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# **ezdxf Documentation**

***Release 0.15.1***

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**Jan 15, 2021**



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Welcome! This is the documentation for ezdxf release 0.15.1, last updated Jan 15, 2021.

- *ezdxf* is a Python package to create new DXF files and read/modify/write existing DXF files
- the intended audience are developers
- requires at least Python 3.6
- OS independent
- additional required packages: [pyparsing](#)
- optional Cython implementation of some low level math classes
- MIT-License
- read/write/new support for DXF versions: R12, R2000, R2004, R2007, R2010, R2013 and R2018
- additional read support for DXF versions R13/R14 (upgraded to R2000)
- additional read support for older DXF versions than R12 (upgraded to R12)
- read/write support for ASCII DXF and Binary DXF
- preserves third-party DXF content



# CHAPTER 1

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## Included Extensions

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- `drawing` add-on to visualise and convert DXF files to images which can be saved to various formats such as png, pdf and svg
- `geo` add-on to support the `__geo_interface__`
- `r12writer` add-on to write basic DXF entities direct and fast into a DXF R12 file or stream
- `iterdxf` add-on to iterate over entities of the modelspace of really big (> 5GB) DXF files 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



## 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](#), it 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 3.6 and will be tested with the latest stable CPython 3 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* 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 (>=3.6).

### 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* reads also 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 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 ezdxf
```

### 6.2.1 Loading DXF Files

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

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

or from a zip-file:

```
doc = ezdxf.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 `ezdxf.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 `ezdxf.recover` module.

**See also:**

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

## 6.2.2 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.

## 6.2.3 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.

## 6.2.4 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](#)

## 6.2.5 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](#)

## 6.2.6 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 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](#)

## 6.2.7 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](#)

## 6.2.8 Create New DXF Entities

The factory functions for creating new graphical DXF entities are located in the `BaseLayout` class. This means this factory function 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'})
```

A few important or required DXF attributes are explicit method arguments, most additional and optional DXF attributes are gives 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`.

## 6.2.9 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')
```

**See also:**

See [Tutorial for Blocks](#) for more advanced features like using `Attrib` entities.

## 6.2.10 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.new('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](#)

## 6.2.11 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.

The current version of `ezdxf` 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.

## 6.2.12 Further Information

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

# 6.3 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.

## 6.3.1 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. *ezdxf* 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 \(CTB/STB\)](#)

## 6.3.2 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](#)

### 6.3.3 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.

## **6.3.4 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  $\neq (0, 0, 1)$ , 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.

**6.3.5 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, and the elevation value.

For a given z-axis (or 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.

These 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
# Extrusion vector normalization should not be necessary, but don't rely on any DXF_
↪content
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 * Wx.y + pz * Wx.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)
```

### 6.3.6 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 form 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.

```
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.

```
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*:

```
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:

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

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

## Helper Tools

`ezdxf.units.conversion_factor(source_units: int, target_units: int) → 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

## 6.4 Tutorials

### 6.4.1 Tutorial for getting data from DXF files

In this tutorial I show you how to get data from an existing DXF drawing.

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 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.

See also:

*Document Management*

## 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 exactly 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.

## 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.

```
# 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)

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)
```

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 the later DXF versions you get a list of the names of the available layouts by `layout_names()`.

## 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('    {}'.format(str(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:

```
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('    {}'.format(str(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

## 6.4.2 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 eздxf

doc = eздxf.new('R2010') # create a new DXF R2010 drawing, official DXF version
                         ↴name: 'AC1024'

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

New entities are always added to layouts, a layout can be the modelspace, a paperspace layout or a block layout.

#### See also:

Look at factory methods of the `BaseLayout` class to see all the available DXF entities.

### 6.4.3 Tutorial for Layers

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

#### Create a Layer Definition

```
import eздxf

doc = eздxf.new(setup=True) # setup required line types
msp = doc.modelspace()
doc.layers.new(name='MyLines', dxfattribs={'linetype': 'DASHED', 'color': 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 so you can left off this assignments:

```
msp.add_line((0, 0), (10, 0), dxfattribs={'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.

## 6.4.4 Tutorial for Blocks

### What are Blocks?

Blocks are collections of DXF entities which can be placed multiply times as block references in different layouts and other block definitions. The block reference ([Insert](#)) can be rotated, scaled, placed in 3D 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` by a `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 scaled and rotated individually.

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

New in version 0.12.

This is an advanced and still experimental feature and because *ezdxf* is still not a CAD application, the results may not 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

New in version 0.12.

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)}.'
```

## 6.4.5 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')[0] # take first LWPolyline
line.append_points([(8, 7), (10, 7)])

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

Getting points always returns a 5-tuple  $(x, y, start\_width, end\_width, bulge)$ , `start_width`, `end_width` and `bulge` is 0 if not present:

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

Use context manager to edit polyline points, this method was introduced because accessing single points was very slow, but since `ezdxf` v0.8.9, direct access by index operator `[]` is very fast and using the context manager is not required anymore. 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 # take first LWPolyline, 'first' was introduced
# with v0.10

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

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```
del points[-2:] # delete last 2 points
points.extend([(4, 7), (0, 7)]) # adding 2 other points
# the same as one command
# points[-2:] = [(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 polyline is closed else the values are ignored. Start- and end-width only works if the DXF attribute `dxfl.const_width` is unset, to be sure delete it:

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

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")
```

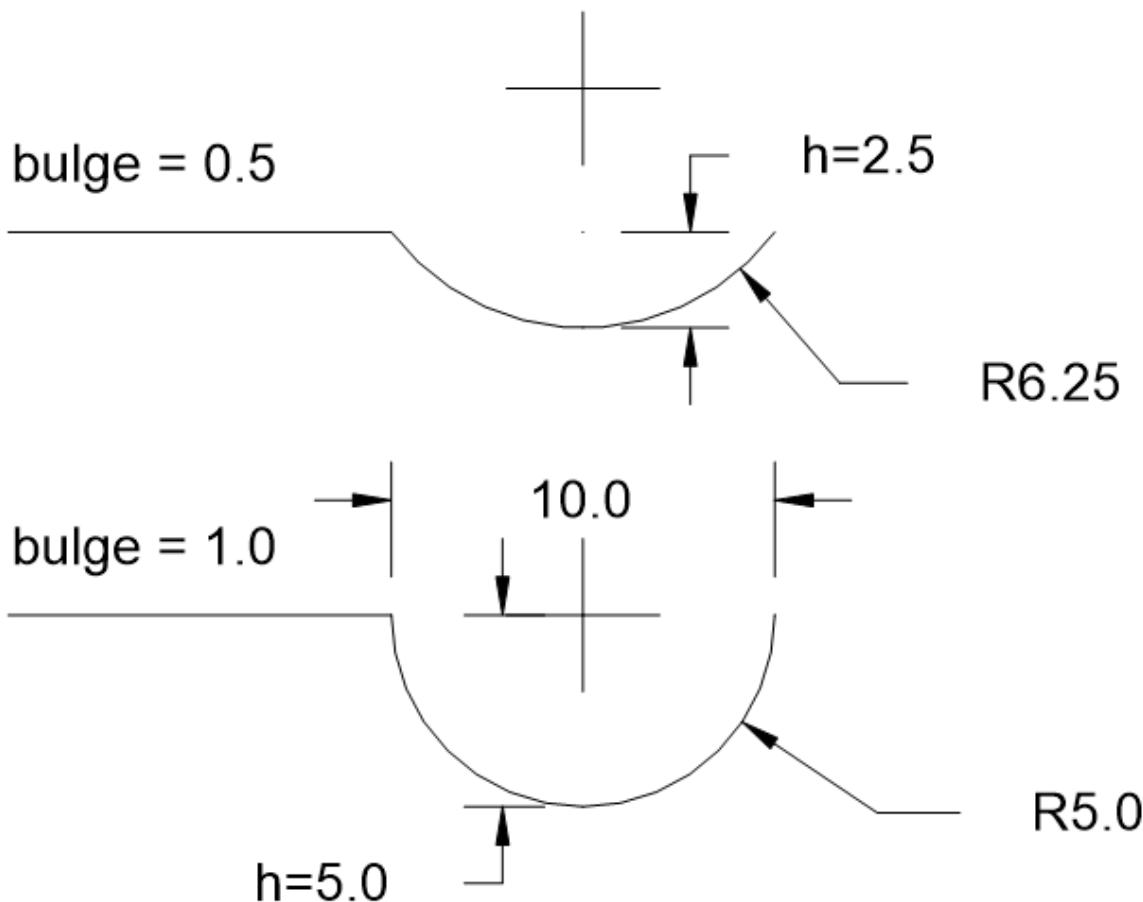


The curved segment is drawn from the point which defines the *bulge* value to the following point, the curved segment is always an arc. The bulge value defines the ratio of the arc sagitta (*segment height h*) to half line segment length (point distance), a bulge value of 1 defines a semicircle. *bulge > 0* the curve is on the right side of the vertex connection line, *bulge < 0* the curve is on the left side.

*ezdxf* v0.8.9 supports a user defined points 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='xyseb')
msp.add_lwpolyline([(0, 10, 0), (10, 10, .5), (20, 10, 0)], format='xyseb')
```



#### 6.4.6 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.
```

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```
# 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.

Alignment	Description
<code>ALIGNED</code>	Text is stretched or compressed to fit exactly between <i>p1</i> and <i>p2</i> and the text height is also adjusted to preserve height/width ratio.
<code>FIT</code>	Text is stretched or compressed to fit exactly between <i>p1</i> and <i>p2</i> 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](#).

### 6.4.7 Tutorial for MText

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:

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

**Latin Text:**

  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 = "{\C1red text} - {\C3green text} - {\C5blue text}"
```

red text - green text - blue text

## 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;"
```

Available helper function for text formatting:

- `set_color()` - append text color change
- `set_font()` - append text font change
- `add_stacked_text()` - append stacked text

## 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.

**Consectetur** adipisci  
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.

## 6.4.8 Tutorial for Spline

Background information about B-spline at Wikipedia.

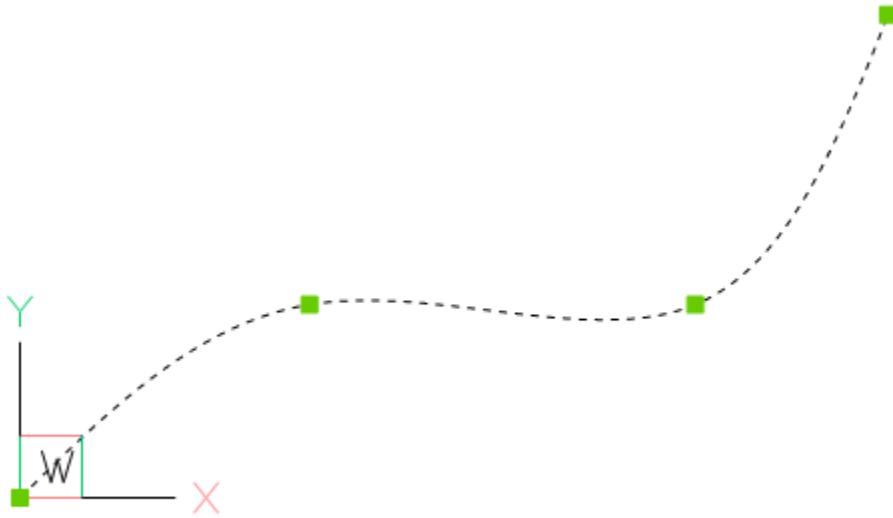
## Splines from fit points

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:

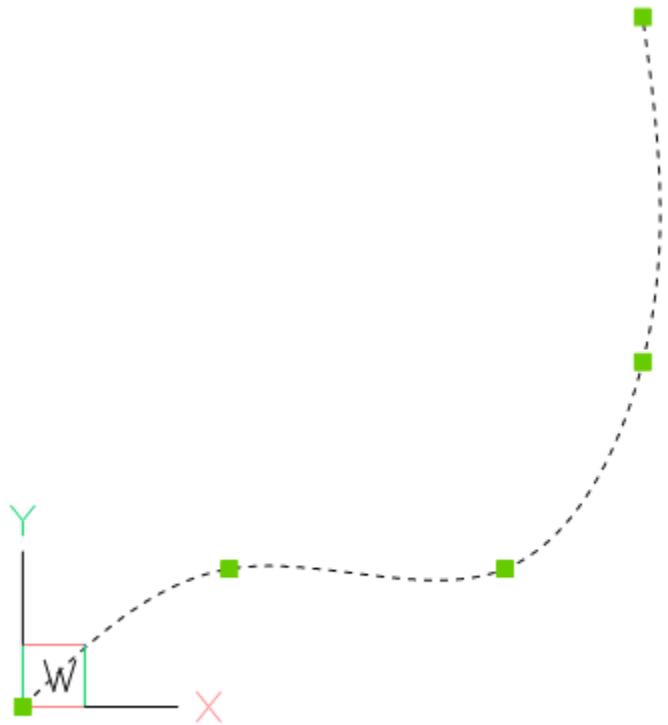
```
doc = ezdxf.new('R2000')

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

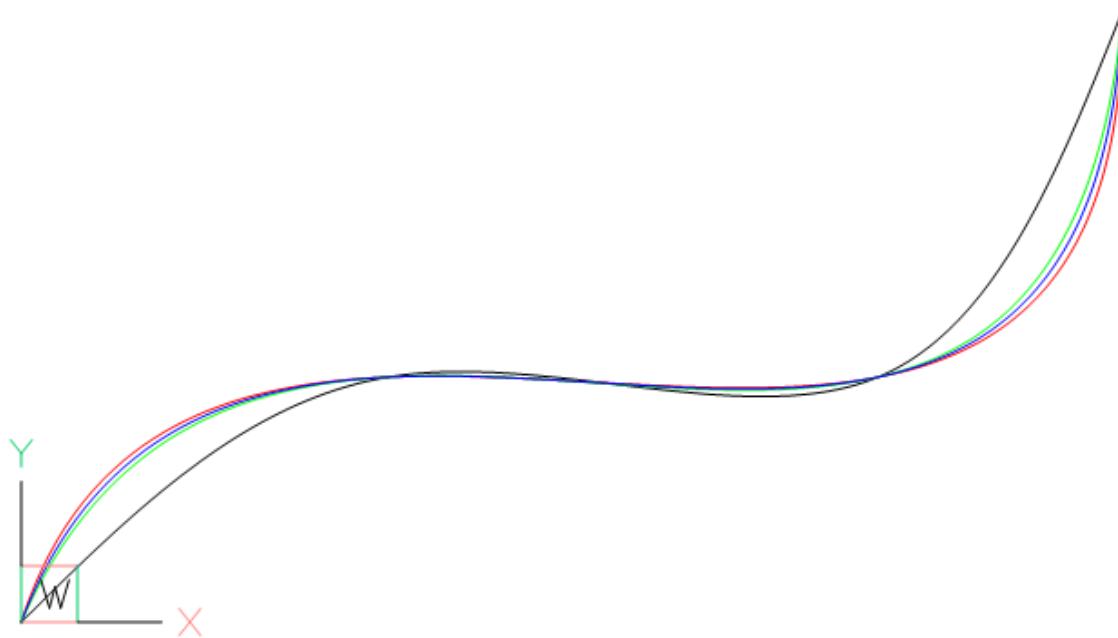
To create splines from fit points is the easiest way to create splines, but this method is also the least accurate, because a spline is defined by control points and knot values, which are generated for the case of a definition by fit points, and the worst fact is that for every given set of fit points 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})
    ↵
```

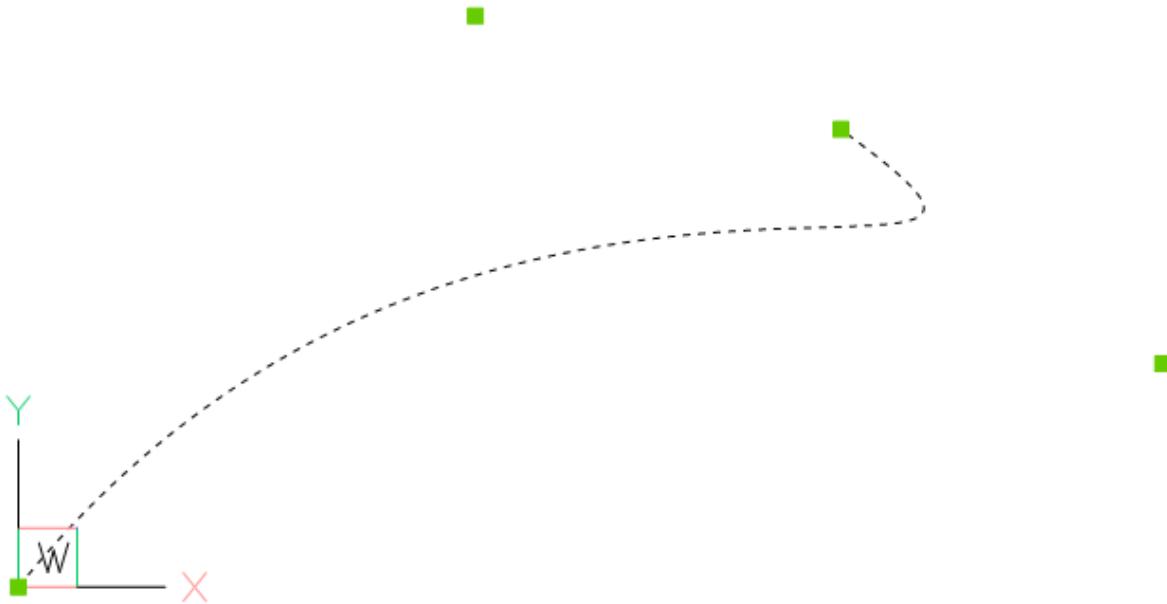
- black curve: AutoCAD/BricsCAD spline generated from fit points
- red curve: spline curve interpolation, “uniform” method
- green curve: spline curve interpolation, “chord” method
- blue curve: spline curve interpolation, “centripetal” method



## 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.

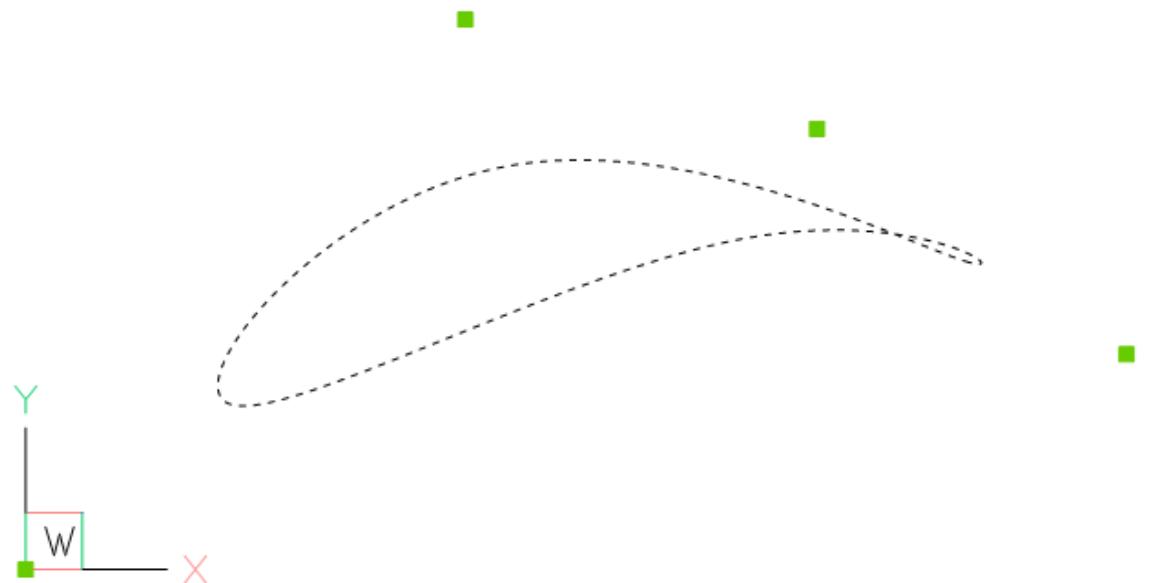
```
control_points = [(0, 0, 0), (1250, 1560, 0), (3130, 610, 0), (2250, 1250, 0)]  
msp.add_open_spline(control_points)
```



## Closed Spline

A closed spline is continuous closed curve.

