17.2.

```
ezdxf.math.cubic_bezier_from_arc(center: UVec = (0, 0, 0), radius: float = 1, start_angle: float = 0, end_angle: float = 360, segments: int = 1) → Iterable[Bezier4P]
```

Returns an approximation for a circular 2D arc by multiple cubic Bézier-curves.

#### Parameters

- **center** – circle center as `Vec3` compatible object
- **radius** – circle radius
- **start\_angle** – start angle in degrees
- **end\_angle** – end angle in degrees
- **segments** – count of Bézier-curve segments, at least one segment for each quarter (90 deg), 1 for as few as possible.

```
ezdxf.math.cubic_bezier_from_ellipse(ellipse: ConstructionEllipse, segments: int = 1) → Iterable[ezdxf.math._bezier4p.Bezier4P]
```

Returns an approximation for an elliptic arc by multiple cubic Bézier-curves.

#### Parameters

- **ellipse** – ellipse parameters as `ConstructionEllipse` object
- **segments** – count of Bézier-curve segments, at least one segment for each quarter ( $\pi/2$ ), 1 for as few as possible.

```
ezdxf.math.cubic_bezier_interpolation(points: Iterable[Union[Sequence[float],  
ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3]]) → Iterable[ezdxf.math._bezier4p.Bezier4P]
```

Returns an interpolation curve for given data *points* as multiple cubic Bézier-curves. Returns n-1 cubic Bézier-curves for n given data points, curve i goes from point[i] to point[i+1].

#### Parameters **points** – data points

```
ezdxf.math.distance_point_line_3d(point: ezdxf.math._vector.Vec3, start:  
ezdxf.math._vector.Vec3, end: ezdxf.math._vector.Vec3) → float
```

Returns the normal distance from *point* to 3D line defined by *start*- and *end* point.

```
ezdxf.math.estimate_end_tangent_magnitude(points: List[ezdxf.math._vector.Vec3], method: str = 'chord') → Tuple[float, float]
```

Estimate tangent magnitude of start- and end tangents.

Available estimation methods:

- “chord”: total chord length, curve approximation by straight segments
- “arc”: total arc length, curve approximation by arcs
- “bezier-n”: total length from cubic bezier curve approximation, n segments per section

#### Parameters

- **points** – start-, end- and passing points of curve
- **method** – tangent magnitude estimation method

```
ezdxf.math.estimate_tangents(points: List[ezdxf.math._vector.Vec3], method: str = '5-points',  
normalize=True) → List[ezdxf.math._vector.Vec3]
```

Estimate tangents for curve defined by given fit points. Calculated tangents are normalized (unit-vectors).

Available tangent estimation methods:

- “3-points”: 3 point interpolation
- “5-points”: 5 point interpolation
- “bezier”: tangents from an interpolated cubic bezier curve
- “diff”: finite difference

#### Parameters

- **points** – start-, end- and passing points of curve
- **method** – tangent estimation method
- **normalize** – normalize tangents if True

**Returns** tangents as list of `Vec3` objects

```
ezdxf.math.fit_points_to_cad_cv (fit_points: Iterable[Union[Sequence[float],  
ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3]],  
tangents: Optional[Iterable[Union[Sequence[float],  
ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3]]] = None,  
estimate: str = '5-p') → BSpline
```

Returns a cubic `BSpline` from fit points as close as possible to common CAD applications like BricsCAD.

There exist infinite numerical correct solution for this setup, but some facts are known:

- Global curve interpolation with start- and end derivatives, e.g. 6 fit points creates 8 control vertices in BricsCAD
- Degree of B-spline is always 3, the stored degree is ignored, this is only valid for B-splines defined by fit points
- Knot parametrization method is “chord”
- Knot distribution is “natural”

The last missing parameter is the start- and end tangents estimation method used by BricsCAD, if these tangents are stored in the DXF file provide them as argument `tangents` as 2-tuple (start, end) and the interpolated control vertices will match the BricsCAD calculation, except for floating point imprecision.

If the end tangents are not given, the start- and ent tangent directions will be estimated. The argument `estimate` lets choose from different estimation methods (first 3 letters are significant):

- “3-points”: 3 point interpolation
- “5-points”: 5 point interpolation
- “bezier”: tangents from an interpolated cubic bezier curve
- “diff”: finite difference

The estimation method “5-p” yields the closest match to the BricsCAD rendering, but sometimes “bez” creates a better result.

If I figure out how BricsCAD estimates the end tangents directions, the argument `estimate` gets an additional value for that case. The existing estimation methods will perform the same way as now, except for bug fixes. But the default value may change, therefore set argument `estimate` to specific value to always get the same result in the future.

#### Parameters

- **fit\_points** – points the spline is passing through
- **tangents** – start- and end tangent, default is autodetect

- **estimate** – tangent direction estimation method

Changed in version 0.16: removed unused arguments *degree* and *method*

```
ezdxf.math.fit_points_to_cubic_bezier (fit_points: Iterable[Union[Sequence[float],  
ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3]]])  
→ BSpline
```

Returns a cubic *BSpline* from fit points **without** end tangents.

This function uses the cubic Bézier interpolation to create multiple Bézier curves and combine them into a single B-spline, this works for short simple splines better than the *fit\_points\_to\_cad\_cv()*, but is worse for longer and more complex splines.

**Parameters** **fit\_points** – points the spline is passing through

New in version 0.16.

```
ezdxf.math.global_bspline_interpolation (fit_points: Iterable[Union[Sequence[float],  
ezdxf.math._vector.Vec2,  
ezdxf.math._vector.Vec3]]], degree: int = 3, tangents: Optional[Iterable[Union[Sequence[float],  
ezdxf.math._vector.Vec2,  
ezdxf.math._vector.Vec3]]]] = None, method:  
str = 'chord') → BSpline
```

B-spline interpolation by the Global Curve Interpolation. Given are the fit points and the degree of the B-spline. The function provides 3 methods for generating the parameter vector t:

- “uniform”: creates a uniform t vector, from 0 to 1 evenly spaced, see *uniform* method
- “chord”, “distance”: creates a t vector with values proportional to the fit point distances, see *chord length* method
- “centripetal”, “sqrt\_chord”: creates a t vector with values proportional to the fit point  $\sqrt(\text{distances})$ , see *centripetal* method
- “arc”: creates a t vector with values proportional to the arc length between fit points.

It is possible to constraint the curve by tangents, by start- and end tangent if only two tangents are given or by one tangent for each fit point.

If tangents are given, they represent 1st derivatives and should be scaled if they are unit vectors, if only start- and end tangents given the function *estimate\_end\_tangent\_magnitude()* helps with an educated guess, if all tangents are given, scaling by chord length is a reasonable choice (Piegl & Tiller).

#### Parameters

- **fit\_points** – fit points of B-spline, as list of *Vec3* compatible objects
- **tangents** – if only two vectors are given, take the first and the last vector as start- and end tangent constraints or if for all fit points a tangent is given use all tangents as interpolation constraints (optional)
- **degree** – degree of B-spline
- **method** – calculation method for parameter vector t

**Returns** *BSpline*

```
ezdxf.math.have_bezier_curves_g1_continuity (b1: Union[ezdxf.math._bezier3p.Bezier3P,  
ezdxf.math._bezier4p.Bezier4P], b2:  
Union[ezdxf.math._bezier3p.Bezier3P,  
ezdxf.math._bezier4p.Bezier4P], g1_tol:  
float = 0.0001) → bool
```

Return True if the given adjacent bezier curves have G1 continuity.

New in version 0.16.

```
ezdxf.math.intersect_polylines_3d(p1: Sequence[ezdxf.math._vector.Vec3], p2: Sequence[ezdxf.math._vector.Vec3], abs_tol=1e-10) → List[ezdxf.math._vector.Vec3]
```

Returns the intersection points for two polylines as list of `Vec3` objects, the list is empty if no intersection points exist. Does not return self intersection points of `p1` or `p2`. Duplicate intersection points are removed from the result list, but the list does not have a particular order! You can sort the result list by `result.sort()` to introduce an order.

#### Parameters

- `p1` – first polyline as sequence of `Vec3` objects
- `p2` – second polyline as sequence of `Vec3` objects
- `abs_tol` – absolute tolerance for comparisons

New in version 0.17.2.

```
ezdxf.math.intersection_line_line_3d(line1: Sequence[ezdxf.math._vector.Vec3], line2: Sequence[ezdxf.math._vector.Vec3], virtual: bool = True, abs_tol: float = 1e-10) → Optional[ezdxf.math._vector.Vec3]
```

Returns the intersection point of two 3D lines, returns `None` if lines do not intersect.

#### Parameters

- `line1` – first line as tuple of two points as `Vec3` objects
- `line2` – second line as tuple of two points as `Vec3` objects
- `virtual` – `True` returns any intersection point, `False` returns only real intersection points
- `abs_tol` – absolute tolerance for comparisons

New in version 0.17.2.

```
ezdxf.math.intersection_line_polygon_3d(start: eздxf.math._vector.Vec3, end: eздxf.math._vector.Vec3, polygon: Iterable[ezdxf.math._vector.Vec3], *, coplanar=True, boundary=True, abs_tol=1e-09) → Optional[ezdxf.math._vector.Vec3]
```

Returns the intersection point of the 3D line form `start` to `end` and the given `polygon`.

#### Parameters

- `start` – start point of 3D line as `Vec3`
- `end` – end point of 3D line as `Vec3`
- `polygon` – 3D polygon as iterable of `Vec3`
- `coplanar` – if `True` a coplanar start- or end point as intersection point is valid
- `boundary` – if `True` an intersection point at the polygon boundary line is valid
- `abs_tol` – absolute tolerance for comparisons

New in version 0.18.

```
ezdxf.math.intersection_ray_polygon_3d(origin:           eздxf.math._vector.Vec3,      direction:           eздxf.math._vector.Vec3,      poly-
                                         Iterable[eздxf.math._vector.Vec3],      *,  

                                         boundary=True,      abs_tol=1e-09)      →      Op-
                                         tional[eздxf.math._vector.Vec3]
```

Returns the intersection point of the infinite 3D ray defined by *origin* and the *direction* vector and the given *polygon*.

#### Parameters

- **origin** – origin point of the 3D ray as *Vec3*
- **direction** – direction vector of the 3D ray as *Vec3*
- **polygon** – 3D polygon as iterable of *Vec3*
- **boundary** – if True intersection points at the polygon boundary line are valid
- **abs\_tol** – absolute tolerance for comparisons

New in version 0.18.

```
ezdxf.math.intersection_ray_ray_3d(ray1: Sequence[eздxf.math._vector.Vec3], ray2: Sequence[eздxf.math._vector.Vec3], abs_tol=1e-10) → Sequence[eздxf.math._vector.Vec3]
```

Calculate intersection of two 3D rays, returns a 0-tuple for parallel rays, a 1-tuple for intersecting rays and a 2-tuple for not intersecting and not parallel rays with points of the closest approach on each ray.

#### Parameters

- **ray1** – first ray as tuple of two points as *Vec3* objects
- **ray2** – second ray as tuple of two points as *Vec3* objects
- **abs\_tol** – absolute tolerance for comparisons

```
ezdxf.math.is_planar_face(face: Sequence[eздxf.math._vector.Vec3], abs_tol=1e-09) → bool
```

Returns True if sequence of vectors is a planar face.

#### Parameters

- **face** – sequence of *Vec3* objects
- **abs\_tol** – tolerance for normals check

```
ezdxf.math.linear_vertex_spacing(start: eздxf.math._vector.Vec3, end: eздxf.math._vector.Vec3, count: int) → List[eздxf.math._vector.Vec3]
```

Returns *count* evenly spaced vertices from *start* to *end*.

```
ezdxf.math.local_cubic_bspline_interpolation(fit_points: Iterable[Union[Sequence[float], eздxf.math._vector.Vec2, eздxf.math._vector.Vec3]]], method: str = '5-points', tangents: Optional[Iterable[Union[Sequence[float], eздxf.math._vector.Vec2, eздxf.math._vector.Vec3]]]] = None) → BSpline
```

B-spline interpolation by ‘Local Cubic Curve Interpolation’, which creates B-spline from fit points and estimated tangent direction at start-, end- and passing points.

Source: Piegl & Tiller: “The NURBS Book” - chapter 9.3.4

Available tangent estimation methods:

- “3-points”: 3 point interpolation

- “5-points”: 5 point interpolation
- “bezier”: cubic bezier curve interpolation
- “diff”: finite difference

or pass pre-calculated tangents, which overrides tangent estimation.

#### Parameters

- **fit\_points** – all B-spline fit points as `Vec3` compatible objects
- **method** – tangent estimation method
- **tangents** – tangents as `Vec3` compatible objects (optional)

#### Returns `BSpline`

```
ezdxf.math.normal_vector_3p(a: eздxf.math._vector.Vec3, b: eздxf.math._vector.Vec3, c:  
eздxf.math._vector.Vec3) → eздxf.math._vector.Vec3
```

Returns normal vector for 3 points, which is the normalized cross product for:  $a \rightarrow b \times a \rightarrow c$ .

```
ezdxf.math.open_uniform_bspline(control_points: Iterable[Union[Sequence[float],  
eздxf.math._vector.Vec2, eздxf.math._vector.Vec3]], order:  
int = 4, weights: Optional[Iterable[float]] = None) →  
eздxf.math.bspline.BSpline
```

Creates an open uniform (periodic) B-spline curve ([open curve](#)).

This is an unclamped curve, which means the curve passes none of the control points.

#### Parameters

- **control\_points** – iterable of control points as `Vec3` compatible objects
- **order** – spline order (degree + 1)
- **weights** – iterable of weight values

```
ezdxf.math.quadratic_bezier_bbox(curve: eздxf.math._bezier3p.Bezier3P, *, abs_tol=1e-12) →  
eздxf.math.bbox.BoundingBox
```

Returns the [BoundingBox](#) of a quadratic Bézier curve of type [Bezier3P](#).

New in version 0.18.

```
ezdxf.math.quadratic_bezier_from_3p(p1: Union[Sequence[float], eздxf.math._vector.Vec2,  
eздxf.math._vector.Vec3], p2: Union[Sequence[float], eздxf.math._vector.Vec2,  
eздxf.math._vector.Vec3], p3: Union[Sequence[float], e Zukxf.math._vector.Vec2, e Zukxf.math._vector.Vec3]) →  
e Zukxf.math._bezier3p.Bezier3P
```

Returns a quadratic Bézier curve [Bezier3P](#) from three points. The curve starts at  $p1$ , goes through  $p2$  and ends at  $p3$ . (source: [pomax-2](#))

New in version 0.17.2.

```
ezdxf.math.quadratic_to_cubic_bezier(curve: e Zukxf.math._bezier3p.Bezier3P) →  
e Zukxf.math._bezier4p.Bezier4P
```

Convert quadratic Bézier curves ([ezdxf.math.Bezier3P](#)) into cubic Bézier curves ([ezdxf.math.Bezier4P](#)).

New in version 0.16.

```
ezdxf.math.rational_bspline_from_arc(center: e Zukxf.math._vector.Vec3 = (0, 0), radius: float  
= 1, start_angle: float = 0, end_angle: float = 360,  
segments: int = 1) → e Zukxf.math.bspline.BSpline
```

Returns a rational B-splines for a circular 2D arc.

**Parameters**

- **center** – circle center as `Vec3` compatible object
- **radius** – circle radius
- **start\_angle** – start angle in degrees
- **end\_angle** – end angle in degrees
- **segments** – count of spline segments, at least one segment for each quarter (90 deg), default is 1, for as few as needed.

`ezdxf.math.rational_bspline_from_ellipse(ellipse: ConstructionEllipse, segments: int = 1)`  
 $\rightarrow$  `ezdxf.math.bspline.BSpline`

Returns a rational B-splines for an elliptic arc.

**Parameters**

- **ellipse** – ellipse parameters as `ConstructionEllipse` object
- **segments** – count of spline segments, at least one segment for each quarter ( $\pi/2$ ), default is 1, for as few as needed.

`ezdxf.math.safe_normal_vector(vertices: Sequence[ezdxf.math._vector.Vector3])`  
 $\rightarrow$   
`ezdxf.math._vector.Vector3`

Safe function to detect the normal vector for a face or polygon defined by 3 or more *vertices*.

`ezdxf.math.spherical_envelope(points: Sequence[Union[Sequence[float],  
ezdxf.math._vector.Vector2, ezdxf.math._vector.Vector3]])`  
 $\rightarrow$  `Tuple[ezdxf.math._vector.Vector3, float]`

Calculate the spherical envelope for the given points. Returns the centroid (a.k.a. geometric center) and the radius of the enclosing sphere.

**Note:** The result does not represent the minimal bounding sphere!

New in version 0.18.

`ezdxf.math.split_bezier(control_points: Sequence[T], t: float)`  $\rightarrow$  `Tuple[List[T], List[T]]`

Split Bézier curves at parameter *t* by de Casteljau's algorithm (source: `pomax-1`). Returns the control points for two new Bézier curves of the same degree and type as the input curve.

**Parameters**

- **control\_points** – of the Bézier curve as `Vec2` or `Vec3` objects. Requires 3 points for a quadratic curve, 4 points for a cubic curve , ...
- **t** – parameter where to split the curve in the range [0, 1]

New in version 0.17.2.

`ezdxf.math.split_polygon_by_plane(polygon: Iterable[ezdxf.math._vector.Vector3],  
plane: ezdxf.math.construct3d.Plane, *,  
coplanar=True, abs_tol=1e-09)`  $\rightarrow$  `Tuple[Sequence[ezdxf.math._vector.Vector3], Sequence[ezdxf.math._vector.Vector3]]`

Split a convex *polygon* by the given *plane* if needed. Returns a tuple of front- and back vertices (front, back). Returns also coplanar polygons if the argument *coplanar* is True, the coplanar vertices goes into either front or back depending on their orientation with respect to this plane.

New in version 0.18.

```
ezdxf.math.subdivide_face(face: Sequence[Union[ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3]]], quads: bool = True) → Iterable[Tuple[ezdxf.math._vector.Vec3, ...]]
```

Yields new subdivided faces. Creates new faces from subdivided edges and the face midpoint by linear interpolation.

#### Parameters

- **face** – a sequence of vertices, `Vec2` and `Vec3` objects supported.
- **quads** – create quad faces if `True` else create triangles

```
ezdxf.math.subdivide_ngons(faces: Iterable[Sequence[Union[ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3]]], max_vertex_count=4) → Iterable[Sequence[ezdxf.math._vector.Vec3]]
```

Yields only triangles or quad faces, subdivides ngons into triangles.

#### Parameters

- **faces** – iterable of faces as sequence of `Vec2` and `Vec3` objects
- **max\_vertex\_count** – subdivide only ngons with more vertices

## Transformation Classes

### OCS Class

```
class ezdxf.math.OCS(extrusion: Union[Sequence[float], ezdxf.math._vector.Vec3] = Vec3(0.0, 0.0, 1.0))
```

Establish an `OCS` for a given extrusion vector.

**Parameters** `extrusion` – extrusion vector.

**ux**

x-axis unit vector

**uy**

y-axis unit vector

**uz**

z-axis unit vector

```
from_wcs(point: Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3]) → Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3]
```

Returns OCS vector for WCS `point`.

```
points_from_wcs(points: Iterable[Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3]]) → Iterable[Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3]]
```

Returns iterable of OCS vectors from WCS `points`.

```
to_wcs(point: Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3]) → Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3]
```

Returns WCS vector for OCS `point`.

```
points_to_wcs(points: Iterable[Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3]]) → Iterable[Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3]]
```

Returns iterable of WCS vectors for OCS `points`.

```
render_axis(layout: BaseLayout, length: float = 1, colors: RGB = (1, 3, 5)) → None
```

Render axis as 3D lines into a `layout`.

## UCS Class

```
class ezdxf.math.UCS (origin: Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3] = (0, 0, 0), ux: Union[Sequence[float], ezdxf.math._vector.Vec2, None] = None, uy: Union[Sequence[float], ezdxf.math._vector.Vec2, None] = None, uz: Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3, None] = None)
```

Establish an user coordinate system ([UCS](#)). The UCS is defined by the origin and two unit vectors for the x-, y- or z-axis, all axis in [WCS](#). The missing axis is the cross product of the given axis.

If x- and y-axis are None:  $\text{ux} = (1, 0, 0)$ ,  $\text{uy} = (0, 1, 0)$ ,  $\text{uz} = (0, 0, 1)$ .

Unit vectors don't have to be normalized, normalization is done at initialization, this is also the reason why scaling gets lost by copying or rotating.

### Parameters

- **origin** – defines the UCS origin in world coordinates
- **ux** – defines the UCS x-axis as vector in [WCS](#)
- **uy** – defines the UCS y-axis as vector in [WCS](#)
- **uz** – defines the UCS z-axis as vector in [WCS](#)

#### **ux**

x-axis unit vector

#### **uy**

y-axis unit vector

#### **uz**

z-axis unit vector

#### **is\_cartesian**

Returns True if cartesian coordinate system.

#### **copy()** → UCS

Returns a copy of this UCS.

#### **to\_wcs** (*point*: ezdxf.math.\_vector.Vec3) → ezdxf.math.\_vector.Vec3

Returns WCS point for UCS *point*.

#### **points\_to\_wcs** (*points*: Iterable[ezdxf.math.\_vector.Vec3]) → Iterable[ezdxf.math.\_vector.Vec3]

Returns iterable of WCS vectors for UCS *points*.

#### **direction\_to\_wcs** (*vector*: ezdxf.math.\_vector.Vec3) → ezdxf.math.\_vector.Vec3

Returns WCS direction for UCS *vector* without origin adjustment.

#### **from\_wcs** (*point*: ezdxf.math.\_vector.Vec3) → ezdxf.math.\_vector.Vec3

Returns UCS point for WCS *point*.

#### **points\_from\_wcs** (*points*: Iterable[ezdxf.math.\_vector.Vec3]) → Iterable[ezdxf.math.\_vector.Vec3]

Returns iterable of UCS vectors from WCS *points*.

#### **direction\_from\_wcs** (*vector*: ezdxf.math.\_vector.Vec3) → ezdxf.math.\_vector.Vec3

Returns UCS vector for WCS *vector* without origin adjustment.

#### **to\_octs** (*point*: ezdxf.math.\_vector.Vec3) → ezdxf.math.\_vector.Vec3

Returns OCS vector for UCS *point*.

The [OCS](#) is defined by the z-axis of the [UCS](#).

**points\_to\_ocs** (*points*: *Iterable[ezdxf.math.\_vector.Vec3]*) → *Iterable[ezdxf.math.\_vector.Vec3]*

Returns iterable of OCS vectors for UCS *points*.

The *OCS* is defined by the z-axis of the *UCS*.

**Parameters** **points** – iterable of UCS vertices

**to\_ocs\_angle\_deg** (*angle*: *float*) → *float*

Transforms *angle* from current UCS to the parent coordinate system (most likely the WCS) including the transformation to the OCS established by the extrusion vector *UCS.uz*.

**Parameters** **angle** – in UCS in degrees

**transform** (*m*: *ezdxf.math.\_matrix44.Matrix44*) → *UCS*

General inplace transformation interface, returns *self* (floating interface).

**Parameters** **m** – 4x4 transformation matrix (*ezdxf.math.Matrix44*)

**rotate** (*axis*: *Union[Sequence[float], ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3]*, *angle*: *float*) → *UCS*

Returns a new rotated UCS, with the same origin as the source UCS. The rotation vector is located in the origin and has *WCS* coordinates e.g. (0, 0, 1) is the WCS z-axis as rotation vector.

**Parameters**

- **axis** – arbitrary rotation axis as vector in *WCS*
- **angle** – rotation angle in radians

**rotate\_local\_x** (*angle*: *float*) → *UCS*

Returns a new rotated UCS, rotation axis is the local x-axis.

**Parameters** **angle** – rotation angle in radians

**rotate\_local\_y** (*angle*: *float*) → *UCS*

Returns a new rotated UCS, rotation axis is the local y-axis.

**Parameters** **angle** – rotation angle in radians

**rotate\_local\_z** (*angle*: *float*) → *UCS*

Returns a new rotated UCS, rotation axis is the local z-axis.

**Parameters** **angle** – rotation angle in radians

**shift** (*delta*: *Union[Sequence[float], ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3]*) → *UCS*

Shifts current UCS by *delta* vector and returns *self*.

**Parameters** **delta** – shifting vector

**moveto** (*location*: *Union[Sequence[float], ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3]*) → *UCS*

Place current UCS at new origin *location* and returns *self*.

**Parameters** **location** – new origin in WCS

**static from\_x\_axis\_and\_point\_in\_xy** (*origin*: *Union[Sequence[float], ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3]*, *axis*: *Union[Sequence[float], ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3]*, *point*: *Union[Sequence[float], ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3]*) → *UCS*

Returns an new *UCS* defined by the origin, the x-axis vector and an arbitrary point in the xy-plane.

**Parameters**

- **origin** – UCS origin as (x, y, z) tuple in *WCS*

- **axis** – x-axis vector as (x, y, z) tuple in *WCS*
- **point** – arbitrary point unlike the origin in the xy-plane as (x, y, z) tuple in *WCS*

```
static from_x_axis_and_point_in_xz(origin: Union[Sequence[float],  
ezdxf.math._vector.Vector2, eздxf.math._vector.Vector3],  
axis: Union[Sequence[float],  
ezdxf.math._vector.Vector2, eздxf.math._vector.Vector3],  
point: Union[Sequence[float],  
ezdxf.math._vector.Vector2, eздxf.math._vector.Vector3])  
→ UCS
```

Returns an new *UCS* defined by the origin, the x-axis vector and an arbitrary point in the xz-plane.

#### Parameters

- **origin** – UCS origin as (x, y, z) tuple in *WCS*
- **axis** – x-axis vector as (x, y, z) tuple in *WCS*
- **point** – arbitrary point unlike the origin in the xz-plane as (x, y, z) tuple in *WCS*

```
static from_y_axis_and_point_in_xy(origin: Union[Sequence[float],  
ezdxf.math._vector.Vector2, eздxf.math._vector.Vector3],  
axis: Union[Sequence[float],  
ezdxf.math._vector.Vector2, eздxf.math._vector.Vector3],  
point: Union[Sequence[float],  
ezdxf.math._vector.Vector2, eздxf.math._vector.Vector3])  
→ UCS
```

Returns an new *UCS* defined by the origin, the y-axis vector and an arbitrary point in the xy-plane.

#### Parameters

- **origin** – UCS origin as (x, y, z) tuple in *WCS*
- **axis** – y-axis vector as (x, y, z) tuple in *WCS*
- **point** – arbitrary point unlike the origin in the xy-plane as (x, y, z) tuple in *WCS*

```
static from_y_axis_and_point_in_yz(origin: Union[Sequence[float],  
ezdxf.math._vector.Vector2, eздxf.math._vector.Vector3],  
axis: Union[Sequence[float],  
ezdxf.math._vector.Vector2, eздxf.math._vector.Vector3],  
point: Union[Sequence[float],  
ezdxf.math._vector.Vector2, eздxf.math._vector.Vector3])  
→ UCS
```

Returns an new *UCS* defined by the origin, the y-axis vector and an arbitrary point in the yz-plane.

#### Parameters

- **origin** – UCS origin as (x, y, z) tuple in *WCS*
- **axis** – y-axis vector as (x, y, z) tuple in *WCS*
- **point** – arbitrary point unlike the origin in the yz-plane as (x, y, z) tuple in *WCS*

```
static from_z_axis_and_point_in_xz(origin: Union[Sequence[float],  
ezdxf.math._vector.Vector2, eздxf.math._vector.Vector3],  
axis: Union[Sequence[float],  
ezdxf.math._vector.Vector2, eздxf.math._vector.Vector3],  
point: Union[Sequence[float],  
ezdxf.math._vector.Vector2, eздxf.math._vector.Vector3])  
→ UCS
```

Returns an new *UCS* defined by the origin, the z-axis vector and an arbitrary point in the xz-plane.

### Parameters

- **origin** – UCS origin as (x, y, z) tuple in [WCS](#)
- **axis** – z-axis vector as (x, y, z) tuple in [WCS](#)
- **point** – arbitrary point unlike the origin in the xz-plane as (x, y, z) tuple in [WCS](#)

```
static from_z_axis_and_point_in_yz(origin: Union[Sequence[float],  
                                              ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3],  
                                              axis: Union[Sequence[float],  
                                             ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3],  
                                              point: Union[Sequence[float],  
                                             ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3])  
                                → UCS
```

Returns an new [UCS](#) defined by the origin, the z-axis vector and an arbitrary point in the yz-plane.

### Parameters

- **origin** – UCS origin as (x, y, z) tuple in [WCS](#)
- **axis** – z-axis vector as (x, y, z) tuple in [WCS](#)
- **point** – arbitrary point unlike the origin in the yz-plane as (x, y, z) tuple in [WCS](#)

```
render_axis(layout: BaseLayout, length = 1, colors: Tuple[int, int, int] = (1, 3, 5))
```

Render axis as 3D lines into a *layout*.

## Matrix44

```
class ezdxf.math.Matrix44(*args)
```

This is a 4x4 transformation matrix.

The utility functions for constructing transformations and transforming vectors and points assumes that vectors are stored as row vectors, meaning when multiplied, transformations are applied left to right (e.g. vAB transforms v by A then by B).

Matrix44 initialization:

- `Matrix44()` returns the identity matrix.
- `Matrix44(values)` values is an iterable with the 16 components of the matrix.
- `Matrix44(row1, row2, row3, row4)` four rows, each row with four values.

```
__repr__() → str
```

Returns the representation string of the matrix: `Matrix44((col0, col1, col2, col3), (...), (...), (...))`

```
get_row(row: int) → Tuple[float, ...]
```

Get row as list of four float values.

**Parameters** `row` – row index [0 .. 3]

```
set_row(row: int, values: Sequence[float]) → None
```

Sets the values in a row.

### Parameters

- `row` – row index [0 .. 3]
- `values` – iterable of four row values

**get\_col**(*col: int*) → Tuple[float, ...]

Returns a column as a tuple of four floats.

**Parameters** **col** – column index [0 .. 3]

**set\_col**(*col: int, values: Sequence[float]*)

Sets the values in a column.

**Parameters**

- **col** – column index [0 .. 3]

- **values** – iterable of four column values

**copy**() → ezdxf.math.\_matrix44.Matrix44

Returns a copy of same type.

**\_\_copy\_\_**() → ezdxf.math.\_matrix44.Matrix44

Returns a copy of same type.

**classmethod scale**(*sx: float, sy: Optional[float] = None, sz: Optional[float] = None*) → ezdxf.math.\_matrix44.Matrix44

Returns a scaling transformation matrix. If *sy* is None, *sy* = *sx*, and if *sz* is None *sz* = *sx*.

**classmethod translate**(*dx: float, dy: float, dz: float*) → ezdxf.math.\_matrix44.Matrix44

Returns a translation matrix for translation vector (*dx*, *dy*, *dz*).

**classmethod x\_rotate**(*angle: float*) → ezdxf.math.\_matrix44.Matrix44

Returns a rotation matrix about the x-axis.

**Parameters** **angle** – rotation angle in radians

**classmethod y\_rotate**(*angle: float*) → ezdxf.math.\_matrix44.Matrix44

Returns a rotation matrix about the y-axis.

**Parameters** **angle** – rotation angle in radians

**classmethod z\_rotate**(*angle: float*) → ezdxf.math.\_matrix44.Matrix44

Returns a rotation matrix about the z-axis.

**Parameters** **angle** – rotation angle in radians

**classmethod axis\_rotate**(*axis: UVec, angle: float*) → Matrix44

Returns a rotation matrix about an arbitrary *axis*.

**Parameters**

- **axis** – rotation axis as (*x*, *y*, *z*) tuple or *Vec3* object

- **angle** – rotation angle in radians

**classmethod xyz\_rotate**(*angle\_x: float, angle\_y: float, angle\_z: float*) → ezdxf.math.\_matrix44.Matrix44

Returns a rotation matrix for rotation about each axis.

**Parameters**

- **angle\_x** – rotation angle about x-axis in radians

- **angle\_y** – rotation angle about y-axis in radians

- **angle\_z** – rotation angle about z-axis in radians

**classmethod shear\_xy**(*angle\_x: float = 0, angle\_y: float = 0*) → ezdxf.math.\_matrix44.Matrix44

Returns a translation matrix for shear mapping (visually similar to slanting) in the xy-plane.

**Parameters**

- **angle\_x** – slanting angle in x direction in radians
- **angle\_y** – slanting angle in y direction in radians

```
classmethod perspective_projection(left: float, right: float, top: float, bottom: float, near: float, far: float) → ezdxf.math._matrix44.Matrix44
```

Returns a matrix for a 2D projection.

#### Parameters

- **left** – Coordinate of left of screen
- **right** – Coordinate of right of screen
- **top** – Coordinate of the top of the screen
- **bottom** – Coordinate of the bottom of the screen
- **near** – Coordinate of the near clipping plane
- **far** – Coordinate of the far clipping plane

```
classmethod perspective_projection_fov(fov: float, aspect: float, near: float, far: float) → ezdxf.math._matrix44.Matrix44
```

Returns a matrix for a 2D projection.

#### Parameters

- **fov** – The field of view (in radians)
- **aspect** – The aspect ratio of the screen (width / height)
- **near** – Coordinate of the near clipping plane
- **far** – Coordinate of the far clipping plane

```
static chain(*matrices) → ezdxf.math._matrix44.Matrix44
```

Compose a transformation matrix from one or more *matrices*.

```
static ucs(ux: ezdxf.math._vector.Vec3 = Vec3(1.0, 0.0, 0.0), uy: ezdxf.math._vector.Vec3 = Vec3(0.0, 1.0, 0.0), uz: ezdxf.math._vector.Vec3 = Vec3(0.0, 0.0, 1.0), origin: ezdxf.math._vector.Vec3 = Vec3(0.0, 0.0, 0.0)) → ezdxf.math._matrix44.Matrix44
```

Returns a matrix for coordinate transformation from WCS to UCS. For transformation from UCS to WCS, transpose the returned matrix.

#### Parameters

- **ux** – x-axis for UCS as unit vector
- **uy** – y-axis for UCS as unit vector
- **uz** – z-axis for UCS as unit vector
- **origin** – UCS origin as location vector

```
__hash__()
```

Return hash(self).

```
__getitem__(index: Tuple[int, int])
```

Get (row, column) element.

```
__setitem__(index: Tuple[int, int], value: float)
```

Set (row, column) element.

```
__iter__() → Iterator[float]
```

Iterates over all matrix values.

---

**rows** () → Iterable[Tuple[float, ...]]  
     Iterate over rows as 4-tuples.

**columns** () → Iterable[Tuple[float, ...]]  
     Iterate over columns as 4-tuples.

**\_\_mul\_\_** (other: *ezdxf.math.\_matrix44.Matrix44*) → *ezdxf.math.\_matrix44.Matrix44*  
     Returns a new matrix as result of the matrix multiplication with another matrix.

**\_imul\_\_** (other: *ezdxf.math.\_matrix44.Matrix44*) → *ezdxf.math.\_matrix44.Matrix44*  
     Inplace multiplication with another matrix.

**transform** (vector: *UVec*) → *Vec3*  
     Returns a transformed vertex.

**transform\_direction** (vector: *UVec*, normalize=False) → *Vec3*  
     Returns a transformed direction vector without translation.

**transform\_vertices** (vectors: Iterable[*UVec*]) → Iterable[*Vec3*]  
     Returns an iterable of transformed vertices.

**transform\_directions** (vectors: Iterable[*UVec*], normalize=False) → Iterable[*Vec3*]  
     Returns an iterable of transformed direction vectors without translation.

**transpose** () → None  
     Swaps the rows for columns inplace.

**determinant** () → float  
     Returns determinant.

**inverse** () → None  
     Calculates the inverse of the matrix.  
**Raises** `ZeroDivisionError` – if matrix has no inverse.

## Basic Construction Classes

### UVec

**class** *ezdxf.math.UVec*  
     Type alias for Union[Sequence[float], Vec2, Vec3]

### Vec3

**class** *ezdxf.math.Vec3*(\*args)

This is an immutable universal 3D vector object. This class is optimized for universality not for speed. Immutable means you can't change (x, y, z) components after initialization:

```
v1 = Vec3(1, 2, 3)
v2 = v1
v2.z = 7 # this is not possible, raises AttributeError
v2 = Vec3(v2.x, v2.y, 7) # this creates a new Vec3() object
assert v1.z == 3 # and v1 remains unchanged
```

*Vec3* initialization:

- `Vec3()`, returns `Vec3(0, 0, 0)`
- `Vec3((x, y))`, returns `Vec3(x, y, 0)`

- `Vec3((x, y, z))`, returns `Vec3(x, y, z)`
- `Vec3(x, y)`, returns `Vec3(x, y, 0)`
- `Vec3(x, y, z)`, returns `Vec3(x, y, z)`

Addition, subtraction, scalar multiplication and scalar division left and right handed are supported:

```
v = Vec3(1, 2, 3)
v + (1, 2, 3) == Vec3(2, 4, 6)
(1, 2, 3) + v == Vec3(2, 4, 6)
v - (1, 2, 3) == Vec3(0, 0, 0)
(1, 2, 3) - v == Vec3(0, 0, 0)
v * 3 == Vec3(3, 6, 9)
3 * v == Vec3(3, 6, 9)
Vec3(3, 6, 9) / 3 == Vec3(1, 2, 3)
-Vec3(1, 2, 3) == (-1, -2, -3)
```

Comparison between vectors and vectors or tuples is supported:

```
Vec3(1, 2, 3) < Vec3(2, 2, 2)
(1, 2, 3) < tuple(Vec3(2, 2, 2)) # conversion necessary
Vec3(1, 2, 3) == (1, 2, 3)

bool(Vec3(1, 2, 3)) is True
bool(Vec3(0, 0, 0)) is False
```

**x**

x-axis value

**y**

y-axis value

**z**

z-axis value

**xy**

`Vec3` as `(x, y, 0)`, projected on the xy-plane.

**xyz**

`Vec3` as `(x, y, z)` tuple.

**vec2**

Real 2D vector as `Vec2` object.

**magnitude**

Length of vector.

**magnitude\_xy**

Length of vector in the xy-plane.

**magnitude\_square**

Square length of vector.

**is\_null**

`Vec3(0, 0, 0)`. Has a fixed absolute testing tolerance of 1e-12!

**Type** `True` if all components are close to zero

**angle**

Angle between vector and x-axis in the xy-plane in radians.

**angle\_deg**

Returns angle of vector and x-axis in the xy-plane in degrees.

**spatial\_angle**

Spatial angle between vector and x-axis in radians.

**spatial\_angle\_deg**

Spatial angle between vector and x-axis in degrees.

**\_\_str\_\_ () → str**

Return '(x, y, z)' as string.

**\_\_repr\_\_ () → str**

Return 'Vec3(x, y, z)' as string.

**\_\_len\_\_ () → int**

Returns always 3.

**\_\_hash\_\_ () → int**

Returns hash value of vector, enables the usage of vector as key in set and dict.

**copy () → Vec3**

Returns a copy of vector as `Vec3` object.

**\_\_copy\_\_ () → Vec3**

Returns a copy of vector as `Vec3` object.

**\_\_deepcopy\_\_ (memodict: dict) → Vec3**

`copy.deepcopy()` support.

**\_\_getitem\_\_ (index: int) → float**

Support for indexing:

- v[0] is v.x

- v[1] is v.y

- v[2] is v.z

**\_\_iter\_\_ () → Iterator[float]**

Returns iterable of x-, y- and z-axis.

**\_\_abs\_\_ () → float**

Returns length (magnitude) of vector.

**replace (x: Optional[float] = None, y: Optional[float] = None, z: Optional[float] = None) → Vec3**

Returns a copy of vector with replaced x-, y- and/or z-axis.

**classmethod generate (items: Iterable[UVec]) → Iterable[Vec3]**

Returns an iterable of `Vec3` objects.

**classmethod list (items: Iterable[UVec]) → List[Vec3]**

Returns a list of `Vec3` objects.

**classmethod tuple (items: Iterable[UVec]) → Sequence[Vec3]**

Returns a tuple of `Vec3` objects.

**classmethod from\_angle (angle: float, length: float = 1.0) → Vec3**

Returns a `Vec3` object from `angle` in radians in the xy-plane, z-axis = 0.

**classmethod from\_deg\_angle (angle: float, length: float = 1.0) → Vec3**

Returns a `Vec3` object from `angle` in degrees in the xy-plane, z-axis = 0.

**orthogonal (ccw: bool = True) → Vec3**

Returns orthogonal 2D vector, z-axis is unchanged.

**Parameters** `ccw` – counter clockwise if True else clockwise

**lerp** (*other*: UVec, *factor*=0.5) → Vec3

Returns linear interpolation between *self* and *other*.

**Parameters**

- **other** – end point as `Vec3` compatible object
- **factor** – interpolation factor (0 = self, 1 = other, 0.5 = mid point)

**is\_parallel** (*other*: Vec3, \*, *rel\_tol*: float = 1e-09, *abs\_tol*: float = 1e-12) → bool

Returns True if *self* and *other* are parallel to vectors.

**project** (*other*: UVec) → Vec3

Returns projected vector of *other* onto *self*.

**normalize** (*length*: float = 1.0) → Vec3

Returns normalized vector, optional scaled by *length*.

**reversed**() → Vec3

Returns negated vector (-*self*).

**isclose** (*other*: UVec, \*, *rel\_tol*: float = 1e-09, *abs\_tol*: float = 1e-12) → bool

Returns True if *self* is close to *other*. Uses `math.isclose()` to compare all axis.

Learn more about the `math.isclose()` function in [PEP 485](#).

**\_\_neg\_\_**() → Vec3

Returns negated vector (-*self*).

**\_\_bool\_\_**() → bool

Returns True if vector is not (0, 0, 0).

**\_\_eq\_\_** (*other*: UVec) → bool

Equal operator.

**Parameters** `other` – `Vec3` compatible object

**\_\_lt\_\_** (*other*: UVec) → bool

Lower than operator.

**Parameters** `other` – `Vec3` compatible object

**\_\_add\_\_** (*other*: UVec) → Vec3

Add `Vec3` operator: *self* + *other*.

**\_\_radd\_\_** (*other*: UVec) → Vec3

RAdd `Vec3` operator: *other* + *self*.

**\_\_sub\_\_** (*other*: UVec) → Vec3

Sub `Vec3` operator: *self* - *other*.

**\_\_rsub\_\_** (*other*: UVec) → Vec3

RSub `Vec3` operator: *other* - *self*.

**\_\_mul\_\_** (*other*: float) → Vec3

Scalar Mul operator: *self* \* *other*.

**\_\_rmul\_\_** (*other*: float) → Vec3

Scalar RMul operator: *other* \* *self*.

**\_\_truediv\_\_** (*other*: float) → Vec3

Scalar Div operator: *self* / *other*.

**dot** (*other: UVec*) → float  
 Dot operator: *self* . *other*

**Parameters** **other** – *Vec3* compatible object

**cross** (*other: UVec*) → *Vec3*  
 Dot operator: *self* x *other*

**Parameters** **other** – *Vec3* compatible object

**distance** (*other: UVec*) → float  
 Returns distance between *self* and *other* vector.

**angle\_about** (*base: UVec, target: UVec*) → float  
 Returns counter clockwise angle in radians about *self* from *base* to *target* when projected onto the plane defined by *self* as the normal vector.

**Parameters**

- **base** – base vector, defines angle 0
- **target** – target vector

**angle\_between** (*other: UVec*) → float  
 Returns angle between *self* and *other* in radians. +angle is counter clockwise orientation.

**Parameters** **other** – *Vec3* compatible object

**rotate** (*angle: float*) → *Vec3*  
 Returns vector rotated about *angle* around the z-axis.

**Parameters** **angle** – angle in radians

**rotate\_deg** (*angle: float*) → *Vec3*  
 Returns vector rotated about *angle* around the z-axis.

**Parameters** **angle** – angle in degrees

**static sum** (*items: Iterable[UVec]*) → *Vec3*  
 Add all vectors in *items*.

`ezdxf.math.X_AXIS`  
`Vec3(1, 0, 0)`

`ezdxf.math.Y_AXIS`  
`Vec3(0, 1, 0)`

`ezdxf.math.Z_AXIS`  
`Vec3(0, 0, 1)`

`ezdxf.math.NULLVEC`  
`Vec3(0, 0, 0)`

## Vec2

**class** `ezdxf.math.Vec2(v=(0.0, 0.0), y=None)`

*Vec2* represents a special 2D vector (*x*, *y*). The *Vec2* class is optimized for speed and not immutable, *iadd()*, *isub()*, *imul()* and *idiv()* modifies the vector itself, the *Vec3* class returns a new object.

*Vec2* initialization accepts float-tuples (*x*, *y* [, *z*]), two floats or any object providing *x* and *y* attributes like *Vec2* and *Vec3* objects.

**Parameters**

- **v** – vector object with `x` and `y` attributes/properties or a sequence of float [`x`, `y`, ...] or x-axis as float if argument `y` is not `None`
- **y** – second float for `Vec2(x, y)`

`Vec2` implements a subset of `Vec3`.

## Plane

**class** `ezdxf.math.Plane(normal: Vec3, distance: float)`

Represents a plane in 3D space as normal vector and the perpendicular distance from origin.

**normal**

Normal vector of the plane.

**distance\_from\_origin**

The (perpendicular) distance of the plane from origin (0, 0, 0).

**vector**

Returns the location vector.

**classmethod from\_3p** (`a: ezdxf.math._vector.Vec3, b: ezdxf.math._vector.Vec3, c: ezdxf.math._vector.Vec3`) → `Plane`

Returns a new plane from 3 points in space.

**classmethod from\_vector** (`vector: Union[Sequence[float], ezdxf.math._vector.Vec3]`) → `Plane`

Returns a new plane from the given location vector.

**copy()** → `Plane`

Returns a copy of the plane.

**signed\_distance\_to** (`v: ezdxf.math._vector.Vec3`) → `float`

Returns signed distance of vertex `v` to plane, if distance is > 0, `v` is in ‘front’ of plane, in direction of the normal vector, if distance is < 0, `v` is at the ‘back’ of the plane, in the opposite direction of the normal vector.

**distance\_to** (`v: ezdxf.math._vector.Vec3`) → `float`

Returns absolute (unsigned) distance of vertex `v` to plane.

**is\_coplanar\_vertex** (`v: ezdxf.math._vector.Vec3, abs_tol=1e-09`) → `bool`

Returns `True` if vertex `v` is coplanar, distance from plane to vertex `v` is 0.

**is\_coplanar\_plane** (`p: Plane, abs_tol=1e-09`) → `bool`

Returns `True` if plane `p` is coplanar, normal vectors in same or opposite direction.

**intersect\_line** (`start: ezdxf.math._vector.Vec3, end: ezdxf.math._vector.Vec3, *, coplanar=True, abs_tol=1e-09`) → `Optional[ezdxf.math._vector.Vec3]`

Returns the intersection point of the 3D line from `start` to `end` and this plane or `None` if there is no intersection. If the argument `coplanar` is `False` the start- or end point of the line are ignored as intersection points.

New in version 0.18.

**intersect\_ray** (`origin: ezdxf.math._vector.Vec3, direction: ezdxf.math._vector.Vec3`) → `Optional[ezdxf.math._vector.Vec3]`

Returns the intersection point of the infinite 3D ray defined by `origin` and the `direction` vector and this plane or `None` if there is no intersection. A coplanar ray does not intersect the plane!

New in version 0.18.

## BoundingBox

```
class ezdxf.math.BoundingBox(vertices: Optional[Iterable[Union[Sequence[float],
ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3]]] = None)
```

3D bounding box.

**Parameters** **vertices** – iterable of (x, y, z) tuples or *Vec3* objects

**extmin**

“lower left” corner of bounding box

**extmax**

“upper right” corner of bounding box

```
inside(vertex: Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3]) → bool
```

Returns True if *vertex* is inside this bounding box.

Vertices at the box border are inside!

```
any_inside(vertices: Iterable[Union[Sequence[float],
ezdxf.math._vector.Vec3]]) → bool
```

Returns True if any vertex is inside this bounding box.

Vertices at the box border are inside!

```
all_inside(vertices: Iterable[Union[Sequence[float],
ezdxf.math._vector.Vec3]]) → bool
```

Returns True if all vertices are inside this bounding box.

Vertices at the box border are inside!

```
has_intersection(other: AbstractBoundingBox) → bool
```

Returns True if this bounding box intersects with *other* but does not include touching bounding boxes,  
see also *has\_overlap()*:

```
bbox1 = BoundingBox([(0, 0, 0), (1, 1, 1)])
bbox2 = BoundingBox([(1, 1, 1), (2, 2, 2)])
assert bbox1.has_intersection(bbox2) is False
```

```
has_overlap(other: AbstractBoundingBox) → bool
```

Returns True if this bounding box intersects with *other* but in contrast to *has\_intersection()*  
includes touching bounding boxes too:

```
bbox1 = BoundingBox([(0, 0, 0), (1, 1, 1)])
bbox2 = BoundingBox([(1, 1, 1), (2, 2, 2)])
assert bbox1.has_overlap(bbox2) is True
```

```
contains(other: AbstractBoundingBox) → bool
```

Returns True if the *other* bounding box is completely inside of this bounding box.

New in version 0.17.2.

```
extend(vertices: Iterable[Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3]])
```

→ None

Extend bounds by *vertices*.

**Parameters** **vertices** – iterable of vertices

```
union(other: AbstractBoundingBox)
```

Returns a new bounding box as union of this and *other* bounding box.

**intersection** (*other: AbstractBoundingBox*) → *BoundingBox*

Returns the bounding box of the intersection cube of both 3D bounding boxes. Returns an empty bounding box if the intersection volume is 0.

**rect\_vertices** () → *Tuple[ezdxf.math.\_vector.Vec2, ...]*

Returns the corners of the bounding box in the xy-plane as *Vec2* objects.

**cube\_vertices** () → *Tuple[ezdxf.math.\_vector.Vec3, ...]*

Returns the 3D corners of the bounding box as *Vec3* objects.

**grow** (*value: float*) → *None*

Grow or shrink the bounding box by an uniform value in x, y and z-axis. A negative value shrinks the bounding box. Raises *ValueError* for shrinking the size of the bounding box to zero or below in any dimension.

## BoundingBox2d

**class** *ezdxf.math.BoundingBox2d* (*vertices: Optional[Iterable[Union[Sequence[float], ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3]]] = None*)

Optimized 2D bounding box.

**Parameters** **vertices** – iterable of (x, y[, z]) tuples or *Vec3* objects

**extmin**

“lower left” corner of bounding box

**extmax**

“upper right” corner of bounding box

**inside** (*vertex: Union[Sequence[float], ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3]*) → *bool*

Returns True if *vertex* is inside this bounding box.

Vertices at the box border are inside!

**any\_inside** (*vertices: Iterable[Union[Sequence[float], ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3]]*) → *bool*

Returns True if any vertex is inside this bounding box.

Vertices at the box border are inside!

**all\_inside** (*vertices: Iterable[Union[Sequence[float], ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3]]*) → *bool*

Returns True if all vertices are inside this bounding box.

Vertices at the box border are inside!

**has\_intersection** (*other: AbstractBoundingBox*) → *bool*

Returns True if this bounding box intersects with *other* but does not include touching bounding boxes, see also *has\_overlap()*:

```
bbox1 = BoundingBox2d([(0, 0), (1, 1)])
bbox2 = BoundingBox2d([(1, 1), (2, 2)])
assert bbox1.has_intersection(bbox2) is False
```

**has\_overlap** (*other: AbstractBoundingBox*) → *bool*

Returns True if this bounding box intersects with *other* but in contrast to *has\_intersection()* includes touching bounding boxes too:

```
bbox1 = BoundingBox2d([(0, 0), (1, 1)])
bbox2 = BoundingBox2d([(1, 1), (2, 2)])
assert bbox1.has_overlap(bbox2) is True
```

New in version 0.17.2.

**contains** (*other*: *AbstractBoundingBox*) → bool

Returns True if the *other* bounding box is completely inside of this bounding box.

New in version 0.17.2.

**extend** (*vertices*: *Iterable[Union[Sequence[float], ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3]]*)

→ None

Extend bounds by *vertices*.

**Parameters** **vertices** – iterable of vertices

**union** (*other*: *AbstractBoundingBox*)

Returns a new bounding box as union of this and *other* bounding box.

**intersection** (*other*: *AbstractBoundingBox*) → *BoundingBox2d*

Returns the bounding box of the intersection rectangle of both 2D bounding boxes. Returns an empty bounding box if the intersection area is 0.

**rect\_vertices** () → *Tuple[ezdxf.math.\_vector.Vec2, ...]*

Returns the corners of the bounding box in the xy-plane as *Vec2* objects.

## ConstructionRay

```
class ezdxf.math.ConstructionRay(p1: Union[Sequence[float], ezdxf.math._vector.Vec2,
                                                ezdxf.math._vector.Vec3], p2: Union[Sequence[float],
                                                ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3, None] =
                                                None, angle: Optional[float] = None)
```

Infinite 2D construction ray as immutable object.

### Parameters

- **p1** – definition point 1
- **p2** – ray direction as 2nd point or None
- **angle** – ray direction as angle in radians or None

#### location

Location vector as *Vec2*.

#### direction

Direction vector as *Vec2*.

#### slope

Slope of ray or None if vertical.

#### angle

Angle between x-axis and ray in radians.

#### angle\_deg

Angle between x-axis and ray in degrees.

#### is\_vertical

True if ray is vertical (parallel to y-axis).

```
is_horizontal
    True if ray is horizontal (parallel to x-axis).

__str__()
    Return str(self).

is_parallel(other: ConstructionRay) → bool
    Returns True if rays are parallel.

intersect(other: ConstructionRay) → ezdxf.math._vector.Vec2
    Returns the intersection point as (x, y) tuple of self and other.

    Raises ParallelRaysError – if rays are parallel

orthogonal(location: Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3]) →
    ConstructionRay
    Returns orthogonal ray at location.

bisectrix(other: ConstructionRay) → ConstructionRay
    Bisectrix between self and other.

yof(x: float) → float
    Returns y-value of ray for x location.

    Raises ArithmeticError – for vertical rays

xof(y: float) → float
    Returns x-value of ray for y location.

    Raises ArithmeticError – for horizontal rays
```

## ConstructionLine

```
class ezdxf.math.ConstructionLine(start: Union[Sequence[float], ezdxf.math._vector.Vec2,
                                                ezdxf.math._vector.Vec3], end: Union[Sequence[float],
                                                ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3])
```

2D ConstructionLine is similar to [ConstructionRay](#), but has a start- and endpoint. The direction of line goes from start- to endpoint, “left of line” is always in relation to this line direction.

### Parameters

- **start** – start point of line as [Vec2](#) compatible object
- **end** – end point of line as [Vec2](#) compatible object

#### start

start point as [Vec2](#)

#### end

end point as [Vec2](#)

#### bounding\_box

bounding box of line as [BoundingBox2d](#) object.

#### ray

collinear [ConstructionRay](#).

#### is\_vertical

True if line is vertical.

#### is\_horizontal

True if line is horizontal.

**\_\_str\_\_()**

Return str(self).

**translate(dx: float, dy: float) → None**

Move line about *dx* in x-axis and about *dy* in y-axis.

**Parameters**

- **dx** – translation in x-axis
- **dy** – translation in y-axis

**length() → float**

Returns length of line.

**midpoint() → Vec2**

Returns mid point of line.

**inside\_bounding\_box(point: Union[Sequence[float], ezdxf.math.\_vector.Vector3]) → bool**

Returns True if *point* is inside of line bounding box.

**intersect(other: ConstructionLine, abs\_tol: float = 1e-10) → Optional[Vec2]**

Returns the intersection point of to lines or None if they have no intersection point.

**Parameters**

- **other** – other *ConstructionLine*
- **abs\_tol** – tolerance for distance check

**has\_intersection(other: ConstructionLine, abs\_tol: float = 1e-10) → bool**

Returns True if has intersection with *other* line.

**is\_point\_left\_of\_line(point: Union[Sequence[float], ezdxf.math.\_vector.Vector3], colinear=False) → bool**

Returns True if *point* is left of construction line in relation to the line direction from start to end.

If *colinear* is True, a colinear point is also left of the line.

## ConstructionCircle

**class ezdxf.math.ConstructionCircle(center: Union[Sequence[float], ezdxf.math.\_vector.Vector2, ezdxf.math.\_vector.Vector3], radius: float = 1.0)**

Circle construction tool.

**Parameters**

- **center** – center point as *Vec2* compatible object
- **radius** – circle radius > 0

**center**

center point as *Vec2*

**radius**

radius as float

**bounding\_box**

2D bounding box of circle as *BoundingBox2d* object.

**static from\_3p**(*p1: Union[Sequence[float], ezdxf.math.\_vector.Vector2, ezdxf.math.\_vector.Vector3], p2: Union[Sequence[float], ezdxf.math.\_vector.Vector2, ezdxf.math.\_vector.Vector3], p3: Union[Sequence[float], ezdxf.math.\_vector.Vector2, ezdxf.math.\_vector.Vector3])* → ConstructionCircle

Creates a circle from three points, all points have to be compatible to `Vec2` class.

**\_\_str\_\_**() → str

Returns string representation of circle “ConstructionCircle(*center, radius*)”.

**translate**(*dx: float, dy: float*) → None

Move circle about *dx* in x-axis and about *dy* in y-axis.

#### Parameters

- **dx** – translation in x-axis
- **dy** – translation in y-axis

**point\_at**(*angle: float*) → ezdxf.math.\_vector.Vector2

Returns point on circle at *angle* as `Vec2` object.

**Parameters angle** – angle in radians, angle goes counter clockwise around the z-axis, x-axis = 0 deg.

**vertices**(*angles: Iterable[float]*) → Iterable[ezdxf.math.\_vector.Vector2]

Yields vertices of the circle for iterable *angles*.

**Parameters angles** – iterable of angles as radians, angle goes counter clockwise around the z-axis, x-axis = 0 deg.

New in version 0.17.1.

**flattening**(*sagitta: float*) → Iterator[ezdxf.math.\_vector.Vector2]

Approximate the circle by vertices, argument *sagitta* is the max. distance from the center of an arc segment to the center of its chord. Returns a closed polygon where the start vertex is coincident with the end vertex!

New in version 0.17.1.

**inside**(*point: Union[Sequence[float], ezdxf.math.\_vector.Vector2, ezdxf.math.\_vector.Vector3]*) → bool

Returns True if *point* is inside circle.

**tangent**(*angle: float*) → ezdxf.math.line.ConstructionRay

Returns tangent to circle at *angle* as `ConstructionRay` object.

**Parameters angle** – angle in radians

**intersect\_ray**(*ray: ezdxf.math.line.ConstructionRay, abs\_tol: float = 1e-10*) → Sequence[ezdxf.math.\_vector.Vector2]

Returns intersection points of circle and *ray* as sequence of `Vec2` objects.

#### Parameters

- **ray** – intersection ray
- **abs\_tol** – absolute tolerance for tests (e.g. test for tangents)

#### Returns

tuple of `Vec2` objects

tuple size	Description
0	no intersection
1	ray is a tangent to circle
2	ray intersects with the circle

---

**intersect\_line** (*line*: `ezdxf.math.line.ConstructionLine`, *abs\_tol*: `float = 1e-10`) → Sequence[`ezdxf.math._vector.Vec2`]  
 Returns intersection points of circle and *line* as sequence of `Vec2` objects.

**Parameters**

- **line** – intersection line
- **abs\_tol** – absolute tolerance for tests (e.g. test for tangents)

**Returns**

tuple of `Vec2` objects

tuple size	Description
0	no intersection
1	line intersects or touches the circle at one point
2	line intersects the circle at two points

New in version 0.17.1.

**intersect\_circle** (*other*: `ConstructionCircle`, *abs\_tol*: `float = 1e-10`) → Sequence[`ezdxf.math._vector.Vec2`]  
 Returns intersection points of two circles as sequence of `Vec2` objects.

**Parameters**

- **other** – intersection circle
- **abs\_tol** – absolute tolerance for tests

**Returns**

tuple of `Vec2` objects

tuple size	Description
0	no intersection
1	circle touches the <i>other</i> circle at one point
2	circle intersects with the <i>other</i> circle

## ConstructionArc

```
class eздxf.math.ConstructionArc(center: Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3] = (0, 0), radius: float = 1.0, start_angle: float = 0.0, end_angle: float = 360.0, is_counter_clockwise: bool = True)
```

This is a helper class to create parameters for the DXF `Arc` class.

`ConstructionArc` represents a 2D arc in the xy-plane, use an `UCS` to place arc in 3D space, see method `add_to_layout()`.

Implements the 2D transformation tools: `translate()`, `scale_uniform()` and `rotate_z()`

**Parameters**

- **center** – center point as `Vec2` compatible object
- **radius** – radius
- **start\_angle** – start angle in degrees

- **end\_angle** – end angle in degrees
- **is\_counter\_clockwise** – swaps start- and end angle if False

**center**

center point as `Vec2`

**radius**

radius as float

**start\_angle**

start angle in degrees

**end\_angle**

end angle in degrees

**angle\_span**

Returns angle span of arc from start- to end param.

**start\_angle\_rad**

Returns the start angle in radians.

**end\_angle\_rad**

Returns the end angle in radians.

**start\_point**

start point of arc as `Vec2`.

**end\_point**

end point of arc as `Vec2`.

**bounding\_box**

bounding box of arc as `BoundingBox2d`.

**angles** (*num: int*) → Iterable[float]

Returns *num* angles from start- to end angle in degrees in counter-clockwise order.

All angles are normalized in the range from [0, 360).

**vertices** (*a: Iterable[float]*) → Iterable[ezdxf.math.\_vector.Vec2]

Yields vertices on arc for angles in iterable *a* in WCS as location vectors.

**Parameters** *a* – angles in the range from 0 to 360 in degrees, arc goes counter clockwise around the z-axis, WCS x-axis = 0 deg.

**tangents** (*a: Iterable[float]*) → Iterable[ezdxf.math.\_vector.Vec2]

Yields tangents on arc for angles in iterable *a* in WCS as direction vectors.

**Parameters** *a* – angles in the range from 0 to 360 in degrees, arc goes counter-clockwise around the z-axis, WCS x-axis = 0 deg.

**translate** (*dx: float, dy: float*) → eздxf.math.arc.ConstructionArc

Move arc about *dx* in x-axis and about *dy* in y-axis, returns *self* (floating interface).

**Parameters**

- **dx** – translation in x-axis
- **dy** – translation in y-axis

**scale\_uniform** (*s: float*) → eздxf.math.arc.ConstructionArc

Scale arc inplace uniform about *s* in x- and y-axis, returns *self* (floating interface).

**rotate\_z** (*angle: float*) → eздxf.math.arc.ConstructionArc

Rotate arc inplace about z-axis, returns *self* (floating interface).

**Parameters** `angle` – rotation angle in degrees

```
classmethod from_2p_angle (start_point: Union[Sequence[float], ezdxf.math._vector.Vec2,
                                              ezdxf.math._vector.Vec3], end_point: Union[Sequence[float],
                                              ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3], angle: float,
                                              ccw: bool = True) → ezdxf.math.arc.ConstructionArc
```

Create arc from two points and enclosing angle. Additional precondition: arc goes by default in counter-clockwise orientation from `start_point` to `end_point`, can be changed by `ccw` = `False`.

**Parameters**

- `start_point` – start point as `Vec2` compatible object
- `end_point` – end point as `Vec2` compatible object
- `angle` – enclosing angle in degrees
- `ccw` – counter-clockwise direction if `True`

```
classmethod from_2p_radius (start_point: Union[Sequence[float], ezdxf.math._vector.Vec2,
                                               ezdxf.math._vector.Vec3], end_point: Union[Sequence[float],
                                               ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3], radius: float,
                                               ccw: bool = True, center_is_left: bool = True) →
ezdxf.math.arc.ConstructionArc
```

Create arc from two points and arc radius. Additional precondition: arc goes by default in counter-clockwise orientation from `start_point` to `end_point` can be changed by `ccw` = `False`.

The parameter `center_is_left` defines if the center of the arc is left or right of the line from `start_point` to `end_point`. Parameter `ccw` = `False` swaps start- and end point, which also inverts the meaning of `center_is_left`.

**Parameters**

- `start_point` – start point as `Vec2` compatible object
- `end_point` – end point as `Vec2` compatible object
- `radius` – arc radius
- `ccw` – counter-clockwise direction if `True`
- `center_is_left` – center point of arc is left of line from start- to end point if `True`

```
classmethod from_3p (start_point: Union[Sequence[float], ezdxf.math._vector.Vec2,
                                         ezdxf.math._vector.Vec3], end_point: Union[Sequence[float],
                                         ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3], def_point:
                                         Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3],
                                         ccw: bool = True) → ezdxf.math.arc.ConstructionArc
```

Create arc from three points. Additional precondition: arc goes in counter-clockwise orientation from `start_point` to `end_point`.

**Parameters**

- `start_point` – start point as `Vec2` compatible object
- `end_point` – end point as `Vec2` compatible object
- `def_point` – additional definition point as `Vec2` compatible object
- `ccw` – counter-clockwise direction if `True`

`add_to_layout` (`layout: BaseLayout, ucs: Optional[ezdxf.math.ucs.ucs] = None, dxftattribs=None`)

Add arc as DXF `Arc` entity to a layout.

Supports 3D arcs by using an [UCS](#). An [ConstructionArc](#) is always defined in the xy-plane, but by using an arbitrary UCS, the arc can be placed in 3D space, automatically OCS transformation included.

#### Parameters

- **layout** – destination layout as [BaseLayout](#) object
- **ucs** – place arc in 3D space by [UCS](#) object
- **dxfattribs** – additional DXF attributes for the ARC entity

**intersect\_ray**(*ray*: [ezdxf.math.line.ConstructionRay](#), *abs\_tol*: [float](#) =  $1e-10$ ) → Sequence[[ezdxf.math.\\_vector.Vec2](#)]

Returns intersection points of arc and *ray* as sequence of [Vec2](#) objects.

#### Parameters

- **ray** – intersection ray
- **abs\_tol** – absolute tolerance for tests (e.g. test for tangents)

#### Returns

tuple of [Vec2](#) objects

tuple size	Description
0	no intersection
1	line intersects or touches the arc at one point
2	line intersects the arc at two points

New in version 0.17.1.

**intersect\_line**(*line*: [ezdxf.math.line.ConstructionLine](#), *abs\_tol*: [float](#) =  $1e-10$ ) → Sequence[[ezdxf.math.\\_vector.Vec2](#)]

Returns intersection points of arc and *line* as sequence of [Vec2](#) objects.

#### Parameters

- **line** – intersection line
- **abs\_tol** – absolute tolerance for tests (e.g. test for tangents)

#### Returns

tuple of [Vec2](#) objects

tuple size	Description
0	no intersection
1	line intersects or touches the arc at one point
2	line intersects the arc at two points

New in version 0.17.1.

**intersect\_circle**(*circle*: [ezdxf.math.circle.ConstructionCircle](#), *abs\_tol*: [float](#) =  $1e-10$ ) → Sequence[[ezdxf.math.\\_vector.Vec2](#)]

Returns intersection points of arc and *circle* as sequence of [Vec2](#) objects.

#### Parameters

- **circle** – intersection circle
- **abs\_tol** – absolute tolerance for tests

**Returns**

tuple of `Vec2` objects

tuple size	Description
0	no intersection
1	circle intersects or touches the arc at one point
2	circle intersects the arc at two points

New in version 0.17.1.

```
intersect_arc(other: ezdxf.math.arc.ConstructionArc, abs_tol: float = 1e-10) → Sequence[ezdxf.math._vector.Vec2]
```

Returns intersection points of two arcs as sequence of `Vec2` objects.

**Parameters**

- **other** – other intersection arc
- **abs\_tol** – absolute tolerance for tests

**Returns**

tuple of `Vec2` objects

tuple size	Description
0	no intersection
1	other arc intersects or touches the arc at one point
2	other arc intersects the arc at two points

New in version 0.17.1.

**ConstructionEllipse**

```
class ezdxf.math.ConstructionEllipse(center: Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3] = Vec3(0.0, 0.0, 0.0), major_axis: Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3] = Vec3(1.0, 0.0, 0.0), extrusion: Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3] = Vec3(0.0, 0.0, 1.0), ratio: float = 1, start_param: float = 0, end_param: float = 6.283185307179586, ccw: bool = True)
```

This is a helper class to create parameters for 3D ellipses.

**Parameters**

- **center** – 3D center point
- **major\_axis** – major axis as 3D vector
- **extrusion** – normal vector of ellipse plane
- **ratio** – ratio of minor axis to major axis
- **start\_param** – start param in radians
- **end\_param** – end param in radians
- **ccw** – is counter clockwise flag - swaps start- and end param if `False`

**center**

center point as `Vec3`

**major\_axis**

major axis as `Vec3`

**minor\_axis**

minor axis as `Vec3`, automatically calculated from `major_axis` and `extrusion`.

**extrusion**

extrusion vector (normal of ellipse plane) as `Vec3`

**ratio**

ratio of minor axis to major axis (float)

**start**

start param in radians (float)

**end**

end param in radians (float)

**start\_point**

Returns start point of ellipse as `Vec3`.

**end\_point**

Returns end point of ellipse as `Vec3`.

**to\_octs ()** → `ConstructionEllipse`

Returns ellipse parameters as OCS representation.

OCS elevation is stored in `center.z`.

**params (num: int)** → `Iterable[float]`

Returns `num` params from start- to end param in counter clockwise order.

All params are normalized in the range from  $[0, 2\pi]$ .

**vertices (params: Iterable[float])** → `Iterable[ezdxf.math._vector.Vector]`

Yields vertices on ellipse for iterable `params` in WCS.

**Parameters** `params` – param values in the range from  $[0, 2\pi]$  in radians, param goes counter clockwise around the extrusion vector, `major_axis` = local x-axis = 0 rad.

**flattening (distance: float, segments: int = 4)** → `Iterable[ezdxf.math._vector.Vector]`

Adaptive recursive flattening. The argument `segments` is the minimum count of approximation segments, if the distance from the center of the approximation segment to the curve is bigger than `distance` the segment will be subdivided. Returns a closed polygon for a full ellipse: start vertex == end vertex.

**Parameters**

- `distance` – maximum distance from the projected curve point onto the segment chord.
- `segments` – minimum segment count

New in version 0.15.

**params\_from\_vertices (vertices: Iterable[Union[Sequence[float], ezdxf.math.\_vector.Vector2, ezdxf.math.\_vector.Vector3]])** → `Iterable[float]`

Yields ellipse params for all given vertices.

The vertex don't has to be exact on the ellipse curve or in the range from start- to end param or even in the ellipse plane. Param is calculated from the intersection point of the ray projected on the ellipse plane from the center of the ellipse through the vertex.

**Warning:** An input for start- and end vertex at param 0 and  $2\pi$  return unpredictable results because of floating point inaccuracy, sometimes 0 and sometimes  $2\pi$ .

**dxfattribs () → Dict[KT, VT]**

Returns required DXF attributes to build an ELLIPSE entity.

Entity ELLIPSE has always a ratio in range from 1e-6 to 1.

**main\_axis\_points () → Iterable[ezdxf.math.\_vector.Vec3]**

Yields main axis points of ellipse in the range from start- to end param.

```
classmethod from_arc (center: Union[Sequence[float], ezdxf.math._vector.Vec2,
                                     ezdxf.math._vector.Vec3] = Vec3(0.0, 0.0, 0.0), radius: float = 1, extrusion:
                                     Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3]
                                     = Vec3(0.0, 0.0, 1.0), start_angle: float = 0, end_angle: float = 360, ccw:
                                     bool = True) → ConstructionEllipse
```

Returns [ConstructionEllipse](#) from arc or circle.

Arc and Circle parameters defined in OCS.

**Parameters**

- **center** – center in OCS
- **radius** – arc or circle radius
- **extrusion** – OCS extrusion vector
- **start\_angle** – start angle in degrees
- **end\_angle** – end angle in degrees
- **ccw** – arc curve goes counter clockwise from start to end if `True`

**transform (m: ezdxf.math.\_matrix44.Matrix44) → None**

Transform ellipse in place by transformation matrix `m`.

**swap\_axis () → None**

Swap axis and adjust start- and end parameter.

**add\_to\_layout (layout: BaseLayout, dxfattribs=None) → Ellipse**

Add ellipse as DXF [Ellipse](#) entity to a layout.

**Parameters**

- **layout** – destination layout as [BaseLayout](#) object
- **dfattribs** – additional DXF attributes for the ELLIPSE entity

**ConstructionBox**

```
class ezdxf.math.ConstructionBox (center: Union[Sequence[float], ezdxf.math._vector.Vec2,
                                                 ezdxf.math._vector.Vec3] = (0, 0), width: float = 1, height:
                                                 float = 1, angle: float = 0)
```

Helper class to create rectangles.

**Parameters**

- **center** – center of rectangle
- **width** – width of rectangle

- **height** – height of rectangle
- **angle** – angle of rectangle in degrees

**center**

box center

**width**

box width

**height**

box height

**angle**

rotation angle in degrees

**corners**

box corners as sequence of `Vec2` objects.

**bounding\_box**

`BoundingBox2d`

**incircle\_radius**

incircle radius

**circumcircle\_radius**

circum circle radius

**\_\_iter\_\_ () → Iterable[ezdxf.math.\_vector.Vec2]**

Iterable of box corners as `Vec2` objects.

**\_\_getitem\_\_ (corner) → ezdxf.math.\_vector.Vec2**

Get corner by index `corner`, list like slicing is supported.

**\_\_repr\_\_ () → str**

Returns string representation of box as `ConstructionBox(center, width, height, angle)`

**classmethod from\_points (p1: Union[Sequence[float], ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3], p2: Union[Sequence[float], ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3]) → ezdxf.math.box.ConstructionBox**

Creates a box from two opposite corners, box sides are parallel to x- and y-axis.

**Parameters**

- **p1** – first corner as `Vec2` compatible object
- **p2** – second corner as `Vec2` compatible object

**translate (dx: float, dy: float) → None**

Move box about `dx` in x-axis and about `dy` in y-axis.

**Parameters**

- **dx** – translation in x-axis
- **dy** – translation in y-axis

**expand (dw: float, dh: float) → None**

Expand box: `dw` expand width, `dh` expand height.

**scale (sw: float, sh: float) → None**

Scale box: `sw` scales width, `sh` scales height.

**rotate**(*angle: float*) → None

Rotate box by *angle* in degrees.

**is\_inside**(*point: Union[Sequence[float], ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3]*) → bool

Returns True if *point* is inside of box.

**is\_any\_corner\_inside**(*other: ezdxf.math.box.ConstructionBox*) → bool

Returns True if any corner of *other* box is inside this box.

**is\_overlapping**(*other: ezdxf.math.box.ConstructionBox*) → bool

Returns True if this box and *other* box do overlap.

**border\_lines**() → Sequence[ezdxf.math.line.ConstructionLine]

Returns borderlines of box as sequence of *ConstructionLine*.

**intersect**(*line: ezdxf.math.line.ConstructionLine*) → List[ezdxf.math.\_vector.Vec2]

Returns 0, 1 or 2 intersection points between *line* and box borderlines.

**Parameters** **line** – line to intersect with borderlines

**Returns**

list of intersection points

list size	Description
0	no intersection
1	line touches box at one corner
2	line intersects with box

## ConstructionPolyline

```
class ezdxf.math.ConstructionPolyline(vertices: Iterable[Union[Sequence[float],
    ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3]],
    close: bool = False, rel_tol: float = 1e-09)
```

A polyline construction tool to measure, interpolate and divide anything that can be approximated or flattened into vertices. This is an immutable data structure which supports the Sequence interface.

**Parameters**

- **vertices** – iterable of polyline vertices
- **close** – True to close the polyline (first vertex == last vertex)
- **rel\_tol** – relative tolerance for floating point comparisons

Example to measure or divide a SPLINE entity:

```
import ezdxf
from ezdxf.math import ConstructionPolyline

doc = ezdxf.readfile("your.dxf")
msp = doc.modelspace()
spline = msp.query("SPLINE").first
if spline is not None:
    polyline = ConstructionPolyline(spline.flattening(0.01))
    print(f"Entity {spline} has an approximated length of {polyline.length}")
    # get dividing points with a distance of 1.0 drawing unit to each other
    points = list(polyline.divide_by_length(1.0))
```

New in version 0.18.

**data** (*index: int*) → Tuple[float, float, ezdxf.math.\_vector.Vec3]

Returns the tuple (distance from start, distance from previous vertex, vertex). All distances measured along the polyline.

**index\_at** (*distance: float*) → int

Returns the data index of the exact or next data entry for the given *distance*. Returns the index of last entry if *distance* > length.

**vertex\_at** (*distance: float*) → ezdxf.math.\_vector.Vec3

Returns the interpolated vertex at the given *distance* from the start of the polyline.

**divide** (*count: int*) → Iterator[ezdxf.math.\_vector.Vec3]

Returns *count* interpolated vertices along the polyline. Argument *count* has to be greater than 2 and the start- and end vertices are always included.

**divide\_by\_length** (*length: float, force\_last: bool = False*) → Iterator[ezdxf.math.\_vector.Vec3]

Returns interpolated vertices along the polyline. Each vertex has a fix distance *length* from its predecessor. Yields the last vertex if argument *force\_last* is True even if the last distance is not equal to *length*.

## Shape2d

**class** ezdxf.math.Shape2d(*vertices: Iterable[Union[Sequence[float], ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3]] = None*)

2D geometry object as list of *Vec2* objects, vertices can be moved, rotated and scaled.

**Parameters** **vertices** – iterable of *Vec2* compatible objects.

**vertices**

List of *Vec2* objects

**bounding\_box**

*BoundingBox2d*

**\_\_len\_\_** () → int

Returns *count* of vertices.

**\_\_getitem\_\_** (*item: Union[int, slice]*) → ezdxf.math.\_vector.Vec2

Get vertex by index *item*, supports list like slicing.

**append** (*vertex: Union[Sequence[float], ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3]*) → None

Append single *vertex*.

**Parameters** **vertex** – vertex as *Vec2* compatible object

**extend** (*vertices: Iterable[T\_co]*) → None

Append multiple *vertices*.

**Parameters** **vertices** – iterable of vertices as *Vec2* compatible objects

**translate** (*vector: Union[Sequence[float], ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3]*) → None

Translate shape about *vector*.

**scale** (*sx: float = 1.0, sy: float = 1.0*) → None

Scale shape about *sx* in x-axis and *sy* in y-axis.

**scale\_uniform** (*scale: float*) → None

Scale shape uniform about *scale* in x- and y-axis.

**rotate** (*angle: float, center: Union[Sequence[float], ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3]*) → None

= *None*) → None

Rotate shape around rotation *center* about *angle* in degrees.

---

**rotate\_rad** (*angle: float, center: Union[Sequence[float], ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3]] = None*) → None  
Rotate shape around rotation *center* about *angle* in radians.

**offset** (*offset: float, closed: bool = False*) → ezdxf.math.shape.Shape2d  
Returns a new offset shape, for more information see also [ezdxf.math.offset\\_vertices\\_2d\(\)](#) function.

#### Parameters

- **offset** – line offset perpendicular to direction of shape segments defined by vertices order, offset > 0 is ‘left’ of line segment, offset < 0 is ‘right’ of line segment
- **closed** – True to handle as closed shape

**convex\_hull** () → ezdxf.math.shape.Shape2d  
Returns convex hull as new shape.

## Curves

### BSpline

**class** ezdxf.math.BSpline (*control\_points: Iterable[Union[Sequence[float], ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3]], order: int = 4, knots: Optional[Iterable[float]] = None, weights: Optional[Iterable[float]] = None*)

Representation of a B-spline curve. The default configuration of the knot vector is an uniform open *knot* vector (“clamped”).

Factory functions:

- [fit\\_points\\_to\\_cad\\_cv\(\)](#)
- [fit\\_points\\_to\\_cubic\\_bezier\(\)](#)
- [open\\_uniform\\_bspline\(\)](#)
- [closed\\_uniform\\_bspline\(\)](#)
- [rational\\_bspline\\_from\\_arc\(\)](#)
- [rational\\_bspline\\_from\\_ellipse\(\)](#)
- [global\\_bspline\\_interpolation\(\)](#)
- [local\\_cubic\\_bspline\\_interpolation\(\)](#)

#### Parameters

- **control\_points** – iterable of control points as *Vec3* compatible objects
- **order** – spline order (degree + 1)
- **knots** – iterable of knot values
- **weights** – iterable of weight values

**knots** () → Tuple[float, ...]

Returns a tuple of *knot* values as floats, the knot vector **always** has order + count values (n + p + 2 in text book notation).

**weights** () → Tuple[float, ...]

Returns a tuple of weights values as floats, one for each control point or an empty tuple.

**params** (*segments: int*) → Iterable[float]  
Yield evenly spaced parameters for given segment count.

**reverse** () → BSpline  
Returns a new *BSpline* object with reversed control point order.

**transform** (*m: Matrix44*) → BSpline  
Returns a new *BSpline* object transformed by a *Matrix44* transformation matrix.

**approximate** (*segments: int = 20*) → Iterable[ezdxf.math.\_vector.Vec3]  
Approximates curve by vertices as *Vec3* objects, vertices count = segments + 1.

**flattening** (*distance: float, segments: int = 4*) → Iterator[ezdxf.math.\_vector.Vec3]  
Adaptive recursive flattening. The argument *segments* is the minimum count of approximation segments between two knots, if the distance from the center of the approximation segment to the curve is bigger than *distance* the segment will be subdivided.

#### Parameters

- **distance** – maximum distance from the projected curve point onto the segment chord.
- **segments** – minimum segment count between two knots

New in version 0.15.

**point** (*t: float*) → eздxf.math.\_vector.Vec3  
Returns point for parameter *t*.

**Parameters** **t** – parameter in range [0, max\_t]

**points** (*t: Iterable[float]*) → Iterable[ezdxf.math.\_vector.Vec3]  
Yields points for parameter vector *t*.

**Parameters** **t** – parameters in range [0, max\_t]

**derivative** (*t: float, n: int = 2*) → List[ezdxf.math.\_vector.Vec3]  
Return point and derivatives up to *n* <= degree for parameter *t*.

e.g. n=1 returns point and 1st derivative.

#### Parameters

- **t** – parameter in range [0, max\_t]
- **n** – compute all derivatives up to n <= degree

**Returns** n+1 values as *Vec3* objects

**derivatives** (*t: Iterable[float], n: int = 2*) → Iterable[List[ezdxf.math.\_vector.Vec3]]  
Yields points and derivatives up to *n* <= degree for parameter vector *t*.

e.g. n=1 returns point and 1st derivative.

#### Parameters

- **t** – parameters in range [0, max\_t]
- **n** – compute all derivatives up to n <= degree

**Returns** List of n+1 values as *Vec3* objects

**insert\_knot** (*t: float*) → BSpline  
Insert an additional knot, without altering the shape of the curve. Returns a new *BSpline* object.

**Parameters** **t** – position of new knot 0 < t < max\_t

**knot\_refinement** (*u*: Iterable[float]) → BSpline

Insert multiple knots, without altering the shape of the curve. Returns a new *BSpline* object.

**Parameters** *u* – vector of new knots t and for each t:  $0 < t < \text{max\_t}$

**static from\_ellipse** (*ellipse*: ConstructionEllipse) → BSpline

Returns the ellipse as *BSpline* of 2nd degree with as few control points as possible.

**static from\_arc** (*arc*: ConstructionArc) → BSpline

Returns the arc as *BSpline* of 2nd degree with as few control points as possible.

**static from\_fit\_points** (*points*: Iterable[Union[Sequence[float], ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3]]], *degree*=3, *method*='chord') → BSpline

Returns *BSpline* defined by fit points.

**static arc\_approximation** (*arc*: ConstructionArc, *num*: int = 16) → BSpline

Returns an arc approximation as *BSpline* with *num* control points.

**static ellipse\_approximation** (*ellipse*: ConstructionEllipse, *num*: int = 16) → BSpline

Returns an ellipse approximation as *BSpline* with *num* control points.

**bezier\_decomposition** () → Iterable[List[ezdxf.math.\_vector.Vec3]]

Decompose a non-rational B-spline into multiple Bézier curves.

This is the preferred method to represent the most common non-rational B-splines of 3rd degree by cubic Bézier curves, which are often supported by render backends.

**Returns** Yields control points of Bézier curves, each Bézier segment has degree+1 control points  
e.g. B-spline of 3rd degree yields cubic Bézier curves of 4 control points.

**cubic\_bezier\_approximation** (*level*: int = 3, *segments*: Optional[int] = None) → Iterable[Bezier4P]

Approximate arbitrary B-splines (degree != 3 and/or rational) by multiple segments of cubic Bézier curves. The choice of cubic Bézier curves is based on the widely support of this curves by many render backends. For cubic non-rational B-splines, which is maybe the most common used B-spline, is *bezier\_decomposition()* the better choice.

1. approximation by *level*: an educated guess, the first level of approximation segments is based on the count of control points and their distribution along the B-spline, every additional level is a subdivision of the previous level.

E.g. a B-Spline of 8 control points has 7 segments at the first level, 14 at the 2nd level and 28 at the 3rd level, a level  $\geq 3$  is recommended.

2. approximation by a given count of evenly distributed approximation segments.

**Parameters**

- **level** – subdivision level of approximation segments (ignored if argument *segments* is not None)
- **segments** – absolute count of approximation segments

**Returns** Yields control points of cubic Bézier curves as *Bezier4P* objects

## Bezier

**class ezdxf.math.Bezier** (*defpoints*: Iterable[Union[Sequence[float], ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3]])

A *Bézier curve* is a parametric curve used in computer graphics and related fields. Bézier curves are used to model smooth curves that can be scaled indefinitely. “Paths”, as they are commonly referred to in image

manipulation programs, are combinations of linked Bézier curves. Paths are not bound by the limits of rasterized images and are intuitive to modify. (Source: Wikipedia)

This is a generic implementation which works with any count of definition points greater than 2, but it is a simple and slow implementation. For more performance look at the specialized `Bezier4P` class.

Objects are immutable.

**Parameters** `defpoints` – iterable of definition points as `Vec3` compatible objects.

**control\_points**

Control points as tuple of `Vec3` objects.

**params** (`segments: int`) → Iterable[float]

Yield evenly spaced parameters from 0 to 1 for given segment count.

**reverse** () → `ezdxf.math.bezier.Bezier`

Returns a new Bèzier-curve with reversed control point order.

**transform** (`m: ezdxf.math._matrix44.Matrix44`) → `ezdxf.math.bezier.Bezier`

General transformation interface, returns a new `Bezier` curve.

**Parameters** `m` – 4x4 transformation matrix (`ezdxf.math.Matrix44`)

**approximate** (`segments: int = 20`) → Iterable[`ezdxf.math._vector.Vec3`]

Approximates curve by vertices as `Vec3` objects, vertices count = segments + 1.

**flattening** (`distance: float, segments: int = 4`) → Iterable[`ezdxf.math._vector.Vec3`]

Adaptive recursive flattening. The argument `segments` is the minimum count of approximation segments, if the distance from the center of the approximation segment to the curve is bigger than `distance` the segment will be subdivided.

**Parameters**

- **distance** – maximum distance from the center of the curve (Cn) to the center of the linear (C1) curve between two approximation points to determine if a segment should be subdivided.
- **segments** – minimum segment count

New in version 0.15.

**point** (`t: float`) → `ezdxf.math._vector.Vec3`

Returns a point for parameter `t` in range [0, 1] as `Vec3` object.

**points** (`t: Iterable[float]`) → Iterable[`ezdxf.math._vector.Vec3`]

Yields multiple points for parameters in vector `t` as `Vec3` objects. Parameters have to be in range [0, 1].

**derivative** (`t: float`) → Tuple[`ezdxf.math._vector.Vec3`, `ezdxf.math._vector.Vec3`]

Returns (point, 1st derivative, 2nd derivative) tuple for parameter `t` in range [0, 1] as `Vec3` objects.

**derivatives** (`t: Iterable[float]`) → Iterable[Tuple[`ezdxf.math._vector.Vec3`, `ezdxf.math._vector.Vec3`, `ezdxf.math._vector.Vec3`]]

Returns multiple (point, 1st derivative, 2nd derivative) tuples for parameter vector `t` as `Vec3` objects.

Parameters in range [0, 1]

## Bezier4P

**class** `ezdxf.math.Bezier4P` (`defpoints: Sequence[UVec]`)

**control\_points**

Control points as tuple of `Vec3` or `Vec2` objects.

**reverse ()** → Bezier4P

Returns a new Bézier-curve with reversed control point order.

**transform (m: ezdxf.math.\_matrix44.Matrix44)** → Bezier4P

General transformation interface, returns a new `Bezier4P` curve and it is always a 3D curve.

**Parameters** `m` – 4x4 transformation matrix (`ezdxf.math.Matrix44`)

New in version 0.14.

**approximate (segments: int)** → Iterable[AnyVec]

Approximate Bézier curve by vertices, yields `segments` + 1 vertices as `(x, y[, z])` tuples.

**Parameters** `segments` – count of segments for approximation

**flattening (distance: float, segments: int = 4)** → Iterable[Union[ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3]]

Adaptive recursive flattening. The argument `segments` is the minimum count of approximation segments, if the distance from the center of the approximation segment to the curve is bigger than `distance` the segment will be subdivided.

**Parameters**

- **distance** – maximum distance from the center of the cubic (C3) curve to the center of the linear (C1) curve between two approximation points to determine if a segment should be subdivided.
- **segments** – minimum segment count

New in version 0.15.

**approximated\_length (segments: int = 128)** → float

Returns estimated length of Bézier-curve as approximation by line `segments`.

**point (t: float)** → AnyVec

Returns point for location  $t'$  at the Bézier-curve.

**Parameters** `t` – curve position in the range [0, 1]

**tangent (t: float)** → AnyVec

Returns direction vector of tangent for location  $t$  at the Bézier-curve.

**Parameters** `t` – curve position in the range [0, 1]

**Bezier3P****class ezdxf.math.Bezier3P (defpoints: Sequence[UVec])****control\_points**

Control points as tuple of `Vec3` or `Vec2` objects.

**reverse ()** → Bezier3P

Returns a new Bézier-curve with reversed control point order.

**transform (m: ezdxf.math.\_matrix44.Matrix44)** → Bezier3P

General transformation interface, returns a new `Bezier3P` curve and it is always a 3D curve.

**Parameters** `m` – 4x4 transformation matrix (`ezdxf.math.Matrix44`)

**approximate** (*segments*: int) → Iterable[AnyVec]Approximate Bézier curve by vertices, yields *segments* + 1 vertices as (x, y[, z]) tuples.**Parameters** **segments** – count of segments for approximation**flattening** (*distance*: float, *segments*: int = 4) → Iterable[AnyVec]Adaptive recursive flattening. The argument *segments* is the minimum count of approximation segments, if the distance from the center of the approximation segment to the curve is bigger than *distance* the segment will be subdivided.**Parameters**

- **distance** – maximum distance from the center of the quadratic (C2) curve to the center of the linear (C1) curve between two approximation points to determine if a segment should be subdivided.

- **segments** – minimum segment count

**approximated\_length** (*segments*: int = 128) → floatReturns estimated length of Bézier-curve as approximation by line *segments*.**point** (*t*: float) → AnyVecReturns point for location *t* at the Bézier-curve.**Parameters** **t** – curve position in the range [0, 1]**tangent** (*t*: float) → AnyVecReturns direction vector of tangent for location *t* at the Bézier-curve.**Parameters** **t** – curve position in the range [0, 1]

## ApproxParamT

**class** eздxf.math.**ApproxParamT** (*curve*, \*, *max\_t*: float = 1.0, *segments*: int = 100)

Approximation tool for parametrized curves.

- approximate parameter *t* for a given distance from the start of the curve
- approximate the distance for a given parameter *t* from the start of the curve

These approximations can be applied to all parametrized curves which provide a `point()` method, like `Bezier4P`, `Bezier3P` and `BSpline`.The approximation is based on equally spaced parameters from 0 to *max\_t* for a given segment count. The `flattening()` method can not be used for the curve approximation, because the required parameter *t* is not logged by the flattening process.**Parameters**

- **curve** – curve object, requires a method `point()`
- **max\_t** – the max. parameter value
- **segments** – count of approximation segments

New in version 0.18.

**param\_t** (*distance*: float)Approximate parameter *t* for the given *distance* from the start of the curve.**distance** (*t*: float) → floatApproximate the distance from the start of the curve to the point *t* on the curve.

## BezierSurface

```
class ezdxf.math.BezierSurface (defpoints: List[List[Union[Sequence[float],  
ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3]]])
```

`BezierSurface` defines a mesh of  $m \times n$  control points. This is a parametric surface, which means the  $m$ -dimension goes from 0 to 1 as parameter  $u$  and the  $n$ -dimension goes from 0 to 1 as parameter  $v$ .

**Parameters** **defpoints** – matrix (list of lists) of  $m$  rows and  $n$  columns: [ [m1n1, m1n2, ... ], [m2n1, m2n2, ... ] ... ] each element is a 3D location as ( $x$ ,  $y$ ,  $z$ ) tuple.

**nrows**

count of rows (m-dimension)

**ncols**

count of columns (n-dimension)

**point** ( $u: float, v: float$ ) → ezdxf.math.\_vector.Vec3

Returns a point for location ( $u, v$ ) at the Bézier surface as ( $x$ ,  $y$ ,  $z$ ) tuple, parameters  $u$  and  $v$  in the range of [0, 1].

**approximate** ( $usegs: int, vsegs: int$ ) → List[List[ezdxf.math.\_vector.Vec3]]

Approximate surface as grid of ( $x$ ,  $y$ ,  $z$ ) `Vec3`.

### Parameters

- **usegs** – count of segments in  $u$ -direction (m-dimension)
- **vsegs** – count of segments in  $v$ -direction (n-dimension)

**Returns** list of  $usegs + 1$  rows, each row is a list of  $vsegs + 1$  vertices as `Vec3`.

## EulerSpiral

```
class ezdxf.math.EulerSpiral (curvature: float = 1.0)
```

This class represents an euler spiral (clothoid) for `curvature` (Radius of curvature).

This is a parametric curve, which always starts at the origin = (0, 0).

**Parameters** **curvature** – radius of curvature

**radius** ( $t: float$ ) → float

Get radius of circle at distance  $t$ .

**tangent** ( $t: float$ ) → ezdxf.math.\_vector.Vec3

Get tangent at distance  $t$  as `Vec3` object.

**distance** ( $radius: float$ ) → float

Get distance L from origin for `radius`.

**point** ( $t: float$ ) → ezdxf.math.\_vector.Vec3

Get point at distance  $t$  as `Vec3`.

**circle\_center** ( $t: float$ ) → ezdxf.math.\_vector.Vec3

Get circle center at distance  $t$ .

**approximate** ( $length: float, segments: int$ ) → Iterable[ezdxf.math.\_vector.Vec3]

Approximate curve of length with line segments. Generates segments+1 vertices as `Vec3` objects.

**bspline** ( $length: float, segments: int = 10, degree: int = 3, method: str = 'uniform'$ ) →

ezdxf.math.bspline.BSpline

Approximate euler spiral as B-spline.

## Parameters

- **length** – length of euler spiral
- **segments** – count of fit points for B-spline calculation
- **degree** – degree of BSpline
- **method** – calculation method for parameter vector t

**Returns** *BSpline*

## Clipping

Clipping module: `ezdxf.math.clipping`

```
ezdxf.math.clipping.clip_polygon_2d(clip:           Iterable[Union[Sequence[float],  
                    eздxf.math._vector.Vec2,      eздxf.math._vector.Vec3]],  
        subject:            Iterable[Union[Sequence[float],  
                    eздxf.math._vector.Vec2,      eздxf.math._vector.Vec3]],  
        ccw_check:          bool      =      True)    →  
        List[eздxf.math._vector.Vec2]
```

Clip the *subject* polygon by the **convex** clipping polygon *clip*.

Implements the Sutherland–Hodgman algorithm for clipping polygons.

## Parameters

- **clip** – the convex clipping polygon as iterable of vertices
- **subject** – the polygon to clip as a iterable of vertices
- **ccw\_check** – check if the clipping polygon is in counter-clockwise orientation if `True`, set to `False` if the ccw check is done by the caller

**Returns** the clipped subject as list of *Vec2*

New in version 0.16.

```
ezdxf.math.clipping.greiner_hormann_union(p1:           Iterable[Union[Sequence[float],  
                    eздxf.math._vector.Vec2,  
                    eздxf.math._vector.Vec3]],      p2:           It-  
                    erable[Union[Sequence[float],  
                    e Zukxf.math._vector.Vec2,  
                    e Zukxf.math._vector.Vec3]])    →  
                    List[List[e Zukxf.math._vector.Vec2]]
```

Returns the UNION of polygon *p1* | polygon *p2*. This algorithm works only for polygons with real intersection points and line end points on face edges are not considered as such intersection points!

New in version 0.18.

```
ezdxf.math.clipping.greiner_hormann_difference(p1:   Iterable[Union[Sequence[float],  
                    e Zukxf.math._vector.Vec2,  
                    e Zukxf.math._vector.Vec3]],   p2:   It-  
                    erable[Union[Sequence[float],  
                    e Zukxf.math._vector.Vec2,  
                    e Zukxf.math._vector.Vec3]]) →  
                    List[List[e Zukxf.math._vector.Vec2]]
```

Returns the DIFFERENCE of polygon *p1* - polygon *p2*. This algorithm works only for polygons with real intersection points and line end points on face edges are not considered as such intersection points!

New in version 0.18.

```
ezdxf.math.clipping.greiner_hormann_intersection(p1: Iterable[Union[Sequence[float],
ezdxf.math._vector.Vec2,
ezdxf.math._vector.Vec3]], p2:
Iterable[Union[Sequence[float],
ezdxf.math._vector.Vec2,
ezdxf.math._vector.Vec3]]) →
List[List[ezdxf.math._vector.Vec2]]
```

Returns the INTERSECTION of polygon  $p1$  & polygon  $p2$ . This algorithm works only for polygons with real intersection points and line end points on face edges are not considered as such intersection points!

New in version 0.18.

## Clustering

Clustering module: `ezdxf.math.clustering`

```
ezdxf.math.clustering.average_cluster_radius(clusters: List[List[Union[ezdxf.math._vector.Vec2,
ezdxf.math._vector.Vec3]]]) → float
```

Returns the average cluster radius.

```
ezdxf.math.clustering.average_intra_cluster_distance(clusters:
List[List[Union[ezdxf.math._vector.Vec2,
ezdxf.math._vector.Vec3]]]) → float
```

Returns the average point-to-point intra cluster distance.

```
ezdxf.math.clustering.dbscan(points: List[Union[ezdxf.math._vector.Vec2,
ezdxf.math._vector.Vec3]], *, radius: float, min_points: int
= 4, rtree: ezdxf.math.rtree.RTree = None, max_node_size:
int = 5) → List[List[Union[ezdxf.math._vector.Vec2,
ezdxf.math._vector.Vec3]]]
```

DBSCAN clustering.

<https://en.wikipedia.org/wiki/DBSCAN>

### Parameters

- **points** – list of points to cluster
- **radius** – radius of the dense regions
- **min\_points** – minimum number of points that needs to be within the *radius* for a point to be a core point (must be  $\geq 2$ )
- **rtree** – optional *RTree*
- **max\_node\_size** – max node size for internally created RTree

**Returns** list of clusters, each cluster is a list of points

New in version 0.18.

```
ezdxf.math.clustering.k_means(points: List[Union[ezdxf.math._vector.Vec2,
ezdxf.math._vector.Vec3]], k: int, max_iter: int
= 10) → List[List[Union[ezdxf.math._vector.Vec2,
ezdxf.math._vector.Vec3]]]
```

K-means clustering.

[https://en.wikipedia.org/wiki/K-means\\_clustering](https://en.wikipedia.org/wiki/K-means_clustering)

### Parameters

- **points** – list of points to cluster

- **k** – number of clusters
- **max\_iter** – max iterations

**Returns** list of clusters, each cluster is a list of points

New in version 0.18.

## Linear Algebra

Linear algebra module **for internal usage**: `ezdxf.math.linalg`

### Functions

```
ezdxf.math.linalg.gauss_jordan_solver (A: Iterable[Iterable[float]], B: Iterable[Iterable[float]]) → Tuple[ezdxf.math.linalg.Matrix, eздxf.math.linalg.Matrix]
```

Solves the linear equation system given by a nxn Matrix A . x = B, right-hand side quantities as nxm Matrix B by the [Gauss-Jordan](#) algorithm, which is the slowest of all, but it is very reliable. Returns a copy of the modified input matrix A and the result matrix x.

Internally used for matrix inverse calculation.

#### Parameters

- **A** – matrix [[a11, a12, ..., a1n], [a21, a22, ..., a2n], [a21, a22, ..., a2n], ... [an1, an2, ..., ann]]
- **B** – matrix [[b11, b12, ..., b1m], [b21, b22, ..., b2m], ... [bn1, bn2, ..., bnm]]

**Returns** 2-tuple of [`Matrix`](#) objects

**Raises** `ZeroDivisionError` – singular matrix

```
ezdxf.math.linalg.gauss_jordan_inverse (A: Iterable[Iterable[float]]) → eздxf.math.linalg.Matrix
```

Returns the inverse of matrix A as [`Matrix`](#) object.

---

**Hint:** For small matrices (n<10) is this function faster than `LUDecomposition(m).inverse()` and as fast even if the decomposition is already done.

---

**Raises** `ZeroDivisionError` – singular matrix

```
ezdxf.math.linalg.gauss_vector_solver (A: Iterable[Iterable[float]], B: Iterable[float]) → List[float]
```

Solves the linear equation system given by a nxn Matrix A . x = B, right-hand side quantities as vector B with n elements by the [Gauss-Elimination](#) algorithm, which is faster than the [Gauss-Jordan](#) algorithm. The speed improvement is more significant for solving multiple right-hand side quantities as matrix at once.

Reference implementation for error checking.

#### Parameters

- **A** – matrix [[a11, a12, ..., a1n], [a21, a22, ..., a2n], [a21, a22, ..., a2n], ... [an1, an2, ..., ann]]
- **B** – vector [b1, b2, ..., bn]

**Returns** vector as list of floats

**Raises** ZeroDivisionError – singular matrix

```
ezdxf.math.linalg.gauss_matrix_solver(A: Iterable[Iterable[float]], B: Iterable[Iterable[float]]) → ezdxf.math.linalg.Matrix
```

Solves the linear equation system given by a nxn Matrix A . x = B, right-hand side quantities as nxm Matrix B by the [Gauss-Elimination](#) algorithm, which is faster than the [Gauss-Jordan](#) algorithm.

Reference implementation for error checking.

#### Parameters

- **A** – matrix [[a11, a12, ..., a1n], [a21, a22, ..., a2n], [a21, a22, ..., a2n], ..., [an1, an2, ..., ann]]
- **B** – matrix [[b11, b12, ..., b1m], [b21, b22, ..., b2m], ..., [bn1, bn2, ..., bnm]]

**Returns** matrix as [\*Matrix\*](#) object

**Raises** ZeroDivisionError – singular matrix

```
ezdxf.math.linalg.tridiagonal_vector_solver(A: Iterable[Iterable[float]], B: Iterable[float]) → List[float]
```

Solves the linear equation system given by a tri-diagonal nxn Matrix A . x = B, right-hand side quantities as vector B. Matrix A is diagonal matrix defined by 3 diagonals [-1 (a), 0 (b), +1 (c)].

Note: a0 is not used but has to be present, cn-1 is also not used and must not be present.

If an `ZeroDivisionError` exception occurs, the equation system can possibly be solved by `BandedMatrixLU(A, 1, 1).solve_vector(B)`

#### Parameters

- **A** – diagonal matrix [[a0..an-1], [b0..bn-1], [c0..cn-1]]

```
[ [b0, c0, 0, 0, ...],
  [a1, b1, c1, 0, ...],
  [0, a2, b2, c2, ...],
  ... ]
```

- **B** – iterable of floats [[b1, b1, ..., bn]

**Returns** list of floats

**Raises** ZeroDivisionError – singular matrix

```
ezdxf.math.linalg.tridiagonal_matrix_solver(A: Iterable[Iterable[float]], B: Iterable[Iterable[float]]) → ezdxf.math.linalg.Matrix
```

Solves the linear equation system given by a tri-diagonal nxn Matrix A . x = B, right-hand side quantities as nxm Matrix B. Matrix A is diagonal matrix defined by 3 diagonals [-1 (a), 0 (b), +1 (c)].

Note: a0 is not used but has to be present, cn-1 is also not used and must not be present.

If an `ZeroDivisionError` exception occurs, the equation system can possibly be solved by `BandedMatrixLU(A, 1, 1).solve_vector(B)`

#### Parameters

- **A** – diagonal matrix [[a0..an-1], [b0..bn-1], [c0..cn-1]]

```
[ [b0, c0, 0, 0, ...],  
[a1, b1, c1, 0, ...],  
[0, a2, b2, c2, ...],  
... ]
```

- **B** – matrix [[b11, b12, ..., b1m], [b21, b22, ..., b2m], ... [bn1, bn2, ..., bnm]]

**Returns** matrix as *Matrix* object

**Raises** ZeroDivisionError – singular matrix

```
ezdxf.math.linalg.banded_matrix(A: eздxf.math.linalg.Matrix, check_all=True) → Tu-  
ple[eздxf.math.linalg.Matrix, int, int]
```

Transform matrix A into a compact banded matrix representation. Returns compact representation as *Matrix* object and lower- and upper band count m1 and m2.

#### Parameters

- **A** – input *Matrix*
- **check\_all** – check all diagonals if True or abort testing after first all zero diagonal if False.

```
ezdxf.math.linalg.detect_banded_matrix(A: e Zukxf.math.linalg.Matrix, check_all=True) →  
Tuple[int, int]
```

Returns lower- and upper band count m1 and m2.

#### Parameters

- **A** – input *Matrix*
- **check\_all** – check all diagonals if True or abort testing after first all zero diagonal if False.

```
ezdxf.math.linalg.compact_banded_matrix(A: e Zukxf.math.linalg.Matrix, m1: int, m2: int) →  
ezdxf.math.linalg.Matrix
```

Returns compact banded matrix representation as *Matrix* object.

#### Parameters

- **A** – matrix to transform
- **m1** – lower band count, excluding main matrix diagonal
- **m2** – upper band count, excluding main matrix diagonal

```
ezdxf.math.linalg.freeze_matrix(A: Union[Iterable[Iterable[float]], e Zukxf.math.linalg.Matrix]) →  
ezdxf.math.linalg.Matrix
```

Returns a frozen matrix, all data is stored in immutable tuples.

## Matrix Class

```
class e Zukxf.math.linalg.Matrix(items: Any = None, shape: Tuple[int, int] = None, matrix:  
List[List[float]] = None)
```

Basic matrix implementation without any optimization for speed or memory usage. Matrix data is stored in row major order, this means in a list of rows, where each row is a list of floats. Direct access to the data is accessible by the attribute *Matrix.matrix*.

The matrix can be frozen by function *freeze\_matrix()* or method *Matrix.freeze()*, than the data is stored in immutable tuples.

Initialization:

- `Matrix(shape=(rows, cols))` ... new matrix filled with zeros
- `Matrix(matrix[, shape=(rows, cols)])` ... from copy of matrix and optional reshape
- `Matrix([[row_0], [row_1], ..., [row_n]])` ... from `Iterable[Iterable[float]]`
- `Matrix([a1, a2, ..., an], shape=(rows, cols))` ... from `Iterable[float]` and shape

**nrows**

Count of matrix rows.

**ncols**

Count of matrix columns.

**shape**

Shape of matrix as (n, m) tuple for n rows and m columns.

**static reshape** (`items: Iterable[float], shape: Tuple[int, int]`) → `ezdxf.math.linalg.Matrix`  
 Returns a new matrix for iterable `items` in the configuration of `shape`.

**classmethod identity** (`shape: Tuple[int, int]`) → `ezdxf.math.linalg.Matrix`  
 Returns the identity matrix for configuration `shape`.

**row** (`index: int`) → `List[float]`  
 Returns row `index` as list of floats.

**iter\_row** (`index: int`) → `Iterator[float]`  
 Yield values of row `index`.

**col** (`index: int`) → `List[float]`  
 Return column `index` as list of floats.

**iter\_col** (`index: int`) → `Iterator[float]`  
 Yield values of column `index`.

**diag** (`index: int`) → `List[float]`  
 Returns diagonal `index` as list of floats.

An `index` of 0 specifies the main diagonal, negative values specifies diagonals below the main diagonal and positive values specifies diagonals above the main diagonal.

e.g. given a 4x4 matrix:

- index 0 is [00, 11, 22, 33],
- index -1 is [10, 21, 32] and
- index +1 is [01, 12, 23]

**iter\_diag** (`index: int`) → `Iterator[float]`  
 Yield values of diagonal `index`, see also `diag()`.

**rows** () → `List[List[float]]`  
 Return a list of all rows.

**cols** () → `List[List[float]]`  
 Return a list of all columns.

**set\_row** (`index: int, items: Union[float, Sequence[float]] = 1.0`) → `None`  
 Set row values to a fixed value or from an iterable of floats.

**set\_col** (`index: int, items: Union[float, Iterable[float]] = 1.0`) → `None`  
 Set column values to a fixed value or from an iterable of floats.

**set\_diag** (*index: int = 0, items: Union[float, Iterable[float]] = 1.0*) → None

Set diagonal values to a fixed value or from an iterable of floats.

An *index* of 0 specifies the main diagonal, negative values specifies diagonals below the main diagonal and positive values specifies diagonals above the main diagonal.

e.g. given a 4x4 matrix: index 0 is [00, 11, 22, 33], index -1 is [10, 21, 32] and index +1 is [01, 12, 23]

**append\_row** (*items: Sequence[float]*) → None

Append a row to the matrix.

**append\_col** (*items: Sequence[float]*) → None

Append a column to the matrix.

**swap\_rows** (*a: int, b: int*) → None

Swap rows *a* and *b* inplace.

**swap\_cols** (*a: int, b: int*) → None

Swap columns *a* and *b* inplace.

**transpose** () → ezdxf.math.linalg.Matrix

Returns a new transposed matrix.

**inverse** () → ezdxf.math.linalg.Matrix

Returns inverse of matrix as new object.

**determinant** () → float

Returns determinant of matrix, raises `ZeroDivisionError` if matrix is singular.

**freeze** () → ezdxf.math.linalg.Matrix

Returns a frozen matrix, all data is stored in immutable tuples.

**lu\_decomp** () → ezdxf.math.linalg.LUDecomposition

Returns the `LU decomposition` as `LUDecomposition` object, a faster linear equation solver.

**\_\_getitem\_\_** (*item: Tuple[int, int]*) → float

Get value by (row, col) index tuple, fancy slicing as known from numpy is not supported.

**\_\_setitem\_\_** (*item: Tuple[int, int], value: float*)

Set value by (row, col) index tuple, fancy slicing as known from numpy is not supported.

**\_\_eq\_\_** (*other: object*) → bool

Returns `True` if matrices are equal, tolerance value for comparison is adjustable by the attribute `Matrix.abs_tol`.

**\_\_add\_\_** (*other: Union[Matrix, float]*) → ezdxf.math.linalg.Matrix

Matrix addition by another matrix or a float, returns a new matrix.

**\_\_sub\_\_** (*other: Union[Matrix, float]*) → ezdxf.math.linalg.Matrix

Matrix subtraction by another matrix or a float, returns a new matrix.

**\_\_mul\_\_** (*other: Union[Matrix, float]*) → ezdxf.math.linalg.Matrix

Matrix multiplication by another matrix or a float, returns a new matrix.

## LUDecomposition Class

**class** ezdxf.math.linalg.**LUDecomposition** (*A: Iterable[Iterable[float]]*)

Represents a `LU decomposition` matrix of *A*, raise `ZeroDivisionError` for a singular matrix.

This algorithm is a little bit faster than the `Gauss-Elimination` algorithm using CPython and much faster when using pypy.

The `LUdecomposition.matrix` attribute gives access to the matrix data as list of rows like in the `Matrix` class, and the `LUdecomposition.index` attribute gives access to the swapped row indices.

**Parameters** `A` – matrix  $[[a_{11}, a_{12}, \dots, a_{1n}], [a_{21}, a_{22}, \dots, a_{2n}], [a_{21}, a_{22}, \dots, a_{2n}], \dots [a_{n1}, a_{n2}, \dots, a_{nn}]]$

**Raises** `ZeroDivisionError` – singular matrix

#### **nrows**

Count of matrix rows (and cols).

**solve\_vector** (`B: Iterable[float]`) → `List[float]`

Solves the linear equation system given by the nxn Matrix  $A \cdot x = B$ , right-hand side quantities as vector `B` with n elements.

**Parameters** `B` – vector  $[b_1, b_2, \dots, b_n]$

**Returns** vector as list of floats

**solve\_matrix** (`B: Iterable[Iterable[float]]`) → `ezdxf.math.linalg.Matrix`

Solves the linear equation system given by the nxn Matrix  $A \cdot x = B$ , right-hand side quantities as nxm Matrix `B`.

**Parameters** `B` – matrix  $[[b_{11}, b_{12}, \dots, b_{1m}], [b_{21}, b_{22}, \dots, b_{2m}], \dots [b_{n1}, b_{n2}, \dots, b_{nm}]]$

**Returns** matrix as `Matrix` object

**inverse** () → `ezdxf.math.linalg.Matrix`

Returns the inverse of matrix as `Matrix` object, raise `ZeroDivisionError` for a singular matrix.

**determinant** () → float

Returns the determinant of matrix, raises `ZeroDivisionError` if matrix is singular.

## BandedMatrixLU Class

**class** `ezdxf.math.linalg.BandedMatrixLU` (`A: eздxf.math.linalg.Matrix, m1: int, m2: int`)

Represents a LU decomposition of a compact banded matrix.

#### **upper**

Upper triangle

#### **lower**

Lower triangle

#### **m1**

Lower band count, excluding main matrix diagonal

#### **m2**

Upper band count, excluding main matrix diagonal

#### **index**

Swapped indices

#### **nrows**

Count of matrix rows.

**solve\_vector** (`B: Iterable[float]`) → `List[float]`

Solves the linear equation system given by the banded nxn Matrix  $A \cdot x = B$ , right-hand side quantities as vector `B` with n elements.

**Parameters** `B` – vector  $[b_1, b_2, \dots, b_n]$

**Returns** vector as list of floats

**solve\_matrix**(*B*: Iterable[Iterable[float]]) → ezdxf.math.linalg.Matrix

Solves the linear equation system given by the banded nxn Matrix A . x = B, right-hand side quantities as nxm Matrix B.

**Parameters** *B* – matrix [[b11, b12, ..., b1m], [b21, b22, ..., b2m], ... [bn1, bn2, ..., bnm]]**Returns** matrix as *Matrix* object**determinant**() → float

Returns the determinant of matrix.

## RTree

RTree module: `ezdxf.math.rtree`**class** ezdxf.math.rtree.RTree(*points*: Iterable[AnyVec], *max\_node\_size*: int = 5)

Immutable spatial search tree loosely based on R-trees.

The search tree is buildup once at initialization and immutable afterwards, because rebuilding the tree after inserting or deleting nodes is very costly and also keeps the implementation very simple. Without the ability to alter the content the restrictions which forces the tree balance at growing and shrinking of the original R-trees, could be ignored, like the fixed minimum and maximum node size.

This class uses internally only 3D bounding boxes, but also supports Vec2 as well as Vec3 objects as input data, but point types should not be mixed in a single search tree.

The point objects keep their type and identity and the returned points of queries can be compared by the `is` operator for identity to the input points.

The implementation requires a maximum node size of at least 2 and does not support empty trees!

**Raises** ValueError – max. node size too small or no data given

New in version 0.18.

**\_\_len\_\_**()

Returns the count of points in the search tree.

**\_\_iter\_\_**() → Iterator[Union[ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3]]

Yields all points in the search tree.

**contains**(*point*: Union[ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3]) → bool

Returns True if *point* exists, the comparison is done by the `isclose()` method and not by the identity operator `is`.

**nearest\_neighbor**(*target*: Union[ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3]) → Tuple[Union[ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3], float]

Returns the closest point to the *target* point and the distance between these points.

**points\_in\_sphere**(*center*: Union[ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3], *radius*: float) → Iterator[Union[ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3]]

Returns all points in the range of the given sphere including the points at the boundary.

**points\_in\_bbox**(*bbox*: ezdxf.math.bbox.BoundingBox) → Iterator[Union[ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3]]

Returns all points in the range of the given bounding box including the points at the boundary.

**avg\_leaf\_size**(*spread* = 1.0) → float

Returns the average size of the leaf bounding boxes. The size of a leaf bounding box is the maximum size in all dimensions. Excludes outliers of sizes beyond mean + standard deviation \* *spread*. Returns 0.0 if less than two points in tree.

**avg\_spherical\_envelope\_radius** (*spread: float = 1.0*) → float

Returns the average radius of spherical envelopes of the leaf nodes. Excludes outliers with radius beyond mean + standard deviation \* spread. Returns 0.0 if less than two points in tree.

**avg\_nn\_distance** (*spread: float = 1.0*) → float

Returns the average of the nearest neighbor distances inside (!) leaf nodes. Excludes outliers with a distance beyond the overall mean + standard deviation \* spread. Returns 0.0 if less than two points in tree.

**Warning:** This is a brute force check with  $O(n!)$  for each leaf node, where  $n$  is the point count of the leaf node.

## Triangulation

Triangulation module: `ezdxf.math.triangulation`

```
ezdxf.math.triangulation.mapbox_earcut_2d(exterior: Iterable[Union[Sequence[float],  
ezdxf.math._vector.Vector2,  
ezdxf.math._vector.Vector3]], holes: Optional[Iterable[Iterable[Union[Sequence[float],  
ezdxf.math._vector.Vector2,  
ezdxf.math._vector.Vector3]]]] = None) →  
List[Sequence[ezdxf.math._vector.Vector2]]
```

Mapbox triangulation algorithm with hole support for 2D polygons.

Implements a modified ear slicing algorithm, optimized by z-order curve hashing and extended to handle holes, twisted polygons, degeneracies and self-intersections in a way that doesn't guarantee correctness of triangulation, but attempts to always produce acceptable results for practical data.

Source: <https://github.com/mapbox/earcut>

### Parameters

- **exterior** – exterior polygon as iterable of `Vec2` objects
- **holes** – iterable of holes as iterable of `Vec2` objects, a hole with single point represents a Steiner point.

**Returns** yields the result as 3-tuples of `Vec2` objects

New in version 0.18.

```
ezdxf.math.triangulation.mapbox_earcut_3d(exterior: Iterable[Union[Sequence[float],  
ezdxf.math._vector.Vector2,  
ezdxf.math._vector.Vector3]], holes: Optional[Iterable[Iterable[Union[Sequence[float],  
ezdxf.math._vector.Vector2,  
ezdxf.math._vector.Vector3]]]] = None) →  
Iterator[Tuple[ezdxf.math._vector.Vector3,  
ezdxf.math._vector.Vector3,  
ezdxf.math._vector.Vector3]]
```

Mapbox triangulation algorithm with hole support for flat 3D polygons.

Implements a modified ear slicing algorithm, optimized by z-order curve hashing and extended to handle holes, twisted polygons, degeneracies and self-intersections in a way that doesn't guarantee correctness of triangulation, but attempts to always produce acceptable results for practical data.

Source: <https://github.com/mapbox/earcut>

### Parameters

- **exterior** – exterior polygon as iterable of `Vec3` objects
- **holes** – iterable of holes as iterable of `Vec3` objects, a hole with single point represents a Steiner point.

**Returns** yields the result as 3-tuples of `Vec3` objects

**Raise:** `TypeError`: invalid input data type `ZeroDivisionError`: normal vector calculation failed

New in version 0.18.

## 6.8.8 Construction

### Path

This module implements a geometric `Path`, supported by several render backends, with the goal to create such paths from DXF entities like `LWPOLYLINE`, `POLYLINE` or `HATCH` and send them to the render backend, see `ezdxf.addons.drawing`.

Minimum common interface:

- **matplotlib: PathPatch**
  - `matplotlib.path.Path()` codes:
  - `MOVETO`
  - `LINETO`
  - `CURVE3` - quadratic Bézier-curve
  - `CURVE4` - cubic Bézier-curve
- **PyQt: QPainterPath**
  - `moveTo()`
  - `lineTo()`
  - `quadTo()` - quadratic Bézier-curve (converted to a cubic Bézier-curve)
  - `cubicTo()` - cubic Bézier-curve
- **PyCairo: Context**
  - `move_to()`
  - `line_to()`
  - no support for quadratic Bézier-curve
  - `curve_to()` - cubic Bézier-curve
- **SVG: SVG-Path**
  - “M” - absolute move to
  - “L” - absolute line to
  - “Q” - absolute quadratic Bézier-curve
  - “C” - absolute cubic Bézier-curve

ARC and ELLIPSE entities are approximated by multiple cubic Bézier-curves, which are close enough for display rendering. Non-rational SPLINES of 3rd degree can be represented exact as multiple cubic Bézier-curves, other B-splines will be approximated. The XLINE and the RAY entities are not supported, because of their infinite nature.

This `Path` class is a full featured 3D object, although the backends only support 2D paths.

---

**Hint:** A `Path` can not represent a point. A `Path` with only a start point yields no vertices!

---

Changed in version 0.16: Refactored the module `ezdxf.render.path` into the subpackage `ezdxf.path`.

The usability of the `Path` class expanded by the introduction of the reverse conversion from `Path` to DXF entities (LWPOLYLINE, POLYLINE, LINE), and many other tools in `ezdxf` v0.16. To emphasize this new usability, the `Path` class has got its own subpackage `ezdxf.path`.

New in version 0.17: Added the `Path.move_to()` command and *Multi-Path* support.

**Empty-Path** Contains only a start point, the length of the path is 0 and the methods `Path.approximate()`, `Path.flattening()` and `Path.control_vertices()` do not yield any vertices.

**Single-Path** The `Path` object contains only one path without gaps, the property `Path.has_sub_paths` is `False` and the method `Path.sub_paths()` yields only this one path.

**Multi-Path** The `Path` object contains more than one path, the property `Path.has_sub_paths` is `True` and the method `Path.sub_paths()` yields all paths within this object as single-path objects. It is not possible to detect the orientation of a multi-path object, therefore the methods `Path.has_clockwise_orientation()`, `Path.clockwise()` and `Path.counter_clockwise()` raise a `TypeError` exception.

**Warning:** Always import from the top level `ezdxf.path`, never from the sub-modules

## Factory Functions

Functions to create `Path` objects from other objects.

`ezdxf.path.make_path(entity: DXFEntity) → Path`

Factory function to create a single `Path` object from a DXF entity. Supported DXF types:

- LINE
- CIRCLE
- ARC
- ELLIPSE
- SPLINE and HELIX
- LWPOLYLINE
- 2D and 3D POLYLINE
- SOLID, TRACE, 3DFACE
- IMAGE, WIPEOUT clipping path
- VIEWPORT clipping path
- HATCH as *Multi-Path* object, new in v0.17

## Parameters

- **entity** – DXF entity
- **segments** – minimal count of cubic Bézier-curves for elliptical arcs like CIRCLE, ARC, ELLIPSE, see `Path.add_ellipse()`
- **level** – subdivide level for SPLINE approximation, see `Path.add_spline()`

**Raises** `TypeError` – for unsupported DXF types

New in version 0.16.

Changed in version 0.17: support for HATCH as *Multi-Path* object

`ezdxf.path.from_hatch(hatch: ezdxf.entities.hatch.Hatch) → Iterator[ezdxf.path.path.Path]`

Yield all HATCH boundary paths as separated `Path` objects.

New in version 0.16.

Changed in version 17.1: Attaches the boundary state to each path as `ezdxf.lldxf.const.BoundaryPathState`.

`ezdxf.path.from_vertices(vertices: Iterable[Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3]], close=False) → ezdxf.path.path.Path`

Returns a `Path` object from the given `vertices`.

`ezdxf.path.from_matplotlib_path(mpath, curves=True) → Iterator[ezdxf.path.path.Path]`

Yields multiple `Path` objects from a Matplotlib `Path` (`TextPath`) object. (requires Matplotlib)

New in version 0.16.

`ezdxf.path.multi_path_from_matplotlib_path(mpath, curves=True) → ezdxf.path.path.Path`

Returns a `Path` object from a Matplotlib `Path` (`TextPath`) object. (requires Matplotlib). Returns a multi-path object if necessary.

New in version 0.17.

`ezdxf.path.from_qpainter_path(qpath) → Iterator[ezdxf.path.path.Path]`

Yields multiple `Path` objects from a `QPainterPath`. (requires Qt bindings)

New in version 0.16.

`ezdxf.path.multi_path_from_qpainter_path(qpath) → ezdxf.path.path.Path`

Returns a `Path` objects from a `QPainterPath`. Returns a multi-path object if necessary. (requires Qt bindings)

New in version 0.17.

## Render Functions

Functions to create DXF entities from paths and add them to the modelspace, a paperspace layout or a block definition.

`ezdxf.path.render_lwpolylines(layout: Layout, paths: Iterable[ezdxf.path.path.Path], *, distance: float = 0.01, segments: int = 4, extrusion: Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3] = Vec3(0.0, 0.0, 1.0), dxfattribs=None) → ezdxf.query.EntityQuery`

Render the given `paths` into `layout` as `LWPolyline` entities. The `extrusion` vector is applied to all paths, all vertices are projected onto the plane normal to this extrusion vector. The default extrusion vector is the WCS z-axis. The plane elevation is the distance from the WCS origin to the start point of the first path.

## Parameters

- **layout** – the modelspace, a paperspace layout or a block definition
- **paths** – iterable of [Path](#) objects
- **distance** – maximum distance, see [Path.flattening\(\)](#)
- **segments** – minimum segment count per Bézier curve
- **extrusion** – extrusion vector for all paths
- **dxfattribs** – additional DXF attribs

**Returns** created entities in an [EntityQuery](#) object

New in version 0.16.

```
ezdxf.path.render_polylines2d(layout: Layout, paths: Iterable[ezdxf.path.Path], *, distance:
    float = 0.01, segments: int = 4, extrusion: Union[Sequence[float],
    eздxf.math._vector.Vec2, eздxf.math._vector.Vec3] = Vec3(0.0, 0.0,
    1.0), dxfattribs=None) → eздxf.query.EntityQuery
```

Render the given *paths* into *layout* as 2D [Polyline](#) entities. The *extrusion* vector is applied to all paths, all vertices are projected onto the plane normal to this extrusion vector. The default extrusion vector is the WCS z-axis. The plane elevation is the distance from the WCS origin to the start point of the first path.

#### Parameters

- **layout** – the modelspace, a paperspace layout or a block definition
- **paths** – iterable of [Path](#) objects
- **distance** – maximum distance, see [Path.flattening\(\)](#)
- **segments** – minimum segment count per Bézier curve
- **extrusion** – extrusion vector for all paths
- **dxfattribs** – additional DXF attribs

**Returns** created entities in an [EntityQuery](#) object

New in version 0.16.

```
ezdxf.path.render_hatches(layout: Layout, paths: Iterable[ezdxf.path.Path], *, edge_path:
    bool = True, distance: float = 0.01, segments: int = 4, g1_tol: float
    = 0.0001, extrusion: Union[Sequence[float], eздxf.math._vector.Vec2,
    eздxf.math._vector.Vec3] = Vec3(0.0, 0.0, 1.0), dxfattribs=None) →
ezdxf.query.EntityQuery
```

Render the given *paths* into *layout* as [Hatch](#) entities. The *extrusion* vector is applied to all paths, all vertices are projected onto the plane normal to this extrusion vector. The default extrusion vector is the WCS z-axis. The plane elevation is the distance from the WCS origin to the start point of the first path.

#### Parameters

- **layout** – the modelspace, a paperspace layout or a block definition
- **paths** – iterable of [Path](#) objects
- **edge\_path** – True for edge paths build of LINE and SPLINE edges, False for only LWPOLYLINE paths as boundary paths
- **distance** – maximum distance, see [Path.flattening\(\)](#)
- **segments** – minimum segment count per Bézier curve to flatten polyline paths
- **g1\_tol** – tolerance for G1 continuity check to separate SPLINE edges
- **extrusion** – extrusion vector for all paths

- **dxfattribs** – additional DXF attribs

**Returns** created entities in an [EntityQuery](#) object

New in version 0.16.

```
ezdxf.path.render_mpolygons(layout: Layout, paths: Iterable[ezdxf.path.Path], *, distance:  
    float = 0.01, segments: int = 4, extrusion: Union[Sequence[float],  
        eздxf.math._vector.Vec2, eздxf.math._vector.Vec3] = Vec3(0.0, 0.0,  
        1.0), dxfattribs=None) → eздxf.query.EntityQuery
```

Render the given *paths* into *layout* as [MPolygon](#) entities. The MPOLYGON entity supports only polyline boundary paths. All curves will be approximated.

The *extrusion* vector is applied to all paths, all vertices are projected onto the plane normal to this extrusion vector. The default extrusion vector is the WCS z-axis. The plane elevation is the distance from the WCS origin to the start point of the first path.

#### Parameters

- **layout** – the modelspace, a paperspace layout or a block definition
- **paths** – iterable of [Path](#) objects
- **distance** – maximum distance, see [Path.flattening\(\)](#)
- **segments** – minimum segment count per Bézier curve to flatten polyline paths
- **extrusion** – extrusion vector for all paths
- **dfattribs** – additional DXF attribs

**Returns** created entities in an [EntityQuery](#) object

New in version 0.17.

```
ezdxf.path.render_polylines3d(layout: Layout, paths: Iterable[ezdxf.path.Path], *, dis-  
    tance: float = 0.01, segments: int = 4, dfattribs=None) →  
    eздxf.query.EntityQuery
```

Render the given *paths* into *layout* as 3D [Polyline](#) entities.

#### Parameters

- **layout** – the modelspace, a paperspace layout or a block definition
- **paths** – iterable of [Path](#) objects
- **distance** – maximum distance, see [Path.flattening\(\)](#)
- **segments** – minimum segment count per Bézier curve
- **dfattribs** – additional DXF attribs

**Returns** created entities in an [EntityQuery](#) object

New in version 0.16.

```
ezdxf.path.render_lines(layout: Layout, paths: Iterable[ezdxf.path.Path], *, distance: float =  
    0.01, segments: int = 4, dfattribs=None) → eздxf.query.EntityQuery
```

Render the given *paths* into *layout* as [Line](#) entities.

#### Parameters

- **layout** – the modelspace, a paperspace layout or a block definition
- **paths** – iterable of [Path](#) objects
- **distance** – maximum distance, see [Path.flattening\(\)](#)

- **segments** – minimum segment count per Bézier curve
- **dxfattribs** – additional DXF attribs

**Returns** created entities in an [EntityQuery](#) object

New in version 0.16.

```
ezdxf.path.render_splines_and_polylines(layout: Layout, paths: Iterable[ezdxf.path.Path], *, g1_tol: float = 0.0001, dxfattribs=None) → ezdxf.query.EntityQuery
```

Render the given *paths* into *layout* as [Spline](#) and 3D [Polyline](#) entities.

#### Parameters

- **layout** – the modelspace, a paperspace layout or a block definition
- **paths** – iterable of [Path](#) objects
- **g1\_tol** – tolerance for G1 continuity check
- **dxfattribs** – additional DXF attribs

**Returns** created entities in an [EntityQuery](#) object

New in version 0.16.

## Entity Maker

Functions to create DXF entities from paths.

```
ezdxf.path.to_lwpolylines(paths: Iterable[ezdxf.path.Path], *, distance: float = 0.01, segments: int = 4, extrusion: Union[Sequence[float], ezdxf.math._vector(Vec2, ezdxf.math._vector(Vec3)) = Vec3(0.0, 0.0, 1.0), dxfattribs=None]) → Iterator[ezdxf.entities.lwpolyline.LWPolyline]
```

Convert the given *paths* into [LWPolyline](#) entities. The *extrusion* vector is applied to all paths, all vertices are projected onto the plane normal to this extrusion vector. The default extrusion vector is the WCS z-axis. The plane elevation is the distance from the WCS origin to the start point of the first path.

#### Parameters

- **paths** – iterable of [Path](#) objects
- **distance** – maximum distance, see [Path.flattening\(\)](#)
- **segments** – minimum segment count per Bézier curve
- **extrusion** – extrusion vector for all paths
- **dxfattribs** – additional DXF attribs

**Returns** iterable of [LWPolyline](#) objects

New in version 0.16.

```
ezdxf.path.to_polylines2d(paths: Iterable[ezdxf.path.Path], *, distance: float = 0.01, segments: int = 4, extrusion: Union[Sequence[float], ezdxf.math._vector(Vec2, ezdxf.math._vector(Vec3)) = Vec3(0.0, 0.0, 1.0), dxfattribs=None]) → Iterator[ezdxf.entities.polyline.Polyline]
```

Convert the given *paths* into 2D [Polyline](#) entities. The *extrusion* vector is applied to all paths, all vertices are projected onto the plane normal to this extrusion vector. The default extrusion vector is the WCS z-axis. The plane elevation is the distance from the WCS origin to the start point of the first path.

## Parameters

- **paths** – iterable of [Path](#) objects
- **distance** – maximum distance, see [Path.flattening\(\)](#)
- **segments** – minimum segment count per Bézier curve
- **extrusion** – extrusion vector for all paths
- **dxfattribs** – additional DXF attribs

**Returns** iterable of 2D [Polyline](#) objects

New in version 0.16.

```
ezdxf.path.to_hatches(paths: Iterable[ezdxf.path.Path], *, edge_path: bool = True, distance: float = 0.01, segments: int = 4, g1_tol: float = 0.0001, extrusion: Union[Sequence[float], ezdxf.math._vector.Vector2, ezdxf.math._vector.Vector3] = Vec3(0.0, 0.0, 1.0), dxfattribs=None) → Iterator[ezdxf.entities.hatch.Hatch]
```

Convert the given *paths* into [Hatch](#) entities. Uses LWPOLYLINE paths for boundaries without curves and edge paths, build of LINE and SPLINE edges, as boundary paths for boundaries including curves. The *extrusion* vector is applied to all paths, all vertices are projected onto the plane normal to this extrusion vector. The default extrusion vector is the WCS z-axis. The plane elevation is the distance from the WCS origin to the start point of the first path.

## Parameters

- **paths** – iterable of [Path](#) objects
- **edge\_path** – True for edge paths build of LINE and SPLINE edges, False for only LWPOLYLINE paths as boundary paths
- **distance** – maximum distance, see [Path.flattening\(\)](#)
- **segments** – minimum segment count per Bézier curve to flatten LWPOLYLINE paths
- **g1\_tol** – tolerance for G1 continuity check to separate SPLINE edges
- **extrusion** – extrusion vector to all paths
- **dxfattribs** – additional DXF attribs

**Returns** iterable of [Hatch](#) objects

New in version 0.16.

```
ezdxf.path.to_mpolygons(paths: Iterable[ezdxf.path.Path], *, distance: float = 0.01, segments: int = 4, extrusion: Union[Sequence[float], ezdxf.math._vector.Vector2, ezdxf.math._vector.Vector3] = Vec3(0.0, 0.0, 1.0), dxfattribs=None) → Iterator[ezdxf.entities.mpolygon.MPolygon]
```

Convert the given *paths* into [MPolygon](#) entities. In contrast to HATCH, MPOLYGON supports only polyline boundary paths. All curves will be approximated.

The *extrusion* vector is applied to all paths, all vertices are projected onto the plane normal to this extrusion vector. The default extrusion vector is the WCS z-axis. The plane elevation is the distance from the WCS origin to the start point of the first path.

## Parameters

- **paths** – iterable of [Path](#) objects
- **distance** – maximum distance, see [Path.flattening\(\)](#)
- **segments** – minimum segment count per Bézier curve to flatten LWPOLYLINE paths
- **extrusion** – extrusion vector to all paths

- **dxfattribs** – additional DXF attribs

**Returns** iterable of [MPolygon](#) objects

New in version 0.17.

```
ezdxf.path.to_polylines3d(paths: Iterable[ezdxf.path.Path], *, distance: float = 0.01, segments: int = 4, dxfattribs=None) → Iterator[ezdxf.entities.polyline.Polyline]
```

Convert the given *paths* into 3D [Polyline](#) entities.

#### Parameters

- **paths** – iterable of [Path](#) objects
- **distance** – maximum distance, see [Path.flattening\(\)](#)
- **segments** – minimum segment count per Bézier curve
- **dfattribs** – additional DXF attribs

**Returns** iterable of 3D [Polyline](#) objects

New in version 0.16.

```
ezdxf.path.to_lines(paths: Iterable[ezdxf.path.Path], *, distance: float = 0.01, segments: int = 4, dxfattribs=None) → Iterator[ezdxf.entities.line.Line]
```

Convert the given *paths* into [Line](#) entities.

#### Parameters

- **paths** – iterable of [Path](#) objects
- **distance** – maximum distance, see [Path.flattening\(\)](#)
- **segments** – minimum segment count per Bézier curve
- **dfattribs** – additional DXF attribs

**Returns** iterable of [Line](#) objects

New in version 0.16.

```
ezdxf.path.to_splines_and_polylines(paths: Iterable[ezdxf.path.Path], *, g1_tol: float = 0.0001, dxfattribs=None) → Iterator[Union[ezdxf.entities.spline.Spline, ezdxf.entities.polyline.Polyline]]
```

Convert the given *paths* into [Spline](#) and 3D [Polyline](#) entities.

#### Parameters

- **paths** – iterable of [Path](#) objects
- **g1\_tol** – tolerance for G1 continuity check
- **dfattribs** – additional DXF attribs

**Returns** iterable of [Line](#) objects

New in version 0.16.

## Tool Maker

Functions to create construction tools.

```
ezdxf.path.to_bsplines_and_vertices(path: ezdxf.path.Path, g1_tol: float = 0.0001)
                                     → Iterator[Union[ezdxf.math.bspline.BSpline,
                                         List[ezdxf.math._vector.Vec3]]]
```

Convert a [Path](#) object into multiple cubic B-splines and polylines as lists of vertices. Breaks adjacent Bézier without G1 continuity into separated B-splines.

#### Parameters

- **path** – [Path](#) objects
- **g1\_tol** – tolerance for G1 continuity check

**Returns** [BSpline](#) and lists of [Vec3](#)

New in version 0.16.

```
ezdxf.path.to_matplotlib_path(paths: Iterable[ezdxf.path.Path], extrusion:
                               Union[Sequence[float], ezdxf.math._vector.Vec2,
                               ezdxf.math._vector.Vec3] = Vec3(0.0, 0.0, 1.0))
```

Convert the given *paths* into a single `matplotlib.path.Path` object. The *extrusion* vector is applied to all paths, all vertices are projected onto the plane normal to this extrusion vector. The default extrusion vector is the WCS z-axis. The Matplotlib [Path](#) is a 2D object with [OCS](#) coordinates and the z-elevation is lost. (requires Matplotlib)

#### Parameters

- **paths** – iterable of [Path](#) objects
- **extrusion** – extrusion vector for all paths

**Returns** `matplotlib Path` in OCS!

New in version 0.16.

```
ezdxf.path.to_qpainter_path(paths: Iterable[ezdxf.path.Path], extrusion:
                            Union[Sequence[float], ezdxf.math._vector.Vec2,
                            ezdxf.math._vector.Vec3] = Vec3(0.0, 0.0, 1.0))
```

Convert the given *paths* into a `QtGui.QPainterPath` object. The *extrusion* vector is applied to all paths, all vertices are projected onto the plane normal to this extrusion vector. The default extrusion vector is the WCS z-axis. The `QPainterPath` is a 2D object with [OCS](#) coordinates and the z-elevation is lost. (requires Qt bindings)

#### Parameters

- **paths** – iterable of [Path](#) objects
- **extrusion** – extrusion vector for all paths

**Returns** `QPainterPath` in OCS!

New in version 0.16.

## Utility Functions

```
ezdxf.path.transform_paths(paths: Iterable[ezdxf.path.Path], m:
                           ezdxf.math._matrix44.Matrix44) → List[ezdxf.path.Path]
```

Transform multiple [Path](#) objects at once by transformation matrix *m*. Returns a list of the transformed [Path](#) objects.

#### Parameters

- **paths** – iterable of [Path](#) objects
- **m** – transformation matrix of type [Matrix44](#)

---

```
ezdxf.path.transform_paths_to_ocs (paths:           Iterable[ezdxf.path.Path],      ocs:
                                  ezdxf.math.ucs.OCS) → List[ezdxf.path.Path]
```

Transform multiple *Path* objects at once from WCS to OCS. Returns a list of the transformed *Path* objects.

**Parameters**

- **paths** – iterable of *Path* objects
- **ocs** – OCS transformation of type *OCS*

```
ezdxf.path.bbox (paths:           Iterable[ezdxf.path.Path],      *,      fast=False)      →
                  ezdxf.math.bbox.BoundingBox
```

Returns the *BoundingBox* for the given paths.

**Parameters**

- **paths** – iterable of *Path* objects
- **fast** – calculates the precise bounding box of Bézier curves if `False`, otherwise uses the control points of Bézier curves to determine their bounding box.

Changed in version 0.18: Uses a new algorithm to determine exact Bézier curve bounding boxes. Added argument *fast* and removed the arguments *flatten* and *segments*.

```
ezdxf.path.fit_paths_into_box (paths:   Iterable[ezdxf.path.Path],   size:   Tuple[float,
                                         float, float], uniform: bool = True, source_box: Optional[ezdxf.math.bbox.BoundingBox] = None) →
                                         List[ezdxf.path.Path]
```

Scale the given *paths* to fit into a box of the given *size*, so that all path vertices are inside these borders. If *source\_box* is `None` the default source bounding box is calculated from the control points of the *paths*.

*Note:* if the target size has a z-size of 0, the *paths* are projected into the xy-plane, same is true for the x-size, projects into the yz-plane and the y-size, projects into and xz-plane.

**Parameters**

- **paths** – iterable of *Path* objects
- **size** – target box size as tuple of x-, y- and z-size values
- **uniform** – `True` for uniform scaling
- **source\_box** – pass precalculated source bounding box, or `None` to calculate the default source bounding box from the control vertices

```
ezdxf.path.add_bezier3p (path:           ezdxf.path.Path,      curves:           Iterable[ezdxf.math._bezier3p.Bezier3P]) → None
```

Add multiple quadratic Bézier-curves to the given *path*.

Auto-detect the connection point to the given *path*, if neither the start- nor the end point of the curves is close to the path end point, a line from the path end point to the start point of the first curve will be added automatically.

Changed in version 0.16.2: add linear Bézier curve segments as LINE\_TO commands

```
ezdxf.path.add_bezier4p (path:           ezdxf.path.Path,      curves:           Iterable[ezdxf.math._bezier4p.Bezier4P]) → None
```

Add multiple cubic Bézier-curves to the given *path*.

Auto-detect the connection point to the given *path*, if neither the start- nor the end point of the curves is close to the path end point, a line from the path end point to the start point of the first curve will be added automatically.

Changed in version 0.16.2: add linear Bézier curve segments as LINE\_TO commands

`ezdxf.path.add_ellipse(path: ezdxf.path.path.Path, ellipse: ezdxf.math.ellipse.ConstructionEllipse,  
segments=1, reset=True) → None`

Add an elliptical arc as multiple cubic Bézier-curves to the given `path`, use `from_arc()` constructor of class `ConstructionEllipse` to add circular arcs.

Auto-detect the connection point to the given `path`, if neither the start- nor the end point of the ellipse is close to the path end point, a line from the path end point to the ellipse start point will be added automatically (see `add_bezier4p()`).

By default the start of an **empty** path is set to the start point of the ellipse, setting argument `reset` to `False` prevents this behavior.

#### Parameters

- **path** – `Path` object
- **ellipse** – ellipse parameters as `ConstructionEllipse` object
- **segments** – count of Bézier-curve segments, at least one segment for each quarter ( $\pi/2$ ), 1 for as few as possible.
- **reset** – set start point to start of ellipse if path is empty

`ezdxf.path.add_spline(path: ezdxf.path.path.Path, spline: ezdxf.math.bspline.BSpline, level=4, re-  
set=True) → None`

Add a B-spline as multiple cubic Bézier-curves.

Non-rational B-splines of 3rd degree gets a perfect conversion to cubic bezier curves with a minimal count of curve segments, all other B-spline require much more curve segments for approximation.

Auto-detect the connection point to the given `path`, if neither the start- nor the end point of the B-spline is close to the path end point, a line from the path end point to the start point of the B-spline will be added automatically. (see `add_bezier4p()`).

By default the start of an **empty** path is set to the start point of the spline, setting argument `reset` to `False` prevents this behavior.

#### Parameters

- **path** – `Path` object
- **spline** – B-spline parameters as `BSpline` object
- **level** – subdivision level of approximation segments
- **reset** – set start point to start of spline if path is empty

`ezdxf.path.to_multi_path(paths: Iterable[ezdxf.path.path.Path]) → ezdxf.path.path.Path`

Returns a multi-path object from all given paths and their sub-paths. Ignores paths without any commands (empty paths).

New in version 0.17.

`ezdxf.path.single_paths(paths: Iterable[ezdxf.path.path.Path]) → Iterable[ezdxf.path.path.Path]`

Yields all given paths and their sub-paths as single path objects.

New in version 0.17.

`ezdxf.path.have_close_control_vertices(a: ezdxf.path.path.Path, b: ezdxf.path.path.Path, *,  
rel_tol=1e-09, abs_tol=1e-12) → bool`

Returns True if the control vertices of given paths are close.

New in version 0.16.5.

`ezdxf.path.lines_to_curve3(path: ezdxf.path.path.Path) → ezdxf.path.path.Path`

Replaces all lines by quadratic Bézier curves. Returns a new `Path` instance.

`ezdxf.path.lines_to_curve4(path: ezdxf.path.path.Path) → ezdxf.path.path.Path`

Replaces all lines by cubic Bézier curves. Returns a new `Path` instance.

`ezdxf.path.chamfer(points: Sequence[ezdxf.math._vector.Vec3], length: float) → ezdxf.path.path.Path`

Returns a `Path` with chamfers of given `length` between straight line segments.

#### Parameters

- **points** – coordinates of the line segments
- **length** – chamfer length

New in version 0.18.

`ezdxf.path.chamfer2(points: Sequence[ezdxf.math._vector.Vec3], a: float, b: float) → ezdxf.path.path.Path`

Returns a `Path` with chamfers at the given distances `a` and `b` from the segment points between straight line segments.

#### Parameters

- **points** – coordinates of the line segments
- **a** – distance of the chamfer start point to the segment point
- **b** – distance of the chamfer end point to the segment point

New in version 0.18.

`ezdxf.path.fillet(points: Sequence[ezdxf.math._vector.Vec3], radius: float) → ezdxf.path.path.Path`

Returns a `Path` with circular fillets of given `radius` between straight line segments.

#### Parameters

- **points** – coordinates of the line segments
- **radius** – fillet radius

New in version 0.18.

`ezdxf.path.polygonal_fillet(points: Sequence[ezdxf.math._vector.Vec3], radius: float, count: int = 32) → ezdxf.path.path.Path`

Returns a `Path` with polygonal fillets of given `radius` between straight line segments. The `count` argument defines the vertex count of the fillet for a full circle.

#### Parameters

- **points** – coordinates of the line segments
- **radius** – fillet radius
- **count** – polygon vertex count for a full circle, minimum is 4

New in version 0.18.

## Basic Shapes

`ezdxf.path.elliptic_transformation(center: Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3] = (0, 0, 0), radius: float = 1, ratio: float = 1, rotation: float = 0) → ezdxf.math.matrix44.Matrix44`

Returns the transformation matrix to transform an unit circle into an arbitrary circular- or elliptic arc.

Example how to create an ellipse with an major axis length of 3, a minor axis length 1.5 and rotated about 90°:

```
m = elliptic_transformation(radius=3, ratio=0.5, rotation=math.pi / 2)
ellipse = shapes.unit_circle(transform=m)
```

### Parameters

- **center** – curve center in WCS
- **radius** – radius of the major axis in drawing units
- **ratio** – ratio of minor axis to major axis
- **rotation** – rotation angle about the z-axis in radians

`ezdxf.path.gear(count: int, top_width: float, bottom_width: float, height: float, outside_radius: float, transform: Optional[ezdxf.math._matrix44.Matrix44] = None) → eздxf.path.Path`

Returns a `gear` (cogwheel) shape as a `Path` object, with the center at (0, 0, 0). The base geometry is created by function `ezdxf.render.forms.gear()`.

**Warning:** This function does not create correct gears for mechanical engineering!

### Parameters

- **count** – teeth count  $\geq 3$
- **top\_width** – teeth width at outside radius
- **bottom\_width** – teeth width at base radius
- **height** – teeth height; base radius = outside radius - height
- **outside\_radius** – outside radius
- **transform** – transformation Matrix applied to the gear shape

`ezdxf.path.helix(radius: float, pitch: float, turns: float, ccw=True, segments: int = 4) → eздxf.path.Path`

Returns a `helix` as a `Path` object. The center of the helix is always (0, 0, 0), a positive `pitch` value creates a helix along the +z-axis, a negative value along the -z-axis.

### Parameters

- **radius** – helix radius
- **pitch** – the height of one complete helix turn
- **turns** – count of turns
- **ccw** – creates a counter-clockwise turning (right-handed) helix if True
- **segments** – cubic Bezier segments per turn

New in version 0.18.

`ezdxf.path.ngon(count: int, length: Optional[float] = None, radius: float = 1.0, transform: Optional[ezdxf.math._matrix44.Matrix44] = None) → eздxf.path.Path`

Returns a `regular polygon` a `Path` object, with the center at (0, 0, 0). The polygon size is determined by the edge `length` or the circum `radius` argument. If both are given `length` has higher priority. Default size is a `radius` of 1. The ngon starts with the first vertex is on the x-axis! The base geometry is created by function `ezdxf.render.forms.ngon()`.

### Parameters

- **count** – count of polygon corners  $\geq 3$
- **length** – length of polygon side
- **radius** – circum radius, default is 1
- **transform** – transformation Matrix applied to the ngon

`ezdxf.path.rect(width: float = 1, height: float = 1, transform: Optional[ezdxf.math._matrix44.Matrix44] = None) → ezdxf.path.Path`

Returns a closed rectangle as a `Path` object, with the center at (0, 0, 0) and the given `width` and `height` in drawing units.

#### Parameters

- **width** – width of the rectangle in drawing units, `width > 0`
- **height** – height of the rectangle in drawing units, `height > 0`
- **transform** – transformation Matrix applied to the rectangle

`ezdxf.path.star(count: int, r1: float, r2: float, transform: Optional[ezdxf.math._matrix44.Matrix44] = None) → ezdxf.path.Path`

Returns a star shape as a `Path` object, with the center at (0, 0, 0).

Argument `count` defines the count of star spikes, `r1` defines the radius of the “outer” vertices and `r2` defines the radius of the “inner” vertices, but this does not mean that `r1` has to be greater than `r2`. The star shape starts with the first vertex is on the x-axis! The base geometry is created by function `ezdxf.render.forms.star()`.

#### Parameters

- **count** – spike count  $\geq 3$
- **r1** – radius 1
- **r2** – radius 2
- **transform** – transformation Matrix applied to the star

`ezdxf.path.unit_circle(start_angle: float = 0, end_angle: float = 6.283185307179586, segments: int = 1, transform: Optional[ezdxf.math._matrix44.Matrix44] = None) → ezdxf.path.Path`

Returns an unit circle as a `Path` object, with the center at (0, 0, 0) and the radius of 1 drawing unit.

The arc spans from the start- to the end angle in counter clockwise orientation. The end angle has to be greater than the start angle and the angle span has to be greater than 0.

#### Parameters

- **start\_angle** – start angle in radians
- **end\_angle** – end angle in radians (`end_angle > start_angle!`)
- **segments** – count of Bèzier-curve segments, default is one segment for each arc quarter ( $\pi/2$ )
- **transform** – transformation Matrix applied to the unit circle

`ezdxf.path.wedge(start_angle: float, end_angle: float, segments: int = 1, transform: Optional[ezdxf.math._matrix44.Matrix44] = None) → ezdxf.path.Path`

Returns a wedge as a `Path` object, with the center at (0, 0, 0) and the radius of 1 drawing unit.

The arc spans from the start- to the end angle in counter clockwise orientation. The end angle has to be greater than the start angle and the angle span has to be greater than 0.

#### Parameters

- **start\_angle** – start angle in radians

- **end\_angle** – end angle in radians ( $\text{end\_angle} > \text{start\_angle!}$ )
- **segments** – count of Bézier-curve segments, default is one segment for each arc quarter ( $\pi/2$ )
- **transform** – transformation Matrix applied to the wedge

The `text2path` add-on provides additional functions to create paths from text strings and DXF text entities.

## The Path Class

**class** `ezdxf.path.Path`

**append\_path** (`path: Path`) → None

Append another path to this path. Adds a `self.line_to(path.start)` if the end of this path != the start of appended path.

New in version 0.17.

**approximate** (`segments: int = 20`) → Iterator[`ezdxf.math._vector.Vec3`]

Approximate path by vertices, `segments` is the count of approximation segments for each Bézier curve.

Does not yield any vertices for empty paths, where only a start point is present!

Approximation of `Multi-Path` objects is possible, but gaps are indistinguishable from line segments.

**clockwise** () → Path

Returns new `Path` in clockwise orientation.

**Raises** `TypeError` – can't detect orientation of a `Multi-Path` object

**clone** () → Path

Returns a new copy of `Path` with shared immutable data.

**close** () → None

Close path by adding a line segment from the end point to the start point.

**close\_sub\_path** () → None

Close last sub-path by adding a line segment from the end point to the start point of the last sub-path.  
Behaves like `close()` for `Single-Path` instances.

New in version 0.17.

**control\_vertices** () → List[`ezdxf.math._vector.Vec3`]

Yields all path control vertices in consecutive order.

**counter\_clockwise** () → Path

Returns new `Path` in counter-clockwise orientation.

**Raises** `TypeError` – can't detect orientation of a `Multi-Path` object

**curve3\_to** (`location: Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3], ctrl:`

`Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3]]`) → None

Add a quadratic Bézier-curve from actual path end point to `location`, `ctrl` is the control point for the quadratic Bézier-curve.

**curve4\_to** (`location: Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3], ctrl1:`

`Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3], ctrl2:`

`Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3]]`) → None

Add a cubic Bézier-curve from actual path end point to `location`, `ctrl1` and `ctrl2` are the control points for the cubic Bézier-curve.

**extend\_multi\_path**(*path: Path*) → None

Extend the path by another path. The source path is automatically a *Multi-Path* object, even if the previous end point matches the start point of the appended path. Ignores paths without any commands (empty paths).

New in version 0.17.

**flattening**(*distance: float, segments: int = 16*) → Iterator[ezdxf.math.\_vector.Vec3]

Approximate path by vertices and use adaptive recursive flattening to approximate Bézier curves. The argument *segments* is the minimum count of approximation segments for each curve, if the distance from the center of the approximation segment to the curve is bigger than *distance* the segment will be subdivided.

Does not yield any vertices for empty paths, where only a start point is present!

Flattening of *Multi-Path* objects is possible, but gaps are indistinguishable from line segments.

**Parameters**

- **distance** – maximum distance from the center of the curve to the center of the line segment between two approximation points to determine if a segment should be subdivided.
- **segments** – minimum segment count per Bézier curve

**has\_clockwise\_orientation**() → bool

Returns True if 2D path has clockwise orientation, ignores z-axis of all control vertices.

**Raises** `TypeError` – can't detect orientation of a *Multi-Path* object

**line\_to**(*location: Union[Sequence[float], ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3]*) →

*None*

Add a line from actual path end point to *location*.

**move\_to**(*location: Union[Sequence[float], ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3]*) →

*None*

Start a new sub-path at *location*. This creates a gap between the current end-point and the start-point of the new sub-path. This converts the instance into a *Multi-Path* object.

If the `move_to()` command is the first command, the start point of the path will be reset to *location*.

New in version 0.17.

**reversed**() → Path

Returns a new *Path* with reversed segments and control vertices.

**sub\_paths**() → Iterator[Path]

Yield sub-path as *Single-Path* objects.

It is safe to call `sub_paths()` on any path-type: *Single-Path*, *Multi-Path* and *Empty-Path*.

New in version 0.17.

**transform**(*m: Matrix44*) → Path

Returns a new transformed path.

**Parameters** *m* – transformation matrix of type *Matrix44*

**Disassemble**

New in version 0.16. This module provide tools for the recursive decomposition of nested block reference structures into a flat stream of DXF entities and converting DXF entities into geometric primitives of *Path* and *MeshBuilder* objects encapsulated into intermediate *Primitive* classes.

Changed in version 0.17: The *Hatch* entity is no special case anymore and has regular support by the `make_primitive()` function.

**Warning:** Do not expect advanced vectorization capabilities: Text entities like TEXT, ATTRIB, ATTDEF and MTEXT get only a rough border box representation. The [text2path](#) add-on can convert text into paths. VIEWPORT, IMAGE and WIPEOUT are represented by their clipping path. Unsupported entities: all ACIS based entities, XREF, UNDERLAY, ACAD\_TABLE, RAY, XLINE. Unsupported entities will be ignored.

## Text Boundary Calculation

Text boundary calculations are based on monospaced (fixed-pitch, fixed-width, non-proportional) font metrics, which do not provide a good accuracy for text height calculation and much less accuracy for text width calculation. It is possible to improve this results by using the font support from the **optional Matplotlib** package.

Install Matplotlib from command line:

```
C:\> pip3 install matplotlib
```

The *Matplotlib* font support will improve the results for TEXT, ATTRIB and ATTDEF. The MTEXT entity has many advanced features which would require a full “Rich Text Format” rendering and that is far beyond the goals and capabilities of this library, therefore the boundary box for MTEXT will **never** be as accurate as in a dedicated CAD application.

Using the *Matplotlib* font support adds **runtime overhead**, therefore it is possible to deactivate the *Matplotlib* font support by setting the global option:

```
options.use_matplotlib_font_support = False
```

## Flatten Complex DXF Entities

```
ezdxf.disassemble.recursive_decompose(entities: Iterable[ezdxf.entities.dxfentity.DXFEntity])  
    → Iterable[ezdxf.entities.dxfentity.DXFEntity]
```

Recursive decomposition of the given DXF entity collection into a flat DXF entity stream. All block references (INSERT) and entities which provide a `virtual_entities()` method will be disassembled into simple DXF sub-entities, therefore the returned entity stream does not contain any INSERT entity.

Point entities will **not** be disassembled into DXF sub-entities, as defined by the current point style \$PDMODE.

These entity types include sub-entities and will be decomposed into simple DXF entities:

- INSERT
- DIMENSION
- LEADER
- MLEADER
- MLINE

Decomposition of XREF, UNDERLAY and ACAD\_TABLE entities is not supported.

## Entity Deconstruction

These functions disassemble DXF entities into simple geometric objects like meshes, paths or vertices. The `Primitive` is a simplified intermediate class to use a common interface on various DXF entities.

```
ezdxf.disassemble.make_primitive(entity:           ezdxf.entities.dxentity.DXFEntity,
                                 max_flattening_distance=None) →
                                 ezdxf.disassemble.Primitive
```

Factory to create path/mesh primitives. The `max_flattening_distance` defines the max distance between the approximation line and the original curve. Use `max_flattening_distance` to override the default value.

Returns an **empty primitive** for unsupported entities. The `empty` state of a primitive can be checked by the property `is_empty`. The `path` and the `mesh` attributes of an empty primitive are `None` and the `vertices()` method yields no vertices.

Changed in version 0.17: regular support for the `Hatch` entity.

```
ezdxf.disassemble.to_primitives(entities:      Iterable[ezdxf.entities.dxentity.DXFEntity],
                                 max_flattening_distance: float = None) → Iterable[ezdxf.disassemble.Primitive]
```

Yields all DXF entities as path or mesh primitives. Yields unsupported entities as empty primitives, see `make_primitive()`.

#### Parameters

- **entities** – iterable of DXF entities
- **max\_flattening\_distance** – override the default value

```
ezdxf.disassemble.to_meshes(primitives: Iterable[ezdxf.disassemble.Primitive]) → Iterable[ezdxf.render.mesh.MeshBuilder]
```

Yields all `MeshBuilder` objects from the given `primitives`. Ignores primitives without a defined mesh.

```
ezdxf.disassemble.to_paths(primitives: Iterable[ezdxf.disassemble.Primitive]) → Iterable[ezdxf.path.path.Path]
```

Yields all `Path` objects from the given `primitives`. Ignores primitives without a defined path.

```
ezdxf.disassemble.to_vertices(primitives: Iterable[ezdxf.disassemble.Primitive]) → Iterable[ezdxf.math._vector.Vec3]
```

Yields all vertices from the given `primitives`. Paths will be flattened to create the associated vertices. See also `to_control_vertices()` to collect only the control vertices from the paths without flattening.

```
ezdxf.disassemble.to_control_vertices(primitives: Iterable[ezdxf.disassemble.Primitive]) → Iterable[ezdxf.math._vector.Vec3]
```

Yields all path control vertices and all mesh vertices from the given `primitives`. Like `to_vertices()`, but without flattening.

### class eздxf.disassemble.Primitive

Interface class for path/mesh primitives.

#### entity

Reference to the source DXF entity of this primitive.

#### max\_flattening\_distance

The `max_flattening_distance` attribute defines the max distance in drawing units between the approximation line and the original curve. Set the value by direct attribute access. (float) default = 0.01

#### vertices() → Iterable[ezdxf.math.\_vector.Vec3]

Yields all vertices of the path/mesh representation as `Vec3` objects.

#### bbox(fast=False) → eздxf.math.bbox.BoundingBox

Returns the `BoundingBox` of the path/mesh representation. Returns the precise bounding box for the path representation if `fast` is `False`, otherwise the bounding box for Bézier curves is based on their control points.

New in version 0.18.

## Bounding Box

New in version 0.16. The `ezdxf.bbox` module provide tools to calculate bounding boxes for many DXF entities, but not for all. The bounding box calculation is based on the `ezdxf.disassemble` module and therefore has the same limitation.

**Warning:** If accurate boundary boxes for text entities are important for you, read this first: [Text Boundary Calculation](#). TL;DR: Boundary boxes for text entities are **not accurate!**

Unsupported DXF entities:

- All ACIS based types like BODY, 3DSOLID or REGION
- External references (XREF) and UNDERLAY object
- RAY and XRAY, extend into infinite
- ACAD\_TABLE, no basic support - only preserved by `ezdxf`

Unsupported entities are silently ignored, filtering of these DXF types is not necessary.

The base type for bounding boxes is the `BoundingBox` class from the module `ezdxf.math`.

The `entities` iterable as input can be the whole modelspace, an entity query or any iterable container of DXF entities.

The Calculation of bounding boxes of curves is done by flattening the curve by a default flattening distance of 0.01. Set argument `flatten` to 0 to speedup the bounding box calculation by accepting less precision for curved objects by using only the control vertices.

The **optional** caching object `Cache` has to be instantiated by the user, this is only useful if the same entities will be processed multiple times.

Example usage with caching:

```
from eздxf import bbox

msp = doc.modelspace()
cache = bbox.Cache()
# get overall bounding box
first_bbox = bbox.extents(msp, cache=cache)
# bounding box of all LINE entities
second_bbox = bbox.extend(msp.query("LINE"), cache=cache)
```

## Functions

`ezdxf.bbox.extents(entities: Iterable[DXFEntity], *, fast=False, cache: eздxf.bbox.Cache = None, **kwargs) → eздxf.math.bbox.BoundingBox`

Returns a single bounding box for all given `entities`.

If argument `fast` is `True` the calculation of Bézier curves is based on their control points, this may return a slightly larger bounding box. The `fast` mode also uses a simpler and mostly inaccurate text size calculation instead of the more precise but very slow calculation by `matplotlib`.

---

**Hint:** The fast mode is not much faster for non-text based entities, so using the slower default mode is not a big disadvantage if a more precise text size calculation is important.

---

Changed in version 0.18: added fast mode, replaced argument `flatten` by argument `fast`

---

`ezdxf.bbox.multi_flat(entities: Iterable[DXFEntity], *, fast=False, cache: ezdxf.bbox.Cache = None, **kwargs) → Iterable[ezdxf.math.bbox.BoundingBox]`

Yields a bounding box for each of the given *entities*.

If argument *fast* is True the calculation of Bézier curves is based on their control points, this may return a slightly larger bounding box.

Changed in version 0.18: replaced argument *flatten* by argument *fast*

`ezdxf.bbox.multi_recursive(entities: Iterable[DXFEntity], *, fast=False, cache: ezdxf.bbox.Cache = None, **kwargs) → Iterable[ezdxf.math.bbox.BoundingBox]`

Yields all bounding boxes for the given *entities* or all bounding boxes for their sub entities. If an entity (INSERT) has sub entities, only the bounding boxes of these sub entities will be yielded, **not** the bounding box of the entity (INSERT) itself.

If argument *fast* is True the calculation of Bézier curves is based on their control points, this may return a slightly larger bounding box.

Changed in version 0.18: replaced argument *flatten* by argument *fast*

## Caching Strategies

Because *ezdxf* is not a CAD application, *ezdxf* does not manage data structures which are optimized for a usage by a CAD kernel. This means that the content of complex entities like block references or leaders has to be created on demand by DXF primitives on the fly. These temporarily created entities are called virtual entities and have no handle and are not stored in the entity database.

All this is required to calculate the bounding box of complex entities, and it is therefore a very time consuming task. By using a *Cache* object it is possible to speedup this calculations, but this is not a magically feature, it requires an understanding of what is happening under the hood to achieve any performance gains.

For a single bounding box calculation, without any reuse of entities it makes no sense of using a *Cache* object, e.g. calculation of the modelspace extents:

```
from pathlib import Path
import eздxf
from eздxf import bbox

CADKitSamples = Path(eздxf.EZDXF_TEST_FILES) / 'CADKitSamples'

doc = eздxf.readfile(CADKitSamples / 'A_000217.dxf')
cache = bbox.Cache()
ext = bbox.extents(doc.modelspace(), cache)

print(cache)
```

1226 cached objects and not a single cache hit:

```
Cache(n=1226, hits=0, misses=3273)
```

The result for using UUIDs to cache virtual entities is not better:

```
Cache(n=2206, hits=0, misses=3273)
```

Same count of hits and misses, but now the cache also references ~1000 virtual entities, which block your memory until the cache is deleted, luckily this is a small DXF file (~838 kB).

Bounding box calculations for multiple entity queries, which have overlapping entity results, using a *Cache* object may speedup the calculation:

```
doc = ezdxf.readfile(CADKitSamples / 'A_000217.dxf.dxf')
msp = doc.modelspace()
cache = bbox.Cache(uuid=False)

ext = bbox.extents(msp, cache)
print(cache)

# process modelspace again
ext = bbox.extents(msp, cache)
print(cache)
```

Processing the same data again leads some hits:

```
1st run: Cache(n=1226, hits=0, misses=3273)
2nd run: Cache(n=1226, hits=1224, misses=3309)
```

Using `uuid=True` leads not to more hits, but more cache entries:

```
1st run: Cache(n=2206, hits=0, misses=3273)
2nd run: Cache(n=2206, hits=1224, misses=3309)
```

Creating stable virtual entities by disassembling the entities at first leads to more hits:

```
from ezdxf import disassemble

entities = list(disassemble.recursive_decompose(msp))
cache = bbox.Cache(uuid=False)

bbox.extents(entities, cache)
print(cache)

bbox.extents(entities, cache)
print(cache)
```

First without UUID for stable virtual entities:

```
1st run: Cache(n=1037, hits=0, misses=4074)
2nd run: Cache(n=1037, hits=1037, misses=6078)
```

Using UUID for stable virtual entities leads to more hits:

```
1st run: Cache(n=2019, hits=0, misses=4074)
2nd run: Cache(n=2019, hits=2018, misses=4116)
```

But caching virtual entities needs also more memory.

In conclusion: Using a cache is only useful, if you often process **nearly the same data**; only then can an increase in performance be expected.

### Cache Class

```
class ezdxf.bbox.Cache(uuid=False)
    Caching object for ezdxf.math.BoundingBox objects.
```

**Parameters** `uuid` – use UUIDs for virtual entities

**hits**

**misses****invalidate**(entities: Iterable[DXFEntity]) → None

Invalidate cache entries for the given DXF entities.

If entities are changed by the user, it is possible to invalidate individual entities. Use with care - discarding the whole cache is the safer workflow.

Ignores entities which are not stored in cache.

**Upright**

New in version 0.17. The functions in this module can help to convert an inverted *OCS* defined by an extrusion vector  $(0, 0, -1)$  into a *WCS* aligned OCS defined by an extrusion vector  $(0, 0, 1)$ .

This simplifies 2D entity processing for *ezdxf* users and creates DXF output for 3rd party DXF libraries which ignore the existence of the *OCS*.

Supported DXF entities:

- CIRCLE
- ARC
- ELLIPSE (WCS entity, flips only the extrusion vector)
- SOLID
- TRACE
- LWPOLYLINE
- POLYLINE (only 2D entities)
- HATCH
- MPOLYGON
- INSERT (block references)

**Warning:** The WCS representation of OCS entities with flipped extrusion vector is not 100% identical to the source entity, curve orientation and vertex order may change, see *additional explanation* below. A mirrored text represented by an extrusion vector  $(0, 0, -1)$  cannot be represented by an extrusion vector  $(0, 0, 1)$ , therefore this CANNOT work for text entities or entities including text: TEXT, ATTRIB, ATTDEF, MTEXT, DIMENSION, LEADER, MLEADER

**Usage**

The functions can be applied to any DXF entity without expecting errors or exceptions if the DXF entity is not supported or the extrusion vector differs from  $(0, 0, -1)$ . This also means you can apply the functions multiple times to the same entities without any problems. A common case would be to upright all entities of the model space:

```
import ezdxf
from ezdxf.upright import upright_all

doc = ezdxf.readfile("your.dxf")
msp = doc.modelspace()
upright_all(msp)
```

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```
# doing it again is no problem but also has no further effects
upright_all(msp)
```

Another use case is exploding block references (INSERT) which may include reflections (= scaling by negative factors) that can lead to inverted extrusion vectors.

```
for block_ref in msp.query("INSERT"):
    entities = block_ref.explode() # -> EntityQuery object
    upright_all(entities)
```

## Functions

`ezdxf.upright.upright(entity: ezdxf.entities.dxfgfx.DXFGraphic) → None`

Flips an inverted *OCS* defined by extrusion vector (0, 0, -1) into a *WCS* aligned *OCS* defined by extrusion vector (0, 0, 1). DXF entities with other extrusion vectors and unsupported DXF entities will be silently ignored. For more information about the limitations read the documentation of the `ezdxf.upright` module.

`ezdxf.upright.upright_all(entities: Iterable[ezdxf.entities.dxfgfx.DXFGraphic]) → None`

Call function `upright()` for all DXF entities in iterable *entities*:

```
upright_all(doc.modelspace())
```

## Additional Explanation

This example shows why the entities with an inverted OCS, extrusion vector is (0, 0, -1), are not exact the same as with an WCS aligned OCS, extrusion vector is (0, 0, 1).

**Note:** The ARC entity represents the curve **always** in counter-clockwise orientation around the extrusion vector.

```
import eздxf
from eздxf.upright import upright
from eздxf.math import Matrix44

doc = eздxf.new()
msp = doc.modelspace()

arc = msp.add_arc(
    (5, 0),
    radius=5,
    start_angle=-90,
    end_angle=90,
    dxffattribs={"color": eздxf.const.RED},
)
# draw lines to the start- and end point of the ARC
msp.add_line((0, 0), arc.start_point, dxffattribs={"color": eздxf.const.GREEN})
msp.add_line((0, 0), arc.end_point, dxffattribs={"color": e Zukxf.const.BLUE})

# copy arc
mirrored_arc = arc.copy()
msp.add_entity(mirrored_arc)
```

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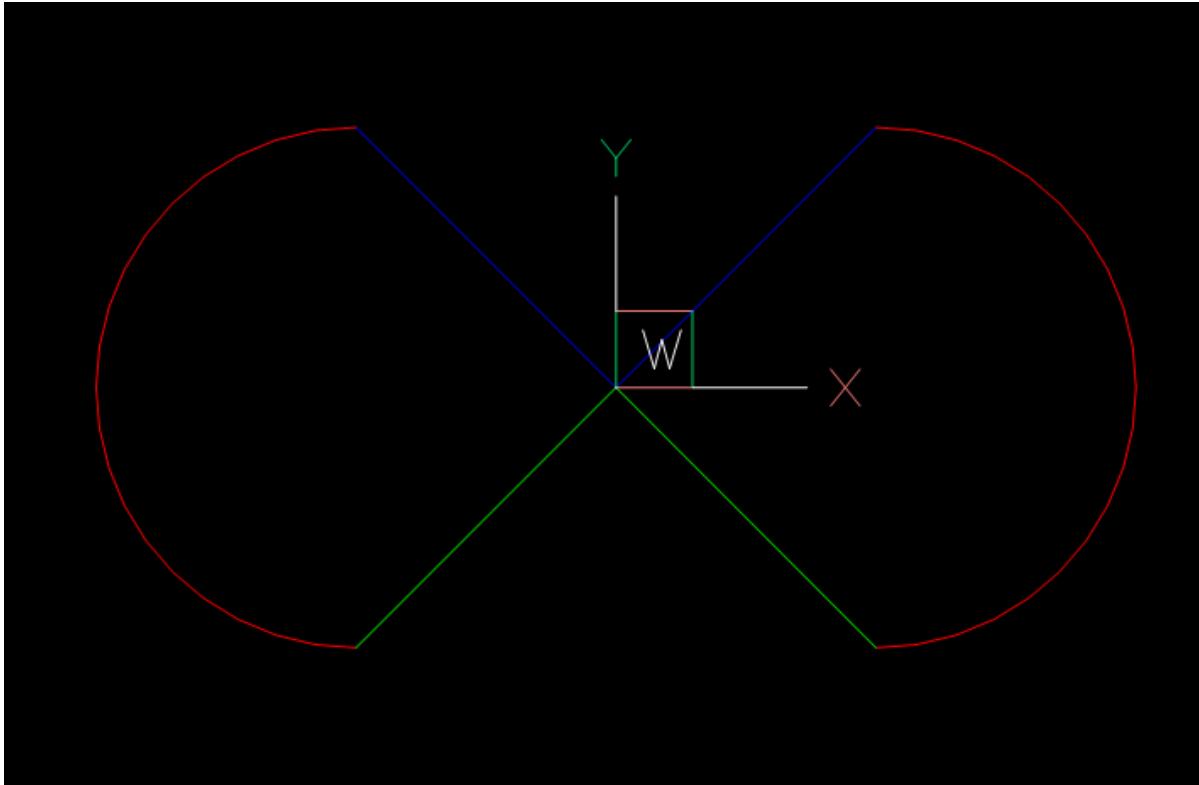
(continued from previous page)

```
# mirror copy
mirrored_arc.transform(Matrix44.scale(-1, 1, 1))

# This creates an inverted extrusion vector:
assert mirrored_arc.dxf.extrusion.isclose((0, 0, -1))

# draw lines to the start- and end point of the mirrored ARC
msp.add_line((0, 0), mirrored_arc.start_point, dxftattribs={"color": ezdxf.const.GREEN}
             )
msp.add_line((0, 0), mirrored_arc.end_point, dxftattribs={"color": ezdxf.const.BLUE})
```

Result without applying the `upright()` function - true mirroring:



```
...

# This creates an inverted extrusion vector:
assert mirrored_arc.dxf.extrusion.isclose((0, 0, -1))

start_point_inv = mirrored_arc.start_point
end_point_inv = mirrored_arc.end_point

upright(mirrored_arc)
# OCS is aligned with WCS:
assert mirrored_arc.dxf.extrusion.isclose((0, 0, 1))

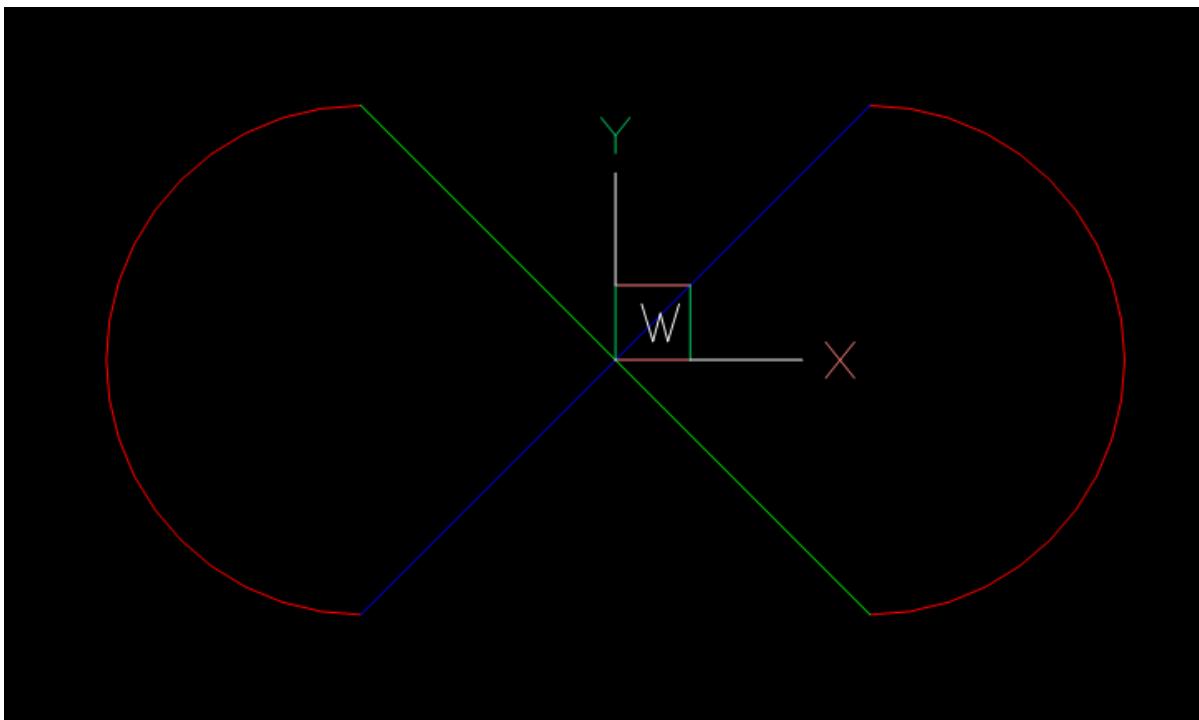
# start- and end points are swapped after applying upright()
assert mirrored_arc.start_point.isclose(end_point_inv)
assert mirrored_arc.end_point.isclose(start_point_inv)
```

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```
# draw lines to the start- and end point of the mirrored ARC
msp.add_line((0, 0), mirrored_arc.start_point, dxftattribs={"color": ezdxf.const.GREEN}
    ↵)
msp.add_line((0, 0), mirrored_arc.end_point, dxftattribs={"color": ezdxf.const.BLUE})
```

Result after applying the `upright()` function - false mirroring:



To avoid this issue the ARC entity would have to represent the curve in clockwise orientation around the extrusion vector (0, 0, 1), which is not possible!

---

**Note:** The shape of the mirrored arcs is the same for both extrusion vectors, but the start- and the end points are swapped (reversed vertex order)!

---

## Reorder

Tools to reorder DXF entities by handle or a special sort handle mapping.

Such reorder mappings are stored only in layouts as `Modelspace`, `Paperspace` or `BlockLayout`, and can be retrieved by the method `get_redraw_order()`.

Each entry in the handle mapping replaces the actual entity handle, where the “0” handle has a special meaning, this handle always shows up at last in ascending ordering.

```
ezdxf.reorder.ascending(entities: Iterable[DXFGraphic], mapping: Union[Dict[KT,
    VT], Iterable[Tuple[str, str]]] = None) → Iterable[ezdxf.entities.dxfgfx.DXFGraphic]
```

Yields entities in ascending handle order.

The sort handle doesn't have to be the entity handle, every entity handle in `mapping` will be replaced by the given sort handle, `mapping` is an iterable of 2-tuples (entity\_handle, sort\_handle) or a dict (entity\_handle, sort\_handle).

Entities with equal sort handles show up in source entities order.