```
msp.add_closed_spline(control_points)
```



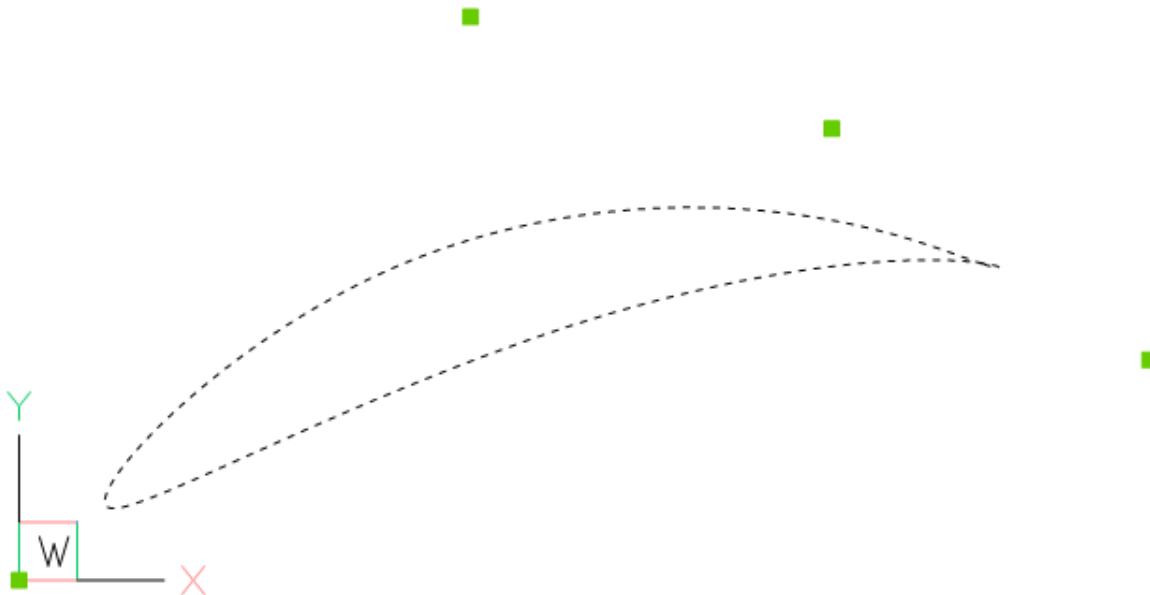
## Rational Spline

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
```

## 6.4.9 Tutorial for Polyface

coming soon ...

## 6.4.10 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]
]

doc = ezdxf.new('R2000') # MESH requires DXF R2000 or later
msp = doc.modelspace()
mesh = msp.add_mesh()
mesh.dxf.subdivision_levels = 0 # do not subdivide cube, 0 is the default value
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 method calls:

```
import ezdxf

# 8 corner vertices
p = [
```

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```
(0, 0, 0),
(1, 0, 0),
(1, 1, 0),
(0, 1, 0),
(0, 0, 1),
(1, 0, 1),
(1, 1, 1),
(0, 1, 1),
]

doc = ezdxf.new('R2000') # MESH requires DXF R2000 or later
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]])
    mesh_data.optimize() # optional, minimizes vertex count

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

## 6.4.11 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

doc = ezdxf.new('R2000') # hatch requires the DXF R2000 (AC1015) format or later
msp = doc.modelspace() # adding entities to the model space

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

# every boundary path is always 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=1)

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

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

```
import ezdxf

doc = ezdxf.new('R2000') # hatch requires the DXF R2000 (AC1015) format or later
msp = doc.modelspace() # adding entities to the model space

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

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```
# every boundary path is always a 2D element
# 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=1)

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 consist of a number of 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

doc = ezdxf.new('R2000') # hatch requires the DXF R2000 (AC1015) format or later
msp = doc.modelspace() # adding entities to the model space

# 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 always 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={
    'hatch_style': 0,
    # 0 = nested
```

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```

# 1 = outer
# 2 = 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=1, ↵
←flags=1)

```

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=1, flags=16)

```

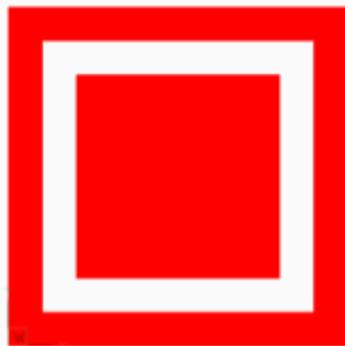
This is also the result for all 4 paths and `hatch_style` set to 1 (outer).



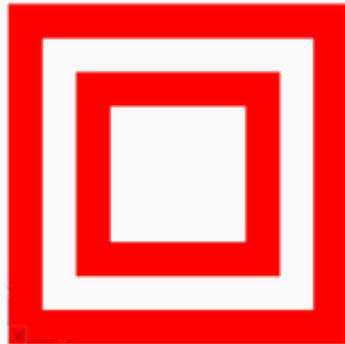
```

# The third path has to set flag: 0 = default
hatch.paths.add_polyline_path([(2, 2), (8, 2), (8, 8), (2, 8)], is_closed=1, flags=0)

```



```
# 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=1, flags=0)
```



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),
    (0, 210, 0),
    (0, 0, 0.),
    (240, 0, 0),
],
    is_closed=1,
    flags=1,
)
# 2. edge path
edge_path = hatch.paths.add_edge_path(flags=16)
edge_path.add_spline(
    control_points=[
        (126.658105895725, 177.0823706957212),
        (141.5497003747484, 187.8907860433995),
```

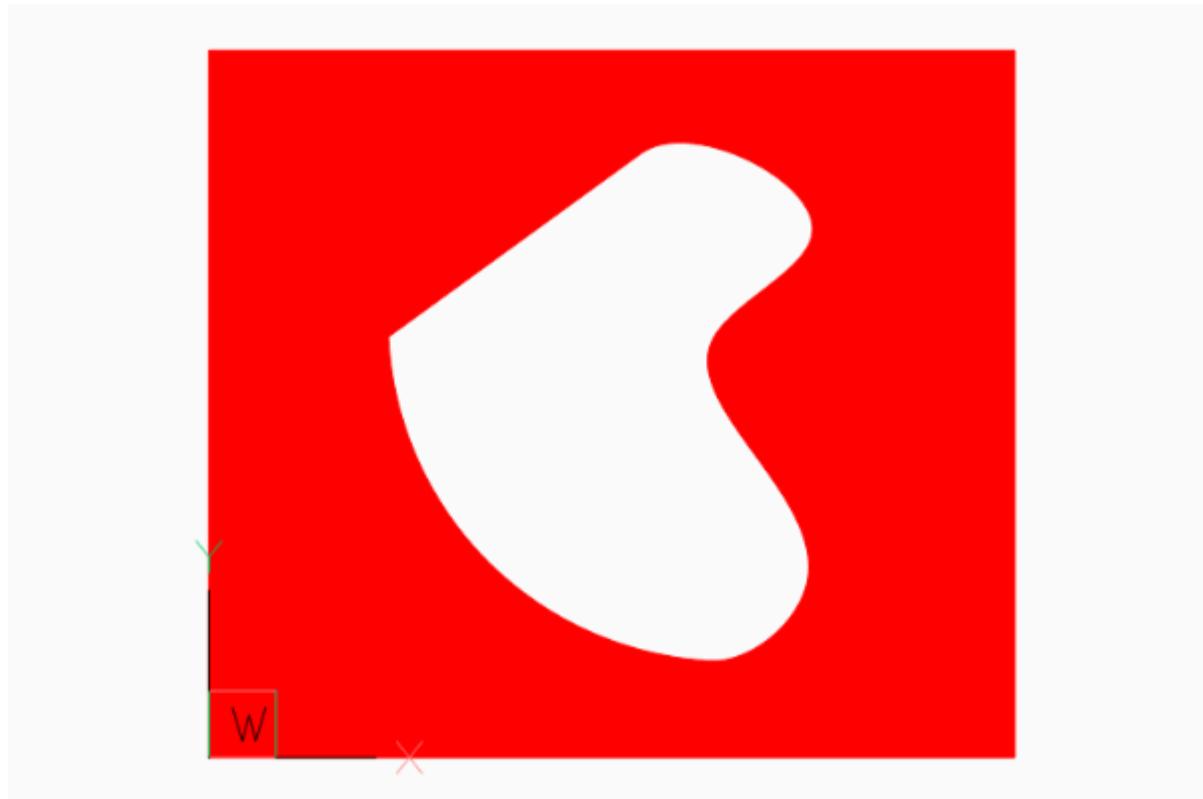
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```

        (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, .5), (10, 10, 0), (0, 10, 0)],
    format='xyb',
    dxffattribs={'closed': 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,
)

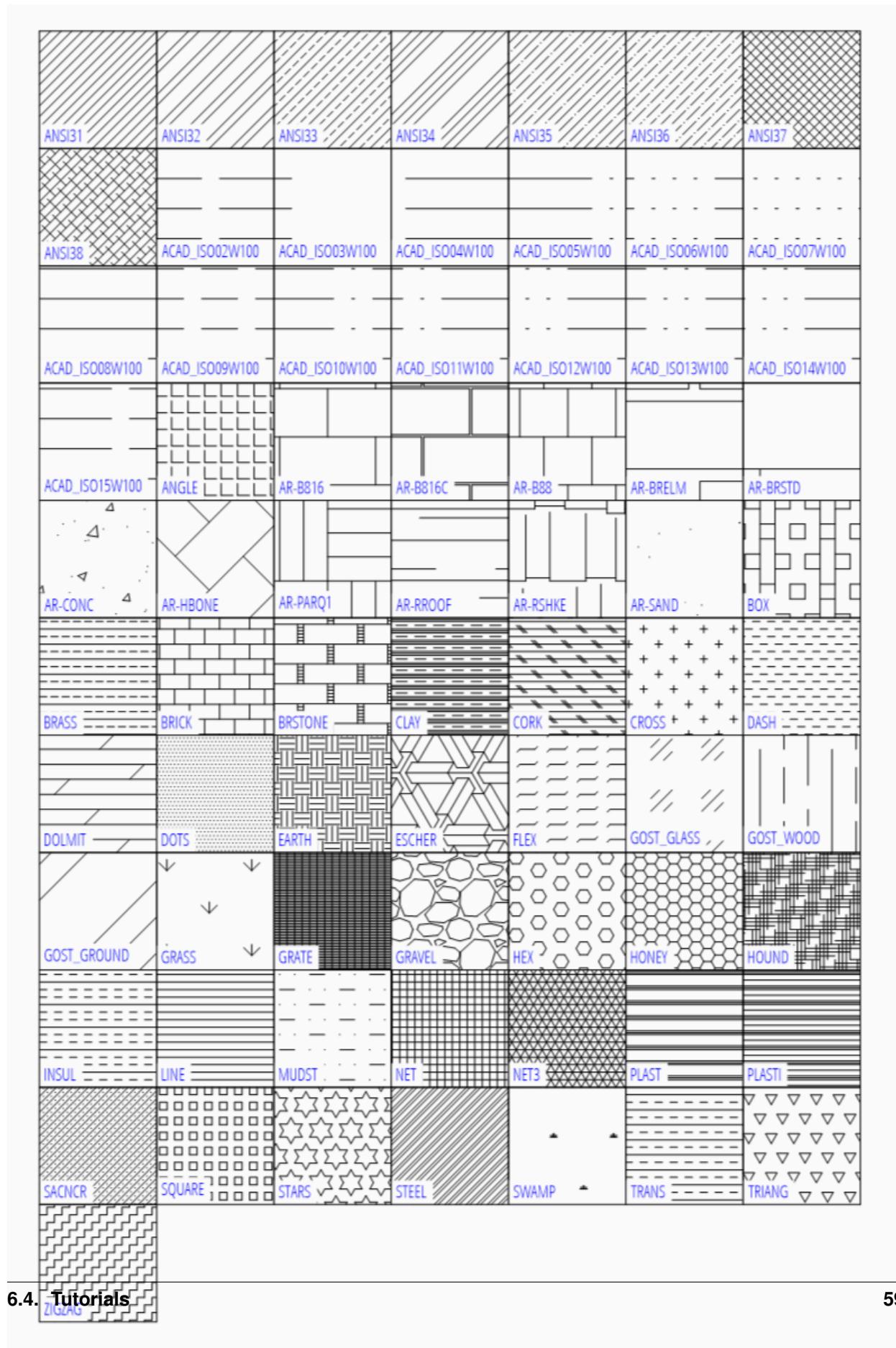
# Set association between boundary path and LWPOLYLINE
hatch.associate(path, [lwpolyline])
```

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

### 6.4.12 Tutorial for Hatch Pattern Definition

TODO

### 6.4.13 Tutorial for Image and ImageDef

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

```
import ezdxf

doc = ezdxf.new('AC1015') # image requires the DXF R2000 format or later
my_image_def = doc.add_image_def(filename='mycat.jpg', size_in_pixel=(640, 360))
# The IMAGEDEF entity is like a block definition, it just defines the image

msp = doc.modelspace()
# add first image
msp.add_image(insert=(2, 1), size_in_units=(6.4, 3.6), image_def=my_image_def, ↴
    rotation=0)
# The IMAGE entity is like the INSERT entity, it creates an image reference,
# and there can be multiple references to the same picture in a drawing.

msp.add_image(insert=(4, 5), size_in_units=(3.2, 1.8), image_def=my_image_def, ↴
    rotation=30)

# get existing image definitions, Important: IMAGEDEFs resides in the objects section
image_defs = doc.objects.query('IMAGEDEF') # get all image defs in drawing

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

### 6.4.14 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

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,
```

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```
# 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")
```

## 6.4.15 Tutorial for Linetypes

## Simple line type example:

You can define your own line types. A DXF linetype definition consists of name, description and 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

Setup some predefined linetypes:

```
for name, desc, pattern in linetypes():
    if name not in doc.linetypes:
        doc.linetypes.new(name=name, dxfattribs={'description': desc, 'pattern': pattern})
```

## Check Available Linetypes

The `linetypes` object supports some standard Python protocols:

```
# iteration
print('available line types:')
for linetype in doc.linetypes:
    print('{}: {}'.format(linetype.dxf.name, linetype.dxf.description))

# check for existing line type
if 'DOTTED' in doc.linetypes:
    pass

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

## Removing Linetypes

**Warning:** Deleting of linetypes still in use generates invalid DXF files.

You can delete a linetype:

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

This just deletes the linetype definition, all DXF entity with the DXF attribute linetype set to DASHED still refers to linetype DASHED and AutoCAD will not open DXF files with undefined line types.

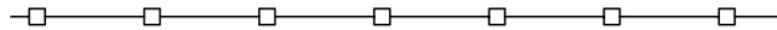
### 6.4.16 Tutorial for Complex Linetypes

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

Complex line type example with text:



Complex line type example with shapes:



For simplicity 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.new('GASLEITUNG2', dxftattribs={
    'description': 'Gasleitung2 ----GAS----GAS----GAS----GAS----GAS--',
    'length': 1, # required for complex line types
    # line type definition in acadlt.lin:
    'pattern': 'A,.5,-.2,[ "GAS", STANDARD, S=.1, U=0.0, X=-0.1, Y=-.05],-.25',
})
```

The pattern always starts with an A, the following float values have the same meaning as for simple line types, a value > 0 is a line, a value < 0 is a gap, and a 0 is a point, the [ starts the complex part of the line pattern. A following text in quotes defines a TEXT type, a following text without quotes defines a SHAPE type, in .lin files the shape type is a shape name, but ezdxf can not translate this name into the required shape file index, so *YOU* have to translate this

name into the shape file index (e.g. saving the file with AutoCAD as DXF and searching for the line type definition, see also DXF Internals: [LTYPE Table](#)).

The second parameter is the text style for a TEXT type and the shape file name for the SHAPE type, the shape file has to be in the same directory as the DXF file. The following parameters in the scheme of S=1.0 are:

- 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)

The parameters are case insensitive. ] ends the complex part of the line pattern.

The fine tuning of this parameters is still a try an error process for me, for TEXT the scaling factor (STANDARD text style) sets the text height (S=.1 the text is .1 units in height), by shifting in y direction by half of the scaling factor, the center of the text is on 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.new('GRENZE2', dxfattribs={
    'description': 'Grenze eckig ----[]-----[]----[]----[]----[]--',
    'length': 1.45, # required for complex line types
    # line type definition in acadlt.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',
})
```

Complex line types with shapes only work if the associated shape file (ltypeshp.shx) and the DXF file are in the same directory.

#### 6.4.17 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.

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,
    dxfattribs={
```

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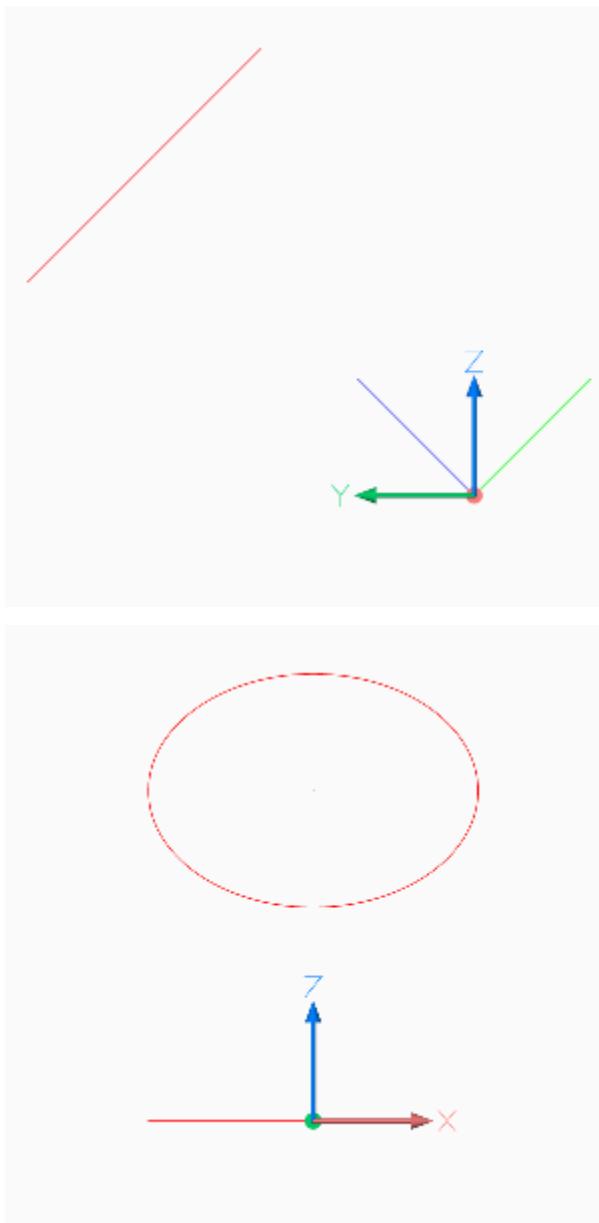
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```

# 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.

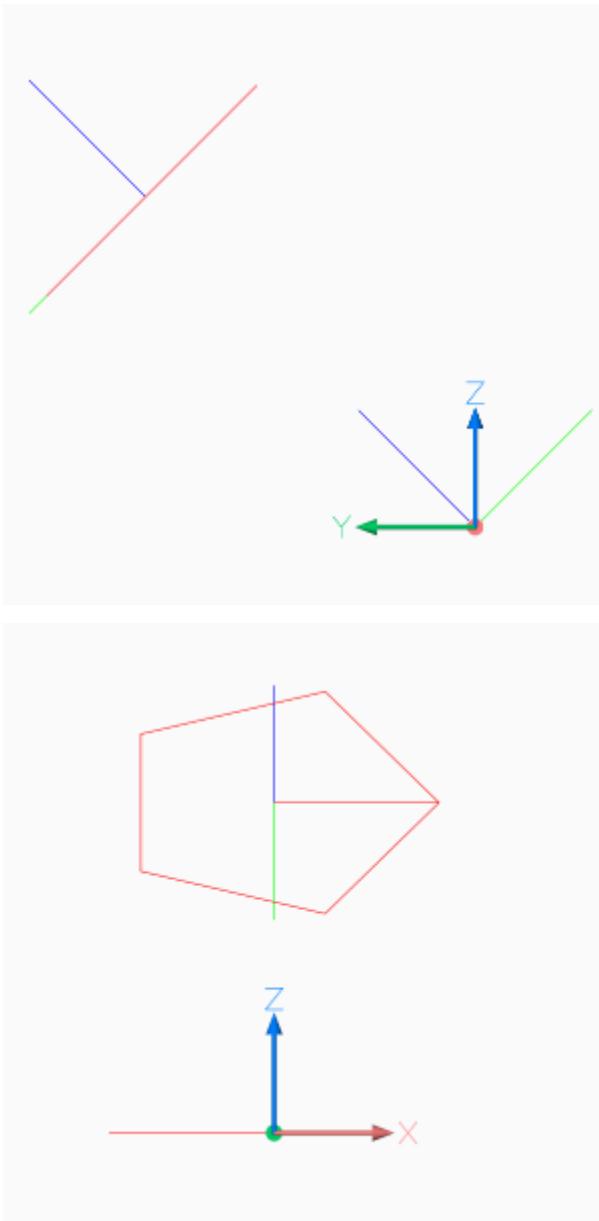
```
# The center of the pentagon should be (0, 2, 2), and the shape is
# rotated around x-axis about 45 degree, to accomplish this I use an
# UCS with z-axis (0, 1, 1) and an x-axis parallel to WCS x-axis.
ucs = UCS(
    origin=(0, 2, 2), # center of pentagon
    ux=(1, 0, 0), # x-axis parallel to WCS 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)]
# 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
    dxftattribs={
        'elevation': elevation,
        'extrusion': ucs.uz,
        'closed': True,
        '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
```

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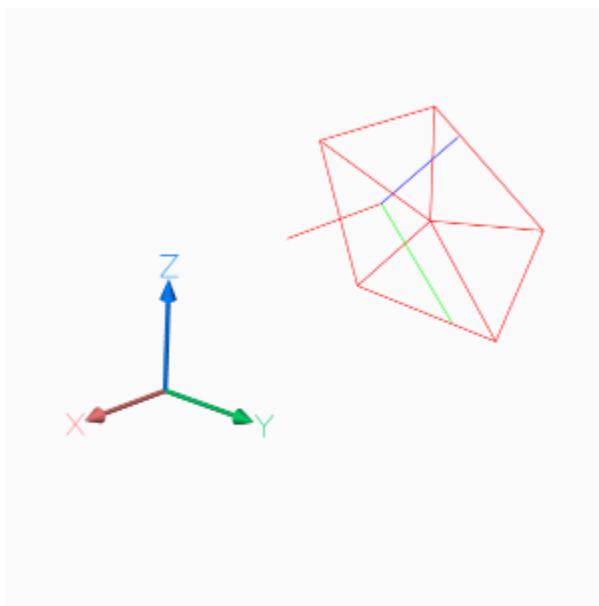
```