#### Parameters

- **entities** – iterable of DXFGraphic objects
- **mapping** – iterable of 2-tuples (entity\_handle, sort\_handle) or a handle mapping as dict.

```
ezdxf.reorder.descending(entities: Iterable[DXFGraphic], mapping: Union[Dict[KT, VT], Iterable[Tuple[str, str]]] = None) → Iterable[ezdxf.entities.dxfgfx.DXFGraphic]
```

Yields entities in descending handle order.

The sort handle doesn't have to be the entity handle, every entity handle in *mapping* will be replaced by the given sort handle, *mapping* is an iterable of 2-tuples (entity\_handle, sort\_handle) or a dict (entity\_handle, sort\_handle). Entities with equal sort handles show up in reversed source entities order.

#### Parameters

- **entities** – iterable of DXFGraphic objects
- **mapping** – iterable of 2-tuples (entity\_handle, sort\_handle) or a handle mapping as dict.

## 6.8.9 Custom Data

### Custom XDATA

The classes `XDataUserList` and `XDataUserDict` manage custom user data stored in the XDATA section of a DXF entity. For more information about XDATA see reference section: [Extended Data \(XDATA\)](#)

These classes store only a limited set of data types with fixed group codes and the types are checked by `isinstance()` so a `Vec3` object can not be replaced by a (x, y, z)-tuple:

Group Code	Data Type
1000	str, limited to 255 characters, line breaks "\n" and "\r" are not allowed
1010	<code>Vec3</code>
1040	float
1071	32-bit int, restricted by the DXF standard not by Python!

Strings are limited to 255 characters, line breaks "\n" and "\r" are not allowed.

This classes assume a certain XDATA structure and therefore can not manage arbitrary XDATA!

This classes do not create the required AppID table entry, only the default AppID "EZDXF" exist by default. Setup a new AppID in the AppID table: `doc.appids.add("MYAPP")`.

For usage look at this [example](#) at github or go to the tutorial: [Storing Custom Data in DXF Files](#).

#### See also:

- Tutorial: [Storing Custom Data in DXF Files](#)
- Example at [github](#)
- XDATA reference: [Extended Data \(XDATA\)](#)
- XDATA management class: `XData`

## XDataUserList

```
class ezdxf.entities.xdata.XDataUserList
```

Manage user data as a named list-like object in XDATA. Multiple user lists with different names can be stored in a single `XData` instance for a single AppID.

Recommended usage by context manager `entity()`:

```
with XDataUserList.entity(entity, name="MyList", appid="MYAPP") as ul:
    ul.append("The value of PI") # str "\n" and "\r" are not allowed
    ul.append(3.141592) # float
    ul.append(1) # int
    ul.append(Vec3(1, 2, 3)) # Vec3

    # invalid data type raises DXFTypeError
    ul.append((1, 2, 3)) # tuple instead of Vec3

    # retrieve a single value
    s = ul[0]

    # store whole content into a Python list
    data = list(ul)
```

Implements the `MutableSequence` interface.

### xdata

The underlying `XData` instance.

```
__init__(xdata: ezdxf.entities.xdata.XData = None, name='DefaultList', appid='EZDXF')
```

Setup a XDATA user list `name` for the given `appid`.

The data is stored in the given `xdata` object, or in a new created `XData` instance if `None`. Changes of the content has to be committed at the end to be stored in the underlying `xdata` object.

#### Parameters

- `xdata` (`XData`) – underlying `XData` instance, if `None` a new one will be created
- `name` (`str`) – name of the user list
- `appid` (`str`) – application specific AppID

```
__str__()
```

Return `str(self)`.

```
__len__() → int
```

Returns `len(self)`.

```
__getitem__(item)
```

Get `self[item]`.

```
__setitem__(item, value)
```

Set `self[item]` to `value`.

```
__delitem__(item)
```

Delete `self[item]`.

```
classmethod entity(entity: DXFEntity, name='DefaultList', appid='EZDXF') → Iterator[XDataUserList]
```

Context manager to manage a XDATA list `name` for a given DXF `entity`. Appends the user list to the existing `XData` instance or creates new `XData` instance.

#### Parameters

- **entity** (`DXFEntity`) – target DXF entity for the XDATA
- **name** (`str`) – name of the user list
- **appid** (`str`) – application specific AppID

`commit()` → None

Store all changes to the underlying `XData` instance. This call is not required if using the `entity()` context manager.

#### Raises

- `DXFValueError` – invalid chars "\n" or "\r" in a string
- `DXFTypError` – invalid data type

## XDataUserDict

`class ezdxf.entities.xdata.XDataUserDict`

Manage user data as a named dict-like object in XDATA. Multiple user dicts with different names can be stored in a single `XData` instance for a single AppID. The keys have to be strings.

Recommended usage by context manager `entity()`:

```
with XDataUserDict.entity(entity, name="MyDict", appid="MYAPP") as ud:
    ud["comment"] = "The value of PI" # str "\n" and "\r" are not allowed
    ud["pi"] = 3.141592 # float
    ud["number"] = 1 # int
    ud["vertex"] = Vec3(1, 2, 3) # Vec3

    # invalid data type raises DXFTypError
    ud["vertex"] = (1, 2, 3) # tuple instead of Vec3

    # retrieve single values
    s = ud["comment"]
    pi = ud.get("pi", 3.141592)

    # store whole content into a Python dict
    data = dict(ud)
```

Implements the `MutableMapping` interface.

The data is stored in XDATA like a `XDataUserList` by (key, value) pairs, therefore a `XDataUserDict` can also be loaded as `XDataUserList`. It is not possible to distinguish a `XDataUserDict` from a `XDataUserList` except by the name of the data structure.

#### xdata

The underlying `XData` instance.

`__init__(xdata: ezdxf.entities.xdata.XData = None, name='DefaultDict', appid='EZDXF')`  
Setup a XDATA user dict `name` for the given `appid`.

The data is stored in the given `xdata` object, or in a new created `XData` instance if `None`. Changes of the content has to be committed at the end to be stored in the underlying `xdata` object.

#### Parameters

- **xdata** (`XData`) – underlying `XData` instance, if `None` a new one will be created
- **name** (`str`) – name of the user list
- **appid** (`str`) – application specific AppID

**`__str__()`**  
Return str(self).

**`__len__()`**  
Returns len(self).

**`__getitem__(key)`**  
Get self[key].

**`__setitem__(key, item)`**  
Set self[key] to value, key has to be a string.  
**Raises** DXFTypError – key is not a string

**`__delitem__(key)`**  
Delete self[key].

**`discard(key)`**  
Delete self[key], without raising a KeyError if key does not exist.

**`__iter__()`**  
Implement iter(self).

**`classmethod entity(entity: DXFEntity, name='DefaultDict', appid='EZDXF') → Iterator[XDataUserDict]`**  
Context manager to manage a XDATA dict *name* for a given DXF *entity*. Appends the user dict to the existing `XData` instance or creates new `XData` instance.

#### Parameters

- **entity** (`DXFEntity`) – target DXF entity for the XDATA
- **name** (`str`) – name of the user list
- **appid** (`str`) – application specific AppID

**`commit() → None`**

Store all changes to the underlying `XData` instance. This call is not required if using the `entity()` context manager.

#### Raises

- `DXFValueError` – invalid chars "\n" or "\r" in a string
- `DXFTypError` – invalid data type

## Custom XRecord

The `UserRecord` and `BinaryRecord` classes help to store custom data in DXF files in `XRecord` objects a simple and safe way. This way requires DXF version R2000 or later, for DXF version R12 the only way to store custom data is *Extended Data (XDATA)*.

The `UserRecord` stores Python types and nested container types: `int`, `float`, `str`, `Vec2`, `Vec3`, `list` and `dict`.

Requirements for Python structures:

- The top level structure has to be a list.
- Strings has to have max. 2049 characters and can not contain line breaks "\n" or "\r".
- Dict keys have to be simple Python types: `int`, `float`, `str`.

DXF Tag layout for Python types and structures stored in the `XRecord` object:

Only for the `UserRecord` the first tag is (2, user record name).

Type	DXF Tag(s)
str	(1, value) string with less than 2050 chars and including no line breaks
int	(90, value) int 32-bit, restricted by the DXF standard not by Python!
float	(40, value) “C” double
Vec2	(10, x), (20, y)
Vec3	(10, x) (20, y) (30, z)
list	starts with (2, “[”) and ends with (2, “”])
dict	starts with (2, “{”) and ends with (2, “}”)

The `BinaryRecord` stores arbitrary binary data as `BLOB`.

Storage size limits of XRECORD according the DXF reference:

“This object is similar in concept to XDATA but is not limited by size or order.”

For usage look at this [example](#) at github or go to the tutorial: *Storing Custom Data in DXF Files*.

#### See also:

- Tutorial: [Storing Custom Data in DXF Files](#)
- Example at [github](#)
- `ezdxf.entities.XRecord`

## UserRecord

```
class ezdxf.urecord.UserRecord

    xrecord
        The underlying XRecord instance

    name
        The name of the UserRecord, an arbitrary string with less than 2050 chars and including no line breaks.

    data
        The Python data. The top level structure has to be a list (MutableSequence). Inside this container the
        following Python types are supported: str, int, float, Vec2, Vec3, list, dict

        Nested data structures are supported list or/and dict in list or dict. Dict keys have to be simple Python
        types: int, float, str.

    __init__ (xrecord: ezdxf.entities.dxfoobj.XRecord = None, *, name: str = 'UserRecord', doc: Drawing
              = None)
        Setup a UserRecord with the given name.

    The data is stored in the given xrecord object, or in a new created XRecord instance if None. If doc is
    not None the new xrecord is added to the OBJECTS section of the DXF document.

    Changes of the content has to be committed at the end to be stored in the underlying xrecord object.
```

#### Parameters

- **xrecord** (`XRecord`) – underlying `XRecord` instance, if `None` a new one will be created

- **name** (*str*) – name of the user list
- **doc** ([Drawing](#)) – DXF document or None

**\_\_str\_\_()**

Return str(self).

**commit()** → [ezdxf.entities.dxfobj.XRecord](#)

Store *data* in the underlying [XRecord](#) instance. This call is not required if using the class by the `with` statement.

**Raises**

- [DXFValueError](#) – invalid chars "\n" or "\r" in a string
- [DXFTypError](#) – invalid data type

## BinaryRecord

```
class ezdxf.urecord.BinaryRecord
```

**xrecord**

The underlying [XRecord](#) instance

**data**

The binary data as bytes, bytearray or memoryview.

**\_\_init\_\_(xrecord: ezdxf.entities.dxfobj.XRecord = None, \*, doc: Drawing = None)**

Setup a [BinaryRecord](#).

The data is stored in the given *xrecord* object, or in a new created [XRecord](#) instance if None. If *doc* is not None the new *xrecord* is added to the OBJECTS section of the DXF document.

Changes of the content has to be committed at the end to be stored in the underlying [xrecord](#) object.

**Parameters**

- **xrecord** ([XRecord](#)) – underlying [XRecord](#) instance, if None a new one will be created
- **doc** ([Drawing](#)) – DXF document or None

**\_\_str\_\_()** → str

Return str(self).

**commit()** → [ezdxf.entities.dxfobj.XRecord](#)

Store binary *data* in the underlying [XRecord](#) instance. This call is not required if using the class by the `with` statement.

## 6.8.10 Tools

### Functions

#### DXF Unicode Decoder

The DXF format uses a special form of unicode encoding: “\U+xxxx”.

To avoid a speed penalty such encoded characters are not decoded automatically by the regular loading function:func:`ezdxf.readfile`, only the `recover` module does the decoding automatically, because this loading mode is already slow.

This kind of encoding is most likely used only in older DXF versions, because since DXF R2007 the whole DXF file is encoded in `utf8` and a special unicode encoding is not necessary.

The `ezdxf.has_dxf_unicode()` and `ezdxf.decode_dxf_unicode()` are new support functions to decode unicode characters “\U+xxxx” manually.

`ezdxf.has_dxf_unicode(s: str) → bool`  
Detect if string *s* contains encoded DXF unicode characters “\U+xxxx”.

`ezdxf.decode_dxf_unicode(s: str) → str`  
Decode DXF unicode characters “\U+xxxx” in string *s*.

## Tools

Some handy tool functions used internally by ezdxf.

`ezdxf.tools.juliandate(date: datetime.datetime) → float`  
`ezdxf.tools.calendardate(juliandate: float) → datetime.datetime`  
`ezdxf.tools.set_flag_state(flags: int, flag: int, state: bool = True) → int`  
Set/clear binary *flag* in data *flags*.

### Parameters

- **flags** – data value
- **flag** – flag to set/clear
- **state** – True for setting, False for clearing

`ezdxf.tools.guid() → str`  
Returns a general unique ID, based on `uuid.uuid4()`.

This function creates a GUID for the header variables `$VERSIONGUID` and `$FINGERPRINTGUID`, which matches the AutoCAD pattern {XXXXXXXX-XXXX-XXXX-XXXX-XXXXXXXXXXXX}.

`ezdxf.tools.bytes_to_hexstr(data: bytes) → str`  
Returns *data* bytes as plain hex string.

`ezdxf.tools.suppress_zeros(s: str, leading: bool = False, trailing: bool = True)`  
Suppress trailing and/or leading 0 of string *s*.

### Parameters

- **s** – data string
- **leading** – suppress leading 0
- **trailing** – suppress trailing 0

`ezdxf.tools.normalize_text_angle(angle: float, fix_upside_down=True) → float`  
Normalizes text *angle* to the range from 0 to 360 degrees and fixes upside down text angles.

### Parameters

- **angle** – text angle in degrees
- **fix\_upside\_down** – rotate upside down text angle about 180 degree

## SAT Format “Encryption”

```
ezdxf.tools.crypt.encode(text_lines: Iterable[str]) → Iterable[str]
    Encode the Standard ACIS Text (SAT) format by AutoCAD “encryption” algorithm.

ezdxf.tools.crypt.decode(text_lines: Iterable[str]) → Iterable[str]
    Decode the Standard ACIS Text (SAT) format “encrypted” by AutoCAD.
```

## GfxAttribs

New in version 0.18.

The `ezdxf.gfxattribs` module provides the `GfxAttribs` class to create valid attribute dictionaries for the most often used DXF attributes supported by all graphical DXF entities. The advantage of using this class is auto-completion support by IDEs and an instant validation of the attribute values.

```
import ezdxf
from ezdxf.gfxattribs import GfxAttribs

doc = ezdxf.new()
msp = doc.modelspace()

attribs = GfxAttribs(layer="MyLayer", color=ezdxf.colors.RED)
line = msp.add_line((0, 0), (1, 0), dxfattribs=attribs)
circle = msp.add_circle((0, 0), radius=1.0, dxfattribs=attribs)

# Update DXF attributes of existing entities:
attribs = GfxAttribs(layer="MyLayer2", color=ezdxf.colors.BLUE)

# Convert GfxAttribs() to dict(), but this method cannot reset
# attributes to the default values like setting layer to "0".
line.update_dxf_attribs(dict(attribs))

# Using GfxAttribs.asdict(default_values=True), can reset attributes to the
# default values like setting layer to "0", except for true_color and
# transparency, which do not have default values, their absence is the
# default value.
circle.update_dxf_attribs(attribs.asdict(default_values=True))

# Remove true_color and transparency by assigning None
attribs.transparency = None # reset to transparency by layer!
attribs.rgb = None
```

Validation features:

- **layer** - string which can not contain certain characters: <>/\":;?\*=`
- **color** - *AutoCAD Color Index (ACI)* value as integer in the range from 0 to 257
- **rgb** - true color value as (red, green, blue) tuple, all channel values as integer values in the range from 0 to 255
- **linetype** - string which can not contain certain characters: <>/\":;?\*=`, does not check if the linetype exists
- **lineweight** - integer value in the range from 0 to 211, see [Lineweights](#) for valid values
- **transparency** - float value in the range from 0.0 to 1.0 and -1.0 for transparency by block
- **ltscale** - float value > 0.0

---

```
class ezdxf.gfxattribs.GfxAttribs (*, layer: str = '0', color: int = 256, rgb: Optional[Tuple[int, int, int]] = None, linetype: str = 'ByLayer', linewidth: int = -1, transparency: Optional[float] = None, ltscale: float = 1.0)
```

Represents often used DXF attributes of graphical entities.

New in version 0.18.

#### Parameters

- **layer** (*str*) – layer name as string
- **color** (*int*) – *AutoCAD Color Index (ACI)* color value as integer
- **rgb** – RGB true color (red, green, blue) tuple, each channel value in the range from 0 to 255, None for not set
- **linetype** (*str*) – linetype name, does not check if the linetype exist!
- **linewidth** (*int*) – see [Lineweights](#) documentation for valid values
- **transparency** (*float*) – transparency value in the range from 0.0 to 1.0, where 0.0 is opaque and 1.0 if fully transparent, -1.0 for transparency by block, None for transparency by layer
- **ltscale** (*float*) – linetype scaling value > 0.0, default value is 1.0

**Raises** `DXFValueError` – invalid attribute value

**\_\_str\_\_** () → *str*

Return `str(self)`.

**\_\_repr\_\_** () → *str*

Return `repr(self)`.

**\_\_iter\_\_** () → `Iterator[Tuple[str, Any]]`

Returns `iter(self)`.

**asdict** (*default\_values=False*) → `Dict[str, Any]`

Returns the DXF attributes as `dict`, returns also the default values if argument *default\_values* is True. The `true_color` and `transparency` attributes do not have default values, the absence of these attributes is the default value.

**items** (*default\_values=False*) → `List[Tuple[str, Any]]`

Returns the DXF attributes as list of name, value pairs, returns also the default values if argument *default\_values* is True. The `true_color` and `transparency` attributes do not have default values, the absence of these attributes is the default value.

**classmethod load\_from\_header** (*doc: Drawing*) → `GfxAttribs`

Load default DXF attributes from the HEADER section.

There is no default true color value and the default transparency is not stored in the HEADER section.

Loads following header variables:

- `$CLAYER` - current layer name
- `$CECOLOR` - current ACI color
- `$CELTYPE` - current linetype name
- `$CELWEIGHT` - current linewidth
- `$CELTSCALE` - current linetype scaling factor

**write\_to\_header** (*doc: Drawing*) → None  
Write DXF attributes as default values to the HEADER section.  
Writes following header variables:

- \$CLAYER - current layer name, if a layer table entry exist in *doc*
- \$CECOLOR - current ACI color
- \$CELTYPE - current linetype name, if a linetype table entry exist in *doc*
- \$CELWEIGHT - current linewidth
- \$CELTSCALE - current linetype scaling factor

**classmethod from\_entity** (*entity: DXFEntity*) → GfxAttribs  
Get the graphical attributes of an *entity* as *GfxAttribs* object.

## Text Tools

### MTextEditor

**class** ezdxf.tools.text.MTextEditor (*text: str = ”*)

The *MTextEditor* is a helper class to build MTEXT content strings with support for inline codes to change color, font or paragraph properties. The result is always accessible by the *text* attribute or the magic *\_\_str\_\_()* function as *str(MTextEditor("text"))*.

All text building methods return *self* to implement a floating interface:

```
e = MTextEditor("This example ").color("red").append("switches color to red.")
mtext = msp.add_mtext(str(e))
```

The initial text height, color, text style and so on is determined by the DXF attributes of the *MText* entity.

**Warning:** The *MTextEditor* assembles just the inline code, which has to be parsed and rendered by the target CAD application, *ezdxf* has no influence to that result.

Keep inline formatting as simple as possible, don't test the limits of its capabilities, this will not work across different CAD applications and keep the formatting in a logic manner like, do not change paragraph properties in the middle of a paragraph.

**There is no official documentation for the inline codes!**

**Parameters** **text** – init value of the MTEXT content string.

#### text

The MTEXT content as a simple string.

**append** (*text: str*) → ezdxf.tools.text.MTextEditor

Append *text*.

**\_\_iadd\_\_** (*text: str*) → ezdxf.tools.text.MTextEditor

Append *text*:

```
e = MTextEditor("First paragraph.\n")
e += "Second paragraph.\n")
```

**\_\_str\_\_()** → str

Returns the MTEXT content attribute `text`.

**clear()**

Reset the content to an empty string.

**font(name: str, bold: bool = False, italic: bool = False)** → ezdxf.tools.text.MTextEditor

Set the text font by the font family name. Changing the font height should be done by the `height()` or the `scale_height()` method. The font family name is the name shown in font selection widgets in desktop applications: “Arial”, “Times New Roman”, “Comic Sans MS”. Switching the codepage is not supported.

**Parameters**

- **name** – font family name
- **bold** – flag
- **italic** – flag

**height(height: float)** → ezdxf.tools.text.MTextEditor

Set the absolute text height in drawing units.

**scale\_height(factor: float)** → ezdxf.tools.text.MTextEditor

Scale the text height by a *factor*. This scaling will accumulate, which means starting at height 2.5 and scaling by 2 and again by 3 will set the text height to  $2.5 \times 2 \times 3 = 15$ . The current text height is not stored in the `MTextEditor`, you have to track the text height by yourself! The initial text height is stored in the `MText` entity as DXF attribute `char_height`.

**width\_factor(factor: float)** → ezdxf.tools.text.MTextEditor

Set the absolute text width factor.

**char\_tracking\_factor(factor: float)** → ezdxf.tools.text.MTextEditor

Set the absolute character tracking factor.

**oblique(angle: int)** → ezdxf.tools.text.MTextEditor

Set the text oblique angle in degrees, vertical is 0, a value of 15 will lean the text 15 degree to the right.

**color(name: str)** → ezdxf.tools.text.MTextEditor

Set the text color by color name: “red”, “yellow”, “green”, “cyan”, “blue”, “magenta” or “white”.

**aci(aci: int)** → ezdxf.tools.text.MTextEditor

Set the text color by *AutoCAD Color Index (ACI)* in range [0, 256].

**rgb(rgb: Tuple[int, int, int])** → ezdxf.tools.text.MTextEditor

Set the text color as RGB value.

**underline(text: str)** → ezdxf.tools.text.MTextEditor

Append *text* with a line below the text.

**overline(text: str)** → ezdxf.tools.text.MTextEditor

Append *text* with a line above the text.

**strike\_through(text: str)** → ezdxf.tools.text.MTextEditor

Append *text* with a line through the text.

**group(text: str)** → ezdxf.tools.text.MTextEditor

Group *text*, all properties changed inside a group are reverted at the end of the group. AutoCAD supports grouping up to 8 levels.

**stack(upr: str, lwr: str, t: str = '^')** → ezdxf.tools.text.MTextEditor

Append stacked text *upr* over *lwr*, argument *t* defines the kind of stacking, the space ” ” after the “^” will be added automatically to avoid caret decoding:

```
"^": vertical stacked without divider line, e.g. \SA^ B:  
    A  
    B  
  
"/": vertical stacked with divider line, e.g. \SX/Y:  
    X  
    -  
    Y  
  
"#": diagonal stacked, with slanting divider line, e.g. \S1#4:  
    1/4
```

**paragraph** (*props: ezdxf.tools.text.ParagraphProperties*) → *ezdxf.tools.text.MTextEditor*

Set paragraph properties by a *ParagraphProperties* object.

**bullet\_list** (*indent: float, bullets: Iterable[str], content: Iterable[str]*) → *ezdxf.tools.text.MTextEditor*

Build bulleted lists by utilizing paragraph indentation and a tabulator stop. Any string can be used as bullet. Indentation is a multiple of the initial MTEXT char height (see also docs about *ParagraphProperties*), which means indentation in drawing units is *MText.dxf.char\_height* × *indent*.

Useful UTF bullets:

- “bull” U+2022 = • (Alt Numpad 7)
- “circle” U+25CB = (Alt Numpad 9)

For numbered lists just use numbers as bullets:

```
MTextEditor.bullet_list(  
    indent=2,  
    bullets=["1.", "2."],  
    content=["first", "second"],  
)
```

### Parameters

- **indent** – content indentation as multiple of the initial MTEXT char height
- **bullets** – iterable of bullet strings, e.g. [ “-” ] \* 3, for 3 dashes as bullet strings
- **content** – iterable of list item strings, one string per list item, list items should not contain new line or new paragraph commands.

Constants stored in the *MTextEditor* class:

NEW_LINE	'\P'
NEW_PARAGRAPH	'\P'
NEW_COLUMN	'\N'
UNDERLINE_START	'\L'
UNDERLINE_STOP	'\l'
OVERSTRIKE_START	'\O'
OVERSTRIKE_STOP	'\o'
STRIKE_START	'\K'
STRIKE_STOP	'\k'
ALIGN_BOTTOM	'\A0;'
ALIGN_MIDDLE	'\A1;'
ALIGN_TOP	'\A2;'
NBSP	'\~'
TAB	'^I'

```
class ezdxf.tools.text.ParagraphProperties(indent=0, left=0, right=0, align=DEFAULT, tab_stops=[])
```

Stores all known MTEXT paragraph properties in a NamedTuple. Indentations and tab stops are multiples of the default text height MText.dxf.char\_height. E.g. char\_height is 0.25 and indent is 4, the real indentation is  $4 \times 0.25 = 1$  drawing unit. The default tabulator stops are 4, 8, 12, ... if no tabulator stops are explicit defined.

#### Parameters

- **indent** (*float*) – left indentation of the first line, relative to **left**, which means an indent of 0 has always the same indentation as **left**
- **left** (*float*) – left indentation of the paragraph except for the first line
- **right** (*float*) – left indentation of the paragraph
- **align** – *MTextParagraphAlignment* enum
- **tab\_stops** – tuple of tabulator stops, as float or as str, float values are left aligned tab stops, strings with prefix "c" are center aligned tab stops and strings with prefix "r" are right aligned tab stops

**tostring()** → str

Returns the MTEXT paragraph properties as MTEXT inline code e.g. "\pxi-2,12;".

```
class ezdxf.lldxf.const.MTextParagraphAlignment
```

```
DEFAULT
LEFT
RIGHT
CENTER
JUSTIFIED
DISTRIBUTED
```

### Single Line Text

```
class ezdxf.tools.text.TextLine(text: str, font: AbstractFont)
```

Helper class which represents a single line text entity (e.g. *Text*).

## Parameters

- **text** – content string
- **font** – eздxf font definition like `MonospaceFont` or `MatplotlibFont`

**stretch** (`alignment: ezdxf.enums.TextEntityAlignment, p1: ezdxf.math._vector.Vector[Vec3], p2: ezdxf.math._vector.Vector[Vec3]`) → None

Set stretch factors for FIT and ALIGNED alignments to fit the text between `p1` and `p2`, only the distance between these points is important. Other given `alignment` values are ignore.

**font\_measurements** () → eздxf.tools.fonts.FontMeasurements

Returns the scaled font measurements.

**baseline\_vertices** (`insert: Union[Sequence[float], ezdxf.math._vector.Vector[Vec2], ezdxf.math._vector.Vector[Vec3]], halign: int = 0, valign: int = 0, angle: float = 0, scale: Tuple[float, float] = (1, 1)`) → List[ezdxf.math.\_vector.Vector[Vec3]]

Returns the left and the right baseline vertex of the text line.

## Parameters

- **insert** – insertion location
- **halign** – horizontal alignment left=0, center=1, right=2
- **valign** – vertical alignment baseline=0, bottom=1, middle=2, top=3
- **angle** – text rotation in radians
- **scale** – scale in x- and y-axis as 2-tuple of float

**corner\_vertices** (`insert: Union[Sequence[float], ezdxf.math._vector.Vector[Vec2], ezdxf.math._vector.Vector[Vec3]], halign: int = 0, valign: int = 0, angle: float = 0, scale: Tuple[float, float] = (1, 1), oblique: float = 0`) → List[ezdxf.math.\_vector.Vector[Vec3]]

Returns the corner vertices of the text line in the order bottom left, bottom right, top right, top left.

## Parameters

- **insert** – insertion location
- **halign** – horizontal alignment left=0, center=1, right=2
- **valign** – vertical alignment baseline=0, bottom=1, middle=2, top=3
- **angle** – text rotation in radians
- **scale** – scale in x- and y-axis as 2-tuple of float
- **oblique** – shear angle (slanting) in x-direction in radians

**static transform\_2d** (`vertices: Iterable[Union[Sequence[float], ezdxf.math._vector.Vector[Vec2], ezdxf.math._vector.Vector[Vec3]]], insert: Union[Sequence[float], ezdxf.math._vector.Vector[Vec2], ezdxf.math._vector.Vector[Vec3]] = Vec3(0.0, 0.0, 0.0), shift: Tuple[float, float] = (0, 0), rotation: float = 0, scale: Tuple[float, float] = (1, 1), oblique: float = 0`) → List[ezdxf.math.\_vector.Vector[Vec3]]

Transform any vertices from the text line located at the base location at (0, 0) and alignment LEFT.

## Parameters

- **vertices** – iterable of vertices
- **insert** – insertion location
- **shift** – (shift-x, shift-y) as 2-tuple of float
- **rotation** – text rotation in radians
- **scale** – (scale-x, scale-y) as 2-tuple of float

- **oblique** – shear angle (slanting) in x-direction in radians

## Functions

`ezdxf.tools.text.caret_decode(text: str) → str`

DXF stores some special characters using caret notation. This function decodes this notation to normalise the representation of special characters in the string.

see: [https://en.wikipedia.org/wiki/Caret\\_notation](https://en.wikipedia.org/wiki/Caret_notation)

`ezdxf.tools.text.estimate_mtext_content_extents(content: str, font: ezdxf.tools.fonts.AbstractFont, column_width: float = 0.0, line_spacing_factor: float = 1.0) → Tuple[float, float]`

Estimate the width and height of the `MText` content string. The result is very inaccurate if inline codes are used or line wrapping at the column border is involved! Column breaks `\N` will be ignored.

This function uses the optional *Matplotlib* package if available.

### Parameters

- **content** – the `MText` content string
- **font** – font abstraction based on `ezdxf.tools.fonts.AbstractFont`
- **column\_width** – `MText.dxf.width` or 0.0 for an unrestricted column width
- **line\_spacing\_factor** – `MText.dxf.line_spacing_factor`

**Returns** `Tuple[width, height]`

`ezdxf.tools.text.estimate_mtext_extents(mtext: MText) → Tuple[float, float]`

Estimate the width and height of a single column `MText` entity.

This function is faster than the `mtext_size()` function, but the result is very inaccurate if inline codes are used or line wrapping at the column border is involved!

This function uses the optional *Matplotlib* package if available.

**Returns** `Tuple[width, height]`

`ezdxf.tools.text.fast_plain_mtext(text: str, split=False) → Union[List[str], str]`

Returns the plain MTEXT content as a single string or a list of strings if `split` is True. Replaces `\P` by `\n` and removes other controls chars and inline codes.

This function is more than 4x faster than `plain_mtext()`, but does not remove single letter inline commands with arguments without a terminating semicolon like this "`\C1;red text`".

---

**Note:** Well behaved CAD applications and libraries always create inline codes for commands with arguments with a terminating semicolon like this "`\C1;red text`"!

---

### Parameters

- **text** – MTEXT content string
- **split** – split content at line endings `\P`

`ezdxf.tools.text.is_text_vertical_stacked(text: DXFEntity) → bool`

Returns True if the associated text `Textstyle` is vertical stacked.

`ezdxf.tools.text.is_upside_down_text_angle(angle: float, tol: float = 3.0) → bool`

Returns True if the given text *angle* in degrees causes an upside down text in the [WCS](#). The strict flip range is  $90^\circ < \text{angle} < 270^\circ$ , the tolerance angle *tol* extends this range to:  $90+\text{tol} < \text{angle} < 270-\text{tol}$ . The angle is normalized to [0, 360).

#### Parameters

- **angle** – text angle in degrees
- **tol** – tolerance range in which text flipping will be avoided

New in version 0.18.

`ezdxf.tools.text.leading(cap_height: float, line_spacing: float = 1.0) → float`

Returns the distance from baseline to baseline.

#### Parameters

- **cap\_height** – cap height of the line
- **line\_spacing** – line spacing factor as percentage of 3-on-5 spacing

`ezdxf.tools.text.plain_mtext(text: str, split=False, tabszie: int = 4) → Union[List[str], str]`

Returns the plain MTEXT content as a single string or a list of strings if *split* is True. Replaces \P by \n and removes other controls chars and inline codes.

This function is much slower than [fast\\_plain\\_mtext\(\)](#), but removes all inline codes.

#### Parameters

- **text** – MTEXT content string
- **split** – split content at line endings \P
- **tabszie** – count of replacement spaces for tabulators ^I

`ezdxf.tools.text.plain_text(text: str) → str`

Returns the plain text for [Text](#), [Attrib](#) and [Attdef](#) content.

`ezdxf.tools.text.safe_string(s: Optional[str], max_len: int = 255) → str`

Returns a string with line breaks \n replaced by \P and the length limited to *max\_len*.

`ezdxf.tools.text.text_wrap(text: str, box_width: Optional[float], get_text_width: Callable[[str], float]) → List[str]`

Wrap text at \n and given *box\_width*. This tool was developed for usage with the MTEXT entity. This isn't the most straightforward word wrapping algorithm, but it aims to match the behavior of AutoCAD.

#### Parameters

- **text** – text to wrap, included \n are handled as manual line breaks
- **box\_width** – wrapping length, None to just wrap at \n
- **get\_text\_width** – callable which returns the width of the given string

`ezdxf.tools.text.upright_text_angle(angle: float, tol: float = 3.0) → float`

Returns a readable (upright) text angle in the range *angle*  $\leq 90+\text{tol}$  or *angle*  $\geq 270-\text{tol}$ . The angle is normalized to [0, 360).

#### Parameters

- **angle** – text angle in degrees
- **tol** – tolerance range in which text flipping will be avoided

New in version 0.18.

## Text Size Tools

```
class ezdxf.tools.text_size.TextSize
```

A frozen dataclass as return type for the `text_size()` function.

### width

The text width in drawing units (float).

### cap\_height

The font cap-height in drawing units (float).

### total\_height

The font total-height = cap-height + descender-height in drawing units (float).

```
ezdxf.tools.text_size.text_size(text: ezdxf.entities.text.Text) → ezdxf.tools.text_size.TextSize
```

Returns the measured text width, the font cap-height and the font total-height for a `Text` entity. This function uses the optional *Matplotlib* package if available to measure the final rendering width and font-height for the `Text` entity as close as possible. This function does not measure the real char height! Without access to the *Matplotlib* package the `MonospaceFont` is used and the measurements are very inaccurate.

See the `text2path` add-on for more tools to work with the text path objects created by the *Matplotlib* package.

```
class ezdxf.tools.text_size.MTextSize
```

A frozen dataclass as return type for the `mtext_size()` function.

### total\_width

The total width in drawing units (float)

### total\_height

The total height in drawing units (float), same as `max(column_heights)`.

### column\_width

The width of a single column in drawing units (float)

### gutter\_width

The space between columns in drawing units (float)

### column\_heights

A tuple of columns heights (float) in drawing units. Contains at least one column height and the the column height is 0 for an empty column.

### column\_count

The count of columns (int).

```
ezdxf.tools.text_size.mtext_size(mtext: ezdxf.entities.mtext.MText, tool: Op-
```

```
tional[ezdxf.tools.text_size.MTextSizeDetector] = None)
```

```
→ ezdxf.tools.text_size.MTextSize
```

Returns the total-width, -height and columns information for a `MText` entity.

This function uses the optional *Matplotlib* package if available to do font measurements and the internal text layout engine to determine the final rendering size for the `MText` entity as close as possible. Without access to the *Matplotlib* package the `MonospaceFont` is used and the measurements are very inaccurate.

Attention: The required full layout calculation is slow!

The first call to this function with *Matplotlib* support is very slow, because *Matplotlib* lookup all available fonts on the system. To speedup the calculation and accepting inaccurate results you can disable the *Matplotlib* support manually:

```
ezdxf.option.use_matplotlib = False
```

```
ezdxf.tools.text_size.estimate_mtext_extents (mtext: MText) → Tuple[float, float]
```

Estimate the width and height of a single column *MText* entity.

This function is faster than the *mtext\_size()* function, but the result is very inaccurate if inline codes are used or line wrapping at the column border is involved!

This function uses the optional *Matplotlib* package if available.

**Returns** Tuple[width, height]

## Fonts

The module *ezdxf.tools.fonts* manages the internal usage of fonts and has no relation how the DXF formats manages text styles.

### See also:

The *Textstyle* entity, the DXF way to define fonts.

The tools in this module provide abstractions to get font measurements with and without the optional *Matplotlib* package.

For a proper text rendering the font measurements are required. *Ezdx*f has a lean approach to package dependencies, therefore the rendering results without support from the optional Matplotlib package are not very good.

---

**Hint:** If *Matplotlib* does not find an installed font and rebuilding the matplotlib font cache does not help, deleting the cache file `~/.matplotlib/fontlist-v330.json` may help.

---

## Font Classes

```
ezdxf.tools.fonts.make_font (ttf_path: str, cap_height: float, width_factor: float = 1.0) → ezdxf.tools.fonts.AbstractFont
```

Factory function to create a font abstraction.

Creates a *MatplotlibFont* if the Matplotlib font support is available and enabled or else a *MonospaceFont*.

### Parameters

- **ttf\_path** – raw font file name as stored in the *Textstyle* entity
- **cap\_height** – desired cap height in drawing units.
- **width\_factor** – horizontal text stretch factor

```
class ezdxf.tools.fonts.AbstractFont (measurements: ezdxf.tools.fonts.FontMeasurements)
```

The *ezdxf* font abstraction.

#### measurement

The *FontMeasurements* data.

**text\_width** (*text*: str) → float

**space\_width** () → float

```
class ezdxf.tools.fonts.MonospaceFont (cap_height: float, width_factor: float = 1.0, base-line: float = 0, descender_factor: float = 0.333, x_height_factor: float = 0.666)
```

Defines a monospaced font without knowing the real font properties. Each letter has the same cap- and descender height and the same width. This font abstraction is used if no Matplotlib font support is available.

Use the `make_font()` factory function to create a font abstraction.

**text\_width** (*text: str*) → float

Returns the text width in drawing units for the given *text* based on a simple monospaced font calculation.

**space\_width** () → float

Returns the width of a “space” char.

**class** `ezdxf.tools.fonts.MatplotlibFont` (*ttf\_path: str, cap\_height: float = 1.0, width\_factor: float = 1.0*)

This class provides proper font measurement support by using the optional Matplotlib font support.

Use the `make_font()` factory function to create a font abstraction.

**text\_width** (*text: str*) → float

Returns the text width in drawing units for the given *text* string. Text rendering and width calculation is done by the Matplotlib `TextPath` class.

**space\_width** () → float

Returns the width of a “space” char.

## Font Anatomy

- A Visual Guide to the Anatomy of Typography: <https://visme.co/blog/type-anatomy/>
- Anatomy of a Character: <https://www.fonts.com/content/learning/fontology/level-1/type-anatomy/anatomy>

## Font Properties

The default way of DXF to store fonts in the `Textstyle` entity by using the raw TTF file name is not the way how most render backends select fonts.

The render backends and web technologies select the fonts by their properties. This list shows the Matplotlib properties:

**family** List of font names in decreasing order of priority. The items may include a generic font family name, either “serif”, “sans-serif”, “cursive”, “fantasy”, or “monospace”.

**style** “normal” (“regular”), “italic” or “oblique”

**stretch** A numeric value in the range 0-1000 or one of “ultra-condensed”, “extra-condensed”, “condensed”, “semi-condensed”, “normal”, “semi-expanded”, “expanded”, “extra-expanded” or “ultra-expanded”

**weight** A numeric value in the range 0-1000 or one of “ultralight”, “light”, “normal”, “regular”, “book”, “medium”, “roman”, “semibold”, “demibold”, “demi”, “bold”, “heavy”, “extra bold”, “black”.

This way the backend can choose a similar font if the original font is not available.

**See also:**

- Matplotlib: [https://matplotlib.org/stable/api/font\\_manager\\_api.html](https://matplotlib.org/stable/api/font_manager_api.html)
- PyQt: <https://doc.qt.io/archives/qtforpython-5.12/PySide2/QtGui/QFont.html>
- W3C: <https://www.w3.org/TR/2018/REC-css-fonts-3-20180920/>

**class** `ezdxf.tools.fonts.FontFace` (*ttf, family, style, stretch, weight*)

This is the equivalent to the Matplotlib `FontProperties` class.

**ttf**

Raw font file name as string, e.g. “arial.ttf”

**family**

Family name as string, the default value is “sans-serif”

**style**

Font style as string, the default value is “normal”

**stretch**

Font stretch as string, the default value is “normal”

**weight**

Font weight as string, the default value is “normal”

**class ezdxf.tools.fonts.FontMeasurements**

See [Font Anatomy](#) for more information.

**baseline****cap\_height****x\_height****descender\_height**

**scale** (*factor: float = 1.0*) → ezdxf.tools.fonts.FontMeasurements

**scale\_from\_baseline** (*desired\_cap\_height: float*) → ezdxf.tools.fonts.FontMeasurements

**shift** (*distance: float = 0.0*) → ezdxf.tools.fonts.FontMeasurements

## Font Caching

*Ezdx*f uses Matplotlib to manage fonts and caches the collected information. The default installation of *ezdxf* provides a basic set of font properties. It is possible to create your own font cache specific for your system: see [ezdxf.options.font\\_cache\\_directory](#)

The font cache is loaded automatically at startup, if not disabled by setting config variable `auto_load_fonts` in [core] section to `False`: see [Environment Variables](#)

`ezdxf.tools.fonts.get_font_face(ttf_path: str, map_shx=True)` → `ezdxf.tools.fonts.FontFace`

Get cached font face definition by TTF file name e.g. “Arial.ttf”.

This function translates a DXF font definition by the raw TTF font file name into a `FontFace` object. Fonts which are not available on the current system gets a default font face.

**Parameters**

- **ttf\_path** – raw font file name as stored in the `Textstyle` entity
- **map\_shx** – maps SHX font names to TTF replacement fonts, e.g. “TXT” -> “txt\_\_\_\_.ttf”

`ezdxf.tools.fonts.get_entity_font_face(entity: DXFEntity, doc=None)` → `ezdxf.tools.fonts.FontFace`

Returns the `FontFace` defined by the associated text style. Returns the default font face if the `entity` does not have or support the DXF attribute “style”. Supports the extended font information stored in `Textstyle` table entries.

Pass a DXF document as argument `doc` to resolve text styles for virtual entities which are not assigned to a DXF document. The argument `doc` always overrides the DXF document to which the `entity` is assigned to.

`ezdxf.tools.fonts.get_font_measurements(ttf_path: str, map_shx=True)` → `ezdxf.tools.fonts.FontMeasurements`

Get cached font measurements by TTF file name e.g. “Arial.ttf”.

**Parameters**

- **ttf\_path** – raw font file name as stored in the `Textstyle` entity
- **map\_shx** – maps SHX font names to TTF replacement fonts, e.g. “TXT” -> “txt\_\_\_\_.ttf”

`ezdxf.tools.fonts.build_system_font_cache(*, path=None, rebuild=True) → None`

Build system font cache and save it to directory *path* if given. Set *rebuild* to `False` to just add new fonts. Requires the Matplotlib package!

A rebuild has to be done only after a new ezdxf installation, or new fonts were added to your system (which you want to use), or an update of ezdxf if you don’t use your own external font cache directory.

See also: `ezdxf.options.font_cache_directory`

`ezdxf.tools.fonts.load(path=None, reload=False)`

Load all caches from given *path* or from default location, defined by `ezdxf.options.font_cache_directory` or the default cache from the `ezdxf.tools` folder.

This function is called automatically at startup if not disabled by environment variable `EZDXF_AUTO_LOAD_FONTS`.

`ezdxf.tools.fonts.save(path=None)`

Save all caches to given *path* or to default location, defined by `options.font_cache_directory` or into the `ezdxf.tools` folder.

## ACIS Tools

New in version 0.18.

The `ezdxf.acis` sub-package provides some `ACIS` data management tools. The main goals of this tools are:

1. load and parse simple and known `ACIS` data structures
2. create and export simple and known `ACIS` data structures

It is NOT a goal to load and edit arbitrary existing `ACIS` structures.

Don’t even try it!

These tools cannot replace the official `ACIS` SDK due to the complexity of the data structures and the absence of an `ACIS` kernel. Without access to the full documentation it is very cumbersome to reverse-engineer entities and their properties, therefore the analysis of the `ACIS` data structures is limited to the use as embedded data in DXF and DWG files.

The `ezdxf` library does not provide an `ACIS` kernel and there are no plans for implementing one because this is far beyond my capabilities, but it is possible to extract geometries made up only by flat polygonal faces (polyhedron) from ACIS data. Exporting polyhedrons as ACIS data and loading this DXF file by Autodesk products or BricsCAD works for `SAT` data for DXF R2000-R2010 and for `SAB` data for DXF R2013-R2018.

---

**Important:** Always import from the public interface module `ezdxf.acis.api`, the internal package and module structure may change in the future and imports from other modules than `api` will break.

---

## Functions

`ezdxf.acis.api.load_dxf(entity: ezdxf.entities.dxfentity.DXFEntity) → List[ezdxf.acis.entities.Body]`

Load the `ACIS` bodies from the given DXF entity. This is the recommended way to load ACIS data.

The DXF entity has to be an ACIS based entity and inherit from `ezdxf.entities.Body`. The entity has to be bound to a valid DXF document and the DXF version of the document has to be DXF R2000 or newer.

### Raises

- `DXFTypeError` – invalid DXF entity type
- `DXFValueError` – invalid DXF document
- `DXFVersionError` – invalid DXF version

**Warning:** Only a limited count of `ACIS` entities is supported, all unsupported entities are loaded as `NONE_ENTITY` and their data is lost. Exporting such `NONE_ENTITIES` will raise an `ExportError` exception.

To emphasize that again: **It is not possible to load and re-export arbitrary ACIS data!**

Example:

```
import ezdxf
from ezdxf.acis import api as acis

doc = ezdxf.readfile("your.dxf")
msp = doc.modelspace()

for e in msp.query("3DSOLID"):
    bodies = acis.load_dxf(e)
    ...
```

```
ezdxf.acis.api.export_dxf(entity:      ezdxf.entities.dxentity.DXFEntity,      bodies:      Se-
                           quence[ezdxf.acis.entities.Body])
```

Store the `ACIS` bodies in the given DXF entity. This is the recommended way to set ACIS data of DXF entities.

The DXF entity has to be an ACIS based entity and inherit from `ezdxf.entities.Body`. The entity has to be bound to a valid DXF document and the DXF version of the document has to be DXF R2000 or newer.

### Raises

- `DXFTypeError` – invalid DXF entity type
- `DXFValueError` – invalid DXF document
- `DXFVersionError` – invalid DXF version

Example:

```
import ezdxf
from ezdxf.render import forms
from ezdxf.acis import api as acis

doc = ezdxf.new("R2000")
msp = doc.modelspace()

# create an ACIS body from a simple cube-mesh
body = acis.body_from_mesh(forms.cube())
solid3d = msp.add_3dsolid()
acis.export_dxf(solid3d, [body])
doc.saveas("cube.dxf")
```

```
ezdxf.acis.api.load(data:      Union[str,      Sequence[str],      bytes,      bytearray]) →
                           List[ezdxf.acis.entities.Body]
```

Returns a list of Body entities from `SAT` or `SAB` data. Accepts `SAT` data as a single string or a sequence of strings and `SAB` data as bytes or bytearray.

---

```
ezdxf.acis.api.export_sat(bodies: Sequence[ezdxf.acis.entities.Body], version: int = 700) →
    List[str]
```

Export one or more Body entities as text based [SAT](#) data.

ACIS version 700 is sufficient for DXF versions R2000, R2004, R2007 and R2010, later DXF versions require [SAB](#) data.

#### Raises

- [ExportError](#) – ACIS structures contain unsupported entities
- [InvalidLinkStructure](#) – corrupt link structure

```
ezdxf.acis.api.export_sab(bodies: Sequence[ezdxf.acis.entities.Body], version: int = 21800) →
    bytes
```

Export one or more Body entities as binary encoded [SAB](#) data.

ACIS version 21800 is sufficient for DXF versions R2013 and R2018, earlier DXF versions require [SAT](#) data.

#### Raises

- [ExportError](#) – ACIS structures contain unsupported entities
- [InvalidLinkStructure](#) – corrupt link structure

```
ezdxf.acis.api.mesh_from_body(body: eздxf.acis.entities.Body, merge_lumps=True) →
    List[ezdxf.render.mesh.MeshTransformer]
```

Returns a list of [MeshTransformer](#) instances from the given ACIS Body entity. The list contains multiple meshes if `merge_lumps` is `False` or just a single mesh if `merge_lumps` is `True`.

The ACIS format stores the faces in counter-clockwise orientation where the face-normal points outwards (away) from the solid body (material).

---

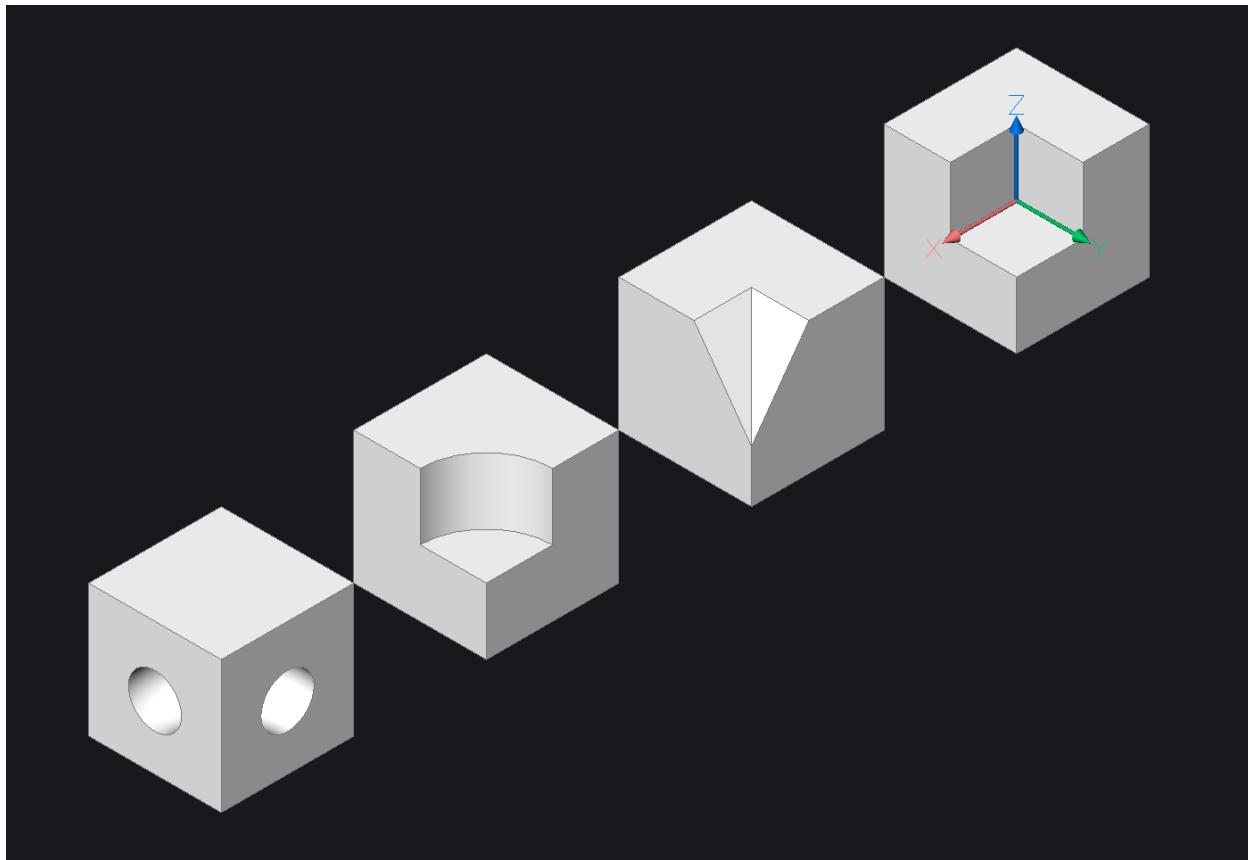
**Note:** This function returns meshes build up only from flat polygonal Face entities, for a tessellation of more complex ACIS entities (spline surfaces, tori, cones, ...) is an ACIS kernel required which `ezdxf` does not provide.

#### Parameters

- **body** – ACIS entity of type Body
- **merge\_lumps** – returns all Lump entities from a body as a single mesh if `True` otherwise each Lump entity is a separated mesh

**Raises** `TypeError` – given `body` entity has invalid type

The following images show the limitations of the `mesh_from_body()` function. The first image shows the source 3DSOLID entities with subtraction of entities with flat and curved faces:



Example script to extracts all flat polygonal faces as meshes:

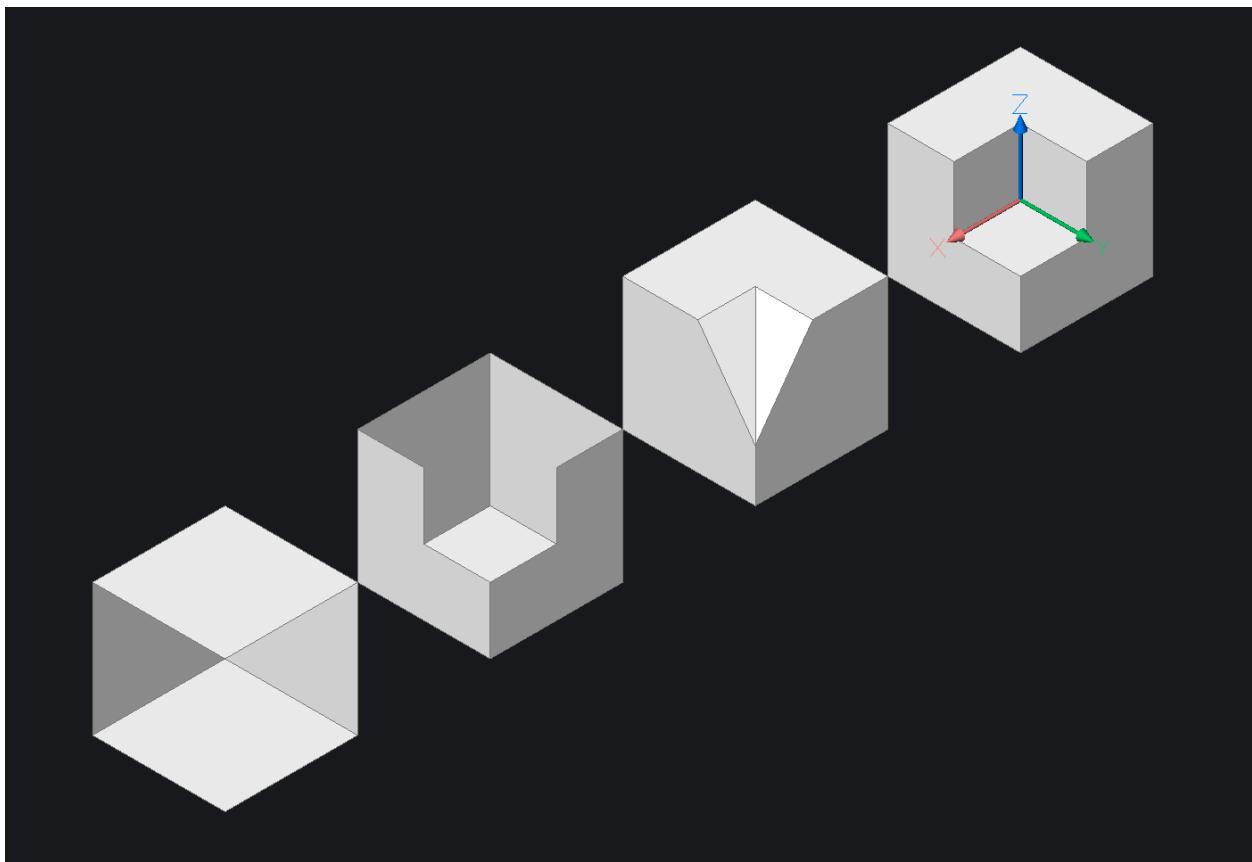
```
import ezdxf
from ezdxf.acis import api as acis

doc = ezdxf.readfile("3dsolids.dxf")
msp = doc.modelspace()

doc_out = ezdxf.new()
msp_out = doc_out.modelspace()

for e in msp.query("3DSOLID"):
    for body in acis.load_dxf(data):
        for mesh in acis.mesh_from_body(body):
            mesh.render_mesh(msp_out)
doc_out.saveas("meshes.dxf")
```

The second image shows the flat faces extracted from the 3DSOLID entities and exported as *Mesh* entities:



As you can see all faces which do not have straight lines as boundaries are lost.

```
ezdxf.acis.api.body_from_mesh(mesh: ezdxf.render.mesh.MeshBuilder, precision: int = 6) →
    ezdxf.acis.entities.Body
Returns a ACIS Body entity from a MeshBuilder instance.
```

This entity can be assigned to a *Solid3d* DXF entity as *SAT* or *SAB* data according to the version your DXF document uses (SAT for DXF R2000 to R2010 and SAB for DXF R2013 and later).

If the *mesh* contains multiple separated meshes, each mesh will be a separated *Lump* node. If each mesh should get its own *Body* entity, separate the meshes beforehand by the method *separate\_meshes*.

A closed mesh creates a solid body and an open mesh creates an open (hollow) shell. The detection if the mesh is open or closed is based on the edges of the mesh: if **all** edges of mesh have two adjacent faces the mesh is closed.

The current implementation applies automatically a vertex optimization, which merges coincident vertices into a single vertex.

## Exceptions

```
class ezdxf.acis.api.AcisException
Base exception of the ezdxf.acis package.
```

```
class ezdxf.acis.api.ParsingError
Exception raised when loading invalid or unknown ACIS structures.
```

```
class ezdxf.acis.api.ExportError
Exception raised when exporting invalid or unknown ACIS structures.
```

```
class ezdxf.acis.api.InvalidLinkStructure
    Exception raised when the internal link structure is damaged.
```

## Entities

A document ([sat.pdf](#)) about the basic ACIS 7.0 file format is floating in the internet.

This section contains the additional information about the entities, I got from analyzing the SAT data extracted from DXF files exported by BricsCAD.

This documentation ignores the differences to the ACIS format prior to version 7.0 and all this differences are handled internally.

Writing support for ACIS version < 7.0 is not required because all CAD applications should be able to process version 7.0, even if embedded in a very old DXF R2000 format (tested with Autodesk TrueView, BricsCAD and Nemetschek Allplan).

The first goal is to document the entities which are required to represent a geometry as flat polygonal faces (polyhedron), which can be converted into a [\*MeshBuilder\*](#) object.

Topology Entities:

- [\*Body\*](#)
- [\*Lump\*](#)
- [\*Shell\*](#)
- [\*Face\*](#)
- [\*Loop\*](#)
- [\*Coedge\*](#)
- [\*Edge\*](#)
- [\*Vertex\*](#)

Geometry Entities:

- [\*Transform\*](#)
- [\*Surface\*](#)
- [\*Plane\*](#)
- [\*Curve\*](#)
- [\*StraightCurve\*](#)
- [\*Point\*](#)

`ezdxf.acis.entities.NONE_REF`

Special sentinel entity which supports the `type` attribute and the `is_none` property. Represents all unset entities. Use this idiom on any entity type to check if an entity is unset:

```
if entity.is_none:  
    ...
```

## AcisEntity

```
class ezdxf.acis.entities.AcisEntity
```

Base class for all ACIS entities.

### **type**

Name of the type as str.

### **id**

Unique id as int or -1 if not set.

### **attributes**

Reference to the first Attribute entity (not supported).

### **is\_none**

True for unset entities represented by the `NONE_REF` instance.

## Transform

```
class ezdxf.acis.entities.Transform (AcisEntity)
```

Represents an affine transformation operation which transform the `body` to the final location, size and rotation.

### **matrix**

Transformation matrix of type `ezdxf.math.Matrix44`.

## Body

```
class ezdxf.acis.entities.Body (AcisEntity)
```

Represents a solid geometry, which can consist of multiple `Lump` entities.

### **pattern**

Reference to the `Pattern` entity.

### **lump**

Reference to the first `Lump` entity

### **wire**

Reference to the first `Wire` entity

### **transform**

Reference to the `Transform` entity (optional)

### **lumps ()** → List[ezdxf.acis.entities.Lump]

Returns all linked `Lump` entities as a list.

### **append\_lump** (*lump: ezdxf.acis.entities.Lump*) → None

Append a `Lump` entity as last lump.

## Pattern

```
class ezdxf.acis.entities.Pattern (AcisEntity)
```

Not implemented.

## Lump

```
class ezdxf.acis.entities.Lump (AcisEntity)
```

The lump represents a connected entity and there can be multiple lumps in a *Body*. Multiple lumps are linked together by the *next\_lump* attribute which points to the next lump entity the last lump has a *NONE\_REF* as next lump. The *body* attribute references to the parent *Body* entity.

**next\_lump**

Reference to the next *Lump* entity, the last lump references *NONE\_REF*.

**shell**

Reference to the *Shell* entity.

**body**

Reference to the parent *Body* entity.

**shells () → List[ezdxf.acis.entities.Shell]**

Returns all linked *Shell* entities as a list.

**append\_shell (shell: ezdxf.acis.entities.Shell) → None**

Append a *Shell* entity as last shell.

## Wire

```
class ezdxf.acis.entities.Wire (AcisEntity)
```

Not implemented.

## Shell

```
class ezdxf.acis.entities.Shell (AcisEntity)
```

A shell defines the boundary of a solid object or a void (subtraction object). A shell references a list of *Face* and *Wire* entities. All linked *Shell* entities are disconnected.

**next\_shell**

Reference to the next *Shell* entity, the last shell references *NONE\_REF*.

**subshell**

Reference to the first *Subshell* entity.

**face**

Reference to the first *Face* entity.

**wire**

Reference to the first *Wire* entity.

**lump**

Reference to the parent *Lump* entity.

**faces () → List[ezdxf.acis.entities.Face]**

Returns all linked *Face* entities as a list.

**append\_face (face: ezdxf.acis.entities.Face) → None**

Append a *Face* entity as last face.

## Subshell

```
class ezdxf.acis.entities.Subshell (AcisEntity)
    Not implemented.
```

## Face

```
class ezdxf.acis.entities.Face (AcisEntity)
```

A face is the building block for *Shell* entities. The boundary of a face is represented by one or more *Loop* entities. The spatial geometry of the face is defined by the *surface* object, which is a bounded or unbounded parametric 3d surface (plane, ellipsoid, spline-surface, ...).

### **next\_face**

Reference to the next *Face* entity, the last face references *NONE\_REF*.

### **loop**

Reference to the first *Loop* entity.

### **shell**

Reference to the parent *Shell* entity.

### **subshell**

Reference to the parent *Subshell* entity.

### **surface**

Reference to the parametric *Surface* geometry.

### **sense**

Boolean value of direction of the face normal with respect to the *Surface* entity:

- True: “reversed” direction of the face normal
- False: “forward” for same direction of the face normal

### **double\_sided**

Boolean value which indicates the sides of the face:

- True: the face is part of a hollow object and has two sides.
- False: the face is part of a solid object and has only one side which points away from the “material”.

### **containment**

Unknown meaning.

If *double\_sided* is True:

- True is “in”
- False is “out”

### **loops () → List[ezdxf.acis.entities.Loop]**

Returns all linked *Loop* entities as a list.

### **append\_loop (loop: ezdxf.acis.entities.Loop) → None**

Append a *Loop* entity as last loop.

## Loop

```
class ezdxf.acis.entities.Loop (AcisEntity)
```

A loop represents connected coedges which are building the boundaries of a *Face*, there can be multiple loops

for a single face e.g. faces can contain holes. The `coedge` attribute references the first `Coedge` of the loop, the additional coedges are linked to this first `Coedge`. In closed loops the coedges are organized as a circular list, in open loops the last coedge references the `NONE_REF` entity as `next_coedge` and the first coedge references the `NONE_REF` as `prev_coedge`.

**next\_loop**

Reference to the next `Loop` entity, the last loop references `NONE_REF`.

**coedge**

Reference to the first `Coedge` entity.

**face**

Reference to the parent `Face` entity.

**coedges () → List[ezdxf.acis.entities.Coedge]**

Returns all linked `Coedge` entities as a list.

**set\_coedges (coedges: List[ezdxf.acis.entities.Coedge], close=True) → None**

Set all coedges of a loop at once.

## Coedge

**class ezdxf.acis.entities.Coedge (AcisEntity)**

The coedges are a double linked list where `next_coedge` points to the next `Coedge` and `prev_coedge` to the previous `Coedge`.

The `partner_coedge` attribute references the first partner `Coedge` of an adjacent `Face`, the partner edges are organized as a circular list. In a manifold closed surface each `Face` is connected to one partner face by an `Coedge`. In a non-manifold surface a face can have more than one partner face.

**next\_coedge**

References the next `Coedge`, reference the `NONE_REF` if it is the last coedge in an open `Loop`.

**prev\_coedge**

References the previous `Coedge`, reference the `NONE_REF` if it is the first coedge in an open `Loop`.

**partner\_coedge**

References the partner `Coedge` of an adjacent `Face` entity. The partner coedges are organized in a circular list.

**edge**

References the `Edge` entity.

**loop**

References the parent `Loop` entity.

**pcurve**

References the `PCurve` entity.

## Edge

**class ezdxf.acis.entities.Edge (AcisEntity)**

The `Edge` entity represents the physical edge of an object. Its geometry is defined by the the bounded portion of a parametric space curve. This bounds are stored as object-space `Vertex` entities.

**start\_vertex**

The start `Vertex` of the space-curve in object coordinates, if `NONE_REF` the curve is unbounded in this direction.

**start\_param**

The parametric starting bound for the parametric curve. Evaluating the `curve` for this parameter should return the coordinates of the `start_vertex`.

**end\_vertex**

The end `Vertex` of the space-curve in object coordinates, if `NONE_REF` the curve is unbounded in this direction.

**end\_param**

The parametric end bound for the parametric curve.

**coedge**

Parent `Coedge` of this edge.

**curve**

The parametric space-curve which defines this edge. The curve can be the `NULL_REF` while both `Vertex` entities are the same vertex. In this case the `Edge` represents a single point like the apex of a cone.

**sense**

Boolean value which indicates the direction of the edge:

- True: the edge has the “reversed” direction as the underlying curve
- False: the edge has the same direction as the underlying curve (“forward”)

**convexity**

Unknown meaning, always the string “unknown”.

## Vertex

**class ezdxf.acis.entities.Vertex (AcisEntity)**

Represents a vertex of an `Edge` entity and references a `Point` entity.

**point**

The spatial location in object-space as `Point` entity.

**edge**

Parent `Edge` of this vertex. The vertex can be referenced by multiple edges, anyone of them can be the parent of the vertex.

## Surface

**class ezdxf.acis.entities.Surface (AcisEntity)**

Abstract base class for all parametric surfaces.

The parameterization of any `Surface` maps a 2D rectangle (u, v parameters) into the spatial object-space (x, y, z).

**u\_bounds**

Tuple of (start bound, end bound) parameters as two floats which define the bounds of the parametric surface in the u-direction, one or both values can be `math.inf` which indicates an unbounded state of the surface in that direction.

**v\_bounds**

Tuple of (start bound, end bound) parameters as two floats which define the bounds of the parametric surface in the v-direction, one or both values can be `math.inf` which indicates an unbounded state of the surface in that direction.

**evaluate** ( $u: float, v: float$ ) → eздxf.math.\_vector.Vec3Returns the spatial location at the parametric surface for the given parameters  $u$  and  $v$ .

## Plane

**class** eздxf.acis.entities.**Plane** (*Surface*)

Defines a flat plan as parametric surface.

**origin**Location vector of the origin of the flat plane as *Vec3*.**normal**Normal vector of the plane as *Vec3*. Has to be an unit-vector!**u\_dir**Direction vector of the plane in u-direction as *Vec3*. Has to be an unit-vector!**v\_dir**Direction vector of the plane in v-direction as *Vec3*. Has to be an unit-vector!**reverse\_v**

Boolean value which indicates the orientation of the coordinate system:

- True: left-handed system, the v-direction is reversed and the normal vector is *v\_dir* cross *u\_dir*.
- False: right-handed system and the normal vector is *u\_dir* cross *v\_dir*.

## Curve

**class** eздxf.acis.entities.**Curve** (*AcisEntity*)

Abstract base class for all parametric curves.

The parameterization of any *Curve* maps a 1D line (the parameter) into the spatial object-space (x, y, z).**bounds**Tuple of (start bound, end bound) parameters as two floats which define the bounds of the parametric curve, one or both values can be *math.inf* which indicates an unbounded state of the curve in that direction.**evaluate** (*param: float*) → eздxf.math.\_vector.Vec3

Returns the spatial location at the parametric curve for the given parameter.

## StraightCurve

**class** eздxf.acis.entities.**StraightCurve** (*Curve*)

Defines a straight line as parametric curve.

**origin**Location vector of the origin of the straight line as *Vec3*.**direction**Direction vector the straight line as *Vec3*. Has to be an unit-vector!

## PCurve

**class** eздxf.acis.entities.**PCurve** (*AcisEntity*)

Not implemented.

## Point

```
class ezdxf.acis.entities.Point (AcisEntity)
    Represents a point in the 3D object-space.
```

### location

Cartesian coordinates as `Vec3`.

## 6.8.11 Global Options

### Global Options Object

The global `ezdxf` options are stored in the object `ezdxf.options`.

Recommended usage of the global options object:

```
import ezdxf
value = ezdxf.options.attribute
```

The options object uses the Standard Python class `ConfigParser` to manage the configuration. Shortcut attributes like `test_files` are simple properties and most shortcuts are read only marked by (Read only), read and writeable attributes are marked by (Read/Write).

To change options, especially the read only attributes, you have to edit the config file with a text editor, or set options by the `set()` method and write the current configuration into a config file.

### Config Files

New in version 0.16.5.

The default config files are loaded from the user home directory as “`~/.config/ezdxf/ezdxf.ini`”, and the current working directory as “`./ezdxf.ini`”. A custom config file can be specified by the environment variable `EZDXF_CONFIG_FILE`. Ezdxf follows the [XDG Base Directory specification](#) if the environment variable `XDG_CONFIG_HOME` is set.

The config file loading order:

1. user home directory: “`~/.config/ezdxf/ezdxf.ini`”
2. current working directory: “`./ezdxf.ini`”
3. config file specified by `EZDXF_CONFIG_FILE`

A configuration file that is loaded later does not replace the previously loaded ones, only the existing options in the newly loaded file are added to the configuration and can overwrite existing options.

Configuration files are regular INI files, managed by the standard Python `ConfigParser` class.

File Structure:

```
[core]
default_dimension_text_style = OpenSansCondensed-Light
test_files = D:\Source\dxftest
font_cache_directory =
load_proxy_graphics = true
store_proxy_graphics = true
log_unprocessed_tags = false
filter_invalid_xdata_group_codes = true
```

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```
write_fixed_meta_data_for_testing = false
disable_c_ext = false

[browse-command]
text_editor = "C:\Program Files\Notepad++\notepad++.exe" "{filename}" -n{num}
```

## Modify and Save Changes

This code shows how to get and set values of the underlying ConfigParser object, but use the shortcut attributes if available:

```
# Set options, value has to be a str, use "true"/"false" for boolean values
ezdxf.options.set(section, key, value)

# Get option as string
value = ezdxf.options.get(section, key, default="")

# Special getter for boolean, int and float
value = ezdxf.options.get_bool(section, key, default=False)
value = ezdxf.options.get_int(section, key, default=0)
value = ezdxf.options.get_float(section, key, default=0.0)
```

If you set options, they are not stored automatically in a config file, you have to write back the config file manually:

```
# write back the default user config file "ezdxf.ini" in the
# user home directory
ezdxf.options.write_home_config()

# write back to the default config file "ezdxf.ini" in the
# current working directory
ezdxf.options.write_file()

# write back to a specific config file
ezdxf.options.write_file("my_config.ini")
# which has to be loaded manually at startup
ezdxf.options.read_file("my_config.ini")
```

This example shows how to change the `test_files` path and save the changes into a custom config file “my\_config.ini”:

```
import eздxf

test_files = Path("~/my-dxf-test-files").expand_user()
ezdxf.options.set(
    eздxf.options.CORE, # section
    "test_files", # key
    "~/my-dxf-test-files", # value
)
ezdxf.options.write_file("my_config.ini")
```

## Use a Custom Config File

You can specify a config file by the environment variable EZDXF\_CONFIG\_FILE, which is loaded after the default config files.

```
C:\> set EZDXF_CONFIG_FILE=D:\user\path\custom.ini
```

Custom config files are not loaded automatically like the default config files.

This example shows how to load the previous created custom config file “my\_config.ini” from the current working directory:

```
import ezdxf
ezdxf.options.read("my_config.ini")
```

That is all and because this is the last loaded config file, it overrides all default config files and the config file specified by EZDXF\_CONFIG\_FILE.

## Functions

`ezdxf.options.set(section: str, key: str, value: str)`

Set option `key` in `section` to `values` as `str`.

`ezdxf.options.get(section: str, key: str, default: str = "") → str`

Get option `key` in `section` as string.

`ezdxf.options.get_bool(section: str, key: str, default: bool = False) → bool`

Get option `key` in `section` as `bool`.

`ezdxf.options.get_int(section: str, key: str, default: int = 0) → int`

Get option `key` in `section` as `int`.

`ezdxf.options.get_float(section: str, key: str, default: float = 0.0) → float`

Get option `key` in `section` as `float`.

`ezdxf.options.write(fp: TextIO)`

Write configuration into given file object `fp`, the file object must be a writeable text file with “utf8” encoding.

`ezdxf.options.write_file(filename: str = "ezdxf.ini")`

Write current configuration into file `filename`, default is “ezdxf.ini” in the current working directory.

`ezdxf.options.write_home_config()`

Write configuration into file “`~/.config/ezdxf/ezdxf.ini`”, `$XDG_CONFIG_HOME` is supported if set.

`ezdxf.options.read_file(filename: str)`

Append content from config file `filename`, but does not reset the configuration.

`ezdxf.options.print()`

Print configuration to `stdout`.

`ezdxf.options.reset()`

Reset options to factory default values.

`ezdxf.options.delete_default_config_files()`

Delete the default config files “ezdxf.ini” in the current working and in the user home directory “`~/.config/ezdxf`”, `$XDG_CONFIG_HOME` is supported if set.

`ezdxf.options.preserve_proxy_graphics(state=True)`

Enable/disable proxy graphic load/store support by setting the options `load_proxy_graphics` and `store_proxy_graphics` to `state`.

`ezdxf.options.loaded_config_files`

Read only property of loaded config files as tuple for `Path` objects.

## Core Options

For all core options the section name is `core`.

### Default Dimension Text Style

The default dimension text style is used by the DIMENSION renderer of *ezdxf*, if the specified text style exist in the STYLE table. To use any of the default style of *ezdxf* you have to setup the styles at the creation of the DXF document: `ezdxf.new(setup=True)`, or setup the *ezdxf* default styles for a loaded DXF document:

```
import ezdxf
from ezdxf.tool.standard import setup_drawing

doc = ezdxf.readfile("your.dxf")
setup_drawing(doc)
```

Config file key: `default_dimension_text_style`

Shortcut attribute:

```
ezdxf.options.default_dimension_text_style
(Read/Write) Get/Set default text style for DIMENSION rendering, default value is
OpenSansCondensed-Light.
```

### Font Cache Directory

*Ezdx*f has a bundled font cache to have faster access to font metrics. This font cache includes only fonts installed on the developing workstation. To add the fonts of your computer to this cache, you have to create your own external font cache. This has to be done only once after *ezdxf* was installed, or to add new installed fonts to the cache, and this requires the *Matplotlib* package.

This example shows, how to create an external font cache in the recommended directory of the XDG Base Directory specification: "`~/.cache/ezdxf`".

```
import ezdxf
from ezdxf.tools import fonts

# xdg_path() returns "$XDG_CACHE_HOME/ezdxf" or "~/.cache/ezdxf" if
# $XDG_CACHE_HOME is not set
font_cache_dir = ezdxf.options.xdg_path("XDG_CACHE_HOME", ".cache")
fonts.build_system_font_cache(path=font_cache_dir)
ezdxf.options.font_cache_directory = font_cache_dir
# Save changes to the default config file "~/.config/ezdxf/ezdxf.ini"
# to load the font cache always from the new location.
ezdxf.options.write_home_config()
```

Config file key: `font_cache_directory`

Shortcut attribute:

```
ezdxf.options.font_cache_directory
(Read/Write) Get/set the font cache directory, if the directory is an empty string, the bundled font cache is used.
Expands "~" construct automatically.
```

## Load Proxy Graphic

Proxy graphics are not essential for DXF files, but they can provide a simple graphical representation for complex entities, but extra memory is needed to store this information. You can save some memory by not loading the proxy graphic, but the proxy graphic is lost if you write back the DXF file.

The current version of *ezdxf* uses this proxy graphic to render MLEADER entities by the *drawing* add-on.

Config file key: `load_proxy_graphics`

Shortcut attribute:

```
ezdxf.options.load_proxy_graphics
(Read/Write) Load proxy graphics if True, default is True.
```

## Store Proxy Graphic

Prevent exporting proxy graphics if set to False.

Config file key: `store_proxy_graphics`

Shortcut attribute:

```
ezdxf.options.store_proxy_graphics
(Read/Write) Export proxy graphics if True, default is True.
```

## Debugging Options

For all debugging options the section name is `core`.

## Test Files

Path to test files. Some of the `CADKit` test files are used by the integration tests, these files should be located in the `ezdxf.options.test_files_path / "CADKitSamples"` folder.

Config file key: `test_files`

Shortcut attributes:

```
ezdxf.options.test_files
(Read only) Returns the path to the ezdxf test files as str, expands “~” construct automatically.
```

```
ezdxf.options.test_files_path
(Read only) Path to test files as pathlib.Path object.
```

## Filter Invalid XDATA Group Codes

Only a very limited set of group codes is valid in the XDATA section and AutoCAD is very picky about that. *Ezdx*f removes invalid XDATA group codes if this option is set to True, but this needs processing time, which is wasted if you get your DXF files from trusted sources like AutoCAD or BricsCAD.

Config file key: `filter_invalid_xdata_group_codes`

```
ezdxf.options.filter_invalid_xdata_group_codes
(Read only) Filter invalid XDATA group codes, default value is True.
```

## Log Unprocessed Tags

Logs unprocessed DXF tags, this helps to find new and undocumented DXF features.

Config file key: `log_unprocessed_tags`

`ezdxf.options.log_unprocessed_tags`

(Read/Write) Log unprocessed DXF tags for debugging, default value is `False`.

## Write Fixed Meta Data for Testing

Write the DXF files with fixed meta data to test your DXF files by a diff-like command, this is necessary to get always the same meta data like the saving time stored in the HEADER section. This may not work across different *ezdxf* versions!

Config file key: `write_fixed_meta_data_for_testing`

`ezdxf.options.write_fixed_meta_data_for_testing`

(Read/Write) Enable this option to always create same meta data for testing scenarios, e.g. to use a diff-like tool to compare DXF documents, default is `False`.

## Disable C-Extension

It is possible to deactivate the optional C-extensions if there are any issues with the C-extensions. This has to be done in a default config file or by environment variable before the first import of *ezdxf*. For `pypy3` the C-extensions are always disabled, because the JIT compiled Python code is much faster.

---

**Important:** This option works only in the **default config files**, user config files which are loaded by `ezdxf.options.read_file()` cannot disable the C-Extensions, because at this point the setup process of *ezdxf* is already finished!

---

Config file key: `disable_c_ext`

`ezdxf.options.disable_c_ext`

(Read only) This option disables the C-extensions if `True`. This can only be done before the first import of *ezdxf* by using a config file or the environment variable `EZDXF_DISABLE_C_EXT`.

## Use C-Extensions

`ezdxf.options.use_c_ext`

(Read only) Shows the actual state of C-extensions usage.

## Use Matplotlib

This option can deactivate Matplotlib support for testing. This option is not stored in the `ConfigParser` object and is therefore not supported by config files!

Only attribute access is supported:

`ezdxf.options.use_matplotlib`

(Read/Write) Activate/deactivate Matplotlib support (e.g. for testing) if Matplotlib is installed, else `use_matplotlib` is always `False`.

## Environment Variables

Some feature can be controlled by environment variables. Command line example for disabling the optional C-extensions on Windows:

```
C:\> set EZDXF_DISABLE_C_EXT=1
```

---

**Important:** If you change any environment variable, you have to restart the Python interpreter!

---

**EZDXF\_DISABLE\_C\_EXT** Set environment variable EZDXF\_DISABLE\_C\_EXT to 1 or True to disable the usage of the C-extensions.

**EZDXF\_TEST\_FILES** Path to the *ezdxf* test files required by some tests, for instance the CADKit sample files should be located in the EZDXF\_TEST\_FILES/CADKitSamples folder. See also option *ezdxf.options.test\_files*.

**EZDXF\_CONFIG\_FILE** Specifies a user config file which will be loaded automatically after the default config files at the first import of *ezdxf*.

### 6.8.12 Miscellaneous

#### Zoom Layouts

New in version 0.16.

These functions mimic the ZOOM commands in CAD applications.

Zooming means resetting the current viewport limits to new values. The coordinates for the functions *center()* and *window()* are drawing units for the model space and paper space units for paper space layouts. The modelspace units in *Drawing.units* are ignored.

The extents detection for the functions *entities()* and *extents()* is done by the *ezdxf.bbox* module. Read the associated documentation to understand the limitations of the *ezdxf.bbox* module. Tl;dr The extents detection is **slow** and **not accurate**.

Because the ZOOM operations in CAD applications are not that precise, then zoom functions of this module uses the fast bounding box calculation mode of the *bbox* module, which means the argument *flatten* is always *False* for *extents()* function calls.

The region displayed by CAD applications also depends on the aspect ratio of the application window, which is not available to *ezdxf*, therefore the viewport size is just an educated guess of an aspect ratio of 2:1 (16:9 minus top toolbars and the bottom status bar).

**Warning:** All zoom functions replace the current viewport configuration by a single window configuration.

Example to reset the main CAD viewport of the model space to the extents of its entities:

```
import eздxf
from eздxf import zoom

doc = eздxf.new()
msp = doc.modelspace()
... # add your DXF entities
```

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```
zoom extents (msp)
doc.saveas("your.dxf")
```

`ezdxf.zoom.center(layout: ezdxf.layouts.layout.Layout, point: Union[Sequence[float], ezdxf.math._vector.Vector2, ezdxf.math._vector.Vector3], size: Union[Sequence[float], ezdxf.math._vector.Vector2, ezdxf.math._vector.Vector3])`

Resets the active viewport center of *layout* to the given *point*, argument *size* defines the width and height of the viewport. Replaces the current viewport configuration by a single window configuration.

`ezdxf.zoom.objects(layout: ezdxf.layouts.layout.Layout, entities: Iterable[ezdxf.entities.DXFEntity], factor: float = 1)`

Resets the active viewport limits of *layout* to the extents of the given *entities*. Only entities in the given *layout* are taken into account. The argument *factor* scales the viewport limits. Replaces the current viewport configuration by a single window configuration.

`ezdxf.zoom.extents(layout: ezdxf.layouts.layout.Layout, factor: float = 1)`

Resets the active viewport limits of *layout* to the extents of all entities in this *layout*. The argument *factor* scales the viewport limits. Replaces the current viewport configuration by a single window configuration.

`ezdxf.zoom.window(layout: ezdxf.layouts.layout.Layout, p1: Union[Sequence[float], ezdxf.math._vector.Vector2, ezdxf.math._vector.Vector3], p2: Union[Sequence[float], ezdxf.math._vector.Vector2, ezdxf.math._vector.Vector3])`

Resets the active viewport limits of *layout* to the lower left corner *p1* and the upper right corner *p2*. Replaces the current viewport configuration by a single window configuration.

## Load DXF Comments

`ezdxf.comments.from_stream(stream: TextIO, codes: Set[int] = None) → Iterable[DXFTag]`

Yields comment tags from text *stream* as `DXFTag` objects.

### Parameters

- **stream** – input text stream
- **codes** – set of group codes to yield additional DXF tags e.g. {5, 0} to also yield handle and structure tags

`ezdxf.comments.from_file(filename: str, codes: Set[int] = None) → Iterable[DXFTag]`

Yields comment tags from file *filename* as `DXFTag` objects.