)
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,
    dxftattribs={
        'closed': True,
        'color': 1,
    })
# 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})

```



## 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](#).

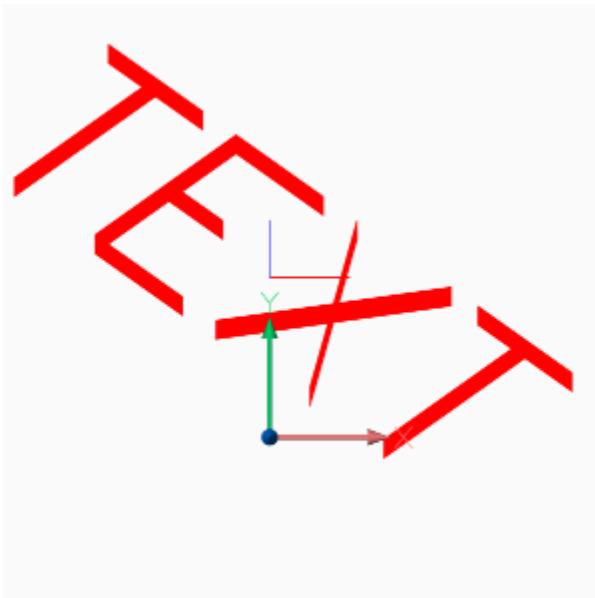
Calculate the OCS rotation angle by converting the TEXT rotation angle (in UCS or WCS) into a vector or begin with text direction as vector, transform this direction vector into OCS and convert the OCS vector back into an angle in the OCS xy-plane (see example), this procedure is available as `UCS.to_ocs_angle_deg()`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

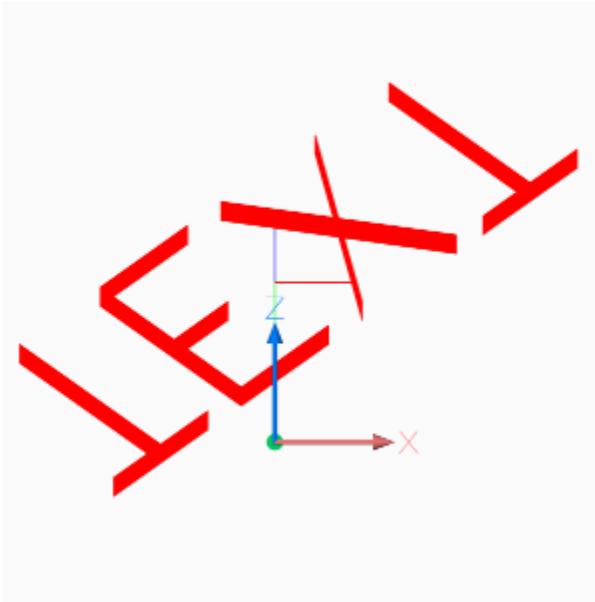
AutoCAD supports thickness for the TEXT entity only for `.shx` fonts and not for true type fonts.

```
# 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')
```





---

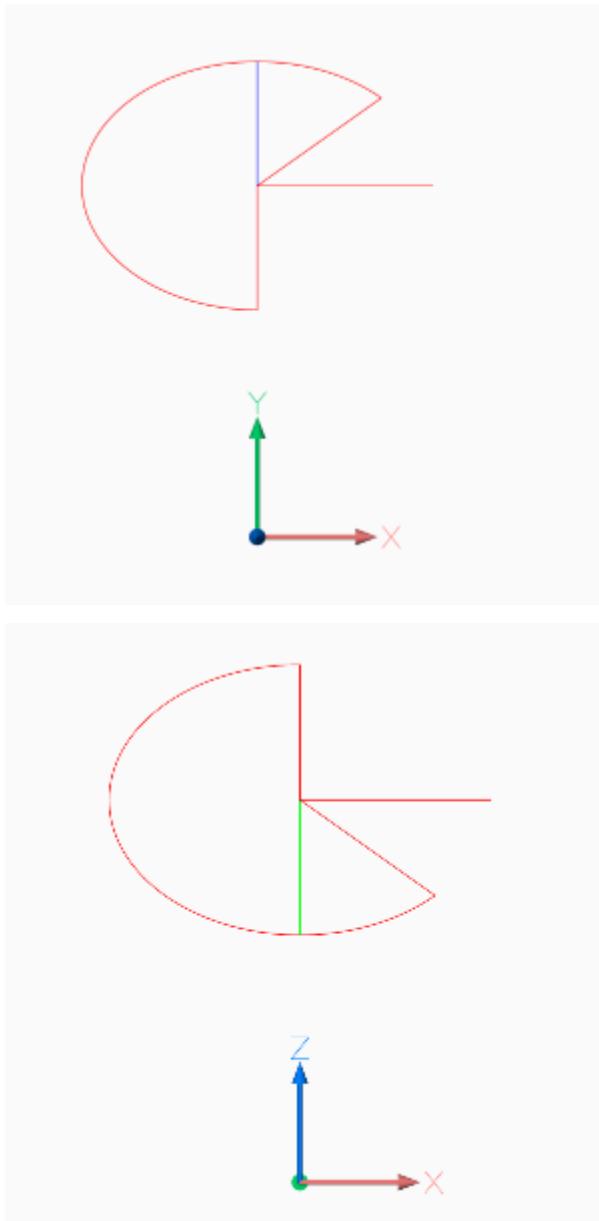
**Hint:** For calculating OCS angles from an UCS, be aware that 2D entities, like TEXT or ARC, are placed parallel to the xy-plane of the UCS.

---

## 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,
    start_angle=ucs.to_ocs_angle_deg(45),
    end_angle=ucs.to_ocs_angle_deg(270),
    dxffattribs={
        '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)),
    dxffattribs={'color': 1},
)
msp.add_line(
    start=center,
    end=ucs.to_wcs(Vec3.from_deg_angle(270)),
    dxffattribs={'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.

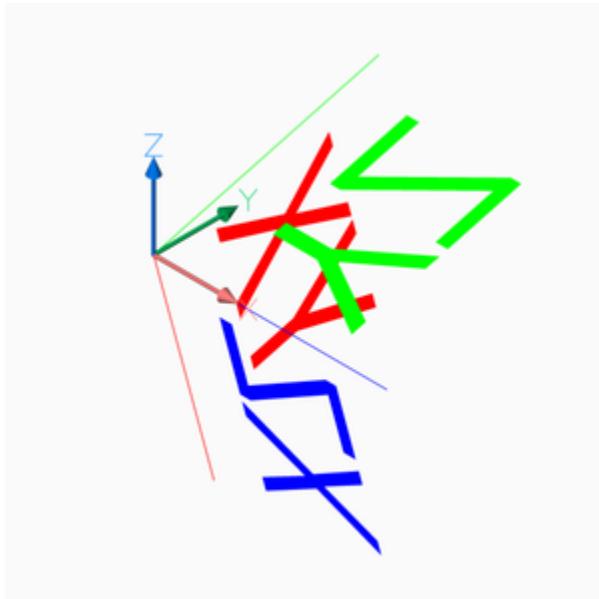
Simple placing by OCS and rotation about the z-axis, can be achieved the same way as for generic 2D entity types. The DXF attribute `Insert.dxf.rotation` rotates a block reference around the block z-axis, which is located in the `Block.dxf.base_point`. To rotate the block reference around the WCS x-axis, 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:

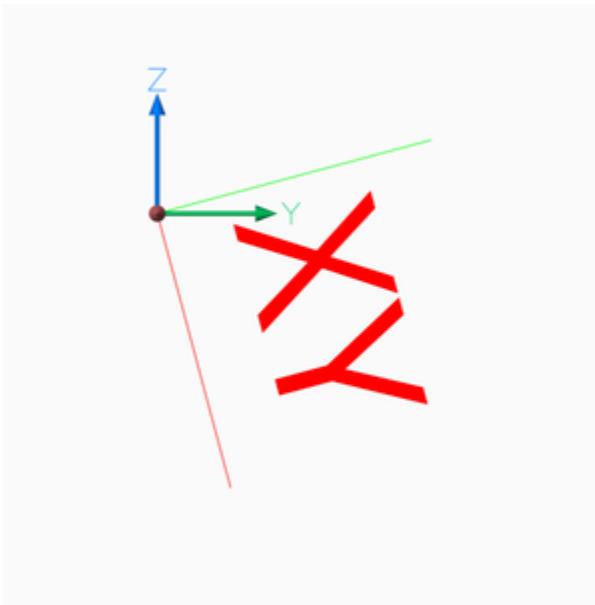
This is just an excerpt of the important parts, see the whole code of `insert.py` at [github](#).

```
# 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()

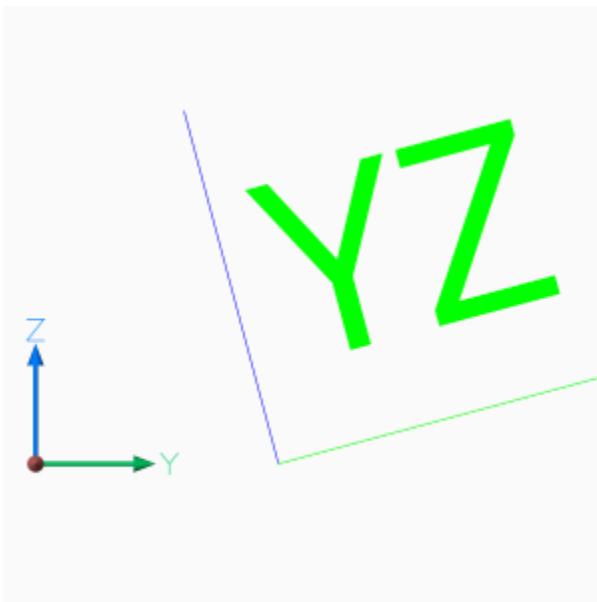
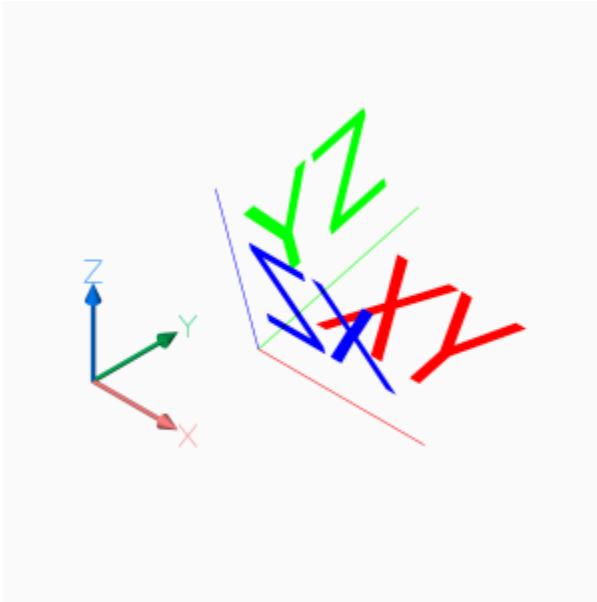
ucs = ucs_rotation(UCS(), axis=Y_AXIS, angle=90)
# transform insert location to OCS
insert = ucs.to_ocs((0, 0, 0))
# rotation angle about the z-axis (= WCS x-axis)
rotation = ucs.to_ocs_angle_deg(15)
msp.add_blockref('CSYS', insert, dxftattribs={
    'extrusion': ucs.uz,
    'rotation': rotation,
})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





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:

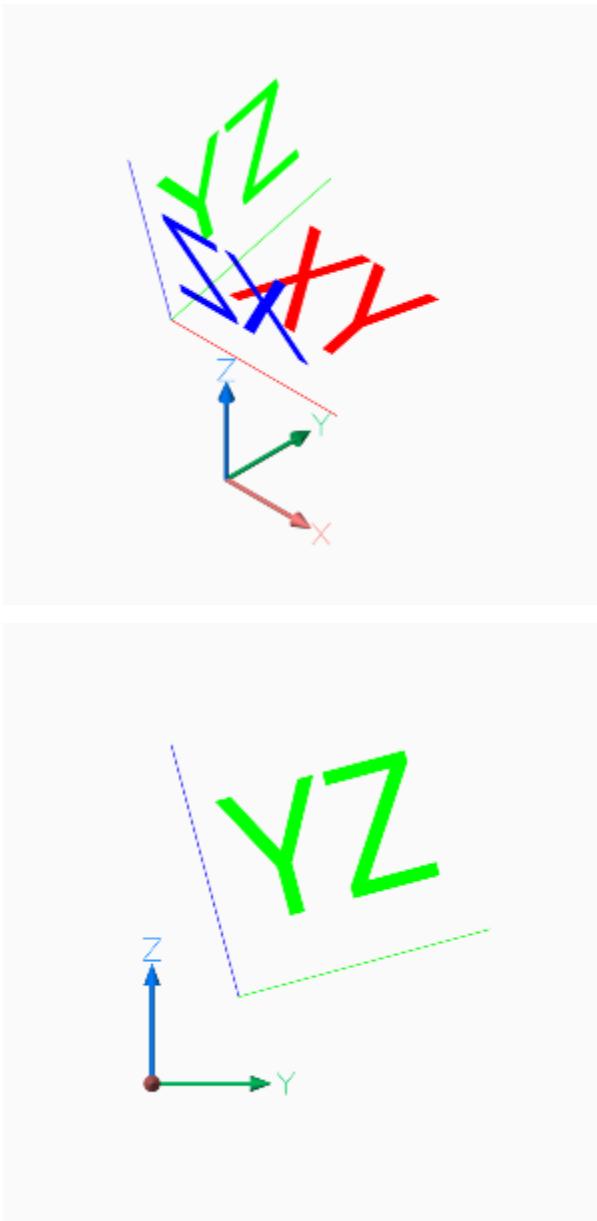
```
# t is a transformation matrix to rotate 15 degree around the x-axis
t = Matrix44.axis_rotate(axis=X_AXIS, angle=math.radians(15))
# transform block z-axis into new UCS z-axis (= extrusion vector)
uz = Vec3(t.transform(Z_AXIS))
# create new UCS at the insertion point, because we are rotating around 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
blockref = msp.add_blockref('CSYS', insert, dxftattribs={
    '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
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 90°
#degree
ocs = blockref.ocs()
# 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
```

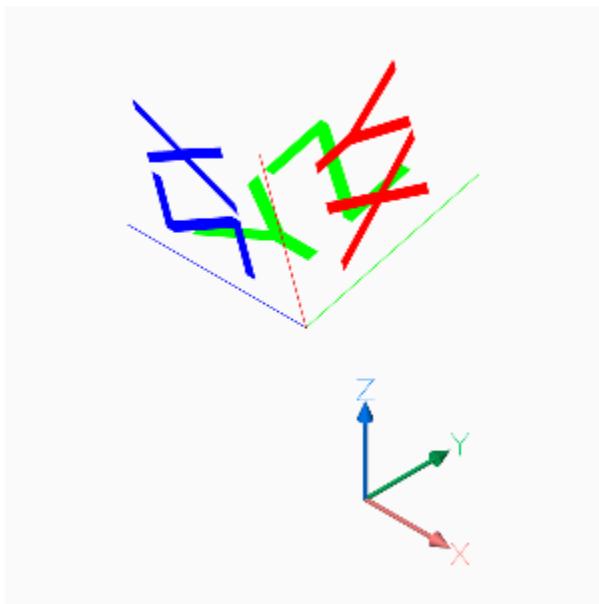
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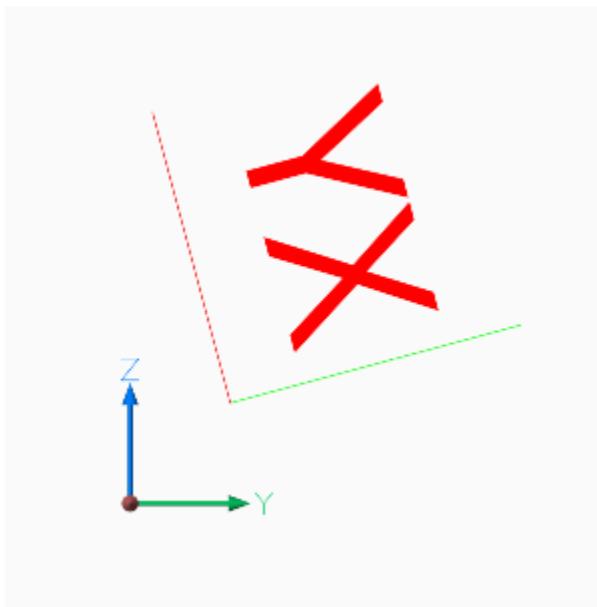
(continued from previous page)

```
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.

#### 6.4.18 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()

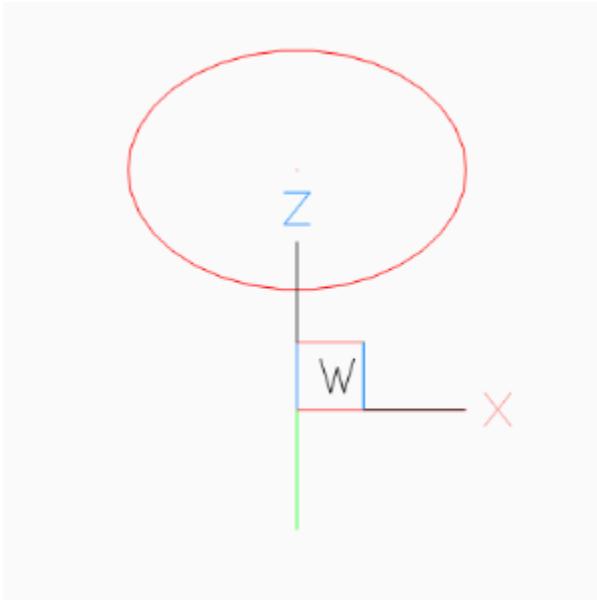
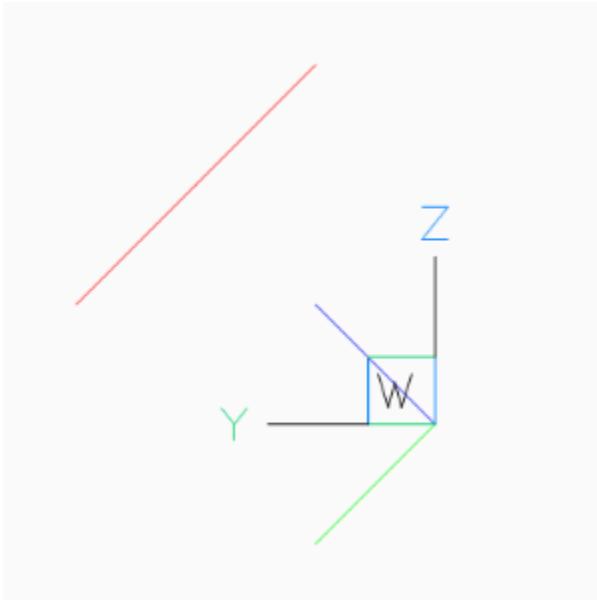
ucs = UCS() # New default UCS
# All rotation angles in radians, and rotation
# methods always return a new UCS.
ucs = ucs.rotate_local_x(math.radians(-45))
circle = msp.add_circle(
    # Use UCS coordinates to place the 2d circle in 3d space
    center=(0, 0, 2),
    radius=1,
    dxftattribs={'color':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

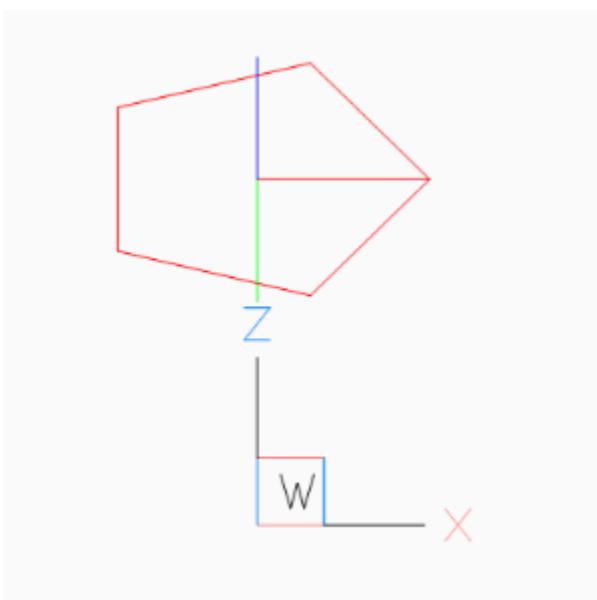
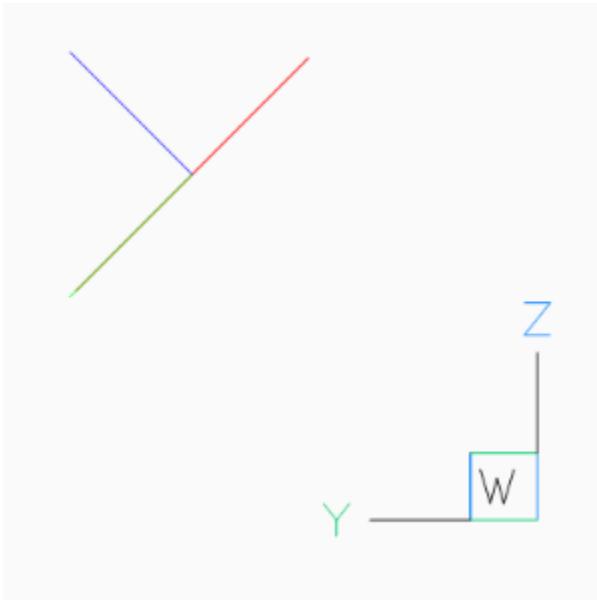
```
# The center of the pentagon should be (0, 2, 2), and the shape is
# rotated around x-axis about -45 degree
ucs = UCS(origin=(0, 2, 2)).rotate_local_x(math.radians(-45))
```

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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  
    dxffattribs={  
        'closed': True,  
        'color': 1,  
    }  
) .transform(ucs.matrix)
```