### Parameters

- **filename** – filename as string
- **codes** – yields also additional tags with specified group codes e.g. {5, 0} to also yield handle and structure tags

## 6.9 Launcher

The command line script `ezdxf` launches various sub-commands:

pp	DXF pretty printer, replacement for the previous <i>dxfpp</i> command
audit	Audit and repair DXF files
draw	Draw and convert DXF files by the Matplotlib backend
view	PyQt DXF file viewer
browse	PyQt DXF structure browser for DXF debugging and curious people
browse-acis	PyQt ACIS entity content browser for SAT/SAB debugging
strip	Strip comments and THUMBNAILIMAGE section from DXF files
config	Manage config files
info	Show information and optional stats of DXF files as loaded by ezdxf

The help option `-h` is supported by the main script and all sub-commands:

```
C:\> ezdxf -h
usage: ezdxf [-h] [-V] [-v] [--config CONFIG] [--log LOG]
              {pp,audit,draw,view,browse,browse-acis,strip,config} ...

Command launcher for the Python package "ezdxf":
https://pypi.org/project/ezdxf/

positional arguments:
  {pp,audit,draw,view,browse,strip}
    pp                  pretty print DXF files as HTML file
    audit               audit and repair DXF files
    draw                draw and convert DXF files by Matplotlib
    view                view DXF files by the PyQt viewer
    browse              browse DXF file structure
    browse-acis         browse ACIS structures in DXF files
    strip               strip comments from DXF files
    config              manage config files
    info                show information and optional stats of DXF files loaded by ezdxf
    this may not represent the original content of the file, use the browse command to see the original content

optional arguments:
  -h, --help            show this help message and exit
  -V, --version         show version and exit
  -v, --verbose          give more output
  --config CONFIG        path to a config file
  --log LOG             path to a verbose appending log
```

---

**Note:** The `ezdxf` script is the only executable script installed on the user system.

---

## 6.9.1 Pretty Printer

Pretty print the DXF text content as HTML file and open the file in the default web browser:

```
C:\> ezdxf pp -o gear.dxf
```

[DXF Reference](#) | [Autodesk®](#) | [DWG TrueView](#) | [AutoCAD® Release History](#)

# gear.dxf

[HEADER](#) | [CLASSES](#) | [TABLES](#) | [BLOCKS](#) | [ENTITIES](#) | [OBJECTS](#)

## SECTION: HEADER

[previous](#) | [next](#) | [top](#)

```

9 <str> $ACADVER
1 <str> AC1027
9 <str> $ACADMAINTVER
70 <int> 105, b01101001
9 <str> $DWGCODEPAGE
3 <str> ANSI_1252
9 <str> $LASTSAVEDBY
1 <str> eздxf
9 <str> $REQUIREDVERSIONS
160 <int> 0
9 <str> $INSBASE
10 <point> (0.0, 0.0, 0.0)
9 <str> $EXTMIN
10 <point> (1e+20, 1e+20, 1e+20)
9 <str> $EXTMAX
10 <point> (-1e+20, -1e+20, -1e+20)
9 <str> $LIMMIN
10 <point> (0.0, 0.0)
9 <str> $LIMMAX
10 <point> (420.0, 297.0)

```

Print help:

```
C:\> eздxf pp -h
usage: eздxf pp [-h] [-o] [-r] [-x] [-l] [-s SECTION] FILE [FILE ...]

positional arguments:
  FILE                  DXF files pretty print

optional arguments:
  -h, --help            show this help message and exit
  -o, --open             open generated HTML file by the default web browser
  -r, --raw              raw mode, no DXF structure interpretation
  -x, --nocompile       don't compile points coordinates into single tags (only in
  ↪ raw mode)
  -l, --legacy           legacy mode, reorder DXF point coordinates
```

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```
-s SECTIONS, --sections SECTIONS
    choose sections to include and their order, h=HEADER, l
↳c=CLASSES,
t=TABLES, b=BLOCKS, e=ENTITIES, o=OBJECTS
```

## 6.9.2 Auditor

Audit and recover the DXF file “gear.dxf” and save the recovered version as “gear.rec.dxf”:

```
C:\> ezdxf audit -s gear.dxf
auditing file: gear.dxf
No errors found.
Saved recovered file as: gear.rec.dxf
```

Print help:

```
C:\> ezdxf audit -h
usage: ezdxf audit [-h] [-s] FILE [FILE ...]

positional arguments:
  FILE      audit DXF files

optional arguments:
  -h, --help  show this help message and exit
  -s, --save   save recovered files with extension ".rec.dxf"
```

## 6.9.3 Draw

Convert the DXF file “gear.dxf” into a SVG file by the *Matplotlib* backend:

```
C:\> ezdxf draw -o gear.svg gear.dxf
```

The “gear.svg” created by the *Matplotlib* backend:

Show all output formats supported by the *Matplotlib* backend on your system. This output may vary:

```
C:\> ezdxf draw --formats
eps: Encapsulated Postscript
jpg: Joint Photographic Experts Group
jpeg: Joint Photographic Experts Group
pdf: Portable Document Format
pgf: PGF code for LaTeX
png: Portable Network Graphics
ps: Postscript
raw: Raw RGBA bitmap
rgba: Raw RGBA bitmap
svg: Scalable Vector Graphics
svgz: Scalable Vector Graphics
tif: Tagged Image File Format
tiff: Tagged Image File Format
```

Print help:

```
C:\> eздxf draw -h
usage: eздxf draw [-h] [--formats] [--layout LAYOUT] [--all-layers-visible]
                   [--all-entities-visible] [-o OUT] [--dpi DPI]
                   [--ltype {approximate,accurate}]
                   [FILE]

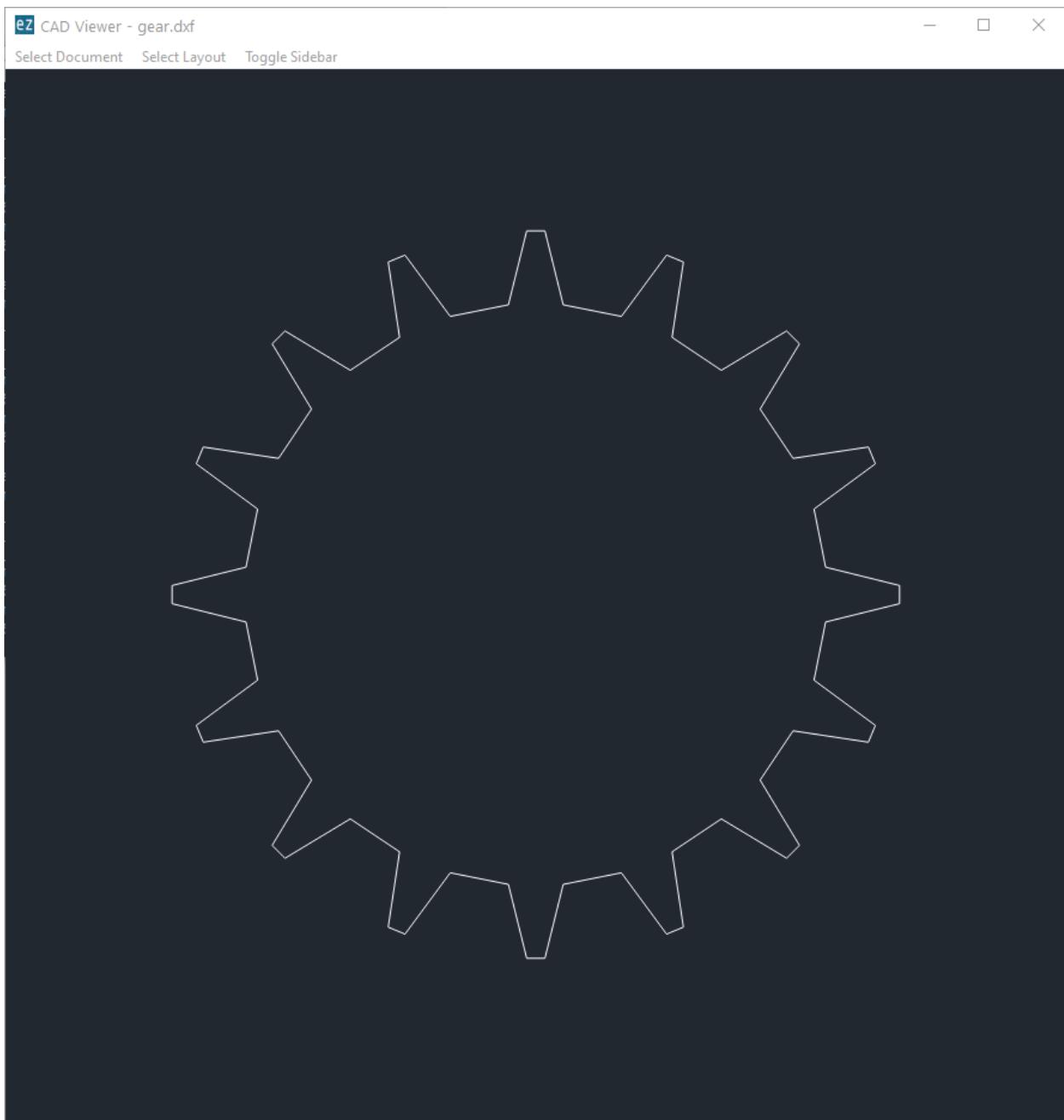
positional arguments:
  FILE                  DXF file to view or convert

optional arguments:
  -h, --help            show this help message and exit
  --formats            show all supported export formats and exit
  --layout LAYOUT      select the layout to draw
  --all-layers-visible draw all layers including the ones marked as invisible
  --all-entities-visible
                      draw all entities including the ones marked as
                      invisible (some entities are individually marked as
                      invisible even if the layer is visible)
  -o OUT, --out OUT    output filename for export
  --dpi DPI            target render resolution, default is 300
  --ltype {approximate,accurate}
                      select the line type rendering method, default is
                      approximate. Approximate uses the closest
                      approximation available to the backend, the accurate
                      method renders as accurately as possible but this
                      approach is slower.
```

## 6.9.4 View

View the DXF file “gear.dxf” by the *PyQt* backend:

```
C:\> eздxf view gear.dxf
```



Print help:

```
C:\> ezdxf view -h
usage: ezdxf view [-h] [--layout LAYOUT]
                  [--ltype {approximate,accurate}] [--lwscale LWSIZE]
                  [FILE]

positional arguments:
  FILE              DXF file to view

optional arguments:
  -h, --help         show this help message and exit
```

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```
--layout LAYOUT      select the layout to draw
--ltype {approximate,accurate}
                                select the line type rendering method, default
                                is approximate. Approximate uses the closest
                                approximation available to the backend, the
                                accurate method renders as accurately as
                                possible but this approach is slower.
--lwscale LWSCALE    set custom line weight scaling, default is 0 to
                                disable line weights at all
```

## 6.9.5 Browse

Browse the internal structure of a DXF file like a file system:

```
C:\> ezdxf browse gear.dxf
```

	Group Code	Data Type	Content
2029	0	<ctrl>	LWPOLYLINE
2031	5	<handle>	2F
2033	330	<ref>	17
2035	100	<ctrl>	AcDbEntity
2037	8	<str>	0
2039	100	<ctrl>	AcDbPolyline
2041	90	<int>	64
2043	70	<int>	1
2045	10	<point>	(9.99687255538428, -0.25007821057531726)
2049	10	<point>	(9.99687255538428, 0.25007821057531726)
2053	10	<point>	(7.964450219004663, 0.7533476680766843)
2057	10	<point>	(7.646486216427265, 2.3518606553084402)
2061	10	<point>	(9.331606731026024, 3.5945953621332394)
2065	10	<point>	(9.14020515506066, 4.0566796426884055)
2069	10	<point>	(7.069898873659621, 3.74386563811075)
2073	10	<point>	(6.164414002968977, 5.0990195135927845)
2077	10	<point>	(7.24568837309472, 6.892024376045111)
2081	10	<point>	(6.892024376045111, 7.24568837309472)
2085	10	<point>	(5.0990195135927845, 6.164414002968977)
2089	10	<point>	(3.7438656381107513, 7.069898873659621)

```
C:\> ezdxf browse -h
usage: ezdxf browse [-h] [-l LINE] [-g HANDLE] [FILE]

positional arguments:
  FILE                  DXF file to browse

optional arguments:
  -h, --help             show this help message and exit
```

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```
-l LINE, --line LINE  go to line number
-g HANDLE, --handle HANDLE
                    go to entity by HANDLE, HANDLE has to be a hex value without
                    any prefix like 'fefe'
```

The *browse* command stores options in the config file, e.g. for the *Notepad++* on Windows:

#### [browse-command]

```
text_editor = "C:\Program Files\Notepad++\notepad++.exe" "{filename}" -n{num}
icon_size = 32
```

`text_editor` is a simple format string: `text_editor.format(filename="test.dxf", num=100)`

Quote commands including spaces and always quote the filename argument!

For *xed* on Linux Mint use (note: absolute path to executable):

#### [browse-command]

```
text_editor = /usr/bin/xed "{filename}" +{num}
icon_size = 32
```

For *gedit* on Linux use (untested):

#### [browse-command]

```
text_editor = /use/bin/gedit +{num} "{filename}"
icon_size = 32
```

The *browse* command opens a DXF structure browser to investigate the internals of a DXF file without interpreting the content. The functionality of the DXF browser is similar to the DXF *Pretty Printer* (`pp` command), but without the disadvantage of creating giant HTML files. The intended usage is debugging invalid DXF files, which can not be loaded by the `ezdxf.readfile()` or the `ezdxf.recover.readfile()` functions.

## Line Numbers

The low level tag loader ignores DXF comments (group code 999). If there are comments in the DXF file the line numbers displayed in the DXF browser are not synchronized, use the `strip` command beforehand to remove all comments from the DXF file in order to keep the line numbers synchronized.

## GUI Features

The tree view on the left shows the outline of the DXF file. The number in round brackets on the right side of each item shows the count of structure entities within the structure layer, the value in angle brackets on the left side is the entity handle.

The right list view shows the entity content as DXF tags. Structure tags (data type `<ctrl>`) are shown in blue, a double click on a reference handle (datatype `<ref>`) jumps to the referenced entity, reference handles of non-existent targets are shown in red.

Clicking on the first structure tag in the list opens the DXF reference provided by Autodesk in the standard web browser.

## Auto Reload

The browser automatically displays a dialog for reloading DXF files if they have been modified by an external application.

## Menus and Shortcuts

- **File Menu**

- **Open DXF file...** *Ctrl+O*
- **Reload DXF file** *Ctrl+R*
- **Open in Text Editor** *Ctrl+T*, open the DXF file in the associated text editor at the current location
- **Export DXF Entity...** *Ctrl+E*, export the current DXF entity shown in the list view as text file
- **Copy selected DXF Tags to Clipboard** *Ctrl+C*, copy the current selected DXF tags into the clipboard
- **Copy DXF Entity to Clipboard** *Ctrl+Shift+C*, copy all DXF tags of the current DXF entity shown in the list view into the clipboard
- **Quit** *Ctrl+Q*

- **Navigate Menu**

- **Go to Handle...** *Ctrl+G*
- **Go to Line...** *Ctrl+L*
- **Find Text...** *Ctrl+F*, opens the find text dialog
- **Next Entity** *Ctrl+Right*, go to the next entity in the DXF structure
- **Previous Entity** *Ctrl+Left*, go to the previous entity in the DXF structure
- **Show Entity in TreeView** *Ctrl+Down*, expand the left tree view to the currently displayed entity in the list view - this does not happen automatically for performance reasons
- **Entity History Back** *Alt+Left*
- **Entity History Forward** *Alt+Right*
- **Go to HEADERS Section** *Shift+H*
- **Go to BLOCKS Section** *Shift+B*
- **Go to ENTITIES Section** *Shift+E*
- **Go to OBJECTS Section** *Shift+O*

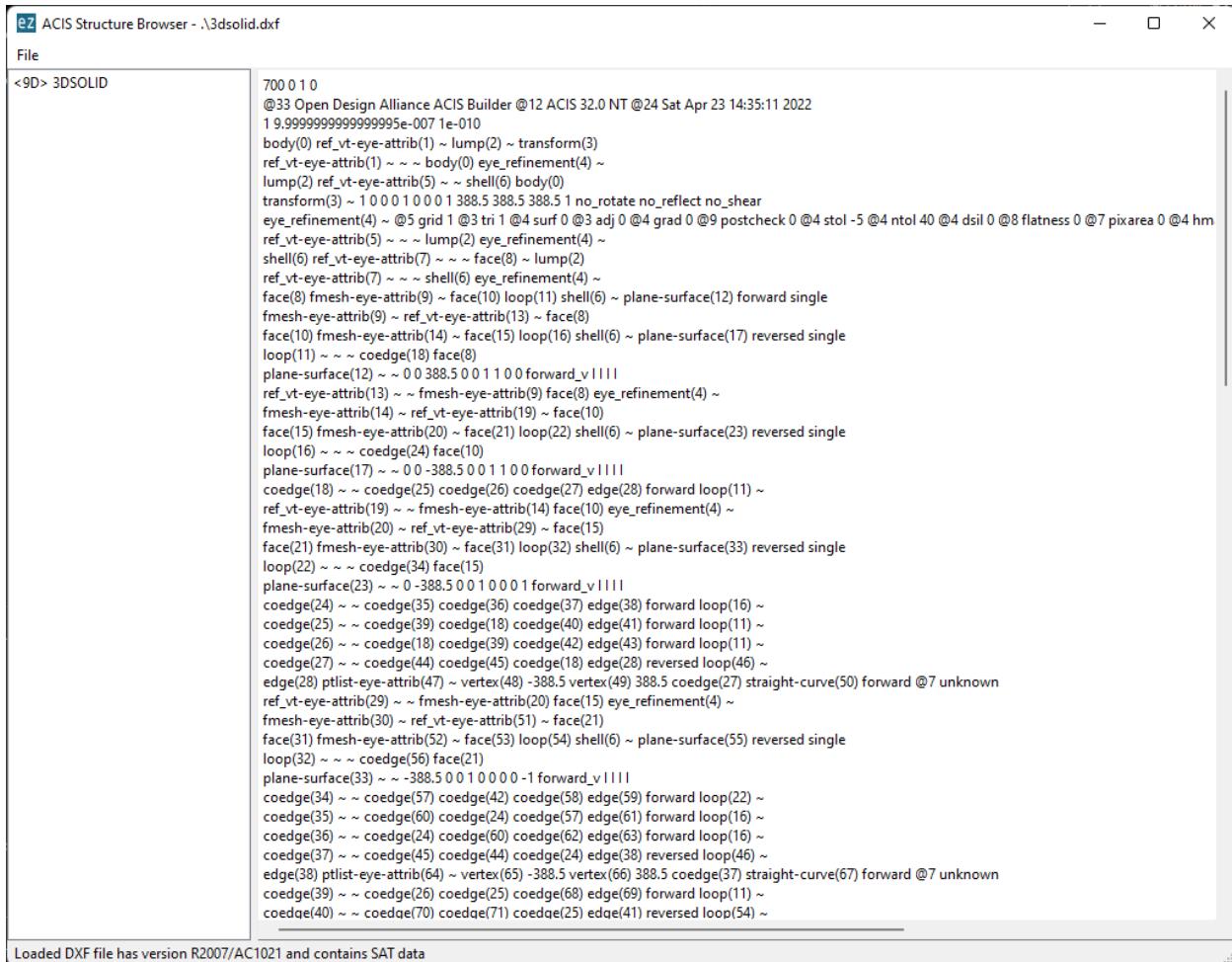
- **Bookmarks Menu**

- **Store Bookmark...** *Ctrl+Shift+B*, store current location as named bookmark
- **Go to Bookmark...** *Ctrl+B*, go to stored location

## 6.9.6 Browse-ACIS

Show and export the **SAT** or **SAB** content of **ACIS** entities:

```
C:\> ezdxf browse-acis 3dsolid.dxf
```



The screenshot shows a window titled "ez ACIS Structure Browser - .\3dsolid.dxf". The window contains a large block of raw DXF code. At the bottom of the window, there is a status bar that says "Loaded DXF file has version R2007/AC1021 and contains SAT data".

```

<9D> 3DSOLID
700 0 1 0
@33 Open Design Alliance ACIS Builder @12 ACIS 32.0 NT @24 Sat Apr 23 14:35:11 2022
1 9.099999999999995e-007 1e-010
body(0) ref_vt-eye-attrib(1) ~ lump(2) ~ transform(3)
ref_vt-eye-attrib(1) ~ ~ ~ body(0) eye_refinement(4) ~
lump(2) ref_vt-eye-attrib(5) ~ ~ shell(6) body(0)
transform(3) ~ 1 0 0 1 0 0 1 388.5 388.5 1 no_rotate no_reflect no_shear
eye_refinement(4) ~ @5 grid 1 @3 tri 1 @4 surf 0 @3 adj 0 @4 grad 0 @9 postcheck 0 @4 stol -5 @4 ntol 40 @4 dsil 0 @8 flatness 0 @7 pixarea 0 @4 hm
ref_vt-eye-attrib(5) ~ ~ ~ lump(2) eye_refinement(4) ~
shell(6) ref_vt-eye-attrib(7) ~ ~ ~ face(8) ~ lump(2)
ref_vt-eye-attrib(7) ~ ~ ~ shell(6) eye_refinement(4) ~
face(8) fmesh-eye-attrib(9) ~ face(10) loop(11) shell(6) ~ plane-surface(12) forward single
fmesh-eye-attrib(9) ~ ref_vt-eye-attrib(13) ~ face(8)
face(10) fmesh-eye-attrib(14) ~ face(15) loop(16) shell(6) ~ plane-surface(17) reversed single
loop(11) ~ ~ ~ coedge(18) face(8)
plane-surface(12) ~ ~ ~ 0 388.5 0 1 0 0 forward_v 1111
ref_vt-eye-attrib(13) ~ fmesh-eye-attrib(9) face(8) eye_refinement(4) ~
fmesh-eye-attrib(14) ~ ref_vt-eye-attrib(19) ~ face(10)
face(15) fmesh-eye-attrib(20) ~ face(21) loop(22) shell(6) ~ plane-surface(23) reversed single
loop(16) ~ ~ ~ coedge(24) face(10)
plane-surface(17) ~ ~ 0 0 -388.5 0 0 1 0 0 forward_v 1111
coedge(18) ~ ~ coedge(25) coedge(26) coedge(27) edge(28) forward loop(11) ~
ref_vt-eye-attrib(19) ~ ~ fmesh-eye-attrib(14) face(10) eye_refinement(4) ~
fmesh-eye-attrib(20) ~ ref_vt-eye-attrib(29) ~ face(15)
face(21) fmesh-eye-attrib(30) ~ face(31) loop(32) shell(6) ~ plane-surface(33) reversed single
loop(22) ~ ~ ~ coedge(34) face(15)
plane-surface(23) ~ ~ ~ 0 -388.5 0 0 1 0 0 forward_v 1111
coedge(24) ~ ~ coedge(35) coedge(36) coedge(37) edge(38) forward loop(16) ~
coedge(25) ~ ~ coedge(39) coedge(18) coedge(40) edge(41) forward loop(11) ~
coedge(26) ~ ~ coedge(18) coedge(39) coedge(42) edge(43) forward loop(11) ~
coedge(27) ~ ~ coedge(44) coedge(45) coedge(18) edge(28) reversed loop(46) ~
edge(28) ptlist-eye-attrib(47) ~ vertex(48) -388.5 vertex(49) 388.5 coedge(27) straight-curve(50) forward @7 unknown
ref_vt-eye-attrib(29) ~ ~ fmesh-eye-attrib(20) face(15) eye_refinement(4) ~
fmesh-eye-attrib(30) ~ ref_vt-eye-attrib(51) ~ face(21)
face(31) fmesh-eye-attrib(52) ~ face(53) loop(54) shell(6) ~ plane-surface(55) reversed single
loop(32) ~ ~ ~ coedge(56) face(21)
plane-surface(33) ~ ~ ~ -388.5 0 0 1 0 0 0 -1 forward_v 1111
coedge(34) ~ ~ coedge(57) coedge(42) coedge(58) edge(59) forward loop(22) ~
coedge(35) ~ ~ coedge(60) coedge(24) coedge(57) edge(61) forward loop(16) ~
coedge(36) ~ ~ coedge(24) coedge(60) coedge(62) edge(63) forward loop(16) ~
coedge(37) ~ ~ coedge(45) coedge(44) coedge(24) edge(38) reversed loop(46) ~
edge(38) ptlist-eye-attrib(64) ~ vertex(65) -388.5 vertex(66) 388.5 coedge(37) straight-curve(67) forward @7 unknown
coedge(39) ~ ~ coedge(26) coedge(25) coedge(68) edge(69) forward loop(11) ~
coedge(40) ~ ~ coedge(70) coedge(71) coedge(25) edge(41) reversed loop(54) ~

```

Loaded DXF file has version R2007/AC1021 and contains SAT data

The DXF format stores modern solid geometry as *SAT* data for DXF R2000 - R2010 and as *SAB* data for DXF R2013 and later. This command shows the content of this entities and also let you export the raw data for further processing.

## Entity View

The entity view is a read-only text editor, it is possible to select and copy parts of the text into the clipboard. All ACIS content entities get an id assigned automatically, this way the data is more readable, by default AutoCAD and BricsCAD do not use ids for ACIS entities. The id is shown as decimal number in parenthesis after the entity name. The ~ is a shortcut for a null-pointer.

```

C:\>ezdxf browse-acis -h
usage: ezdxf browse-acis [-h] [-g HANDLE] [FILE]

positional arguments:
  FILE                  DXF file to browse

options:
  -h, --help            show this help message and exit
  -g HANDLE, --handle HANDLE
                        go to entity by HANDLE, HANDLE has to be a hex value
                        without any prefix like 'fefe'

```

## Menus and Shortcuts

- **File Menu**
  - **Open DXF file...** *Ctrl+O*
  - **Reload DXF file** *Ctrl+R*
  - **Export Current Entity View...** *Ctrl+E*, Export the parsed content of the entity view as text file
  - **Export Raw SAT/SAB Data...** *Ctrl+W*, export the raw SAT data as text file and the raw SAB data as a binary file for further processing
  - **Quit** *Ctrl+Q*

## 6.9.7 Strip

Strip comment tags (group code 999) from ASCII DXF files and can remove the THUMBNAILIMAGE section. Binary DXF files are not supported.

```
C:\> eздxf strip -h
usage: eздxf strip [-h] [-b] [-v] FILE [FILE ...]

positional arguments:
  FILE           DXF file to process, wildcards "*" and "?" are supported

optional arguments:
  -h, --help      show this help message and exit
  -b, --backup    make a backup copy with extension ".bak" from the DXF file,
                  overwrites existing backup files
  -t, --thumbnail strip THUMBNAILIMAGE section
  -v, --verbose   give more output
```

## 6.9.8 Config

Manage config files.

```
C:\> eздxf config -h
usage: eздxf config [-h] [-p] [--home] [--reset]

optional arguments:
  -h, --help      show this help message and exit
  -p, --print     print configuration, to store the configuration use:
                  "eздxf config -p > my.ini"
  --home         create config file 'eздxf.ini' in the user home directory
                 '~/.config/eздxf', $XDG_CONFIG_HOME is supported if set

  --reset        factory reset, delete default config files 'eздxf.ini'
```

To create a new config file “my.ini” by printing the configuration into a file:

```
C:\> eздxf config -p > my.ini
```

## 6.9.9 Info

Show information and optional stats of DXF files as loaded by ezdxf, this may not represent the original content of the file, use the [browse](#) command to see the original content. The upgrade is necessary for very old DXF versions prior to R12 and for the “special” versions R13 and R14. The `-s` option shows some statistics about the DXF content like entity count or table count. Use the `-v` option show more of everything.

```
C:\> ezdxf info -h
usage: ezdxf info [-h] [-v] [-s] FILE [FILE ...]

positional arguments:
  FILE          DXF file to process, wildcards "*" and "?" are supported

options:
  -h, --help      show this help message and exit
  -v, --verbose   give more output
  -s, --stats     show content stats
```

This is the verbose output for an old DXF R10 file and shows that the loading process created some required structures which do not exist in DXF R10 files, like the BLOCK\_RECORD table or the OBJECTS section:

```
C:\> ezdxf info -v -s test_R10.dxf

Filename: "test_R10.dxf"
Loaded content was upgraded from DXF Version AC1006 (R10)
Release: R12
DXF Version: AC1009
Maintenance Version: <undefined>
Codepage: ANSI_1252
Encoding: cp1252
Unit system: Imperial
Modelspace units: Unitless
$LASTSAVEDBY: <undefined>
$HANDSEED: 0
$FINGERPRINTGUID: {9EADDC7C-5982-4C68-B770-8A62378C2B90}
$VERSIONGUID: {49336E63-D99B-45EC-803C-4D2BD03A7DE0}
$USERI1=0
$USERI2=0
$USERI3=0
$USERI4=0
$USERI5=0
$USERR1=0.0
$USERR2=0.0
$USERR3=0.0
$USERR4=0.0
$USERR5=0.0
File was not created by ezdxf >= 0.16.4
File was not written by ezdxf >= 0.16.4
Content stats:
LAYER table entries: 18
  0
  Defpoints
  LYR_00
  LYR_01
  LYR_02
  LYR_03
  LYR_04
```

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```
LYR_05
LYR_06
LYR_07
LYR_08
LYR_09
LYR_10
LYR_11
LYR_12
LYR_13
LYR_14
LYR_15
LTYPE table entries: 13
    BORDER
    ByBlock
    ByLayer
    CENTER
    CONTINUOUS
    CUTTING
    DASHDOT
    DASHED
    DIVIDE
    DOT
    HIDDEN
    PHANTOM
    STITCH
STYLE table entries: 1
    STANDARD
DIMSTYLE table entries: 1
    Standard
APPID table entries: 1
    ACAD
UCS table entries: 0
VIEW table entries: 0
VPORT table entries: 1
    *Active
BLOCK_RECORD table entries: 2
    *Model_Space
    *Paper_Space
Entities in modelspace: 78
    ARC (2)
    CIRCLE (2)
    LINE (74)
Entities in OBJECTS section: 20
    ACDBDICTIONARYWDFLT (1)
    ACDBPLACEHOLDER (1)
    DICTIONARY (11)
    LAYOUT (2)
    MATERIAL (3)
    MLEADERSTYLE (1)
    MLINESTYLE (1)
```

## 6.9.10 Show Version & Configuration

Show the *ezdxf* version and configuration:

```
C:\> eздxf -Vv

ezdxf v0.16.5b0 @ d:\source\ezdxf.git\src\ezdxf
Python version: 3.9.6 (tags/v3.9.6:db3ff76, Jun 28 2021, 15:26:21) [MSC v.1929 64 bit_
↪ (AMD64)]
using C-extensions: yes
using Matplotlib: yes

Configuration:
[core]
default_dimension_text_style = OpenSansCondensed-Light
test_files = D:\Source\dxftest
font_cache_directory =
load_proxy_graphics = true
store_proxy_graphics = true
log_unprocessed_tags = false
filter_invalid_xdata_group_codes = true
write_fixed_meta_data_for_testing = false
disable_c_ext = false

[browse-command]
text_editor = "C:\Program Files\Notepad++\notepad++.exe" "{filename}" -n{num}

Environment Variables:
EZDXF_DISABLE_C_EXT=
EZDXF_TEST_FILES=D:\Source\dxftest
EZDXF_CONFIG_FILE=

Existing Configuration Files:
C:\Users\manfred\.config\ezdxf\ezdxf.ini
```

**See also:**

Documentation of the `ezdxf.options` module and the *Environment Variables*.

## 6.10 Rendering

The `ezdxf.render` subpackage provides helpful utilities to create complex forms.

- create complex meshes as `Mesh` entity.
- render complex curves like bezier curves, euler spirals or splines as `Polyline` entity
- vertex generators for simple and complex forms like circle, ellipse or euler spiral

### Content

#### 6.10.1 Spline

```
class eздxf.render.Spline(points: Optional[Iterable[Union[Sequence[float],
ezdxf.math._vector.Vec2, eздxf.math._vector.Vec3]]] = None, seg-
ments: int = 100)
```

This class can be used to render B-splines into DXF R12 files as approximated `Polyline` entities. The advantage of this class over the `R12Spline` class is, that this is a real 3D curve, which means that the B-spline vertices do have to be located in a flat plane, and no `UCS` class is needed to place the curve in 3D space.

**See also:**

The newer `BSpline` class provides the advanced vertex interpolation method `flattening()`.

`__init__(points: Optional[Iterable[Union[Sequence[float], ezdxf.math._vector.Vector2, ezdxf.math._vector.Vector3]]] = None, segments: int = 100)`

**Parameters**

- **points** – spline definition points
- **segments** – count of line segments for approximation, vertex count is `segments + 1`

`subdivide(segments: int = 4) → None`

Calculate overall segment count, where `segments` is the sub-segment count, `segments = 4`, means 4 line segments between two definition points e.g. 4 definition points and 4 segments = 12 overall segments, useful for fit point rendering.

**Parameters** `segments` – sub-segments count between two definition points

`render_as_fit_points(layout: BaseLayout, degree: int = 3, method: str = 'chord', dxftattribs: Optional[dict] = None) → None`

Render a B-spline as 2D/3D `Polyline`, where the definition points are fit points.

- 2D spline vertices uses: `add_polyline2d()`
- 3D spline vertices uses: `add_polyline3d()`

**Parameters**

- **layout** – `BaseLayout` object
- **degree** – degree of B-spline (order = `degree + 1`)
- **method** – “uniform”, “distance”/“chord”, “centripetal”/“sqrt\_chord” or “arc” calculation method for parameter t
- **dxftattribs** – DXF attributes for `Polyline`

`render_open_bspline(layout: BaseLayout, degree: int = 3, dxftattribs: Optional[dict] = None) → None`

Render an open uniform B-spline as 3D `Polyline`. Definition points are control points.

**Parameters**

- **layout** – `BaseLayout` object
- **degree** – degree of B-spline (order = `degree + 1`)
- **dxftattribs** – DXF attributes for `Polyline`

`render_uniform_bspline(layout: BaseLayout, degree: int = 3, dxftattribs: Optional[dict] = None) → None`

Render a uniform B-spline as 3D `Polyline`. Definition points are control points.

**Parameters**

- **layout** – `BaseLayout` object
- **degree** – degree of B-spline (order = `degree + 1`)
- **dxftattribs** – DXF attributes for `Polyline`

`render_closed_bspline(layout: BaseLayout, degree: int = 3, dxftattribs: Optional[dict] = None) → None`

Render a closed uniform B-spline as 3D `Polyline`. Definition points are control points.

**Parameters**

- **layout** – `BaseLayout` object
- **degree** – degree of B-spline (order =  $degree + 1$ )
- **dxfattribs** – DXF attributes for `Polyline`

`render_open_rbspline(layout: BaseLayout, weights: Iterable[float], degree: int = 3, dxfattribs: Optional[dict] = None) → None`

Render a rational open uniform BSpline as 3D `Polyline`. Definition points are control points.

#### Parameters

- **layout** – `BaseLayout` object
- **weights** – list of weights, requires a weight value (float) for each definition point.
- **degree** – degree of B-spline (order =  $degree + 1$ )
- **dxfattribs** – DXF attributes for `Polyline`

`render_uniform_rbspline(layout: BaseLayout, weights: Iterable[float], degree: int = 3, dxfattribs: Optional[dict] = None) → None`

Render a rational uniform B-spline as 3D `Polyline`. Definition points are control points.

#### Parameters

- **layout** – `BaseLayout` object
- **weights** – list of weights, requires a weight value (float) for each definition point.
- **degree** – degree of B-spline (order =  $degree + 1$ )
- **dxfattribs** – DXF attributes for `Polyline`

`render_closed_rbspline(layout: BaseLayout, weights: Iterable[float], degree: int = 3, dxfattribs: Optional[dict] = None) → None`

Render a rational B-spline as 3D `Polyline`. Definition points are control points.

#### Parameters

- **layout** – `BaseLayout` object
- **weights** – list of weights, requires a weight value (float) for each definition point.
- **degree** – degree of B-spline (order =  $degree + 1$ )
- **dxfattribs** – DXF attributes for `Polyline`

## 6.10.2 R12Spline

```
class ezdxf.render.R12Spline(control_points: Iterable[Union[Sequence[float],  
ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3]], degree:  
int = 2, closed: bool = True)
```

DXF R12 supports 2D B-splines, but Autodesk do not document the usage in the DXF Reference. The base entity for splines in DXF R12 is the POLYLINE entity. The spline itself is always in a plane, but as any 2D entity, the spline can be transformed into the 3D object by elevation and extrusion ([OCS](#), [UCS](#)).

This way it was possible to store the spline parameters in the DXF R12 file, to allow CAD applications to modify the spline parameters and rerender the B-spline afterward again as polyline approximation. Therefore the result is not better than an approximation by the `Spline` class, it is also just a POLYLINE entity, but maybe someone need exact this tool in the future.

```
__init__(control_points: Iterable[Union[Sequence[float],  
ezdxf.math._vector.Vec3]], degree: int = 2, closed: bool = True)
```

### Parameters

- **control\_points** – B-spline control frame vertices
- **degree** – degree of B-spline, only 2 and 3 is supported
- **closed** – True for closed curve

**render**(*layout*: *BaseLayout*, *segments*: *int* = 40, *ucs*: *Optional[UCS]* = *None*, *dxfattribs*: *Optional[dict]* = *None*) → *Polyline*

Renders the B-spline into *layout* as 2D *Polyline* entity. Use an *UCS* to place the 2D spline in the 3D space, see [approximate\(\)](#) for more information.

### Parameters

- **layout** – *BaseLayout* object
- **segments** – count of line segments for approximation, vertex count is *segments* + 1
- **ucs** – *UCS* definition, control points in ucs coordinates.
- **dxfattribs** – DXF attributes for *Polyline*

**approximate**(*segments*: *int* = 40, *ucs*: *Optional[UCS]* = *None*) → *List[Union[Sequence[float], ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3]]*

Approximate the B-spline by a polyline with *segments* line segments. If *ucs* is not *None*, ucs defines an *UCS*, to transformed the curve into *OCS*. The control points are placed xy-plane of the UCS, don't use z-axis coordinates, if so make sure all control points are in a plane parallel to the OCS base plane (UCS xy-plane), else the result is unpredictable and depends on the CAD application used to open the DXF file - it may crash.

### Parameters

- **segments** – count of line segments for approximation, vertex count is *segments* + 1
- **ucs** – *UCS* definition, control points in ucs coordinates

**Returns** list of vertices in *OCS* as *Vec3* objects

## 6.10.3 Bezier

**class** *ezdxf.render.Bezier*

Render a bezier curve as 2D/3D *Polyline*.

The *Bezier* class is implemented with multiple segments, each segment is an optimized 4 point bezier curve, the 4 control points of the curve are: the start point (1) and the end point (4), point (2) is start point + start vector and point (3) is end point + end vector. Each segment has its own approximation count.

### See also:

The new *ezdxf.path* package provides many advanced construction tools based on the *Path* class.

**start**(*point*: *Union[Sequence[float], ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3]*, *tangent*: *Union[Sequence[float], ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3]*) → *None*  
Set start point and start tangent.

### Parameters

- **point** – start point
- **tangent** – start tangent as vector, example: (5, 0, 0) means a horizontal tangent with a length of 5 drawing units

```
append(point: Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3], tangent1: Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3], tangent2: Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3], tangent2: Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3, None] = None, segments: int = 20)
```

Append a control point with two control tangents.

#### Parameters

- **point** – control point
- **tangent1** – first tangent as vector “left” of the control point
- **tangent2** – second tangent as vector “right” of the control point, if omitted *tangent2* = *-tangent1*
- **segments** – count of line segments for the polyline approximation, count of line segments from the previous control point to the appended control point.

```
render(layout: BaseLayout, force3d: bool = False, dxfattribs: Optional[dict] = None) → None
```

Render bezier curve as 2D/3D *Polyline*.

#### Parameters

- **layout** – *BaseLayout* object
- **force3d** – force 3D polyline rendering
- **dfattribs** – DXF attributes for *Polyline*

### 6.10.4 EulerSpiral

```
class ezdxf.render.EulerSpiral(curvature: float = 1)
```

Render an *euler spiral* as a 3D *Polyline* or a *Spline* entity.

This is a parametric curve, which always starts at the origin (0, 0).

```
__init__(curvature: float = 1)
```

**Parameters** **curvature** – Radius of curvature

```
render_polyline(layout: BaseLayout, length: float = 1, segments: int = 100, matrix: Optional[Matrix44] = None, dxfattribs: Optional[dict] = None)
```

Render curve as *Polyline*.

#### Parameters

- **layout** – *BaseLayout* object
- **length** – length measured along the spiral curve from its initial position
- **segments** – count of line segments to use, vertex count is *segments* + 1
- **matrix** – transformation matrix as *Matrix44*
- **dfattribs** – DXF attributes for *Polyline*

**Returns** *Polyline*

```
render_spline(layout: BaseLayout, length: float = 1, fit_points: int = 10, degree: int = 3, matrix: Optional[Matrix44] = None, dxfattribs: Optional[dict] = None)
```

Render curve as *Spline*.

#### Parameters

- **layout** – *BaseLayout* object

- **length** – length measured along the spiral curve from its initial position
- **fit\_points** – count of spline fit points to use
- **degree** – degree of B-spline
- **matrix** – transformation matrix as *Matrix44*
- **dxftattribs** – DXF attributes for *Spline*

Returns *Spline*

## 6.10.5 Random Paths

Random path generators for testing purpose.

```
ezdxf.render.random_2d_path(steps: int = 100, max_step_size: float = 1.0, max_heading:  
                           float = 1.5707963267948966, retarget: int = 20) → Iterable[ezdxf.math._vector.Vec2]
```

Returns a random 2D path as iterable of *Vec2* objects.

### Parameters

- **steps** – count of vertices to generate
- **max\_step\_size** – max step size
- **max\_heading** – limit heading angle change per step to  $\pm \text{max\_heading}/2$  in radians
- **retarget** – specifies steps before changing global walking target

```
ezdxf.render.random_3d_path(steps: int = 100, max_step_size: float = 1.0, max_heading: float  
                           = 1.5707963267948966, max_pitch: float = 0.39269908169872414,  
                           retarget: int = 20) → Iterable[ezdxf.math._vector.Vec3]
```

Returns a random 3D path as iterable of *Vec3* objects.

### Parameters

- **steps** – count of vertices to generate
- **max\_step\_size** – max step size
- **max\_heading** – limit heading angle change per step to  $\pm \text{max\_heading}/2$ , rotation about the z-axis in radians
- **max\_pitch** – limit pitch angle change per step to  $\pm \text{max\_pitch}/2$ , rotation about the x-axis in radians
- **retarget** – specifies steps before changing global walking target

## 6.10.6 Forms

This module provides functions to create 2D and 3D forms as vertices or mesh objects.

### 2D Forms

- *box()*
- *circle()*
- *ellipse()*
- *euler\_spiral()*
- *gear()*

- `ngon()`
- `square()`
- `star()`

### 3D Forms

- `cone_2p()`
- `cone()`
- `cube()`
- `cylinder()`
- `cylinder_2p()`
- `helix()`
- `sphere()`
- `torus()`

### 3D Form Builder

- `extrude()`
- `extrude_twist_scale()`
- `from_profiles_linear()`
- `from_profiles_spline()`
- `rotation_form()`
- `sweep()`
- `sweep_profile()`

## 2D Forms

Basic 2D shapes as iterable of `Vec3`.

```
ezdxf.render.forms.box(sx: float = 1.0, sy: float = 1.0, center=False) →
    Tuple[ezdxf.math._vector.Vector3, ezdxf.math._vector.Vector3,
          ezdxf.math._vector.Vector3, ezdxf.math._vector.Vector3]
```

Returns 4 vertices for a box with a width of `sx` by and a height of `sy`. The center of the box in (0, 0) if `center` is True otherwise the lower left corner is (0, 0), upper right corner is (`sx, sy`).

Changed in version 0.18: added argument `center`

```
ezdxf.render.forms.circle(count: int, radius: float = 1, elevation: float = 0, close: bool = False) →
    Iterable[ezdxf.math._vector.Vector3]
```

Create polygon vertices for a `circle` with the given `radius` and approximated by `count` vertices, `elevation` is the z-axis for all vertices.

### Parameters

- **count** – count of polygon vertices
- **radius** – circle radius
- **elevation** – z-axis for all vertices
- **close** – yields first vertex also as last vertex if True.

**Returns** vertices in counter-clockwise orientation as `Vec3` objects

```
ezdxf.render.forms.ellipse(count: int, rx: float = 1, ry: float = 1, start_param: float = 0,  
end_param: float = 6.283185307179586, elevation: float = 0) → Iterable[ezdxf.math._vector.Vec3]
```

Create polygon vertices for an [ellipse](#) with given `rx` as x-axis radius and `ry` as y-axis radius approximated by `count` vertices, `elevation` is the z-axis for all vertices. The ellipse goes from `start_param` to `end_param` in counter clockwise orientation.

#### Parameters

- `count` – count of polygon vertices
- `rx` – ellipse x-axis radius
- `ry` – ellipse y-axis radius
- `start_param` – start of ellipse in range  $[0, 2\pi]$
- `end_param` – end of ellipse in range  $[0, 2\pi]$
- `elevation` – z-axis for all vertices

**Returns** vertices in counter clockwise orientation as [Vec3](#) objects

```
ezdxf.render.forms.euler_spiral(count: int, length: float = 1, curvature: float = 1, elevation:  
float = 0) → Iterable[ezdxf.math._vector.Vec3]
```

Create polygon vertices for an [euler spiral](#) of a given `length` and radius of curvature. This is a parametric curve, which always starts at the origin  $(0, 0)$ .

#### Parameters

- `count` – count of polygon vertices
- `length` – length of curve in drawing units
- `curvature` – radius of curvature
- `elevation` – z-axis for all vertices

**Returns** vertices as [Vec3](#) objects

```
ezdxf.render.forms.gear(count: int, top_width: float, bottom_width: float, height: float, out-  
side_radius: float, elevation: float = 0, close: bool = False) → Iterable[ezdxf.math._vector.Vec3]
```

Returns the corner vertices of a [gear shape](#) (cogwheel).

**Warning:** This function does not create correct gears for mechanical engineering!

#### Parameters

- `count` – teeth count  $\geq 3$
- `top_width` – teeth width at outside radius
- `bottom_width` – teeth width at base radius
- `height` – teeth height; base radius = outside radius - height
- `outside_radius` – outside radius
- `elevation` – z-axis for all vertices
- `close` – yields first vertex also as last vertex if True.

**Returns** vertices in counter clockwise orientation as [Vec3](#) objects

```
ezdxf.render.forms.ngon(count: int, length: Optional[float] = None, radius: Optional[float] = None,
                        rotation: float = 0.0, elevation: float = 0.0, close: bool = False) → Iterable[ezdxf.math._vector.Vec3]
```

Returns the corner vertices of a [regular polygon](#). The polygon size is determined by the edge *length* or the circum *radius* argument. If both are given *length* has the higher priority.

#### Parameters

- **count** – count of polygon corners  $\geq 3$
- **length** – length of polygon side
- **radius** – circum radius
- **rotation** – rotation angle in radians
- **elevation** – z-axis for all vertices
- **close** – yields first vertex also as last vertex if True.

**Returns** vertices as [Vec3](#) objects

```
ezdxf.render.forms.square(size: float = 1.0, center=False) → Tuple[ezdxf.math._vector.Vec3,
                                                               ezdxf.math._vector.Vec3,
                                                               ezdxf.math._vector.Vec3]
```

Returns 4 vertices for a square with a side length of the given *size*. The center of the square is  $(0, 0)$  if *center* is True otherwise the lower left corner is  $(0, 0)$ , upper right corner is  $(size, size)$ .

Changed in version 0.18: added argument *center*

```
ezdxf.render.forms.star(count: int, r1: float, r2: float, rotation: float = 0.0, elevation: float = 0.0,
                        close: bool = False) → Iterable[ezdxf.math._vector.Vec3]
```

Returns the corner vertices for a [star shape](#).

The shape has *count* spikes, *r1* defines the radius of the “outer” vertices and *r2* defines the radius of the “inner” vertices, but this does not mean that *r1* has to be greater than *r2*.

#### Parameters

- **count** – spike count  $\geq 3$
- **r1** – radius 1
- **r2** – radius 2
- **rotation** – rotation angle in radians
- **elevation** – z-axis for all vertices
- **close** – yields first vertex also as last vertex if True.

**Returns** vertices as [Vec3](#) objects

## 3D Forms

Create 3D forms as [MeshTransformer](#) objects.

```
ezdxf.render.forms.cube(center: bool = True) → ezdxf.render.mesh.MeshTransformer
```

Create a [cube](#) as [MeshTransformer](#) object.

**Parameters** **center** – ‘mass’ center of cube,  $(0, 0, 0)$  if True, else first corner at  $(0, 0, 0)$

**Returns:** [MeshTransformer](#)

```
ezdxf.render.forms.cone(count: int = 16, radius: float = 1.0, apex: Union[Sequence[float],  
                      eздxf.math._vector.Vec2, eздxf.math._vector.Vec3] = (0, 0, 1), *,  
                      caps=True) → eздxf.render.mesh.MeshTransformer
```

Create a cone as *MeshTransformer* object, the base center is fixed in the origin (0, 0, 0).

#### Parameters

- **count** – edge count of basis\_vector
- **radius** – radius of basis\_vector
- **apex** – tip of the cone
- **caps** – add a bottom face as ngon if True

```
ezdxf.render.forms.cone_2p(count: int = 16, radius: float = 1.0, base_center=(0, 0, 0), apex=(0, 0,  
                                         1), *, caps=True) → eздxf.render.mesh.MeshTransformer
```

Create a cone as *MeshTransformer* object from two points, *base\_center* is the center of the base circle and *apex* as the tip of the cone.

#### Parameters

- **count** – edge count of basis\_vector
- **radius** – radius of basis\_vector
- **base\_center** – center point of base circle
- **apex** – tip of the cone
- **caps** – add a bottom face as ngon if True

```
ezdxf.render.forms.cylinder(count: int = 16, radius: float = 1.0, top_radius: Optional[float] =  
                           None, top_center: Union[Sequence[float], eздxf.math._vector.Vec2,  
                           eздxf.math._vector.Vec3] = (0, 0, 1), *, caps=True) →  
                           eздxf.render.mesh.MeshTransformer
```

Create a cylinder as *MeshTransformer* object, the base center is fixed in the origin (0, 0, 0).

#### Parameters

- **count** – profiles edge count
- **radius** – radius for bottom profile
- **top\_radius** – radius for top profile, if None top\_radius == radius
- **top\_center** – location vector for the center of the top profile
- **caps** – close hull with top- and bottom faces (ngons)

```
ezdxf.render.forms.cylinder_2p(count: int = 16, radius: float = 1, base_center=(0,  
                                0, 0), top_center=(0, 0, 1), caps=True) →  
                                eздxf.render.mesh.MeshTransformer
```

Create a cylinder as *MeshTransformer* object from two points, *base\_center* is the center of the base circle and, *top\_center* the center of the top circle.

#### Parameters

- **count** – profiles edge count
- **radius** – radius for bottom profile
- **base\_center** – center of base circle
- **top\_center** – center of top circle
- **caps** – close hull with top- and bottom faces (ngons)

Returns: *MeshTransformer*

```
ezdxf.render.forms.helix(radius: float, pitch: float, turns: float, resolution: int = 16, ccw=True) →
    Iterator[ezdxf.math._vector.Vec3]
```

Yields the vertices of a [helix](#). The center of the helix is always (0, 0), a positive *pitch* value creates a helix along the +z-axis, a negative value along the -z-axis.

#### Parameters

- **radius** – helix radius
- **pitch** – the height of one complete helix turn
- **turns** – count of turns
- **resolution** – vertices per turn
- **ccw** – creates a counter-clockwise turning (right-handed) helix if True

New in version 0.18.

```
ezdxf.render.forms.sphere(count: int = 16, stacks: int = 8, radius: float = 1, *, quads=True) →
    ezdxf.render.mesh.MeshTransformer
```

Create a [sphere](#) as *MeshTransformer* object, the center of the sphere is always at (0, 0, 0).

#### Parameters

- **count** – longitudinal slices
- **stacks** – latitude slices
- **radius** – radius of sphere
- **quads** – use quadrilaterals as faces if True else triangles

```
ezdxf.render.forms.torus(major_count: int = 16, minor_count: int = 8, ma-
    jor_radius=1.0, minor_radius=0.1, start_angle: float = 0.0,
    end_angle: float = 6.283185307179586, *, caps=True) →
    ezdxf.render.mesh.MeshTransformer
```

Create a [torus](#) as *MeshTransformer* object, the center of the torus is always at (0, 0, 0). The *major\_radius* has to be bigger than the *minor\_radius*.

#### Parameters

- **major\_count** – count of circles
- **minor\_count** – count of circle vertices
- **major\_radius** – radius of the circle center
- **minor\_radius** – radius of circle
- **start\_angle** – start angle of torus in radians
- **end\_angle** – end angle of torus in radians
- **caps** – close hull with start- and end faces (ngons) if the torus is open

New in version 0.18.

## 3D Form Builder

```
ezdxf.render.forms.extrude(profile: Iterable[Union[Sequence[float], eздxf.math._vector.Vec2, eздxf.math._vector.Vec3]], path: Iterable[Union[Sequence[float], eздxf.math._vector.Vec2, eздxf.math._vector.Vec3]], close=True, caps=False) → eздxf.render.mesh.MeshTransformer
```

Extrude a *profile* polygon along a *path* polyline, the vertices of *profile* should be in counter-clockwise order. The sweeping profile will not be rotated at extrusion!

### Parameters

- **profile** – sweeping profile as list of (x, y, z) tuples in counter-clockwise order
- **path** – extrusion path as list of (x, y, z) tuples
- **close** – close profile polygon if True
- **caps** – close hull with top- and bottom faces (ngons)

Returns: *MeshTransformer*

Changed in version 0.18: added parameter *caps* to close hull with top- and bottom faces

```
ezdxf.render.forms.extrude_twist_scale(profile: Iterable[Union[Sequence[float], eздxf.math._vector.Vec2, eздxf.math._vector.Vec3]], path: Iterable[Union[Sequence[float], eздxf.math._vector.Vec2, eздxf.math._vector.Vec3]], *, twist: float = 0.0, scale: float = 1.0, step_size: float = 1.0, close=True, caps=False, quads=True) → eздxf.render.mesh.MeshTransformer
```

Extrude a *profile* polygon along a *path* polyline, the vertices of *profile* should be in counter-clockwise order. This implementation can scale and twist the sweeping profile along the extrusion path. The *path* segment points are fix points, the *max\_step\_size* is used to create intermediate profiles between this fix points. The *max\_step\_size* is adapted for each segment to create equally spaced distances. The twist angle is the rotation angle in radians and the scale *argument* defines the scale factor of the final profile. The twist angle and scaling factor of the intermediate profiles will be linear interpolated between the start and end values.

### Parameters

- **profile** – sweeping profile as list of (x, y, z) tuples in counter-clockwise order
- **path** – extrusion path as list of (x, y, z) tuples
- **twist** – rotate sweeping profile up to the given end rotation angle in radians
- **scale** – scale sweeping profile gradually from 1.0 to given value
- **step\_size** – rough distance between automatically created intermediate profiles, the step size is adapted to the distances between the path segment points, a value od 0.0 disables creating intermediate profiles
- **close** – close profile polygon if True
- **caps** – close hull with top- and bottom faces (ngons)
- **quads** – use quads for “sweeping” faces if True else triangles, the top and bottom faces are always ngons

New in version 0.18.

Returns: *MeshTransformer*

```
ezdxf.render.forms.from_profiles_linear(profiles: Sequence[Sequence[ezdxf.math._vector.Vec3]],  
                                         *, close=True, quads=True, caps=False) →  
                                         ezdxf.render.mesh.MeshTransformer
```

Returns a [MeshTransformer](#) instance from linear connected *profiles*.

#### Parameters

- **profiles** – list of profiles
- **close** – close profile polygon if True
- **quads** – use quadrilaterals as connection faces if True else triangles
- **caps** – close hull with top- and bottom faces (ngons)

```
ezdxf.render.forms.from_profiles_spline(profiles: Sequence[Sequence[ezdxf.math._vector.Vec3]],  
                                         subdivide: int = 4, *, close=True,  
                                         quads=True, caps=False) →  
                                         ezdxf.render.mesh.MeshTransformer
```

Returns a [MeshTransformer](#) instance by spline interpolation between given *profiles*. Requires at least 4 profiles. A *subdivide* value of 4, means, create 4 face loops between two profiles, without interpolation two profiles create one face loop.

#### Parameters

- **profiles** – list of profiles
- **subdivide** – count of face loops
- **close** – close profile polygon if True
- **quads** – use quadrilaterals as connection faces if True else triangles
- **caps** – close hull with top- and bottom faces (ngons)

```
ezdxf.render.forms.rotation_form(count: int, profile: Iterable[Union[Sequence[float],  
                                                               ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3]], angle:  
                                         float = 6.283185307179586, axis: Union[Sequence[float],  
                                                               ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3] = (1, 0, 0),  
                                         *, caps=False) → ezdxf.render.mesh.MeshTransformer
```

Returns a [MeshTransformer](#) instance created by rotating a *profile* around an *axis*.

#### Parameters

- **count** – count of rotated profiles
- **profile** – profile to rotate as list of vertices
- **angle** – rotation angle in radians
- **axis** – rotation axis
- **caps** – close hull with start- and end faces (ngons)

Changed in version 0.18: added arguments *caps* and *triangulation*

```
ezdxf.render.forms.sweep(profile: Iterable[Union[Sequence[float], ezdxf.math._vector.Vec2,  
                                              ezdxf.math._vector.Vec3]], sweeping_path: Iterable[Union[Sequence[float],  
                                                               ezdxf.math._vector.Vec2,  
                                                               ezdxf.math._vector.Vec3]], *, close=True, quads=True, caps=True)  
→ ezdxf.render.mesh.MeshTransformer
```

Returns the mesh from sweeping a profile along a 3D path, where the sweeping path defines the final location in the WCS.

The profile is defined in a reference system. The origin of this reference system will be moved along the sweeping path where the z-axis of the reference system is pointing into the moving direction.

Returns the mesh as `ezdxf.render.MeshTransformer` object.

#### Parameters

- **profile** – sweeping profile defined in the reference system as iterable of (x, y, z) coordinates in counter-clockwise order
- **sweeping\_path** – the sweeping path defined in the WCS as iterable of (x, y, z) coordinates
- **close** – close sweeping profile if True
- **quads** – use quadrilaterals as connection faces if True else triangles
- **caps** – close hull with top- and bottom faces (ngons)

New in version 0.18.

```
ezdxf.render.forms.sweep_profile(profile: Iterable[Union[Sequence[float],  
ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3]]],  
sweeping_path: Iterable[Union[Sequence[float],  
ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3]]) →  
List[Sequence[ezdxf.math._vector.Vec3]]
```

Returns the intermediate profiles of sweeping a profile along a 3D path where the sweeping path defines the final location in the WCS.

The profile is defined in a reference system. The origin of this reference system will be moved along the sweeping path where the z-axis of the reference system is pointing into the moving direction.

Returns the start-, end- and all intermediate profiles along the sweeping path.

New in version 0.18.

## 6.10.7 MeshBuilder

The `MeshBuilder` classes are helper tools to manage meshes buildup by vertices and faces. The vertices are stored in a vertices list as `Vec3` instances. The faces are stored as a sequence of vertex indices which is the location of the vertex in the vertex list. A single `MeshBuilder` class can contain multiple separated meshes at the same time.

The method `MeshBuilder.render_mesh()` renders the content as a single DXF `Mesh` entity, which supports ngons, ngons are polygons with more than 4 vertices. This entity requires at least DXF R2000.

The method `MeshBuilder.render_polyface()` renders the content as a single DXF `Polyface` entity, which supports only triangles and quadrilaterals. This entity is supported by DXF R12.

The method `MeshBuilder.render_3dfaces()` renders each face of the mesh as a single DXF `Face3d` entity, which supports only triangles and quadrilaterals. This entity is supported by DXF R12.

The `MeshTransformer` class is often used as an interface object to transfer mesh data between functions and modules, like for the mesh exchange add-on `meshex`.

The basic `MeshBuilder` class does not support transformations.

```
class eздxf.render.MeshBuilder
```

#### vertices

List of vertices as `Vec3` or (x, y, z) tuple

#### faces

List of faces as list of vertex indices, where a vertex index is the index of the vertex in the `vertices` list. A face requires at least three vertices, `Mesh` supports ngons, so the count of vertices is not limited.

---

**add\_face** (*vertices*: *Iterable[Union[Sequence[float], ezdxf.math.\_vector.Vec3]]*) → None

Add a face as vertices list to the mesh. A face requires at least 3 vertices, each vertex is a (x, y, z) tuple or *Vec3* object. The new vertex indices are stored as face in the *faces* list.

**Parameters** **vertices** – list of at least 3 vertices [(x1, y1, z1), (x2, y2, z2), (x3, y3, z3), ...]

**add\_mesh** (*vertices*: *Optional[List[ezdxf.math.\_vector.Vec3]]* = None, *faces*: *Optional[List[Sequence[int]]]* = None, *mesh*=None) → None

Add another mesh to this mesh.

A *mesh* can be a *MeshBuilder*, *MeshVertexMerger* or *Mesh* object or requires the attributes *vertices* and *faces*.

#### Parameters

- **vertices** – list of vertices, a vertex is a (x, y, z) tuple or *Vec3* object
- **faces** – list of faces, a face is a list of vertex indices
- **mesh** – another mesh entity

**add\_vertices** (*vertices*: *Iterable[Union[Sequence[float], ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3]]*) → Sequence[int]

Add new vertices to the mesh, each vertex is a (x, y, z) tuple or a *Vec3* object, returns the indices of the *vertices* added to the *vertices* list.

e.g. adding 4 vertices to an empty mesh, returns the indices (0, 1, 2, 3), adding additional 4 vertices returns the indices (4, 5, 6, 7).

**Parameters** **vertices** – list of vertices, vertex as (x, y, z) tuple or *Vec3* objects

**Returns** indices of the *vertices* added to the *vertices* list

**Return type** tuple

**bbox** () → ezdxf.math.bbox.BoundingBox

Returns the *BoundingBox* of the mesh.

New in version 0.18.

**copy** ()

Returns a copy of mesh.

**diagnose** () → ezdxf.render.mesh.MeshDiagnose

Returns the *MeshDiagnose* object for this mesh.

New in version 0.18.

**face\_normals** () → Iterator[ezdxf.math.\_vector.Vec3]

Yields all face normals, yields the NULLVEC instance for degenerated faces.

New in version 0.18.

**face\_orientation\_detector** (*reference*: int = 0) → ezdxf.render.mesh.FaceOrientationDetector

Returns a *FaceOrientationDetector* or short *fod* instance. The forward orientation is defined by the *reference* face which is 0 by default.

The *fod* can check if all faces are reachable from the reference face and if all faces have the same orientation. The *fod* can be reused to unify the face orientation of the mesh.

**faces\_as\_vertices** () → Iterator[List[ezdxf.math.\_vector.Vec3]]

Yields all faces as list of vertices.

**flip\_normals ()** → None  
Flips the normals of all faces by reversing the vertex order inplace.  
New in version 0.18.

**classmethod from\_builder (other: MeshBuilder)**  
Create new mesh from other mesh builder, faster than `from_mesh ()` but supports only `MeshBuilder` and inherited classes.

**classmethod from\_mesh (other: Union[MeshBuilder, Mesh])** → T  
Create new mesh from other mesh as class method.

**Parameters** `other` – mesh of type `MeshBuilder` and inherited or DXF `Mesh` entity or any object providing attributes `vertices`, `edges` and `faces`.

**classmethod from\_polyface (other: Union[Polymesh, Polyface])** → T  
Create new mesh from a `Polyface` or `Polymesh` object.

**get\_face\_vertices (index: int)** → Sequence[ezdxf.math.\_vector.Vec3]  
Returns the face `index` as sequence of `Vec3` objects.  
New in version 0.18.

**get\_face\_normal (index: int)** → ezdxf.math.\_vector.Vec3  
Returns the normal vector of the face `index` as `Vec3`, returns the `NULVEC` instance for degenerated faces.  
New in version 0.18.

**merge\_coplanar\_faces (passes: int = 1)** → ezdxf.render.mesh.MeshTransformer  
Returns a new `MeshBuilder` object with merged adjacent coplanar faces.  
The faces have to share at least two vertices and have to have the same clockwise or counter-clockwise vertex order.  
The current implementation is not very capable!  
New in version 0.18.

**mesh\_tessellation (max\_vertex\_count: int = 4)** → ezdxf.render.mesh.MeshTransformer  
Returns a new `MeshTransformer` instance, where each face has no more vertices than the given `max_vertex_count`.  
The `fast` mode uses a shortcut for faces with less than 6 vertices which may not work for concave faces!  
New in version 0.18.

**normalize\_faces ()** → None  
Removes duplicated vertex indices from faces and stores all faces as open faces, where the last vertex is not coincident with the first vertex.  
New in version 0.18.

**open\_faces ()** → Iterator[Sequence[int]]  
Yields all faces as sequence of integers where the first vertex is not coincident with the last vertex.  
New in version 0.18.

**optimize\_vertices (precision: int = 6)** → ezdxf.render.mesh.MeshTransformer  
Returns a new mesh with optimized vertices. Coincident vertices are merged together and all faces are open faces (first vertex != last vertex). Uses internally the `MeshVertexMerger` class to merge vertices.  
New in version 0.18.

**render\_3dfaces (layout: GenericLayoutType, dxfattribs=None, matrix: Matrix44 = None, ucs: UCS = None)**  
Render mesh as `Face3d` entities into `layout`.

## Parameters

- **layout** – `BaseLayout` object
- **dxfattribs** – dict of DXF attributes e.g. `{'layer': 'mesh', 'color': 7}`
- **matrix** – transformation matrix of type `Matrix44`
- **ucs** – transform vertices by `UCS` to `WCS`

Changed in version 0.18: Uses the `tessellation()` method to process ngons with more than the 4 vertices which can handle concave faces.

**render\_mesh** (`layout: GenericLayoutType, dxfattribs=None, matrix: Matrix44 = None, ucs: UCS = None`)

Render mesh as `Mesh` entity into `layout`.

## Parameters

- **layout** – `BaseLayout` object
- **dxfattribs** – dict of DXF attributes e.g. `{'layer': 'mesh', 'color': 7}`
- **matrix** – transformation matrix of type `Matrix44`
- **ucs** – transform vertices by `UCS` to `WCS`

**render\_normals** (`layout: GenericLayoutType, length: float = 1, relative=True, dxfattribs=None`)

Render face normals as `Line` entities into `layout`, useful to check orientation of mesh faces.

## Parameters

- **layout** – `BaseLayout` object
- **length** – visual length of normal, use length < 0 to point normals in opposite direction
- **relative** – scale length relative to face size if True
- **dxfattribs** – dict of DXF attributes e.g. `{'layer': 'normals', 'color': 6}`

**render\_polyface** (`layout: GenericLayoutType, dxfattribs=None, matrix: Matrix44 = None, ucs: UCS = None`)

Render mesh as `Polyface` entity into `layout`.

## Parameters

- **layout** – `BaseLayout` object
- **dxfattribs** – dict of DXF attributes e.g. `{'layer': 'mesh', 'color': 7}`
- **matrix** – transformation matrix of type `Matrix44`
- **ucs** – transform vertices by `UCS` to `WCS`

Changed in version 0.18: Uses the `tessellation()` method to process ngons with more than the 4 vertices which can handle concave faces.

**separate\_meshes** () → List[ezdxf.render.mesh.MeshTransformer]

A single `MeshBuilder` instance can store multiple separated meshes. This function returns this separated meshes as multiple `MeshTransformer` instances.

New in version 0.18.

**subdivide** (*level: int = 1, quads=True*) → ezdxf.render.mesh.MeshTransformer

Returns a new *MeshTransformer* object with all faces subdivided.

#### Parameters

- **level** – subdivide levels from 1 to max of 5
- **quads** – create quad faces if True else create triangles

**subdivide\_ngons** (*max\_vertex\_count=4*) → Iterator[Sequence[ezdxf.math.\_vector.Vec3]]

Yields all faces as sequence of *Vec3* instances, where all ngons which have more than *max\_vertex\_count* vertices gets subdivided. In contrast to the **tesselation()** method, creates this method a new vertex in the centroid of the face. This can create a more regular tessellation but only works reliable for convex faces!

New in version 0.18.

**tesselation** (*max\_vertex\_count: int = 4*) → Iterator[Sequence[ezdxf.math.\_vector.Vec3]]

Yields all faces as sequence of *Vec3* instances, each face has no more vertices than the given *max\_vertex\_count*. This method uses the “ear clipping” algorithm which works with concave faces too and does not create any additional vertices.

New in version 0.18.

**unify\_face\_normals** (\*, *fod: Optional[ezdxf.render.mesh.FaceOrientationDetector] = None*) → ezdxf.render.mesh.MeshTransformer

Returns a new *MeshTransformer* object with unified face normal vectors of all faces. The forward direction (not necessarily outwards) is defined by the face-normals of the majority of the faces. This function can not process non-manifold meshes (more than two faces are connected by a single edge) or multiple disconnected meshes in a single *MeshBuilder* object.

It is possible to pass in an existing *FaceOrientationDetector* instance as argument *fod*.

#### Raises

- **NonManifoldError** – non-manifold mesh
- **MultipleMeshesError** – the *MeshBuilder* object contains multiple disconnected meshes

New in version 0.18.

**unify\_face\_normals\_by\_reference** (*reference: int = 0, \*, force\_outwards=False, fod: Optional[ezdxf.render.mesh.FaceOrientationDetector] = None*) → ezdxf.render.mesh.MeshTransformer

Returns a new *MeshTransformer* object with unified face normal vectors of all faces. The forward direction (not necessarily outwards) is defined by the reference face, which is the first face of the *mesh* by default. This function can not process non-manifold meshes (more than two faces are connected by a single edge) or multiple disconnected meshes in a single *MeshBuilder* object.

The outward direction of all face normals can be forced by setting the argument *force\_outwards* to True but this works only for closed surfaces, and it's time-consuming!

It is not possible to check for a closed surface as long the face normal vectors are not unified. But it can be done afterward by the attribute *MeshDiagnose.is\_closed\_surface()* to see if the result is trustworthy.

It is possible to pass in an existing *FaceOrientationDetector* instance as argument *fod*.

#### Parameters

- **reference** – index of the reference face

- **force\_outwards** – forces face-normals to point outwards, this works only for closed surfaces, and it's time-consuming!
- **fod** – *FaceOrientationDetector* instance

**Raises** ValueError – non-manifold mesh or the *MeshBuilder* object contains multiple disconnected meshes

New in version 0.18.

## 6.10.8 MeshTransformer

Same functionality as *MeshBuilder* but supports inplace transformation.

**class** ezdxf.render.MeshTransformer

Subclass of *MeshBuilder*

**transform**(matrix: ezdxf.math.\_matrix44.Matrix44)

Transform mesh inplace by applying the transformation *matrix*.

**Parameters** **matrix** – 4x4 transformation matrix as *Matrix44* object

**translate**(dx: Union[float, Sequence[float], ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3] = 0, dy: float = 0, dz: float = 0)

Translate mesh inplace.

**Parameters**

- **dx** – translation in x-axis or translation vector
- **dy** – translation in y-axis
- **dz** – translation in z-axis

**scale**(sx: float = 1, sy: float = 1, sz: float = 1)

Scale mesh inplace.

**Parameters**

- **sx** – scale factor for x-axis
- **sy** – scale factor for y-axis
- **sz** – scale factor for z-axis

**scale\_uniform**(s: float)

Scale mesh uniform inplace.

**Parameters** **s** – scale factor for x-, y- and z-axis

**rotate\_x**(angle: float)

Rotate mesh around x-axis about *angle* inplace.

**Parameters** **angle** – rotation angle in radians

**rotate\_y**(angle: float)

Rotate mesh around y-axis about *angle* inplace.

**Parameters** **angle** – rotation angle in radians

**rotate\_z**(angle: float)

Rotate mesh around z-axis about *angle* inplace.

**Parameters** **angle** – rotation angle in radians

```
rotate_axis (axis: Union[Sequence[float], ezdxf.math._vector.Vector2, ezdxf.math._vector.Vector3], angle:  
           float)
```

Rotate mesh around an arbitrary axis located in the origin (0, 0, 0) about *angle*.

#### Parameters

- **axis** – rotation axis as Vec3
- **angle** – rotation angle in radians

### 6.10.9 MeshVertexMerger

Same functionality as [MeshBuilder](#), but created meshes with unique vertices and no doublets, but [MeshVertexMerger](#) needs extra memory for bookkeeping and also does not support transformations. The location of the merged vertices is the location of the first vertex with the same key.

This class is intended as intermediate object to create compact meshes and convert them to [MeshTransformer](#) objects to apply transformations:

```
mesh = MeshVertexMerger()  
  
# create your mesh  
mesh.add_face(...)  
  
# convert mesh to MeshTransformer object  
return MeshTransformer.from_builder(mesh)
```

```
class ezdxf.render.MeshVertexMerger (precision: int = 6)
```

Subclass of [MeshBuilder](#)

Mesh with unique vertices and no doublets, but needs extra memory for bookkeeping.

[MeshVertexMerger](#) creates a key for every vertex by rounding its components by the Python `round()` function and a given *precision* value. Each vertex with the same key gets the same vertex index, which is the index of first vertex with this key, so all vertices with the same key will be located at the location of this first vertex. If you want an average location of all vertices with the same key use the [MeshAverageVertexMerger](#) class.

**Parameters** **precision** – floating point precision for vertex rounding

### 6.10.10 MeshAverageVertexMerger

This is an extended version of [MeshVertexMerger](#). The location of the merged vertices is the average location of all vertices with the same key, this needs extra memory and runtime in comparison to [MeshVertexMerger](#) and this class also does not support transformations.

```
class ezdxf.render.MeshAverageVertexMerger (precision: int = 6)
```

Subclass of [MeshBuilder](#)

Mesh with unique vertices and no doublets, but needs extra memory for bookkeeping and runtime for calculation of average vertex location.

[MeshAverageVertexMerger](#) creates a key for every vertex by rounding its components by the Python `round()` function and a given *precision* value. Each vertex with the same key gets the same vertex index, which is the index of first vertex with this key, the difference to the [MeshVertexMerger](#) class is the calculation of the average location for all vertices with the same key, this needs extra memory to keep track of the count of vertices for each key and extra runtime for updating the vertex location each time a vertex with an existing key is added.

**Parameters** `precision` – floating point precision for vertex rounding

**class** `ezdxf.render.mesh.EdgeStat`

Named tuple of edge statistics.

**count**

how often the edge  $(a, b)$  is used in faces as  $(a, b)$  or  $(b, a)$

**balance**

count of edges  $(a, b)$  - count of edges  $(b, a)$  and should be 0 in “healthy” closed surfaces, if the balance is not 0, maybe doubled coincident faces exist or faces may have mixed clockwise and counter-clockwise vertex orders

## 6.10.11 MeshBuilder Helper Classes

**class** `ezdxf.render.MeshDiagnose`

Diagnose tool which can be used to analyze and detect errors of `MeshBuilder` objects like topology errors for closed surfaces. The object contains cached values, which do not get updated if the source mesh will be changed!

---

**Note:** There exist no tools in `ezdxf` to repair broken surfaces, but you can use the `ezdxf.addons.meshex` addon to exchange meshes with the open source tool `MeshLab`.

---

Create an instance of this tool by the `MeshBuilder.diagnose()` method.

New in version 0.18.

**centroid()** → `ezdxf.math._vector.Vec3`

Returns the centroid of all vertices. (center of mass)

**estimate\_face\_normals\_direction()** → float

Returns the estimated face-normals direction as float value in the range [-1.0, 1.0] for a closed surface.

This heuristic works well for simple convex hulls but struggles with more complex structures like a torus (doughnut).

A counter-clockwise (ccw) vertex arrangement for outward pointing faces is assumed but a clockwise (cw) arrangement works too but the return values are reversed.

The closer the value to 1.0 (-1.0 for cw) the more likely all normals pointing outwards from the surface.

The closer the value to -1.0 (1.0 for cw) the more likely all normals pointing inwards from the surface.

There are no exact confidence values if all faces pointing outwards, here some examples for surfaces created by `ezdxf.render.forms` functions:

- `cube()` returns 1.0

- `cylinder()` returns 0.9992

- `sphere()` returns 0.9994

- `cone()` returns 0.9162

- `cylinder()` with all hull faces pointing outwards but caps pointing inwards returns 0.7785 but the property `is_edge_balance_broken` returns True which indicates the mixed vertex orientation

- and the estimation of 0.0469 for a `torus()` is barely usable

**has\_non\_planar\_faces()** → bool

Returns True if any face is non-planar.

**surface\_area()** → float

Returns the surface area.

**total\_edge\_count()** → int

Returns the total edge count of all faces, shared edges are counted separately for each face. In closed surfaces this count should be 2x the unique edge count `n_edges`. (cached data)

**unique\_edges()** → Iterable[Tuple[int, int]]

Yields the unique edges of the mesh as int 2-tuples. (cached data)

**volume()** → float

Returns the volume of a closed surface or 0 otherwise.

**Warning:** The face vertices have to be in counter-clockwise order, this requirement is not checked by this method.

The result is not correct for multiple separated meshes in a single `MeshBuilder` object!!!

```
class ezdxf.render.FaceOrientationDetector(mesh: ezdxf.render.mesh.MeshBuilder, reference: int = 0)
```

Helper class for face orientation and face normal vector detection. Use the method `MeshBuilder.face_orientation_detector()` to create an instance.

The face orientation detector classifies the faces of a mesh by their forward or backward orientation. The forward orientation is defined by a reference face, which is the first face of the mesh by default and this orientation is not necessarily outwards.

This class has some overlapping features with `MeshDiagnose` but it has a longer setup time and needs more memory than `MeshDiagnose`.

#### Parameters

- **mesh** – source mesh as `MeshBuilder` object
- **reference** – index of the reference face

New in version 0.18.

**is\_manifold**

True if all edges have an edge count < 3. A non-manifold mesh has edges with 3 or more connected faces.

**classify\_faces(reference: int = 0) → None**

Detect the forward and backward oriented faces.

The forward and backward orientation has to be defined by a `reference` face.

**is\_reference\_face\_pointing\_outwards() → bool**

Returns True if the normal vector of the reference face is pointing outwards. This works only for meshes with unified faces which represent a closed surfaces, and it's a time-consuming calculation!

## 6.10.12 Trace

This module provides tools to create banded lines like LWPOLYLINE with width information. Path rendering as quadrilaterals: `Trace`, `Solid` or `Face3d`.

```
class ezdxf.render.trace.TraceBuilder
```

Sequence of 2D banded lines like polylines with start- and end width or curves with start- and end width.

---

**Note:** Accepts 3D input, but z-axis is ignored. The `TraceBuilder` is a 2D only object and uses only the *OCS* coordinates!

---

**abs\_tol**

Absolute tolerance for floating point comparisons

**append**(*trace*: `ezdxf.render.trace.AbstractTrace`) → None

Append a new trace.

**close()**

Close multi traces by merging first and last trace, if linear traces.

**faces()** → Iterable[Tuple[`ezdxf.math._vector.Vec2`, `ezdxf.math._vector.Vec2`, `ezdxf.math._vector.Vec2`, `ezdxf.math._vector.Vec2`]]

Yields all faces as 4-tuples of `Vec2` objects in *OCS*.

**faces\_wcs**(*ocs*: `ezdxf.math.ucs.OCS`, *elevation*: `float`) → Iterable[Sequence[`ezdxf.math._vector.Vec3`]]

Yields all faces as 4-tuples of `Vec3` objects in *WCS*.

**virtual\_entities**(*dxf\_type*=’TRACE’, *dxf\_attributes*=None, *doc*: `Drawing` = None) → Iterable[`Quadrilateral`]

Yields faces as SOLID, TRACE or 3DFACE entities with DXF attributes given in *dxf\_attributes*.

If a document is given, the doc attribute of the new entities will be set and the new entities will be automatically added to the entity database of that document.

---

**Note:** The `TraceBuilder` is a 2D only object and uses only the *OCS* coordinates!

---

**Parameters**

- **dxf\_type** – DXF type as string, “SOLID”, “TRACE” or “3DFACE”
- **dxf\_attributes** – DXF attributes for SOLID, TRACE or 3DFACE entities
- **doc** – associated document

**classmethod from\_polyline**(*polyline*: `DXFGraphic`, *segments*: int = 64) → `TraceBuilder`

Create a complete trace from a LWPOLYLINE or a 2D POLYLINE entity, the trace consist of multiple sub-traces if *bulge* values are present. Uses only the *OCS* coordinates!

**Parameters**

- **polyline** – `LWPolyline` or 2D `Polyline`
- **segments** – count of segments for bulge approximation, given count is for a full circle, partial arcs have proportional less segments, but at least 3

**\_\_len\_\_()****\_\_getitem\_\_()****class ezdxf.render.trace.LinearTrace**

Linear 2D banded lines like polylines with start- and end width.

Accepts 3D input, but z-axis is ignored.

**abs\_tol**

Absolute tolerance for floating point comparisons

**is\_started**

*True* if at least one station exist.

**add\_station** (*point*: Union[Sequence[float], ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3],

*start\_width*: float, *end\_width*: Optional[float] = None) → None

Add a trace station (like a vertex) at location *point*, *start\_width* is the width of the next segment starting at this station, *end\_width* is the end width of the next segment.

Adding the last location again, replaces the actual last location e.g. adding lines (a, b), (b, c), creates only 3 stations (a, b, c), this is very important to connect to/from splines.

**Parameters**

- **point** – 2D location (vertex), z-axis of 3D vertices is ignored.
- **start\_width** – start width of next segment
- **end\_width** – end width of next segment

**faces()** → Iterable[Tuple[ezdxf.math.\_vector.Vec2,

ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec2]]

Yields all faces as 4-tuples of *Vec2* objects.

First and last miter is 90 degrees if the path is not closed, otherwise the intersection of first and last segment is taken into account, a closed path has to have explicit the same last and first vertex.

**virtual\_entities** (*dxftype*=’TRACE’, *dxfattribs*=None, *doc*: Optional[Drawing] = None) → Iterable[Union[Solid, Trace, Face3d]]

Yields faces as SOLID, TRACE or 3DFACE entities with DXF attributes given in *dxfattribs*.

If a document is given, the doc attribute of the new entities will be set and the new entities will be automatically added to the entity database of that document.

**Parameters**

- **dxftype** – DXF type as string, “SOLID”, “TRACE” or “3DFACE”
- **dxfattribs** – DXF attributes for SOLID, TRACE or 3DFACE entities
- **doc** – associated document

**class ezdxf.render.trace.CurvedTrace**

2D banded curves like arcs or splines with start- and end width.

Represents always only one curved entity and all miter of curve segments are perpendicular to curve tangents.

Accepts 3D input, but z-axis is ignored.

**faces()** → Iterable[Tuple[ezdxf.math.\_vector.Vec2,

ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec2]]

Yields all faces as 4-tuples of *Vec2* objects.

**virtual\_entities** (*dxftype*=’TRACE’, *dxfattribs*=None, *doc*: Optional[Drawing] = None) → Iterable[Union[Solid, Trace, Face3d]]

Yields faces as SOLID, TRACE or 3DFACE entities with DXF attributes given in *dxfattribs*.

If a document is given, the doc attribute of the new entities will be set and the new entities will be automatically added to the entity database of that document.

**Parameters**

- **dxftype** – DXF type as string, “SOLID”, “TRACE” or “3DFACE”
- **dxfattribs** – DXF attributes for SOLID, TRACE or 3DFACE entities
- **doc** – associated document

---

```
classmethod from_arc(arc: ezdxf.math.arc.ConstructionArc, start_width: float, end_width: float,
                      segments: int = 64) → ezdxf.render.trace.CurvedTrace
```

Create curved trace from an arc.

**Parameters**

- **arc** – `ConstructionArc` object
- **start\_width** – start width
- **end\_width** – end width
- **segments** – count of segments for full circle (360 degree) approximation, partial arcs have proportional less segments, but at least 3

**Raises** `ValueError` – if `arc.radius <= 0`

```
classmethod from_spline(spline: ezdxf.math.bspline.BSpline, start_width: float, end_width: float,
                        segments: int) → ezdxf.render.trace.CurvedTrace
```

Create curved trace from a B-spline.

**Parameters**

- **spline** – `BSpline` object
- **start\_width** – start width
- **end\_width** – end width
- **segments** – count of segments for approximation

### 6.10.13 Point Rendering

Helper function to render `Point` entities as DXF primitives.

```
ezdxf.render.point.virtual_entities(point: ezdxf.entities.point.Point, pd-
                                     size: float = 1, pdmode: int = 0) →
                                     List[ezdxf.entities.dxfgfx.DXFGraphic]
```

Yields point graphic as DXF primitives LINE and CIRCLE entities. The dimensionless point is rendered as zero-length line!

Check for this condition:

```
e.dxftype() == 'LINE' and e.dxf.start.isclose(e.dxf.end)
```

if the rendering engine can't handle zero-length lines.

**Parameters**

- **point** – DXF POINT entity
- **pdszie** – point size in drawing units
- **pdmode** – point styling mode, see `Point` class

New in version 0.15.

**See also:**

Go to `ezdxf.entities.Point` class documentation for more information about POINT styling modes.

## 6.10.14 MultiLeaderBuilder

These are helper classes to build `MultiLeader` entities in an easy way. The `MultiLeader` entity supports two kinds of content, for each exist a specialized builder class:

- `MultiLeaderMTextBuilder` for `MText` content
- `MultiLeaderBlockBuilder` for `Block` content

The usual steps of the building process are:

1. create entity by a factory method
  - `add_multileader_mtext()`
  - `add_multileader_block()`
2. set the content
  - `MultiLeaderMTextBuilder.set_content()`
  - `MultiLeaderBlockBuilder.set_content()`
  - `MultiLeaderBlockBuilder.set_attribute()`
3. set properties
  - `MultiLeaderBuilder.set_arrow_properties()`
  - `MultiLeaderBuilder.set_connection_properties()`
  - `MultiLeaderBuilder.set_connection_types()`
  - `MultiLeaderBuilder.set_leader_properties()`
  - `MultiLeaderBuilder.set_mleader_style()`
  - `MultiLeaderBuilder.set_overall_scaling()`
4. add one ore more leader lines
  - `MultiLeaderBuilder.add_leader_line()`
5. finalize building process
  - `MultiLeaderBuilder.build()`

The [Tutorial for MultiLeader](#) shows how to use these helper classes in more detail.

New in version 0.18.

```
class ezdxf.render.MultiLeaderBuilder
    Abstract base class to build MultiLeader entities.

    add_leader_line(side:           ezdxf.render.mleader.ConnectionSide,      vertices:        Iterable[ezdxf.math.vector.Vec2J] → None
                    ,           ,           ,           )
                    Add leader as iterable of vertices in render UCS coordinates (WCS by default).
```

---

**Note:** Vertical (top, bottom) and horizontal attachment sides (left, right) can not be mixed in a single entity - this is a limitation of the MULTILEADER entity.

---

### Parameters

- **side** – connection side where to attach the leader line
- **vertices** – leader vertices

---

**build** (*insert: ezdxf.math.\_vector.Vec2, rotation: float = 0.0, ucs: ezdxf.math.ucs.UCS = None*) → None  
Compute the required geometry data. The construction plane is the xy-plane of the given render *UCS*.

#### Parameters

- **insert** – insert location for the content in render UCS coordinates
- **rotation** – content rotation angle around the render UCS z-axis in degrees
- **ucs** – the render *UCS*, default is the *WCS*

**set\_arrow\_properties** (*name: str = "", size: float = 0.0*)

Set leader arrow properties all leader lines have the same arrow type.

The MULTILEADER entity is able to support multiple arrows, but this seems to be unsupported by CAD applications and is therefore also not supported by the builder classes.

**set\_connection\_properties** (*landing\_gap: float = 0.0, dogleg\_length: float = 0.0*)

Set the properties how to connect the leader line to the content.

The landing gap is the space between the content and the start of the leader line. The “dogleg” is the first line segment of the leader in the “horizontal” direction of the content.

**set\_connection\_types** (*left=<HorizontalConnection.by\_style: -1>, right=<HorizontalConnection.by\_style: -1>, top=<VerticalConnection.by\_style: 0>, bottom=<VerticalConnection.by\_style: 0>*)

Set the connection type for each connection side.

**set\_leader\_properties** (*color: Union[int, Tuple[int, int, int]] = 0, linetype: str = 'BYBLOCK', linewidth: int = -2, leader\_type=<LeaderType.straight\_lines: 1>*)

Set leader line properties.

#### Parameters

- **color** – line color as *AutoCAD Color Index (ACI)* or RGB tuple
- **linetype** – as name string, e.g. “BYLAYER”
- **linewidth** – as integer value, see: *Lineweights*
- **leader\_type** – straight lines of spline type

**set\_mleader\_style** (*style: ezdxf.entities.mleader.MLeaderStyle*)

Reset base properties by *MLeaderStyle* properties. This also resets the content!

**set\_overall\_scaling** (*scale: float*)

Set the overall scaling factor for the whole entity, except for the leader line vertices!

Parameters **scale** – scaling factor > 0.0

## MultiLeaderMTextBuilder

Specialization of *MultiLeaderBuilder* to build *MultiLeader* with MTEXT content.

**class** ezdxf.render.**MultiLeaderMTextBuilder**

**set\_content** (*content: str, color: Union[int, Tuple[int, int, int]] = None, char\_height: float = 0.0, alignment: ezdxf.render.mleader.TextAlignment = <TextAlignment.left: 1>, style: str = None*)

Set MTEXT content.

#### Parameters

- **content** – MTEXT content as string
- **color** – block color as *AutoCAD Color Index (ACI)* or RGB tuple
- **char\_height** – initial char height in drawing units
- **alignment** – *TextAlignment* - left, center, right
- **style** – name of *Textstyle* as string

```
quick_leader(content: str, target: ezdxf.math._vector.Vector[Vec2], segment1: ezdxf.math._vector.Vector[Vec2], segment2: ezdxf.math._vector.Vector[Vec2] = None, connection_type: Union[ezdxf.render.mleader.HorizontalConnection, ezdxf.render.mleader.VerticalConnection] = <HorizontalConnection.middle_of_top_line: 1>, ucs: ezdxf.math.UCS = None) → None
```

Creates a quick MTEXT leader. The *target* point defines where the leader points to. The *segment1* is the first segment of the leader line relative to the *target* point, *segment2* is an optional second line segment relative to the first line segment. The *connection\_type* defines the type of connection (horizontal or vertical) and the MTEXT alignment (left, center or right). Horizontal connections are always left or right aligned, vertical connections are always center aligned.

#### Parameters

- **content** – MTEXT content string
- **target** – leader target point as *Vec2*
- **segment1** – first leader line segment as relative distance to *insert*
- **segment2** – optional second leader line segment as relative distance to first line segment
- **connection\_type** – one of *HorizontalConnection* or *VerticalConnection*
- **ucs** – the rendering *UCS*, default is the *WCS*

## MultiLeaderBlockBuilder

Specialization of *MultiLeaderBuilder* to build *MultiLeader* with BLOCK content.

```
class ezdxf.render.MultiLeaderBlockBuilder
```

```
set_content(name: str, color: Union[int, Tuple[int, int, int]] = 0, scale: float = 1.0, alignment=<BlockAlignment.center_extents: 0>)
```

Set BLOCK content.

#### Parameters

- **name** – the block name as string
- **color** – block color as *AutoCAD Color Index (ACI)* or RGB tuple
- **scale** – the block scaling, not to be confused with overall scaling
- **alignment** – the block insertion point or the center of extents

```
set_attribute(tag: str, text: str, width: float = 1.0)
```

Add BLOCK attributes based on an ATTDEF entity in the block definition. All properties of the new created ATTRIB entity are defined by the template ATTDEF entity including the location.

#### Parameters

- **tag** – attribute tag name

- **text** – attribute content string
- **width** – width factor

## Enums

**class ezdxf.render.LeaderType**

The leader type.

**none**

**straight\_lines**

**splines**

**class ezdxf.render.ConnectionSide**

The leader connection side.

Vertical (top, bottom) and horizontal attachment sides (left, right) can not be mixed in a single entity - this is a limitation of the MULTILEADER entity.

**left**

**right**

**top**

**bottom**

**class ezdxf.render.HorizontalConnection**

The horizontal leader connection type.

**by\_style**

**top\_of\_top\_line**

**middle\_of\_top\_line**

**middle\_of\_text**

**middle\_of\_bottom\_line**

**bottom\_of\_bottom\_line**

**bottom\_of\_bottom\_line\_underline**

**bottom\_of\_top\_line\_underline**

**bottom\_of\_top\_line**

**bottom\_of\_top\_line\_underline\_all**

**class ezdxf.render.VerticalConnection**

The vertical leader connection type.

**by\_style**

**center**

**center\_overline**

**class ezdxf.render.TextAlignment**

The MText alignment type.

**left**

**center**

```
right
class ezdxf.render.BlockAlignment
    The Block alignment type.

center_extents
insertion_point
```

## 6.10.15 Arrows

This module provides support for the AutoCAD standard arrow heads used in DIMENSION, LEADER and MULTILEADER entities. Library user don't have to use the `ARROWS` objects directly, but should know the arrow names stored in it as attributes. The arrow names should be accessed that way:

```
import ezdxf

arrow = ezdxf.ARROWS.closed_filled
```

```
ezdxf.render.arrows.ARROWS
Single instance of _Arrows to work with.

class ezdxf.render.arrows._Arrows
Management object for standard arrows.

__acad__
Set of AutoCAD standard arrow names.

__ezdxf__
Set of arrow names special to ezdxf.
```

`architectural_tick`

\_\_\_\_\_

ARCHTICK



`closed_filled`

\_\_\_\_\_

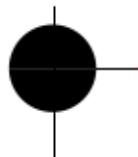
"" = closed filled



`dot`

\_\_\_\_\_

DOT



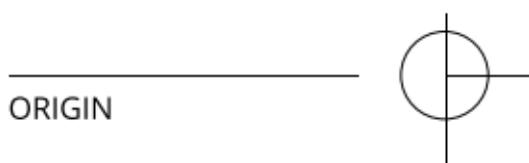
`dot_small`



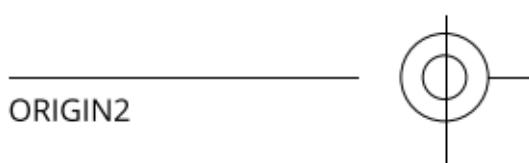
`dot_blank`



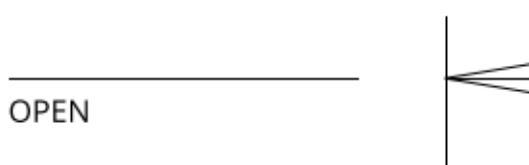
`origin_indicator`



`origin_indicator_2`



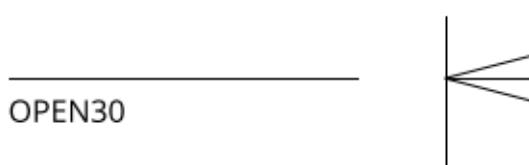
`open`



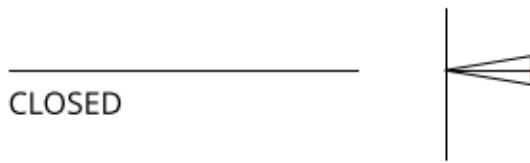
`right_angle`



`open_30`



**closed**



CLOSED

**dot\_smallblank**



SMALL

**none**



NONE

**oblique**



OBLIQUE

**box\_filled**



BOXFILLED

**box**



BOXBLANK

**closed\_blank**



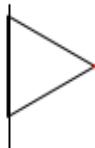
CLOSEDBLANK

`datum_triangle_filled`

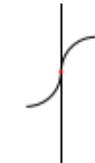

---

 DATUMFILLED
`datum_triangle`

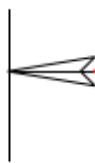

---

 DATUMBLANK
`integral`

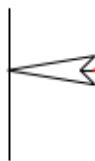

---

 INTEGRAL
`ez_arrow`

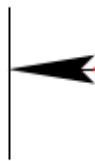

---

 EZ\_ARROW
`ez_arrow_blank`


---

 EZ\_ARROW\_BLANK
`ez_arrow_filled`


---

 EZ\_ARROW\_FILLED
`is_acad_arrow(item: str) → bool`

Returns True if *item* is a standard AutoCAD arrow.

`is_ezdxdf_arrow(item: str) → bool`

Returns True if *item* is a special *ezdxdf* arrow.

`insert_arrow(layout: GenericLayoutType, name: str, insert: Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3] = Vec3(0.0, 0.0, 0.0), size: float = 1.0, rotation: float = 0, *, dxftattribs=None) → ezdxf.math._vector.Vec2`

Insert arrow as block reference into *layout*.

```
render_arrow(layout: GenericLayoutType, name: str, insert: Union[Sequence[float],  
ezdxf.math._vector.Vector2, ezdxf.math._vector.Vector3] = Vec3(0.0, 0.0, 0.0), size:  
float = 1.0, rotation: float = 0, *, dxftattribs=None) → ezdxf.math._vector.Vector2
```

Render arrow as basic DXF entities into *layout*.

```
virtual_entities(name: str, insert: Union[Sequence[float], ezdxf.math._vector.Vector2,  
ezdxf.math._vector.Vector3] = Vec3(0.0, 0.0, 0.0), size: float = 0.625, rota-  
tion: float = 0, *, dxftattribs=None) → Iterator[DXFGraphic]
```

Returns all arrow components as virtual DXF entities.

## 6.11 Add-ons

### 6.11.1 Drawing / Export Addon

This add-on provides the functionality to render a DXF document to produce a rasterized or vector-graphic image which can be saved to a file or viewed interactively depending on the backend being used.

The module provides two example scripts in the folder examples/addons/drawing which can be run to save rendered images to files or view an interactive visualisation

Example for the usage of the matplotlib backend:

```
import sys  
import matplotlib.pyplot as plt  
from eздxf import recover  
from eздxf.addons.drawing import RenderContext, Frontend  
from eздxf.addons.drawing.matplotlib import MatplotlibBackend  
  
# Safe loading procedure (requires eздxf v0.14):  
try:  
    doc, auditor = recover.readfile('your.dxf')  
except IOError:  
    print(f'Not a DXF file or a generic I/O error.')  
    sys.exit(1)  
except eздxf.DXFStructureError:  
    print(f'Invalid or corrupted DXF file.')  
    sys.exit(2)  
  
# The auditor.errors attribute stores severe errors,  
# which may raise exceptions when rendering.  
if not auditor.has_errors:  
    fig = plt.figure()  
    ax = fig.add_axes([0, 0, 1, 1])  
    ctx = RenderContext(doc)  
    out = MatplotlibBackend(ax)  
    Frontend(ctx, out).draw_layout(doc.modelspace(), finalize=True)  
    fig.savefig('your.png', dpi=300)
```

Simplified render workflow but with less control:

```
from eздxf import recover  
from eздxf.addons.drawing import matplotlib  
  
# Exception handling left out for compactness:
```

(continues on next page)

(continued from previous page)

```
doc, auditor = recover.readfile('your.dxf')
if not auditor.has_errors:
    matplotlib.savefig(doc.modelspace(), 'your.png')
```

## MatplotlibBackend

```
class ezdxf.addons.drawing.matplotlib.MatplotlibBackend
```

```
__init__(ax: plt.Axes, *, adjust_figure: bool = True, font: FontProperties, use_text_cache: bool = True)
```

## PyQtBackend

```
class ezdxf.addons.drawing.pyqt.PyQtBackend
```

```
__init__(scene: qw.QGraphicsScene = None, *, use_text_cache: bool = True, debug_draw_rect: bool = False)
```

## Configuration

Additional options for the drawing add-on can be passed by the *config* argument of the Frontend constructor `__init__()`. Not every option will be supported by all backends.

```
class ezdxf.addons.drawing.config.Configuration
```

Configuration options for the drawing add-on.

### pdsiz

the size to draw POINT entities (in drawing units) set to None to use the \$PDSIZE value from the dxf document header

0	5% of draw area height
<0	Specifies a percentage of the viewport size
>0	Specifies an absolute size
None	use the \$PDMODE value from the dxf document header

### pdmode

point styling mode (see POINT documentation)

see [Point](#) class documentation

### measurement

whether to use metric or imperial units as enum `ezdxf.enums.Measurement`

0	use imperial units (in, ft, yd, ...)
1	use metric units (ISO meters)
None	use the \$MEASUREMENT value from the dxf document header

### show\_defpoints

whether to show or filter out POINT entities on the defpoints layer

**proxy\_graphic\_policy**

the action to take when a proxy graphic is encountered

**line\_policy**

the method to use when drawing styled lines (eg dashed, dotted etc)

**hatch\_policy**

the method to use when drawing HATCH entities

**infinite\_line\_length**

the length to use when drawing infinite lines

**lineweight\_scaling**

set to 0.0 for a constant minimal width the current result is correct, in SVG the line width is 0.7 points for 0.25mm as required, but it often looks too thick

**min\_lineweight**

the minimum line width in 1/300 inch, set to None for let the the backend choose.

**min\_dash\_length**

the minimum length for a dash when drawing a styled line (default value is arbitrary)

**max\_flattening\_distance**

Max flattening distance in drawing units see Path.flattening documentation. The backend implementation should calculate an appropriate value, like 1 screen- or paper pixel on the output medium, but converted into drawing units. Sets Path() approximation accuracy

**circle\_approximation\_count**

Approximate a full circle by  $n$  segments, arcs have proportional less segments. Only used for approximation of arcs in banded polylines.

**defaults()**

Returns a frozen *Configuration* object with default values.

**with\_changes()**

Returns a new frozen *Configuration* object with modified values.

Usage:

```
my_config = Configuration.defaults()  
my_config = my_config.with_changes(lineweight_scaling=2)
```

## LinePolicy

```
class ezdxf.addons.drawing.config.LinePolicy
```

**SOLID**

draw all lines as solid regardless of the linetype style

**APPROXIMATE**

use the closest approximation available to the backend for rendering styled lines

**ACCURATE**

analyse and render styled lines as accurately as possible. This approach is slower and is not well suited to interactive applications.

## HatchPolicy

```
class ezdxf.addons.drawing.config.HatchPolicy
```

The action to take when a HATCH entity is encountered

### IGNORE

do not show HATCH entities at all

### SHOW\_OUTLINE

show only the outline of HATCH entities

### SHOW\_SOLID

show HATCH entities but draw with solid fill regardless of the pattern

### SHOW\_APPROXIMATE\_PATTERN

show HATCH entities using the closest approximation available to the current backend

## ProxyGraphicPolicy

```
class ezdxf.addons.drawing.config.ProxyGraphicPolicy
```

The action to take when an entity with a proxy graphic is encountered

**Note:** To get proxy graphics support proxy graphics have to be loaded: Set the global option `ezdxf.options.load_proxy_graphics` to True, which is the default value.

This can not prevent drawing proxy graphic inside of blocks, because this is outside of the domain of the drawing add-on!

### IGNORE

do not display proxy graphics (skip\_entity will be called instead)

### SHOW

if the entity cannot be rendered directly (eg if not implemented) but a proxy is present: display the proxy

### PREFER

display proxy graphics even for entities where direct rendering is available

## Properties

```
class ezdxf.addons.drawing.properties.Properties
```

## LayerProperties

```
class ezdxf.addons.drawing.properties.LayerProperties
```

## RenderingContext

```
class ezdxf.addons.drawing.properties.RenderContext
```

## Frontend

```
class ezdxf.addons.drawing.frontend.Frontend
```

## Backend

```
class ezdxf.addons.drawing.backend.Backend
```

### Details

The rendering is performed in two stages. The front-end traverses the DXF document structure, converting each encountered entity into primitive drawing commands. These commands are fed to a back-end which implements the interface: *Backend*.

Currently a `PyQtBackend` (`QGraphicsScene` based) and a `MatplotlibBackend` are implemented.

Although the resulting images will not be pixel-perfect with AutoCAD (which was taken as the ground truth when developing this add-on) great care has been taken to achieve similar behavior in some areas:

- The algorithm for determining color should match AutoCAD. However, the color palette is not stored in the dxf file, so the chosen colors may be different to what is expected. The `RenderContext` class supports passing a plot style table (`CTB`-file) as custom color palette but uses the same palette as AutoCAD by default.
- Text rendering is quite accurate, text positioning, alignment and word wrapping are very faithful. Differences may occur if a different font from what was used by the CAD application but even in that case, for supported backends, measurements are taken of the font being used to match text as closely as possible.
- Visibility determination (based on which layers are visible) should match AutoCAD

See `examples/addons/drawing/cad_viewer.py` for an advanced use of the module.

See `examples/addons/drawing/draw_cad.py` for a simple use of the module.

See `drawing.md` in the `ezdxf` repository for additional behaviours documented during the development of this add-on.

## Limitations

- Rich text formatting is ignored (drawn as plain text)
- If the backend does not match the font then the exact text placement and wrapping may appear slightly different
- `MULTILEADER` renders only proxy graphic if available
- relative size of `POINT` entities cannot be replicated exactly
- only basic support for:
  - infinite lines (rendered as lines with a finite length)
  - `VIEWPORT` and `OLE2FRAME` entities (rendered as rectangles)
  - 3D entities are projected into the xy-plane and 3D text is not supported
  - vertical text (will render as horizontal text)
  - multiple columns of text (placement of additional columns may be incorrect)

## 6.11.2 Geo Interface

### Intended Usage

The intended usage of the `ezdxf.addons.geo` module is as tool to work with geospatial data in conjunction with dedicated geospatial applications and libraries and the module can not and should not replicate their functionality.

The only reimplemented feature is the most common WSG84 EPSG:3395 World Mercator projection, for everything else use the dedicated packages like:

- [pyproj](#) - Cartographic projections and coordinate transformations library.
- [Shapely](#) - Manipulation and analysis of geometric objects in the Cartesian plane.
- [PyShp](#) - The Python Shapefile Library (PyShp) reads and writes ESRI Shapefiles in pure Python.
- [GeoJSON](#) - GeoJSON interface for Python.
- [GDAL](#) - Tools for programming and manipulating the GDAL Geospatial Data Abstraction Library.
- [Fiona](#) - Fiona is GDAL's neat and nimble vector API for Python programmers.
- [QGIS](#) - A free and open source geographic information system.
- and many more ...

This module provides support for the `__geo_interface__`: <https://gist.github.com/sgillies/2217756>

Which is also supported by [Shapely](#), for supported types see the [GeoJSON](#) Standard and examples in [Appendix-A](#).

#### See also:

[Tutorial for the Geo Add-on](#) for loading GPX data into DXF files with an existing geo location reference and exporting DXF entities as GeoJSON data.

## Proxy From Mapping

The [GeoProxy](#) represents a `__geo_interface__` mapping, create a new proxy by `GeoProxy.parse()` from an external `__geo_interface__` mapping. `GeoProxy.to_dxf_entities()` returns new DXF entities from this mapping. Returns “Point” as `Point` entity, “LineString” as `LWPolyline` entity and “Polygon” as `Hatch` entity or as separated `LWPolyline` entities (or both) and new in v0.16.6 as `MPolygon`. Supports “MultiPoint”, “Multi-LineString”, “MultiPolygon”, “GeometryCollection”, “Feature” and “FeatureCollection”. Add new DXF entities to a layout by the `Layout.add_entity()` method.

## Proxy From DXF Entity

The `proxy()` function or the constructor `GeoProxy.from_dxf_entities()` creates a new `GeoProxy` object from a single DXF entity or from an iterable of DXF entities, entities without a corresponding representation will be approximated.

Supported DXF entities are:

- POINT as “Point”
- LINE as “LineString”
- LWPOLYLINE as “LineString” if open and “Polygon” if closed
- POLYLINE as “LineString” if open and “Polygon” if closed, supports only 2D and 3D polylines, POLYMESH and POLYFACE are not supported
- SOLID, TRACE, 3DFACE as “Polygon”
- CIRCLE, ARC, ELLIPSE and SPLINE by approximation as “LineString” if open and “Polygon” if closed
- HATCH and MPOLYGON as “Polygon”, holes are supported

New in version 0.16.6: MPOLYGON support

**Warning:** This module does no extensive validity checks for “Polygon” objects and because DXF has different requirements for HATCH boundary paths than the [GeoJSON](#) Standard, it is possible to create invalid “Polygon” objects. It is recommended to check critical objects by a sophisticated geometry library like [Shapely](#).

## Module Functions

```
ezdxf.addons.geo.proxy(entity: Union[ezdxf.entities.dxfgfx.DXFGGraphic, Iterable[ezdxf.entities.dxfgfx.DXFGGraphic]], distance: float = 0.1, force_line_string: bool = False) → eздxf.addons.geo.GeoProxy
```

Returns a [GeoProxy](#) object.

### Parameters

- **entity** – a single DXF entity or iterable of DXF entities
- **distance** – maximum flattening distance for curve approximations
- **force\_line\_string** – by default this function returns Polygon objects for closed geometries like CIRCLE, SOLID, closed POLYLINE and so on, by setting argument *force\_line\_string* to True, this entities will be returned as LineString objects.

```
ezdxf.addons.geo.dxf_entities(geo_mapping, polygon: int = 1, dxfattribs=None) → Iterable[ezdxf.entities.dxfgfx.DXFGGraphic]
```

Returns [\\_\\_geo\\_interface\\_\\_](#) mappings as DXF entities.

The *polygon* argument determines the method to convert polygons, use 1 for [Hatch](#) entity, 2 for [LWPolyline](#) or 3 for both. Option 2 returns for the exterior path and each hole a separated LWPolyline entity. The Hatch entity supports holes, but has no explicit border line.

Yields Hatch always before LWPolyline entities.

[MPolygon](#) support was added in v0.16.6, which is like a [Hatch](#) entity with additional border lines, but the MPOLYGON entity is not a core DXF entity and DXF viewers, applications and libraries may not support this entity. The DXF attribute *color* defines the border line color and *fill\_color* the color of the solid filling.

The returned DXF entities can be added to a layout by the `Layout.add_entity()` method.

### Parameters

- **geo\_mapping** – [\\_\\_geo\\_interface\\_\\_](#) mapping as dict or a Python object with a [\\_\\_geo\\_interface\\_\\_](#) property
- **polygon** – method to convert polygons (1-2-3-4)
- **dfattribs** – dict with additional DXF attributes

```
ezdxf.addons.geo.gfilter(entities: Iterable[ezdxf.entities.dxfgfx.DXFGGraphic]) → Iterable[ezdxf.entities.dxfgfx.DXFGGraphic]
```

Filter DXF entities from iterable *entities*, which are incompatible to the [\\_\\_geo\\_reference\\_\\_](#) interface.

## GeoProxy Class

```
class eздxf.addons.geo.GeoProxy(geo_mapping: Dict[KT, VT], places: int = 6)
```

Stores the [\\_\\_geo\\_interface\\_\\_](#) mapping in a parsed and compiled form.

Stores coordinates as Vec3 objects and represents “Polygon” always as tuple (exterior, holes) even without holes.

The GeoJSON specification recommends 6 decimal places for latitude and longitude which equates to roughly 10cm of precision. You may need slightly more for certain applications, 9 decimal places would be sufficient for professional survey-grade GPS coordinates.

#### Parameters

- **geo\_mapping** – parsed and compiled `__geo_interface__` mapping
- **places** – decimal places to round for `__geo_interface__` export

#### `__geo_interface__`

Returns the `__geo_interface__` compatible mapping as dict.

#### `geotype`

Property returns the top level entity type or None.

#### `classmethod parse(geo_mapping: Dict) → GeoProxy`

Parse and compile a `__geo_interface__` mapping as dict or a Python object with a `__geo_interface__` property, does some basic syntax checks, converts all coordinates into Vec3 objects, represents “Polygon” always as tuple (exterior, holes) even without holes.

#### `classmethod from_dxf_entities(entity: Union[ezdxf.entities.dxfgfx.DXFGraphic, Iterable[ezdxf.entities.dxfgfx.DXFGraphic]], distance: float = 0.1, force_line_string: bool = False) → ezdxf.addons.geo.GeoProxy`

Constructor from a single DXF entity or an iterable of DXF entities.

#### Parameters

- **entity** – DXF entity or entities
- **distance** – maximum flattening distance for curve approximations
- **force\_line\_string** – by default this function returns Polygon objects for closed geometries like CIRCLE, SOLID, closed POLYLINE and so on, by setting argument `force_line_string` to True, this entities will be returned as LineString objects.

#### `to_dxf_entities(polygon: int = 1, dxfattribs=None) → Iterable[ezdxf.entities.dxfgfx.DXFGraphic]`

Returns stored `__geo_interface__` mappings as DXF entities.

The `polygon` argument determines the method to convert polygons, use 1 for `Hatch` entity, 2 for `LWPolyline` or 3 for both. Option 2 returns for the exterior path and each hole a separated LWPolyline entity. The Hatch entity supports holes, but has no explicit border line.

Yields Hatch always before LWPolyline entities.

`MPolygon` support was added in v0.16.6, which is like a `Hatch` entity with additional border lines, but the MPOLYGON entity is not a core DXF entity and DXF viewers, applications and libraries may not support this entity. The DXF attribute `color` defines the border line color and `fill_color` the color of the solid filling.

The returned DXF entities can be added to a layout by the `Layout.add_entity()` method.

#### Parameters

- **polygon** – method to convert polygons (1-2-3-4)
- **dxfattribs** – dict with additional DXF attributes

New in version 0.16.6: MPOLYGON support

#### `copy() → ezdxf.addons.geo.GeoProxy`

Returns a deep copy.

**\_\_iter\_\_** () → Iterable[Dict[KT, VT]]

Iterate over all geo content objects.

Yields only “Point”, “LineString”, “Polygon”, “MultiPoint”, “MultiLineString” and “MultiPolygon” objects, returns the content of “GeometryCollection”, “FeatureCollection” and “Feature” as geometry objects (“Point”, …).

**wcs\_to\_crs** (crs: *ezdxf.math.\_matrix44.Matrix44*) → None

Transform all coordinates recursive from [WCS](#) coordinates into Coordinate Reference System (CRS) by transformation matrix *crs* inplace.

The CRS is defined by the [GeoData](#) entity, get the GeoData entity from the modelspace by method `get_geodata()`. The CRS transformation matrix can be acquired form the [GeoData](#) object by `get_crs_transformation()` method:

```
doc = ezdxf.readfile('file.dxf')
msp = doc.modelspace()
geodata = msp.get_geodata()
if geodata:
    matrix, axis_ordering = geodata.get_crs_transformation()
```

If *axis\_ordering* is `False` the CRS is not compatible with the `__geo_interface__` or [GeoJSON](#) (see chapter 3.1.1).

**Parameters** **crs** – transformation matrix of type [Matrix44](#)

**crs\_to\_wcs** (crs: *ezdxf.math.\_matrix44.Matrix44*) → None

Transform all coordinates recursive from CRS into [WCS](#) coordinates by transformation matrix *crs* inplace, see also [GeoProxy.wcs\\_to\\_crs\(\)](#).

**Parameters** **crs** – transformation matrix of type [Matrix44](#)

**globe\_to\_map** (func: *Callable[[ezdxf.math.\_vector.Vec3], ezdxf.math.\_vector.Vec3]* = `None`) → None

Transform all coordinates recursive from globe representation in longitude and latitude in decimal degrees into 2D map representation in meters.

Default is WGS84 EPSG:4326 (GPS) to WGS84 EPSG:3395 World Mercator function [wgs84\\_4326\\_to\\_3395\(\)](#).

Use the [pyproj](#) package to write a custom projection function as needed.

**Parameters** **func** – custom transformation function, which takes one [Vec3](#) object as argument and returns the result as a [Vec3](#) object.

**map\_to\_globe** (func: *Callable[[ezdxf.math.\_vector.Vec3], ezdxf.math.\_vector.Vec3]* = `None`) → None

Transform all coordinates recursive from 2D map representation in meters into globe representation as longitude and latitude in decimal degrees.

Default is WGS84 EPSG:3395 World Mercator to WGS84 EPSG:4326 GPS function [wgs84\\_3395\\_to\\_4326\(\)](#).

Use the [pyproj](#) package to write a custom projection function as needed.

**Parameters** **func** – custom transformation function, which takes one [Vec3](#) object as argument and returns the result as a [Vec3](#) object.

**apply** (func: *Callable[[ezdxf.math.\_vector.Vec3], ezdxf.math.\_vector.Vec3]*) → None

Apply the transformation function *func* recursive to all coordinates.

**Parameters** **func** – transformation function as *Callable[[Vec3], Vec3]*

**filter** (*func: Callable[[GeoProxy], bool]*) → None

Removes all mappings for which *func()* returns `False`. The function only has to handle Point, LineString and Polygon entities, other entities like MultiPolygon are divided into separate entities also any collection.

## Helper Functions

`ezdxf.addons.geo.wgs84_4326_to_3395 (location: ezdxf.math._vector.Vector3) → ezdxf.math._vector.Vector3`  
 Transform WGS84 [EPSG:4326](#) location given as latitude and longitude in decimal degrees as used by GPS into World Mercator cartesian 2D coordinates in meters [EPSG:3395](#).

**Parameters** `location` – `Vector3` object, x-attribute represents the longitude value (East-West) in decimal degrees and the y-attribute represents the latitude value (North-South) in decimal degrees.

`ezdxf.addons.geo.wgs84_3395_to_4326 (location: ezdxf.math._vector.Vector3, tol: float = 1e-06) → ezdxf.math._vector.Vector3`  
 Transform WGS84 World Mercator [EPSG:3395](#) location given as cartesian 2D coordinates x, y in meters into WGS84 decimal degrees as longitude and latitude [EPSG:4326](#) as used by GPS.

### Parameters

- `location` – `Vector3` object, z-axis is ignored
- `tol` – accuracy for latitude calculation

`ezdxf.addons.geo.dms2dd (d: float, m: float = 0, s: float = 0) → float`  
 Convert degree, minutes, seconds into decimal degrees.

`ezdxf.addons.geo.dd2dms (dd: float) → Tuple[float, float, float]`  
 Convert decimal degrees into degree, minutes, seconds.

## 6.11.3 Importer

This add-on is meant to import graphical entities from another DXF drawing and their required table entries like LAYER, LTYPE or STYLE.

Because of complex extensibility of the DXF format and the lack of sufficient documentation, I decided to remove most of the possible source drawing dependencies from imported entities, therefore imported entities may not look the same as the original entities in the source drawing, but at least the geometry should be the same and the DXF file does not break.

Removed data which could contain source drawing dependencies: Extension Dictionaries, AppData and XDATA.

**Warning:** DON'T EXPECT PERFECT RESULTS!

The [Importer](#) supports following data import:

- entities which are really safe to import: LINE, POINT, CIRCLE, ARC, TEXT, SOLID, TRACE, 3DFACE, SHAPE, POLYLINE, ATTRIB, ATTDEF, INSERT, ELLIPSE, MTEXT, LWPOLYLINE, SPLINE, HATCH, MESH, XLINE, RAY, DIMENSION, LEADER, VIEWPORT
- table and table entry import is restricted to LAYER, LTYPE, STYLE, DIMSTYLE
- import of BLOCK definitions is supported
- import of paper space layouts is supported

Import of DXF objects from the OBJECTS section is not supported.

DIMSTYLE override for entities DIMENSION and LEADER is not supported.

Example:

```
import eздxf
from eздxf.addons import Importer

sdoc = eздxf.readfile('original.dxf')
tdoc = eздxf.new()

importer = Importer(sdoc, tdoc)

# import all entities from source modelspace into modelspace of the target drawing
importer.import_models()  
  
# import all paperspace layouts from source drawing
importer.import_paperspace_layouts()  
  
# import all CIRCLE and LINE entities from source modelspace into an arbitrary target
# layout.
# create target layout
tblock = tdoc.blocks.new('SOURCE_ENTS')
# query source entities
ents = sdoc.modelspace().query('CIRCLE LINE')
# import source entities into target block
importer.import_entities(ents, tblock)  
  
# This is ALWAYS the last & required step, without finalizing the target drawing is
# maybe invalid!
# This step imports all additional required table entries and block definitions.
importer.finalize()  
  
tdoc.saveas('imported.dxf')
```

**class** eздxf.addons.importer.**Importer**(source: Drawing, target: Drawing)

The **Importer** class is central element for importing data from other DXF documents.

#### Parameters

- **source** – source Drawing
- **target** – target Drawing

#### **source**

source DXF document

#### **target**

target DXF document

#### **used\_layers**

Set of used layer names as string, AutoCAD accepts layer names without a LAYER table entry.

#### **used\_linetypes**

Set of used linetype names as string, these linetypes require a TABLE entry or AutoCAD will crash.

#### **used\_styles**

Set of used text style names, these text styles require a TABLE entry or AutoCAD will crash.

#### **used\_dimstyles**

Set of used dimension style names, these dimension styles require a TABLE entry or AutoCAD will crash.

**finalize()** → None

Finalize the import by importing required table entries and BLOCK definitions, without finalization the target document is maybe invalid for AutoCAD. Call the [finalize\(\)](#) method as last step of the import process.

**import\_block(block\_name: str, rename=True)** → str

Import one BLOCK definition from source document.

If the BLOCK already exist the BLOCK will be renamed if argument *rename* is True, otherwise the existing BLOCK in the target document will be used instead of the BLOCK in the source document. Required name resolving for imported block references (INSERT), will be done in the [Importer.finalize\(\)](#) method.

To replace an existing BLOCK in the target document, just delete it before importing data: `target.blocks.delete_block(block_name, safe=False)`

**Parameters**

- **block\_name** – name of BLOCK to import
- **rename** – rename BLOCK if a BLOCK with the same name already exist in target document

Returns: (renamed) BLOCK name

**Raises** ValueError – BLOCK in source document not found (defined)

**import\_blocks(block\_names: Iterable[str], rename=False)** → None

Import all BLOCK definitions from source document.

If a BLOCK already exist the BLOCK will be renamed if argument *rename* is True, otherwise the existing BLOCK in the target document will be used instead of the BLOCK from the source document. Required name resolving for imported BLOCK references (INSERT), will be done in the [Importer.finalize\(\)](#) method.

**Parameters**

- **block\_names** – names of BLOCK definitions to import
- **rename** – rename BLOCK if a BLOCK with the same name already exist in target document

**Raises** ValueError – BLOCK in source document not found (defined)

**import\_entities(entities: Iterable[DXFEntity], target\_layout: BaseLayout = None)** → None

Import all *entities* into *target\_layout* or the modelspace of the target document, if *target\_layout* is None.

**Parameters**

- **entities** – Iterable of DXF entities
- **target\_layout** – any layout (modelspace, paperspace or block) from the target document

**Raises** DXFStructureError – *target\_layout* is not a layout of target document

**import\_entity(entity: DXFEntity, target\_layout: BaseLayout = None)** → None

Imports a single DXF *entity* into *target\_layout* or the modelspace of the target document, if *target\_layout* is None.

**Parameters**

- **entity** – DXF entity to import

- **target\_layout** – any layout (modelspace, paperspace or block) from the target document

**Raises** DXFStructureError – *target\_layout* is not a layout of target document

**import\_models**(*target\_layout*: BaseLayout = None) → None

Import all entities from source modelspace into *target\_layout* or the modelspace of the target document, if *target\_layout* is None.

**Parameters** **target\_layout** – any layout (modelspace, paperspace or block) from the target document

**Raises** DXFStructureError – *target\_layout* is not a layout of target document

**import\_paperspace**(*name*: str) → Layout

Import paperspace layout *name* into the target document.

Recreates the source paperspace layout in the target document, renames the target paperspace if a paperspace with same *name* already exist and imports all entities from the source paperspace into the target paperspace.

**Parameters** **name** – source paper space name as string

Returns: new created target paperspace Layout

**Raises**

- KeyError – source paperspace does not exist
- DXFTypError – invalid modelspace import

**import\_paperspace**() → None

Import all paperspace layouts and their content into the target document. Target layouts will be renamed if a layout with the same name already exist. Layouts will be imported in original tab order.

**import\_shape**(*fonts*: Set[str]) → None

Import shape file table entries from the source document into the target document. Shape file entries are stored in the styles table but without a name.

**import\_table**(*name*: str, *entries*: Union[str, Iterable[str]] = '\*', *replace*=False) → None

Import specific table entries from the source document into the target document.

**Parameters**

- **name** – valid table names are “layers”, “linetypes” and “styles”
- **entries** – Iterable of table names as strings, or a single table name or “\*” for all table entries
- **replace** – True to replace the already existing table entry else ignore existing entries

**Raises** TypeError – unsupported table type

**import\_tables**(*table\_names*: Union[str, Iterable[str]] = '\*', *replace*=False) → None

Import DXF tables from the source document into the target document.

**Parameters**

- **table\_names** – iterable of tables names as strings, or a single table name as string or “\*” for all supported tables
- **replace** – True to replace already existing table entries else ignore existing entries

**Raises** TypeError – unsupported table type

**recreate\_source\_layout** (*name: str*) → Layout

Recreate source paperspace layout *name* in the target document. The layout will be renamed if *name* already exist in the target document. Returns target modelspace for layout name “Model”.

**Parameters** **name** – layout name as string

**Raises** KeyError – if source layout *name* not exist

## 6.11.4 dxf2code

Translate DXF entities and structures into Python source code.

Short example:

```
import ezdxf
from ezdxf.addons.dxf2code import entities_to_code, block_to_code

doc = ezdxf.readfile('original.dxf')
msp = doc.modelspace()
source = entities_to_code(msp)

# create source code for a block definition
block_source = block_to_code(doc.blocks['MyBlock'])

# merge source code objects
source.merge(block_source)

with open('source.py', mode='wt') as f:
    f.write(source.import_str())
    f.write('\n\n')
    f.write(source.code_str())
    f.write('\n')
```

`ezdxf.addons.dxf2code.entities_to_code(entities: Iterable[DXFEntity], layout: str = 'layout', ignore: Iterable[str] = None) → Code`

Translates DXF entities into Python source code to recreate this entities by ezdxf.

**Parameters**

- **entities** – iterable of DXFEntity
- **layout** – variable name of the layout (model space or block) as string
- **ignore** – iterable of entities types to ignore as strings like ['IMAGE', 'DIMENSION']

**Returns** `Code`

`ezdxf.addons.dxf2code.block_to_code(block: BlockLayout, drawing: str = 'doc', ignore: Iterable[str] = None) → Code`

Translates a BLOCK into Python source code to recreate the BLOCK by ezdxf.

**Parameters**

- **block** – block definition layout
- **drawing** – variable name of the drawing as string
- **ignore** – iterable of entities types to ignore as strings like ['IMAGE', 'DIMENSION']

**Returns** `Code`

```
ezdxf.addons.dxf2code.table_entries_to_code(entities: Iterable[DXFEntity], draw-
ing='doc') → Code
```

```
ezdxf.addons.dxf2code.black(code: str, line_length=88, fast: bool = True) → str
```

Returns the source `code` as a single string formatted by `Black`

Requires the installed `Black` formatter:

```
pip3 install black
```

### Parameters

- `code` – source code
- `line_length` – max. source code line length
- `fast` – `True` for fast mode, `False` to check that the reformatted code is valid

**Raises** `ImportError` – `Black` is not available

```
class ezdxf.addons.dxf2code.Code
```

Source code container.

#### code

Source code line storage, store lines without line ending \\n

#### imports

source code line storage for global imports, store lines without line ending \\n

#### layers

Layers used by the generated source code, AutoCAD accepts layer names without a LAYER table entry.

#### linetypes

Linetypes used by the generated source code, these linetypes require a TABLE entry or AutoCAD will crash.

#### styles

Text styles used by the generated source code, these text styles require a TABLE entry or AutoCAD will crash.

#### dimstyles

Dimension styles used by the generated source code, these dimension styles require a TABLE entry or AutoCAD will crash.

#### blocks

Blocks used by the generated source code, these blocks require a BLOCK definition in the BLOCKS section or AutoCAD will crash.

```
code_str(indent: int = 0) → str
```

Returns the source code as a single string.

**Parameters** `indent` – source code indentation count by spaces

```
black_code_str(line_length=88) → str
```

Returns the source code as a single string formatted by `Black`

**Parameters** `line_length` – max. source code line length

**Raises** `ImportError` – `Black` is not available

```
import_str(indent: int = 0) → str
```

Returns required imports as a single string.

**Parameters** `indent` – source code indentation count by spaces

**merge** (*code: ezdxf.addons.dxfl2code.Code, indent: int = 0*) → None  
 Add another [Code](#) object.

**add\_import** (*statement: str*) → None  
 Add import statement, identical import statements are merged together.

**add\_line** (*code: str, indent: int = 0*) → None  
 Add a single source code line without line ending \n.

**add\_lines** (*code: Iterable[str], indent: int = 0*) → None  
 Add multiple source code lines without line ending \n.

## 6.11.5 iterdxf

This add-on allows iterating over entities of the modelspace of really big (> 5GB) DXF files which do not fit into memory by only loading one entity at the time. Only ASCII DXF files are supported.

The entities are regular [DXFGraphic](#) objects with access to all supported DXF attributes, this entities can be written to new DXF files created by the [IterDXF.export\(\)](#) method. The new [add\\_foreign\\_entity\(\)](#) method allows also to add this entities to new regular [ezdxf](#) drawings (except for the INSERT entity), but resources like linetype and style are removed, only layer will be preserved but only with default attributes like color 7 and linetype CONTINUOUS.

The following example shows how to split a big DXF files into several separated DXF files which contains only LINE, TEXT or POLYLINE entities.

```
from ezdxf.addons import iterdxf

doc = iterdxf.opendxf('big.dxf')
line_exporter = doc.export('line.dxf')
text_exporter = doc.export('text.dxf')
polyline_exporter = doc.export('polyline.dxf')
try:
    for entity in doc.modelspace():
        if entity.dxftype() == 'LINE':
            line_exporter.write(entity)
        elif entity.dxftype() == 'TEXT':
            text_exporter.write(entity)
        elif entity.dxftype() == 'POLYLINE':
            polyline_exporter.write(entity)
finally:
    line_exporter.close()
    text_exporter.close()
    polyline_exporter.close()
    doc.close()
```

Supported DXF types:

3DFACE, ARC, ATTDEF, ATTRIB, CIRCLE, DIMENSION, ELLIPSE, HATCH, HELIX, IMAGE, INSERT, LEADER, LINE, LWPOLYLINE, MESH, MLEADER, MLINE, MTEXT, POINT, POLYLINE, RAY, SHAPE, SOLID, SPLINE, TEXT, TRACE, VERTEX, WIPEOUT, XLINE

Transfer simple entities to another DXF document, this works for some supported entities, except for entities with strong dependencies to the original document like INSERT look at [add\\_foreign\\_entity\(\)](#) for all supported types:

```
newdoc = ezdxf.new()
msp = newdoc.modelspace()
```

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```
# line is an entity from a big source file
msp.add_foreign_entity(line)
# and so on ...
msp.add_foreign_entity(lwpolyline)
msp.add_foreign_entity(mesh)
msp.add_foreign_entity(polyface)
```

Transfer MESH and POLYFACE (dxftype for POLYFACE and POLYMESH is POLYLINE!) entities into a new DXF document by the MeshTransformer class:

```
from ezdxf.render import MeshTransformer

# mesh is MESH from a big source file
t = MeshTransformer.from_mesh(mesh)
# create a new MESH entity from MeshTransformer
t.render(msp)

# polyface is POLYFACE from a big source file
t = MeshTransformer.from_polyface(polyface)
# create a new POLYMESH entity from MeshTransformer
t.render_polyface(msp)
```

Another way to import entities from a big source file into new DXF documents is to split the big file into smaller parts and use the `Importer` add-on for a more safe entity import.

`ezdxf.addons.iterdxf.opendxf(filename: Union[pathlib.Path, str], errors: str = 'surrogateescape')`  
 $\rightarrow$  `ezdxf.addons.iterdxf.IterDXF`

Open DXF file for iterating, be sure to open valid DXF files, no DXF structure checks will be applied.

Use this function to split up big DXF files as shown in the example above.

#### Parameters

- **filename** – DXF filename of a seekable DXF file.
- **errors** – specify decoding error handler
  - “surrogateescape” to preserve possible binary data (default)
  - “ignore” to use the replacement char U+FFFD “” for invalid data
  - “strict” to raise an `UnicodeDecodeError` exception for invalid data

#### Raises

- `DXFStructureError` – invalid or incomplete DXF file
- `UnicodeDecodeError` – if `errors` is “strict” and a decoding error occurs

`ezdxf.addons.iterdxf.modelspace(filename: Union[pathlib.Path, str], types: Iterable[str] = None, errors: str = 'surrogateescape')  $\rightarrow$  Iterable[ezdxf.entities.dxfgfx.DXFGraphic]`

Iterate over all modelspace entities as `DXFGraphic` objects of a seekable file.

Use this function to iterate “quick” over modelspace entities of a DXF file, filtering DXF types may speed up things if many entity types will be skipped.

#### Parameters

- **filename** – filename of a seekable DXF file
- **types** – DXF types like `['LINE', '3DFACE']` which should be returned, `None` returns all supported types.

- **errors** – specify decoding error handler
  - “surrogateescape” to preserve possible binary data (default)
  - “ignore” to use the replacement char U+FFFD “” for invalid data
  - “strict” to raise an `UnicodeDecodeError` exception for invalid data

**Raises**

- `DXFStructureError` – invalid or incomplete DXF file
- `UnicodeDecodeError` – if `errors` is “strict” and a decoding error occurs

```
ezdxf.addons.iterdx.single_pass_modelspace(stream: BinaryIO, types: Iterable[str] = None, errors: str = 'surrogateescape') → Iterable[ezdxf.entities.dxfgfx.DXFGraphic]
```

Iterate over all modelspace entities as `DXFGraphic` objects in one single pass.

Use this function to ‘quick’ iterate over modelspace entities of a **not** seekable binary DXF stream, filtering DXF types may speed up things if many entity types will be skipped.

**Parameters**

- **stream** – (not seekable) binary DXF stream
- **types** – DXF types like `['LINE', '3DFACE']` which should be returned, `None` returns all supported types.
- **errors** – specify decoding error handler
  - “surrogateescape” to preserve possible binary data (default)
  - “ignore” to use the replacement char U+FFFD “” for invalid data
  - “strict” to raise an `UnicodeDecodeError` exception for invalid data

**Raises**

- `DXFStructureError` – Invalid or incomplete DXF file
- `UnicodeDecodeError` – if `errors` is “strict” and a decoding error occurs

```
class ezdxf.addons.iterdx.IterDXF
```

**export** (`name: Union[pathlib.Path, str]`) → `ezdxf.addons.iterdx.IterDXFWriter`

Returns a companion object to export parts from the source DXF file into another DXF file, the new file will have the same HEADER, CLASSES, TABLES, BLOCKS and OBJECTS sections, which guarantees all necessary dependencies are present in the new file.

**Parameters name** – filename, no special requirements

**modelspace** (`types: Iterable[str] = None`) → `Iterable[ezdxf.entities.dxfgfx.DXFGraphic]`

Returns an iterator for all supported DXF entities in the modelspace. These entities are regular `DXFGraphic` objects but without a valid document assigned. It is **not** possible to add these entities to other `ezdxf` documents.

It is only possible to recreate the objects by factory functions base on attributes of the source entity. For MESH, POLYMESH and POLYFACE it is possible to use the `MeshTransformer` class to render (recreate) this objects as new entities in another document.

**Parameters types** – DXF types like `['LINE', '3DFACE']` which should be returned, `None` returns all supported types.

**close()**

Safe closing source DXF file.

```
class ezdxf.addons.iteadxfr.IterDXFWriter
```

```
    write(entity: ezdxf.entities.dxfgfx.DXFGraphic)
```

Write a DXF entity from the source DXF file to the export file.

Don't write entities from different documents than the source DXF file, dependencies and resources will not match, maybe it will work once, but not in a reliable way for different DXF documents.

```
    close()
```

Safe closing of exported DXF file. Copying of OBJECTS section happens only at closing the file, without closing the new DXF file is invalid.

## 6.11.6 r12writer

The fast file/stream writer creates simple DXF R12 drawings with just an ENTITIES section. The HEADER, TABLES and BLOCKS sections are not present except FIXED-TABLES are written. Only LINE, CIRCLE, ARC, TEXT, POINT, SOLID, 3DFACE and POLYLINE entities are supported. FIXED-TABLES is a predefined TABLES section, which will be written, if the init argument `fixed_tables` of `R12FastStreamWriter` is True.

The `R12FastStreamWriter` writes the DXF entities as strings direct to the stream without creating an in-memory drawing and therefore the processing is very fast.

Because of the lack of a BLOCKS section, BLOCK/INSERT can not be used. Layers can be used, but this layers have a default setting color = 7 (black/white) and linetype = 'Continuous'. If writing the FIXED-TABLES, some predefined text styles and line types are available, else text style is always 'STANDARD' and line type is always 'ByLayer'.

If using FIXED-TABLES, following predefined line types are available:

- CONTINUOUS \_\_\_\_\_
- CENTER \_\_\_\_\_
- CENTERX2 \_\_\_\_\_
- CENTER2 \_\_\_\_\_
- DASHED \_\_\_\_\_
- DASHEDX2 \_\_\_\_\_
- DASHED2 \_\_\_\_\_
- PHANTOM \_\_\_\_\_
- PHANTOMX2 \_\_\_\_\_
- PHANTOM2 \_\_\_\_\_
- DASHDOT \_\_\_\_\_
- DASHDOTX2 \_\_\_\_\_
- DASHDOT2 \_\_\_\_\_
- DOT \_\_\_\_\_
- DOTX2 \_\_\_\_\_
- DOT2 \_\_\_\_\_
- DIVIDE \_\_\_\_\_
- DIVIDEX2 \_\_\_\_\_

- DIVIDE2 \_ . \_ . \_ . \_ . \_ . \_ . \_ . \_ . \_ .

If using FIXED-TABLES, following predefined text styles are available:

- OpenSans
- OpenSansCondensed-Light

## Tutorial

A simple example with different DXF entities:

```
from random import random
from ezdxf.addons import r12writer

with r12writer("quick_and_dirty_dxf_r12.dxf") as dxf:
    dxf.add_line((0, 0), (17, 23))
    dxf.add_circle((0, 0), radius=2)
    dxf.add_arc((0, 0), radius=3, start=0, end=175)
    dxf.add_solid([(0, 0), (1, 0), (0, 1), (1, 1)])
    dxf.add_point((1.5, 1.5))

    # 2d polyline, new in v0.12
    dxf.add_polyline_2d([(5, 5), (7, 3), (7, 6)])

    # 2d polyline with bulge value, new in v0.12
    dxf.add_polyline_2d([(5, 5), (7, 3, 0.5), (7, 6)], format='xyb')

    # 3d polyline only, changed in v0.12
    dxf.add_polyline([(4, 3, 2), (8, 5, 0), (2, 4, 9)])

    dxf.add_text("test the text entity", align="MIDDLE_CENTER")
```

A simple example of writing really many entities in a short time:

```
from random import random
from ezdxf.addons import r12writer

MAX_X_COORD = 1000.0
MAX_Y_COORD = 1000.0
CIRCLE_COUNT = 1000000

with r12writer("many_circles.dxf") as dxf:
    for i in range(CIRCLE_COUNT):
        dxf.add_circle((MAX_X_COORD*random(), MAX_Y_COORD*random()), radius=2)
```

Show all available line types:

```
import ezdxf

LINETYPES = [
    'CONTINUOUS', 'CENTER', 'CENTERX2', 'CENTER2',
    'DASHED', 'DASHEDX2', 'DASHED2', 'PHANTOM', 'PHANTOMX2',
    'PHANTOM2', 'DASHDOT', 'DASHDOTX2', 'DASHDOT2', 'DOT',
    'DOTX2', 'DOT2', 'DIVIDE', 'DIVIDEX2', 'DIVIDE2',
]

with r12writer('r12_linetypes.dxf', fixed_tables=True) as dxf:
```

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```
for n, ltype in enumerate(LINETYPES):
    dxf.add_line((0, n), (10, n), linetype=ltype)
    dxf.add_text(ltype, (0, n+0.1), height=0.25, style='OpenSansCondensed-Light')
```

## Reference

`ezdxf.addons.r12writer.r12writer(stream: Union[TextIO, BinaryIO, str], fixed_tables = False, fmt = 'asc') → R12FastStreamWriter`

Context manager for writing DXF entities to a stream/file. `stream` can be any file like object with a `write()` method or just a string for writing DXF entities to the file system. If `fixed_tables` is `True`, a standard TABLES section is written in front of the ENTITIES section and some predefined text styles and line types can be used.

Set argument `fmt` to “asc” to write ASCII DXF file (default) or “bin” to write Binary DXF files. ASCII DXF require a `TextIO` stream and Binary DXF require a `BinaryIO` stream.

`class ezdxf.addons.r12writer.R12FastStreamWriter(stream: TextIO, fixed_tables=False)`  
Fast stream writer to create simple DXF R12 drawings.

### Parameters

- `stream` – a file like object with a `write()` method.
- `fixed_tables` – if `fixed_tables` is `True`, a standard TABLES section is written in front of the ENTITIES section and some predefined text styles and line types can be used.

`close() → None`

Writes the DXF tail. Call is not necessary when using the context manager `r12writer()`.

`add_line(start: Sequence[float], end: Sequence[float], layer: str = '0', color: int = None, linetype: str = None) → None`  
Add a LINE entity from `start` to `end`.

### Parameters

- `start` – start vertex as `(x, y[, z])` tuple
- `end` – end vertex as `(x, y[, z])` tuple
- `layer` – layer name as string, without a layer definition the assigned color = 7 (black/white) and line type is ‘Continuous’.
- `color` – color as [AutoCAD Color Index \(ACI\)](#) in the range from 0 to 256, 0 is `ByBlock` and 256 is `ByLayer`, default is `ByLayer` which is always color = 7 (black/white) without a layer definition.
- `linetype` – line type as string, if FIXED-TABLES are written some predefined line types are available, else line type is always `ByLayer`, which is always ‘Continuous’ without a LAYERS table.

`add_circle(center: Sequence[float], radius: float, layer: str = '0', color: int = None, linetype: str = None) → None`  
Add a CIRCLE entity.

### Parameters

- `center` – circle center point as `(x, y)` tuple
- `radius` – circle radius as float
- `layer` – layer name as string see `add_line()`
- `color` – color as [AutoCAD Color Index \(ACI\)](#) see `add_line()`

- **linetype** – line type as string see [add\\_line\(\)](#)

**add\_arc** (*center: Sequence[float]*, *radius: float*, *start: float = 0*, *end: float = 360*, *layer: str = '0'*, *color: int = None*, *linetype: str = None*) → None  
Add an ARC entity. The arc goes counter clockwise from *start* angle to *end* angle.

#### Parameters

- **center** – arc center point as (x, y) tuple
- **radius** – arc radius as float
- **start** – arc start angle in degrees as float
- **end** – arc end angle in degrees as float
- **layer** – layer name as string see [add\\_line\(\)](#)
- **color** – color as *AutoCAD Color Index (ACI)* see [add\\_line\(\)](#)
- **linetype** – line type as string see [add\\_line\(\)](#)

**add\_point** (*location: Sequence[float]*, *layer: str = '0'*, *color: int = None*, *linetype: str = None*) → None  
Add a POINT entity.

#### Parameters

- **location** – point location as (x, y [, z]) tuple
- **layer** – layer name as string see [add\\_line\(\)](#)
- **color** – color as *AutoCAD Color Index (ACI)* see [add\\_line\(\)](#)
- **linetype** – line type as string see [add\\_line\(\)](#)

**add\_3dface** (*vertices: Iterable[Sequence[float]]*, *invisible: int = 0*, *layer: str = '0'*, *color: int = None*, *linetype: str = None*) → None  
Add a 3DFACE entity. 3DFACE is a spatial area with 3 or 4 vertices, all vertices have to be in the same plane.

#### Parameters

- **vertices** – iterable of 3 or 4 (x, y, z) vertices.
- **invisible** – bit coded flag to define the invisible edges,
  1. edge = 1
  2. edge = 2
  3. edge = 4
  4. edge = 8

Add edge values to set multiple edges invisible, 1. edge + 3. edge = 1 + 4 = 5, all edges = 15

- **layer** – layer name as string see [add\\_line\(\)](#)
- **color** – color as *AutoCAD Color Index (ACI)* see [add\\_line\(\)](#)
- **linetype** – line type as string see [add\\_line\(\)](#)

**add\_solid** (*vertices: Iterable[Sequence[float]]*, *layer: str = '0'*, *color: int = None*, *linetype: str = None*) → None  
Add a SOLID entity. SOLID is a solid filled area with 3 or 4 edges and SOLID is a 2D entity.

#### Parameters

- **vertices** – iterable of 3 or 4 (`x`, `y` [, `z`]) tuples, z-axis will be ignored.
- **layer** – layer name as string see [add\\_line\(\)](#)
- **color** – color as *AutoCAD Color Index (ACI)* see [add\\_line\(\)](#)
- **linetype** – line type as string see [add\\_line\(\)](#)

**add\_polyline\_2d**(`points: Iterable[Sequence[T_co]]`, `format: str = 'xy'`, `closed: bool = False`,  
`start_width: float = 0`, `end_width: float = 0`, `layer: str = '0'`, `color: int = None`,  
`linetype: str = None`) → None

Add a 2D POLYLINE entity with start width, end width and bulge value support.

Format codes:

x	x-coordinate
y	y-coordinate
s	start width
e	end width
b	bulge value
v	(x, y) tuple (z-axis is ignored)

#### Parameters

- **points** – iterable of (`x`, `y`, [`start_width`, `[end_width, [bulge]]`]) tuple, value order according to the `format` string, unset values default to 0
- **format** – format: format string, default is 'xy'
- **closed** – True creates a closed polyline
- **start\_width** – default start width, default is 0
- **end\_width** – default end width, default is 0
- **layer** – layer name as string see [add\\_line\(\)](#)
- **color** – color as *AutoCAD Color Index (ACI)* see [add\\_line\(\)](#)
- **linetype** – line type as string see [add\\_line\(\)](#)

**add\_polyline**(`vertices: Iterable[Sequence[float]]`, `closed: bool = False`, `layer: str = '0'`, `color: int = None`, `linetype: str = None`) → None

Add a 3D POLYLINE entity.

#### Parameters

- **vertices** – iterable of (`x`, `y` [, `z`]) tuples, z-axis is 0 by default
- **closed** – True creates a closed polyline
- **layer** – layer name as string see [add\\_line\(\)](#)
- **color** – color as *AutoCAD Color Index (ACI)* see [add\\_line\(\)](#)
- **linetype** – line type as string see [add\\_line\(\)](#)

Changed in version 0.12: Write only 3D POLYLINE entity, added `closed` argument.

**add\_polyface**(`vertices: Iterable[Sequence[float]]`, `faces: Iterable[Sequence[int]]`, `layer: str = '0'`,  
`color: int = None`, `linetype: str = None`) → None

Add a POLYFACE entity. The POLYFACE entity supports only faces of maximum 4 vertices, more indices will be ignored. A simple square would be:

```
v0 = (0, 0, 0)
v1 = (1, 0, 0)
v2 = (1, 1, 0)
v3 = (0, 1, 0)
dxf.add_polyface(vertices=[v0, v1, v2, v3], faces=[(0, 1, 2, 3)])
```

All 3D form functions of the `ezdxf.render.forms` module return `MeshBuilder` objects, which provide the required vertex and face lists.

See sphere example: <https://github.com/mozman/ezdxf/blob/master/examples/r12writer.py>

#### Parameters

- **vertices** – iterable of (x, y, z) tuples
- **faces** – iterable of 3 or 4 vertex indices, indices have to be 0-based
- **layer** – layer name as string see `add_line()`
- **color** – color as *AutoCAD Color Index (ACI)* see `add_line()`
- **linetype** – line type as string see `add_line()`

**add\_polymesh** (*vertices*: `Iterable[Sequence[float]]`, *size*: `Tuple[int, int]`, *closed*=`(False, False)`, *layer*: `str = '0'`, *color*: `int = None`, *linetype*: `str = None`) → `None`

Add a POLYMESH entity. A POLYMESH is a mesh of m rows and n columns, each mesh vertex has its own x-, y- and z coordinates. The mesh can be closed in m- and/or n-direction. The vertices have to be in column order: (m0, n0), (m0, n1), (m0, n2), (m1, n0), (m1, n1), (m1, n2), ...

See example: <https://github.com/mozman/ezdxf/blob/master/examples/r12writer.py>

#### Parameters

- **vertices** – iterable of (x, y, z) tuples, in column order
- **size** – mesh dimension as (m, n)-tuple, requirement: `len(vertices) == m*n`
- **closed** – (m\_closed, n\_closed) tuple, for closed mesh in m and/or n direction
- **layer** – layer name as string see `add_line()`
- **color** – color as *AutoCAD Color Index (ACI)* see `add_line()`
- **linetype** – line type as string see `add_line()`

**add\_text** (*text*: `str`, *insert*: `Sequence[float] = (0, 0)`, *height*: `float = 1.0`, *width*: `float = 1.0`, *align*: `str = 'LEFT'`, *rotation*: `float = 0.0`, *oblique*: `float = 0.0`, *style*: `str = 'STANDARD'`, *layer*: `str = '0'`, *color*: `int = None`) → `None`

Add a one line TEXT entity.

#### Parameters

- **text** – the text as string
- **insert** – insert location as (x, y) tuple
- **height** – text height in drawing units
- **width** – text width as factor
- **align** – text alignment, see table below
- **rotation** – text rotation in degrees as float
- **oblique** – oblique in degrees as float, vertical = 0 (default)

- **style** – text style name as string, if FIXED-TABLES are written some predefined text styles are available, else text style is always 'STANDARD'.
- **layer** – layer name as string see `add_line()`
- **color** – color as *AutoCAD Color Index (ACI)* see `add_line()`

Vert/Horiz	Left	Center	Right
Top	TOP_LEFT	TOP_CENTER	TOP_RIGHT
Middle	MIDDLE_LEFT	MIDDLE_CENTER	MIDDLE_RIGHT
Bottom	BOTTOM_LEFT	BOTTOM_CENTER	BOTTOM_RIGHT
Baseline	LEFT	CENTER	RIGHT

The special alignments ALIGNED and FIT are not available.

### 6.11.7 ODA File Converter Support

Use an installed [ODA File Converter](#) for converting between different versions of *.dwg*, *.dxg* and *.dxf*.

**Warning:** Execution of an external application is a big security issue! Especially when the path to the executable can be altered.

To avoid this problem delete the `ezdxf.addons.odafc.py` module.

The [ODA File Converter](#) has to be installed by the user, the application is available for Windows XP, Windows 7 or later, Mac OS X, and Linux in 32/64-bit RPM and DEB format.

At least at Windows the GUI of the ODA File Converter pops up on every call.

ODA File Converter version strings, you can use any of this strings to specify a version, 'R...' and 'AC....' strings will be automatically mapped to 'ACAD....' strings:

ODAFC	ezdxf	Version
ACAD9	not supported	AC1004
ACAD10	not supported	AC1006
ACAD12	R12	AC1009
ACAD13	R13	AC1012
ACAD14	R14	AC1014
ACAD2000	R2000	AC1015
ACAD2004	R2004	AC1018
ACAD2007	R2007	AC1021
ACAD2010	R2010	AC1024
ACAD2013	R2013	AC1027
ACAD2018	R2018	AC1032

On Windows the path to the `ODAFileConverter.exe` executable is stored in the config file (see `ezdxf.options`) in the “odafc-addon” section as key “win\_exec\_path”, the default entry is:

```
[odafc-addon]
win_exec_path = "C:\Program Files\ODA\ODAFileConverter\ODAFileConverter.exe"
```

On Linux and macOS the `ODAFileConverter` command is located by the `shutil.which()` function.

Usage:

```
from ezdxf.addons import odafc

# Load a DWG file
doc = odafc.readfile('my.dwg')

# Use loaded document like any other ezdxf document
print(f'Document loaded as DXF version: {doc.dxfversion}.')
msp = doc.modelspace()
...

# Export document as DWG file for AutoCAD R2018
odafc.export_dwg(doc, 'my_R2018.dwg', version='R2018')
```

**ezdxf.addons.odafc.win\_exec\_path**

Path to installed *ODA File Converter* executable on Windows systems, default is "C:\Program Files\ODA\ODAFileConverter\ODAFileConverter.exe".

**ezdxf.addons.odafc.is\_installed() → bool**

Returns True if the ODAFileConverter is installed.

New in version 0.18.

**ezdxf.addons.odafc.readfile(filename: str, version: Optional[str] = None, \*, audit: bool = False) → Optional[ezdxf.document.Drawing]**

Uses an installed *ODA File Converter* to convert a DWG/DXB/DXF file into a temporary DXF file and load this file by *ezdxf*.

**Parameters**

- **filename** – file to load by ODA File Converter
- **version** – load file as specific DXF version, by default the same version as the source file or if not detectable the latest by *ezdxf* supported version.
- **audit** – audit source file before loading

**Raises**

- `FileNotFoundException` – source file not found
- `odafc.UnknownODAFCError` – conversion failed for unknown reasons
- `odafc.UnsupportedVersion` – invalid DWG version specified
- `odafc.UnsupportedFileFormat` – unsupported file extension
- `odafc.ODAFCNotInstalledError` – ODA File Converter not installed

**ezdxf.addons.odafc.export\_dwg(doc: ezdxf.document.Drawing, filename: str, version: Optional[str] = None, \*, audit: bool = False, replace: bool = False) → None**

Uses an installed *ODA File Converter* to export the DXF document *doc* as a DWG file.

A temporary DXF file will be created and converted to DWG by the ODA File Converter. If *version* is not specified the DXF version of the source document is used.

**Parameters**

- **doc** – *ezdxf* DXF document as Drawing object
- **filename** – output DWG filename, the extension will be set to ".dwg"
- **version** – DWG version to export, by default the same version as the source document.
- **audit** – audit source file by ODA File Converter at exporting

- **replace** – replace existing DWG file if True

#### Raises

- `FileExistsError` – target file already exists, and argument `replace` is False
- `FileNotFoundException` – parent directory of target file does not exist
- `odafc.UnknownODAFCErrror` – exporting DWG failed for unknown reasons
- `odafc.ODAFCNotInstalledError` – ODA File Converter not installed

```
ezdxf.addons.odafc.convert(source: Union[str, pathlib.Path], dest: Union[str, pathlib.Path] = "", *,  
                           version='R2018', audit=True, replace=False)
```

Convert `source` file to `dest` file.

New in version 0.18.

The file extension defines the target format e.g. `convert("test.dxf", "Test.dwg")` converts the source file to a DWG file. If `dest` is an empty string the conversion depends on the source file format and is DXF to DWG or DWG to DXF. To convert DXF to DXF an explicit destination filename is required: `convert("r12.dxf", "r2013.dxf", version="R2013")`

#### Parameters

- **source** – source file
- **dest** – destination file, an empty string uses the source filename with the extension of the target format e.g. “test.dxf” -> “test.dwg”
- **version** – output DXF/DWG version e.g. “ACAD2018”, “R2018”, “AC1032”
- **audit** – audit files
- **replace** – replace existing destination file

#### Raises

- `FileNotFoundException` – source file or destination folder does not exist
- `FileExistsError` – destination file already exists and argument `replace` is False
- `odafc.UnsupportedVersion` – invalid DXF version specified
- `odafc.UnsupportedFileFormat` – unsupported file extension
- `odafc.UnknownODAFCErrror` – conversion failed for unknown reasons
- `odafc.ODAFCNotInstalledError` – ODA File Converter not installed

## 6.11.8 text2path

New in version 0.16.

Tools to convert text strings and text based DXF entities into outer- and inner linear paths as `Path` objects. These tools depend on the optional `Matplotlib` package. At the moment only the TEXT and the ATTRIB entity can be converted into paths and hatches.

Don't expect a 100% match compared to CAD applications.

## Text Alignments

The text alignments are enums of type `ezdxf.enums.TextEntityTypeAlignment`

Vertical	Left	Center	Right
Top	TOP_LEFT	TOP_CENTER	TOP_RIGHT
Middle	MIDDLE_LEFT	MIDDLE_CENTER	MIDDLE_RIGHT
Bottom	BOTTOM_LEFT	BOTTOM_CENTER	BOTTOM_RIGHT
Baseline	LEFT	CENTER	RIGHT

The vertical middle alignments (MIDDLE\_XXX), center the text vertically in the middle of the uppercase letter “X” (cap height).

Special alignments, where the horizontal alignment is always in the center of the text:

- ALIGNED: text is scaled to match the given *length*, scales x- and y-direction by the same factor.
- FIT: text is scaled to match the given *length*, but scales only in x-direction.
- MIDDLE: insertion point is the center of the total height (cap height + descender height) without scaling, the *length* argument is ignored.

## Font Face Definition

A font face is defined by the Matplotlib compatible `FontFace` object by `font-family`, `font-style`, `font-stretch` and `font-weight`.

See also:

- [Font Anatomy](#)
- [Font Properties](#)

## String Functions

### Entity Functions

#### 6.11.9 MTextExplode

This tool is meant to explode MTEXT entities into single line TEXT entities by replicating the MTEXT layout as close as possible. This tool requires the optional Matplotlib package to create usable results, nonetheless it also works without Matplotlib, but then uses a mono-spaced replacement font for text size measuring which leads to very inaccurate results.

The supported MTEXT features are:

- changing text color
- text strokes: underline, overline and strike through
- changing text size, width and oblique
- changing font faces
- stacked text (fractions)
- multi-column support
- background color

- text frame

The tool requires an initialized DXF document to implement all these features by creating additional text styles. When exploding multiple MTEXT entities, they can share this new text styles. Call the `MTextExplode.finalize()` method just once after all MTEXT entities are processed to create the required text styles, or use `MTextExplode` as context manager by using the `with` statement, see examples below.

There are also many limitations:

- A 100% accurate result cannot be achieved.
- Character tracking is not supported.
- Tabulator stops have only limited support for LEFT and JUSTIFIED aligned paragraphs to support numbered and bullet lists. An excessive use of tabs will lead to incorrect results.
- The DISTRIBUTED alignment will be replaced by the JUSTIFIED alignment.
- Text flow is always “left to right”.
- The line spacing mostly corresponds to the “EXACT” style, except for stacked text (fractions), which corresponds more to the “AT LEAST” style, but not precisely. This behavior maybe will improve in the future.
- FIELDS are not evaluated by `ezdxf`.

```
class ezdxf.addons.MTextExplode(layout, doc=None, spacing_factor = 1.0)
```

The `MTextExplode` class is a tool to disassemble MTEXT entities into single line TEXT entities and additional LINE entities if required to emulate strokes.

The `layout` argument defines the target layout for “exploded” parts of the MTEXT entity. Use argument `doc` if the target layout has no DXF document assigned. The `spacing_factor` argument is an advanced tuning parameter to scale the size of space chars.

```
explode(mtext: ezdxf.entities.mtext.MText, destroy=True)
```

Explode `mtext` and destroy the source entity if argument `destroy` is True.

```
finalize()
```

Create required text styles. This method is called automatically if the class is used as context manager.

Example to explode all MTEXT entities in the DXF file “mtext.dxf”:

```
import ezdxf
from ezdxf.addons import MTextExplode

doc = ezdxf.readfile("mtext.dxf")
msp = doc.modelspace()
with MTextExplode(msp) as xpl:
    for mtext in msp.query("MTEXT"):
        xpl.explode(mtext)
doc.saveas("xpl_mtext.dxf")
```

Explode all MTEXT entities into the block “EXPLODE”:

```
import ezdxf
from ezdxf.addons import MTextExplode

doc = ezdxf.readfile("mtext.dxf")
msp = doc.modelspace()
blk = doc.blocks.new("EXPLODE")
with MTextExplode(blk) as xpl:
    for mtext in msp.query("MTEXT"):
        xpl.explode(mtext)
```

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```
msp.add_block_ref("EXPLODE", (0, 0))
doc.saveas("xpl_into_block.dxf")
```

## 6.11.10 PyCSG

Constructive Solid Geometry (CSG) is a modeling technique that uses Boolean operations like union and intersection to combine 3D solids. This library implements CSG operations on meshes elegantly and concisely using BSP trees, and is meant to serve as an easily understandable implementation of the algorithm. All edge cases involving overlapping coplanar polygons in both solids are correctly handled.

Example for usage:

```
import ezdxf
from ezdxf.render.forms import cube, cylinder_2p
from ezdxfaddons.pyCSG import CSG

# create new DXF document
doc = ezdxf.new()
msp = doc.modelspace()

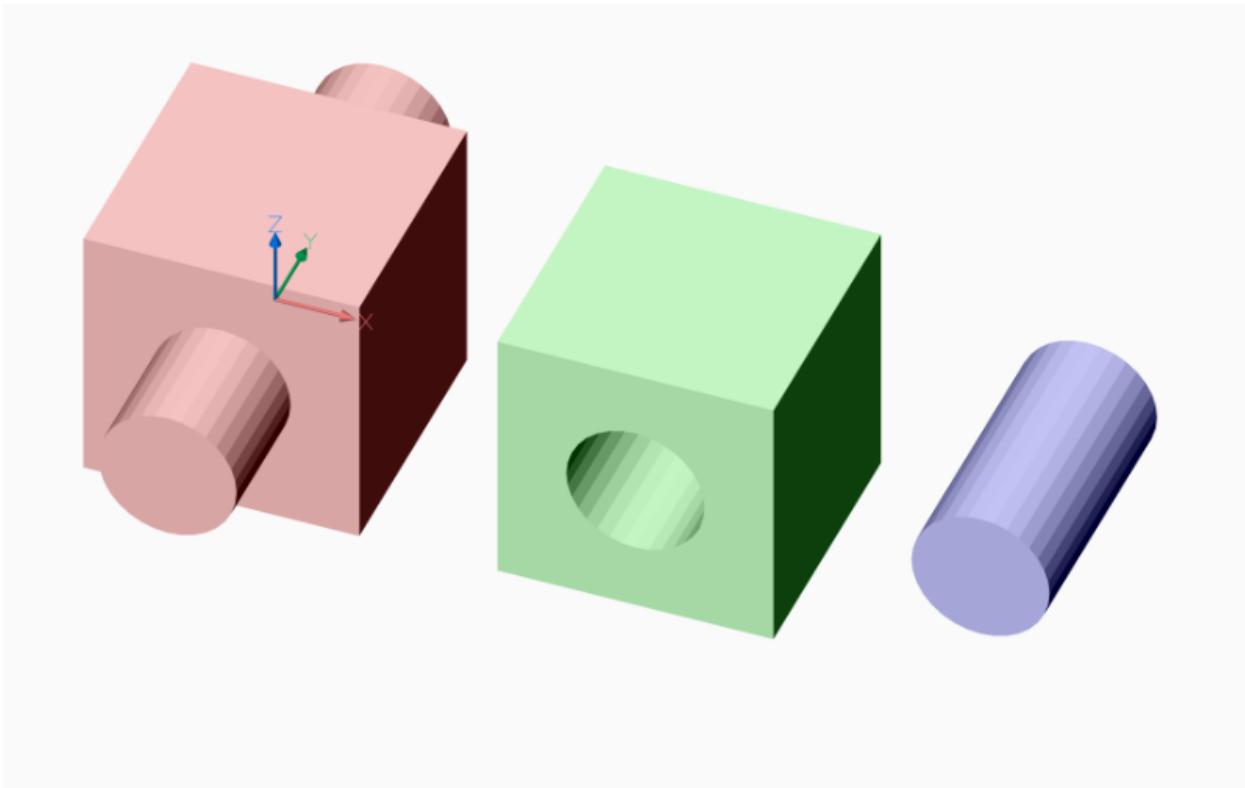
# create same geometric primitives as MeshTransformer() objects
cube1 = cube()
cylinder1 = cylinder_2p(count=32, base_center=(0, -1, 0), top_center=(0, 1, 0),  
                         radius=.25)

# build solid union
union = CSG(cube1) + CSG(cylinder1)
# convert to mesh and render mesh to modelspace
union.mesh().render(msp, dxffattribs={'color': 1})

# build solid difference
difference = CSG(cube1) - CSG(cylinder1)
# convert to mesh, translate mesh and render mesh to modelspace
difference.mesh().translate(1.5).render(msp, dxffattribs={'color': 3})

# build solid intersection
intersection = CSG(cube1) * CSG(cylinder1)
# convert to mesh, translate mesh and render mesh to modelspace
intersection.mesh().translate(2.75).render(msp, dxffattribs={'color': 5})

doc.saveas('csg.dxf')
```



This CSG kernel supports only meshes as [MeshBuilder](#) objects, which can be created from and converted to DXF [Mesh](#) entities.

This CSG kernel is **not** compatible with ACIS objects like [Solid3d](#), [Body](#), [Surface](#) or [Region](#).

---

**Note:** This is a pure Python implementation, don't expect great performance and the implementation is based on an unbalanced BSP tree, so in the case of RecursionError, increase the recursion limit:

```
import sys

actual_limit = sys.getrecursionlimit()
# default is 1000, increasing too much may cause a seg fault
sys.setrecursionlimit(10000)

... # do the CSG stuff

sys.setrecursionlimit(actual_limit)
```

---

CSG works also with spheres, but with really bad runtime behavior and most likely RecursionError exceptions, and use [quadrilaterals](#) as body faces to reduce face count by setting argument *quads* to True.

```
import ezdxf

from ezdxf.render.forms import sphere, cube
from ezdxf.addons.pyccsg import CSG

doc = ezdxf.new()
doc.set_modelspace_vport(6, center=(5, 0))
msp = doc.modelspace()
```

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```

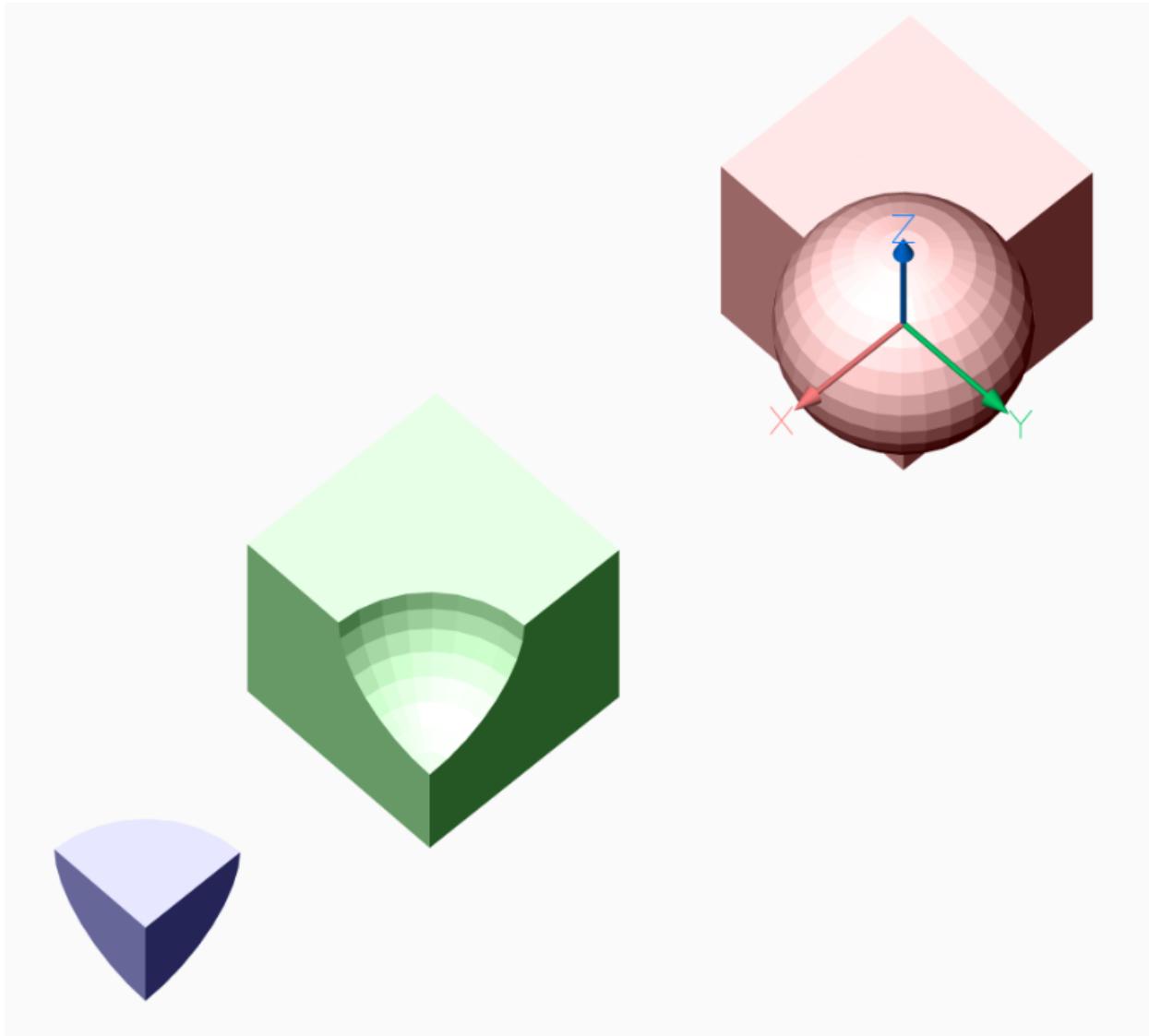
cube1 = cube().translate(-.5, -.5, -.5)
sphere1 = sphere(count=32, stacks=16, radius=.5, quads=True)

union = (CSG(cube1) + CSG(sphere1)).mesh()
union.render(msp, dxfattribs={'color': 1})

subtract = (CSG(cube1) - CSG(sphere1)).mesh().translate(2.5)
subtract.render(msp, dxfattribs={'color': 3})

intersection = (CSG(cube1) * CSG(sphere1)).mesh().translate(4)
intersection.render(msp, dxfattribs={'color': 5})

```



Hard Core CSG - Menger Sponge Level 3 vs Sphere

Required runtime on an old Xeon E5-1620 Workstation @ 3.60GHz, with default recursion limit of 1000 on Windows 10:

- CPython 3.8.1 64bit: ~60 seconds,

- pypy3 [PyPy 7.2.0] 32bit: ~6 seconds, and using `__slots__` reduced runtime below 5 seconds, yes - pypy is worth a look for long running scripts!

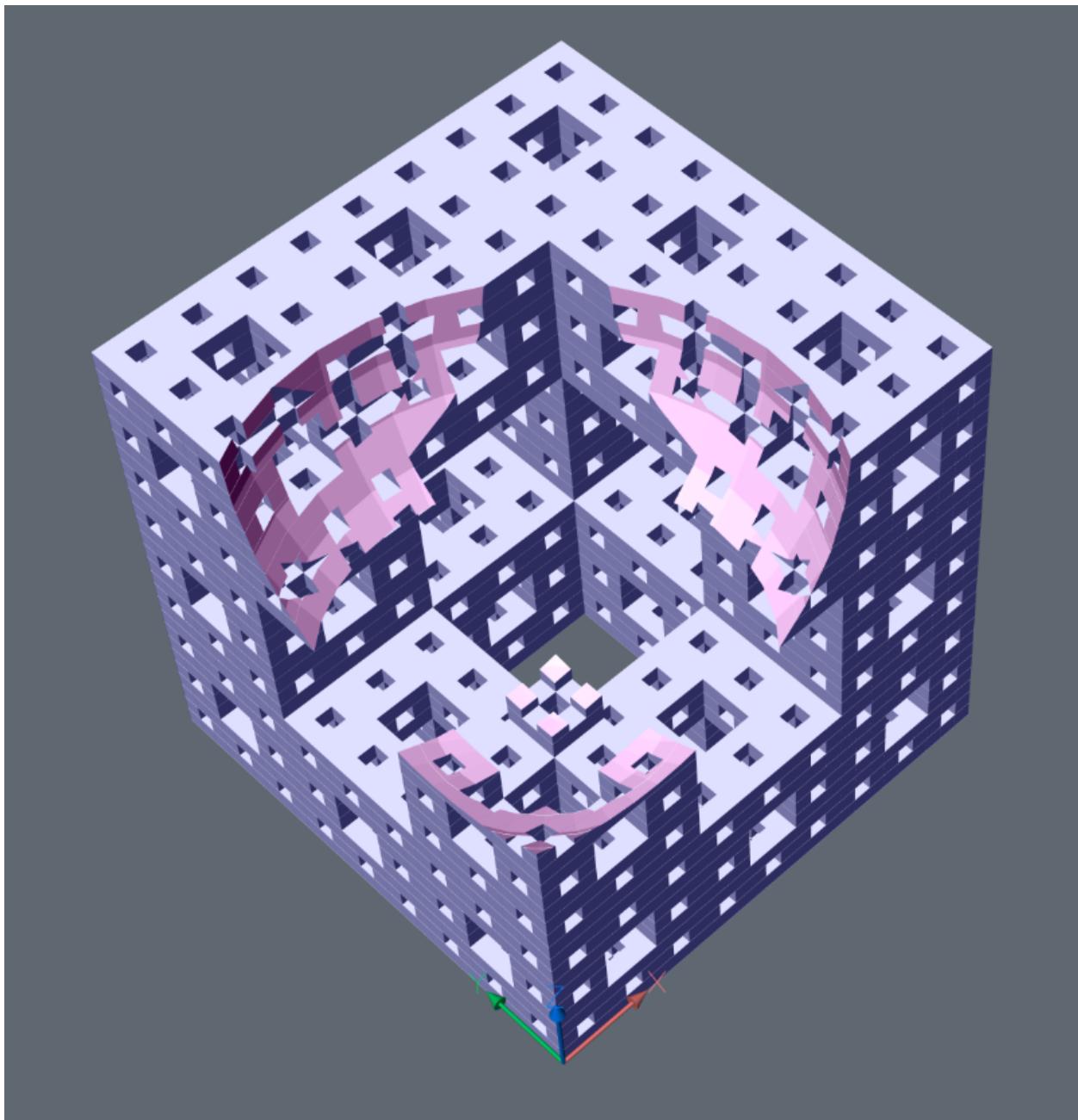
```
from ezdxf.render.forms import sphere
from ezdxf.addons import MengerSponge
from ezdxf.addons.pyccsg import CSG

doc = ezdxf.new()
doc.layers.new('sponge', dxftattribs={'color': 5})
doc.layers.new('sphere', dxftattribs={'color': 6})

doc.set_modelspace_vport(6, center=(5, 0))
msp = doc.modelspace()

sponge1 = MengerSponge(level=3).mesh()
sphere1 = sphere(count=32, stacks=16, radius=.5, quads=True).translate(.25, .25, 1)

subtract = (CSG(sponge1, meshid=1) - CSG(sphere1, meshid=2))
# get mesh result by id
subtract.mesh(1).render(msp, dxftattribs={'layer': 'sponge'})
subtract.mesh(2).render(msp, dxftattribs={'layer': 'sphere'})
```



## CSG Class

```
class ezdxf.addons.pycsg.CSG(mesh: MeshBuilder, meshid: int = 0)
```

Constructive Solid Geometry (CSG) is a modeling technique that uses Boolean operations like union and intersection to combine 3D solids. This class implements CSG operations on meshes.

New 3D solids are created from `MeshBuilder` objects and results can be exported as `MeshTransformer` objects to `ezdxf` by method `mesh()`.

### Parameters

- **mesh** – `ezdxf.render.MeshBuilder` or inherited object
- **meshid** – individual mesh ID to separate result meshes, 0 is default

**mesh** (*meshid*: int = 0) → ezdxf.render.mesh.MeshTransformer

Returns a `ezdxf.render.MeshTransformer` object.

**Parameters** `meshid` – individual mesh ID, 0 is default

**union** (*other*: `ezdxf.addons.pycsg.CSG`) → `ezdxf.addons.pycsg.CSG`

Return a new CSG solid representing space in either this solid or in the solid *other*. Neither this solid nor the solid *other* are modified:

A.union(B)

$$\begin{array}{ccc} +-----+ & & +-----+ \\ | & | & | & | \\ | \quad A \quad | & = & | \quad +---+ \\ | +---+ & & | & +---+ \\ +---+ & | & +---+ & | \\ | \quad B \quad | & & | & | \\ | & | & | & | \\ +-----+ & & +-----+ \end{array}$$

**\_\_add\_\_** ()

union = A + B

**subtract** (*other*: `ezdxf.addons.pycsg.CSG`) → `ezdxf.addons.pycsg.CSG`

Return a new CSG solid representing space in this solid but not in the solid *other*. Neither this solid nor the solid *other* are modified:

A.subtract(B)

$$\begin{array}{ccc} +-----+ & & +-----+ \\ | & | & | & | \\ | \quad A \quad | & = & | \quad +---+ \\ | +---+ & & | & +---+ \\ +---+ & | & +---+ & | \\ | \quad B \quad | & & | & | \\ | & | & | & | \\ +-----+ & & +-----+ \end{array}$$

**\_\_sub\_\_** ()

difference = A - B

**intersect** (*other*: `ezdxf.addons.pycsg.CSG`) → `ezdxf.addons.pycsg.CSG`

Return a new CSG solid representing space both this solid and in the solid *other*. Neither this solid nor the solid *other* are modified:

A.intersect(B)

$$\begin{array}{ccc} +-----+ & & +---+ \\ | & | & | \\ | \quad A \quad | & = & +---+ \\ | +---+ & & | & +---+ \\ +---+ & | & +---+ & | \\ | \quad B \quad | & & | & | \\ | & | & | & | \\ +-----+ & & +---+ \end{array}$$

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**\_\_mul\_\_(self)**

```
intersection = A * B
```

**inverse(self) → ezdxf.addons.pycsg.CSG**

Return a new CSG solid with solid and empty space switched. This solid is not modified.

## License

- Original implementation `csg.js`, Copyright (c) 2011 Evan Wallace (<http://madebyevan.com/>), under the MIT license.
- Python port `pycsg`, Copyright (c) 2012 Tim Knip (<http://www.floorplanner.com>), under the MIT license.
- Additions by Alex Pletzer (Pennsylvania State University)
- Integration as `ezdxf` add-on, Copyright (c) 2020, Manfred Moitzi, MIT License.

### 6.11.11 Plot Style Files (CTB/STB)

CTB and STB files store plot styles used by AutoCAD and BricsCAD for printing and plotting.

If the plot style table is attached to a `Paperspace` or the `Modelspace`, a change of a plot style affects any object that uses that plot style. CTB files contain color dependent plot style tables, STB files contain named plot style tables.

#### See also:

- Using plot style tables in AutoCAD
- AutoCAD Plot Style Table Editor
- BricsCAD Plot Style Table Editor
- AUTODESK KNOWLEDGE NETWORK: How to [install CTB files in AutoCAD](#)

`ezdxf.addons.acadctb.load(filename: str) → Union[ezdxf.addons.acadctb.ColorDependentPlotStyles, ezdxf.addons.acadctb.NamedPlotStyles]`

Load the CTB or STB file `filename` from file system.

`ezdxf.addons.acadctb.new_ctb() → ezdxf.addons.acadctb.ColorDependentPlotStyles`

Create a new CTB file.

Changed in version 0.10: renamed from `new()`

`ezdxf.addons.acadctb.new_stb() → ezdxf.addons.acadctb.NamedPlotStyles`

Create a new STB file.

#### ColorDependentPlotStyles

Color dependent plot style table (CTB file), table entries are `PlotStyle` objects.

**class ezdxf.addons.acadctb.ColorDependentPlotStyles**

**description**

Custom description of plot style file.

**scale\_factor**

Specifies the factor by which to scale non-ISO linetypes and fill patterns.

**apply\_factor**

Specifies whether or not you want to apply the *scale\_factor*.

**custom\_lineweight\_display\_units**

Set 1 for showing linewidth in inch in AutoCAD CTB editor window, but linewidths are always defined in millimeters.

**lineweights**

Lineweights table as `array.array`

**\_\_getitem\_\_(aci: int) → ezdxf.addons.acadctb.PlotStyle**

Returns *PlotStyle* for *AutoCAD Color Index (ACI)* *aci*.

**\_\_iter\_\_()**

Iterable of all plot styles.

**new\_style(aci: int, data: dict = None) → ezdxf.addons.acadctb.PlotStyle**

Set *aci* to new attributes defined by *data* dict.

**Parameters**

- **aci** – *AutoCAD Color Index (ACI)*
- **data** – dict of *PlotStyle* attributes: description, color, physical\_pen\_number, virtual\_pen\_number, screen, linepattern\_size, linetype, adaptive\_linetype, linewidth, end\_style, join\_style, fill\_style

**get\_lineweight(aci: int)**

Returns the assigned linewidth for *PlotStyle* *aci* in millimeter.

**get\_lineweight\_index(linewidth: float) → int**

Get index of *linewidth* in the linewidth table or append *linewidth* to linewidth table.

**get\_table\_lineweight(index: int) → float**

Returns linewidth in millimeters of linewidth table entry *index*.

**Parameters** **index** – linewidth table index = *PlotStyle.linewidth*

**Returns** linewidth in mm or 0.0 for use entity linewidth

**set\_table\_lineweight(index: int, linewidth: float) → int**

Argument *index* is the linewidth table index, not the *AutoCAD Color Index (ACI)*.

**Parameters**

- **index** – linewidth table index = *PlotStyle.linewidth*
- **linewidth** – in millimeters

**save()**

Save CTB file as *filename* to the file system.

**write(stream: BinaryIO) → None**

Compress and write CTB file to binary *stream*.

## NamedPlotStyles

Named plot style table (STB file), table entries are `PlotStyle` objects.

`class ezdxf.addons.acadctb.NamedPlotStyles`

### `description`

Custom description of plot style file.

### `scale_factor`

Specifies the factor by which to scale non-ISO linetypes and fill patterns.

### `apply_factor`

Specifies whether or not you want to apply the `scale_factor`.

### `custom_lineweight_display_units`

Set 1 for showing linewidth in inch in AutoCAD CTB editor window, but linewidths are always defined in millimeters.

### `lineweights`

Lineweights table as `array.array`

### `__getitem__(name: str) → ezdxf.addons.acadctb.PlotStyle`

Returns `PlotStyle` by `name`.

### `__delitem__(name: str) → None`

Delete plot style `name`. Plot style 'Normal' is not deletable.

### `__iter__() → Iterable[str]`

Iterable of all plot style names.

### `new_style(name: str, data: dict = None, localized_name: str = None) → ezdxf.addons.acadctb.PlotStyle`

Create new class:`PlotStyle` `name` by attribute dict `data`, replaces existing class:`PlotStyle` objects.

#### Parameters

- `name` – plot style name
- `localized_name` – name shown in plot style editor, uses `name` if `None`
- `data` – dict of `PlotStyle` attributes: description, color, physical\_pen\_number, virtual\_pen\_number, screen, linepattern\_size, linetype, adaptive\_linetype, linewidth, end\_style, join\_style, fill\_style

### `get_lineweight(name: str)`

Returns the assigned linewidth for `PlotStyle` `name` in millimeter.

### `get_lineweight_index(linewidth: float) → int`

Get index of `linewidth` in the linewidth table or append `linewidth` to linewidth table.

### `get_table_lineweight(index: int) → float`

Returns linewidth in millimeters of linewidth table entry `index`.

#### Parameters `index` – linewidth table index = `PlotStyle.linewidth`

**Returns** linewidth in mm or 0.0 for use entity linewidth

### `set_table_lineweight(index: int, linewidth: float) → int`

Argument `index` is the linewidth table index, not the `AutoCAD Color Index (ACI)`.

#### Parameters

- `index` – linewidth table index = `PlotStyle.linewidth`

- **lineweight** – in millimeters

**save()**

Save STB file as *filename* to the file system.

**write()**

Compress and write STB file to binary *stream*.

## PlotStyle

**class** ezdxf.addons.acadctb.**PlotStyle**

**index**

Table index (0-based). (int)

**aci**

*AutoCAD Color Index (ACI)* in range from 1 to 255. Has no meaning for named plot styles. (int)

**description**

Custom description of plot style. (str)

**physical\_pen\_number**

Specifies physical plotter pen, valid range from 1 to 32 or *AUTOMATIC*. (int)

**virtual\_pen\_number**

Only used by non-pen plotters and only if they are configured for virtual pens. valid range from 1 to 255 or *AUTOMATIC*. (int)

**screen**

Specifies the color intensity of the plot on the paper, valid range is from 0 to 100. (int)

If you select 100 the drawing will plotted with its full color intensity. In order for screening to work, the *dithering* option must be active.

**linetype**

Overrides the entity linetype, default value is *OBJECT\_LINETYPE*. (bool)

**adaptive\_linetype**

True if a complete linetype pattern is more important than a correct linetype scaling, default is True. (bool)

**linepattern\_size**

Line pattern size, default = 0.5. (float)

**lineweight**

Overrides the entity lineWEIGHT, default value is *OBJECT\_LINEWEIGHT*. This is an index into the UserStyles.lineweights table. (int)

**end\_style**

Line end cap style, see table below, default is END\_STYLE\_OBJECT (int)

**join\_style**

Line join style, see table below, default is JOIN\_STYLE\_OBJECT (int)

**fill\_style**

Line fill style, see table below, default is FILL\_STYLE\_OBJECT (int)

**dithering**

Depending on the capabilities of your plotter, dithering approximates the colors with dot patterns. When this option is False, the colors are mapped to the nearest color, resulting in a smaller range of colors when plotting.

Dithering is available only whether you select the object's color or assign a plot style color.