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



## Using UCS to Place 3D Polyline

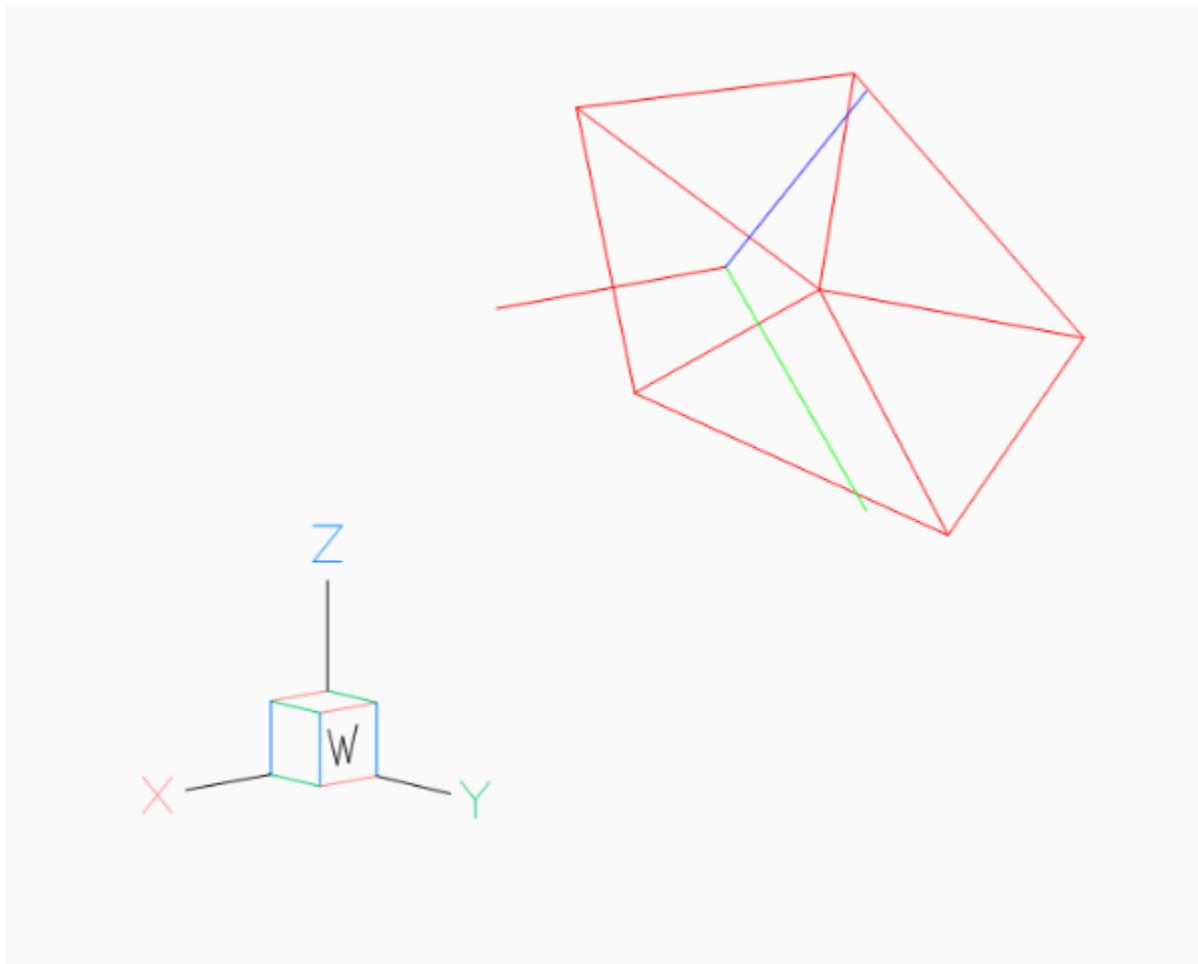
Simplified POLYLINE example: Using a first UCS to transform the POLYLINE and a second UCS to place the POLYLINE in 3D space.

```
# 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,
    dxftattribs={
        'closed': True,
        '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)
```



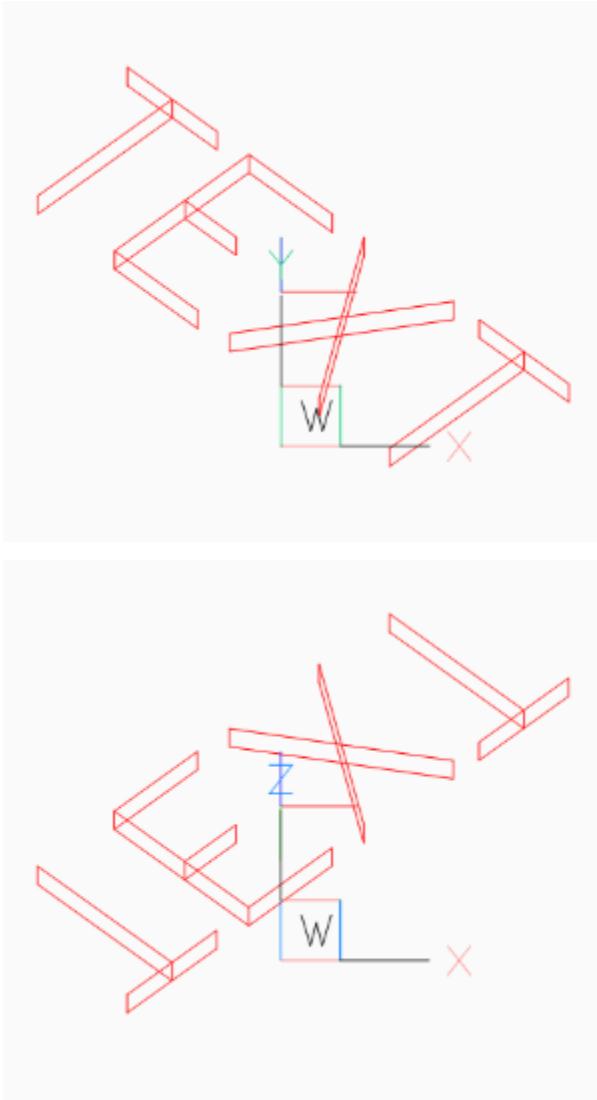
## Placing 2D Text in 3D Space

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

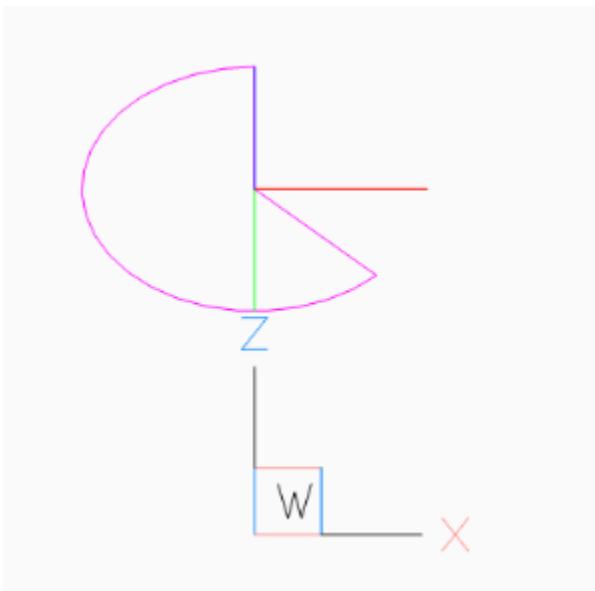
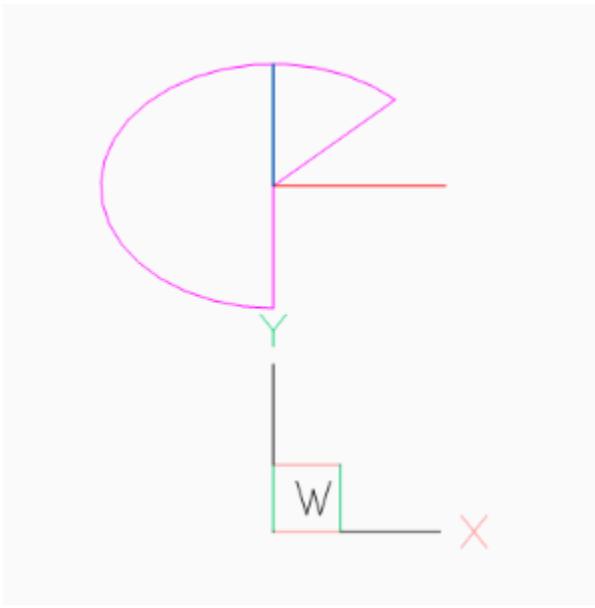
msp.add_arc(
    center=CENTER,
    radius=1,
    start_angle=START_ANGLE,
    end_angle=END_ANGLE,
    dxftattribs={'color': 6},
).transform(ucs.matrix)
```

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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

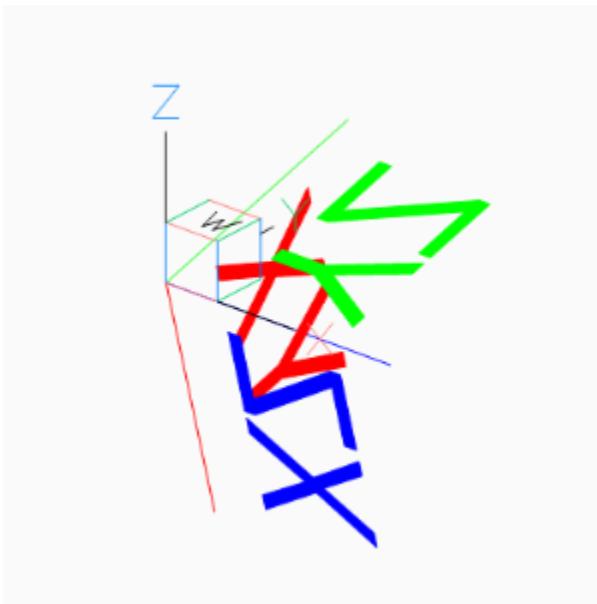
Despite the fact that block references (INSERT) can contain true 3D entities like LINE or MESH, the INSERT entity uses the same placing principle as TEXT or ARC shown in the previous chapters.

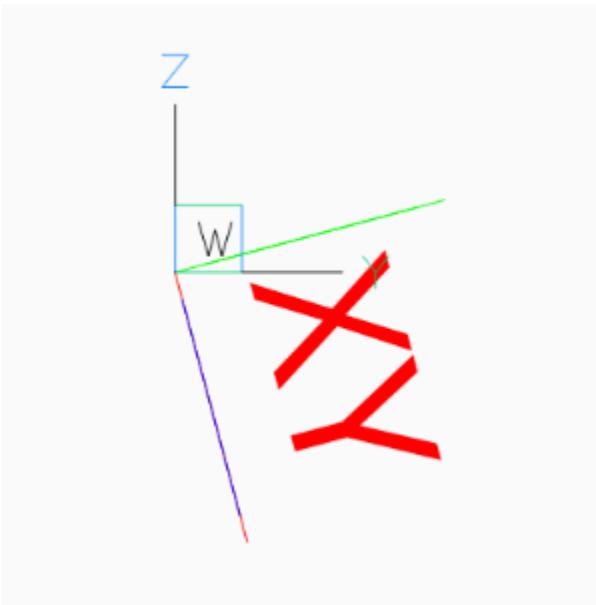
To rotate the block reference 15 degrees around the WCS x-axis, we place the block reference in the origin of the UCS, and rotate the UCS 90 degrees around its local y-axis, to align the UCS z-axis with the WCS x-axis:

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()

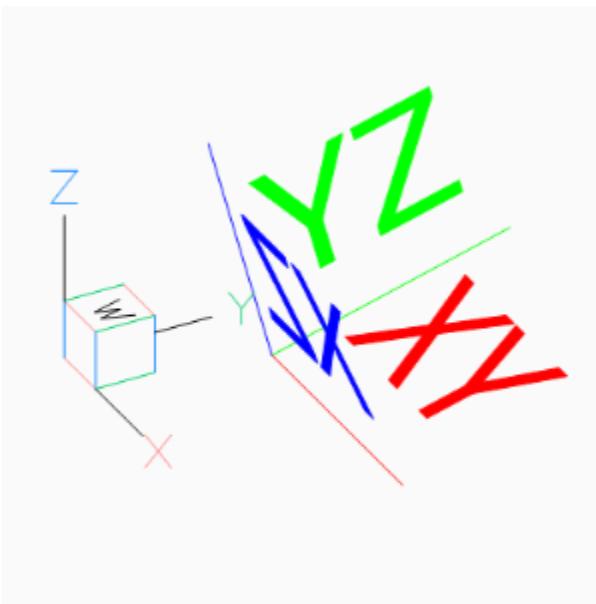
ucs = UCS().rotate_local_y(angle=math.radians(90))
msp.add_blockref(
    'CSYS',
    insert=(0, 0),
    # rotation around the block z-axis (= WCS x-axis)
    dxftattribs={'rotation': 15},
).transform(ucs.matrix)
```

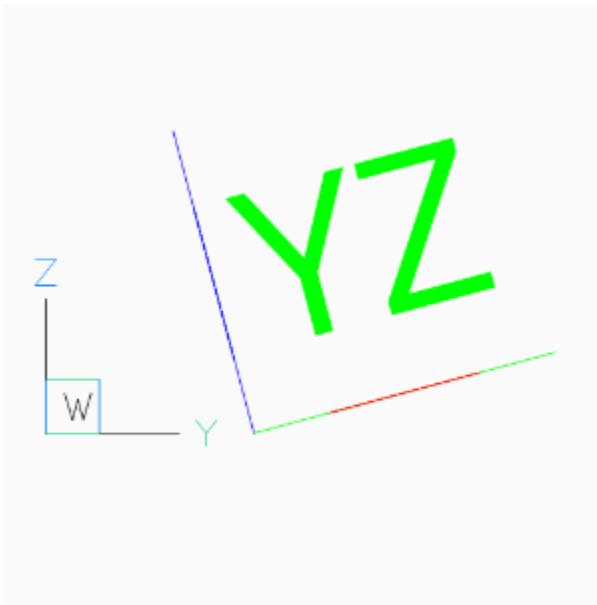




A more simple approach is to ignore the `rotate` attribute at all and just rotate the UCS. To rotate a block reference around any axis rather than the block z-axis, rotate the UCS into the desired position. Following example rotates the block reference around the block x-axis by 15 degrees:

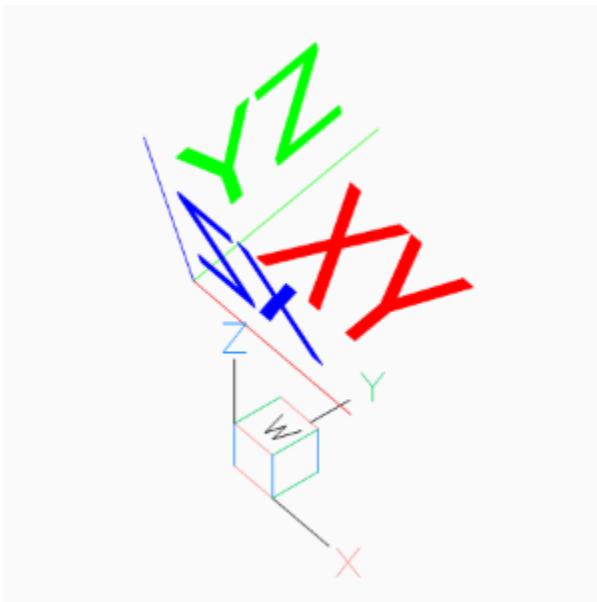
```
ucs = UCS(origin=(1, 2, 0)).rotate_local_x(math.radians(15))
blockref = msp.add_blockref('CSYS', insert=(0, 0, 0))
blockref.transform(ucs.matrix)
```

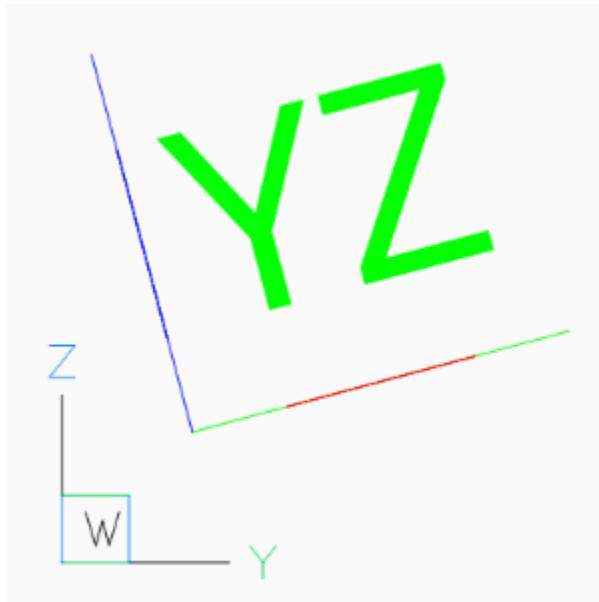




The next example shows how to translate a block references with an already established OCS:

```
# 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)
```





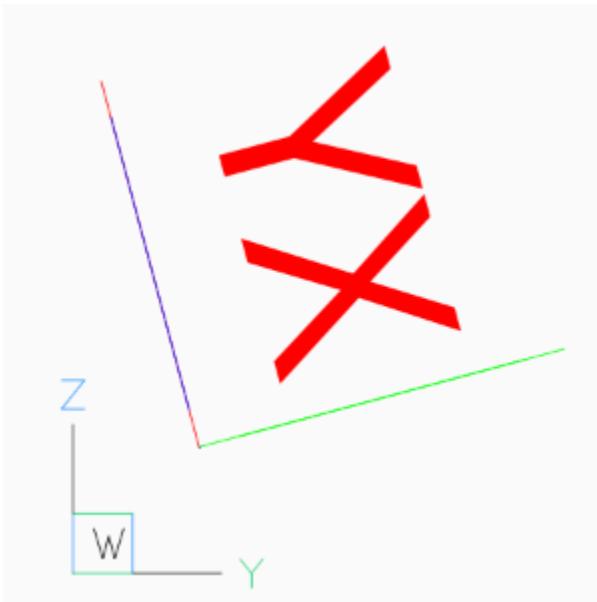
The next operation is to rotate a block reference with an established OCS, rotation axis is the block y-axis, rotation angle is -90 degrees. The idea is to create an UCS in the origin of the already placed block reference, UCS axis aligned to the block axis and resetting the block reference parameters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



#### 6.4.19 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 was not possible to implement all the various combinations of dimension style parameters.