### **grayscale**

Plot colors in grayscale. (bool)

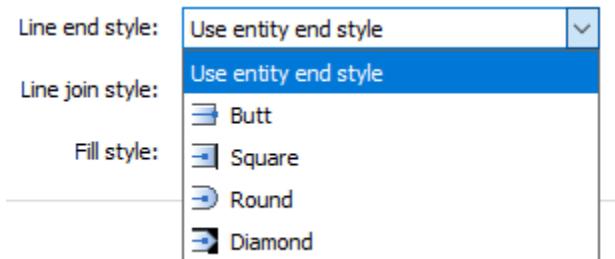
## Default Line Weights

#	[mm]
0	0.00
1	0.05
2	0.09
3	0.10
4	0.13
5	0.15
6	0.18
7	0.20
8	0.25
9	0.30
10	0.35
11	0.40
12	0.45
13	0.50
14	0.53
15	0.60
16	0.65
17	0.70
18	0.80
19	0.90
20	1.00
21	1.06
22	1.20
23	1.40
24	1.58
25	2.00
26	2.11

## Predefined Values

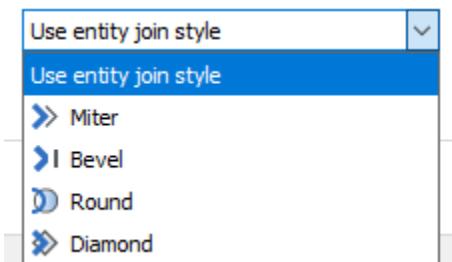
```
ezdxf.addons.acadctb.AUTOMATIC
ezdxf.addons.acadctb.OBJECT_LINEWEIGHT
ezdxf.addons.acadctb.OBJECT_LINETYPE
ezdxf.addons.acadctb.OBJECT_COLOR
ezdxf.addons.acadctb.OBJECT_COLOR2
```

## Line End Style



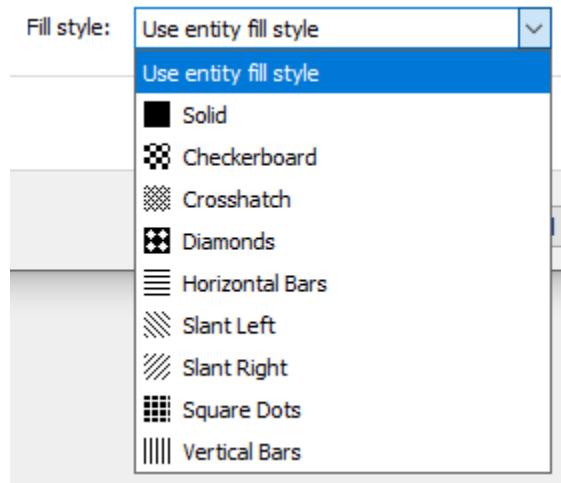
END_STYLE_BUTT	0
END_STYLE_SQUARE	1
END_STYLE_ROUND	2
END_STYLE_DIAMOND	3
END_STYLE_OBJECT	4

## Line Join Style



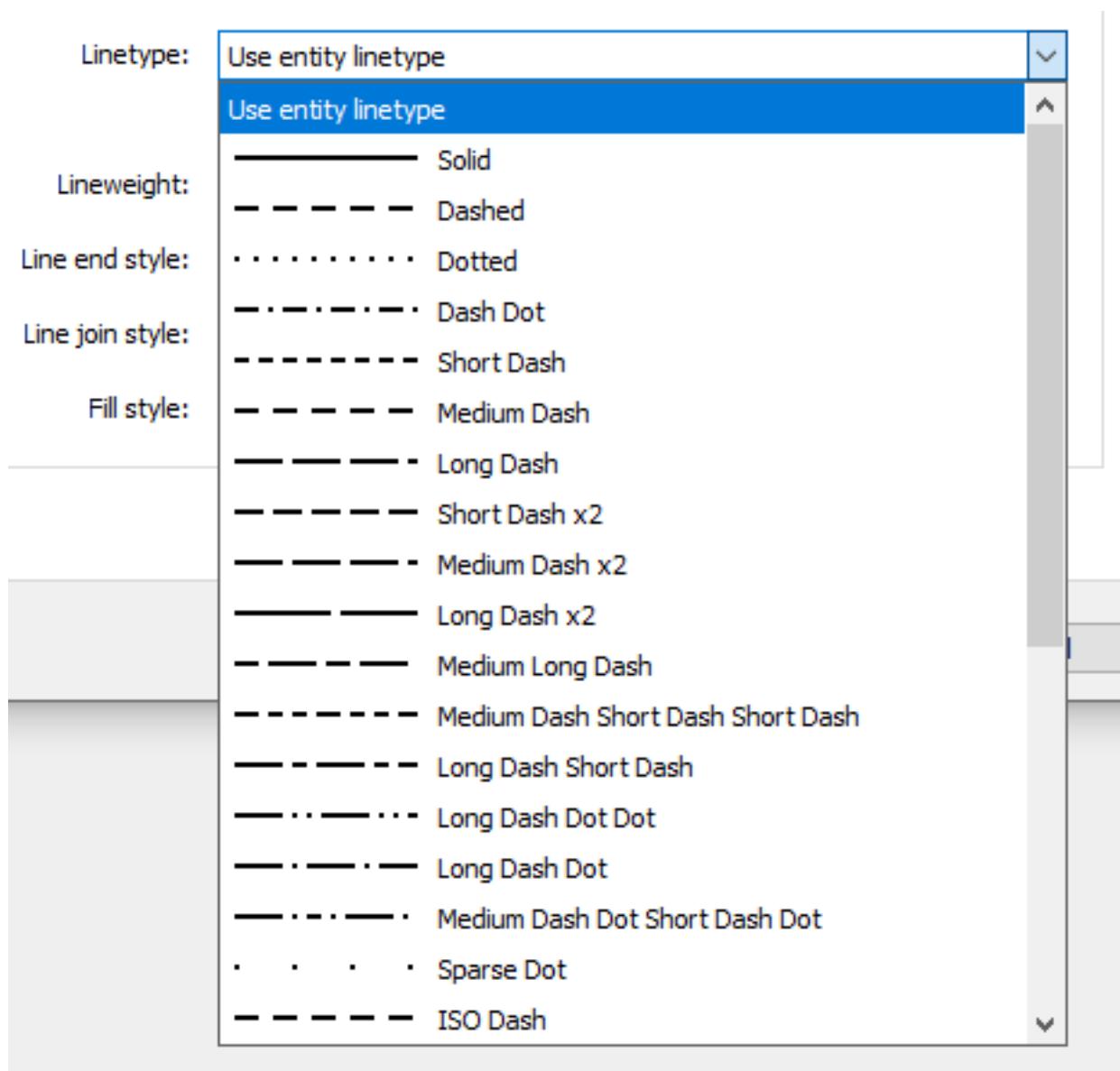
JOIN_STYLE_MITER	0
JOIN_STYLE_BEVEL	1
JOIN_STYLE_ROUND	2
JOIN_STYLE_DIAMOND	3
JOIN_STYLE_OBJECT	5

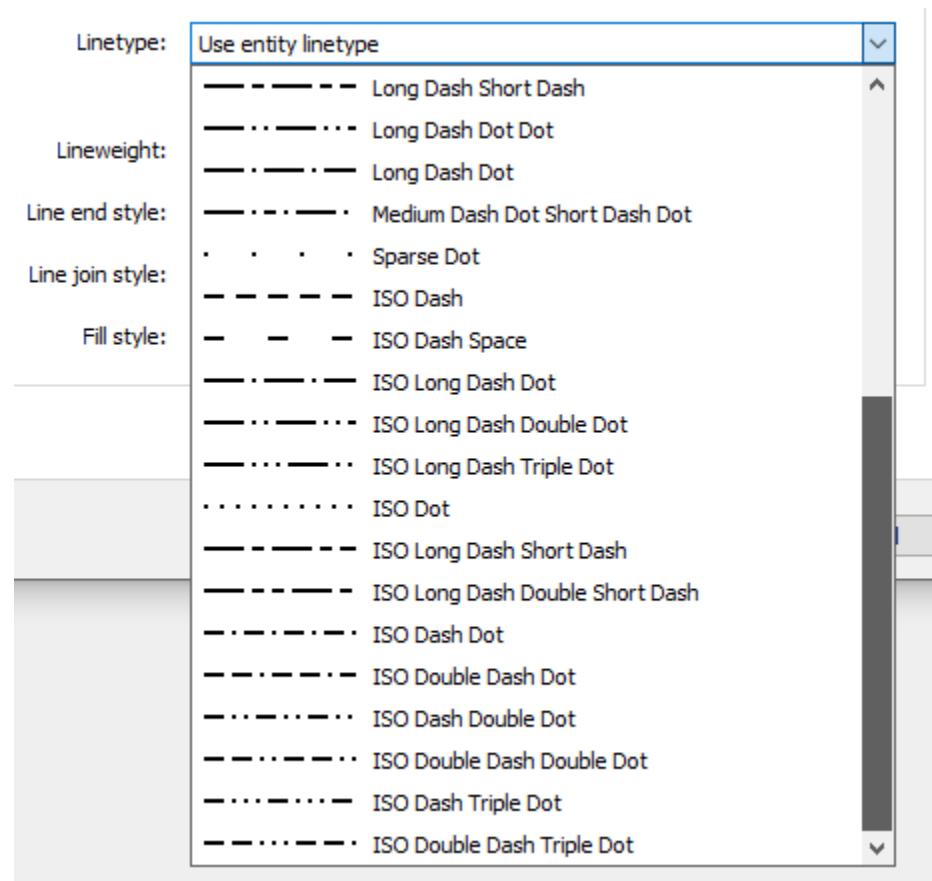
## Fill Style



FILL_STYLE_SOLID	64
FILL_STYLE_CHECKERBOARD	65
FILL_STYLE_CROSSHATCH	66
FILL_STYLE_DIAMONDS	67
FILL_STYLE_HORIZONTAL_BARS	68
FILL_STYLE_SLANT_LEFT	69
FILL_STYLE_SLANT_RIGHT	70
FILL_STYLE_SQUARE_DOTS	71
FILL_STYLE_VERICAL_BARS	72
FILL_STYLE_OBJECT	73

## Linetypes





Linetype name	Value
Solid	0
Dashed	1
Dotted	2
Dash Dot	3
Short Dash	4
Medium Dash	5
Long Dash	6
Short Dash x2	7
Medium Dash x2	8
Long Dash x2	9
Medium Lang Dash	10
Medium Dash Short Dash Short Dash	11
Long Dash Short Dash	12
Long Dash Dot Dot	13
Long Dash Dot	14
Medium Dash Dot Short Dash Dot	15
Sparse Dot	16
ISO Dash	17
ISO Dash Space	18
ISO Long Dash Dot	19
ISO Long Dash Double Dot	20
ISO Long Dash Triple Dot	21

Continued on next page

Table 1 – continued from previous page

Linetype name	Value
ISO Dot	22
ISO Long Dash Short Dash	23
ISO Long Dash Double Short Dash	24
ISO Dash Dot	25
ISO Double Dash Dot	26
ISO Dash Double Dot	27
ISO Double Dash Double Dot	28
ISO Dash Triple Dot	29
ISO Double Dash Triple Dot	30
Use entity linetype	31

## 6.11.12 Showcase Forms

### MengerSponge

Build a 3D Menger sponge.

```
class ezdxf.addons.MengerSponge (location: Union[Sequence[float], ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3] = (0.0, 0.0, 0.0), length: float = 1.0, level: int = 1, kind: int = 0)
```

#### Parameters

- **location** – location of lower left corner as (x, y, z) tuple
- **length** – side length
- **level** – subdivide level
- **kind** – type of menger sponge

0	Original Menger Sponge
1	Variant XOX
2	Variant OXO
3	Jerusalem Cube

```
render(layout: GenericLayoutType, merge: bool = False, dxfattribs=None, matrix: Optional[Matrix44] = None, ucs: Optional[UCS] = None) → None
```

Renders the menger sponge into layout, set *merge* to True for rendering the whole menger sponge into one MESH entity, set *merge* to False for rendering the individual cubes of the menger sponge as MESH entities.

#### Parameters

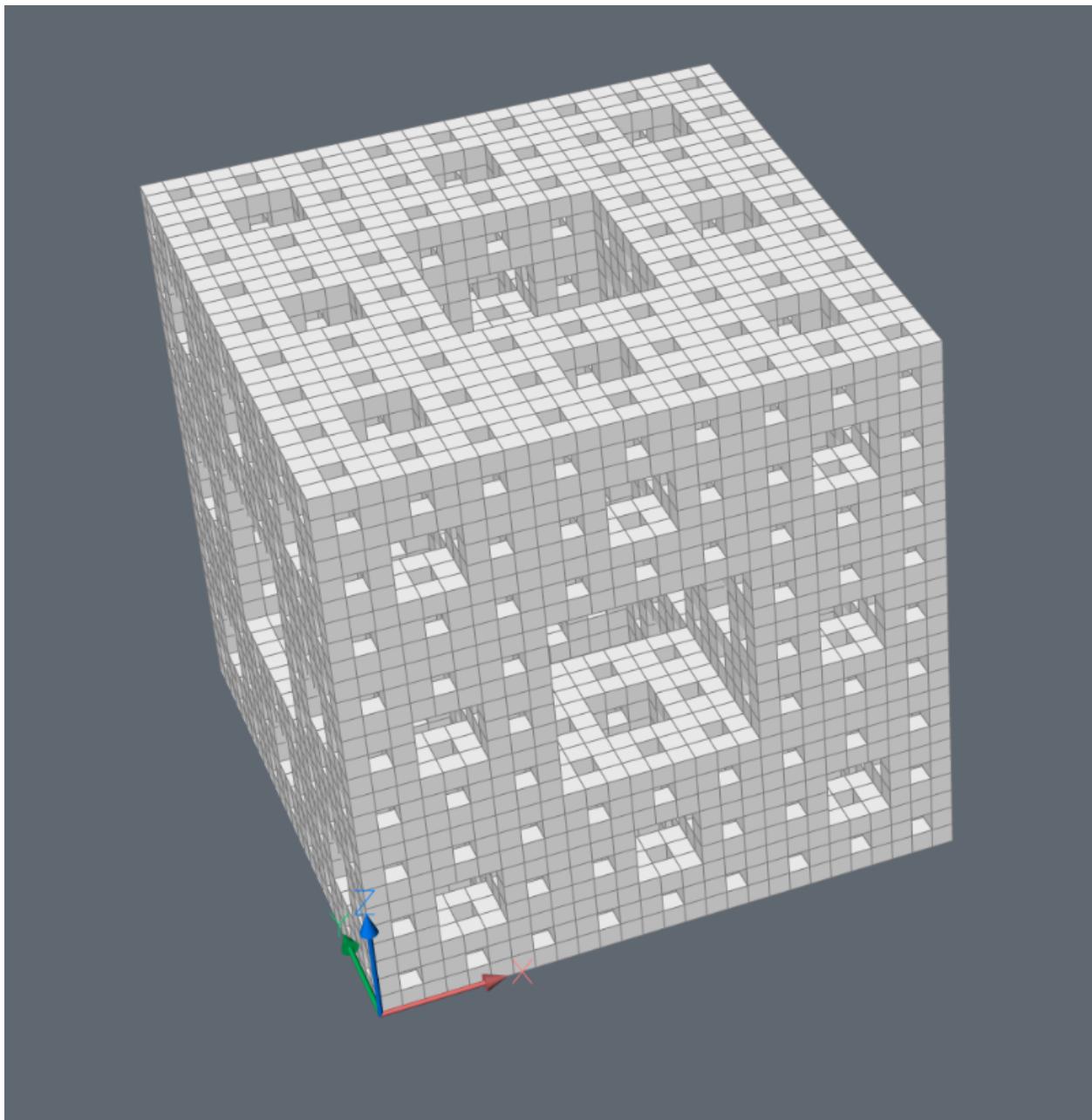
- **layout** – DXF target layout
- **merge** – True for one MESH entity, False for individual MESH entities per cube
- **dfattribs** – DXF attributes for the MESH entities
- **matrix** – apply transformation matrix at rendering
- **ucs** – apply UCS transformation at rendering

```
cubes() → Iterator[ezdxf.render.mesh.MeshTransformer]
```

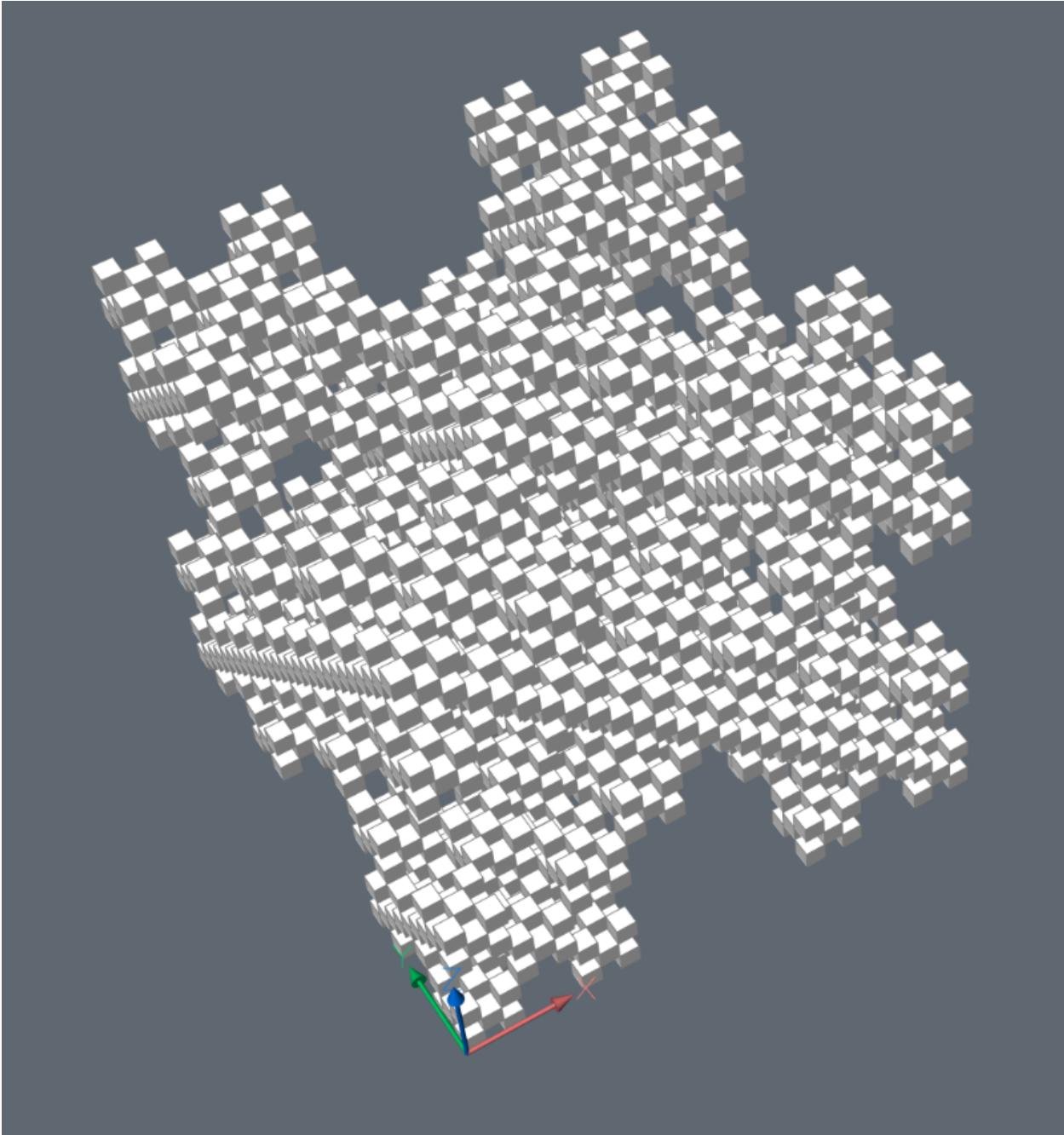
Yields all cubes of the menger sponge as individual MeshTransformer objects.

**mesh()** → ezdxf.render.mesh.MeshTransformer  
Returns geometry as one MeshTransformer object.

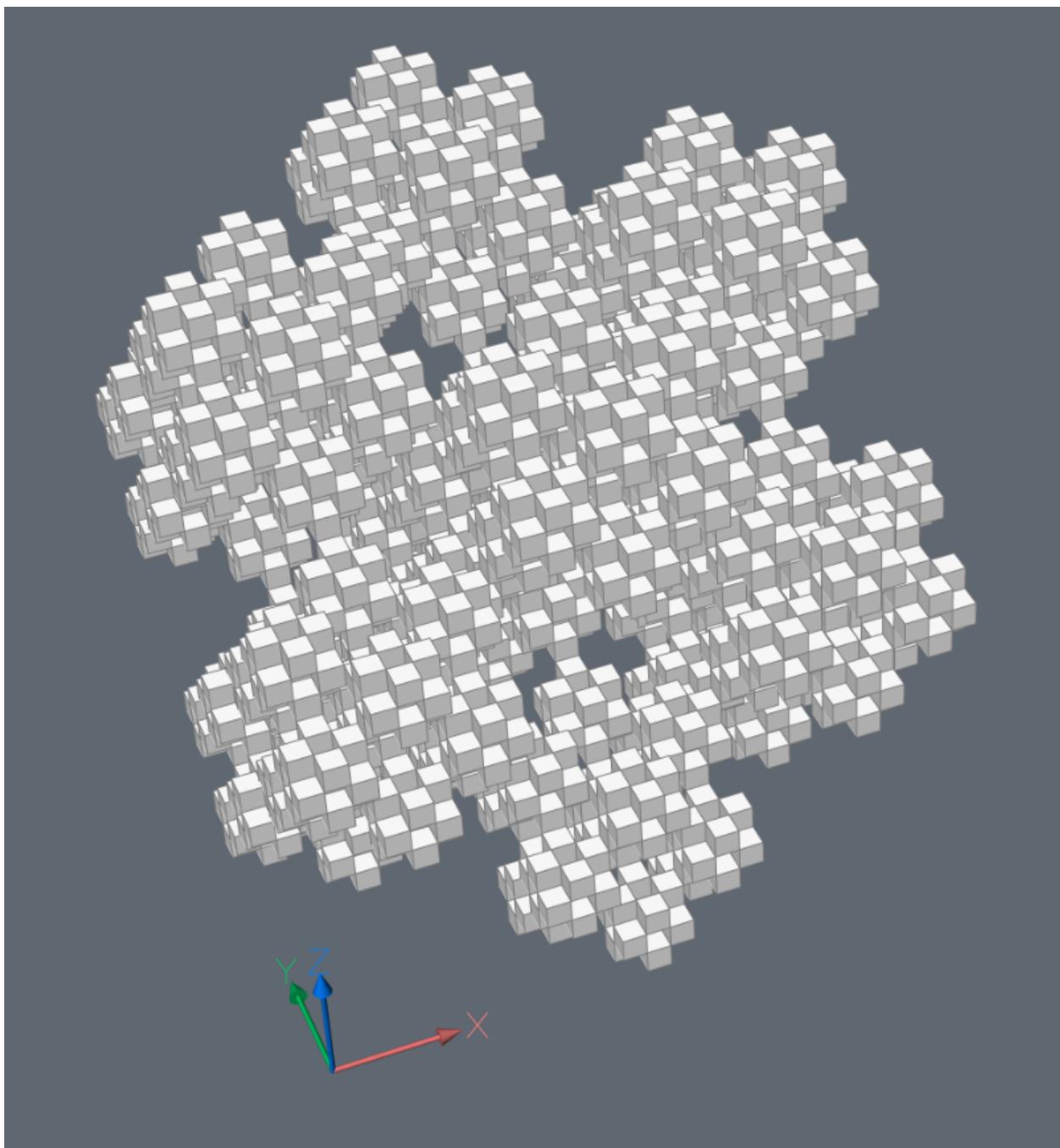
Menger Sponge kind=0:



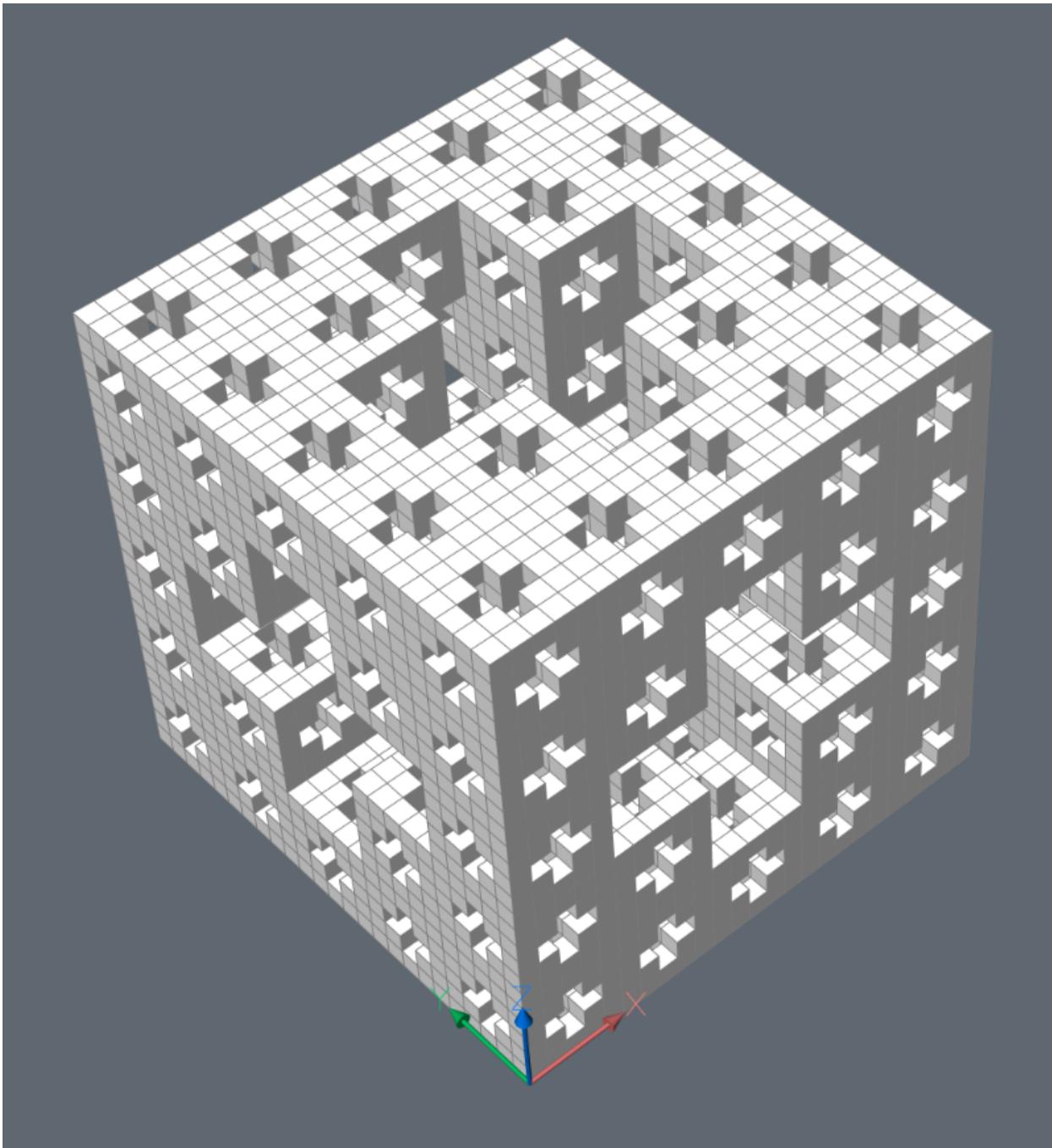
Menger Sponge kind=1:



Menger Sponge kind=2:



Jerusalem Cube kind=3:



## SierpinskyPyramid

Build a 3D Sierpinsky Pyramid.

```
class ezdxf.addons.SierpinskyPyramid(location: Union[Sequence[float],  
ezdxf.math._vector.Vec2, ezdxf.math._vector.Vec3]  
= (0.0, 0.0, 0.0), length: float = 1.0, level: int = 1,  
sides: int = 4)
```

### Parameters

- **location** – location of base center as (x, y, z) tuple
- **length** – side length
- **level** – subdivide level
- **sides** – sides of base geometry

**render**(*layout*: *GenericLayoutType*, *merge*: *bool* = *False*, *dxfattribs*=*None*, *matrix*: *Optional[Matrix44]* = *None*, *ucs*: *Optional[UCS]* = *None*) → *None*

Renders the sierpinsky pyramid into layout, set *merge* to *True* for rendering the whole sierpinsky pyramid into one MESH entity, set *merge* to *False* for individual pyramids as MESH entities.

#### Parameters

- **layout** – DXF target layout
- **merge** – *True* for one MESH entity, *False* for individual MESH entities per pyramid
- **dxfattribs** – DXF attributes for the MESH entities
- **matrix** – apply transformation matrix at rendering
- **ucs** – apply UCS at rendering

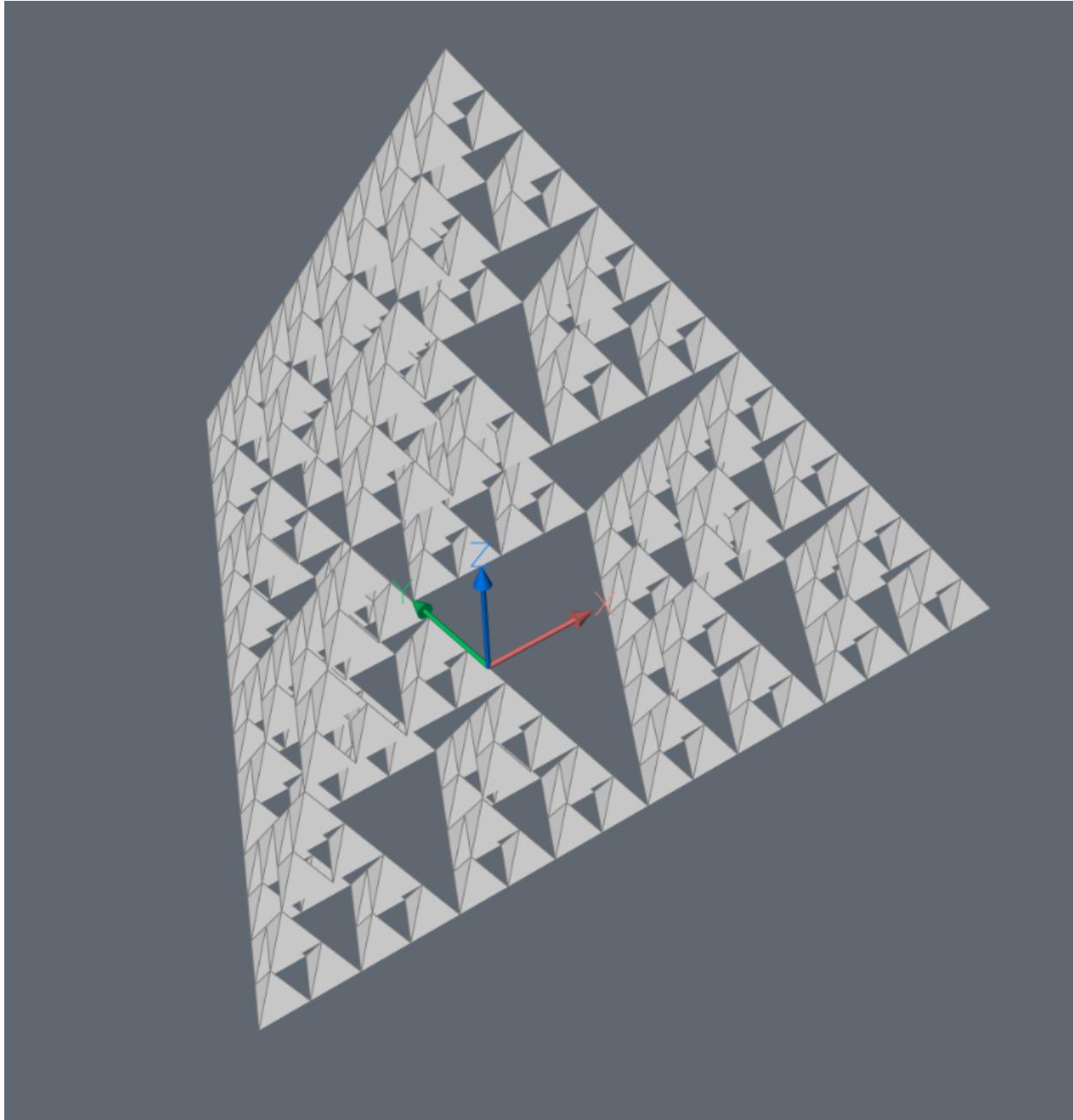
**pyramids**() → *Iterable[ezdxf.render.mesh.MeshTransformer]*

Yields all pyramids of the sierpinsky pyramid as individual *MeshTransformer* objects.

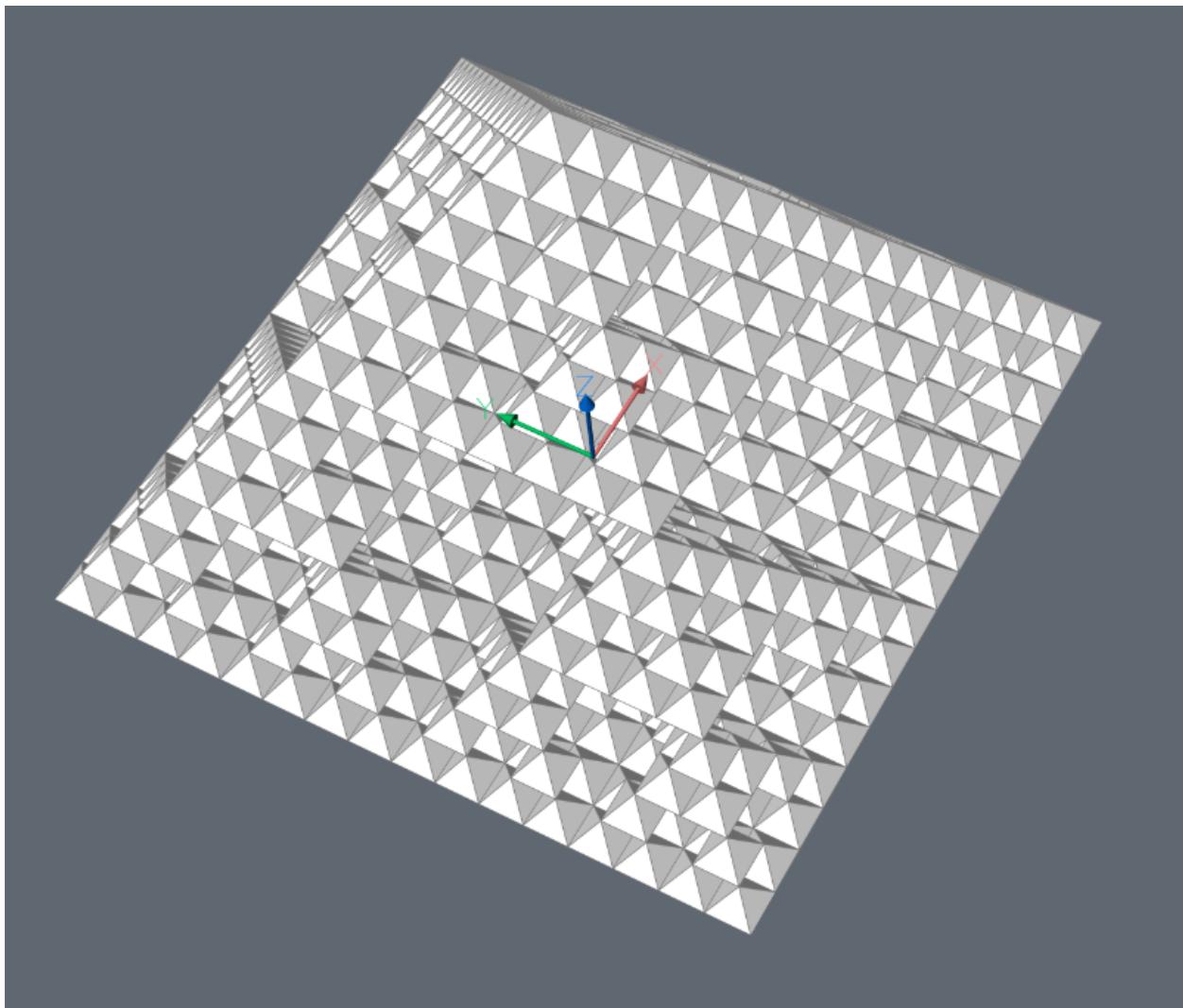
**mesh**() → *ezdxf.render.mesh.MeshTransformer*

Returns geometry as one *MeshTransformer* object.

Sierpinsky Pyramid with triangle base:



Sierpinsky Pyramid with square base:



### 6.11.13 Bin-Pack Add-on

New in version 0.18.

This add-on is based on the 3D bin packing module [py3dbp](#) hosted on PyPI. Both sources of this package are MIT licensed like *ezdxf* itself.

#### The Bin Packing Problem

Quote from the [Wikipedia](#) article:

The bin packing problem is an optimization problem, in which items of different sizes must be packed into a finite number of bins or containers, each of a fixed given capacity, in a way that minimizes the number of bins used.

#### Example

This code replicates the example used by the [py3dbp](#) package:

```
from typing import List
import eздxf
from eздxf import colors
from eздxf.addons import binpacking as bp

SMALL_ENVELOPE = ("small-envelope", 11.5, 6.125, 0.25, 10)
LARGE_ENVELOPE = ("large-envelope", 15.0, 12.0, 0.75, 15)
SMALL_BOX = ("small-box", 8.625, 5.375, 1.625, 70.0)
MEDIUM_BOX = ("medium-box", 11.0, 8.5, 5.5, 70.0)
MEDIUM_BOX2 = ("medium-box-2", 13.625, 11.875, 3.375, 70.0)
LARGE_BOX = ("large-box", 12.0, 12.0, 5.5, 70.0)
LARGE_BOX2 = ("large-box-2", 23.6875, 11.75, 3.0, 70.0)

ALL_BINS = [
    SMALL_ENVELOPE,
    LARGE_ENVELOPE,
    SMALL_BOX,
    MEDIUM_BOX,
    MEDIUM_BOX2,
    LARGE_BOX,
    LARGE_BOX2,
]
]

def build_packer():
    packer = bp.Packer()
    packer.add_item("50g [powder 1]", 3.9370, 1.9685, 1.9685, 1)
    packer.add_item("50g [powder 2]", 3.9370, 1.9685, 1.9685, 2)
    packer.add_item("50g [powder 3]", 3.9370, 1.9685, 1.9685, 3)
    packer.add_item("250g [powder 4]", 7.8740, 3.9370, 1.9685, 4)
    packer.add_item("250g [powder 5]", 7.8740, 3.9370, 1.9685, 5)
    packer.add_item("250g [powder 6]", 7.8740, 3.9370, 1.9685, 6)
    packer.add_item("250g [powder 7]", 7.8740, 3.9370, 1.9685, 7)
    packer.add_item("250g [powder 8]", 7.8740, 3.9370, 1.9685, 8)
    packer.add_item("250g [powder 9]", 7.8740, 3.9370, 1.9685, 9)
    return packer

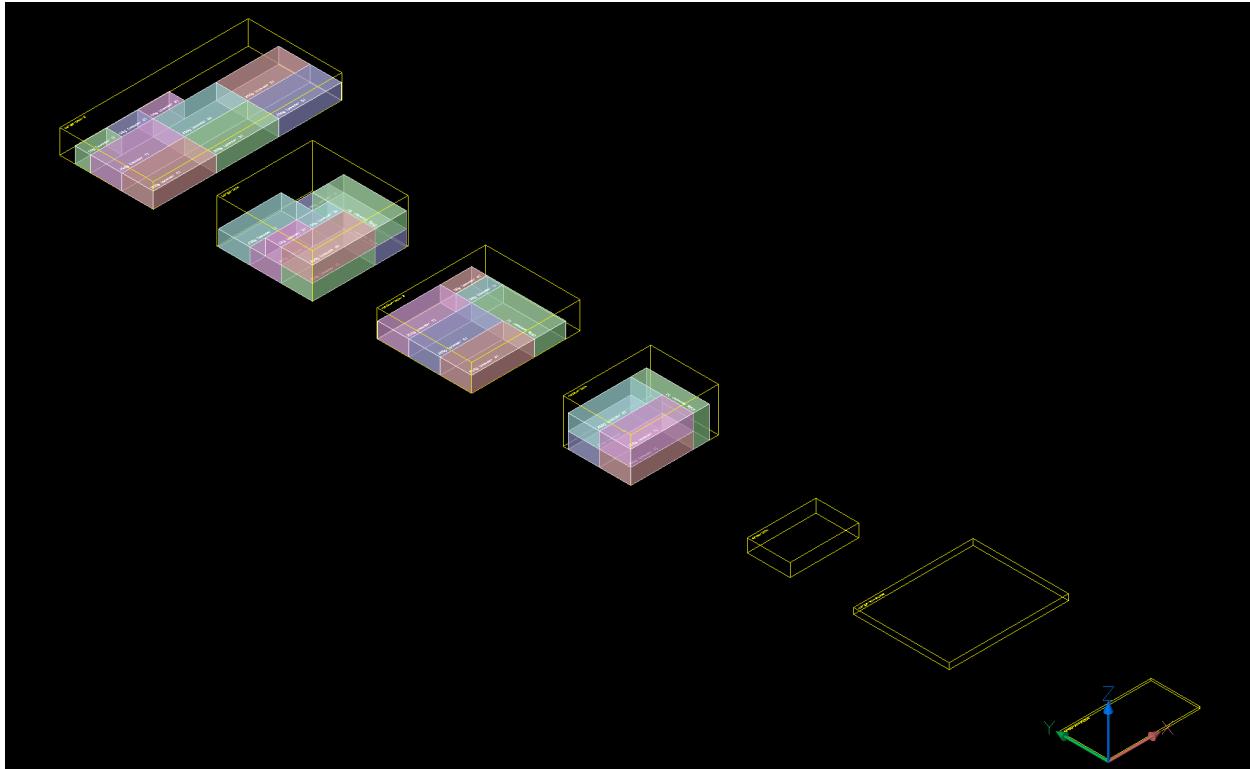
def make_doc():
    doc = eздxf.new()
    doc.layers.add("FRAME", color=colors.YELLOW)
    doc.layers.add("ITEMS")
    doc.layers.add("TEXT")
    return doc

def main(filename):
    bins: List[bp.Bin] = []
    for box in ALL_BINS:
        packer = build_packer()
        packer.add_bin(*box)
        packer.pack(bp.PickStrategy.BIGGER_FIRST)
        bins.extend(packer.bins)
    doc = make_doc()
    bp.export_dxf(doc.modelspace(), bins, offset=(0, 20, 0))
    doc.saveas(filename)
```

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```
if __name__ == "__main__":
    main("py3dbp_example.dxf")
```

**See also:**

- [example1](#) script
- [example2](#) script

**Packer Classes**

```
class ezdxf.addons.binpacking.AbstractPacker
```

**bins**

List of containers to fill.

**items**

List of items to pack into the *bins*.

**\_\_str\_\_ () → str**

Return str(self).

**append\_bin (box: ezdxf.addons.binpacking.Bin) → None**

Append a container.

**append\_item (item: ezdxf.addons.binpacking.Item) → None**

Append a item.

**get\_fill\_ratio () → float**

Return the fill ratio of all bins.

```
get_capacity() → float
    Returns the maximum fill volume of all bins.

get_total_weight() → float
    Returns the total weight of all fitted items in all bins.

get_total_volume() → float
    Returns the total volume of all fitted items in all bins.

pack(pick=<PickStrategy.BIGGER_FIRST: 2>) → None
    Pack items into bins. Distributes all items across all bins.
```

## Packer

```
class ezdxf.addons.binpacking.Packer
    3D Packer inherited from AbstractPacker.

    add_bin(name: str, width: float, height: float, depth: float, max_weight: float = 1e+99) →
        ezdxf.addons.binpacking.Box
        Add a 3D Box container.

    add_item(payload, width: float, height: float, depth: float, weight: float = 0.0) →
        ezdxf.addons.binpacking.Item
        Add a 3D Item to pack.
```

## FlatPacker

```
class ezdxf.addons.binpacking.FlatPacker
    2D Packer inherited from AbstractPacker. All containers and items used by this packer must have a depth of 1.

    add_bin(name: str, width: float, height: float, max_weight: float = 1e+99) →
        ezdxf.addons.binpacking.Envelope
        Add a 2D Envelope container.

    add_item(payload, width: float, height: float, weight: float = 0.0) → ezdxf.addons.binpacking.Item
        Add a 2D FlatItem to pack.
```

## Bin Classes

```
class ezdxf.addons.binpacking.Bin(name, width: float, height: float, depth: float, max_weight:
                                    float = 1e+99)

    name
        Name of then container as string.

    width

    height

    depth

    max_weight

    __str__() → str
        Return str(self).

    copy()
        Returns a copy.
```

---

```
reset()
    Reset the container to empty state.

put_item(item: ezdxf.addons.binpacking.Item, pivot: Tuple[float, float, float]) → bool
get_capacity() → float
    Returns the maximum fill volume of the bin.

get_total_weight() → float
    Returns the total weight of all fitted items.

get_total_volume() → float
    Returns the total volume of all fitted items.

get_fill_ratio() → float
    Return the fill ratio.
```

## Box Class

```
class ezdxf.addons.binpacking.Box(name, width: float, height: float, depth: float, max_weight: float = 1e+99)
    3D container inherited from Bin.
```

## Envelope Class

```
class ezdxf.addons.binpacking.Envelope(name, width: float, height: float, max_weight: float = 1e+99)
    2D container inherited from Bin.
```

## Item Class

```
class ezdxf.addons.binpacking.Item(payload, width: float, height: float, depth: float, weight: float = 0.0)
    3D container item.
```

```
payload
    Arbitrary Python object.

width

height

depth

weight

copy()
    Returns a copy, all copies have a reference to the same payload object.

__str__()
    Return str(self).

get_volume() → float
    Returns the volume of the item.

get_dimension() → Tuple[float, float, float]
    Returns the item dimension according the rotation_type.
```

**get\_transformation()** → eздxf.math.\_matrix44.Matrix44

Returns the transformation matrix to transform the source entity located with the minimum extension corner of its bounding box in (0, 0, 0) to the final location including the required rotation.

## FlatItem Class

**class** eздxf.addons.binpacking.**FlatItem**(*payload*, *width*: float, *height*: float, *weight*: float = 0.0)

2D container item, inherited from [Item](#). Has a default depth of 1.0.

## Functions

**ezdxf.addons.binpacking.shuffle\_pack**(*packer*: eздxf.addons.binpacking.AbstractPacker, *attempts*: int) → eздxf.addons.binpacking.AbstractPacker

Random shuffle packing. Returns a new packer with the best packing result, the input packer is unchanged.

## Enums

### RotationType

**class** eздxf.addons.binpacking.**RotationType**

Rotation type of an item:

- W = width
- H = height
- D = depth

**WHD**

**HWD**

**HDW**

**DHW**

**DWH**

**WDH**

### PickStrategy

**class** eздxf.addons.binpacking.**PickStrategy**

Order of how to pick items for placement.

**BIGGER\_FIRST**

**SMALLER\_FIRST**

**SHUFFLE**

## Credits

- [py3dbp](#) package by Enzo Ruiz Pelaez
- [bp3d](#) by *gedex* - github repository on which [py3dbp](#) is based, written in Go
- Optimizing three-dimensional bin packing through simulation ([PDF](#))

### 6.11.14 MeshExchange

New in version 0.18.

The `ezdxf.addons.meshex` module provides functions to exchange meshes with other tools in the following file formats:

- [STL](#): import/export, supports only triangles as faces
- [OFF](#): import/export, supports ngons as faces and is more compact than STL
- [OBJ](#): import/export, supports ngons as faces and can contain multiple meshes in one file
- [PLY](#): export only, supports ngons as faces
- [OpenSCAD](#): export as [polyhedron](#), supports ngons as faces
- [IFC4](#): export only, supports ngons as faces

The source or target object is always a `MeshBuilder` instance and therefore the supported features are also limited by this class. Only vertices and faces are exchanged, colors, textures and explicit face- and vertex normals are lost.

---

**Note:** This add-on is not a replacement for a proper file format interface for this data formats! It's just a simple way to exchange meshes with other tools like [OpenSCAD](#) or [MeshLab](#).

---

**Warning:** The meshes created by the `ezdxf.addons.pyccsg` add-on are usually not suitable for export because they often violate the vertex-to-vertex rule: A vertex of a face cannot lie on the edge of another face. This was one of the reasons to create this addon to get an interface to [OpenSCAD](#).

Example for a simple STL to DXF converter:

```
import sys
import ezdxf
from ezdxf.addons import meshex

try:
    mesh = meshex.stl_readfile("your.stl")
except (meshex.ParsingError, IOError) as e:
    print(str(e))
    sys.exit(1)

doc = ezdxf.new()
mesh.render_mesh(doc.modelspace())
doc.saveas("your.dxf")
```

**See also:**

Example script `meshex_export.py` at [github](#).

## Import

```
ezdxf.addons.meshex.stl_readfile (filename: Union[str, os.PathLike]) →  
    ezdxf.render.mesh.MeshTransformer  
    Read ascii or binary STL file content as ezdxf.render.MeshTransformer instance.  
  
Raises ParsingError – vertex parsing error or invalid/corrupt data  
  
ezdxf.addons.meshex.stl_loads (content: str) → ezdxf.render.mesh.MeshTransformer  
Load a mesh from an ascii STL content string as ezdxf.render.MeshTransformer instance.  
  
Raises ParsingError – vertex parsing error  
  
ezdxf.addons.meshex.stl_loadb (buffer: bytes) → ezdxf.render.mesh.MeshTransformer  
Load a mesh from a binary STL data ezdxf.render.MeshTransformer instance.  
  
Raises ParsingError – invalid/corrupt data or not a binary STL file  
  
ezdxf.addons.meshex.off_readfile (filename: Union[str, os.PathLike]) →  
    ezdxf.render.mesh.MeshTransformer  
    Read OFF file content as ezdxf.render.MeshTransformer instance.  
  
Raises ParsingError – vertex or face parsing error  
  
ezdxf.addons.meshex.off_loads (content: str) → ezdxf.render.mesh.MeshTransformer  
Load a mesh from a OFF content string as ezdxf.render.MeshTransformer instance.  
  
Raises ParsingError – vertex or face parsing error  
  
ezdxf.addons.meshex.obj_readfile (filename: Union[str, os.PathLike]) →  
    List[ezdxf.render.mesh.MeshTransformer]  
    Read OBJ file content as list of ezdxf.render.MeshTransformer instances.  
  
Raises ParsingError – vertex or face parsing error  
  
ezdxf.addons.meshex.obj_loads (content: str) → List[ezdxf.render.mesh.MeshTransformer]  
Load one or more meshes from an OBJ content string as list of ezdxf.render.MeshTransformer instances.  
  
Raises ParsingError – vertex parsing error
```

## Export

```
ezdxf.addons.meshex.stl_dumps (mesh: ezdxf.render.mesh.MeshBuilder) → str  
    Returns the STL data as string for the given mesh. This function triangulates the meshes automatically because  
    the STL format supports only triangles as faces.  
  
This function does not check if the mesh obey the STL format rules:

- The direction of the face normal is outward.
- The face vertices are listed in counter-clockwise order when looking at the object from the outside (right-hand rule).
- Each triangle must share two vertices with each of its adjacent triangles.
- The object represented must be located in the all-positive octant (non-negative and nonzero).

  
ezdxf.addons.meshex.stl_dumpb (mesh: ezdxf.render.mesh.MeshBuilder) → bytes  
    Returns the STL binary data as bytes for the given mesh.  
  
For more information see function: stl_dumps ()  
  
ezdxf.addons.meshex.off_dumps (mesh: ezdxf.render.mesh.MeshBuilder) → str  
    Returns the OFF data as string for the given mesh. The OFF format supports ngons as faces.
```

`ezdxf.addons.meshex.obj.dumps(mesh: ezdxf.render.mesh.MeshBuilder) → str`  
 Returns the **OBJ** data as string for the given *mesh*. The **OBJ** format supports ngons as faces.

`ezdxf.addons.meshex.ply.dumpb(mesh: ezdxf.render.mesh.MeshBuilder) → bytes`  
 Returns the **PLY** binary data as bytes for the given *mesh*. The **PLY** format supports ngons as faces.

`ezdxf.addons.meshex.scad.dumps(mesh: ezdxf.render.mesh.MeshBuilder) → str`  
 Returns the **OpenSCAD** polyhedron definition as string for the given *mesh*. **OpenSCAD** supports ngons as faces.

---

**Important:** **OpenSCAD** requires the face normals pointing inwards, the method `flip_normals()` of the *MeshBuilder* class can flip the normals inplace.

---

`ezdxf.addons.meshex.ifc4.dumps(mesh: ezdxf.render.mesh.MeshBuilder, entity_type=<IfcEntityType.POLYGON_FACE_SET: 'POLY_FACE_SET'>, *, layer: str = 'MeshExport', color: Tuple[float, float, float] = (1.0, 1.0, 1.0)) → str`  
 Returns the **IFC4** string for the given *mesh*. The caller is responsible for checking if the mesh is a closed or open surface (e.g. `mesh.diagnose().euler_characteristic == 2`) and using the appropriate entity type.

#### Parameters

- **mesh** – *MeshBuilder*
- **entity\_type** – *IfcEntityType*
- **layer** – layer name as string
- **color** – entity color as RGB tuple, values in the range [0,1]

**Warning:** **IFC4** is a very complex data format and this is a minimal effort exporter, so the exported data may not be importable by all CAD applications.

The exported **IFC4** data can be imported by the following applications:

- BricsCAD
- FreeCAD (IfcOpenShell)
- Allplan
- Tekla BIMsight

`ezdxf.addons.meshex.export_ifcZIP(filename: Union[str, os.PathLike], mesh: ezdxf.render.mesh.MeshBuilder, entity_type=<IfcEntityType.POLYGON_FACE_SET: 'POLY_FACE_SET'>, *, layer: str = 'MeshExport', color: Tuple[float, float, float] = (1.0, 1.0, 1.0))`

Export the given *mesh* as zip-compressed **IFC4** file. The filename suffix should be **.ifcZIP**. For more information see function `ifc4.dumps()`.

#### Parameters

- **filename** – zip filename, the data file has the same name with suffix **.ifc**
- **mesh** – *MeshBuilder*
- **entity\_type** – *IfcEntityType*
- **layer** – layer name as string

- **color** – entity color as RGB tuple, values in the range [0,1]

**Raises** `IOError` – IO error when opening the zip-file for writing

**class** `ezdxf.addons.meshex.IfcEntityType`

An enumeration.

**POLYGON\_FACE\_SET**

“SurfaceModel” representation usable for open or closed surfaces.

**CLOSED\_SHELL**

“Brep” representation usable for closed surfaces.

**OPEN\_SHELL**

“SurfaceModel” representation usable for open surfaces.

## 6.11.15 OpenSCAD

New in version 0.18.

Interface to the `OpenSCAD` application to apply boolean operations to `MeshBuilder` objects. For more information about boolean operations read the documentation of `OpenSCAD`. The `OpenSCAD` application is not bundled with `ezdxf`, you need to install the application yourself.

On Windows the path to the `openscad.exe` executable is stored in the config file (see `ezdxf.options`) in the “`openscad-addon`” section as key “`win_exec_path`”, the default entry is:

```
[openscad-addon]
win_exec_path = "C:\Program Files\OpenSCAD\openscad.exe"
```

On Linux and macOS the `openscad` command is located by the `shutil.which()` function.

Example:

```
import eздxf
from eздxf.render import forms
from eздxf.addons import MengerSponge, openscad

doc = eздxf.new()
msp = doc.modelspace()

# 1. create the meshes:
sponge = MengerSponge(level=3).mesh()
sponge.flip_normals() # important for OpenSCAD
sphere = forms.sphere(
    count=32, stacks=16, radius=0.5, quads=True
).translate(0.25, 0.25, 1)
sphere.flip_normals() # important for OpenSCAD

# 2. create the script:
script = openscad.boolean_operation(openscad.DIFFERENCE, sponge, sphere)

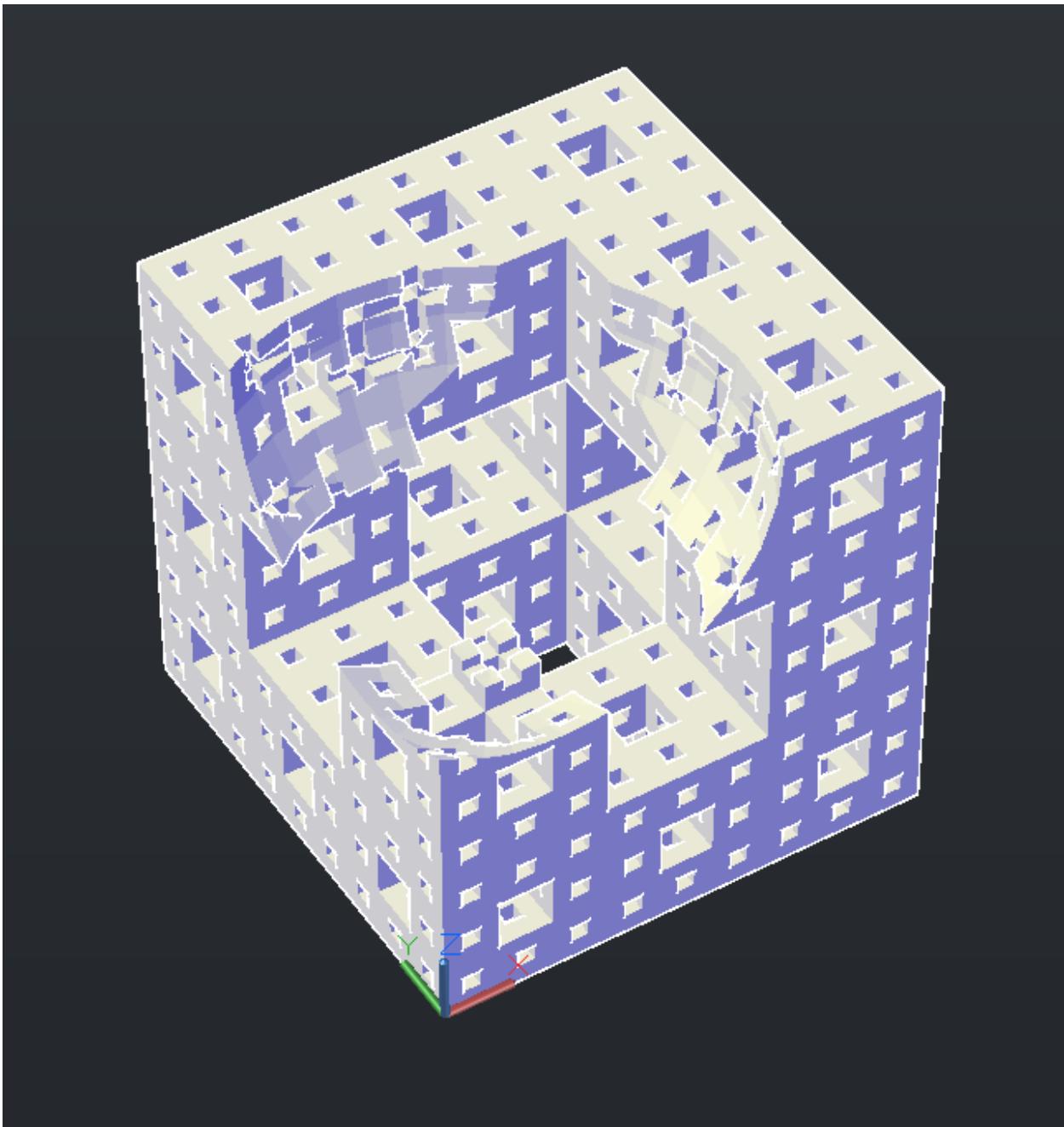
# 3. execute the script by OpenSCAD:
result = openscad.run(script)

# 4. render the MESH entity:
result.render_mesh(msp)
```

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```
doc.set_modelspace_vport(6, center=(5, 0))
doc.saveas("OpenSCAD.dxf")
```



## Functions

```
ezdxf.addons.openscad.run(script: str, exec_path: Optional[str] = None) →
    ezdxf.render.mesh.MeshTransformer
Executes the given script by OpenSCAD and returns the result mesh as MeshTransformer.
```

### Parameters

- **script** – the OpenSCAD script as string
- **exec\_path** – path to the executable as string or `None` to use the default installation path

```
ezdxf.addons.openscad.boolean_operation(op: eздxf.addons.openscad.Operation, mesh1:
                                         eздxf.render.mesh.MeshBuilder, mesh2:
                                         eздxf.render.mesh.MeshBuilder) → str
```

Returns an OpenSCAD script to apply the given boolean operation to the given meshes.

The supported operations are:

- UNION
- DIFFERENCE
- INTERSECTION

```
ezdxf.addons.openscad.is_installed() → bool
```

Returns `True` if OpenSCAD is installed. On Windows only the default install path ‘C:\Program Files\OpenSCAD\openscad.exe’ is checked.

## Script Class

```
class eздxf.addons.openscad.Script
```

Helper class to build OpenSCAD scripts. This is a very simple string building class and does no checks at all! If you need more advanced features to build OpenSCAD scripts look at the packages `pysolid` and `openpyscad`.

**add** (*data: str*) → `None`  
Add a string.

**add\_mirror** (*v: Union[Sequence[float], eздxf.math.\_vector.Vec2, eздxf.math.\_vector.Vec3]*) → `None`  
Add a `mirror()` operation.

OpenSCAD docs: [https://en.wikibooks.org/wiki/OpenSCAD\\_User\\_Manual/Transformations#mirror](https://en.wikibooks.org/wiki/OpenSCAD_User_Manual/Transformations#mirror)

**Parameters** *v* – the normal vector of a plane intersecting the origin through which to mirror the object

**add\_multmatrix** (*m: eздxf.math.\_matrix44.Matrix44*) → `None`  
Add a transformation matrix of type `Matrix44` as `multmatrix()` operation.

OpenSCAD docs: [https://en.wikibooks.org/wiki/OpenSCAD\\_User\\_Manual/Transformations#multmatrix](https://en.wikibooks.org/wiki/OpenSCAD_User_Manual/Transformations#multmatrix)

**add\_polyhedron** (*mesh: eздxf.render.mesh.MeshBuilder*) → `None`  
Add *mesh* as `polyhedron()` command.

OpenSCAD docs: [https://en.wikibooks.org/wiki/OpenSCAD\\_User\\_Manual/Primitive\\_Solids#polyhedron](https://en.wikibooks.org/wiki/OpenSCAD_User_Manual/Primitive_Solids#polyhedron)

**add\_polygon** (*path: Iterable[Union[Sequence[float], eздxf.math.\_vector.Vec2, eздxf.math.\_vector.Vec3]], holes: Optional[Sequence[Iterable[Union[Sequence[float], eздxf.math.\_vector.Vec2, eздxf.math.\_vector.Vec3]]]] = None*) → `None`  
Add a `polygon()` command. This is a 2D command, all z-axis values of the input vertices are ignored and all paths and holes are closed automatically.

OpenSCAD docs: [https://en.wikibooks.org/wiki/OpenSCAD\\_User\\_Manual/Using\\_the\\_2D\\_Subsystem#polygon](https://en.wikibooks.org/wiki/OpenSCAD_User_Manual/Using_the_2D_Subsystem#polygon)

**Parameters**

- **path** – exterior path
- **holes** – a sequence of one or more holes as vertices, or `None` for no holes

---

**add\_resize** (*nx: float, ny: float, nz: float, auto: Union[bool, Tuple[bool, bool, bool], None] = None*)  
                   → None  
     Add a `resize()` operation.

OpenSCAD docs: [https://en.wikibooks.org/wiki/OpenSCAD\\_User\\_Manual/Transformations#resize](https://en.wikibooks.org/wiki/OpenSCAD_User_Manual/Transformations#resize)

#### Parameters

- **nx** – new size in x-axis
- **ny** – new size in y-axis
- **nz** – new size in z-axis
- **auto** – If the *auto* argument is set to `True`, the operation auto-scales any 0-dimensions to match. Set the *auto* argument as a 3-tuple of bool values to auto-scale individual axis.

**add\_rotate** (*ax: float, ay: float, az: float*) → None

Add a `rotation()` operation.

OpenSCAD docs: [https://en.wikibooks.org/wiki/OpenSCAD\\_User\\_Manual/Transformations#rotate](https://en.wikibooks.org/wiki/OpenSCAD_User_Manual/Transformations#rotate)

#### Parameters

- **ax** – rotation about the x-axis in degrees
- **ay** – rotation about the y-axis in degrees
- **az** – rotation about the z-axis in degrees

**add\_rotate\_about\_axis** (*a: float, v: Union[Sequence[float], ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3]*) → None

Add a `rotation()` operation about the given axis *v*.

OpenSCAD docs: [https://en.wikibooks.org/wiki/OpenSCAD\\_User\\_Manual/Transformations#rotate](https://en.wikibooks.org/wiki/OpenSCAD_User_Manual/Transformations#rotate)

#### Parameters

- **a** – rotation angle about axis *v* in degrees
- **v** – rotation axis as `ezdxf.math.UVec` object

**add\_scale** (*sx: float, sy: float, sz: float*) → None

Add a `scale()` operation.

OpenSCAD docs: [https://en.wikibooks.org/wiki/OpenSCAD\\_User\\_Manual/Transformations#scale](https://en.wikibooks.org/wiki/OpenSCAD_User_Manual/Transformations#scale)

#### Parameters

- **sx** – scaling factor for the x-axis
- **sy** – scaling factor for the y-axis
- **sz** – scaling factor for the z-axis

**add\_translate** (*v: Union[Sequence[float], ezdxf.math.\_vector.Vec2, ezdxf.math.\_vector.Vec3]*) → None

Add a `translate()` operation.

OpenSCAD docs: [https://en.wikibooks.org/wiki/OpenSCAD\\_User\\_Manual/Transformations#translate](https://en.wikibooks.org/wiki/OpenSCAD_User_Manual/Transformations#translate)

#### Parameters **v** – translation vector

**get\_string()** → str

Returns the OpenSCAD build script.

## Boolean Operation Constants

```
ezdxf.addons.openscad.UNION
ezdxf.addons.openscad.DIFFERENCE
ezdxf.addons.openscad.INTERSECTION
```

## openpyscad

This add-on is not a complete wrapper around [OpenSCAD](#), if you need such a tool look at the [openpyscad](#) or [pysolid](#) packages at PyPI.

Not sure if the [openpyscad](#) package is still maintained, the last commit at [github](#) is more than a year old and did not pass the CI process! (state June 2022)

This code snippet shows how to get the [MeshTransformer](#) object from the basic [openpyscad](#) example:

```
from eздxf.addons import openscad
import openpyscad as ops

c1 = ops.Cube([10, 20, 10])
c2 = ops.Cube([20, 10, 10])

# dump OpenSCAD script as string:
script = (c1 + c2).dumps()

# execute script and load the result as MeshTransformer instance:
mesh = openscad.run(script)
```

Create an [openpyscad](#) Polyhedron object from an [ezdxf](#) [MeshBuilder](#) object:

```
from eздxf.render import forms
import openpyscad as ops

# create an eздxf MeshBuilder() object
sphere = forms.sphere()
sphere.flip_normals() # required for OpenSCAD

# create an openpyscad Polyhedron() object
polyhedron = ops.Polyhedron(
    points=[list(p) for p in sphere.vertices], # convert Vec3 objects to lists!
    faces=[list(f) for f in sphere.faces], # convert face tuples to face lists!
)

# create the OpenSCAD script:
script = polyhedron.dumps()
```

The type conversion is needed to get valid [OpenSCAD](#) code from [openpyscad](#)!

## pysolid

The [pysolid](#) package seems to be better maintained than the [openpyscad](#) package, but this is just an opinion based on newer commits at [github](#) ([link](#)) for the [pysolid](#) package.

Same example for [pysolid](#):

```

from ezdxf.addons import openscad
from solid import cube, render_scad

c1 = cube([10, 20, 10])
c2 = cube([20, 10, 10])

# dump OpenSCAD script as string:
script = render_scad(c1 + c2)

# execute script and load the result as MeshTransformer instance:
mesh = openscad.run(script)

```

Create a `pysolid` polyhedron object from an `ezdxf MeshBuilder` object:

```

from ezdxf.render import forms
from solid import polyhedron, scad_render

# create an ezdxf MeshBuilder() object
sphere = forms.sphere()
sphere.flip_normals() # required for OpenSCAD

# create a pysolid polyhedron() object
ph = polyhedron(
    points=[v.xyz for v in sphere.vertices], # convert Vec3 objects to tuples!
    faces=sphere.faces, # types are compatible
)

# create the OpenSCAD script:
script = scad_render(ph)

```

## 6.12 DXF Internals

- [DXF Reference](#) provided by Autodesk.
- [DXF Developer Documentation](#) provided by Autodesk.

### 6.12.1 Basic DXF Structures

#### DXF File Encoding

##### DXF R2004 and prior

Drawing files of DXF R2004 (AC1018) and prior are saved as ASCII files with the encoding set by the header variable `$DWGCODEPAGE`, which is `ANSI_1252` by default if `$DWGCODEPAGE` is not set.

Characters used in the drawing which do not exist in the chosen ASCII encoding are encoded as unicode characters with the schema `\U+nnnn`. see [Unicode table](#)

## Known \$DWGCODEPAGE encodings

DXF	Python	Name
ANSI_874	cp874	Thai
ANSI_932	cp932	Japanese
ANSI_936	gbk	UnifiedChinese
ANSI_949	cp949	Korean
ANSI_950	cp950	TradChinese
ANSI_1250	cp1250	CentralEurope
ANSI_1251	cp1251	Cyrillic
ANSI_1252	cp1252	WesternEurope
ANSI_1253	cp1253	Greek
ANSI_1254	cp1254	Turkish
ANSI_1255	cp1255	Hebrew
ANSI_1256	cp1256	Arabic
ANSI_1257	cp1257	Baltic
ANSI_1258	cp1258	Vietnam

## DXF R2007 and later

Starting with DXF R2007 (AC1021) the drawing file is UTF-8 encoded, the header variable \$DWGCODEPAGE is still in use, but I don't know, if the setting still has any meaning.

Encoding characters in the unicode schema \U+nnnn is still functional.

See also:

*String value encoding*

## DXF Tags

A Drawing Interchange File is simply an ASCII text file with a file type of .dxf and special formatted text. The basic file structure are DXF tags, a DXF tag consist of a DXF group code as an integer value on its own line and a the DXF value on the following line. In the ezdxf documentation DXF tags will be written as (group code, value).

With the introduction of extended symbol names in DXF R2000, the 255-character limit for strings has been increased to 2049 single-byte characters not including the newline at the end of the line. Nonetheless its safer to use only strings with 255 and less characters, because its not clear if this fact is true for ALL string group codes or only for symbols like layer- or text style names and not all 3rd party libraries may handle this fact correct. The MTEXT content and binary data is still divided into chunks with less than 255 characters.

Group codes are indicating the value type:

Group Code	Value Type
0-9	String
10-39	Double precision 3D point value
40-59	Double-precision floating-point value
60-79	16-bit integer value
90-99	32-bit integer value
100	String
102	String

Continued on next page

Table 2 – continued from previous page

Group Code	Value Type
105	String representing hexadecimal (hex) handle value
110-119	Double precision floating-point value
120-129	Double precision floating-point value
130-139	Double precision floating-point value
140-149	Double precision scalar floating-point value
160-169	64-bit integer value
170-179	16-bit integer value
210-239	Double-precision floating-point value
270-279	16-bit integer value
280-289	16-bit integer value
290-299	Boolean flag value
300-309	Arbitrary text string
310-319	String representing hex value of binary chunk
320-329	String representing hex handle value
330-369	String representing hex object IDs
370-379	16-bit integer value
380-389	16-bit integer value
390-399	String representing hex handle value
400-409	16-bit integer value
410-419	String
420-429	32-bit integer value
430-439	String
440-449	32-bit integer value
450-459	Long
460-469	Double-precision floating-point value
470-479	String
480-481	String representing hex handle value
999	Comment (string)
1000-1009	String
1010-1059	Double-precision floating-point value
1060-1070	16-bit integer value
1071	32-bit integer value

Explanation for some important group codes:

Group Code	Meaning
0	DXF structure tag, entity start/end or table entries
1	The primary text value for an entity
2	A name: Attribute tag, Block name, and so on. Also used to identify a DXF section or table name.
3-4	Other textual or name values
5	Entity handle as hex string (fixed)
6	Line type name (fixed)
7	Text style name (fixed)
8	Layer name (fixed)
9	Variable name identifier (used only in HEADER section of the DXF file)
10	Primary X coordinate (start point of a Line or Text entity, center of a Circle, etc.)
11-18	Other X coordinates
20	Primary Y coordinate. 2n values always correspond to 1n values and immediately follow them in the file (expected by ezdxf)
21-28	Other Y coordinates

Table 3 – continued from previous page

Group Code	Meaning
30	Primary Z coordinate. 3n values always correspond to 1n and 2n values and immediately follow them in the file (except for 31-38)
31-38	Other Z coordinates
39	This entity's thickness if nonzero (fixed)
40-48	Float values (text height, scale factors, etc.)
49	Repeated value - multiple 49 groups may appear in one entity for variable length tables (such as the dash lengths in the LINE entity)
50-58	Angles in degree
62	Color number (fixed)
66	“Entities follow” flag (fixed), only in INSERT and POLYLINE entities
67	Identifies whether entity is in modelspace (0) or paperspace (1)
68	Identifies whether viewport is on but fully off screen, is not active, or is off
69	Viewport identification number
70-78	Integer values such as repeat counts, flag bits, or modes
210, 220, 230	X, Y, and Z components of extrusion direction (fixed)
310	Proxy entity graphics as binary encoded data
330	Owner handle as hex string
347	MATERIAL handle as hex string
348	VISUALSTYLE handle as hex string
370	Lineweight in mm times 100 (e.g. 0.13mm = 13).
390	PLOTSTYLE handle as hex string
420	True color value as 0x00RRGGBB 24-bit value
430	Color name as string
440	Transparency value 0x020000TT 0 = fully transparent / 255 = opaque
999	Comments

For explanation of all group codes see: [DXF Group Codes in Numerical Order Reference](#) provided by Autodesk

## Extended Data

### DXF R2018 Reference

Extended data (XDATA) is created by AutoLISP or ObjectARX applications but any other application like *ezdxf* can also define XDATA. If an entity contains extended data, it **follows** the entity's normal definition.

But extended group codes (>=1000) can appear **before** the XDATA section, an example is the BLOCKBASEPOINT-PARAMETER entity in AutoCAD Civil 3D or AutoCAD Map 3D.

Group Code	Description
1000	Strings in extended data can be up to 255 bytes long (with the 256th byte reserved for the null character)
1001	(fixed) Registered application name (ASCII string up to 31 bytes long) for XDATA
1002	(fixed) An extended data control string can be either '{' or '}'. These braces enable applications to organize their data by subdividing the data into lists. Lists can be nested.
1003	Name of the layer associated with the extended data
1004	Binary data is organized into variable-length chunks. The maximum length of each chunk is 127 bytes. In ASCII DXF files, binary data is represented as a string of hexadecimal digits, two per binary byte
1005	Database Handle of entities in the drawing database, see also: <a href="#">About 1005 Group Codes</a>
1010, 1020, 1030	Three real values, in the order X, Y, Z. They can be used as a point or vector record that will not be modified at any transformation of the entity.
1011, 1021, 1031	a WCS point that is moved, scaled, rotated and mirrored along with the entity
1012, 1012, 1022	a WCS displacement that is scaled, rotated and mirrored along with the entity, but is not moved
1013, 1023, 1033	a WCS direction that is rotated and mirrored along with the entity, but is not moved or scaled
1040	A real value
1041	Distance, a real value that is scaled along with the parent entity
1042	Scale Factor, also a real value that is scaled along with the parent. The difference between a distance and a scale factor is application-defined
1070	A 16-bit integer (signed or unsigned)
1071	A 32-bit signed (long) integer

The (1001, ...) tag indicates the beginning of extended data. In contrast to normal entity data, with extended data the same group code can appear multiple times, and **order is important**.

Extended data is grouped by registered application name. Each registered application group begins with a (1001, APPID) tag, with the application name as APPID string value. Registered application names correspond to APPID symbol table entries.

An application can use as many APPID names as needed. APPID names are permanent, although they can be purged if they aren't currently used in the drawing. Each APPID name can have **no more than one data group** attached to each entity. Within an application group, the sequence of extended data groups and their meaning is defined by the application.

## String value encoding

String values stored in a DXF file is plain ASCII or UTF-8, AutoCAD also supports CIF (Common Interchange Format) and MIF (Maker Interchange Format) encoding. The UTF-8 format is only supported in DXF R2007 and later.

Ezdxfs import converts all strings into Python unicode strings without encoding or decoding CIF/MIF.

String values containing Unicode characters are represented with control character sequences \U+nnnn. (e.g. r'TEST\U+7F3A\U+4E4F\U+89E3\U+91CA\U+6B63THIS\U+56FE')

To support the DXF unicode encoding ezdxfs registers an encoding codec `dxf_backslash_replace`, defined in `ezdxfs.11dxf.encoding()`.

String values can be stored with these dxf group codes:

- 0 - 9
- 100 - 101
- 300 - 309
- 410 - 419
- 430 - 439
- 470 - 479
- 999 - 1003

### Multi tag text (MTEXT)

If the text string is less than 250 characters, all characters appear in tag (1, ...). If the text string is longer than 250 characters, the string is divided into 250-character chunks, which appear in one or more (3, ...) tags. If (3, ...) tags are used, the last group is a (1, ...) tag and has fewer than 250 characters:

```
3
... TwoHundredAndFifty Characters ....
3
... TwoHundredAndFifty Characters ....
1
less than TwoHundredAndFifty Characters
```

As far I know this is only supported by the MTEXT entity.

**See also:**

[DXF File Encoding](#)

### DXF R13 and later tag structure

With the introduction of DXF R13 Autodesk added additional group codes and DXF tag structures to the DXF Standard.

### Subclass Markers

Subclass markers (100, Subclass Name) divides DXF objects into several sections. Group codes can be reused in different sections. A subclass ends with the following subclass marker or at the beginning of xdata or the end of the object. See [Subclass Marker Example](#) in the DXF Reference.

### Quote about group codes from the DXF reference

Some group codes that define an entity always appear; others are optional and appear only if their values differ from the defaults.

**Do not** write programs that **rely on the order given here**. The end of an entity is indicated by the next 0 group, which begins the next entity or indicates the end of the section.

**Note:** Accommodating DXF files from future releases of AutoCAD will be easier if you write your DXF processing program in a table-driven way, ignore undefined group codes, and make no assumptions about

the order of group codes in an entity. With each new AutoCAD release, new group codes will be added to entities to accommodate additional features.

### Usage of group codes in subclasses twice

Some later entities contains the same group code twice for different purposes, so order in the sense of which one comes first is important. (e.g. ATTDEF group code 280)

### Tag order is sometimes important especially for AutoCAD

In LWPOLYLINE the order of tags is important, if the *count* tag is not the first tag in the AcDbPolyline subclass, AutoCAD will not close the polyline when the *close* flag is set, by the way other applications like BricsCAD ignores the tag order and renders the polyline always correct.

### Extension Dictionary

The extension dictionary is an optional sequence that stores the handle of a DICTIONARY object that belongs to the current object, which in turn may contain entries. This facility allows attachment of arbitrary database objects to any database object. Any object or entity may have this section.

The extension dictionary tag sequence:

```
102
{ACAD_XDICTIONARY
360
Hard-owner ID/handle to owner dictionary
102
}
```

### Persistent Reactors

Persistent reactors are an optional sequence that stores object handles of objects registering themselves as reactors on the current object. Any object or entity may have this section.

The persistent reactors tag sequence:

```
102
{ACAD.REACTORS
330
first Soft-pointer ID/handle to owner dictionary
330
second Soft-pointer ID/handle to owner dictionary
...
102
}
```

### Application-Defined Codes

Starting at DXF R13, DXF objects can contain application-defined codes outside of XDATA. This application-defined codes can contain any tag except (0, ...) and (102, '{...'}). "{YOURAPPID}" means the APPID string with an preceding "{". The application defined data tag sequence:

```
102
{YOURAPPID
...
102
}
```

(102, 'YOURAPPID}') is also a valid closing tag:

```
102
{YOURAPPID
...
102
YOURAPPID}
```

All groups defined with a beginning (102, ...) appear in the DXF reference before the first subclass marker, I don't know if these groups can appear after the first or any subclass marker. Ezdxf accepts them at any position, and by default ezdxf adds new app data in front of the first subclass marker to the first tag section of an DXF object.

**Exception XRECORD:** Tags with group code 102 and a value string without a preceding "{" or the scheme "YOURAPPID}", should be treated as usual group codes.

## Embedded Objects

The concept of embedded objects was introduced with AutoCAD 2018 (DXF version AC1032) and this is the only information I found about it at the Autodesk knowledge base: [Embedded and Encapsulated Objects](#)

Quote from [Embedded and Encapsulated Objects](#):

For DXF filing, the embedded object must be filed out and in after all the data of the encapsulating object has been filed out and in.

A separator is needed between the encapsulating object's data and the subsequent embedded object's data. The separator must be similar in function to the group 0 or 100 in that it must cause the filer to stop reading data. The normal DXF group code 0 cannot be used because DXF proxies use it to determine when to stop reading data. The group code 100 could have been used, but it might have caused confusion when manually reading a DXF file, and there was a need to distinguish when an embedded object is about to be written out in order to do some internal bookkeeping. Therefore, the DXF group code 101 was introduced.

### Hard facts:

- Only used in ATTRIB, ATTDEF (embedded MTEXT) and MTEXT (columns) in DXF R2018.
- Embedded object start with (101, "Embedded Object") tag
- Embedded object is appended to the encapsulated object
- Embedded object tags can contain any group code except the DXF structure tag (0, ...)

### Unconfirmed assumptions:

- The embedded object is written before the *Extended Data*. No examples for entities including embedded objects and XDATA at the same time.
- XDATA sections replaced by embedded objects, at least for the MTEXT entity
- The encapsulating object can contain more than one embedded object.
- Embedded objects separated by (101, "Embedded Object") tags
- every entity can contain embedded objects

Real world example from an AutoCAD 2018 file:

```
100      <<< start of encapsulating object
AcDbMText
10
2762.148
20
2327.073
30
0.0
40
2.5
41
18.852
46
0.0
71
1
72
5
1
{\fArial|i0|c162|p34;CHANGE;\P\P\PTEXT}
73
1
44
1.0
101      <<< start of embedded object
Embedded Object
70
1
10
1.0
20
0.0
30
0.0
11
2762.148
21
2327.073
31
0.0
40
18.852
41
0.0
42
15.428
43
15.043
71
2
72
1
44
18.852
45
12.5
```

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```
73
0
74
0
46
0.0
```

## Handles

A handle is an arbitrary but in your DXF file unique hex value as string like ‘10FF’. It is common to use uppercase letters for hex numbers. Handle can have up to 16 hexadecimal digits (8 bytes).

For DXF R10 until R12 the usage of handles was optional. The header variable \$HANDLING set to 1 indicate the usage of handles, else \$HANDLING is 0 or missing.

For DXF R13 and later the usage of handles is mandatory and the header variable \$HANDLING was removed.

The \$HANDSEED variable in the header section should be greater than the biggest handle used in the DXF file, so a CAD application can assign handle values starting with the \$HANDSEED value. But as always, don’t rely on the header variable it could be wrong, AutoCAD ignores this value.

### Handle Definition

Entity handle definition is always the (5, . . .), except for entities of the DIMSTYLE table (105, . . .), because the DIMSTYLE entity has also a group code 5 tag for DIMBLK.

### Handle Pointer

A pointer is a reference to a DXF object in the same DXF file. There are four types of pointers:

- Soft-pointer handle
- Hard-pointer handle
- Soft-owner handle
- Hard-owner handle

Also, a group code range for “arbitrary” handles is defined to allow convenient storage of handle values that are unchanged at any operation (AutoCAD).

### Pointer and Ownership

A pointer is a reference that indicates usage, but not possession or responsibility, for another object. A pointer reference means that the object uses the other object in some way, and shares access to it. An ownership reference means that an owner object is responsible for the objects for which it has an owner handle. An object can have any number of pointer references associated with it, but it can have only one owner.

### Hard and Soft References

Hard references, whether they are pointer or owner, protect an object from being purged. Soft references do not.

In AutoCAD, block definitions and complex entities are hard owners of their elements. A symbol table and dictionaries are soft owners of their elements. Polyline entities are hard owners of their vertex and seqend entities. Insert entities are hard owners of their attrib and seqend entities.

When establishing a reference to another object, it is recommended that you think about whether the reference should protect an object from the PURGE command.

## Arbitrary Handles

Arbitrary handles are distinct in that they are not translated to session-persistent identifiers internally, or to entity names in AutoLISP, and so on. They are stored as handles. When handle values are translated in drawing-merge operations, arbitrary handles are ignored.

In all environments, arbitrary handles can be exchanged for entity names of the current drawing by means of the handent functions. A common usage of arbitrary handles is to refer to objects in external DXF and DWG files.

## About 1005 Group Codes

(1005, ...) xdata have the same behavior and semantics as soft pointers, which means that they are translated whenever the host object is merged into a different drawing. However, 1005 items are not translated to session-persistent identifiers or internal entity names in AutoLISP and ObjectARX. They are stored as handles.

## DXF File Structure

A DXF File is simply an ASCII text file with a file type of .dxf and special formatted text. The basic file structure are DXF tags, a DXF tag consist of a DXF group code as an integer value on its own line and a the DXF value on the following line. In the ezdxf documentation DXF tags will be written as (group code, value). There exist a binary DXF format, but it seems that it is not often used and for reducing file size, zipping is much more efficient. *ezdxf* does support reading binary encoded DXF files.

### See also:

For more information about DXF tags see: [DXF Tags](#)

A usual DXF file is organized in sections, starting with the DXF tag (0, 'SECTION') and ending with the DXF tag (0, 'ENDSEC'). The (0, 'EOF') tag signals the end of file.

1. **HEADER:** General information about the drawing is found in this section of the DXF file. Each parameter has a variable name starting with '\$' and an associated value. Has to be the first section.
2. **CLASSES:** Holds the information for application defined classes. (DXF R13 and later)
3. **TABLES:** Contains several tables for style and property definitions.
  - Linetype table (LTYPE)
  - Layer table (LAYER)
  - Text Style table (STYLE)
  - View table (VIEW): (IMHO) layout of the CAD working space, only interesting for interactive CAD applications
  - Viewport configuration table (VPORT): The VPORT table is unique in that it may contain several entries with the same name (indicating a multiple-viewport configuration). The entries corresponding to the active viewport configuration all have the name \*ACTIVE. The first such entry describes the current viewport.
  - Dimension Style table (DIMSTYLE)

- User Coordinate System table (UCS) (IMHO) only interesting for interactive CAD applications
  - Application Identification table (APPID): Table of names for all applications registered with a drawing.
  - Block Record table (BLOCK\_RECORD) (DXF R13 and Later)
4. **BLOCKS:** Contains all block definitions. The block name \*Model\_Space or \*MODEL\_SPACE is reserved for the drawing modelspace and the block name \*Paper\_Space or \*PAPER\_SPACE is reserved for the *active* paperspace layout. Both block definitions are empty, the content of the modelspace and the *active* paperspace is stored in the ENTITIES section. The entities of other layouts are stored in special block definitions called \*Paper\_Spacennn, nnn is an arbitrary but unique number.
  5. **ENTITIES:** Contains all graphical entities of the modelspace and the *active* paperspace layout. Entities of other layouts are stored in the BLOCKS sections.
  6. **OBJECTS:** Contains all non-graphical objects of the drawing (DXF R13 and later)
  7. **THUMBNAILIMAGE:** Contains a preview image of the DXF file, it is optional and can usually be ignored. (DXF R13 and later)
  8. **ACDS DATA:** (DXF R2013 and later) No information in the DXF reference about this section
  9. **END OF FILE**

For further information read the original [DXF Reference](#).

Structure of a usual DXF R12 file:

```
0      <<< Begin HEADER section, has to be the first section
SECTION
2
HEADER
        <<< Header variable items go here
0      <<< End HEADER section
ENDSEC
0      <<< Begin TABLES section
SECTION
2
TABLES
0
TABLE
2
VPORT
70      <<< viewport table maximum item count
        <<< viewport table items go here
0
ENDTAB
0
TABLE
2
APPID, DIMSTYLE, LTYPE, LAYER, STYLE, UCS, VIEW, or VPORT
70      <<< Table maximum item count, a not reliable value and ignored by AutoCAD
        <<< Table items go here
0
ENDTAB
0      <<< End TABLES section
ENDSEC
0      <<< Begin BLOCKS section
SECTION
2
BLOCKS
```

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```

        <<< Block definition entities go here
0      <<< End BLOCKS section
ENDSEC
0      <<< Begin ENTITIES section
SECTION
2
ENTITIES
        <<< Drawing entities go here
0      <<< End ENTITIES section
ENDSEC
0      <<< End of file marker (required)
EOF

```

## Minimal DXF Content

### DXF R12

Contrary to the previous chapter, the DXF R12 format (AC1009) and prior requires just the ENTITIES section:

```

0
SECTION
2
ENTITIES
0
ENDSEC
0
EOF

```

### DXF R13/R14 and later

DXF version R13/14 and later needs much more DXF content than DXF R12.

Required sections: HEADER, CLASSES, TABLES, ENTITIES, OBJECTS

The HEADER section requires two entries:

- \$ACADVER
- \$HANDSEED

The CLASSES section can be empty, but some DXF entities require class definitions to work in AutoCAD.

The TABLES section requires following tables:

- VPORT entry \*ACTIVE is not required! Empty table is ok for AutoCAD.
- LTYPE with at least the following line types defined:
  - BYBLOCK
  - BYLAYER
  - CONTINUOUS
- LAYER with at least an entry for layer ‘0’
- STYLE with at least an entry for style STANDARD
- VIEW can be empty

- UCS can be empty
- APPID with at least an entry for ACAD
- DIMSTYLE with at least an entry for style STANDARD
- BLOCK\_RECORDS with two entries:
  - \*MODEL\_SPACE
  - \*PAPER\_SPACE

The BLOCKS section requires two BLOCKS:

- \*MODEL\_SPACE
- \*PAPER\_SPACE

The ENTITIES section can be empty.

The OBJECTS section requires following entities:

- DICTIONARY - the root dict - one entry named ACAD\_GROUP
- DICTIONARY ACAD\_GROUP can be empty

Minimal DXF to download: [https://github.com/mozman/ezdxf/tree/master/examples\\_dxf](https://github.com/mozman/ezdxf/tree/master/examples_dxf)

## Data Model

### Database Objects

(from the DXF Reference)

AutoCAD drawings consist largely of structured containers for database objects. Database objects each have the following features:

- A handle whose value is unique to the drawing/DXF file, and is constant for the lifetime of the drawing. This format has existed since AutoCAD Release 10, and as of AutoCAD Release 13, handles are always enabled.
- An optional XDATA table, as entities have had since AutoCAD Release 11.
- An optional persistent reactor table.
- An optional ownership pointer to an extension dictionary which, in turn, owns subobjects placed in it by an application.