Text rendering is another problem, because *ezdxf* has no real rendering engine. Some font properties, like the real text width, are not available to *ezdxf* and may also vary slightly for different CAD applications. The text properties in *ezdxf* are based on the default monospaced standard font, but for TrueType fonts the space around the text is much bigger than needed.

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 they disappear if the dimension line is edited in the application. *ezdxf* 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 MTEXT to create limits and tolerances and therefore they are not supported (displayed) in DXF R12 files.

#### See also:

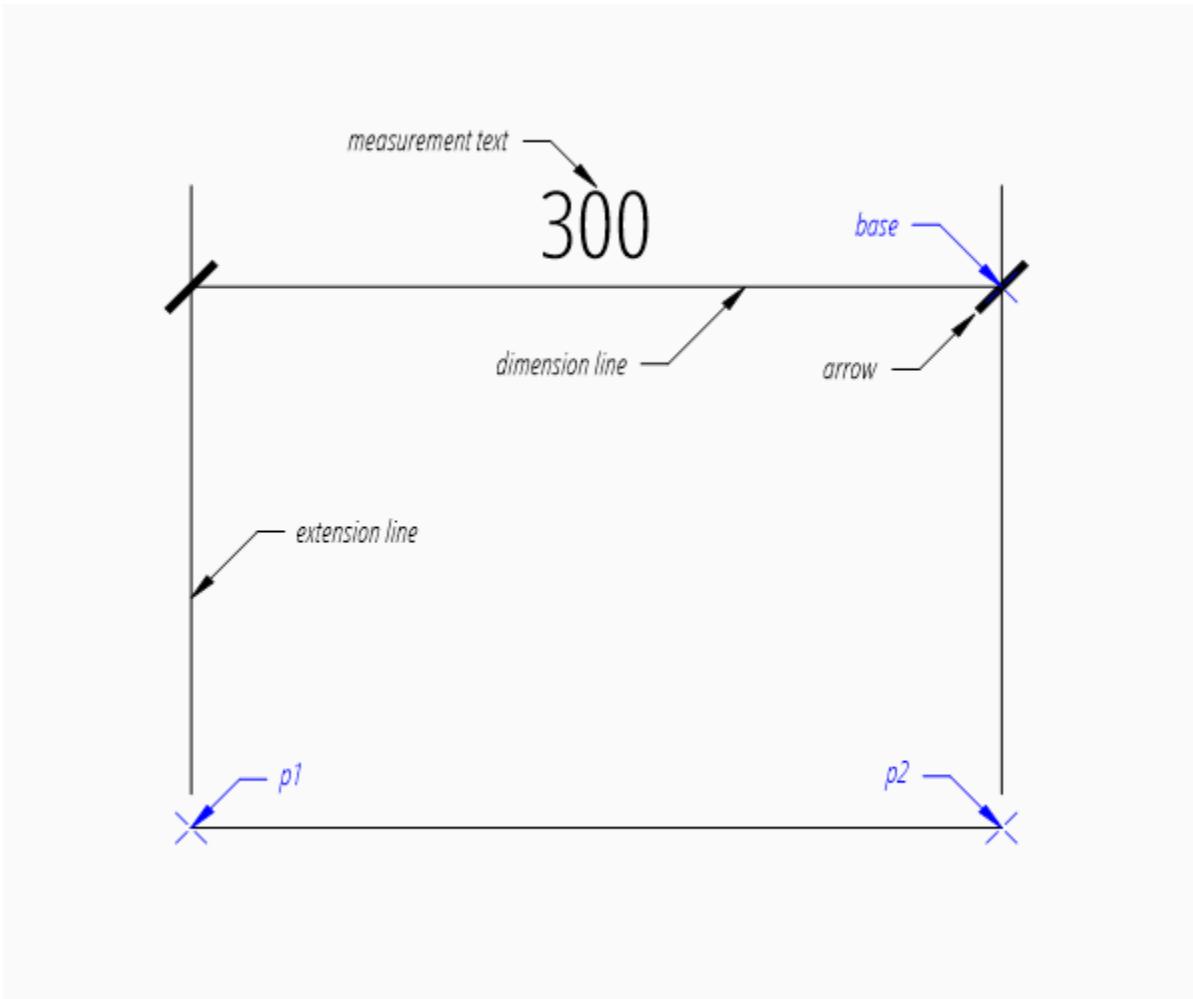
- Graphical reference of many DIMVARS and some advanced information: [DIMSTYLE Table](#)
- Source code file `standards.py` shows how to create your own DIMSTYLES.
- `dimension_linear.py` for linear dimension examples.

### Horizontal Dimension

```
import ezdxf

# Argument setup=True setups the default dimension styles
doc = ezdxf.new('R2010', setup=True)

# Add new dimension entities to the modelspace
msp = doc.modelspace()
# Add a LINE entity, not required
msp.add_line((0, 0), (3, 0))
# Add a horizontal dimension, default dimension style is 'EZDXF'
dim = msp.add_linear_dim(base=(3, 2), p1=(0, 0), p2=(3, 0))
# Necessary second step, to create the BLOCK entity with the dimension geometry.
# Additional processing of the dimension line could happen between adding and
# rendering call.
dim.render()
doc.saveas('dim_linear_horiz.dxf')
```



The example above creates a horizontal `Dimension` entity, the default dimension style 'EZDXF' and is defined as 1 drawing unit is 1m in reality, the drawing scale 1:100 and the length factor is 100, which creates a measurement text in cm.

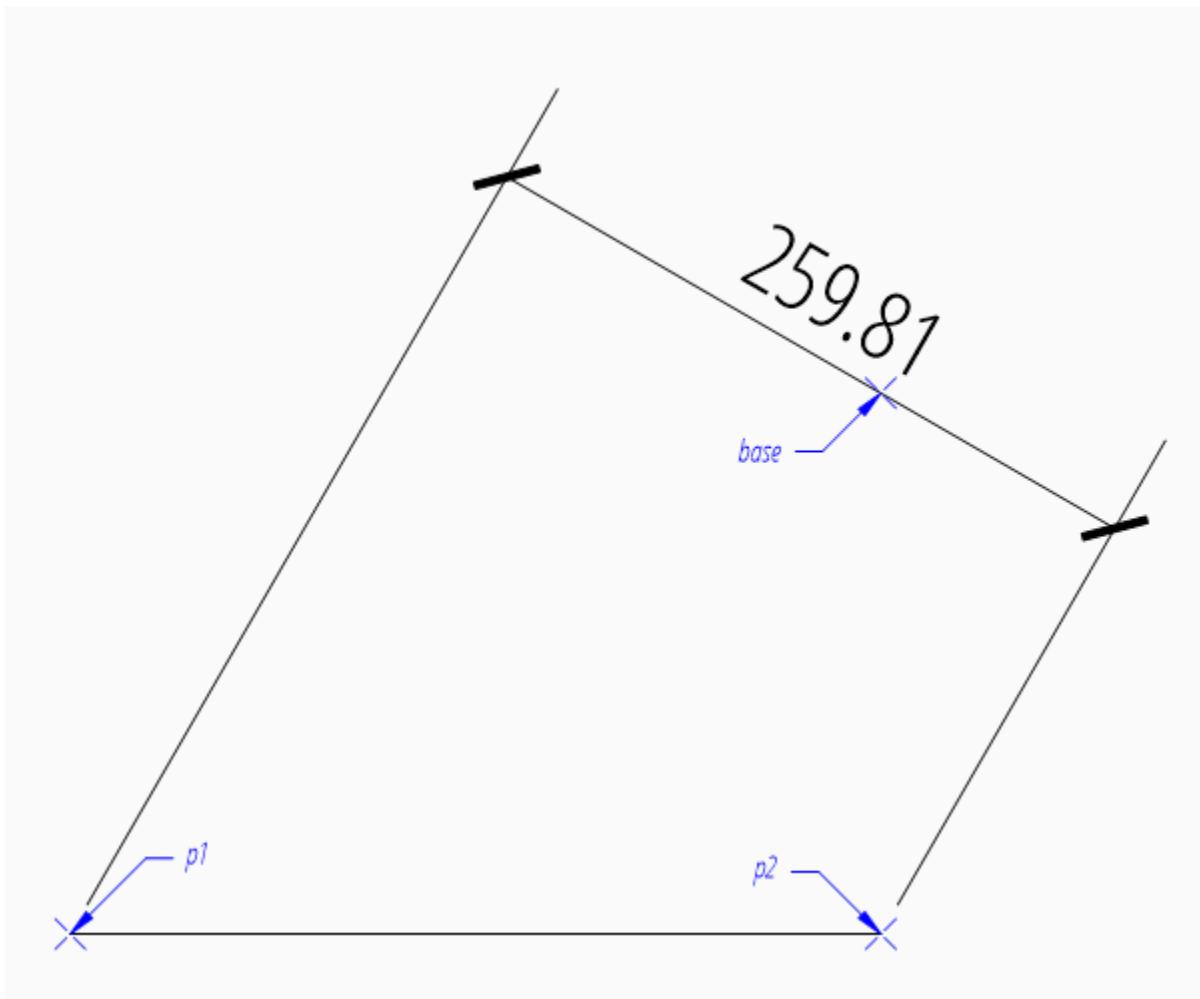
The `base` point defines the location of the dimension line, `ezdxf` accepts any point on the dimension line, the point `p1` defines the start point of the first extension line, which also defines the first measurement point and the point `p2` defines the start point of the second extension line, which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

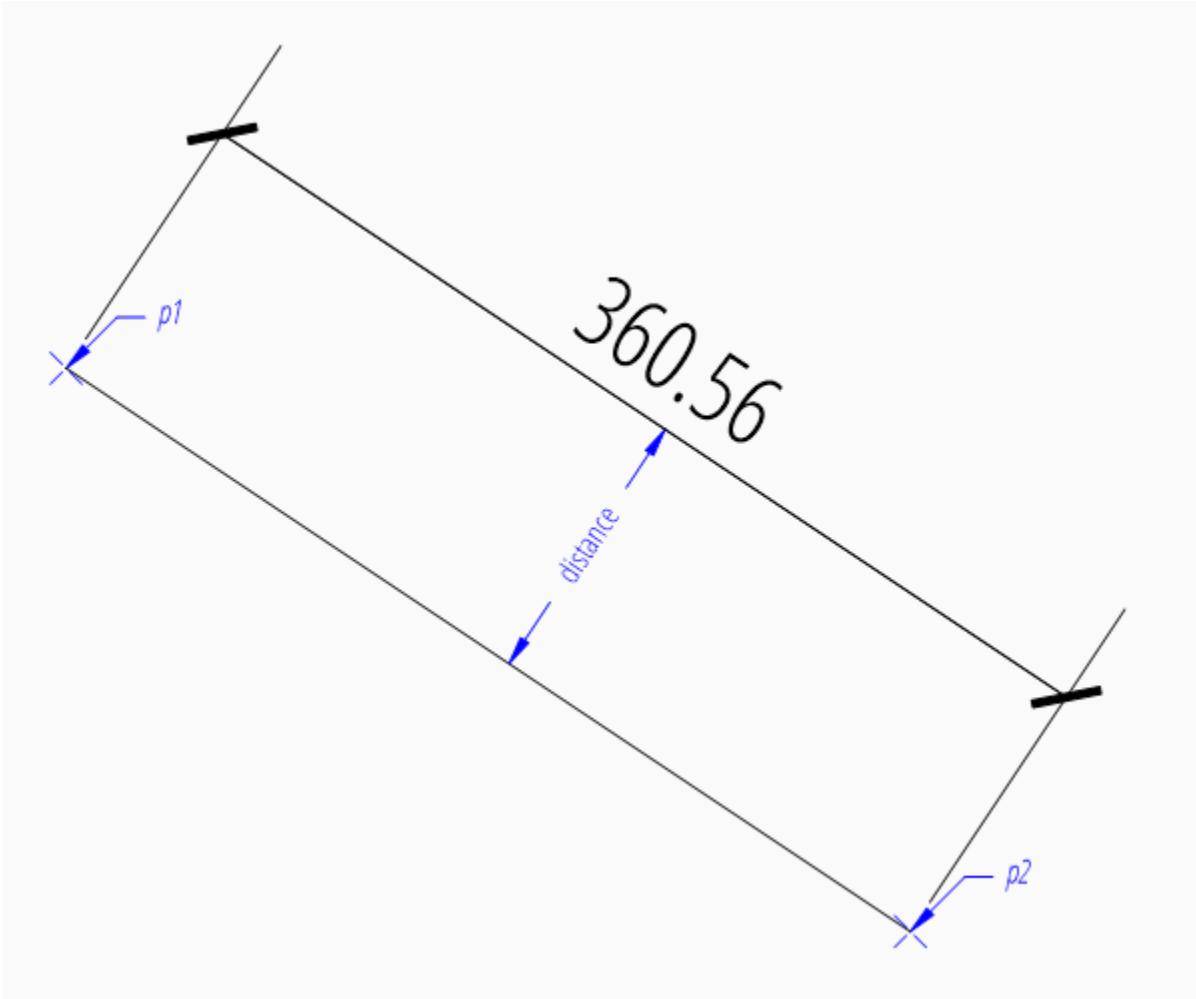


For a vertical dimension set argument *angle* to 90 degree, but in this example the vertical distance would be 0.

### 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.

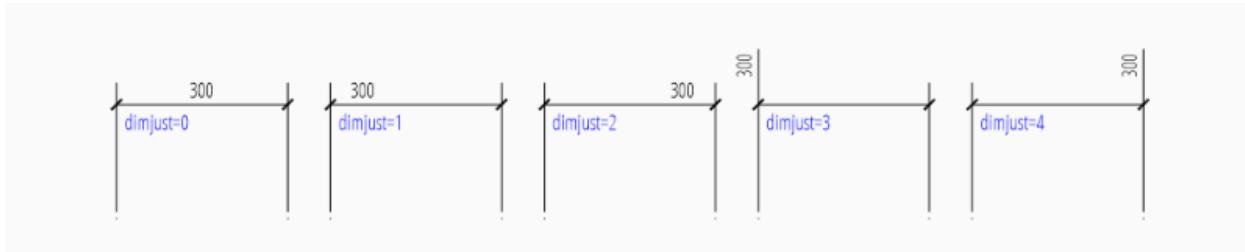
## Default Text Locations

“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

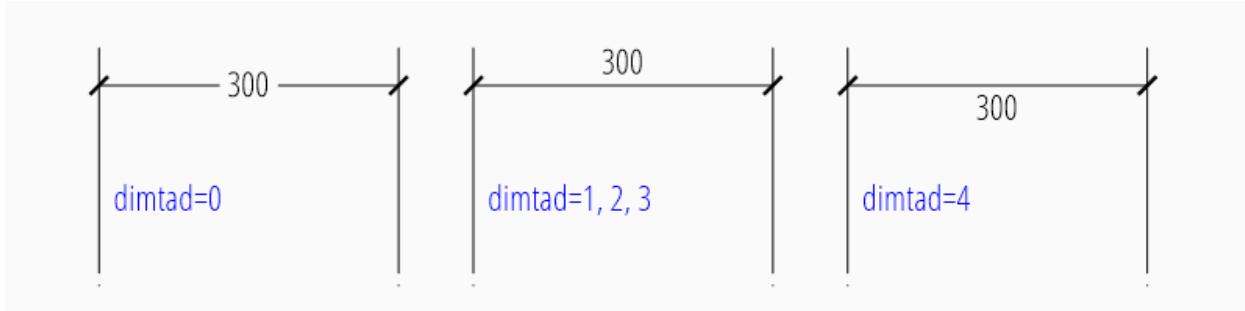
```
msp.add_linear_dim(base=(3, 2), p1=(0, 0), p2=(3, 0), override={'dimjust': 1}).  
render()
```



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*.

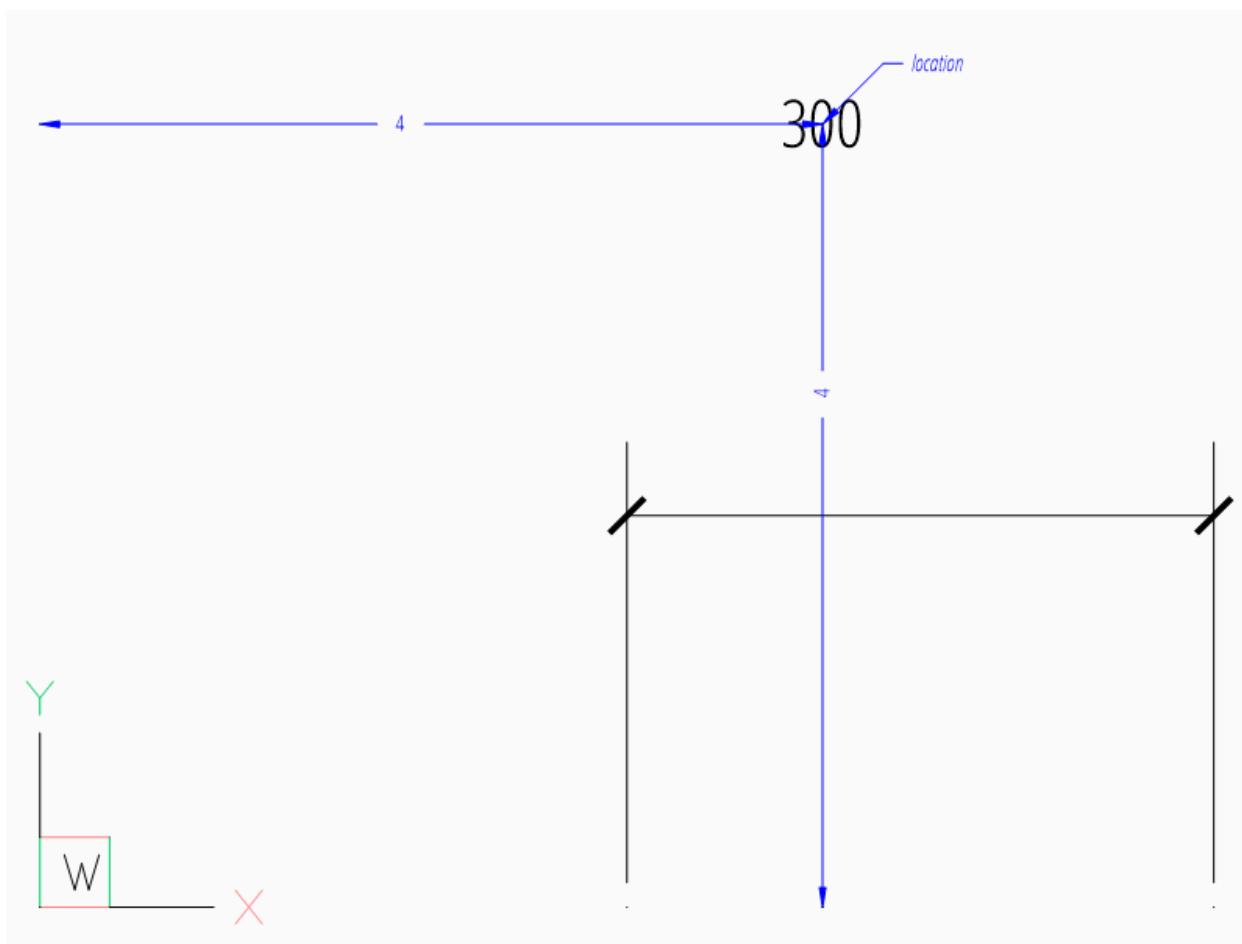
## User Defined Text Locations

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()
```



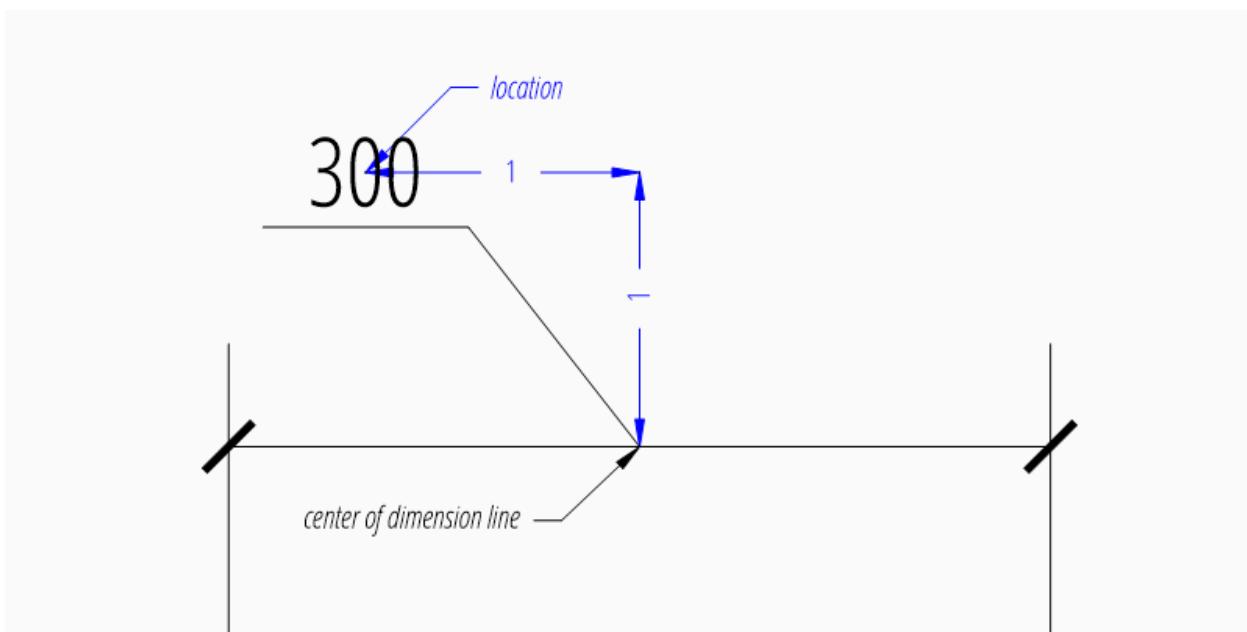
The `location` is relative to origin of the active coordinate system or WCS if no UCS is defined in the `render()` method, the user defined `location` can also be set by `user_location_override()`.

### 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.

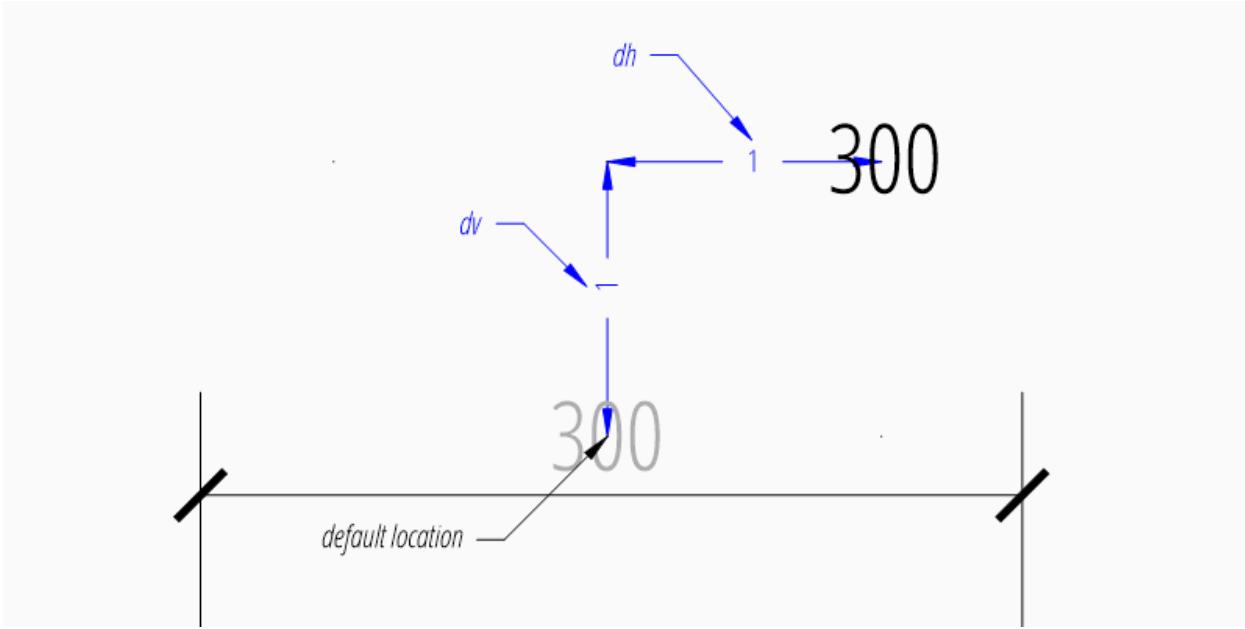
```
dim = msp.add_linear_dim(base=(3, 2), p1=(3, 0), p2=(6, 0))
dim.set_location(location=(-1, 1), leader=True, relative=True)
dim.render()
```



### Location Relative to Default Location

The method `shift_text()` shifts the measurement text away from the default text location. 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()
```

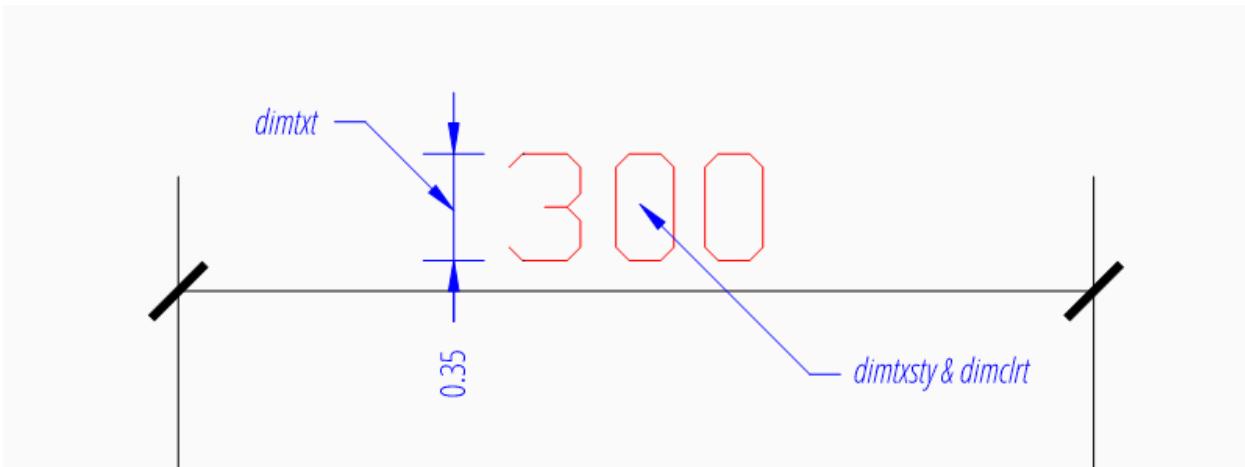


## Measurement Text Formatting and Styling

### Text Properties

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

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



## Background Filling

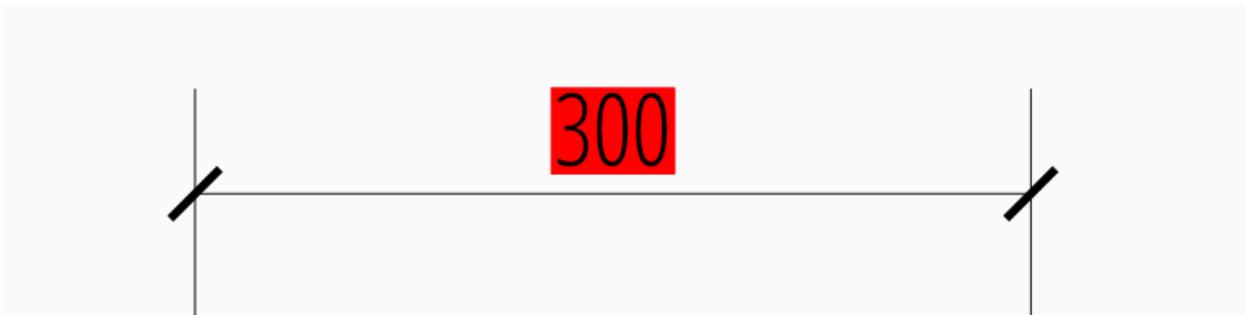
Background fillings are supported since DXF R2007, and *ezdxf* uses the MTEXT entity to implement this feature, so setting background filling in DXF R12 has no effect.

Set `dimtfill` to 1 to use the canvas color as background filling or set `dimtfill` to 2 to use `dimtfillclr` as background filling, color value as *AutoCAD Color Index (ACI)*. Set `dimtfill` to 0 to disable background filling.

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

	DIMVAR	Description
	<code>dimtfill</code>	
0		disabled
1		canvas color
2		color defined by <code>dimtfillclr</code>

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



## Text Formatting

- Set decimal places: `dimdec` defines the number of decimal places displayed for the primary units of a dimension. (DXF R2000)
- Set decimal point character: `dimsep` defines the decimal point as ASCII code, use `ord('.')`
- Set 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.
- Set zero trimming: `dimzin`, *ezdxf* supports only: 4 suppress leading zeros and 8: suppress trailing zeros and both as 12.
- Set 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 for measurement text is defined by `dimpost`, '<>' represents the measurement text, e.g. '`~<>cm`' produces '`~300cm`' for measurement in previous example.

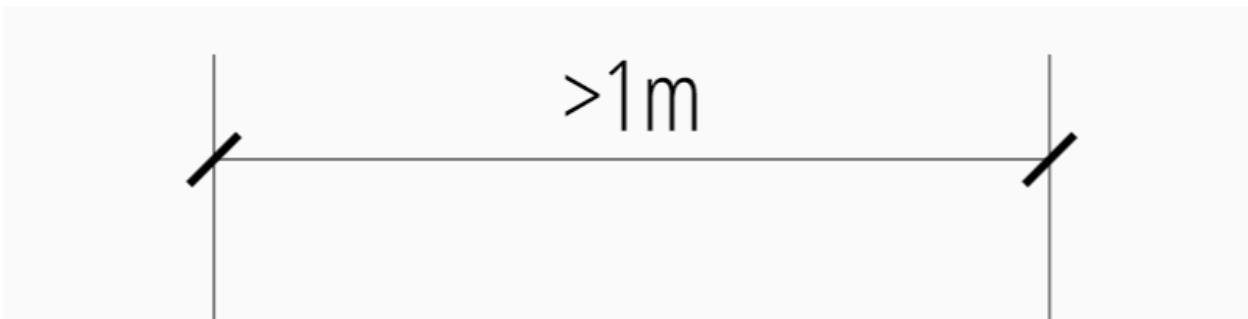
To set this values the `ezdxf.entities.DimStyle.set_text_format()` and `ezdxf.entities.DimStyleOverride.set_text_format()` methods are very recommended.

## Overriding Measurement Text

Measurement text overriding is stored in the `Dimension` entity, the content of to DXF attribute `text` represents the override value as string. Special values are one space ' ' to just suppress the measurement text, an empty string '' or '<>' to get the regular 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()
```

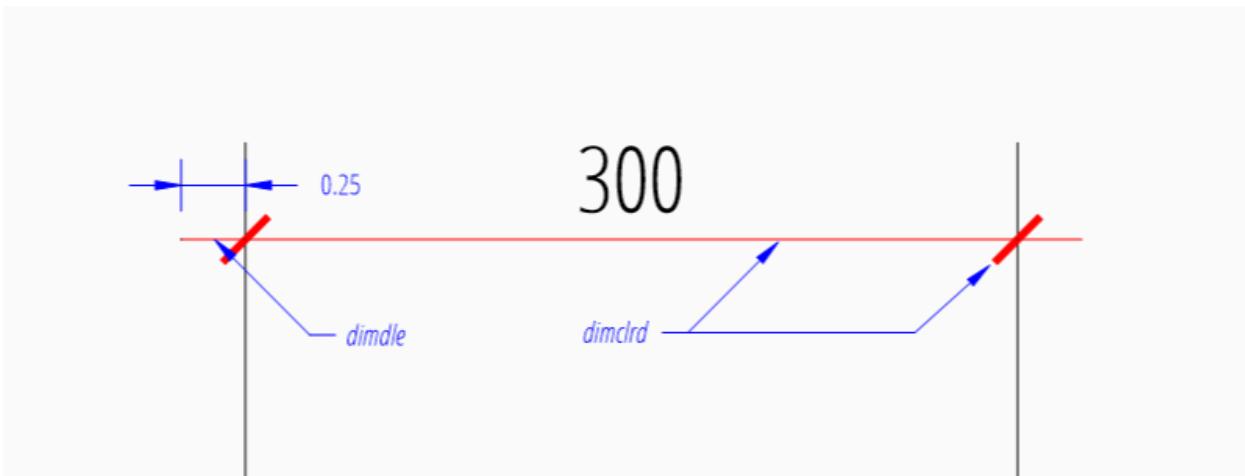


## Dimension Line Properties

The dimension line color is defined by the DIMVAR `dimclrd` as [AutoCAD Color Index \(ACI\)](#), `dimclrd` also defines the color of the arrows. The linetype is defined by `dimltype` but requires DXF R2007 for full support by CAD Applications and the line weight is defined by `dimlwd` (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
<code>dimclrd</code>	dimension line and arrows color as <a href="#">AutoCAD Color Index (ACI)</a>
<code>dimltype</code>	linetype of dimension line
<code>dimlwd</code>	line weight of dimension line
<code>dimdle</code>	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()
```

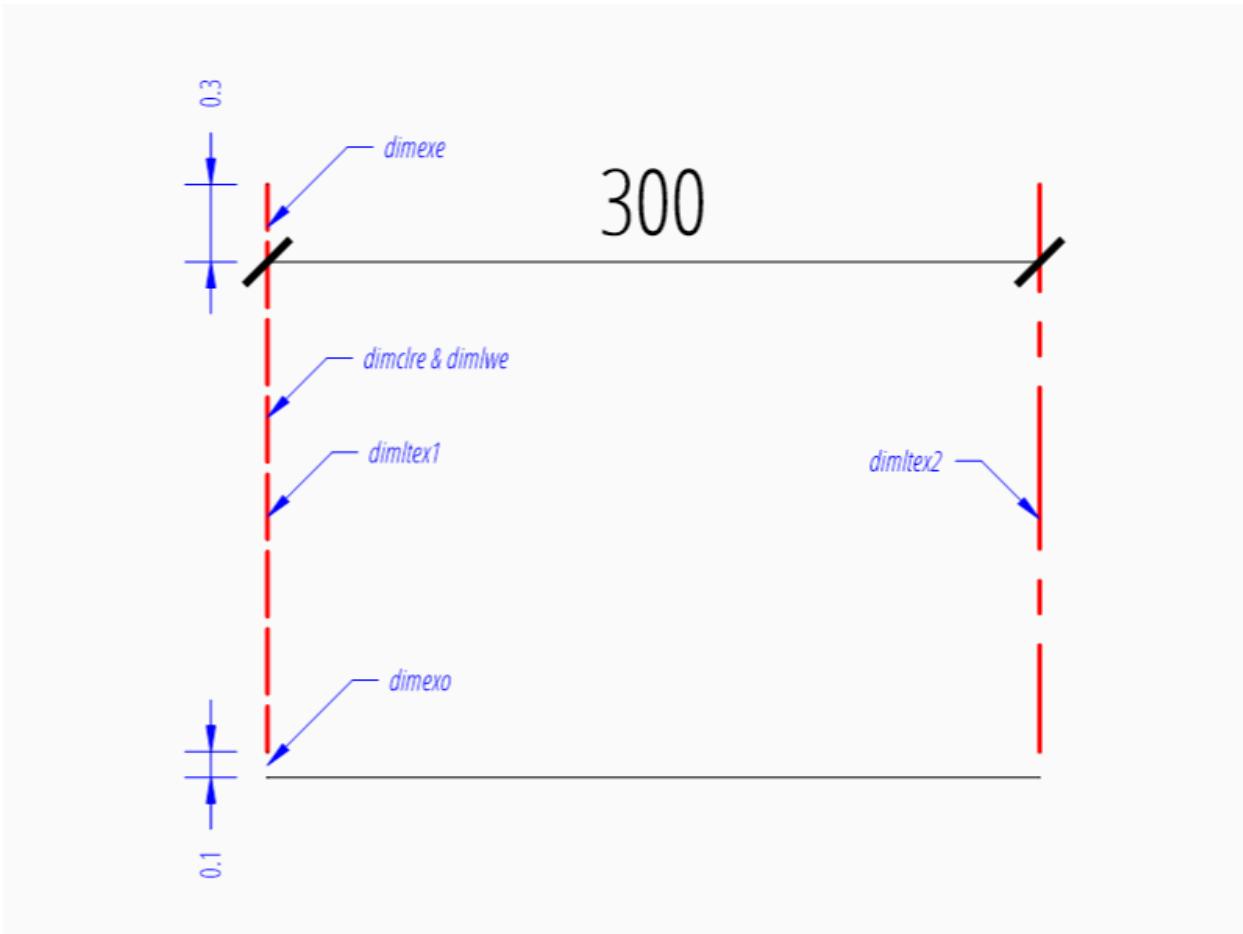
## Extension Line Properties

The extension line color is defined by the DIMVAR `dimclre` as *AutoCAD Color Index (ACI)*. The linetype for first and second extension line is defined by `dimltex1` and `dimltex2` but requires DXF R2007 for full support by CAD Applications and the line weight is defined by `dimlwe` (DXF R2000), see also the `lineweight` 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
<code>dimclre</code>	extension line color as <i>AutoCAD Color Index (ACI)</i>
<code>dimltex1</code>	linetype of first extension line
<code>dimltex2</code>	linetype of second extension line
<code>dimlwe</code>	line weight of extension line
<code>dimexe</code>	extension beyond dimension line in drawing units
<code>dimexo</code>	offset of extension line from measurement point
<code>dimfxlon</code>	set to 1 to enable fixed length extension line
<code>dimfxl</code>	length of fixed length extension line in drawing units
<code>dimse1</code>	suppress first extension line if 1
<code>dimse2</code>	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()
```

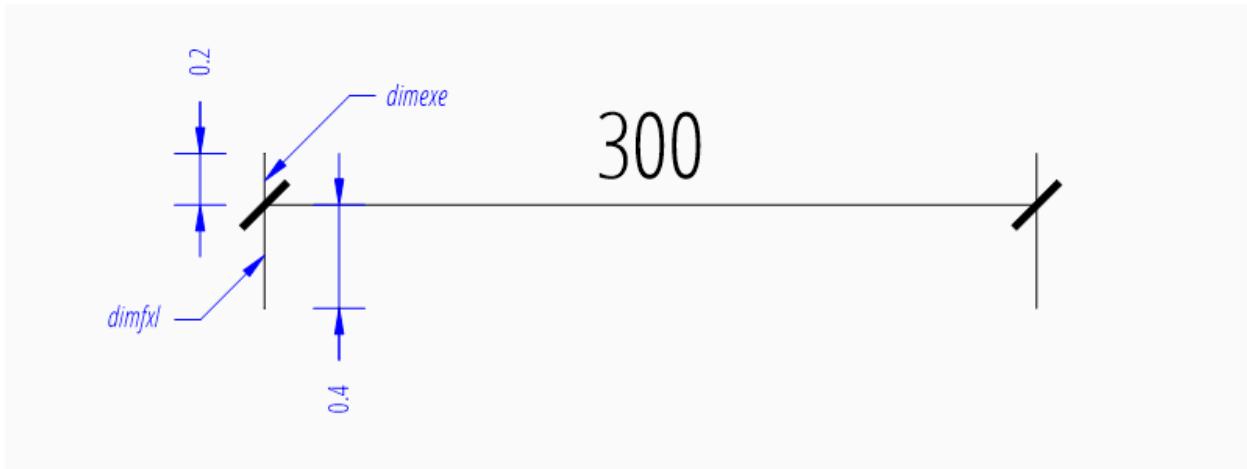


`DimStyleOverride()` methods:

```
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` = 1 to suppress the first extension line and `dimse2` = 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 and arrows as blocks.