Symbol tables and symbol table records are database objects and, thus, have a handle. They can also have xdata and persistent reactors in their DXF records.

### DXF R12 Data Model

The DXF R12 data model is identical to the file structure:

- HEADER section: common settings for the DXF drawing
- TABLES section: definitions for LAYERS, LINETYPE, STYLES ....
- BLOCKS section: block definitions and its content
- ENTITIES section: modelspace and paperspace content

References are realized by simple names. The INSERT entity references the BLOCK definition by the BLOCK name, a TEXT entity defines the associated STYLE and LAYER by its name and so on, handles are not needed. Layout association of graphical entities in the ENTITIES section by the paper\_space tag (67, 0 or 1), 0 or missing tag means model space, 1 means paperspace. The content of BLOCK definitions is enclosed by the BLOCK and the ENDBLK entity, no additional references are needed.

A clean and simple file structure and data model, which seems to be the reason why the DXF R12 Reference (released 1992) is still a widely used file format and Autodesk/AutoCAD supports the format by reading and writing DXF R12 files until today (DXF R13/R14 has no writing support by AutoCAD!).

#### **TODO: list of available entities**

##### **See also:**

More information about the DXF [DXF File Structure](#)

### **DXF R13+ Data Model**

With the DXF R13 file format, handles are mandatory and they are really used for organizing the new data structures introduced with DXF R13.

The HEADER section is still the same with just more available settings.

The new CLASSES section contains AutoCAD specific data, has to be written like AutoCAD it does, but must not be understood.

The TABLES section got a new BLOCK\_RECORD table - see [Block Management Structures](#) for more information.

The BLOCKS sections is mostly the same, but with handles, owner tags and new ENTITY types. Not active paperspace layouts store their content also in the BLOCKS section - see [Layout Management Structures](#) for more information.

The ENTITIES section is also mostly same, but with handles, owner tags and new ENTITY types.

#### **TODO: list of new available entities**

And the new OBJECTS section - now its getting complicated!

Most information about the OBJECTS section is just guessed or gathered by trial and error, because the documentation of the OBJECTS section and its objects in the DXF reference provided by Autodesk is very shallow. This is also the reason why I started the DXF Internals section, may be it helps other developers to start one or two steps above level zero.

The OBJECTS sections stores all the non-graphical entities of the DXF drawing. Non-graphical entities from now on just called ‘DXF objects’ to differentiate them from graphical entities, just called ‘entities’. The OBJECTS section follows commonly the ENTITIES section, but this is not mandatory.

DXF R13 introduces several new DXF objects, which resides exclusive in the OBJECTS section, taken from the DXF R14 reference, because I have no access to the DXF R13 reference, the DXF R13 reference is a compiled .hlp file which can’t be read on Windows 10, a drastic real world example why it is better to avoid closed (proprietary) data formats ;):

- DICTIONARY: a general structural entity as a <name: handle> container
- ACDBDICTIONARYWDFLT: a DICTIONARY with a default value
- DICTIONARYVAR: used by AutoCAD to store named values in the database
- ACAD\_PROXY\_OBJECT: proxy object for entities created by other applications than AutoCAD
- GROUP: groups graphical entities without the need of a BLOCK definition
- IDBUFFER: just a list of references to objects

- IMAGEDEF: IMAGE definition structure, required by the IMAGE entity
- IMAGEDEF\_REACTOR: also required by the IMAGE entity
- LAYER\_INDEX: container for LAYER names
- MLINESTYLE
- OBJECT\_PTR
- RASTERVARIABLES
- SPATIAL\_INDEX: is always written out empty to a DXF file. This object can be ignored.
- SPATIAL\_FILTER
- SORTESTTABLE: control for regeneration/redraw order of entities
- XRECORD: used to store and manage arbitrary data. This object is similar in concept to XDATA but is not limited by size or order. Not supported by R13c0 through R13c3.

Still missing the LAYOUT object, which is mandatory in DXF R2000 to manage multiple paperspace layouts. I don't know how DXF R13/R14 manages multiple layouts or if they even support this feature, but I don't care much about DXF R13/R14, because AutoCAD has no write support for this two formats anymore. ezdxf tries to upgrade this two DXF versions to DXF R2000 with the advantage of only two different data models to support: DXF R12 and DXF R2000+

New objects introduced by DXF R2000:

- LAYOUT: management object for modelspace and multiple paperspace layouts
- ACDBPLACEHOLDER: surprise - just a place holder

New objects in DXF R2004:

- DIMASSOC
- LAYER\_FILTER
- MATERIAL
- PLOTSETTINGS
- VBA\_PROJECT

New objects in DXF R2007:

- DATATABLE
- FIELD
- LIGHTLIST
- RENDER
- RENDERENVIRONMENT
- MENTALRAYRENDERSETTINGS
- RENDERGLOBAL
- SECTION
- SUNSTUDY
- TABLESTYLE
- UNDERLAYDEFINITION
- VISUALSTYLE

- WIPEOUTVARIABLES

New objects in DXF R2013:

- GEODATA

New objects in DXF R2018:

- ACDBNAVISWORKSMODELDEF

Undocumented objects:

- SCALE
- ACDBSECTIONVIEWSTYLE
- FIELDLIST

## Objects Organisation

Many objects in the OBJECTS section are organized in a tree-like structure of DICTIONARY objects. Starting point for this data structure is the ‘root’ DICTIONARY with several entries to other DICTIONARY objects. The root DICTIONARY has to be the first object in the OBJECTS section. The management dicts for GROUP and LAYOUT objects are really important, but IMHO most of the other management tables are optional and for the most use cases not necessary. The ezdxf template for DXF R2018 contains only these entries in the root dict and most of them pointing to an empty DICTIONARY:

- ACAD\_COLOR: points to an empty DICTIONARY
- ACAD\_GROUP: supported by ezdxf
- ACAD\_LAYOUT: supported by ezdxf
- ACAD\_MATERIAL: points to an empty DICTIONARY
- ACAD\_MLEADERSTYLE: points to an empty DICTIONARY
- ACAD\_MLINESTYLE: points to an empty DICTIONARY
- ACAD\_PLOTSETTINGS: points to an empty DICTIONARY
- ACAD\_PLOTSTYLENAME: points to ACDBDICTIONARYWDFLT with one entry: ‘Normal’
- ACAD\_SCALELIST: points to an empty DICTIONARY
- ACAD\_TABLESTYLE: points to an empty DICTIONARY
- ACAD\_VISUALSTYLE: points to an empty DICTIONARY

## Root DICTIONARY content for DXF R2018

```

0
SECTION
2      <<< start of the OBJECTS section
OBJECTS
0      <<< root DICTIONARY has to be the first object in the OBJECTS section
DICTIONARY
5      <<< handle
C
330    <<< owner tag
0      <<< always #0, has no owner

```

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```

100
AcDbDictionary
281      <<< hard owner flag
1
3      <<< first entry
ACAD_CIP_PREVIOUS_PRODUCT_INFO
350      <<< handle to target (pointer)
78B      <<< points to a XRECORD with product info about the creator application
3      <<< entry with unknown meaning, if I shoul guess: something with about colors_
    ↵...
ACAD_COLOR
350
4FB      <<< points to a DICTIONARY
3      <<< entry with unknown meaning
ACAD_DETAILVIEWSTYLE
350
7ED      <<< points to a DICTIONARY
3      <<< GROUP management, mandatory in all DXF versions
ACAD_GROUP
350
4FC      <<< points to a DICTIONARY
3      <<< LAYOUT management, mandatory if more than the *active* paperspace is used
ACAD_LAYOUT
350
4FD      <<< points to a DICTIONARY
3      <<< MATERIAL management
ACAD_MATERIAL
350
4FE      <<< points to a DICTIONARY
3      <<< MLEADERSTYLE management
ACAD_MLEADERSTYLE
350
4FF      <<< points to a DICTIONARY
3      <<< MLINESTYLE management
ACAD_MLINESTYLE
350
500      <<< points to a DICTIONARY
3      <<< PLOTSETTINGS management
ACAD_PLOTSETTINGS
350
501      <<< points to a DICTIONARY
3      <<< plot style name management
ACAD_PLOTSTYLENAME
350
503      <<< points to a ACDBDICTIONARYWDFLT
3      <<< SCALE management
ACAD_SCALELIST
350
504      <<< points to a DICTIONARY
3      <<< entry with unknown meaning
ACAD_SECTIONVIEWSTYLE
350
7EB      <<< points to a DICTIONARY
3      <<< TABLESTYLE management
ACAD_TABLESTYLE
350
505      <<< points to a DICTIONARY

```

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```

3      <<< VISUALSTYLE management
ACAD_VISUALSTYLE
350
506      <<< points to a DICTIONARY
3      <<< entry with unknown meaning
ACDB_RECOMPOSE_DATA
350
7F3
3      <<< entry with unknown meaning
AcDbVariableDictionary
350
7AE      <<< points to a DICTIONARY with handles to DICTIONARYVAR objects
0
DICTIONARY
...
...
0
ENDSEC

```

## 6.12.2 DXF Structures

### DXF Sections

#### HEADER Section

In DXF R12 and prior the HEADER section was optional, but since DXF R13 the HEADER section is mandatory. The overall structure is:

```

0      <<< Begin HEADER section
SECTION
2
HEADER
9
$ACADVER    <<< Header variable items go here
1
AC1009
...
0
ENDSEC    <<< End HEADER section

```

A header variable has a name defined by a (9, Name) tag and following value tags.

#### See also:

Documentation of *ezdxf HeaderSection* class.

DXF Reference: [Header Variables](#)

#### CLASSES Section

The CLASSES section contains CLASS definitions which are only important for Autodesk products, some DXF entities require a class definition or AutoCAD will not open the DXF file.

The CLASSES sections was introduced with DXF AC1015 (AutoCAD Release R13).

**See also:**

DXF Reference: [About the DXF CLASSES Section](#)

Documentation of *ezdxf ClassesSection* class.

The CLASSES section in DXF files holds the information for application-defined classes whose instances appear in the BLOCKS, ENTITIES, and OBJECTS sections of the database. It is assumed that a class definition is permanently fixed in the class hierarchy. All fields are required.

**Update 2019-03-03:**

Class names are not unique, Autodesk Architectural Desktop 2007 uses the same name, but with different CPP class names in the CLASS section, so storing classes in a dictionary by name as key caused loss of class entries in ezdxf, using a tuple of (name, cpp\_class\_name) as storage key solved the problem.

## CLASS Entities

**See also:**

DXF Reference: [Group Codes for the CLASS entity](#)

CLASS entities have no handle and therefore ezdxf does not store the CLASS entity in the drawing entities database!

```
0
SECTION
2      <<< begin CLASSES section
CLASSES
0      <<< first CLASS entity
CLASS
1      <<< class DXF entity name; THIS ENTRY IS MAYBE NOT UNIQUE
ACDBDICTIONARYWDFLT
2      <<< C++ class name; always unique
AcDbDictionaryWithDefault
3      <<< application name
ObjectDBX Classes
90     <<< proxy capabilities flags
0
91     <<< instance counter for custom class, since DXF version AC1018 (R2004)
0      <<< no problem if the counter is wrong, AutoCAD doesn't care about
280     <<< was-a-proxy flag. Set to 1 if class was not loaded when this DXF file
↪was created, and 0 otherwise
0
281     <<< is-an-entity flag. Set to 1 if class reside in the BLOCKS or ENTITIES
↪section. If 0, instances may appear only in the OBJECTS section
0
0      <<< second CLASS entity
CLASS
...
...
0      <<< end of CLASSES section
ENDSEC
```

## TABLES Section

TODO

## BLOCKS Section

The BLOCKS section contains all BLOCK definitions, beside the *normal* reusable BLOCKS used by the INSERT entity, all layouts, as there are the modelspace and all paperspace layouts, have at least a corresponding BLOCK definition in the BLOCKS section. The name of the modelspace BLOCK is “\*Model\_Space” (DXF R12: “\$MODEL\_SPACE”) and the name of the *active* paperspace BLOCK is “\*Paper\_Space” (DXF R12: “\$PAPER\_SPACE”), the entities of these two layouts are stored in the ENTITIES section, the *inactive* paperspace layouts are named by the scheme “\*Paper\_Spacennnn”, and the content of the inactive paperspace layouts are stored in their BLOCK definition in the BLOCKS section.

The content entities of blocks are stored between the BLOCK and the ENDBLK entity.

BLOCKS section structure:

```

0           <<< start of a SECTION
SECTION
2           <<< start of BLOCKS section
BLOCKS
0           <<< start of 1. BLOCK definition
BLOCK
...
<<< Block content
...
0           <<< end of 1. Block definition
ENDBLK
0           <<< start of 2. BLOCK definition
BLOCK
...
<<< Block content
...
0           <<< end of 2. Block definition
ENDBLK
0           <<< end of BLOCKS section
ENDSEC

```

### See also:

[Block Management Structures](#) [Layout Management Structures](#)

## ENTITIES Section

TODO

## OBJECTS Section

Objects in the OBJECTS section are organized in a hierarchical tree order, starting with the *named objects dictionary* as the first entity in the OBJECTS section (`Drawing.rootdict`).

Not all entities in the OBJECTS section are included in this tree, [Extension Dictionary](#) and XRECORD data of graphical entities are also stored in the OBJECTS section.

## DXF Tables

## VIEW Table

The **VIEW** entry stores a named view of the model or a paperspace layout. This stored views makes parts of the drawing or some view points of the model in a CAD applications more accessible. This views have no influence to the drawing content or to the generated output by exporting PDFs or plotting on paper sheets, they are just for the convenience of CAD application users.

Using *ezdxf* you have access to the views table by the attribute `Drawing.views`. The views table itself is not stored in the entity database, but the table entries are stored in entity database, and can be accessed by its handle.

## DXF R12

```
0
VIEW
2      <<< name of view
VIEWNAME
70      <<< flags bit-coded: 1st bit -> (0/1 = modelspace/paperspace)
0      <<< modelspace
40      <<< view width in Display Coordinate System (DCS)
20.01
10      <<< view center point in DCS
40.36      <<<     x value
20      <<<     group code for y value
15.86      <<<     y value
41      <<< view height in DCS
17.91
11      <<< view direction from target point, 3D vector
0.0      <<<     x value
21      <<<     group code for y value
0.0      <<<     y value
31      <<<     group code for z value
1.0      <<<     z value
12      <<< target point in WCS
0.0      <<<     x value
22      <<<     group code for y value
0.0      <<<     y value
32      <<<     group code for z value
0.0      <<<     z value
42      <<< lens (focal) length
50.0      <<< 50mm
43      <<< front clipping plane, offset from target
0.0
44      <<< back clipping plane, offset from target
0.0
50      <<< twist angle
0.0
71      <<< view mode
0
```

See also:

[Coordinate Systems](#)

## DXF R2000+

Mostly the same structure as DXF R12, but with handle, owner tag and subclass markers.

```

0      <<< adding the VIEW table head, just for information
TABLE
2      <<< table name
VIEW
5      <<< handle of table, see owner tag of VIEW table entry
37C
330    <<< owner tag of table, always #0
0
100    <<< subclass marker
AcDbSymbolTable
70     <<< VIEW table (max.) count, not reliable (ignore)
9
0      <<< first VIEW table entry
VIEW
5      <<< handle
3EA
330    <<< owner, the VIEW table is the owner of the VIEW entry
37C    <<< handle of the VIEW table
100    <<< subclass marker
AcDbSymbolTableRecord
100    <<< subclass marker
AcDbViewTableRecord
2      <<< view name, from here all the same as DXF R12
VIEWNAME
70
0
40
20.01
10
40.36
20
15.86
41
17.91
11
0.0
21
0.0
31
1.0
12
0.0
22
0.0
32
0.0
42
50.0
43
0.0
44
0.0
50

```

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```

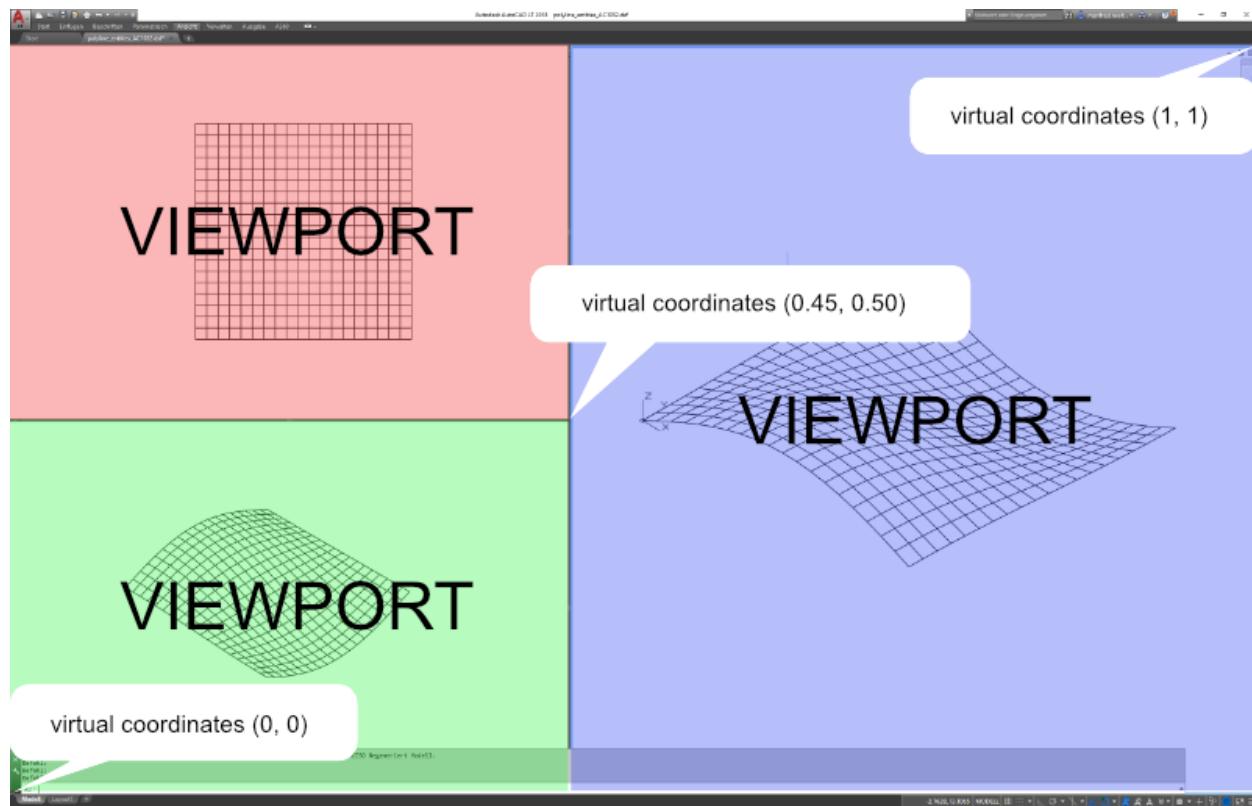
0.0
71
0
281    <<< render mode 0-6 (... too much options)
0      <<< 0= 2D optimized (classic 2D)
72      <<< UCS associated (0/1 = no/yes)
0      <<< 0 = no

```

DXF R2000+ supports additional features in the VIEW entry, see the [VIEW](#) table reference provided by Autodesk.

## VPORT Configuration Table

The [VPORT](#) table stores the modelspace viewport configurations. A viewport configuration is a tiled view of multiple viewports or just one viewport.



In contrast to other tables the VPORT table can have multiple entries with the same name, because all VPORT entries of a multi-viewport configuration are having the same name - the viewport configuration name. The name of the actual displayed viewport configuration is '`*ACTIVE`', as always table entry names are case insensitive ('`*ACTIVE`' == '`*Active`').

The available display area in AutoCAD has normalized coordinates, the lower-left corner is (0, 0) and the upper-right corner is (1, 1) regardless of the true aspect ratio and available display area in pixels. A single viewport configuration has one VPORT entry '`*ACTIVE`' with the lower-left corner (0, 0) and the upper-right corner (1, 1).

The following statements refer to a 2D plan view: the view-target-point defines the origin of the DCS (Display Coordinate system), the view-direction vector defines the z-axis of the [DCS](#), the view-center-point (in DCS) defines the point in modelspace translated to the center point of the viewport, the view height and the aspect-ratio defines how much of the modelspace is displayed. AutoCAD tries to fit the modelspace area into the available viewport space e.g.

view height is 15 units and aspect-ratio is 2.0 the modelspace to display is 30 units wide and 15 units high, if the viewport has an aspect ratio of 1.0, AutoCAD displays 30x30 units of the modelspace in the viewport. If the modelspace aspect-ratio is 1.0 the modelspace to display is 15x15 units and fits properly into the viewport area.

But tests show that the translation of the view-center-point to the middle of the viewport not always work as I expected.  
(still digging...)

---

**Note:** All floating point values are rounded to 2 decimal places for better readability.

---

## DXF R12

Multi-viewport configuration with three viewports.

```

0      <<< table start
TABLE
2      <<< table type
VPORT
70     <<< VPORT table (max.) count, not reliable (ignore)
3
0      <<< first VPORT entry
VPORT
2      <<< VPORT (configuration) name
*ACTIVE
70     <<< standard flags, bit-coded
0
10    <<< lower-left corner of viewport
0.45   <<<     x value, virtual coordinates in range [0 - 1]
20    <<<     group code for y value
0.0    <<<     y value, virtual coordinates in range [0 - 1]
11    <<< upper-right corner of viewport
1.0    <<<     x value, virtual coordinates in range [0 - 1]
21    <<<     group code for y value
1.0    <<<     y value, virtual coordinates in range [0 - 1]
12    <<< view center point (in DCS), ???
13.71  <<<     x value
22    <<<     group code for y value
0.02   <<<     y value
13    <<< snap base point (in DCS)
0.0    <<<     x value
23    <<<     group code for y value
0.0    <<<     y value
14    <<< snap spacing X and Y
1.0    <<<     x value
24    <<<     group code for y value
1.0    <<<     y value
15    <<< grid spacing X and Y
0.0    <<<     x value
25    <<<     group code for y value
0.0    <<<     y value
16    <<< view direction from target point (in WCS), defines the z-axis of the DCS
1.0    <<<     x value
26    <<<     group code for y value
-1.0   <<<     y value
36    <<<     group code for z value
1.0    <<<     z value

```

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```

17      <<< view target point (in WCS), defines the origin of the DCS
0.0      <<<     x value
27      <<<     group code for y value
0.0      <<<     y value
37      <<<     group code for z value
0.0      <<<     z value
40      <<< view height
35.22
41      <<< viewport aspect ratio
0.99
42      <<< lens (focal) length
50.0      <<< 50mm
43      <<< front clipping planes, offsets from target point
0.0
44      <<< back clipping planes, offsets from target point
0.0
50      <<< snap rotation angle
0.0
51      <<< view twist angle
0.0
71      <<< view mode
0
72      <<< circle zoom percent
1000
73      <<< fast zoom setting
1
74      <<< UCSICON setting
3
75      <<< snap on/off
0
76      <<< grid on/off
0
77      <<< snap style
0
78      <<< snap isopair
0
0      <<< next VPORT entry
VPORT
2      <<< VPORT (configuration) name
*ACTIVE <<< same as first VPORT entry
70
0
10
0.0
20
0.5
11
0.45
21
1.0
12
8.21
22
9.41
...
...
0      <<< next VPORT entry

```

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```

VPORT
2      <<< VPORT (configuration) name
*ACTIVE <<< same as first VPORT entry
70
0
10
0.0
20
0.0
11
0.45
21
0.5
12
2.01
22
-9.33
...
...
0
ENDTAB

```

## DXF R2000+

Mostly the same structure as DXF R12, but with handle, owner tag and subclass markers.

```

0      <<< table start
TABLE
2      <<< table type
VPORT
5      <<< table handle
151F
330    <<< owner, table has no owner - always #0
0
100    <<< subclass marker
AcDbSymbolTable
70     <<< VPORT table (max.) count, not reliable (ignore)
3
0      <<< first VPORT entry
VPORT
5      <<< entry handle
158B
330    <<< owner, VPORT table is owner of VPORT entry
151F
100    <<< subclass marker
AcDbSymbolTableRecord
100    <<< subclass marker
AcDbViewportTableRecord
2      <<< VPORT (configuration) name
*ACTIVE
70     <<< standard flags, bit-coded
0
10     <<< lower-left corner of viewport
0.45   <<<     x value, virtual coordinates in range [0 - 1]
20     <<<     group code for y value

```

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```

0.0      <<<      y value, virtual coordinates in range [0 - 1]
11       <<<      upper-right corner of viewport
1.0      <<<      x value, virtual coordinates in range [0 - 1]
21       <<<      group code for y value
1.0      <<<      y value, virtual coordinates in range [0 - 1]
12       <<<      view center point (in DCS)
13.71    <<<      x value
22       <<<      group code for y value
0.38    <<<      y value
13       <<<      snap base point (in DCS)
0.0      <<<      x value
23       <<<      group code for y value
0.0      <<<      y value
14       <<<      snap spacing X and Y
1.0      <<<      x value
24       <<<      group code for y value
1.0      <<<      y value
15       <<<      grid spacing X and Y
0.0      <<<      x value
25       <<<      group code for y value
0.0      <<<      y value
16       <<<      view direction from target point (in WCS)
1.0      <<<      x value
26       <<<      group code for y value
-1.0     <<<      y value
36       <<<      group code for z value
1.0      <<<      z value
17       <<<      view target point (in WCS)
0.0      <<<      x value
27       <<<      group code for y value
0.0      <<<      y value
37       <<<      group code for z value
0.0      <<<      z value
40       <<<      view height
35.22   <<<
41       <<<      viewport aspect ratio
0.99
42       <<<      lens (focal) length
50.0    <<<      50mm
43       <<<      front clipping planes, offsets from target point
0.0
44       <<<      back clipping planes, offsets from target point
0.0
50       <<<      snap rotation angle
0.0
51       <<<      view twist angle
0.0
71       <<<      view mode
0
72       <<<      circle zoom percent
1000
73       <<<      fast zoom setting
1
74       <<<      UCSICON setting
3
75       <<<      snap on/off
0

```

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```

76      <<< grid on/off
0
77      <<< snap style
0
78      <<< snap isopair
0
281      <<< render mode 1-6 (... too many options)
0        <<< 0 = 2D optimized (classic 2D)
65        <<< Value of UCSVP for this viewport. (0 = UCS will not change when this
      ↵viewport is activated)
1        <<< 1 = then viewport stores its own UCS which will become the current UCS
      ↵whenever the viewport is activated.
110      <<< UCS origin (3D point)
0.0      <<<     x value
120      <<<     group code for y value
0.0      <<<     y value
130      <<<     group code for z value
0.0      <<<     z value
111      <<< UCS X-axis (3D vector)
1.0      <<<     x value
121      <<<     group code for y value
0.0      <<<     y value
131      <<<     group code for z value
0.0      <<<     z value
112      <<< UCS Y-axis (3D vector)
0.0      <<<     x value
122      <<<     group code for y value
1.0      <<<     y value
132      <<<     group code for z value
0.0      <<<     z value
79      <<< Orthographic type of UCS 0-6 (... too many options)
0        <<< 0 = UCS is not orthographic
146        <<< elevation
0.0
1001     <<< extended data - undocumented
ACAD_NAV_VCDISPLAY
1070
3
0      <<< next VPORT entry
VPORT
5
158C
330
151F
100
AcDbSymbolTableRecord
100
AcDbViewportTableRecord
2        <<< VPORT (configuration) name
*ACTIVE <<< same as first VPORT entry
70
0
10
0.0
20
0.5
11

```

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```

0.45
21
1.0
12
8.21
22
9.72
...
...
0      <<< next VPORT entry
VPORT
5
158D
330
151F
100
AcDbSymbolTableRecord
100
AcDbViewportTableRecord
2      <<< VPORT (configuration) name
*ACTIVE <<< same as first VPORT entry
70
0
10
0.0
20
0.0
11
0.45
21
0.5
12
2.01
22
-8.97
...
...
0
ENDTAB

```

## LTYPE Table

The **LTYPE** table stores all line type definitions of a DXF drawing. Every line type used in the drawing has to have a table entry, or the DXF drawing is invalid for AutoCAD.

DXF R12 supports just simple line types, DXF R2000+ supports also complex line types with text or shapes included.

You have access to the line types table by the attribute `Drawing.linetypes`. The line type table itself is not stored in the entity database, but the table entries are stored in entity database, and can be accessed by its handle.

### See also:

- DXF Reference: [TABLES Section](#)
- DXF Reference: [LTYPE Table](#)

## Table Structure DXF R12

```

0           <<< start of table
TABLE
2           <<< set table type
LTYPE
70          <<< count of line types defined in this table, AutoCAD ignores this value
9
0           <<< 1. LTYPE table entry
LTYPE
        <<< LTYPE data tags
0           <<< 2. LTYPE table entry
LTYPE
        <<< LTYPE data tags and so on
0           <<< end of LTYPE table
ENDTAB

```

## Table Structure DXF R2000+

```

0           <<< start of table
TABLE
2           <<< set table type
LTYPE
5           <<< LTYPE table handle
5F
330          <<< owner tag, tables has no owner
0
100          <<< subclass marker
AcDbSymbolTable
70          <<< count of line types defined in this table, AutoCAD ignores this value
9
0           <<< 1. LTYPE table entry
LTYPE
        <<< LTYPE data tags
0           <<< 2. LTYPE table entry
LTYPE
        <<< LTYPE data tags and so on
0           <<< end of LTYPE table
ENDTAB

```

## Simple Line Type

*ezdxf* setup for line type ‘CENTER’:

```

dwg.linetypes.new("CENTER", dxfattribs={
    description = "Center _____ - _____ - _____ - _____ - _____ - _____",
    pattern=[2.0, 1.25, -0.25, 0.25, -0.25],
})

```

**Simple Line Type Tag Structure DXF R2000+**

```
0      <<< line type table entry
LTYPE
5      <<< handle of line type
1B1
330      <<< owner handle, handle of LTYPE table
5F
100      <<< subclass marker
AcDbSymbolTableRecord
100      <<< subclass marker
AcDbLinetypeTableRecord
2      <<< line type name
CENTER
70      <<< flags
0
3
Center _____ - - - - - - - - - -
72
65
73
4
40
2.0
49
1.25
74
0
49
-0.25
74
0
49
0.25
74
0
49
-0.25
74
0
```

**Complex Line Type TEXT**

*ezdxf* setup for line type ‘GASLEITUNG’:

```
dwg.linetypes.new('GASLEITUNG', dxfattribs={
    'description': 'Gasleitung2 ----GAS----GAS----GAS----GAS----GAS--',
    'length': 1,
    'pattern': 'A,.5,-.2,[ "GAS", STANDARD, S=.1, U=0.0, X=-0.1, Y=-.05],-.25',
})
```

## TEXT Tag Structure

```
0
LTYPE
5
614
330
5F
100      <<< subclass marker
AcDbSymbolTableRecord
100      <<< subclass marker
AcDbLinetypeTableRecord
2
GASLEITUNG
70
0
3
Gasleitung2 ----GAS----GAS----GAS----GAS----GAS---
72
65
73
3
40
1
49
0.5
74
0
49
-0.2
74
2
75
0
340
11
46
0.1
50
0.0
44
-0.1
45
-0.05
9
GAS
49
-0.25
74
0
```

## Complex Line Type SHAPE

ezdxf setup for line type ‘GRENZE2’:

```
dwg.linetypes.new('GRENZE2', dxftattribs={  
    'description': 'Grenze eckig ----[]-----[]----[]----[]---',  
    'length': 1.45,  
    'pattern': 'A,.25,-.1,[132,ltypeshp.shx,x=-.1,s=.1],-.1,1',  
})
```

## SHAPE Tag Structure

```
0  
LTYPE  
5  
615  
330  
5F  
100      <<< subclass marker  
AcDbSymbolTableRecord  
100      <<< subclass marker  
AcDbLinetypeTableRecord  
2  
GRENZE2  
70  
0  
3  
Grenze eckig ----[]-----[]----[]----[]----[]--  
72  
65  
73  
4  
40  
1.45  
49  
0.25  
74  
0  
49  
-0.1  
74  
4  
75  
132  
340  
616  
46  
0.1  
50  
0.0  
44  
-0.1  
45  
0.0  
49  
-0.1  
74  
0  
49
```

(continues on next page)

(continued from previous page)

1 . 0
74
0

## DIMSTYLE Table

The **DIMSTYLE** table stores all dimension style definitions of a DXF drawing.

You have access to the dimension styles table by the attribute `Drawing.dimstyles`.

### See also:

- DXF Reference: TABLES Section
- DXF Reference: DIMSTYLE Table

## Table Structure DXF R12

```

0           <<< start of table
TABLE
2           <<< set table type
DIMSTYLE
70          <<< count of line types defined in this table, AutoCAD ignores this value
9
0           <<< 1. DIMSTYLE table entry
DIMSTYLE
    <<< DIMSTYLE data tags
0           <<< 2. DIMSTYLE table entry
DIMSTYLE
    <<< DIMSTYLE data tags and so on
0           <<< end of DIMSTYLE table
ENDTAB

```

## DIMSTYLE Entry DXF R12

### DIMSTYLE Variables DXF R12

Source: [CADDManager Blog](#)

DIMVAR	Code	Description
DIMALT	170	Controls the display of alternate units in dimensions.

Continued on next page

Table 4 – continued from previous page

DIMVAR	Code	Description
DIMALTD	171	Controls the number of decimal places in alternate units. If DIMALT is turned on, DIMALTD sets the number of digits displayed to the right of the decimal point in the alternate measurement.
DIMALTF	143	Controls the multiplier for alternate units. If DIMALT is turned on, DIMALTF multiplies linear dimensions by a factor to produce a value in an alternate system of measurement. The initial value represents the number of millimeters in an inch.
DIMAPOST	4	Specifies a text prefix or suffix (or both) to the alternate dimension measurement for all types of dimensions except angular. For instance, if the current units are Architectural, DIMALT is on, DIMALTF is 25.4 (the number of millimeters per inch), DIMALTD is 2, and DIMPOST is set to “mm”, a distance of 10 units would be displayed as 10”[254.00mm].
DIMASZ	41	Controls the size of dimension line and leader line arrowheads. Also controls the size of hook lines. Multiples of the arrowhead size determine whether dimension lines and text should fit between the extension lines. DIMASZ is also used to scale arrowhead blocks if set by DIMBLK. DIMASZ has no effect when DIMTSZ is other than zero.
DIMBLK	5	Sets the arrowhead block displayed at the ends of dimension lines.
DIMBLK1	6	Sets the arrowhead for the first end of the dimension line when DIMSAH is 1.
DIMBLK2	7	Sets the arrowhead for the second end of the dimension line when DIMSAH is 1.

Continued on next page

Table 4 – continued from previous page

DIMVAR	Code	Description
DIMCEN	141	<p>Controls drawing of circle or arc center marks and centerlines by the DIMCENTER, DIMDIAMETER, and DIMRADIUS commands. For DIMDIAMETER and DIMRADIUS, the center mark is drawn only if you place the dimension line outside the circle or arc.</p> <ul style="list-style-type: none"> <li>• 0 = No center marks or lines are drawn</li> <li>• &lt;0 = Centerlines are drawn</li> <li>• &gt;0 = Center marks are drawn</li> </ul>
DIMCLRD	176	<p>Assigns colors to dimension lines, arrowheads, and dimension leader lines.</p> <ul style="list-style-type: none"> <li>• 0 = BYBLOCK</li> <li>• 1-255 = ACI AutoCAD Color Index</li> <li>• 256 = BYLAYER</li> </ul>
DIMCLRE	177	Assigns colors to dimension extension lines, values like DIMCLRD
DIMCLRT	178	Assigns colors to dimension text, values like DIMCLRD
DIMDLE	46	Sets the distance the dimension line extends beyond the extension line when oblique strokes are drawn instead of arrowheads.
DIMDLI	43	Controls the spacing of the dimension lines in baseline dimensions. Each dimension line is offset from the previous one by this amount, if necessary, to avoid drawing over it. Changes made with DIMDLI are not applied to existing dimensions.
DIMEXE	44	Specifies how far to extend the extension line beyond the dimension line.
DIMEXO	42	Specifies how far extension lines are offset from origin points. With fixed-length extension lines, this value determines the minimum offset.

Continued on next page

Table 4 – continued from previous page

DIMVAR	Code	Description
DIMGAP	147	<p>Sets the distance around the dimension text when the dimension line breaks to accommodate dimension text. Also sets the gap between annotation and a hook line created with the LEADER command. If you enter a negative value, DIMGAP places a box around the dimension text.</p> <p>DIMGAP is also used as the minimum length for pieces of the dimension line. When the default position for the dimension text is calculated, text is positioned inside the extension lines only if doing so breaks the dimension lines into two segments at least as long as DIMGAP. Text placed above or below the dimension line is moved inside only if there is room for the arrowheads, dimension text, and a margin between them at least as large as DIMGAP: <math>2 * (\text{DIMASZ} + \text{DIMGAP})</math>.</p>
DIMLFAC	144	<p>Sets a scale factor for linear dimension measurements. All linear dimension distances, including radii, diameters, and coordinates, are multiplied by DIMLFAC before being converted to dimension text. Positive values of DIMLFAC are applied to dimensions in both modelspace and paperspace; negative values are applied to paperspace only.</p> <p>DIMLFAC applies primarily to nonassociative dimensions (DIMASSOC set 0 or 1). For nonassociative dimensions in paperspace, DIMLFAC must be set individually for each layout viewport to accommodate viewport scaling.</p> <p>DIMLFAC has no effect on angular dimensions, and is not applied to the values held in DIMRND, DIMTM, or DIMTP.</p>

Continued on next page

Table 4 – continued from previous page

DIMVAR	Code	Description
DIMLIM	72	<p>Generates dimension limits as the default text. Setting DIMLIM to On turns DIMTOL off.</p> <ul style="list-style-type: none"> <li>• 0 = Dimension limits are not generated as default text</li> <li>• 1 = Dimension limits are generated as default text</li> </ul>
DIMPOST	3	<p>Specifies a text prefix or suffix (or both) to the dimension measurement.</p> <p>For example, to establish a suffix for millimeters, set DIMPOST to mm; a distance of 19.2 units would be displayed as 19.2 mm. If tolerances are turned on, the suffix is applied to the tolerances as well as to the main dimension.</p> <p>Use “&lt;&gt;” to indicate placement of the text in relation to the dimension value. For example, enter “&lt;&gt;mm” to display a 5.0 millimeter radial dimension as “5.0mm”. If you entered mm “&lt;&gt;”, the dimension would be displayed as “mm 5.0”.</p>
DIMRND	45	<p>Rounds all dimensioning distances to the specified value.</p> <p>For instance, if DIMRND is set to 0.25, all distances round to the nearest 0.25 unit. If you set DIMRND to 1.0, all distances round to the nearest integer. Note that the number of digits edited after the decimal point depends on the precision set by DIMDEC. DIMRND does not apply to angular dimensions.</p>
DIMSAH	173	<p>Controls the display of dimension line arrowhead blocks.</p> <ul style="list-style-type: none"> <li>• 0 = Use arrowhead blocks set by DIMBLK</li> <li>• 1 = Use arrowhead blocks set by DIMBLK1 and DIMBLK2</li> </ul>

Continued on next page

Table 4 – continued from previous page

DIMVAR	Code	Description
DIMSCALE	40	<p>Sets the overall scale factor applied to dimensioning variables that specify sizes, distances, or offsets. Also affects the leader objects with the LEADER command.</p> <p>Use MLEADERSCALE to scale multileader objects created with the MLEADER command.</p> <ul style="list-style-type: none"> <li>• 0.0 = A reasonable default value is computed based on the scaling between the current model space viewport and paperspace. If you are in paperspace or modelspace and not using the paperspace feature, the scale factor is 1.0.</li> <li>• &gt;0 = A scale factor is computed that leads text sizes, arrowhead sizes, and other scaled distances to plot at their face values.</li> </ul> <p>DIMSCALE does not affect measured lengths, coordinates, or angles.</p> <p>Use DIMSCALE to control the overall scale of dimensions. However, if the current dimension style is annotative, DIMSCALE is automatically set to zero and the dimension scale is controlled by the CANNOSCALE system variable. DIMSCALE cannot be set to a non-zero value when using annotative dimensions.</p>
DIMSE1	75	<p>Suppresses display of the first extension line.</p> <ul style="list-style-type: none"> <li>• 0 = Extension line is not suppressed</li> <li>• 1 = Extension line is suppressed</li> </ul>
DIMSE2	76	<p>Suppresses display of the second extension line.</p> <ul style="list-style-type: none"> <li>• 0 = Extension line is not suppressed</li> <li>• 1 = Extension line is suppressed</li> </ul>

Continued on next page

Table 4 – continued from previous page

DIMVAR	Code	Description
DIMSOXD	175	<p>Suppresses arrowheads if not enough space is available inside the extension lines.</p> <ul style="list-style-type: none"> <li>• 0 = Arrowheads are not suppressed</li> <li>• 1 = Arrowheads are suppressed</li> </ul> <p>If not enough space is available inside the extension lines and DIMTIX is on, setting DIMSOXD to On suppresses the arrowheads. If DIMTIX is off, DIMSOXD has no effect.</p>
DIMTAD	77	<p>Controls the vertical position of text in relation to the dimension line.</p> <ul style="list-style-type: none"> <li>• 0 = Centers the dimension text between the extension lines.</li> <li>• 1 = Places the dimension text above the dimension line except when the dimension line is not horizontal and text inside the extension lines is forced horizontal (DIMTIH = 1). The distance from the dimension line to the baseline of the lowest line of text is the current DIMGAP value.</li> <li>• 2 = Places the dimension text on the side of the dimension line farthest away from the defining points.</li> <li>• 3 = Places the dimension text to conform to Japanese Industrial Standards (JIS).</li> <li>• 4 = Places the dimension text below the dimension line.</li> </ul>
DIMTFAC	146	<p>Specifies a scale factor for the text height of fractions and tolerance values relative to the dimension text height, as set by DIMTXT.</p> <p>For example, if DIMTFAC is set to 1.0, the text height of fractions and tolerances is the same height as the dimension text. If DIMTFAC is set to 0.7500, the text height of fractions and tolerances is three-quarters the size of dimension text.</p>

Continued on next page

Table 4 – continued from previous page

DIMVAR	Code	Description
DIMTIH	73	Controls the position of dimension text inside the extension lines for all dimension types except Ordinate. <ul style="list-style-type: none"> <li>• 0 = Aligns text with the dimension line</li> <li>• 1 = Draws text horizontally</li> </ul>
DIMTIX	174	Draws text between extension lines. <ul style="list-style-type: none"> <li>• 0 = Varies with the type of dimension. For linear and angular dimensions, text is placed inside the extension lines if there is sufficient room. For radius and diameter dimensions hat don't fit inside the circle or arc, DIMTIX has no effect and always forces the text outside the circle or arc.</li> <li>• 1 = Draws dimension text between the extension lines even if it would ordinarily be placed outside those lines</li> </ul>
DIMTM	48	Sets the minimum (or lower) tolerance limit for dimension text when DIMTOL or DIMLIM is on. DIMTM accepts signed values. If DIMTOL is on and DIMTP and DIMTM are set to the same value, a tolerance value is drawn. If DIMTM and DIMTP values differ, the upper tolerance is drawn above the lower, and a plus sign is added to the DIMTP value if it is positive. For DIMTM, the program uses the negative of the value you enter (adding a minus sign if you specify a positive number and a plus sign if you specify a negative number).

Continued on next page

Table 4 – continued from previous page

DIMVAR	Code	Description
DIMTOFL	172	<p>Controls whether a dimension line is drawn between the extension lines even when the text is placed outside. For radius and diameter dimensions (when DIMTIX is off), draws a dimension line inside the circle or arc and places the text, arrowheads, and leader outside.</p> <ul style="list-style-type: none"> <li>• 0 = Does not draw dimension lines between the measured points when arrowheads are placed outside the measured points</li> <li>• 1 = Draws dimension lines between the measured points even when arrowheads are placed outside the measured points</li> </ul>
DIMTOH	74	<p>Controls the position of dimension text outside the extension lines.</p> <ul style="list-style-type: none"> <li>• 0 = Aligns text with the dimension line</li> <li>• 1 = Draws text horizontally</li> </ul>
DIMTOL	71	Appends tolerances to dimension text. Setting DIMTOL to on turns DIMLIM off.
DIMTP	47	Sets the maximum (or upper) tolerance limit for dimension text when DIMTOL or DIMLIM is on. DIMTP accepts signed values. If DIMTOL is on and DIMTP and DIMTM are set to the same value, a tolerance value is drawn. If DIMTM and DIMTP values differ, the upper tolerance is drawn above the lower and a plus sign is added to the DIMTP value if it is positive.
DIMTSZ	142	<p>Specifies the size of oblique strokes drawn instead of arrowheads for linear, radius, and diameter dimensioning.</p> <ul style="list-style-type: none"> <li>• 0 = Draws arrowheads.</li> <li>• &gt;0 = Draws oblique strokes instead of arrowheads. The size of the oblique strokes is determined by this value multiplied by the DIMSCALE value</li> </ul>

Continued on next page

Table 4 – continued from previous page

DIMVAR	Code	Description
DIMTVP	145	Controls the vertical position of dimension text above or below the dimension line. The DIMTVP value is used when DIMTAD = 0. The magnitude of the vertical offset of text is the product of the text height and DIMTVP. Setting DIMTVP to 1.0 is equivalent to setting DIMTAD = 1. The dimension line splits to accommodate the text only if the absolute value of DIMTVP is less than 0.7.
DIMTXT	140	Specifies the height of dimension text, unless the current text style has a fixed height.
DIMZIN	78	Controls the suppression of zeros in the primary unit value. Values 0-3 affect feet-and-inch dimensions only: <ul style="list-style-type: none"> <li>• 0 = Suppresses zero feet and precisely zero inches</li> <li>• 1 = Includes zero feet and precisely zero inches</li> <li>• 2 = Includes zero feet and suppresses zero inches</li> <li>• 3 = Includes zero inches and suppresses zero feet</li> <li>• 4 (Bit 3) = Suppresses leading zeros in decimal dimensions (for example, 0.5000 becomes .5000)</li> <li>• 8 (Bit 4) = Suppresses trailing zeros in decimal dimensions (for example, 12.5000 becomes 12.5)</li> <li>• 12 (Bit 3+4) = Suppresses both leading and trailing zeros (for example, 0.5000 becomes .5)</li> </ul>

**Table Structure DXF R2000+**

```

0      <<< start of table
TABLE
2      <<< set table type
DIMSTYLE
5      <<< DIMSTYLE table handle
5F
330    <<< owner tag, tables has no owner
0

```

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```
100      <<< subclass marker
AcDbSymbolTable
70       <<< count of dimension styles defined in this table, AutoCAD ignores this _value
9
0       <<< 1. DIMSTYLE table entry
DIMSTYLE
        <<< DIMSTYLE data tags
0       <<< 2. DIMSTYLE table entry
DIMSTYLE
        <<< DIMSTYLE data tags and so on
0       <<< end of DIMSTYLE table
ENDTAB
```

## Additional DIMSTYLE Variables DXF R13/14

Source: [CADDManager Blog](#)

DIMVAR	code	Description
DIMADEC	179	Controls the number of precision places displayed in angular dimensions.
DIMALTTD	274	Sets the number of decimal places for the tolerance values in the alternate units of a dimension.
DIMALTZ	286	Controls suppression of zeros in tolerance values.
DIMALTU	273	Sets the units format for alternate units of all dimension substyles except Angular.
DIMALTZ	285	Controls the suppression of zeros for alternate unit dimension values. DIMALTZ values 0-3 affect feet-and-inch dimensions only.
DIMAUNIT	275	Sets the units format for angular dimensions. <ul style="list-style-type: none"> <li>• 0 = Decimal degrees</li> <li>• 1 = Degrees/minutes/seconds</li> <li>• 2 = Grad</li> <li>• 3 = Radians</li> </ul>
DIMBLK_HANDLE	342	defines DIMBLK as handle to the BLOCK RECORD entry
DIMBLK1_HANDLE	343	defines DIMBLK1 as handle to the BLOCK RECORD entry
DIMBLK2_HANDLE	344	defines DIMBLK2 as handle to the BLOCK RECORD entry
DIMDEC	271	Sets the number of decimal places displayed for the primary units of a dimension. The precision is based on the units or angle format you have selected.
DIMDSEP	278	Specifies a single-character decimal separator to use when creating dimensions whose unit format is decimal. When prompted, enter a single character at the Command prompt. If dimension units is set to Decimal, the DIMDSEP character is used instead of the default decimal point. If DIMDSEP is set to NULL (default value, reset by entering a period), the decimal point is used as the dimension separator.
DIMJUST	280	Controls the horizontal positioning of dimension text. <ul style="list-style-type: none"> <li>• 0 = Positions the text above the dimension line and center-justifies it between the extension lines</li> <li>• 1 = Positions the text next to the first extension line</li> <li>• 2 = Positions the text next to the second extension line</li> <li>• 3 = Positions the text above and aligned with the first extension line</li> </ul>
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## Additional DIMSTYLE Variables DXF R2000

Source: [CADDManager Blog](#)

DIMVAR	Code	Description
DIMALTRND	148	Rounds off the alternate dimension units.
DIMATFIT	289	<p>Determines how dimension text and arrows are arranged when space is not sufficient to place both within the extension lines.</p> <ul style="list-style-type: none"> <li>• 0 = Places both text and arrows outside extension lines</li> <li>• 1 = Moves arrows first, then text</li> <li>• 2 = Moves text first, then arrows</li> <li>• 3 = Moves either text or arrows, whichever fits best</li> </ul> <p>A leader is added to moved dimension text when DIMTMOVE is set to 1.</p>
DIMAZIN	79	<p>Suppresses zeros for angular dimensions.</p> <ul style="list-style-type: none"> <li>• 0 = Displays all leading and trailing zeros</li> <li>• 1 = Suppresses leading zeros in decimal dimensions (for example, 0.5000 becomes .5000)</li> <li>• 2 = Suppresses trailing zeros in decimal dimensions (for example, 12.5000 becomes 12.5)</li> <li>• 3 = Suppresses leading and trailing zeros (for example, 0.5000 becomes .5)</li> </ul>
DIMFRAC	276	<p>Sets the fraction format when DIMLUNIT is set to 4 (Architectural) or 5 (Fractional).</p> <ul style="list-style-type: none"> <li>• 0 = Horizontal stacking</li> <li>• 1 = Diagonal stacking</li> <li>• 2 = Not stacked (for example, 1/2)</li> </ul>
DIMLDRBLK_HANDLE	341	Specifies the arrow type for leaders. Handle to BLOCK RECORD
DIMLUNIT	277	<p>Sets units for all dimension types except Angular.</p> <ul style="list-style-type: none"> <li>• 1 = Scientific</li> <li>• 2 = Decimal</li> <li>• 3 = Engineering</li> <li>• 4 = Architectural (always displayed stacked)</li> <li>• 5 = Fractional (always displayed stacked)</li> <li>• 6 = Microsoft Windows Desktop (decimal format using Chapter 6 contents for decimal separator and number grouping symbols)</li> </ul>
728		

## Text Location

This image shows the default text locations created by BricsCAD for dimension variables `dimtad` and `dimjust`:

## Unofficial DIMSTYLE Variables for DXF R2007 and later

The following DIMVARS are **not documented** in the [DXF Reference](#) by Autodesk.

DIMVAR	Code	Description
DIMTFILL	69	Text fill 0=off; 1=background color; 2=custom color (see <code>DIMTFILLCLR</code> )
DIMTFILL-CLR	70	Text fill custom color as color index
DIMFXLON	290	Extension line has fixed length if set to 1
DIMFXL	49	Length of extension line below dimension line if fixed ( <code>DIMFXLON</code> is 1), <code>DIMEXE</code> defines the the length above the dimension line
DIMJOGANG	50	Angle of oblique dimension line segment in jogged radius dimension
DIML-TYPE_HANDLE	345	Specifies the LINETYPE of the dimension line. Handle to LTYPE table entry
DIML-TEX1_HANDLE	346	Specifies the LINETYPE of the extension line 1. Handle to LTYPE table entry
DIML-TEX2_HANDLE	347	Specifies the LINETYPE of the extension line 2. Handle to LTYPE table entry

## Extended Settings as Special XDATA Groups

Prior to DXF R2007, some extended settings for the dimension and the extension lines are stored in the XDATA section by following entries, this is not documented by Autodesk:

```

1001
ACAD_DSTYLE_DIM_LINETYPE      <<< linetype for dimension line
1070
380                           <<< group code, which differs from R2007 DIMDLTYPE
1005
FFFF                         <<< handle to LTYPE entry
1001
ACAD_DSTYLE_DIM_EXT1_LINETYPE <<< linetype for extension line 1
1070
381                           <<< group code, which differs from R2007 DIMLTEX1
1005
FFFF                         <<< handle to LTYPE entry
1001
ACAD_DSTYLE_DIM_EXT2_LINETYPE <<< linetype for extension line 1
1070
382                           <<< group code, which differs from R2007 DIMLTEX2
1005
FFFF                         <<< handle to LTYPE entry
1001
ACAD_DSTYLE_DIMEXT_ENABLED    <<< extension line fixed
1070
383                           <<< group code, which differs from R2007 DIMEXFIX
1070

```

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1	<<< fixed if 1 else 0
1001	
ACAD_DSTYLE_DIMEXT_LENGTH	<<< extension line fixed length
1070	
378	<<< group code, which differs from R2007 DIMEXLEN
1040	
1.33	<<< length of extension line below dimension line

This XDATA groups requires also an appropriate APPID entry in the APPID table. This feature is not supported by *ezdxf*.

## BLOCK\_RECORD Table

Block records are essential elements for the entities management, each layout (modelspace and paperspace) and every block definition has a block record entry. This block record is the hard *owner* of the entities of layouts, each entity has an owner handle which points to a block record of the layout.

## LAYER Table

TODO

### Table Structure DXF R2000+

0	<<< start of table
TABLE	
2	<<< set table type
LAYER	
5	<<< LAYER table handle
2	
330	<<< owner tag, tables has no owner
0	
100	<<< subclass marker
AcDbSymbolTable	
70	<<< count of layers defined in this table, AutoCAD ignores this value
5	
0	<<< 1. LAYER table entry
LAYER	
...	<<< LAYER entity tags
0	<<< 2. LAYER table entry
LAYER	
...	<<< LAYER entity tags

### Layer Entity Tags DXF R2000+

There are some quirks:

- the frozen/thawed state is stored in flags (group code 70)
- the locked/unlocked state is stored in flags (group code 70)
- the off state is stored as negative color value (group code 6)

- the layer description is stored in the XDATA section
- the transparency value is stored in the XDATA section

```

0      <<< LAYER table entry
LAYER
5      <<< handle of LAYER
10
330     <<< owner handle, handle of LAYER table
2
100     <<< subclass marker
AcDbSymbolTableRecord
100     <<< subclass marker
AcDbLayerTableRecord
2      <<< layer name
0      <<< layer "0"
70      <<< flags
0
62      <<< color
7      <<< a negative value switches the layer off
420     <<< optional true color value
0
6      <<< linetype
Continuous
290     <<< optional plot flag
1
370     <<< linewidth
-3
390     <<< handle to plot style
F
347     <<< material handle
47
348     <<< unknown1
0
1001    <<< XDATA section, APPID
AcAecLayerStandard
1000    <<< unknown first value, here an empty string

1000    <<< layer description
This layer has a description
1001    <<< APPID
AcCmTransparency
1071    <<< layer transparency value
0

```

## Layer Viewport Overrides

Some layer attributes can be overridden individually for any VIEWPORT entity. This overrides are stored as extension dictionary entries of the LAYER entity pointing to XRECORD entities in the objects section:

```

0
LAYER
5
9F
102     <<< APP data, extension dictionary
{ACAD_XDICTIONARY

```

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```

360      <<< handle to the xdict in the objects section
B3
102
}
330
2
100
AcDbSymbolTableRecord
100
AcDbLayerTableRecord
2
LayerA
...

```

The extension DICTIONARY entity:

```

0      <<< entity type
DICTIONARY
5      <<< handle
B3
330      <<< owner handle
9F      <<< the layer owns this dictionary
100     <<< subclass marker
AcDbDictionary
280      <<< hard owned flag
1
281      <<< cloning type
1      <<< keep existing
3      <<< transparency override
ADSK_XREC_LAYER_ALPHA_OVR
360      <<< handle to XRECORD
E5
3      <<< color override
ADSK_XREC_LAYER_COLOR_OVR
360      <<< handle to XRECORD
B4
3      <<< linetype override
ADSK_XREC_LAYER_LINETYPE_OVR
360      <<< handle to XRECORD
DD
3      <<< linewidth override
ADSK_XREC_LAYER_LINEWT_OVR
360      <<< handle to XRECORD
E2

```

Transparency override XRECORD:

```

0      <<< entity type
XRECORD
5      <<< handle
E5
102     <<< reactors app data
{ACAD_REACTORS
330
B3      <<< extension dictionary
102
}

```

(continues on next page)

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```

330      <<< owner tag
B3       <<< extension dictionary
100      <<< subclass marker
AcDbXrecord
280      <<< cloning flag
1        <<< keep existing
102      <<< for each overridden VIEWPORT one entry
{ADSK_LYR_ALPHA_OVERRIDE
335      <<< handle to VIEWPORT
AC
440      <<< transparency override
33554661
102
}

```

Color override XRECORD:

```

0
XRECORD
...      <<< like transparency XRECORD
102      <<< for each overridden VIEWPORT one entry
{ADSK_LYR_COLOR_OVERRIDE
335      <<< handle to VIEWPORT
AF
420      <<< color override
-1023409925 <<< raw color value
102
}

```

Linetype override XRECORD:

```

0
XRECORD
...      <<< like transparency XRECORD
102      <<< for each overridden VIEWPORT one entry
{ADSK_LYR_LINETYPE_OVERRIDE
335      <<< handle to VIEWPORT
AC
343      <<< linetype override
DC      <<< handle to LINETYPE table entry
102
}

```

Lineweight override XRECORD:

```

0
XRECORD
...      <<< like transparency XRECORD
102      <<< for each overridden VIEWPORT one entry
{ADSK_LYR_LINEWT_OVERRIDE
335      <<< handle to VIEWPORT
AC
91      <<< linewidth override
13      <<< linewidth value
102
}

```

## DXF Entities

### DIMENSION Internals

See also:

- DXF Reference: [DIMENSION](#)
- DXFInternals: *DIMSTYLE Table*

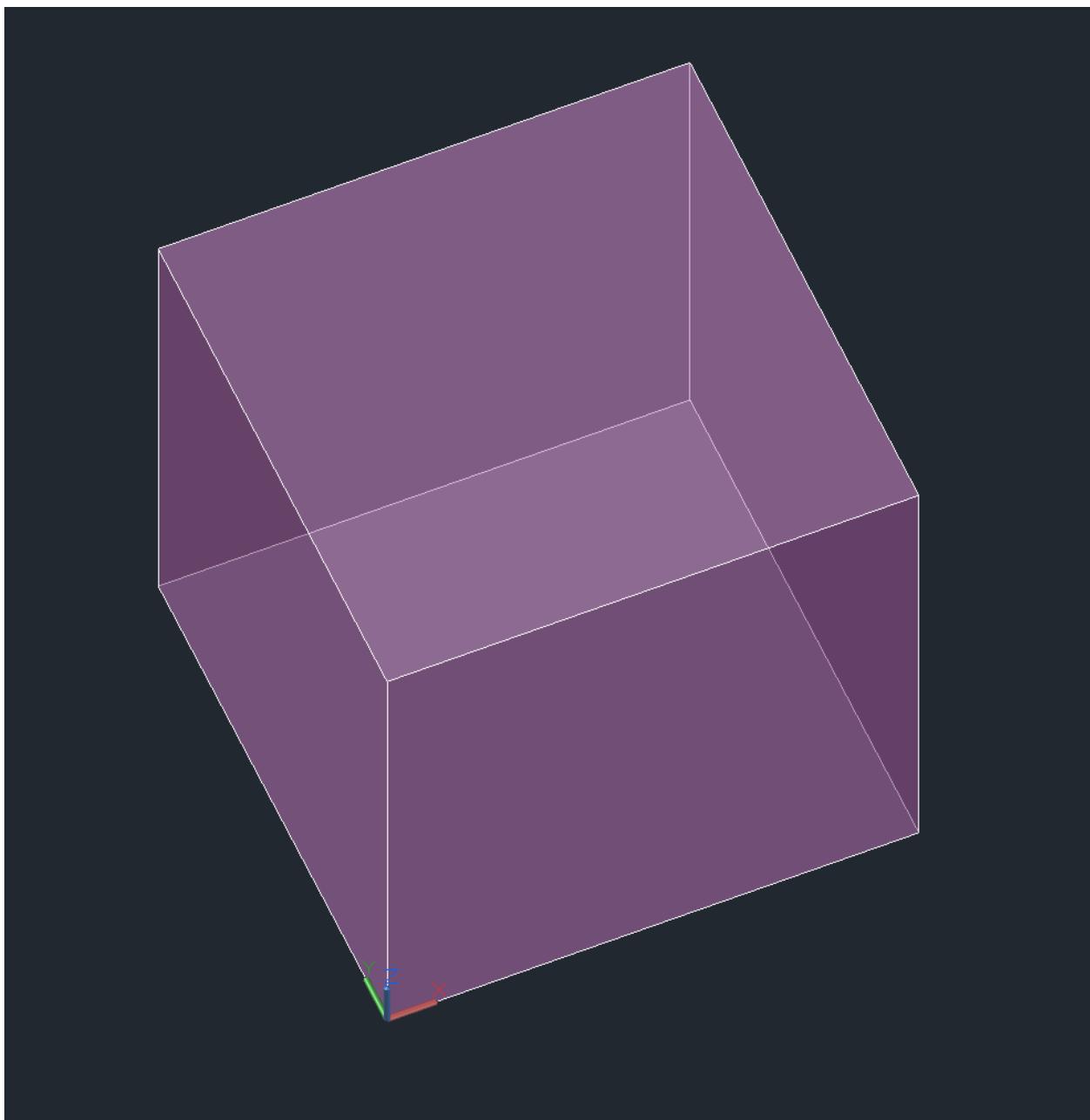
### MESH Internals

The MESH entity is the compact version of the PolyFaceMesh implemented by the *Polyline* entity . The entity stores the vertices, edges and faces in a single entity and was introduced in DXF version R13/R14. For more information about the top level stuff go to the *Mesh* class.

See also:

- DXF Reference: [MESH](#)
- `ezdxf.entities.Mesh` class

The following DXF code represents this cube with subdivision level of 0:



```
0
MESH           <<< DXF type
5              <<< entity handle
2F
330           <<< block record handle of owner layout
17
100
AcDbEntity
8
0              <<< layer
62
6              <<< color
100
```

(continues on next page)

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```
AcDbSubDMesh    <<< subclass marker
71
2          <<< version
72
1          <<< blend crease, 1 is "on", 0 is "off"
91
0          <<< subdivision level is 0
92
8          <<< vertex count, 8 cube corners
10         <<< 1. vertex, x-axis
0.0
20         <<< y-axis
0.0
30         <<< z-axis
0.0
10         <<< 2. vertex
1.0
20
0.0
30
0.0
10         <<< 3. vertex
1.0
20
1.0
30
0.0
10         <<< 4. vertex
0.0
20
1.0
30
0.0
10         <<< 5. vertex
0.0
20
0.0
30
1.0
10         <<< 6. vertex
1.0
20
0.0
30
1.0
10         <<< 7. vertex
1.0
20
1.0
30
1.0
10         <<< 8. vertex
0.0
20
1.0
30
1.0
```

(continues on next page)

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```

93      <<< size of face list
30      <<< size = count of group code 90 tags = 6 x 5
90      <<< vertex count of face 1
4       <<< MESH supports ngons, count = 3, 4, 5, 6 ...
90
0       <<< face 1, index of 1. vertex
90
3       <<< face 1, index of 2. vertex
90
2       <<< face 1, index of 3. vertex
90
1       <<< face 1, index of 4. vertex
90
4           <<< vertex count of face 2
90
4       <<< face 2, index of 1. vertex
90
5       <<< face 2, index of 2. vertex
90
6       <<< face 2, index of 3. vertex
90
7       <<< face 2, index of 4. vertex
90
4           <<< vertex count of face 3
90
0       <<< face 3, index of 1. vertex
90
1       <<< face 3, index of 2. vertex
90
5       <<< face 3, index of 3. vertex
90
4       <<< face 3, index of 4. vertex
90
4           <<< vertex count of face 4
90
1       <<< face 4, index of 1. vertex
90
2       <<< face 4, index of 2. vertex
90
6       <<< face 4, index of 3. vertex
90
5       <<< face 4, index of 4. vertex
90
4           <<< vertex count of face 5
90
3       <<< face 5, index of 1. vertex
90
7       <<< face 5, index of 2. vertex
90
6       <<< face 5, index of 3. vertex
90
2       <<< face 5, index of 4. vertex
90
4           <<< vertex count of face 6
90
0       <<< face 6, index of 1. vertex
90

```

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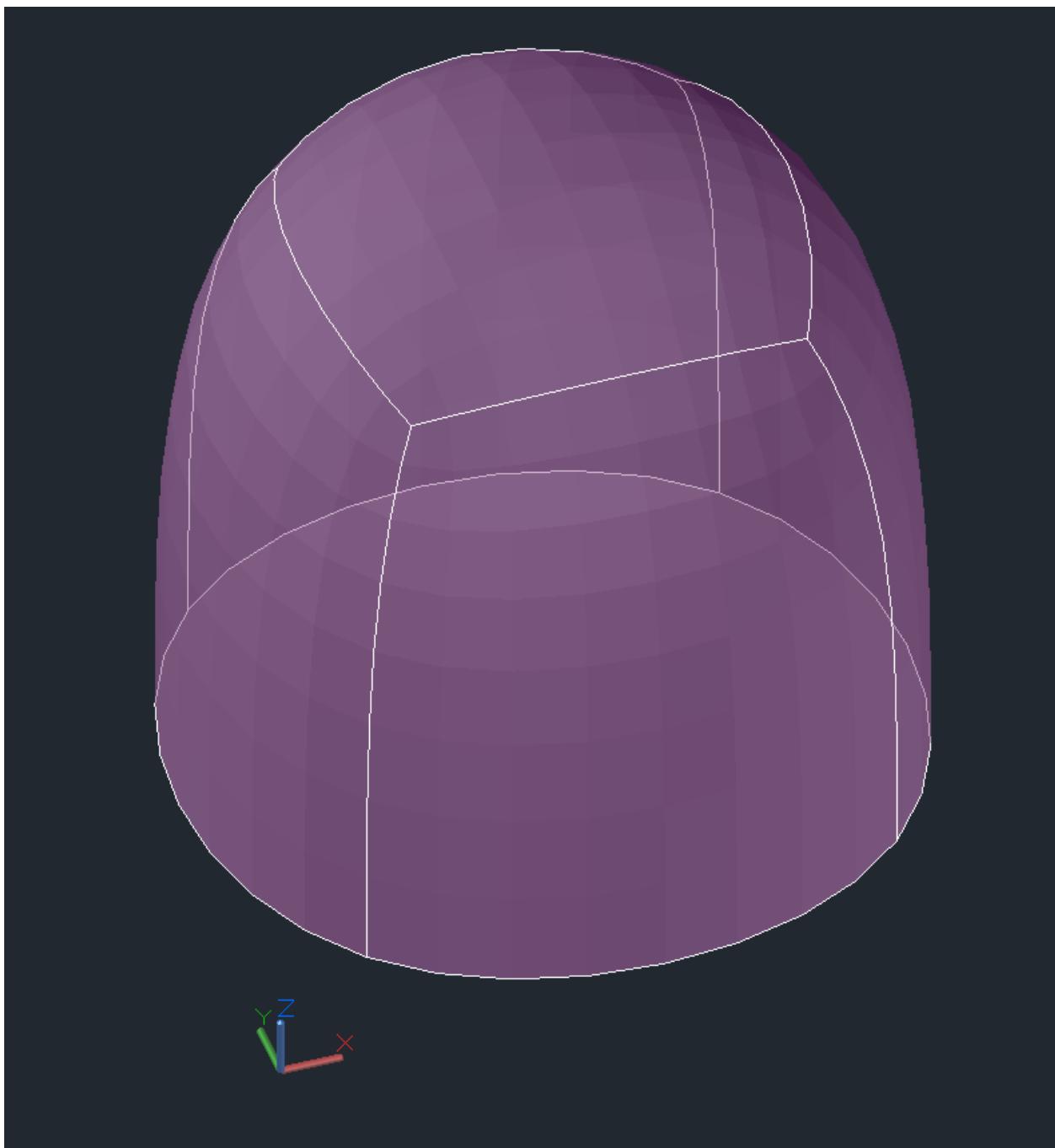
```

4      <<< face 6, index of 2. vertex
90
7      <<< face 6, index of 3. vertex
90
3      <<< face 6, index of 4. vertex
94          <<< edge count, each edge has exact two group code 90 tags
4          <<< the real edge count not the group code 90 tags!
90
0      <<< edge 1, vertex 1
90
1      <<< edge 1, vertex 1
90
1      <<< edge 2, vertex 1
90
2      <<< edge 2, vertex 2
90
2      <<< edge 3, vertex 1
90
3      <<< edge 3, vertex 2
90
3      <<< edge 4, vertex 1
90
0      <<< edge 4, vertex 2
95          <<< edge crease count, has to match edge count!
4
140
3.0    <<< crease value for edge 1
140
3.0    <<< crease value for edge 2
140
3.0    <<< crease value for edge 3
140
3.0    <<< crease value for edge 4
90        <<< property overwrite???
0

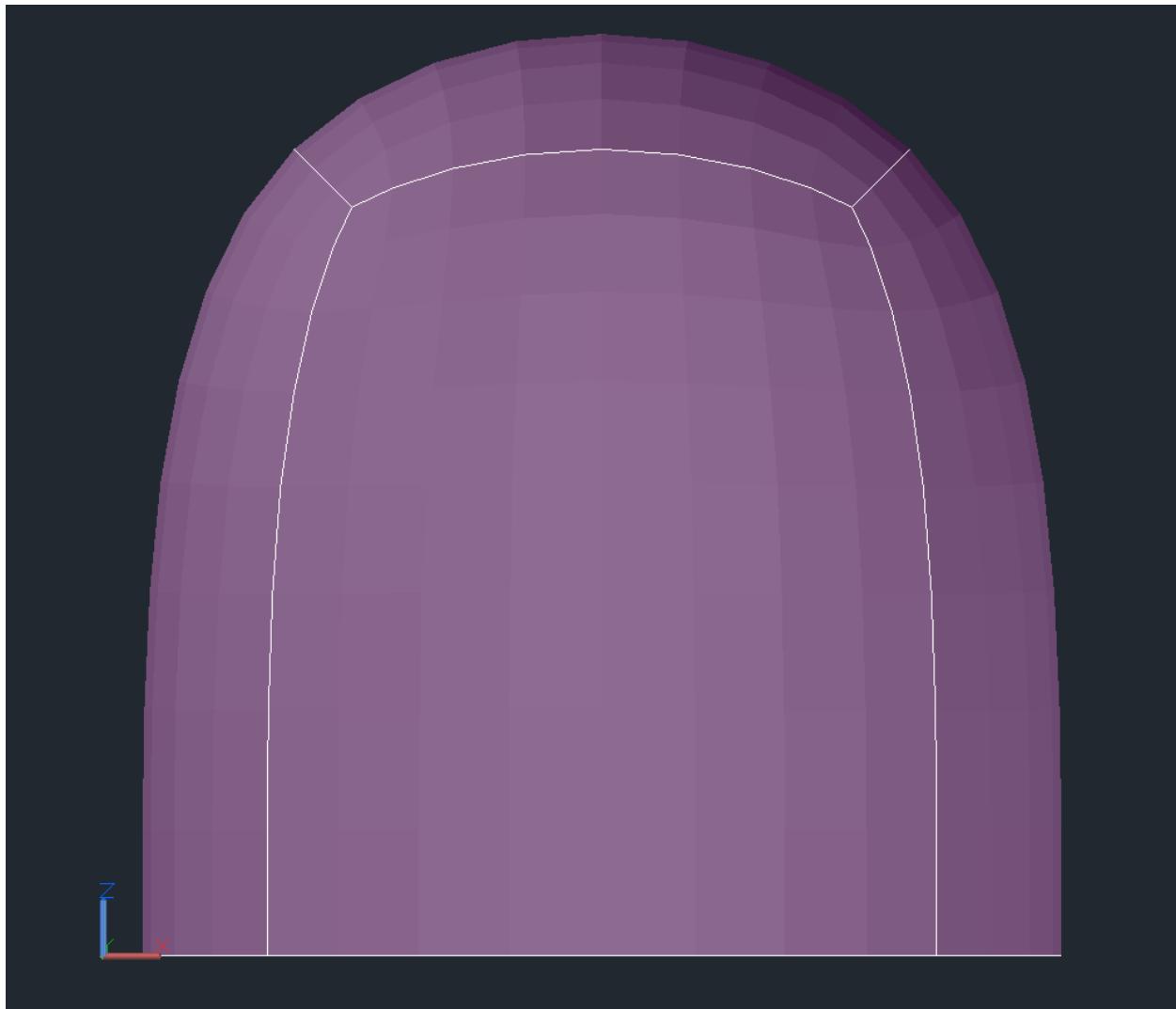
```

The edge and crease data have only a meaning if subdivision of the geometry will be applied! A crease value equal to the subdivision level prevents subdividing for the edge completely, a value between 0.0 and the subdivision level applies subdivision partially.

The cube with subdivision level of 3 and crease values of 3.0:



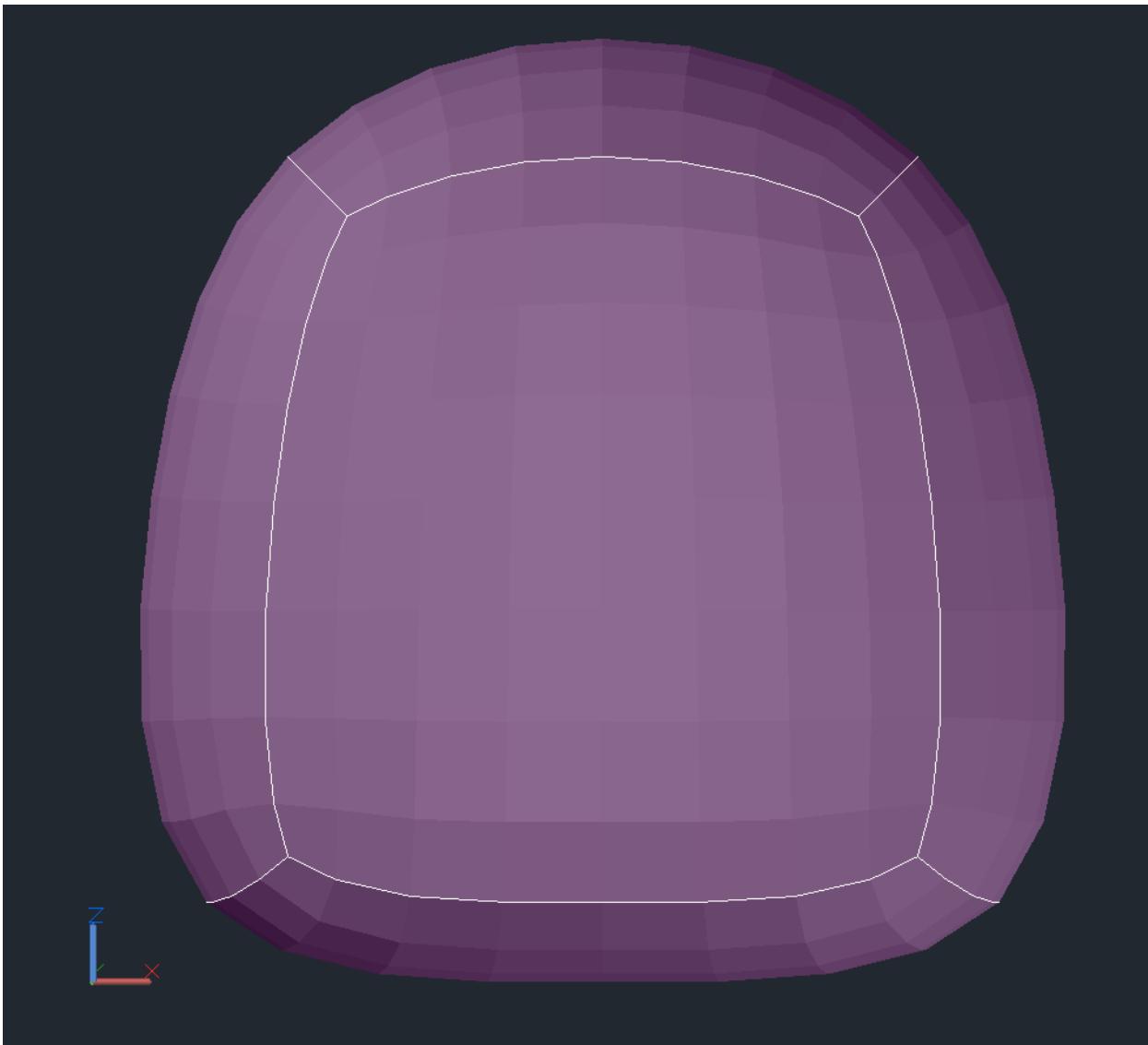
Front view for better details:



The cube with subdivision levels of 3 and crease values of 2.0:



The cube with subdivision level of 3 and crease values of 1.0:



The property overriding protocol is not documented in the DXF reference and currently I have no access to a CAD application which can created property overriding.

## MULTILEADER Internals

The MULTILEADER leader is a very complex entity and has also some weird and unique properties.

1. MULTILEADER has the alias name MLEADER which is accepted by any *reliable CAD application*, but all of them create the entity as MULTILEADER
2. uses *raw color* values to define colors
3. creates a complex context data structures beyond simple tags inside the subclass AcDbMLLeader

See also:

- `ezdxf.entities.MultiLeader`
- `ezdxf.entities.MLeaderStyle`

- `ezdxf.render.MultiLeaderBuilder`
- *Tutorial for MultiLeader*
- DXF Reference: [MLEADER](#)

Example for `ezdxf.entities.MLeaderContext` created by BricsCAD:

## MTEXT Internals

The MTEXT entity stores multiline text in a single entity and was introduced in DXF version R13/R14. For more information about the top level stuff go to the [MText](#) class.

See also:

- DXF Reference: [MTEXT](#)
- `ezdxf.entities.MText` class

## Orientation

The MTEXT entity does not establish an OCS. The entity has a `text_direction` attribute, which defines the local x-axis, the `extrusion` attribute defines the normal vector and the y-axis = extrusion cross x-axis.

The MTEXT entity can have also a `rotation` attribute (in degrees), the x-axis attribute has higher priority than the `rotation` attribute, but it is not clear how to convert the `rotation` attribute into a `text_direction` vector, but for most common cases, where only the `rotation` attribute is present, the `extrusion` is most likely the WCS z-axis and the `rotation` is the direction in the xy-plane.

## Text Content

The content text is divided across multiple tags of group code 3 and 1, the last line has the group code 1, each line can have a maximum line length of 255 bytes, but BricsCAD (and AutoCAD?) store only 249 bytes in single line and one byte is not always one char.

## Inline Code Specials

The text formatting is done by inline codes, see the [MText](#) class.

Information gathered by implementing the `MTextEditor` and the `MTextParser` classes:

- **caret encoded characters:**
  - “^I” tabulator
  - “^J” (LF) is a valid line break like “\P”
  - “^M” (CR) is ignored
  - other characters render as empty square “”
  - a space “ ” after the caret renders the caret glyph: “1^ 2” renders “1^2”
- **special encoded characters:**
  - “%%c” and “%%C” renders “Ø” (alt-0216)
  - “%%d” and “%%D” renders “ø” (alt-0176)

- “%%p” and “%%P” renders “±” (alt-0177)
- **Alignment command “\A”: argument “0”, “1” or “2” is expected**
  - the terminator symbol “;” is optional
  - the arguments “3”, “4”, “5”, “6”, “7”, “8”, “9” and “-” default to 0
  - other characters terminate the command and will be printed: “\AX”, renders “X”
- **ACI color command “\C”: int argument is expected**
  - the terminator symbol “;” is optional
  - a leading “-” or “+” terminates the command, “\C+5” renders “\C+5”
  - arguments > 255, are ignored but consumed “\C1000” renders nothing, not even a “0”
  - a trailing “;” after integers is always consumed, even for much to big values, “\C10000;” renders nothing
- **RGB color command “\c”: int argument is expected**
  - the terminator symbol “;” is optional
  - a leading “-” or “+” terminates the command, “\c+255” renders “\c+255”
  - arguments  $\geq 16777216$  are masked by: value & 0xFFFFFFF
  - a trailing “;” after integers is always consumed, even for much to big values, “\c9999999999;” renders nothing and switches the color to yellow (255, 227, 11)
- **Height command “\H” and “\H...x”: float argument is expected**
  - the terminator symbol “;” is optional
  - a leading “-” is valid, but negative values are ignored
  - a leading “+” is valid
  - a leading “.” is valid like “\H.5x” for height factor 0.5
  - exponential format is valid like “\H1e2” for height factor 100 and “\H1e-2” for 0.01
  - an invalid floating point value terminates the command, “\H1..5” renders “\H1..5”
- **Other commands with floating point arguments like the height command:**
  - Width commands “\W” and “\W...x”
  - Character tracking commands “\T” and “\T...x”, negative values are used
  - Slanting (oblique) command “\Q”
- **Stacking command “\S”:**
  - build fractions: “numerator (upr)” + “stacking type char (t)” + “denominator (lwr)” + “;”
  - divider chars: “^”, “/” or “#”
  - a space ” ” after the divider char “^” is mandatory to avoid caret decoding: “\S1^ 2;”
  - the terminator symbol “;” is mandatory to end the command, all chars beyond the “\S” until the next “;” or the end of the string are part of the fraction
  - backslash escape “\\” to render the terminator char
  - a space ” ” after the divider chars “/” and “#” is rendered as space ” ” in front of the denominator
  - the numerator and denominator can contain spaces

- backslashes “” inside the stacking command are ignored (except “;”) “\\$N^ \\$P” render “N” over “P”, therefore property changes (color, text height, ...) are not possible inside the stacking command
- grouping chars “{” and “}” render as simple curly braces
- caret encoded chars are decoded “^I”, “^J”, “^M”, but render as a simple space ” ” or as the replacement char “” plus a space
- a divider char after the first divider char, renders as the char itself: “\\$1/2/3” renders the horizontal fraction “1” / “2/3”

- **Font command “\f” and “\F”: export only “\f”, parse both, “\F” ignores some arguments**

- the terminator symbol “;” is mandatory to end the command, all chars beyond the “\f” until the next “;” or the end of the string are part of the command
- the command arguments are separated by the pipe char “|”
- arguments: “font family name” | “bold” | “italic” | “codepage” | “pitch”; example “\fArialb0li0lc0lp0;”
- only the “font family name” argument is required, fonts which are not available on the system are replaced by the “TXT.SHX” shape font
- the “font family name” is the font name shown in font selection widgets in desktop applications
- “b1” to use the bold font style, any other second char is interpreted as “non bold”
- “i1” to use an italic font style, any other second char is interpreted as “non italic”
- “c???” change codepage, “c0” use the default codepage, because of the age of unicode no further investigations, also seems to be ignored by AutoCAD and BricsCAD
- “p???” change pitch size, “p0” means don’t change, ignored by AutoCAD and BricsCAD, to change the text height use the “H” command
- the order is not important, but export always in the shown order: “\fArialb0li0;” the arguments “c0” and “p0” are not required

- **Paragraph properties command “\p”**

- the terminator symbol “;” is mandatory to end the command, all chars beyond the “\p” until the next “;” or the end of the string are part of the command
- the command arguments are separated by commas “,”
- all values are factors for the initial char height of the MTEXT entity, example: char height = 2.5, “\pl1;” set the left paragraph indentation to  $1 \times 2.5 = 2.5$  drawing units.
- all values are floating point values, see height command
- arguments are “i”, “l”, “r”, “q”, “t”
- a “\*” as argument value, resets the argument to the initial value: “i0”, “l0”, “r0”, the “q” argument most likely depends on the text direction; I haven’t seen “t\*”. The sequence used by BricsCAD to reset all values is “\pi\*, l\*, r\*, q\*, t;”
- “i” indentation of the first line relative to the “l” argument as floating point value, “\pi1.5”
- “l” left paragraph indentation as floating point value, “\pl1.5”
- “r” right paragraph indentation as floating point value, “\pr1.5”
- “x” is required if a “q” or a “t” argument is present, the placement of the “x” has no obvious rules
- “q” paragraph alignment
  - \* “ql” left paragraph alignment

- \* “qr” right paragraph alignment
  - \* “qc” center paragraph alignment
  - \* “qj” justified paragraph alignment
  - \* “qd” distributed paragraph alignment
- “t” tabulator stops as comma separated list, the default tabulator stops are located at 4, 8, 12, ..., by defining at least one tabulator stop, the default tabulator stops will be ignored. There are 3 kinds of tabulator stops: left, right and center adjusted stops, e.g. “pxt1,r5,c8”:
- \* a left adjusted stop has no leading char, two left adjusted stops “\pxt1,2;”
  - \* a right adjusted stop has a preceding “r” char, “\pxtr1,r2;”
  - \* a center adjusted stop has a preceding “c” char, “\pxtc1,c2;”
- complex example to create a numbered list with two items: “pxi-3,14t4;1.^Ifirst item\P2.^Isecond item”
- a parser should be very flexible, I have seen several different orders of the arguments and placing the sometimes required “x” has no obvious rules.
  - exporting seems to be safe to follow these three rules:
    1. the command starts with “\px”, the “x” does no harm, if not required
    2. argument order “i”, “l”, “r”, “q”, “t”, any of the arguments can be left off
    3. terminate the command with a “;”

## Height Calculation

There is no reliable way to calculate the MTEXT height from the existing DXF attributes. The `rect_height` (group code 43) attribute is not required and seldom present. DXF R2007 introduced the `defined_height` attribute to store the defined column height of the MTEXT entity but only in column mode. MTEXT entities without columns, except MTEXT entities created with column type “No Columns”, store always 0.0 as defined column height. Which seems to mean: defined by the rendered text content.

The only way to calculate the MTEXT height is to replicate the rendering results of AutoCAD/BricsCAD by implementing a rendering engine for MTEXT.

In column mode the MTEXT height is stored for every column for DXF version before R2018. In DXF R2018+ the column heights are only stored if `MTextColumns.auto_height` is `False`. If `MTextColumns.auto_height` is `True`. But DXF R2018+ stores the MTEXT total width and height in explicit attributes.

## Width Calculation

The situation for width calculation is better than for the height calculation, but the attributes `width` and `rect_width` are not mandatory.

There is a difference between MTEXT entities with and without columns:

Without columns the attribute `width` (reference column width) contains the true entity width if present. A long word can overshoot this width! The `rect_width` attribute is seldom present.

For MTEXT with columns, the `width` attribute is maybe wrong, the correct width for a column is stored in the `column_width` attribute and the `total_width` attribute stores the total width of the MTEXT entity overall columns, see also following section “Column Support”.

## Background Filling

The background fill support is available for DXF R2007+. The group code 90 defines the kind of background fill:

0	off
1	color defined by group code 63, 421 or 431
2	drawing window color
3	background (canvas) color
16	bit-flag text frame, see Open Design Alliance Specification 20.4.46

Group codes to define background fill attributes:

45	scaling factor for the border around the text, the value should be in the range of [1, 5], where 1 fits exact the MText entity
63	set the background color by <i>ACI</i> .
421	set the background color as <i>true color</i> value.
431	set the background color by color name - no idea how this works
441	set the transparency of the background fill, not supported by AutoCAD or BricsCAD.

Group codes 45, 90 and 63 are required together if one of them is used. The group code 421 and 431 also requires the group code 63, even this value is ignored.

```
... <snip>
1 <str> eu feugiat nulla facilisis at vero eros et accumsan et iusto ...
73 <int> 1
44 <float> 1.0
90 <int> 1, b00000001    <<< use a color
63 <int> 1                <<< ACI color (red)
45 <float> 1.5            <<< bg scaling factor, relative to the char height
441 <int> 0               <<< ignored (optional)
... <snip>
```

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The background scaling does not alter the `width`, `column_width` or `total_width` attributes. The background acquires additional space around the MTEXT entity.

Columns with background color:

Lorem ipsum dolor sit amet, consetetur sadipscing elitr, sed diam nonumy eirmod tempor invidunt ut labore et dolore magna aliquyam erat, sed diam voluptua. At vero eos et accusam et justo duo dolores et ea rebum. Stet clita kasd gubergren, no sea takimata sanctus est Lorem ipsum dolor sit amet. Lorem ipsum dolor sit amet, consetetur sadipscing elitr, sed diam nonumy eirmod tempor invidunt ut labore et dolore magna aliquyam erat, sed diam voluptua. At vero eos et accusam et justo duo dolores et ea rebum. Stet clita kasd gubergren, no sea takimata sanctus est Lorem ipsum dolor sit amet. Lorem ipsum dolor sit amet, consetetur sadipscing elitr, sed diam nonumy eirmod tempor invidunt ut labore et dolore magna aliquyam erat, sed diam voluptua. At vero eos et accusam et justo duo dolores et ea rebum. Stet clita kasd gubergren, no sea takimata sanctus est Lorem ipsum dolor sit amet.

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## Text Frame

The MTEXT entity can have a text frame only, without a background filling, group code 90 has value 16. In this case all other background related tags are removed (45, 63, 421, 431, 441) and the scaling factor is 1.5 by default.

## XDATA for Text Frame

This XDATA exist only if the text frame flag in group code 90 is set and for DXF version < R2018!

```
... <snip>
1001 <ctrl> ACAD
1000 <str> ACAD_MTEXT_TEXT_BORDERS_BEGIN
1070 <int> 80      <<< group code for repeated flags
1070 <int> 16      <<< repeated group code 90?
1070 <int> 46      <<< group code for scaling factor, which is fixed?
1040 <float> 1.5    <<< scaling factor
1070 <int> 81      <<< group code for repeated flow direction?
1070 <int> 1        <<< flow direction?
1070 <int> 5        <<< group code for a handle, multiple entries possible
1005 <hex> #A8      <<< handle to the LWPOLYLINE text frame
1070 <int> 5        <<< group code for next handle
1005 <hex> #A9      <<< next handle
...
1000 <str> ACAD_MTEXT_TEXT_BORDERS_END
```

## Extra LWPOLYLINE Entity as Text Frame

The newer versions of AutoCAD and BricsCAD get all the information they need from the MTEXT entity, but it seems that older versions could not handle the text frame property correct. Therefore AutoCAD and BricsCAD create a separated LWPOLYLINE entity for the text frame for DXF versions < R2018. The handle to this text frame entity is stored in the XDATA as group code 1005, see section above.

Because this LWPOLYLINE is not required *ezdxf* does **not** create such a text frame entity nor the associated XDATA and *ezdxf* also **removes** this data from loaded DXF files at the second loading stage.

## Column Support

CAD applications build multiple columns by linking 2 or more MTEXT entities together. In this case each column is a self-sufficient entity in DXF version R13 until R2013. The additional columns specifications are stored in the XDATA if the MTEXT which represents the first column.

DXF R2018 changed the implementation into a single MTEXT entity which contains all the content text at once and stores the column specification in an embedded object.

---

**Hint:** The `width` attribute for the linked MTEXT entities could be wrong. Always use the the `column_width` and the `total_width` attributes in column mode.

---

There are two column types, the **static** type has the same column height for all columns, the **dynamic** type can have the same (auto) height or an individual height for each column.

Common facts about columns for all column types:

- all columns have the same column width

- all columns have the same gutter width
- the top of the column are at the same height

## Column Type

The column type defines how a CAD application should create the columns, this is not important for the file format, because the result of this calculation, the column count and the column height, is stored the DXF file.

Column Type in BricsCAD	Description
Static	All columns have the same height. The “auto height” flag is 0.
Dynamic (auto height)	Same as the static type, all columns have the same height. The “auto height” flag is 1. The difference to the static type is only important for interactive CAD applications.
Dynamic (manual height)	same as the dynamic (auto height) type, but each column can have an individual height.
No column	A regular MTEXT with “defined column height” attribute?

Column Type	Defined Height	Auto Height	Column Heights
Static	stored	False	not stored
Dynamic auto	stored	True	not stored
Dynamic manual	not stored	False	stored (last=0)

## Column Count

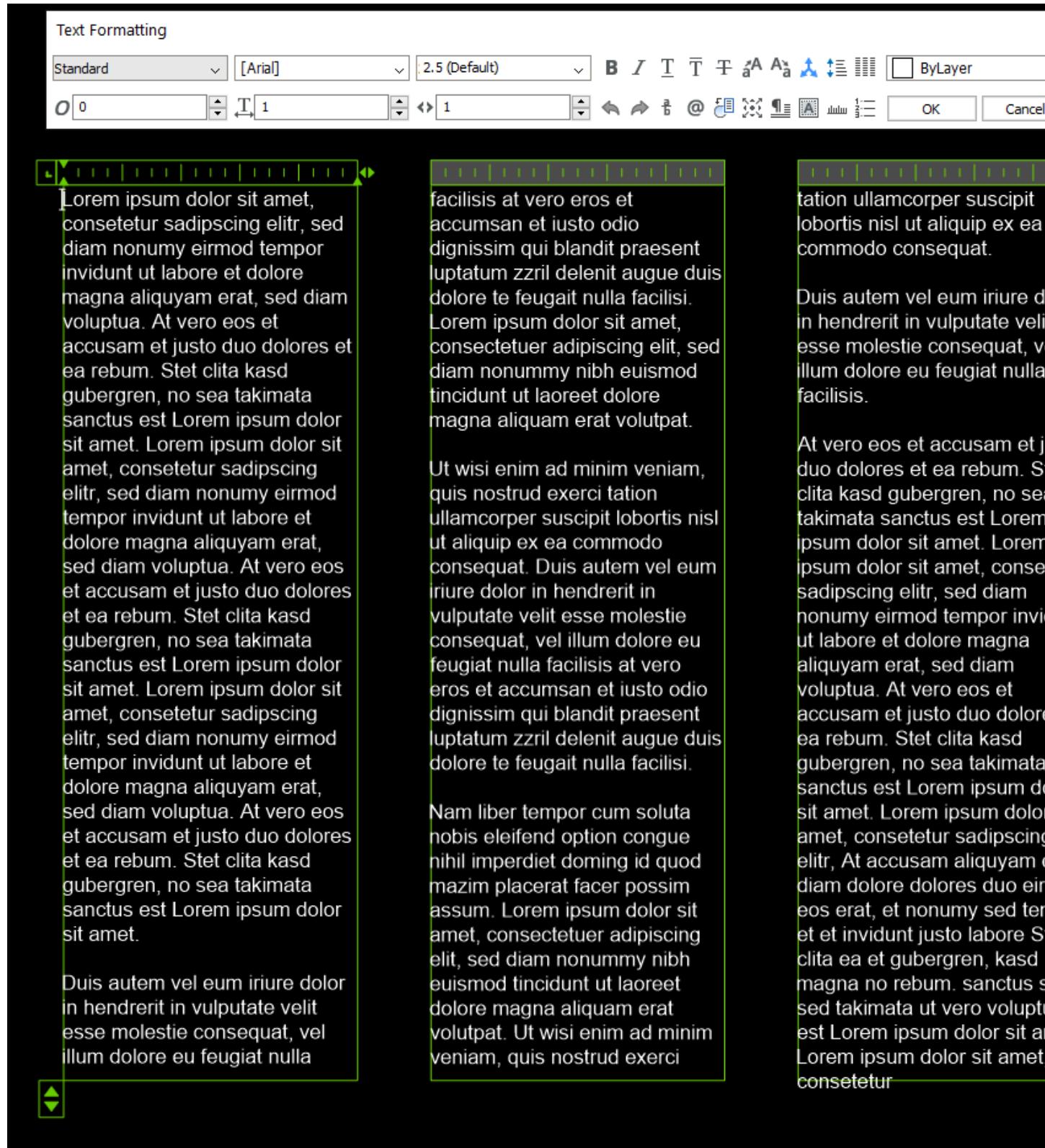
For DXF versions < R2018 the column count is always given by the count of linked MTEXT columns. Caution: the column count stored in the XDATA section by group code 76 may not match the count of linked MTEXT entities and AutoCAD is OK with that! In DXF R2018+ this property is not available, because there are no linked MTEXT entities anymore.

R2018+: For the column types “static” and “dynamic manual” the correct column count is stored as group code 72. For the column type “dynamic auto” the stored *column count is 0*. It is possible to calculate the column count from the total width and the column width if the total width is correct like in AutoCAD and BricsCAD.

## Static Columns R2000

Example for a **static** column specification:

- Column Type: Static
- Number of Columns: 3
- Height: 150.0, manual entered value and all columns have the same height
- Width: 50.0
- Gutter Width: 12.5



The column height is stored as the “defined column height” in XDATA (46) or the embedded object (41).

DXF R2000 example with a static column specification stored in XDATA:

```

0
MTEXT
5           <<< entity handle
9D
102
{ACAD_XDICTIONARY
360
9F
102
}
330           <<< block record handle of owner layout
1F
100
AcDbEntity
8           <<< layer
0
100           <<< begin of MTEXT specific data
AcDbMText
10           <<< (10, 20, 30) insert location in WCS
285.917876152751
20
276.101821192053
30
0.0
40           <<< character height in drawing units
2.5
41           <<< reference column width, if not in column mode
62.694...   <<< in column mode: the real column is defined in XDATA (48)
71           <<< attachment point
1
72           <<< text flow direction
1
3           <<< begin of text
Lorem ipsum dolor sit amet, consetetur sadipscing elitr, sed diam ...
3
kimata sanctus est Lorem ipsum dolor sit amet. Lorem ipsum dolor sit ...
3
ea rebum. Stet clita kasd gubergren, no sea takimata sanctus est Lorem ...
3
At vero eos et accusam et justo duo dolores et ea rebum. Stet clita kasd ...
3
ore eu feugiat nulla facilisis at vero eros et accumsan et iusto odio ...
1           <<< last text line and end of text
euismod tincidunt ut laoreet dolore magna aliquam erat volutpat.
73           <<< line spacing style
1
44           <<< line spacing factor
1.0
1001
AcadAnnotative
1000
AnnotativeData
1002
{
1070
1
1070

```

(continues on next page)

(continued from previous page)

```

0
1002
}
1001      <<< AppID "ACAD" contains the column specification
ACAD
1000
ACAD_MTEXT_COLUMN_INFO_BEGIN
1070
75      <<< group code column type
1070
1      <<< column type: 0=no column; 1=static columns; 2=dynamic columns
1070
79      <<< group code column auto height
1070
0      <<< flag column auto height
1070
76      <<< group code column count
1070
3      <<< column count
1070
78      <<< group code column flow reversed
1070
0      <<< flag column flow reversed
1070
48      <<< group code column width
1040
50.0     <<< column width in column mode
1070
49      <<< group code column gutter
1040
12.5     <<< column gutter width
1000
ACAD_MTEXT_COLUMN_INFO_END
1000      <<< linked MTEXT entities specification
ACAD_MTEXT_COLUMNS_BEGIN
1070
47      <<< group code for column count, incl. the 1st column - this entity
1070
3      <<< column count
1005
1B4      <<< handle to 2nd column as MTEXT entity
1005
1B5      <<< handle to 3rd column as MTEXT entity
1000
ACAD_MTEXT_COLUMNS_END
1000
ACAD_MTEXT_DEFINED_HEIGHT_BEGIN
1070
46      <<< group code for defined column height
1040
150.0     <<< defined column height
1000
ACAD_MTEXT_DEFINED_HEIGHT_END

```

The linked column MTEXT #1B4 in a compressed representation:

```

0 <ctrl> MTEXT
... <snip>
100 <ctrl> AcDbMText
10 <point> (348.417876152751, 276.101821192053, 0.0)
40 <float> 2.5
41 <float> 175.0      <<< invalid reference column width
... <snip>
1001 <ctrl> ACAD
1000 <str> ACAD_MTEXT_DEFINED_HEIGHT_BEGIN
1070 <int> 46          <<< defined column height
1040 <float> 150.0
1000 <str> ACAD_MTEXT_DEFINED_HEIGHT_END

```

The linked MTEXT has no column specification except the “defined column height” in the XDATA. The reference column width is not the real value of 50.0, see XDATA group code 48 in the main MTEXT #9D, instead the total width of 175.0 is stored at group code 41. This is problem if a renderer try to render this MTEXT as a standalone entity. The renderer has to fit the content into the column width by itself and without the correct column width, this will produce an incorrect result.

There exist no back link to the main MTEXT #9D. The linked MTEXT entities appear after the main MTEXT in the layout space, but there can be other entities located between these linked MTEXT entities.

The linked column MTEXT #1B5:

```

0 <ctrl> MTEXT
5 <hex> #1B5
... <snip>
100 <ctrl> AcDbMText
10 <point> (410.917876152751, 276.101821192053, 0.0)
40 <float> 2.5
41 <float> 175.0      <<< invalid reference column width
... <snip>
1001 <ctrl> ACAD
1000 <str> ACAD_MTEXT_DEFINED_HEIGHT_BEGIN
1070 <int> 46          <<< defined column height
1040 <float> 150.0
1000 <str> ACAD_MTEXT_DEFINED_HEIGHT_END

```

## Static Columns R2018

The MTEXT entity in DXF R2018 contains all column information in a single entity. The text content of all three columns are stored in a continuous text string, the separation into columns has to be done by the renderer. The manual column break \N is **not** used to indicate automatic column breaks. The MTEXT renderer has to replicate the AutoCAD/BricsCAD rendering as exact as possible to achieve the same results, which is very hard without rendering guidelines or specifications.

The example from above in DXF R2018 with a static column specification stored in an embedded object:

```

0
MTEXT
5           <<< entity handle
9D
102
{ACAD_XDICTIONARY
360
9F

```

(continues on next page)

(continued from previous page)

```

102
}
330      <<< block record handle of owner layout
1F
100
AcDbEntity
8       <<< layer
0
100
AcDbMText
10      <<< (10, 20, 30) insert location in WCS
285.917876152751
20
276.101821192053
30
0.0
40      <<< character height in drawing units
2.5
41      <<< reference column width, if not in column mode
62.694536423841
46      <<< defined column height
150.0
71      <<< attachment point
1
72      <<< text flow direction
1
3      <<< text content of all three columns
Lorem ipsum dolor sit amet, consetetur sadipscing elitr, sed diam n...
3
imata sanctus est Lorem ipsum dolor sit amet. Lorem ipsum dolor sit...
3
a rebum. Stet clita kasd gubergren, no sea takimata sanctus est Lor...
3
vero eos et accusam et justo duo dolores et ea rebum. Stet clita ka...
3
eu feugiat nulla facilisis at vero eros et accumsan et iusto odio s...
3
od tincidunt ut laboret dolore magna aliquam erat volutpat. \P\PU...
3
e velit esse molestie consequat, vel illum dolore eu feugiat nulla ...
3
obis eleifend option congue nihil imperdiet doming id quod mazim pl...
3
m ad minim veniam, quis nostrud exerci tation ullamcorper suscipit ...
3
lisis. \P\PAAt vero eos et accusam et justo duo dolores et ea rebu...
3
t laboret dolore magna aliquyam erat, sed diam voluptua. At vero ...
3
litr, At accusam aliquyam diam diam dolore dolores duo eirmod eos e...
1
ipsum dolor sit amet, consetetur
73      <<< line spacing style
1
44      <<< line spacing factor
1.0
101     <<< column specification as embedded object

```

(continues on next page)

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```

Embedded Object
70      <<< ???
1
10      <<< (10, 20, 30) text direction vector (local x-axis)
1.0
20
0.0
30
0.0
11      <<< (11, 21, 31) repeated insert location of AcDbMText
285.917876152751
21
276.101821192053
31
0.0
40      <<< repeated reference column width
62.694536423841
41      <<< repeated defined column height
150.0
42      <<< extents (total) width
175.0
43      <<< extents (total) height, max. height if different column heights
150.0
71      <<< column type: 0=no column; 1=static columns; 2=dynamic columns
1
72      <<< column height count
3
44      <<< column width
50.0
45      <<< column gutter width
12.5
73      <<< flag column auto height
0
74      <<< flag reversed column flow
0
1001
AcadAnnotative
1000
AnnotativeData
1002
{
1070
1
1070
0
1002
}

```

## Dynamic (auto height) Columns R2000

Example for a **dynamic** column specification:

- Column Type: Dynamic
- Number of Columns: 3
- Height: 158.189... adjusted by widget and all columns have the same height

- Width: 50.0
- Gutter Width: 12.5

```

0 <ctrl> MTEXT
5 <hex> #A2           <<< entity handle
... <snip>
330 <hex> #1F           <<< block record handle of owner layout
100 <ctrl> AcDbEntity
8 <str> 0           <<< layer
100 <ctrl> AcDbMText
10 <point> (-133.714579865783, 276.101821192053, 0.0)   <<< insert location in WCS
40 <float> 2.5           <<< character height in drawing units
41 <float> 62.694536423841 <<< reference column width, if not in column mode
71 <int> 1           <<< attachment point
72 <int> 1           <<< flag text flow direction
3 <str> Lorem ipsum dolor sit amet, consetetur sadipscing elitr, sed dia...
... <snip>
73 <int> 1           <<< line spacing style
44 <float> 1.0           <<< line spacing factor
1001 <ctrl> AcadAnnotative
... <snip>
1001 <ctrl> ACAD
1000 <str> ACAD_MTEXT_COLUMN_INFO_BEGIN
1070 <int> 75           <<< column type: 2=dynamic columns
1070 <int> 2
1070 <int> 79           <<< flag column auto height
1070 <int> 1
1070 <int> 76           <<< column count
1070 <int> 3
1070 <int> 78           <<< flag column flow reversed
1070 <int> 0
1070 <int> 48           <<< column width in column mode
1040 <float> 50.0
1070 <int> 49           <<< column gutter width
1040 <float> 12.5
1000 <str> ACAD_MTEXT_COLUMN_INFO_END
1000 <str> ACAD_MTEXT_COLUMNS_BEGIN
1070 <int> 47           <<< column count
1070 <int> 3
1005 <hex> #1B6           <<< handle to 2. column as MTEXT entity
1005 <hex> #1B7           <<< handle to 3. column as MTEXT entity
1000 <str> ACAD_MTEXT_COLUMNS_END
1000 <str> ACAD_MTEXT_DEFINED_HEIGHT_BEGIN
1070 <int> 46           <<< defined column height
1040 <float> 158.189308131867
1000 <str> ACAD_MTEXT_DEFINED_HEIGHT_END

```

The linked column MTEXT #1B6:

```

0 <ctrl> MTEXT
... <snip>
100 <ctrl> AcDbMText
10 <point> (-71.214579865783, 276.101821192053, 0.0)
40 <float> 2.5
41 <float> 175.0    <<< invalid column width
... <snip>
1001 <ctrl> ACAD

```

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```

1000 <str> ACAD_MTEXT_DEFINED_HEIGHT_BEGIN
1070 <int> 46      <<< defined column height
1040 <float> 158.189308131867
1000 <str> ACAD_MTEXT_DEFINED_HEIGHT_END

```

The linked column MTEXT #1B7:

```

0 <ctrl> MTEXT
...
100 <ctrl> AcDbMText
10 <point> (-8.714579865783, 276.101821192053, 0.0)
40 <float> 2.5
41 <float> 175.0    <<< invalid column width
...
1001 <ctrl> ACAD
1000 <str> ACAD_MTEXT_DEFINED_HEIGHT_BEGIN
1070 <int> 46      <<< defined column height
1040 <float> 158.189308131867
1000 <str> ACAD_MTEXT_DEFINED_HEIGHT_END

```

## Dynamic (auto height) Columns R2018

```

0 <ctrl> MTEXT
5 <hex> #A2          <<< entity handle
102 <ctrl> {ACAD_XDICTIONARY
360 <hex> #A3
102 <ctrl> }
330 <hex> #1F          <<< block record handle of owner layout
100 <ctrl> AcDbEntity
8 <str> 0            <<< layer
100 <ctrl> AcDbMText
10 <point> (-133.714579865783, 276.101821192053, 0.0)  <<< insert location in WCS
40 <float> 2.5        <<< character height in drawing units
41 <float> 62.694536423841   <<< reference column width, if not in column mode
46 <float> 158.189308131867  <<< defined column height
71 <int> 1            <<< attachment point
72 <int> 1            <<< text flow direction
3 <str> Lorem ipsum dolor sit amet, consetetur sadipscing elitr, sed diam...
... <snip> text content of all three columns
73 <int> 1            <<< line spacing style
44 <float> 1.0         <<< line spacing factor
101 <ctrl> Embedded Object
70 <int> 1, b00000001  <<< ???
10 <point> (1.0, 0.0, 0.0)  <<< text direction vector (local x-axis)
11 <point> (-133.714579865783, 276.101821192053, 0.0)  <<< repeated insert location
40 <float> 62.694536423841  <<< repeated reference column width
41 <float> 158.189308131867  <<< repeated defined column height
42 <float> 175.0        <<< extents (total) width
43 <float> 158.189308131867  <<< extents (total) height, max. height if different
→column heights
71 <int> 2            <<< column type: 2=dynamic columns
72 <int> 0            <<< column height count
44 <float> 50.0        <<< column width
45 <float> 12.5        <<< column gutter width

```

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```
73 <int> 1           <<< flag column auto height
74 <int> 0           <<< flag reversed column flow
1001 <ctrl> AcadAnnotative
1000 <str> AnnotativeData
1002 <str> {
1070 <int> 1
1070 <int> 0
1002 <str> }
```

## Dynamic (manual height) Columns R2000

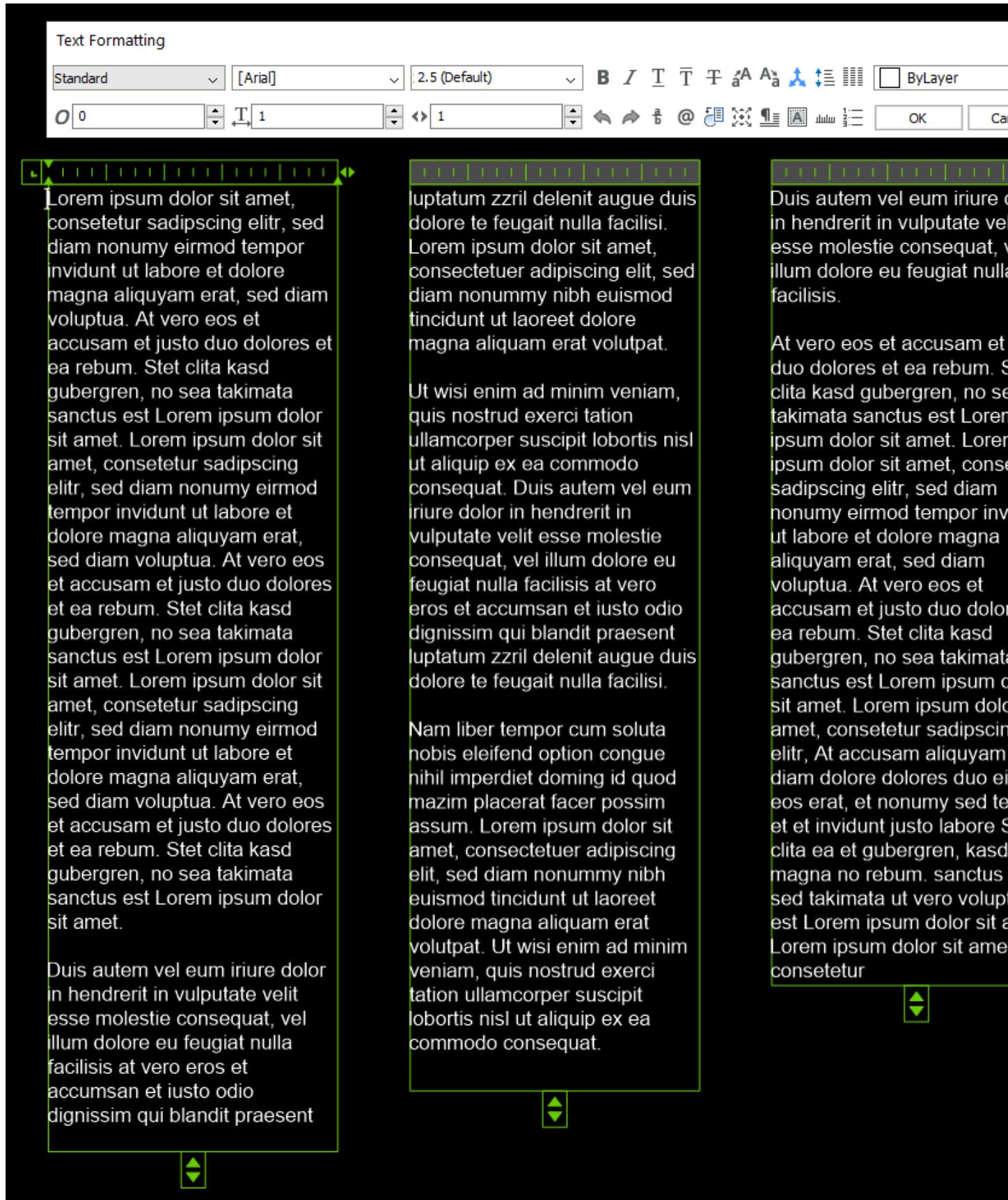
Example for a **dynamic** column specification with manual height definition for three columns with different column heights. None of the (linked) MTEXT entities does contain XDATA for the defined column height.

---

**Hint:** If “content type” is 2 and flag “column auto height” is 0, no defined height in XDATA.

---

- Column Type: Dynamic
- Number of Columns: 3
- Height: 164.802450331126, max. column height
- Width: 50.0
- Gutter Width: 12.5



```

0 <ctrl> MTEXT
5 <hex> #9C                         <<< entity handle
330 <hex> #1F                         <<< block record handle of owner layout
100 <ctrl> AcDbEntity
8 <str> 0                             <<< layer
100 <ctrl> AcDbMText
10 <point> (69.806121185863, 276.101821192053, 0.0)    <<< insert location in WCS
40 <float> 2.5                         <<< character height in drawing units
41 <float> 62.694536423841            <<< reference column width, if not in column mode
71 <int> 1                            <<< attachment point
72 <int> 1                            <<< flag text flow direction
3 <str> Lorem ipsum dolor sit amet, consetetur sadipscing elitr, ...
... <snip>
73 <int> 1                            <<< line spacing style
44 <float> 1.0                         <<< line spacing factor
1001 <ctrl> ACAD
1000 <str> ACAD_MTEXT_COLUMN_INFO_BEGIN
1070 <int> 75                          <<< column type: 2=dynamic columns
1070 <int> 2                           <<< flag column auto height
1070 <int> 79                          <<< column count
1070 <int> 0                           <<< column count
1070 <int> 76                          <<< flag column flow reversed
1070 <int> 0                           <<< column width in column mode
1070 <int> 48                          <<< column gutter width
1040 <float> 50.0
1070 <int> 49                          <<< column height count
1070 <int> 50                          <<< column height 1. column
1070 <int> 3                           <<< column height 2. column
1040 <float> 164.802450331126        <<< column height 3. column, takes the rest?
1040 <float> 154.311699779249
1040 <float> 0.0
1000 <str> ACAD_MTEXT_COLUMN_INFO_END
1000 <str> ACAD_MTEXT_COLUMNS_BEGIN
1070 <int> 47                          <<< column count
1070 <int> 3
1005 <hex> #1B2                         <<< handle to 2. column as MTEXT entity
1005 <hex> #1B3                         <<< handle to 3. column as MTEXT entity
1000 <str> ACAD_MTEXT_COLUMNS_END

```

The linked column MTEXT #1B2:

```

0 <ctrl> MTEXT
... <snip>
100 <ctrl> AcDbMText
10 <point> (132.306121185863, 276.101821192053, 0.0)
40 <float> 2.5                         <<< invalid reference column width
41 <float> 175.0
... <snip>
73 <int> 1
44 <float> 1.0

```

The linked column MTEXT #1B3:

```
0 <ctrl> MTEXT
```

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```

... <snip>
100 <ctrl> AcDbMText
10 <point> (194.806121185863, 276.101821192053, 0.0)
40 <float> 2.5
41 <float> 175.0           <<< invalid reference column width
... <snip>
73 <int> 1
44 <float> 1.0

```

## Dynamic (manual height) Columns R2018

**Hint:** If “content type” is 2 and flag “column auto height” is 0, the “defined column height” is 0.0.

```

0 <ctrl> MTEXT
5 <hex> #9C           <<< entity handle
330 <hex> #1F
100 <ctrl> AcDbEntity
8 <str> 0           <<< block record handle of owner layout
100 <ctrl> AcDbMText
10 <point> (69.806121185863, 276.101821192053, 0.0)    <<< insert location in WCS
40 <float> 2.5           <<< character height in drawing units
41 <float> 62.694536423841      <<< reference column width, if not in column mode
46 <float> 0.0           <<< defined column height
71 <int> 1           <<< attachment point
72 <int> 1           <<< text flow direction
3 <str> Lorem ipsum dolor sit amet, consetetur sadipscing elitr, sed diam...
... <snip> text content of all three columns
73 <int> 1           <<< line spacing style
44 <float> 1.0           <<< line spacing factor
101 <ctrl> Embedded Object
70 <int> 1, b00000001     <<< ???
10 <point> (1.0, 0.0, 0.0)    <<< text direction vector (local x-axis)
11 <point> (69.806121185863, 276.101821192053, 0.0)    <<< repeated insert location
40 <float> 62.694536423841      <<< repeated reference column width
41 <float> 0.0           <<< repeated defined column height
42 <float> 175.0           <<< extents (total) width
43 <float> 164.802450331126      <<< extents (total) height, max. height if different
→column heights
71 <int> 2           <<< column type: 2=dynamic columns
72 <int> 3           <<< column height count
44 <float> 50.0           <<< column width
45 <float> 12.5           <<< column gutter width
73 <int> 0           <<< flag column auto height
74 <int> 0           <<< flag reversed column flow
46 <float> 164.802450331126      <<< column height 1. column
46 <float> 154.311699779249      <<< column height 2. column
46 <float> 0.0           <<< column height 3. column, takes the rest?

```

## No Columns R2000

I have no idea why this column type exist, but at least provides a reliable value for the MTEXT height by the “defined column height” attribute. The column type is not stored in the MTEXT entity and is therefore not detectable!

- Column Type: No columns
- Number of Columns: 1
- Height: 158.189308131867, defined column height
- Width: 175.0, reference column width

```
0 <ctrl> MTEXT
... <snip>
100 <ctrl> AcDbMText
10 <point> (-344.497343455795, 276.101821192053, 0.0)    <<< insert location in WCS
40 <float> 2.5          <<< character height in drawing units
41 <float> 175.0        <<< reference column width
71 <int> 1              <<< attachment point
72 <int> 1              <<< flag text flow direction
3 <str> Lorem ipsum dolor sit amet, consetetur sadipscing elitr, sed diam...
... <snip> text content of all three columns
73 <int> 1              <<< line spacing style
44 <float> 1.0          <<< line spacing factor
... <snip>
1001 <ctrl> ACAD
1000 <str> ACAD_MTEXT_DEFINED_HEIGHT_BEGIN
1070 <int> 46           <<< defined column height
1040 <float> 158.189308131867
1000 <str> ACAD_MTEXT_DEFINED_HEIGHT_END
```

## No Columns R2018

Does not contain an embedded object.

```
0 <ctrl> MTEXT
... <snip>
100 <ctrl> AcDbMText
10 <point> (-334.691900433414, 276.101821192053, 0.0)    <<< insert location in WCS
40 <float> 2.5          <<< character height in drawing units
41 <float> 175.0        <<< reference column width
46 <float> 158.189308131867    <<< defined column height
71 <int> 1              <<< attachment point
72 <int> 1              <<< flag text flow direction
3 <str> Lorem ipsum dolor sit amet, consetetur sadipscing elitr, ...
... <snip>
73 <int> 1              <<< line spacing style
44 <float> 1.0          <<< line spacing factor
1001 <ctrl> AcadAnnotative
... <snip>
```

## DXF Objects

TODO

### 6.12.3 Management Structures

## Block Management Structures

A BLOCK is a layout like the modelspace or a paperspace layout, with the similarity that all these layouts are containers for graphical DXF entities. This block definition can be referenced in other layouts by the INSERT entity. By using block references, the same set of graphical entities can be located multiple times at different layouts, this block references can be stretched and rotated without modifying the original entities. A block is referenced only by its name defined by the DXF tag (2, name), there is a second DXF tag (3, name2) for the block name, which is not further documented by Autodesk, just ignore it.

The (10, base\_point) tag (in BLOCK defines a insertion point of the block, by ‘inserting’ a block by the INSERT entity, this point of the block is placed at the location defined by the (10, insert) tag in the INSERT entity, and it is also the base point for stretching and rotation.

A block definition can contain INSERT entities, and it is possible to create cyclic block definitions (a BLOCK contains a INSERT of itself), but this should be avoided, CAD applications will not load the DXF file at all or maybe just crash. This is also the case for all other kinds of cyclic definitions like: BLOCK “A” -> INSERT BLOCK “B” and BLOCK “B” -> INSERT BLOCK “A”.

### See also:

- ezdxf DXF Internals: [BLOCKS Section](#)
- DXF Reference: [BLOCKS Section](#)
- DXF Reference: [BLOCK Entity](#)
- DXF Reference: [ENDBLK Entity](#)
- DXF Reference: [INSERT Entity](#)

## Block Names

Block names has to be unique and they are case insensitive (“Test” == “TEST”). If there are two or more block definitions with the same name, AutoCAD merges these blocks into a single block with unpredictable properties of all these blocks. In my test with two blocks, the final block has the name of the first block and the base-point of the second block, and contains all entities of both blocks.

## Block Definitions in DXF R12

In DXF R12 the definition of a block is located in the BLOCKS section, no additional structures are needed. The definition starts with a BLOCK entity and ends with a ENDBLK entity. All entities between this two entities are the content of the block, the block is the owner of this entities like any layout.

As shown in the DXF file below (created by AutoCAD LT 2018), the BLOCK entity has no handle, but ezdxf writes also handles for the BLOCK entity and AutoCAD doesn’t complain.

DXF R12 BLOCKS structure:

```

0      <<< start of a SECTION
SECTION
2      <<< start of BLOCKS section
BLOCKS
...
...      <<< modelspace and paperspace block definitions not shown,
...      <<< see layout management
...
0      <<< start of a BLOCK definition
BLOCK

```

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```

8      <<< layer
0
2      <<< block name
ArchTick
70     <<< flags
1
10     <<< base point, x
0.0
20     <<< base point, y
0.0
30     <<< base point, z
0.0
3      <<< second BLOCK name, same as (2, name)
ArchTick
1      <<< xref name, if block is an external reference
        <<< empty string!
0      <<< start of the first entity of the BLOCK
LINE
5
28E
8
0
62
0
10
500.0
20
500.0
30
0.0
11
500.0
21
511.0
31
0.0
0      <<< start of the second entity of the BLOCK
LINE
...
0.0
0      <<< ENDBLK entity, marks the end of the BLOCK definition
ENDBLK
5      <<< ENDBLK gets a handle by AutoCAD, but BLOCK didn't
2F2
8      <<< as every entity, also ENDBLK requires a layer (same as BLOCK entity!)
0
0      <<< start of next BLOCK entity
BLOCK
...
0      <<< end BLOCK entity
ENDBLK
0      <<< end of BLOCKS section
ENDSEC

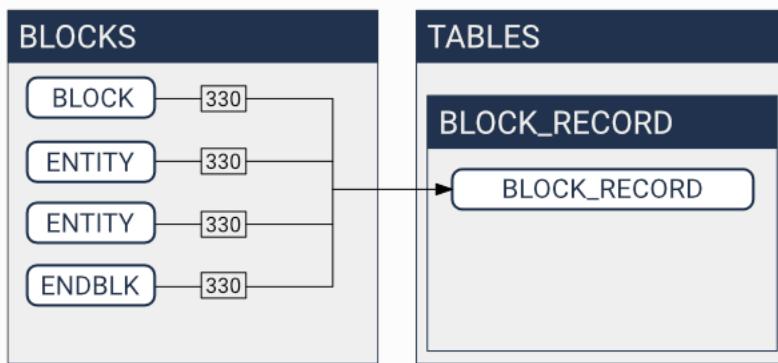
```

## Block Definitions in DXF R2000+

The overall organization in the BLOCKS sections remains the same, but additional tags in the BLOCK entity, have to be maintained.

Especially the concept of ownership is important. Since DXF R13 every graphic entity is associated to a specific layout and a BLOCK definition is also a layout. So all entities in the BLOCK definition, including the BLOCK and the ENDBLK entities, have an owner tag (330, ...), which points to a BLOCK\_RECORD entry in the BLOCK\_RECORD table. This BLOCK\_RECORD is the main management structure for all layouts and is the real owner of the layout entities.

As you can see in the chapter about [Layout Management Structures](#), this concept is also valid for modelspace and paperspace layouts, because these layouts are also BLOCKS, with the special difference, that the entities of the modelspace and the *active* paperspace layout are stored in the ENTITIES section.



### See also:

- [DXF R13 and later tag structure](#)
- ezdxf DXF Internals: [TABLES Section](#)
- DXF Reference: [TABLES Section](#)
- DXF Reference: [BLOCK\\_RECORD Entity](#)

DXF R13 BLOCKS structure:

```

0           <<< start of a SECTION
SECTION
2           <<< start of BLOCKS section
BLOCKS
...
...         <<< modelspace and paperspace block definitions not shown,
...         <<< see layout management
0           <<< start of BLOCK definition
BLOCK
5           <<< even BLOCK gets a handle now ;)
23A
330         <<< owner tag, the owner of a BLOCK is a BLOCK_RECORD in the
...         BLOCK_RECORD table
238
100        <<< subclass marker
AcDbEntity
8           <<< layer of the BLOCK definition
0
100        <<< subclass marker

```

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```

AcDbBlockBegin
2           <<< BLOCK name
ArchTick
70          <<< flags
0
10         <<< base point, x
0.0
20         <<< base point, y
0.0
30         <<< base point, z
0.0
3           <<< second BLOCK name, same as (2, name)
ArchTick
1           <<< xref name, if block is an external reference
                  <<< empty string!
0           <<< start of the first entity of the BLOCK
LWPOLYLINE
5
239
330          <<< owner tag of LWPOLYLINE
238          <<< handle of the BLOCK_RECORD!
100
AcDbEntity
8
0
6
ByBlock
62
0
100
AcDbPolyline
90
2
70
0
43
0.15
10
-0.5
20
-0.5
10
0.5
20
0.5
0           <<< ENDBLK entity, marks the end of the BLOCK definition
ENDBLK
5           <<< handle
23B
330          <<< owner tag, same BLOCK_RECORD as for the BLOCK entity
238
100          <<< subclass marker
AcDbEntity
8           <<< ENDBLK requires the same layer as the BLOCK entity!
0
100          <<< subclass marker
AcDbBlockEnd

```

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```

0           <<< start of the next BLOCK
BLOCK
...
0
ENDBLK
...
0           <<< end of the BLOCKS section
ENDSEC

```

DXF R13 BLOCK\_RECORD structure:

```

0           <<< start of a SECTION
SECTION
2           <<< start of TABLES section
TABLES
0           <<< start of a TABLE
TABLE
2           <<< start of the BLOCK_RECORD table
BLOCK_RECORD
5           <<< handle of the table
1
330          <<< owner tag of the table
0           <<< is always #0
100          <<< subclass marker
AcDbSymbolTable
70          <<< count of table entries, not reliable
4
0           <<< start of first BLOCK_RECORD entry
BLOCK_RECORD
5           <<< handle of BLOCK_RECORD, in ezdxf often referred to as "layout key"
1F
330          <<< owner of the BLOCK_RECORD is the BLOCK_RECORD table
1
100          <<< subclass marker
AcDbSymbolTableRecord
100          <<< subclass marker
AcDbBlockTableRecord
2           <<< name of the BLOCK or LAYOUT
*Model_Space
340          <<< pointer to the associated LAYOUT object
4AF
70           <<< AC1021 (R2007) block insertion units
0
280          <<< AC1021 (R2007) block explodability
1
281          <<< AC1021 (R2007) block scalability
0

...           <<< paperspace not shown
...
0           <<< next BLOCK_RECORD
BLOCK_RECORD
5           <<< handle of BLOCK_RECORD, in ezdxf often referred to as "layout key"
238
330          <<< owner of the BLOCK_RECORD is the BLOCK_RECORD table
1
100          <<< subclass marker

```

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```

AcDbSymbolTableRecord
100      <<< subclass marker
AcDbBlockTableRecord
2      <<< name of the BLOCK
ArchTick
340      <<< pointer to the associated LAYOUT object
0      <<< #0, because BLOCK doesn't have an associated LAYOUT object
70      <<< AC1021 (R2007) block insertion units
0
280      <<< AC1021 (R2007) block explodability
1
281      <<< AC1021 (R2007) block scalability
0
0      <<< end of BLOCK_RECORD table
ENDTAB
0      <<< next TABLE
TABLE
...
0
ENDTAB
0      <<< end of TABLES section
ENDESC

```

## Layout Management Structures

Layouts are separated entity spaces, there are three different Layout types:

1. modelspace contains the ‘real’ world representation of the drawing subjects in real world units.
2. paperspace layouts are used to create different drawing sheets of the modelspace subjects for printing or PDF export
3. Blocks are reusable sets of graphical entities, inserted/referenced by the INSERT entity.

All layouts have at least a BLOCK definition in the BLOCKS section and since DXF R13 exist the BLOCK\_RECORD table with an entry for every BLOCK in the BLOCKS section.

### See also:

Information about [Block Management Structures](#)

The name of the modelspace BLOCK is “\*Model\_Space” (DXF R12: “\$MODEL\_SPACE”) and the name of the *active* paperspace BLOCK is “\*Paper\_Space” (DXF R12: “\$PAPER\_SPACE”), the entities of these two layouts are stored in the ENTITIES section, DXF R12 supports just one paperspace layout.

DXF R13+ supports multiple paperspace layouts, the *active* layout is still called “\*Paper\_Space”, the additional *inactive* paperspace layouts are named by the scheme “\*Paper\_Space0nnn”, where the first inactive paper space is called “\*Paper\_Space0”, the second “\*Paper\_Space1” and so on. A none consecutive numbering is tolerated by AutoCAD. The content of the inactive paperspace layouts are stored as BLOCK content in the BLOCKS section. These names are just the DXF internal layout names, each layout has an additional layout name which is displayed to the user by the CAD application.

A BLOCK definition and a BLOCK\_RECORD is not enough for a proper layout setup, an LAYOUT entity in the OBJECTS section is also required. All LAYOUT entities are managed by a DICTIONARY entity, which is referenced as “ACAD\_LAYOUT” entity in the root DICTIONARY of the DXF file.

---

**Note:** All floating point values are rounded to 2 decimal places for better readability.

---

## LAYOUT Entity

Since DXF R2000 modelspace and paperspace layouts require the DXF LAYOUT entity.

```

0
LAYOUT
5      <<< handle
59
102     <<< extension dictionary (ignore)
{ACAD_XDICTIONARY
360
1C3
102
}
102     <<< reactor (required?)
{ACAD.REACTORS
330
1A     <<< pointer to "ACAD_LAYOUT" DICTIONARY (layout management table)
102
}
330     <<< owner handle
1A     <<< pointer to "ACAD_LAYOUT" DICTIONARY (same as reactor pointer)
100     <<< PLOTSETTINGS
AcDbPlotSettings
1     <<< page setup name

2     <<< name of system printer or plot configuration file
none_device
4     <<< paper size, part in braces should follow the schema
...    (width_x_height_unit) unit is 'Inches' or 'MM'
...    Letter\_(8.50_x_11.00_Inches) the part in front of the braces is
...    ignored by AutoCAD
6     <<< plot view name

40    <<< size of unprintable margin on left side of paper in millimeters,
...    defines also the plot origin-x
6.35
41    <<< size of unprintable margin on bottom of paper in millimeters,
...    defines also the plot origin-y
6.35
42    <<< size of unprintable margin on right side of paper in millimeters
6.35
43    <<< size of unprintable margin on top of paper in millimeters
6.35
44    <<< plot paper size: physical paper width in millimeters
215.90
45    <<< plot paper size: physical paper height in millimeters
279.40
46    <<< X value of plot origin offset in millimeters, moves the plot origin-x
0.0
47    <<< Y value of plot origin offset in millimeters, moves the plot origin-y
0.0

```

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```

48      <<< plot window area: X value of lower-left window corner
0.0
49      <<< plot window area: Y value of lower-left window corner
0.0
140     <<< plot window area: X value of upper-right window corner
0.0
141     <<< plot window area: Y value of upper-right window corner
0.0
142     <<< numerator of custom print scale: real world (paper) units, 1.0
...
for scale 1:50
1.0
143     <<< denominator of custom print scale: drawing units, 50.0
...
for scale 1:50
1.0
70      <<< plot layout flags, bit-coded (... too many options)
688     <<< b1010110000 = UseStandardScale(16)/PlotPlotStyle(32)
...
PrintLineweights(128)/DrawViewportsFirst(512)
72      <<< plot paper units (0/1/2 for inches/millimeters/pixels), are
...
pixels really supported?
0
73      <<< plot rotation (0/1/2/3 for 0deg/90deg counter-cw/upside-down/90deg cw)
1      <<< 90deg clockwise
74      <<< plot type 0-5 (... too many options)
5      <<< 5 = layout information
7      <<< current plot style name, e.g. 'acad.ctb' or 'acadlt.ctb'

75      <<< standard scale type 0-31 (... too many options)
16     <<< 16 = 1:1, also 16 if user scale type is used
147     <<< unit conversion factor
1.0     <<< for plot paper units in mm, else 0.03937... (1/25.4) for inches
...
as plot paper units
76     <<< shade plot mode (0/1/2/3 for as displayed/wireframe/hidden/rendered)
0      <<< as displayed
77     <<< shade plot resolution level 1-5 (... too many options)
2      <<< normal
78     <<< shade plot custom DPI: 100-32767, Only applied when shade plot
...
resolution level is set to 5 (Custom)
300
148     <<< paper image origin: X value
0.0
149     <<< paper image origin: Y value
0.0
100    <<< LAYOUT settings
AcDbLayout
1      <<< layout name
Layout1
70      <<< flags bit-coded
1      <<< 1 = Indicates the PSLTSCALE value for this layout when this
...
layout is current
71      <<< Tab order ("Model" tab always appears as the first tab
...
regardless of its tab order)
1
10     <<< minimum limits for this layout (defined by LIMMIN while this
...
layout is current)
-0.25   <<< x value, distance of the left paper margin from the plot
...
origin-x, in plot paper units and by scale (e.g. x50 for 1:50)
20     <<< group code for y value

```

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```

-0.25 <<<      y value, distance of the bottom paper margin from the plot
...
11   <<< maximum limits for this layout (defined by LIMMAX while this
...
layout is current)
10.75 <<<      x value, distance of the right paper margin from the plot
...
21   <<<      group code for y value
8.25  <<<      y value, distance of the top paper margin from the plot
...
12   <<< insertion base point for this layout (defined by INSBASE while
...
this layout is current)
0.0    <<<      x value
22    <<<      group code for y value
0.0    <<<      y value
32    <<<      group code for z value
0.0    <<<      z value
14    <<< minimum extents for this layout (defined by EXTMIN while this
...
layout is current), AutoCAD default is (1e20, 1e20, 1e20)
1.05  <<<      x value
24    <<<      group code for y value
0.80  <<<      y value
34    <<<      group code for z value
0.0    <<<      z value
15    <<< maximum extents for this layout (defined by EXTMAX while this
...
layout is current), AutoCAD default is (-1e20, -1e20, -1e20)
9.45  <<<      x value
25    <<<      group code for y value
7.20  <<<      y value
35    <<<      group code for z value
0.0    <<<      z value
146   <<< elevation ???
0.0
13    <<< UCS origin (3D Point)
0.0    <<<      x value
23    <<<      group code for y value
0.0    <<<      y value
33    <<<      group code for z value
0.0    <<<      z value
16    <<< UCS X-axis (3D vector)
1.0    <<<      x value
26    <<<      group code for y value
0.0    <<<      y value
36    <<<      group code for z value
0.0    <<<      z value
17    <<< UCS Y-axis (3D vector)
0.0    <<<      x value
27    <<<      group code for y value
1.0    <<<      y value
37    <<<      group code for z value
0.0    <<<      z value
76    <<< orthographic type of UCS 0-6 (... too many options)
0     <<< 0 = UCS is not orthographic ???
330   <<< ID/handle of required block table record
58
331   <<< ID/handle to the viewport that was last active in this layout
...
when the layout was current
1B9

```

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```
1001    <<< extended data (ignore)
...

```

And as it seems this is also not enough for a well defined LAYOUT, at least a “main” VIEWPORT entity with ID=1 is required for paperspace layouts, located in the entity space of the layout.

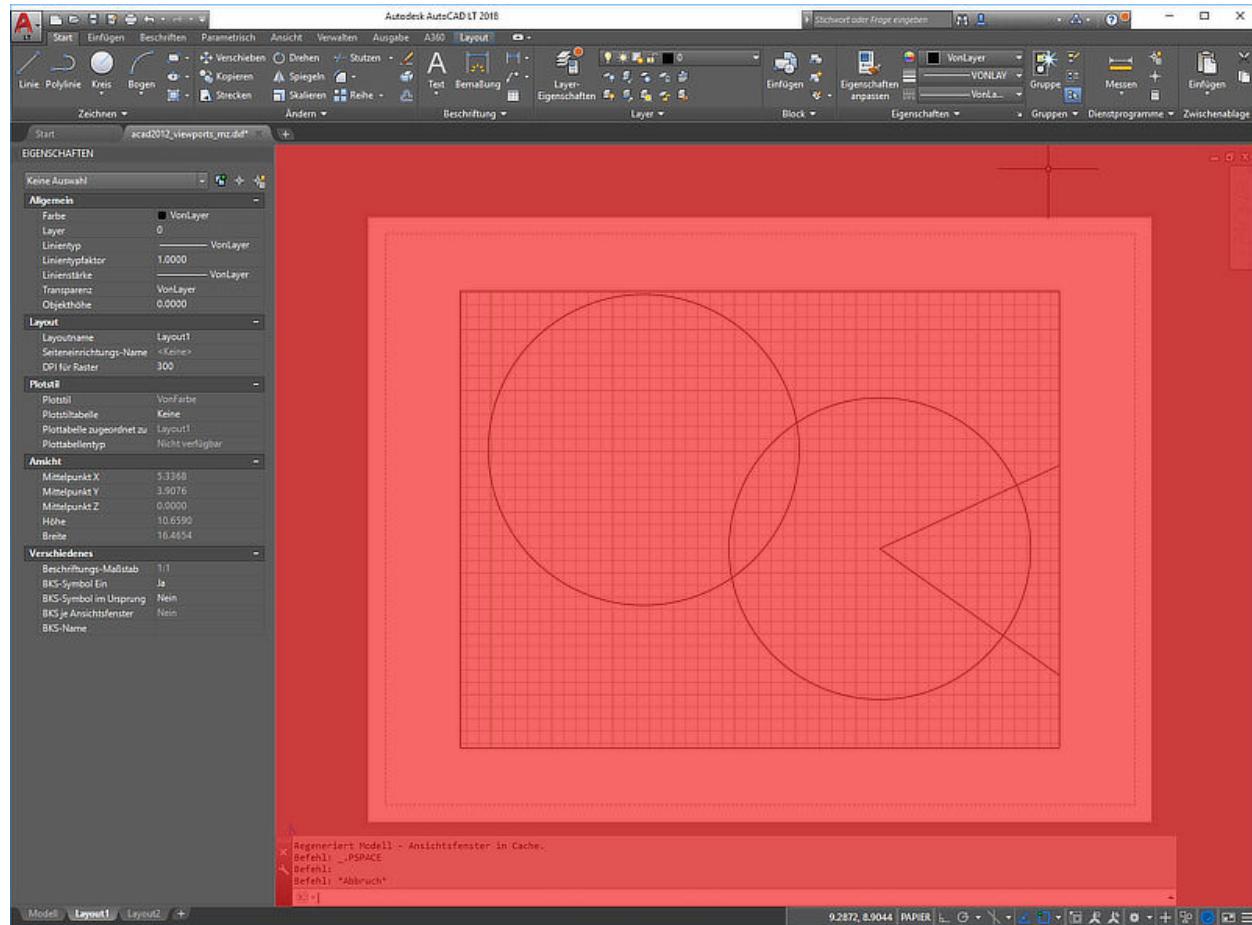
The modelspace layout requires (?) a VPORT entity in the VPORT table (group code 331 in the AcDbLayout subclass).

## Main VIEWPORT Entity for LAYOUT

The “main” viewport for layout “Layout1” shown above. This viewport is located in the associated BLOCK definition called “\*Paper\_Space0”. Group code 330 in subclass AcDbLayout points to the BLOCK\_RECORD of “\*Paper\_Space0”.

Remember: the entities of the *active* paperspace layout are located in the ENTITIES section, therefore “Layout1” is not the active paperspace layout.

The “main” VIEWPORT describes, how the application shows the paperspace layout on the screen, and I guess only AutoCAD needs this values.



```
0
VIEWPORT
5      <<< handle

```

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```

1B4
102      <<< extension dictionary (ignore)
{ACAD_XDICTIONARY
360
1B5
102
}
330      <<< owner handle
58       <<< points to BLOCK_RECORD (same as group code 330 in AcDbLayout of
...     "Layout1")
100
AcDbEntity
67       <<< paperspace flag
1       <<< 0 = modelspace; 1 = paperspace
8       <<< layer,
0
100
AcDbViewport
10      <<< Center point (in WCS)
5.25    <<<     x value
20      <<<     group code for y value
4.00    <<<     y value
30      <<<     group code for z value
0.0    <<<     z value
40      <<< width in paperspace units
23.55   <<< VIEW size in AutoCAD, depends on the workstation configuration
41      <<< height in paperspace units
9.00    <<< VIEW size in AutoCAD, depends on the workstation configuration
68      <<< viewport status field -1/0/n
2       <<< >0 On and active. The value indicates the order of stacking for
...     the viewports, where 1 is the active viewport, 2 is the next, and so forth
69      <<< viewport ID
1       <<< "main" viewport has always ID=1
12      <<< view center point in Drawing Coordinate System (DCS), defines
...     the center point of the VIEW in relation to the LAYOUT origin
5.25    <<<     x value
22      <<<     group code for y value
4.00    <<<     y value
13      <<< snap base point in modelspace
0.0    <<<     x value
23      <<<     group code for y value
0.0    <<<     y value
14      <<< snap spacing in modelspace units
0.5    <<<     x value
24      <<<     group code for y value
0.5    <<<     y value
15      <<< grid spacing in modelspace units
0.5    <<<     x value
25      <<<     group code for y value
0.5    <<<     y value
16      <<< view direction vector from target (in WCS)
0.0    <<<     x value
26      <<<     group code for y value
0.0    <<<     y value
36      <<<     group code for z value
1.0    <<<     z value
17      <<< view target point

```

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```

0.0      <<<     x value
27       <<<     group code for y value
0.0      <<<     y value
37       <<<     group code for z value
0.0      <<<     z value
42       <<<     perspective lens length, focal length?
50.0     <<<     50mm
43       <<<     front clip plane z value
0.0      <<<     z value
44       <<<     back clip plane z value
0.0      <<<     z value
45       <<<     view height (in modelspace units)
9.00
50       <<<     snap angle
0.0
51       <<<     view twist angle
0.0
72       <<<     circle zoom percent
1000
90       <<<     Viewport status bit-coded flags (... too many options)
819232  <<<     b11001000000000100000
1        <<<     plot style sheet name assigned to this viewport

281      <<<     render mode (... too many options)
0        <<<     0 = 2D optimized (classic 2D)
71       <<<     UCS per viewport flag
1        <<<     1 = This viewport stores its own UCS which will become the
...      current UCS whenever the viewport is activated
74       <<<     Display UCS icon at UCS origin flag
0        <<<     this field is currently being ignored and the icon always
...      represents the viewport UCS
110      <<<     UCS origin (3D point)
0.0      <<<     x value
120      <<<     group code for y value
0.0      <<<     y value
130      <<<     group code for z value
0.0      <<<     z value
111      <<<     UCS X-axis (3D vector)
1.0      <<<     x value
121      <<<     group code for y value
0.0      <<<     y value
131      <<<     group code for z value
0.0      <<<     z value
112      <<<     UCS Y-axis (3D vector)
0.0      <<<     x value
122      <<<     group code for y value
1.0      <<<     y value
132      <<<     group code for z value
0.0      <<<     z value
79       <<<     Orthographic type of UCS (... too many options)
0        <<<     0 = UCS is not orthographic
146      <<<     elevation
0.0
170      <<<     shade plot mode (0/1/2/3 for as displayed/wireframe/hidden/rendered)
0        <<<     as displayed
61       <<<     frequency of major grid lines compared to minor grid lines
5        <<<     major grid subdivided by 5

```

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```

348      <<< visual style ID/handle (optional)
9F
292      <<< default lighting flag, on when no user lights are specified.
1
282      <<< Default lighting type (0/1 = one distant light/two distant lights)
1      <<< one distant light
141      <<< view brightness
0.0
142      <<< view contrast
0.0
63       <<< ambient light color (ACI), write only if not black color
250
421      <<< ambient light color (RGB), write only if not black color
3355443

```

## 6.13 Developer Guides

Information about *ezdxf* internals.

### 6.13.1 Source Code Formatting

Reformat code by [Black](#) for a column width of 80:

```
C:\> black -l 80 <python-file>
```

Reformatting the *ezdxf* code base is an ongoing process, add reformatted code in a separate commit without changing the runtime logic.

### 6.13.2 Type Annotations

The use of type annotations is encouraged. New modules should pass [mypy](#) without errors in non-strict mode. Using `# type: ignore` is fine in tricky situations - type annotations should be helpful in understanding the code and not be a burden.

The following global options are required to pass [mypy](#) without error messages:

```
[mypy]
python_version = 3.7
ignore_missing_imports = True
```

Read [this](#) to learn where [mypy](#) searches for config files.

Use the [mypy](#) command line option `--ignore-missing-imports` and `-p` to check the whole package from any location in the file system:

```
PS D:\Source\ezdxf.git> mypy --ignore-missing-imports -p ezdxf
Success: no issues found in 255 source files
```

### 6.13.3 Design

The [Package Design for Developers](#) section shows the structure of the `ezdxf` package for developers with more experience, which want to have more insight into the package and maybe want to develop add-ons or want contribute to the `ezdxf` package.

!!! UNDER CONSTRUCTION !!!

#### Package Design for Developers

A DXF document is divided into several sections, these sections are managed by the `Drawing` object. For each section exist a corresponding attribute in the `Drawing` object:

Section	Attribute
HEADER	<code>Drawing.header</code>
CLASSES	<code>Drawing.classes</code>
TABLES	<code>Drawing.tables</code>
BLOCKS	<code>Drawing.blocks</code>
ENTITIES	<code>Drawing.entities</code>
OBJECTS	<code>Drawing.objects</code>

Resource entities (LAYER, STYLE, LTYPE, ...) are stored in tables in the TABLES section. A table owns the table entries, the owner handle of table entry is the handle of the table. Each table has a shortcut in the `Drawing` object:

Table	Attribute
APPID	<code>Drawing.appids</code>
BLOCK_RECORD	<code>Drawing.block_records</code>
DIMSTYLE	<code>Drawing.dimstyles</code>
LAYER	<code>Drawing.layers</code>
LTYPE	<code>Drawing.linetypes</code>
STYLE	<code>Drawing.styles</code>
UCS	<code>Drawing.ucs</code>
VIEW	<code>Drawing.views</code>
VPORT	<code>Drawing.viewports</code>

Graphical entities are stored in layouts: [Modelspace](#), [Paperspace](#) layouts and [BlockLayout](#). The core management object of these layouts is the `BLOCK_RECORD` entity (`BlockRecord`), the `BLOCK_RECORD` is the real owner of the entities, the owner handle of the entities is the handle of the `BLOCK_RECORD` and the `BLOCK_RECORD` also owns and manages the entity space of the layout which contains all entities of the layout.

For more information about layouts see also: [Layout Management Structures](#)

For more information about blocks see also: [Block Management Structures](#)

Non-graphical entities (objects) are stored in the OBJECTS section. Every object has a parent object in the OBJECTS section, most likely a DICTIONARY object, and is stored in the entity space of the OBJECTS section.

For more information about the OBJECTS section see also: [OBJECTS Section](#)

All table entries, DXF entities and DXF objects are stored in the entities database accessible as `Drawing.entitydb`. The entity database is a simple key, value storage, key is the entity handle, value is the DXF object.

For more information about the DXF data model see also: [Data Model](#)

## Terminology

### States

DXF entities and objects can have different states:

**UNBOUND** Entity is not stored in the Drawing entity database and DXF attribute handle is None and attribute doc can be None

**BOUND** Entity is stored in the Drawing entity database, attribute doc has a reference to Drawing and DXF attribute handle is not None

**UNLINKED** Entity is not linked to a layout/owner, DXF attribute owner is None

**LINKED** Entity is linked to a layout/owner, DXF attribute owner is not None

**Virtual Entity** State: UNBOUND & UNLINKED

**Unlinked Entity** State: BOUND & UNLINKED

**Bound Entity** State: BOUND & LINKED

### Actions

**NEW** Create a new DXF document

**LOAD** Load a DXF document from an external source

**CREATE** Create DXF structures from NEW or LOAD data

**DESTROY** Delete DXF structures

**BIND** Bind an entity to a Drawing, set entity state to BOUND & UNLINKED and check or create required resources

**UNBIND** unbind ...

**LINK** Link an entity to an owner/layout. This makes an entity to a real DXF entity, which will be exported at the saving process. Any DXF entity can only be linked to **one** parent entity like DICTIONARY or BLOCK\_RECORD.

**UNLINK** unlink ...

## Loading a DXF Document

Loading a DXF document from an external source, creates a new Drawing object. This loading process has two stages:

### First Loading Stage

- LOAD content from external source as SectionDict: `loader.load_dxf_structure()`
- LOAD tag structures as DXFEntity objects: `loader.load_dxf_entities()`
- BIND entities: `loader.load_and_bind_dxf_content()`; Special handling of the BIND process, because the Drawing is not full initialized, a complete validation is not possible at this stage.

## Second Loading Stage

Parse SectionDict:

- CREATE sections: HEADER, CLASSES, TABLES, BLOCKS and OBJECTS
- CREATE layouts: Blocks, Layouts
- LINK entities to a owner/layout

The ENTITIES section is a relict from older DXF versions and has to be exported including the modelspace and active paperspace entities, but all entities reside in a BLOCK definition, even modelspace and paperspace layouts are only BLOCK definitions and ezdxf has no explicit ENTITIES section.

Source Code: as developer start your journey at `ezdxf.document.Drawing.read()`, which has no public documentation, because package-user should use `ezdxf.read()` and `ezdxf.readfile()`.

## New DXF Document

### Creating New DXF Entities

The default constructor of each entity type creates a new virtual entity:

- DXF attribute *owner* is None
- DXF attribute *handle* is None
- Attribute *doc* is None

The `DXFEntity.new()` constructor creates entities with given *owner*, *handle* and *doc* attributes, if *doc* is not None and entity is not already bound to a document, the `new()` constructor automatically bind the entity to the given document *doc*.

There exist only two scenarios:

1. UNBOUND: *doc* is None and *handle* is None
2. BOUND: *doc* is not None and *handle* is not None

## Factory functions

- `new()`, create a new virtual DXF object/entity
- `load()`, load (create) virtual DXF object/entity from DXF tags
- `bind()`, bind an entity to a document, create required resources if necessary (e.g. ImageDefReactor, SEQEND) and raise exceptions for non-existing resources.
  - Bind entity loaded from an external source to a document, all referenced resources must exist, but try to repair as many flaws as possible because errors were created by another application and are not the responsibility of the package-user.
  - Bind an entity from another DXF document, all invalid resources will be removed silently or created (e.g. SEQEND). This is a simple import from another document without resource import, for a more advanced import including resources exist the `importer` add-on.
  - Bootstrap problem for binding loaded table entries and objects in the OBJECTS section! Can't use `Auditor` to repair this objects, because the DXF document is not fully initialized.
- `is_bound()` returns True if *entity* is bound to document *doc*

- `unbind()` function to remove an entity from a document and set state to a virtual entity, which should also *UNLINK* the entity from layout, because an layout can not store a virtual entity.
- `cls()`, returns the class
- `register_entity()`, registration decorator
- `replace_entity()`, registration decorator

## Class Interfaces

### DXF Entities

- NEW constructor to create an entity from scratch
- LOAD constructor to create an entity loaded from an external source
- DESTROY interface to kill an entity, set entity state to *dead*, which means `entity.is_alive` returns False. All entity iterators like `EntitySpace`, `EntityQuery`, and `EntityDB` must filter (ignore) *dead* entities. Calling `DXFEntity.destroy()` is a regular way to delete entities.
- LINK an entity to a layout by `BlockRecord.link()`, which set the *owner* handle to `BLOCK_RECORD` handle (= layout key) and add the entity to the entity space of the `BLOCK_RECORD` and set/clear the `perspace` flag.

### DXF Objects

- NEW, LOAD, DESTROY see DXF entities
- LINK: Linking an DXF object means adding the entity to a parent object in the OBJECTS section, most likely a DICTIONARY object, and adding the object to the entity space of the OBJECTS section, the root-dict is the only entity in the OBJECTS section which has an invalid owner handle “0”. Any other object with an invalid or destroyed owner is an orphaned entity. The audit process destroys and removes orphaned objects.
- Extension dictionaries (ACAD\_XDICTIONARY) are DICTIONARY objects located in the OBJECTS sections and can reference/own other entities of the OBJECTS section.
- The root-dictionary is the only entity in the OBJECTS section which has an invalid owner handle “0”. Any other object with an invalid or destroyed owner is an orphaned entity.

### Layouts

- LINK interface to link an entity to a layout
- UNLINK interface to remove an entity from a layout

### Database

- BIND interface to add an entity to the database of a document
- `delete_entity()` interface, same as UNBIND and DESTROY an entity

## 6.13.4 Internal Data Structures

### Entity Database

The `EntityDB` is a simple key/value database to store `DXFEntity` objects by its handle, every `Drawing` has its own `EntityDB`, stored in the Drawing attribute `entitydb`.

Every DXF entity/object, except tables and sections, are represented as `DXFEntity` or inherited types, this entities are stored in the `EntityDB`, database-key is the `dxf.handle` as plain hex string.

All iterators like `keys()`, `values()`, `items()` and `__iter__()` do not yield destroyed entities.

**Warning:** The `get()` method and the index operator `[ ]`, return destroyed entities and entities from the trashcan.

```
class ezdxf.entitydb.EntityDB

    __getitem__(handle: str) → DXFEntity
        Get entity by handle, does not filter destroyed entities nor entities in the trashcan.

    __setitem__(handle: str, entity: DXFEntity) → None
        Set entity for handle.

    __delitem__(handle: str) → None
        Delete entity by handle. Removes entity only from database, does not destroy the entity.

    __contains__(item: Union[str, DXFEntity]) → bool
        True if database contains handle.

    __len__() → int
        Count of database items.

    __iter__() → Iterator[str]
        Iterable of all handles, does filter destroyed entities but not entities in the trashcan.

    get(handle: str) → Optional[DXFEntity]
        Returns entity for handle or None if no entry exist, does not filter destroyed entities.

    next_handle() → str
        Returns next unique handle.

    keys() → Iterable[str]
        Iterable of all handles, does filter destroyed entities.

    values() → Iterable[DXFEntity]
        Iterable of all entities, does filter destroyed entities.

    items() → Iterable[Tuple[str, DXFEntity]]
        Iterable of all (handle, entities) pairs, does filter destroyed entities.

    add(entity: DXFEntity) → None
        Add entity to database, assigns a new handle to the entity if entity.dxf.handle is None. Adding the same entity multiple times is possible and creates only a single database entry.

    new_trashcan() → ezdxf.entitydb.EntityDB.Trashcan
        Returns a new trashcan, empty trashcan manually by: : func:Trashcan.clear().

    trashcan() → ezdxf.entitydb.EntityDB.Trashcan
        Returns a new trashcan in context manager mode, trashcan will be emptied when leaving context.
```

**purge ()** → None

Remove all destroyed entities from database, but does not empty the trashcan.

**query (query: str = '\*')** → ezdxf.query.EntityQuery

Entity query over all entities in the DXF document.

**Parameters** `query` – query string

**See also:**

*Entity Query String* and *Retrieve entities by query language*

## Entity Space

**class ezdxf.entitydb.EntitySpace (entities: Iterable[ezdxf.entities.dxfentity.DXFEntity] = None)**

An `EntitySpace` is a collection of `DXFEntity` objects, that stores only references to `DXFEntity` objects.

The `Modelspace`, any `Paperspace` layout and `BlockLayout` objects have an `EntitySpace` container to store their entities.

**\_\_iter\_\_ ()** → Iterable[DXFEntity]

Iterable of all entities, filters destroyed entities.

**\_\_getitem\_\_ (index)** → DXFEntity

Get entity at index `item`

`EntitySpace` has a standard Python list like interface, therefore `index` can be any valid list indexing or slicing term, like a single index `layout[-1]` to get the last entity, or an index slice `layout[:10]` to get the first 10 or less entities as `List[DXFEntity]`. Does not filter destroyed entities.

**\_\_len\_\_ ()** → int

Count of entities including destroyed entities.

**has\_handle (handle: str)** → bool

True if `handle` is present, does filter destroyed entities.

**purge ()**

Remove all destroyed entities from entity space.

**add (entity: DXFEntity)** → None

Add `entity`.

**extend (entities: Iterable[DXFEntity])** → None

Add multiple `entities`.

**remove (entity: DXFEntity)** → None

Remove `entity`.

**clear ()** → None

Remove all entities.

## DXF Types

Required DXF tag interface:

- property `code`: group code as int
- property `value`: tag value of unspecific type
- `dxfstr ()`: returns the DXF string
- `clone ()`: returns a deep copy of tag

## DXFTag Factory Functions

`ezdxf.lldxf.types.dxftag(code: int, value: Any) → ezdxf.lldxf.types.DXFTag`  
DXF tag factory function.

### Parameters

- **code** – group code
- **value** – tag value

Returns: `DXFTag` or inherited

`ezdxf.lldxf.types.tuples_to_tags(iterable: Iterable[Tuple[int, Any]]) → Iterable[ezdxf.lldxf.types.DXFTag]`

Returns an iterable if `DXFTag` or inherited, accepts an iterable of (code, value) tuples as input.

## DXFTag

**class** `ezdxf.lldxf.types.DXFTag(code: int, value: Any)`

Immutable DXFTag class.

### Parameters

- **code** – group code as int
- **value** – tag value, type depends on group code

#### code

group code as int (do not change)

#### value

tag value (read-only property)

#### `__eq__(other) → bool`

True if `other` and `self` has same content for `code` and `value`.

#### `__getitem__(index: int)`

Returns `code` for index 0 and `value` for index 1, emulates a tuple.

#### `__hash__()`

Hash support, `DXFTag` can be used in sets and as dict key.

#### `__iter__()`

Returns (code, value) tuples.

#### `__repr__() → str`

Returns representation string '`DXFTag(code, value)`'.

#### `__str__() → str`

Returns content string '`(code, value)`'.

#### `clone() → ezdxf.lldxf.types.DXFTag`

Returns a clone of itself, this method is necessary for the more complex (and not immutable) DXF tag types.

#### `dxftag() → str`

Returns the DXF string e.g. '`0\nLINE\n`'

## DXFBinaryTag

```
class ezdxf.lldxftypes.DXFBinaryTag(DXFTag)
    Immutable BinaryTags class - immutable by design, not by implementation.

dxfstr() → str
    Returns the DXF string for all vertex components.

tostring() → str
    Returns binary value as single hex-string.
```

## DXFVertex

```
class ezdxf.lldxftypes.DXFVertex(DXFTag)
    Represents a 2D or 3D vertex, stores only the group code of the x-component of the vertex, because the y-group-code is x-group-code + 10 and z-group-code id x-group-code+20, this is a rule that ALWAYS applies. This tag is immutable by design, not by implementation.
```

### Parameters

- **code** – group code of x-component
- **value** – sequence of x, y and optional z values

```
dxfstr() → str
    Returns the DXF string for all vertex components.

dxftags() → Iterable[ezdxf.lldxftypes.DXFTag]
    Returns all vertex components as single DXFTag objects.
```

## NONE\_TAG

```
ezdxf.lldxftypes.NONE_TAG
    Special tag representing a none existing tag.
```

## Tags

A list of [DXFTag](#), inherits from Python standard list. Unlike the statement in the DXF Reference “Do not write programs that rely on the order given here”, tag order is sometimes essential and some group codes may appear multiples times in one entity. At the worst case (Material: normal map shares group codes with diffuse map) using same group codes with different meanings.

```
class ezdxf.lldxftags.Tags
    Subclass of list.

    Collection of DXFTag as flat list. Low level tag container, only required for advanced stuff.

classmethod from_text(text: str) → Tags
    Constructor from DXF string.

dxftype() → str
    Returns DXF type of entity, e.g. 'LINE'.

get_handle() → str
    Get DXF handle. Raises DXFValueError if handle not exist.

    Returns handle as plain hex string like 'FF00'

    Raises DXFValueError – no handle found
```

**replace\_handle** (*new\_handle: str*) → None  
Replace existing handle.

**Parameters** **new\_handle** – new handle as plain hex string e.g. 'FF00'

**has\_tag** (*code: int*) → bool

Returns True if a *DXFTag* with given group *code* is present.

**Parameters** **code** – group code as int

**has\_embedded\_objects** () → bool

**get\_first\_tag** (*code: int, default=DXFValueError*) → DXFTag

Returns first *DXFTag* with given group code or *default*, if *default* != DXFValueError, else raises DXFValueError.

**Parameters**

- **code** – group code as int
- **default** – return value for default case or raises DXFValueError

**get\_first\_value** (*code: int, default=DXFValueError*) → Any

Returns value of first *DXFTag* with given group code or default if *default* != DXFValueError, else raises DXFValueError.

**Parameters**

- **code** – group code as int
- **default** – return value for default case or raises DXFValueError

**find\_all** (*code: int*) → List[DXFTag]

Returns a list of *DXFTag* with given group code.

**Parameters** **code** – group code as int

**filter** (*codes: Iterable[int]*) → Iterable[DXFTag]

Iterate and filter tags by group *codes*.

**Parameters** **codes** – group codes to filter

**collect\_consecutive\_tags** (*codes: Iterable[int], start: int = 0, end: int = None*) → Tags

Collect all consecutive tags with group code in *codes*, *start* and *end* delimits the search range. A tag code not in *codes* ends the process.

**Parameters**

- **codes** – iterable of group codes
- **start** – start index as int
- **end** – end index as int, None for end index = len (self)

**Returns** collected tags as *Tags*

**tag\_index** (*code: int, start: int = 0, end: int = None*) → int

Return index of first *DXFTag* with given group code.

**Parameters**

- **code** – group code as int
- **start** – start index as int
- **end** – end index as int, None for end index = len (self)

**update**(*tag: DXFTag*)

Update first existing tag with same group code as *tag*, raises `DXFValueError` if tag not exist.

**set\_first**(*tag: DXFTag*)

Update first existing tag with group code *tag.code* or append tag.

**remove\_tags**(*codes: Iterable[int]*) → None

Remove all tags inplace with group codes specified in *codes*.

**Parameters** **codes** – iterable of group codes as int

**remove\_tags\_except**(*codes: Iterable[int]*) → None

Remove all tags inplace except those with group codes specified in *codes*.

**Parameters** **codes** – iterable of group codes

**pop\_tags**(*codes: Iterable[int]*) → Iterable[DXFTag]

Pop tags with group codes specified in *codes*.

**Parameters** **codes** – iterable of group codes

**classmethod strip**(*tags: Tags, codes: Iterable[int]*) → Tags

Constructor from *tags*, strips all tags with group codes in *codes* from tags.

**Parameters**

- **tags** – iterable of `DXFTag`
- **codes** – iterable of group codes as int

ezdxf.lldxf.tags.**group\_tags**(*tags: Iterable[DXFTag], splitcode: int = 0*) → Iterable[Tags]

Group of tags starts with a SplitTag and ends before the next SplitTag. A SplitTag is a tag with code == `splitcode`, like (0, ‘SECTION’) for `splitcode == 0`.

**Parameters**

- **tags** – iterable of `DXFTag`
- **splitcode** – group code of split tag

**class** ezdxf.lldxf.extendedtags.**ExtendedTags**(*tags: Iterable[DXFTag]=None, legacy=False*)

Represents the extended DXF tag structure introduced with DXF R13.

**Args:** *tags*: iterable of `DXFTag` *legacy*: flag for DXF R12 tags

**appdata**

Application defined data as list of Tags

**subclasses**

Subclasses as list of Tags

**xdata**

XDATA as list of Tags

**embedded\_objects**

embedded objects as list of Tags

**noclass**

Short cut to access first subclass.

**get\_handle**() → str

Returns handle as hex string.

**dxftype**() → str

Returns DXF type as string like “LINE”.

**replace\_handle** (*handle: str*) → None  
Replace the existing entity handle by a new value.

**legacy\_repair()**  
Legacy (DXF R12) tags handling and repair.

**clone()** → ExtendedTags  
Shallow copy.

**flatten\_subclasses()**  
Flatten subclasses in legacy mode (DXF R12).

There exists DXF R12 with subclass markers, technical incorrect but works if the reader ignore subclass marker tags, unfortunately ezdxf tries to use this subclass markers and therefore R12 parsing by ezdxf does not work without removing these subclass markers.

This method removes all subclass markers and flattens all subclasses into ExtendedTags.noclass.

**get\_subclass** (*name: str, pos: int = 0*) → Tags  
Get subclass *name*.

#### Parameters

- **name** – subclass name as string like “AcDbEntity”
- **pos** – start searching at subclass *pos*.

**has\_xdata** (*appid: str*) → bool  
True if has XDATA for *appid*.

**get\_xdata** (*appid: str*) → Tags  
Returns XDATA for *appid* as Tags.

**set\_xdata** (*appid: str, tags: IterableTags*) → None  
Set *tags* as XDATA for *appid*.

**new\_xdata** (*appid: str, tags: 'IterableTags' = None*) → Tags  
Append a new XDATA block.

Assumes that no XDATA block with the same *appid* already exist:

```
try:  
    xdata = tags.get_xdata('EZDXF')  
except ValueError:  
    xdata = tags.new_xdata('EZDXF')
```

**has\_app\_data** (*appid: str*) → bool  
True if has application defined data for *appid*.

**get\_app\_data** (*appid: str*) → Tags  
Returns application defined data for *appid* as Tags including marker tags.

**get\_app\_data\_content** (*appid: str*) → Tags  
Returns application defined data for *appid* as Tags without first and last marker tag.

**set\_app\_data\_content** (*appid: str, tags: IterableTags*) → None  
Set application defined data for *appid* for already exiting data.

**new\_app\_data** (*appid: str, tags: 'IterableTags' = None, subclass\_name: str = None*) → Tags  
Append a new application defined data to subclass *subclass\_name*.

Assumes that no app data block with the same *appid* already exist:

```
try:
    app_data = tags.get_app_data('{ACAD_REACTORS}', tags)
except ValueError:
    app_data = tags.new_app_data('{ACAD_REACTORS}', tags)
```

**classmethod from\_text** (*text: str, legacy: bool = False*) → ExtendedTags

Create *ExtendedTags* from DXF text.

## Packed DXF Tags

Store DXF tags in compact data structures as list or array.array to reduce memory usage.

**class** ezdxf.lldxf.packedtags.TagList (*data: Iterable = None*)

Store data in a standard Python list.

**Args:** *data*: iterable of DXF tag values.

**values**

Data storage as list.

**clone** () → TagList

Returns a deep copy.

**classmethod from\_tags** (*tags: Tags, code: int*) → TagList

Setup list from iterable tags.

### Parameters

- **tags** – tag collection as *Tags*
- **code** – group code to collect

**clear** () → None

Delete all data values.

**class** ezdxf.lldxf.packedtags.TagArray (*data: Iterable = None*)

*TagArray* is a subclass of *TagList*, which store data in an array.array. Array type is defined by class variable **DTYPE**.

**Args:** *data*: iterable of DXF tag values.

**DTYPE**

array.array type as string

**values**

Data storage as array.array

**set\_values** (*values: Iterable[T\_co]*) → None

Replace data by *values*.

**class** ezdxf.lldxf.packedtags.VertexArray (*data: Iterable = None*)

Store vertices in an array.array('d'). Vertex size is defined by class variable **VERTEX\_SIZE**.

**Args:** *data*: iterable of vertex values as linear list e.g. [x1, y1, x2, y2, x3, y3, ...].

**VERTEX\_SIZE**

Size of vertex (2 or 3 axis).

**\_\_len\_\_** () → int

Count of vertices.

**\_\_getitem\_\_** (*index: int*)  
Get vertex at *index*, extended slicing supported.

**\_\_setitem\_\_** (*index: int, point: Sequence[float]*) → None  
Set vertex *point* at *index*, extended slicing not supported.

**\_\_delitem\_\_** (*index: int*) → None  
Delete vertex at *index*, extended slicing supported.

**\_\_iter\_\_** () → Iterator[Sequence[float]]  
Returns iterable of vertices.

**\_\_str\_\_** () → str  
String representation.

**insert** (*pos: int, point: Sequence[float]*)  
Insert *point* in front of vertex at index *pos*.

#### Parameters

- **pos** – insert position
- **point** – point as tuple

**append** (*point: Sequence[float]*) → None  
Append *point*.

**extend** (*points: Iterable[Sequence[float]]*) → None  
Extend array by *points*.

**set** (*points: Iterable[Sequence[float]]*) → None  
Replace all vertices by *points*.

**clear** () → None  
Delete all vertices.

**clone** () → VertexArray  
Returns a deep copy.

**classmethod from\_tags** (*tags: Iterable[DXFTag], code: int = 10*) → VertexArray  
Setup point array from iterable tags.

#### Parameters

- **tags** – iterable of *DXFVertex*
- **code** – group code to collect

**export\_dxf** (*tagwriter: ezdxf.lldxf.tagwriter.TagWriter, code=10*)

## XData

**class** ezdxf.entities.xdata.XData  
Internal management class for XDATA.

#### See also:

- XDATA user reference: [Extended Data \(XDATA\)](#)
- Wrapper class to store a list in XDATA: [XDataUserList](#)
- Wrapper class to store a dict in XDATA: [XDataUserDict](#)
- Tutorial: [Storing Custom Data in DXF Files](#)

- DXF Internals: [Extended Data](#)
- [DXF R2018 Reference](#)

**\_\_contains\_\_(appid: str) → bool**

Returns True if DXF tags for *appid* exist.

**add(appid: str, tags: Iterable[Union[Tuple[int, Any], DXFTag]]) → None**

Add a list of DXF tags for *appid*. The *tags* argument is an iterable of (group code, value) tuples, where the group code has to be an integer value. The mandatory XDATA marker (1001, appid) is added automatically if front of the tags if missing.

Each entity can contain only one list of tags for each *appid*. Adding a second list of tags for the same *appid* replaces the existing list of tags.

The valid XDATA group codes are restricted to some specific values in the range from 1000 to 1071, for more information see also the internals about [Extended Data](#).

**get(appid: str) → ezdxf.lldxf.tags.Tags**

Returns the DXF tags as [Tags](#) list stored by *appid*.

**Raises** DXFValueError – no data for *appid* exist

**discard(appid)**

Delete DXF tags for *appid*. None existing appids are silently ignored.

**has\_xlist(appid: str, name: str) → bool**

Returns True if list *name* from XDATA *appid* exists.

#### Parameters

- **appid** – APPID
- **name** – list name

**get\_xlist(appid: str, name: str) → List[Tuple]**

Get list *name* from XDATA *appid*.

#### Parameters

- **appid** – APPID
- **name** – list name

Returns: list of DXFTags including list name and curly braces '{' '}' tags

#### Raises

- DXFKeyError – XDATA *appid* does not exist
- DXFValueError – list *name* does not exist

**set\_xlist(appid: str, name: str, tags: Iterable[T\_co]) → None**

Create new list *name* of XDATA *appid* with *xdata\_tags* and replaces list *name* if already exists.

#### Parameters

- **appid** – APPID
- **name** – list name
- **tags** – list content as DXFTags or (code, value) tuples, list name and curly braces '{' '}' tags will be added

**discard\_xlist(appid: str, name: str) → None**

Deletes list *name* from XDATA *appid*. Ignores silently if XDATA *appid* or list *name* not exist.

**Parameters**

- **appid** – APPID
- **name** – list name

**replace\_xlist** (*appid*: str, *name*: str, *tags*: Iterable[*T\_co*]) → None

Replaces list *name* of existing XDATA *appid* by *tags*. Appends new list if list *name* do not exist, but raises *DXFValueError* if XDATA *appid* do not exist.

Low level interface, if not sure use *set\_xdata\_list()* instead.

**Parameters**

- **appid** – APPID
- **name** – list name
- **tags** – list content as DXFTags or (code, value) tuples, list name and curly braces ‘{’ ‘}’ tags will be added

**Raises** *DXFValueError* – XDATA *appid* do not exist

**transform** (*m*: Matrix44) → None

Transform XDATA tags with group codes 1011, 1012, 1013, 1041 and 1042 inplace. For more information see [Extended Data Internals](#).

## Application-Defined Data (AppData)

Starting at DXF R13, DXF objects can contain application-defined codes (AppData) outside of XDATA.

All AppData is defined with a beginning (102, “{APPID”) tag and according to the DXF reference appear should appear before the first subclass marker.

There are two known use cases of this data structure in Autodesk products:

- ACAD\_REACTORS, store handles to persistent reactors in a DXF entity
- ACAD\_XDICTIONARY, store handle to the extension dictionary of a DXF entity

Both AppIDs are not defined/stored in the AppID table!

**class** ezdxf.entities.appdata.**AppData**

Internal management class for Application defined data.

**See also:**

- User reference: [Application-Defined Data \(AppData\)](#)
- Internals about [Application-Defined Codes](#) tags

**\_\_contains\_\_** (*appid*: str) → bool

Returns True if application-defined data exist for *appid*.

**\_\_len\_\_** () → int

Returns the count of AppData.

**add** (*appid*: str, *data*: Iterable[Sequence[*T\_co*]]) → None

Add application-defined tags for *appid*. Adds first tag (102, “{APPID”) if not exist. Adds last tag (102, “}” if not exist.

**get** (*appid*: str) → ezdxf.lldx.dxf.tags.Tags

Get application-defined data for *appid* as *Tags* container. The first tag is always (102, “{APPID”). The last tag is always (102, “}”).

**set** (*tags: ezdxf.lldxf.tags.Tags*) → None

Store raw application-defined data tags. The first tag has to be (102, “{APPID”). The last tag has to be (102, “}”).

**discard** (*appid: str*)

Delete application-defined data for *appid* without raising an error if *appid* doesn’t exist.

## Reactors

**class** `ezdxf.entities.appdata.Reactors`

Internal management class for persistent reactor handles. Handles are stored as hex strings like "ABBA".

**See also:**

- User reference: *Reactors*

- Internals about *Persistent Reactors* tags

**\_\_contains\_\_** (*handle: str*) → bool

Returns True if *handle* is registered.

**\_\_len\_\_** () → int

Returns count of registered handles.

**\_\_iter\_\_** () → Iterator[str]

Returns an iterator for all registered handles.

**add** (*handle: str*) → None

Add a single *handle*.

**get** () → List[str]

Returns all registered handles as sorted list.

**set** (*handles: Optional[Iterable[str]]*) → None

Reset all handles.

**discard** (*handle: str*)

Discard a single *handle*.

## 6.13.5 Documentation Guide

### Formatting Guide

This section is only for myself, because of the long pauses between develop iterations, I often forget to be consistent in documentation formatting.

Documentation is written with Sphinx and reStructuredText.

Started integration of documentation into source code and using autodoc features of Sphinx wherever useful.

Sphinx theme provided by Read the Docs :

```
pip install sphinx-rtd-theme
```

## guide — Example module

```
guide.example_func(a:int, b:str, test:str=None, flag:bool=True) → None
```

Parameters *a* and *b* are positional arguments, argument *test* defaults to `None` and *flag* to `True`. Set *a* to 70 and *b* to "x" as an example. Inline code examples `example_func(70, 'x')` or simple `example_func(70, "x")`

- arguments: *a*, *b*, *test* and *flags*
- literal number values: 1, 2 ... 999
- literal string values: "a String"
- literal tags: (5, "F000")
- inline code: call a `example_func(x)`
- Python keywords: `None`, `True`, `False`, `tuple`, `list`, `dict`, `str`, `int`, `float`
- Exception classes: `DXFAttributeError`

```
class guide.ExampleCls(**kwargs)
```

The `ExampleCls` constructor accepts a number of optional keyword arguments. Each keyword argument corresponds to an instance attribute, so for example

```
e = ExampleCls(flag=True)
```

### flag

This is the attribute `flag`.

### set\_axis(axis)

axis as (x, y, z) tuple

**Args:** axis: (x, y, z) tuple

### example\_method(flag:bool=False) → None

Method `example_method()` of class `ExampleCls`

## Text Formatting

**DXF version** DXF R12 (AC1009), DXF R2004 (AC1018)

**DXF Types** DXF types are always written in uppercase letters but without further formatting: DXF, LINE, CIRCLE

**(internal API)** Marks methods as internal API, gets no public documentation.

**(internal class)** Marks classes only for internal usage, gets not public documentation.

**Spatial Dimensions** 2D and 3D with an uppercase letter D

**Axis** x-axis, y-axis and z-axis

**Planes** xy-plane, xz-plane, yz-plane

**Layouts** modelspace, paperspace [layout], block [layout]

**Extended Entity Data** AppData, XDATA, embedded object, APPID

## 6.14 Glossary

**ACI** *AutoCAD Color Index (ACI)*

**ACIS** The 3D ACIS Modeler ([ACIS](#)) is a geometric modeling kernel developed by [Spatial Corp.](#) ® (formerly *Spatial Technology*) and now part of *Dassault Systems*. All ACIS based DXF entities store their geometry as [SAT](#) or [SAB](#) data. These are not open data formats and a license has to be purchased to get access to their SDK, therefore *ezdxf* can not provide any support for creating, processing or transforming of ACIS based DXF entities.

**bulge** The *Bulge value* is used to create arc shaped line segments in [Polyline](#) and [LWPolyline](#) entities.

**CAD** Computer-Assisted Drafting or Computer-Aided Design

**CTB** Color dependent plot style table ([ColorDependentPlotStyles](#))

**DWG** Proprietary file format of [AutoCAD](#) ®. Documentation for this format is available from the Open Design Alliance ([ODA](#)) at their [Downloads](#) section. This documentation is created by reverse engineering therefore not perfect nor complete.

**DXF** Drawing eXchange Format is a file format used by [AutoCAD](#) ® to interchange data with other [CAD](#) applications.  
**DXF** is a trademark of [Autodesk](#) ®. See also [What is DXF?](#)

**raw color** Raw color value as stored in DWG files, this integer value can represent [ACI](#) values as well as and [true color](#) values

**reliable CAD application** CAD applications which create valid DXF documents in the meaning and interpretation of [Autodesk](#). See also [What is DXF?](#)

**SAB** ACIS file format (Standard ACIS Binary), binary stored data

**SAT** ACIS file format (Standard ACIS Text), data stored as ASCII text

**STB** Named plot style table ([NamedPlotStyles](#))

**true color** RGB color representation, a combination red, green and blue values to define a color.

## 6.15 Indices and tables

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## Python Module Index

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