Using the simple tick by setting tick size `dimtsz != 0` 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()
```

*ezdxf* 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()
```

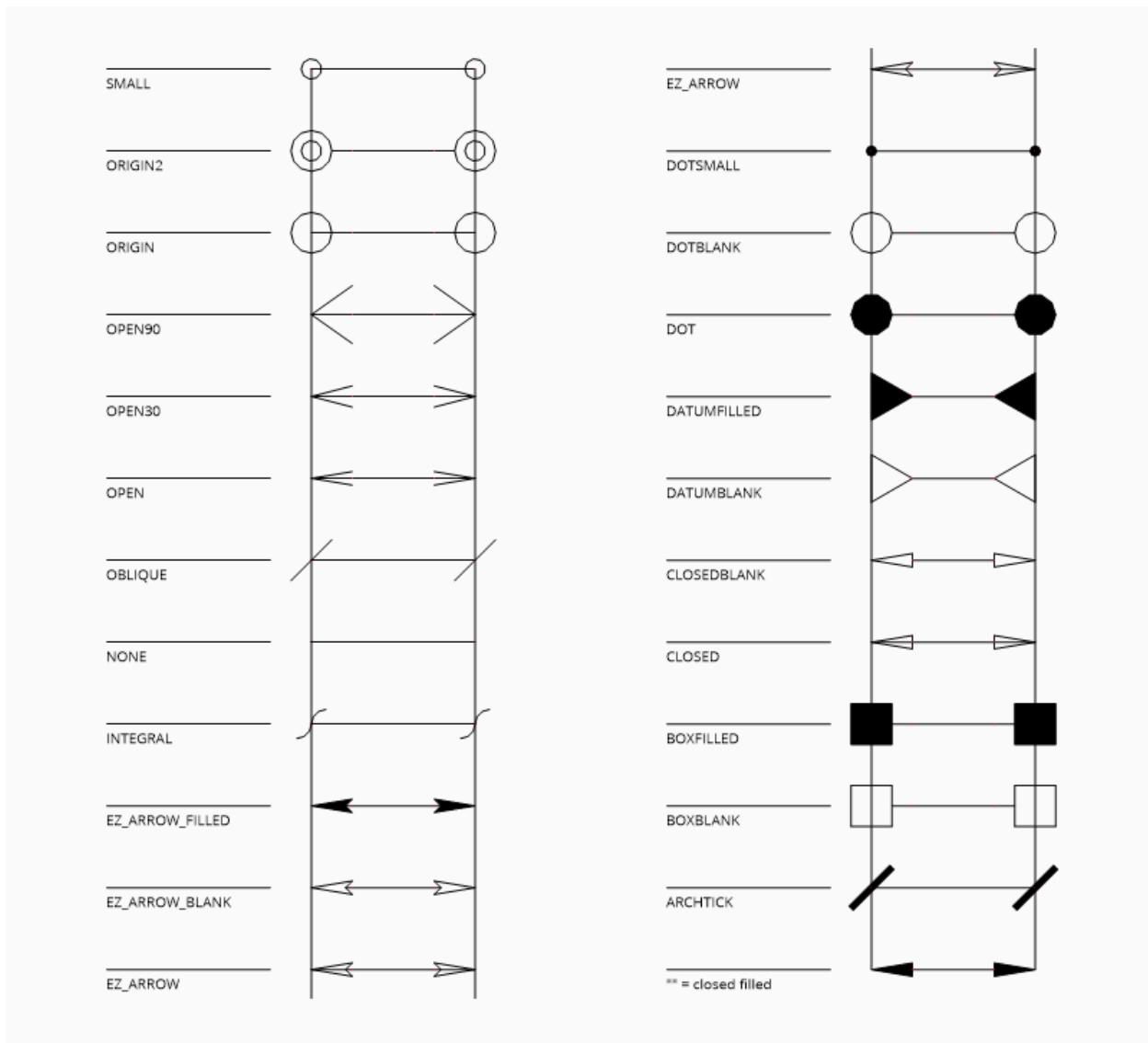
DIMVAR	Description
<code>dimtsz</code>	tick size in drawing units, set to 0 to use arrows
<code>dimblk</code>	set both arrow block names at once
<code>dimblk1</code>	first arrow block name
<code>dimblk2</code>	second arrow block name
<code>dimasz</code>	arrow size in drawing units

```
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()
```

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	"OBLIQUE"
box_filled	"BOXFILLED"
box	"BOXBLANK"
closed_blank	"CLOSEDBLANK"
datum_triangle_filled	"DATUMFILLED"
datum_triangle	"DATUMBANK"
integral	"INTEGRAL"
architectural_tick	"ARCHTICK"
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 the `MText` entity, therefore DXF R2000+ is required to use these features. It is not possible to use both tolerances and limits at the same time.

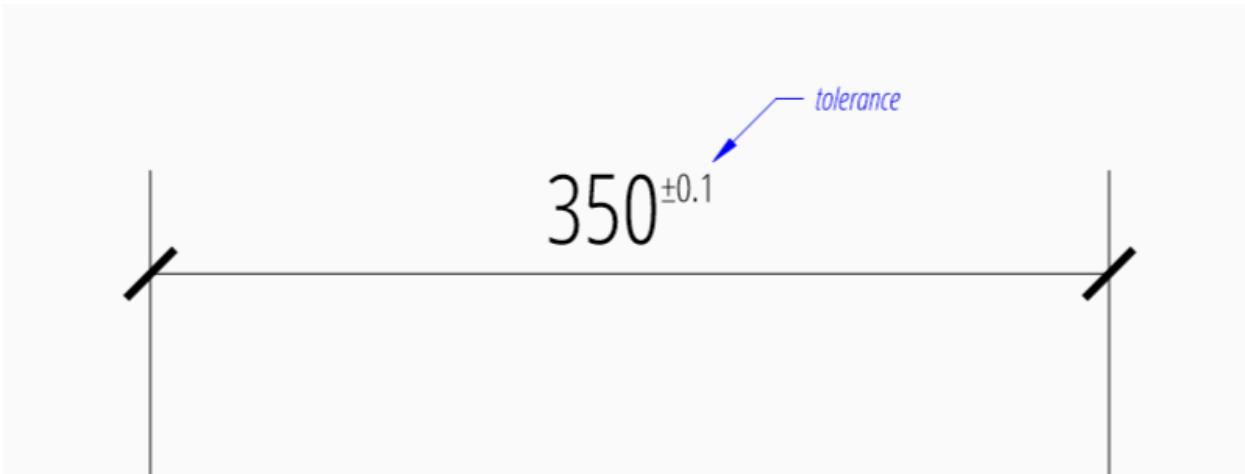
### Tolerances

Geometrical tolerances are shown as additional text appended to the measurement text. It is recommended 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!

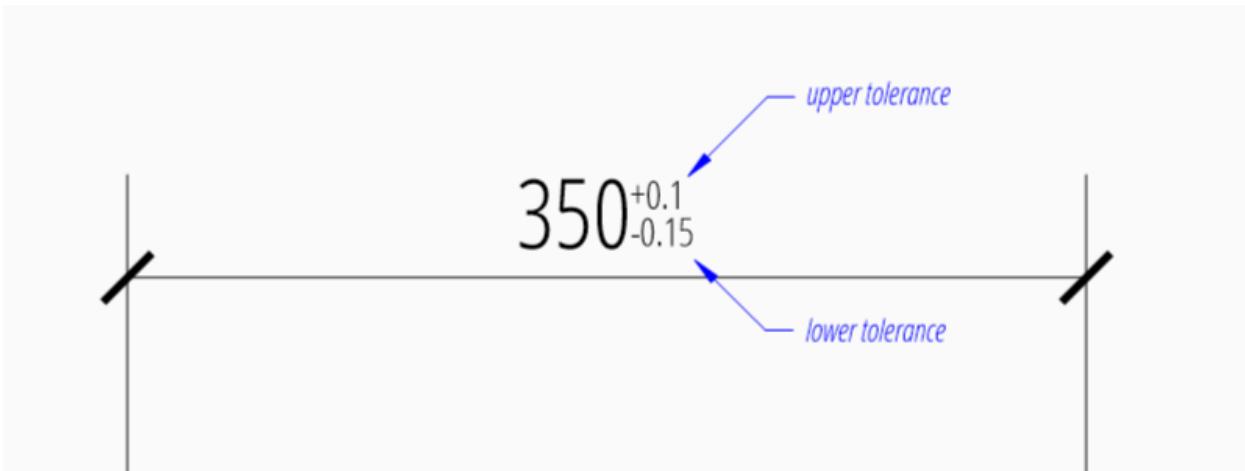
Same upper and lower tolerance value:

```
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.
dimec	set the number of decimal places to display in tolerance values

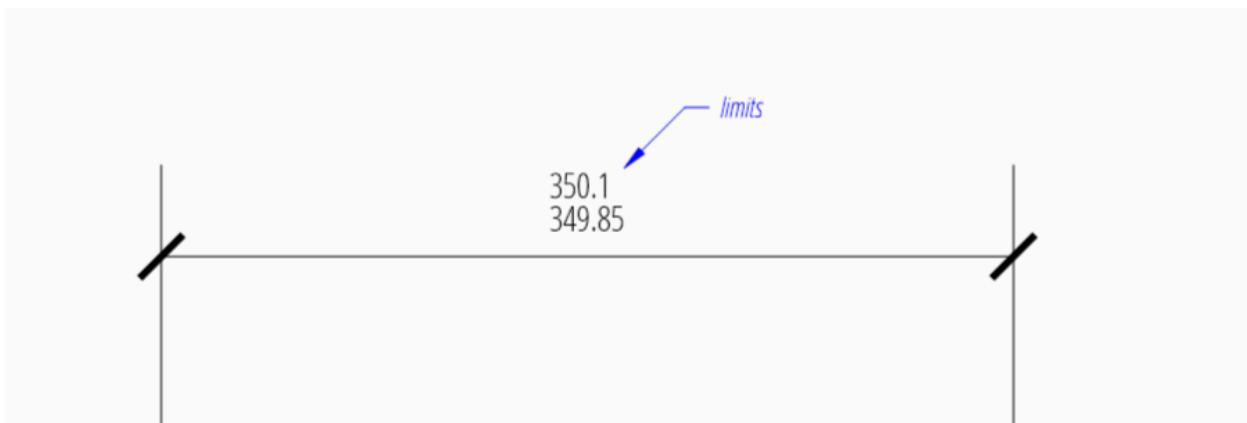
## Limits

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 `dimec` 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.

### 6.4.20 Tutorial for Radius Dimensions

Please read the [Tutorial for Linear Dimensions](#) before, if you haven't.

```

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 is 1m in reality, drawing scale 1:100 and the length factor is 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.

DIMSTYLE 'EZ\_RADIUS' settings are: 1 drawing unit is 1m, scale 1:100, length\_factor is 100 which creates measurement text in cm, and a closed filled arrow with size 0.25 is used.

---

**Note:** Not all possible features of DIMSTYLE are supported and especially for radial dimension there are less features supported as for linear dimension because of the lack of good documentation.

---

### See also:

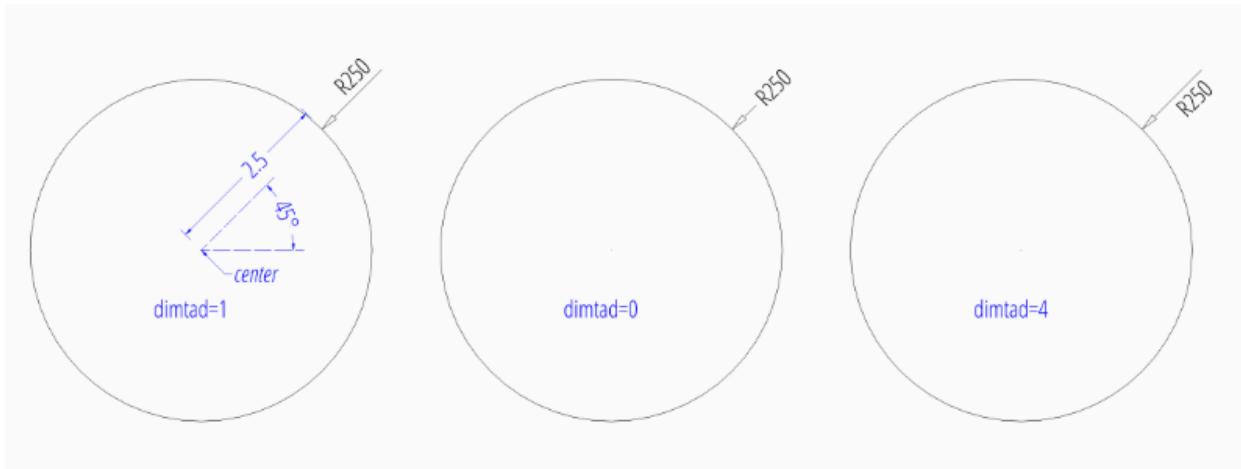
- Graphical reference of many DIMVARS and some advanced information: *DIMSTYLE Table*
- Source code file `standards.py` shows how to create your own DIMSTYLES.
- `dimension_radius.py` for radius dimension examples.

## Default Text Locations Outside

'EZ\_RADIUS' default settings for to place text outside:

tmove	1 to keep dim line with text, this is the best setting for text outside to preserve appearance of the DIMENSION entity, if editing afterwards in BricsCAD or AutoCAD.
dim-tad	1 to place text vertical above the dimension line

```
dim = msp.add_radius_dim(center=(0, 0), radius=2.5, angle=45,
                           dimstyle='EZ_RADIUS'
                           )
dim.render()  # 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}
                           )
```



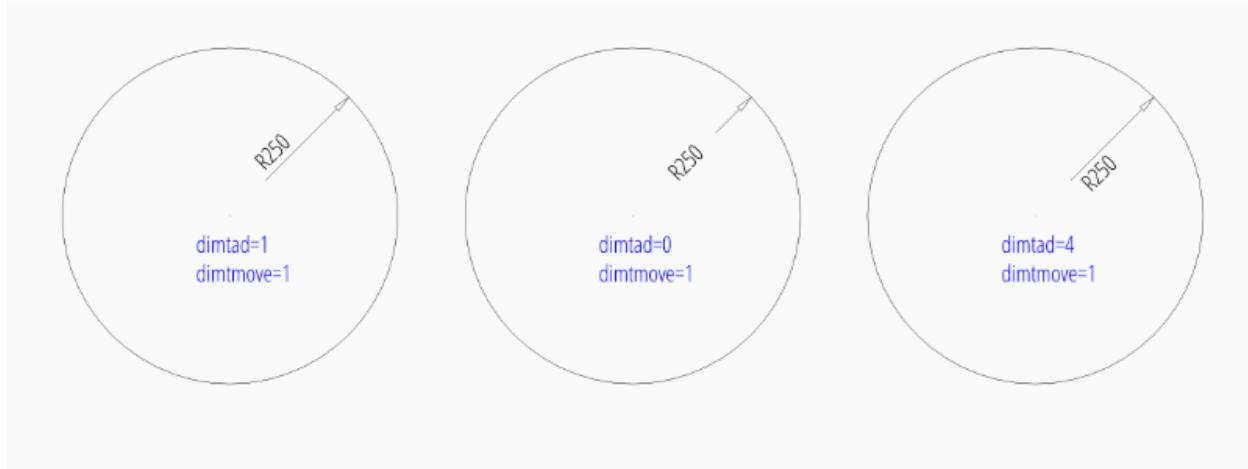
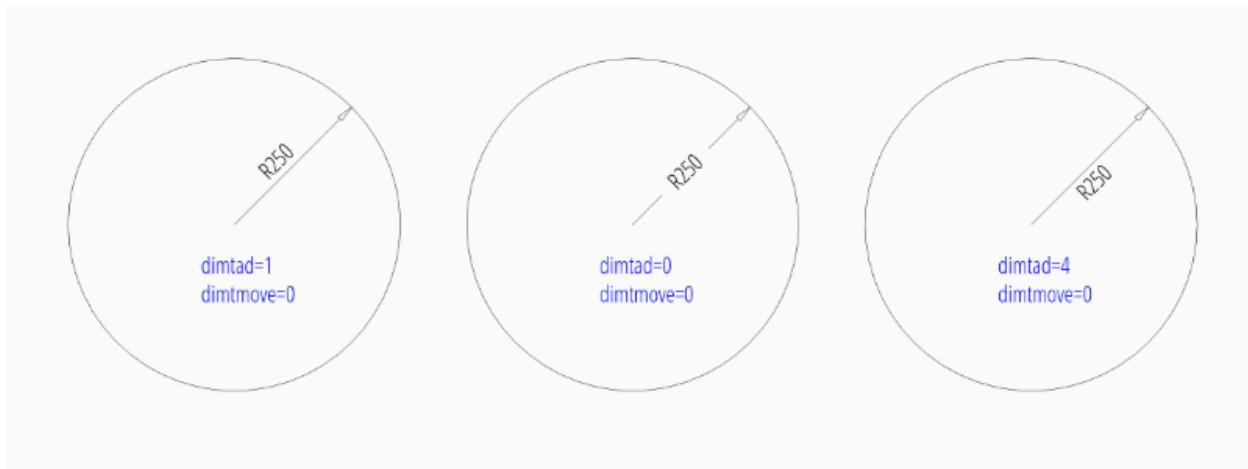
## Default Text Locations Inside

DIMSTYLE 'EZ\_RADIUS\_INSIDE' can be used to place the dimension text inside the circle at a default location. Default DIMSTYLE settings are: 1 drawing unit is 1m, scale 1:100, length\_factor is 100 which creates measurement text in cm, and a closed filled arrow with size 0.25 is used.

'EZ\_RADIUS\_INSIDE' default settings:

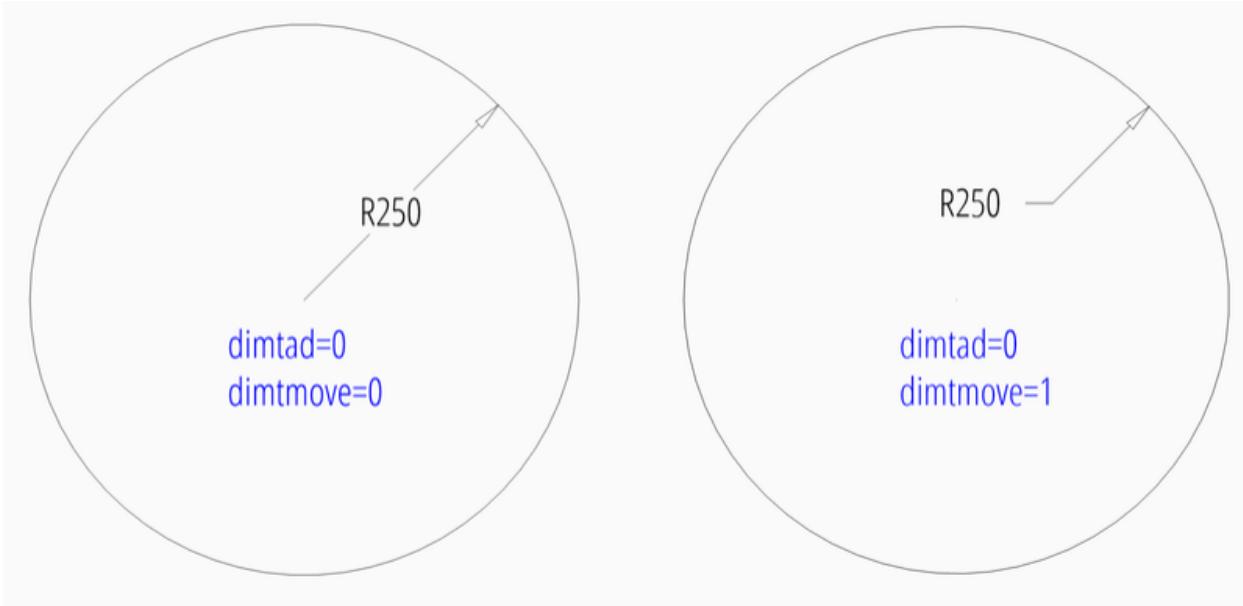
tmove	0 to keep dim line with text, this is the best setting for text inside to preserve appearance of the DIMENSION entity, if editing afterwards in BricsCAD or AutoCAD.
dimtih	1 to force text inside
di-mat-fit	0 to force text inside, required by BricsCAD and AutoCAD
dimtad	0 to center text vertical, BricsCAD and AutoCAD always create 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'
                           )
```



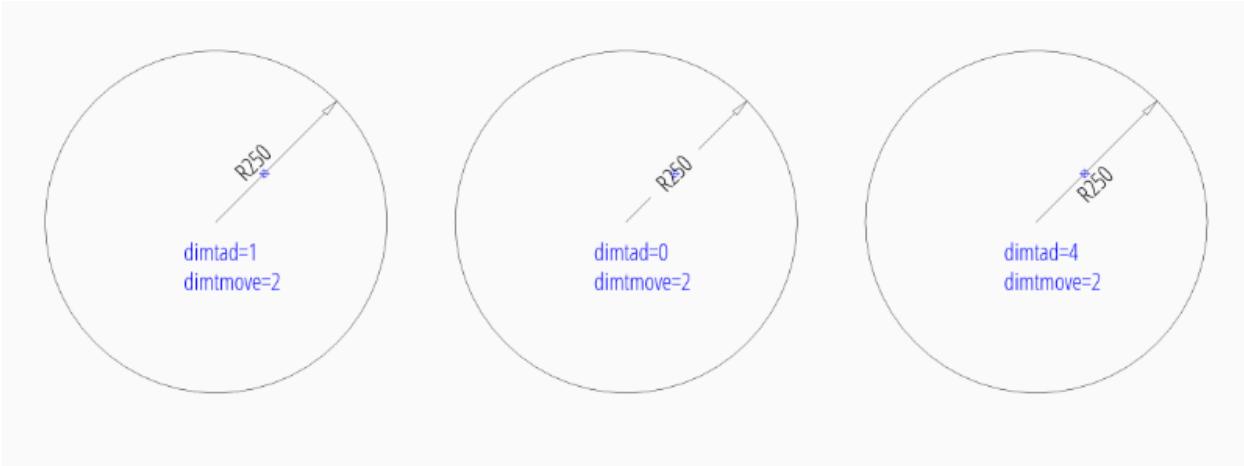
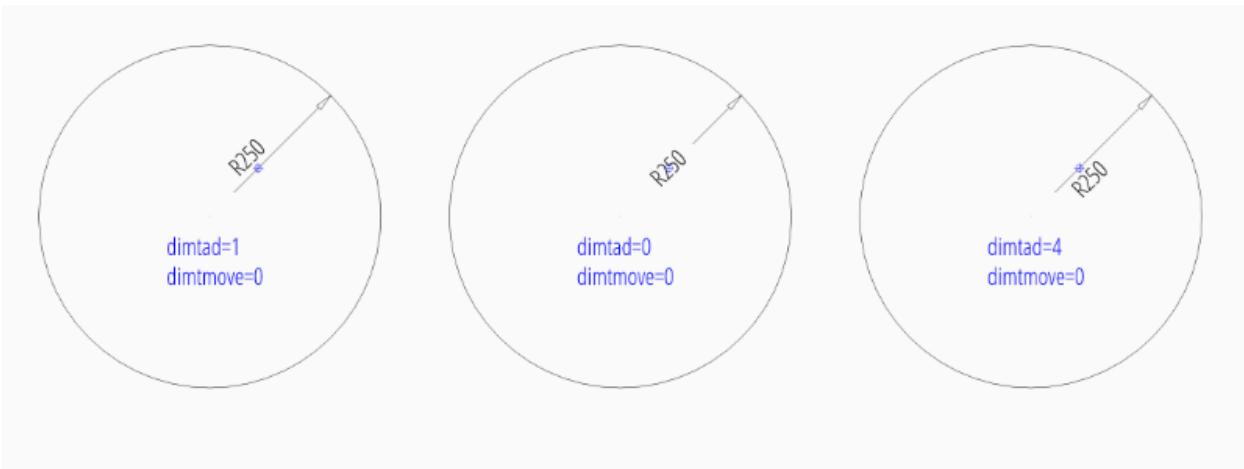
User defined location outside of the circle and forced horizontal text:

```
dim = msp.add_radius_dim(center=(0, 0), radius=2.5, location=(4, 4),
                           dimstyle='EZ_RADIUS',
                           override={'dimtoh': 1}
                           )
```



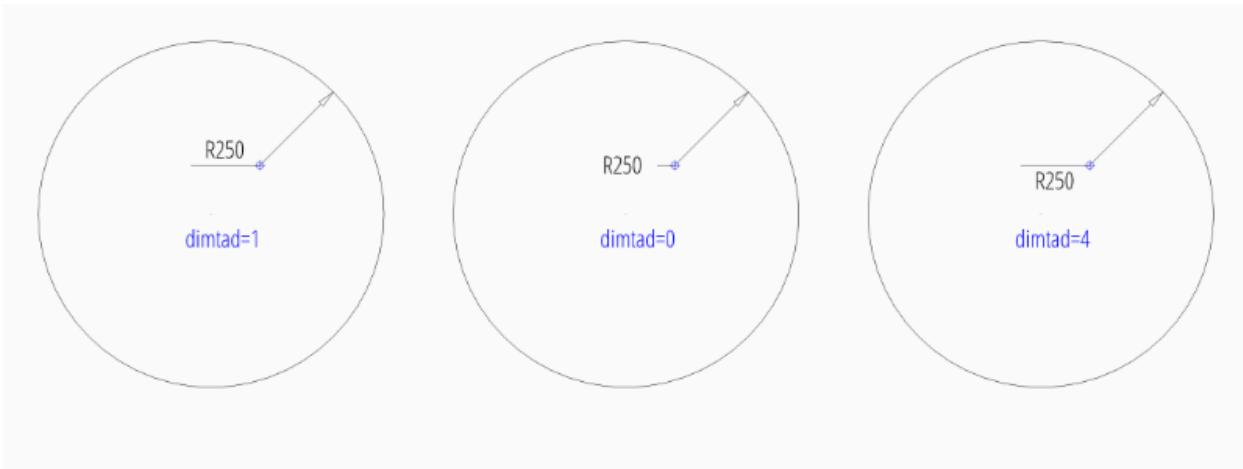
User defined location inside of the circle:

```
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},
                         )
```

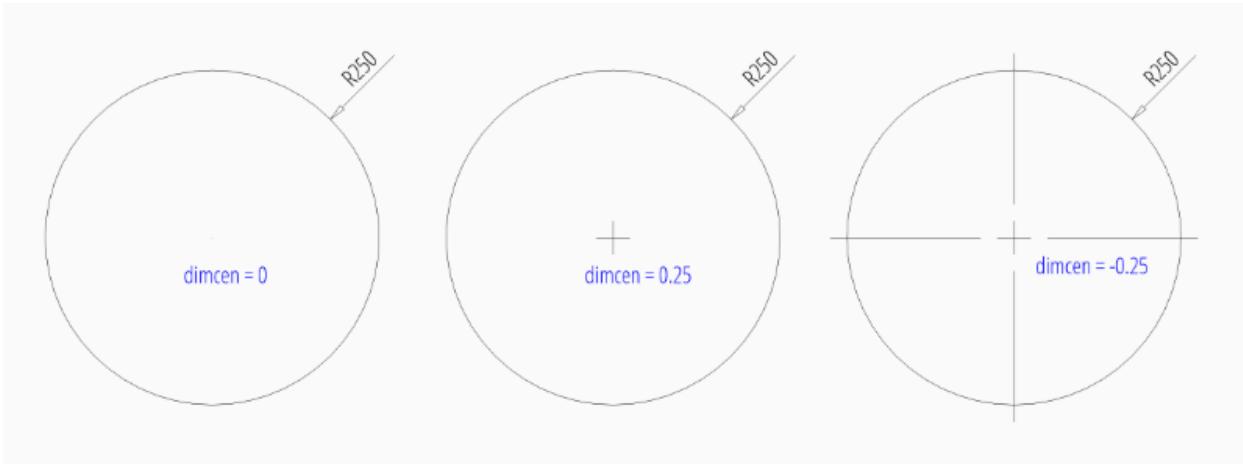


### Center Mark/Lines

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), 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](#)

### 6.4.21 Tutorial for Diameter Dimensions

Please read the [Tutorial for Radius Dimensions](#) before, if you haven't.

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')
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 is 1m in reality, drawing scale 1:100 and the length factor is 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.

DIMSTYLE 'EZ\_RADIUS' settings are: 1 drawing unit is 1m, scale 1:100, length\_factor is 100 which creates measurement text in cm, and a closed filled arrow with size 0.25 is used.

---

**Note:** Not all possible features of DIMSTYLE are supported and especially for diameter dimension there are less features supported as for linear dimension because of the lack of good documentation.

---

#### See also:

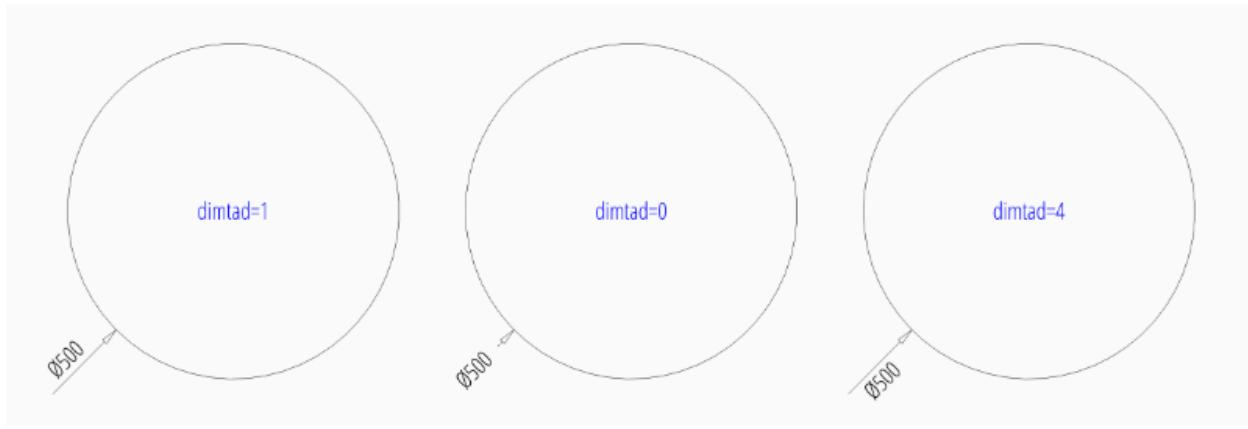
- Graphical reference of many DIMVARS and some advanced information: [DIMSTYLE Table](#)
- Source code file `standards.py` shows how to create your own DIMSTYLES.
- `dimension_diameter.py` for diameter dimension examples.

## Default Text Locations Outside

'EZ\_RADIUS' default settings for to place text outside:

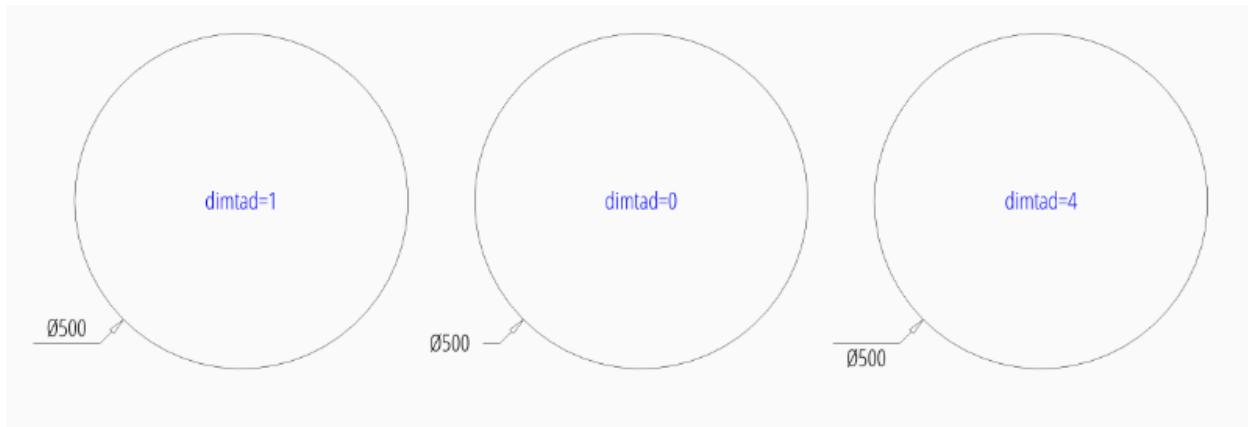
tmove	1 to keep dim line with text, this is the best setting for text outside to preserve appearance of the DIMENSION entity, if editing afterwards in BricsCAD or AutoCAD.
dim-tad	1 to place text vertical above the dimension line

```
dim = msp.add_diameter_dim(center=(0, 0), radius=2.5, angle=45,
                           dimstyle='EZ_RADIUS')
dim.render()  # 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})
```



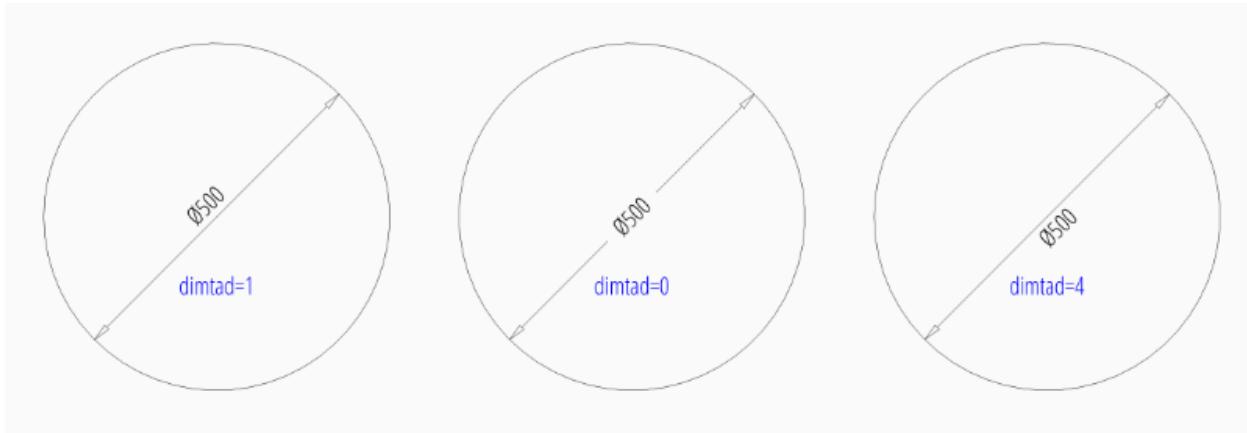
## Default Text Locations Inside

DIMSTYLE 'EZ\_RADIUS\_INSIDE' can be used to place the dimension text inside the circle at a default location. Default DIMSTYLE settings are: 1 drawing unit is 1m, scale 1:100, length\_factor is 100 which creates measurement text in cm, and a closed filled arrow with size 0.25 is used.

'EZ\_RADIUS\_INSIDE' default settings:

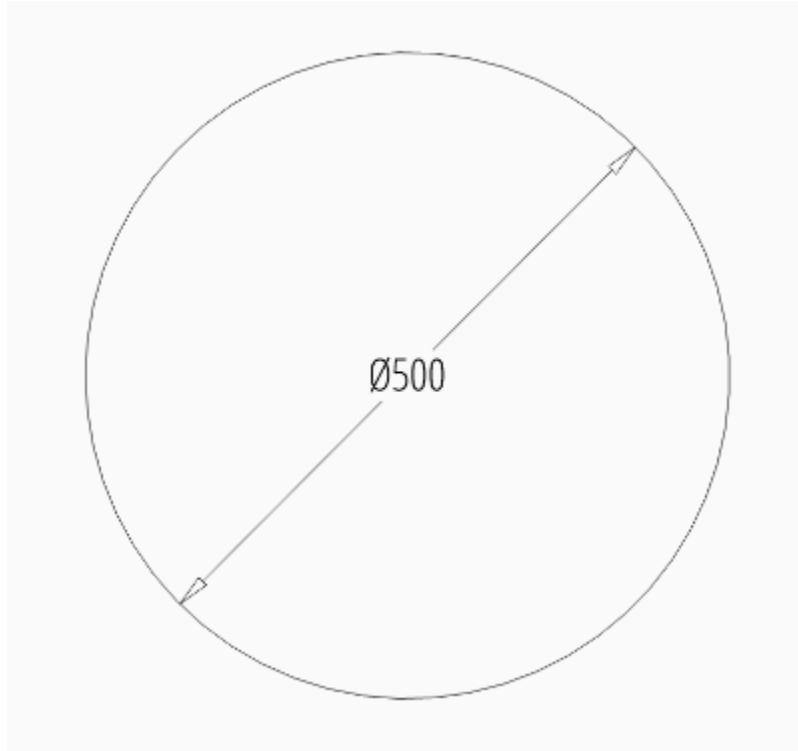
tmove	0 to keep dim line with text, this is the best setting for text inside to preserve appearance of the DIMENSION entity, if editing afterwards in BricsCAD or AutoCAD.
dimtix	1 to force text inside
di-mat-fit	0 to force text inside, required by BricsCAD and AutoCAD
dimtad	0 to center text vertical, BricsCAD and AutoCAD always create 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 *dimtih* to 1:

```
dim = msp.add_diameter_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.

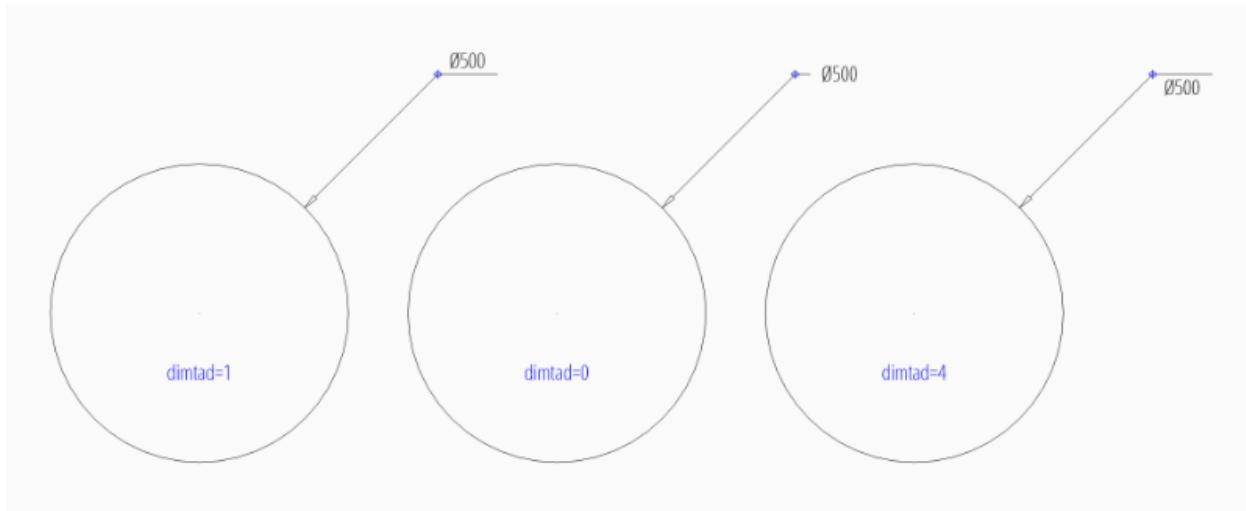
User defined location outside of the circle:

```
dim = msp.add_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={'dimtob': 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](#)

### 6.4.22 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()
```

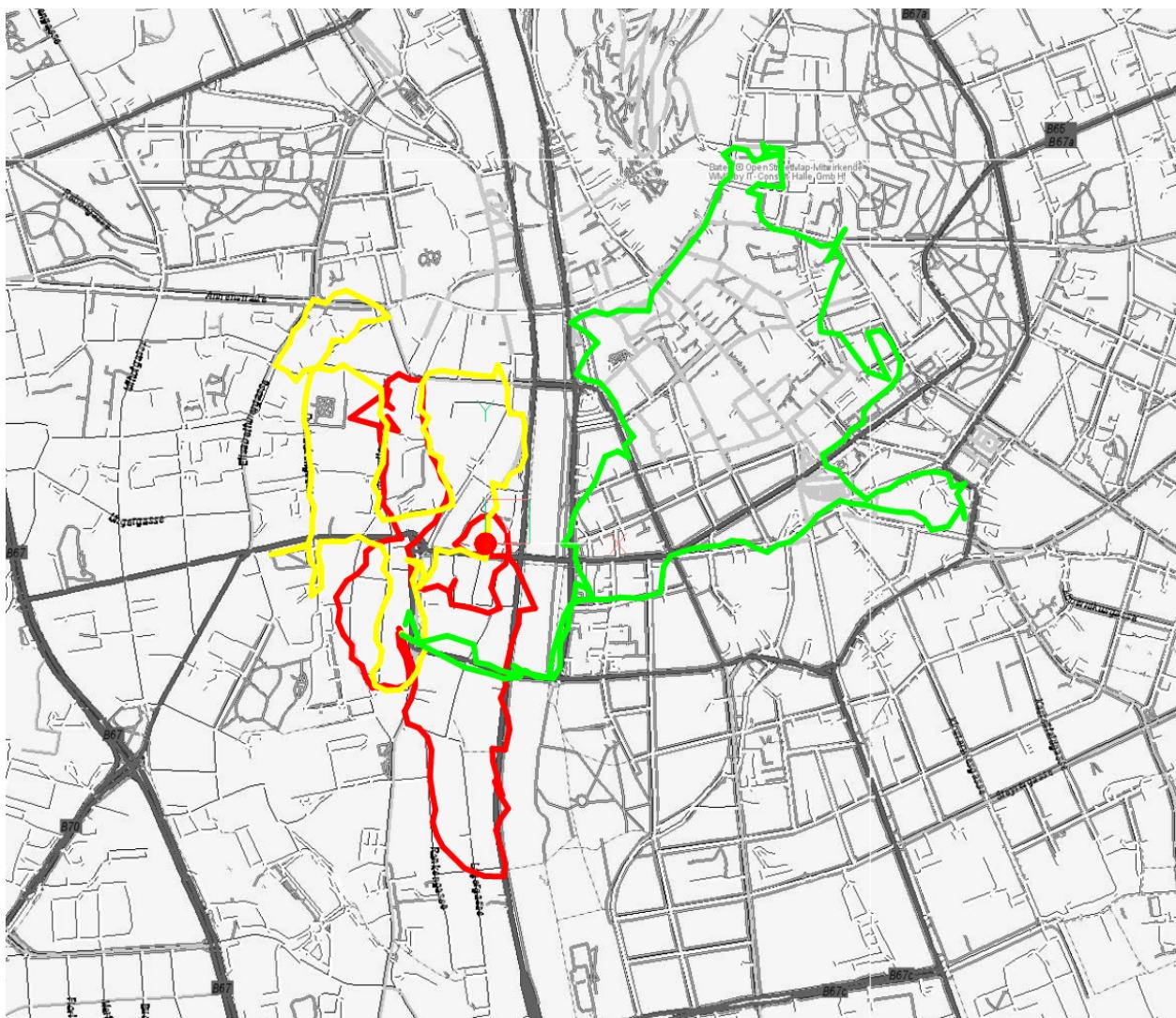
The data is now transformed into 2D cartesian coordinates in meters and most likely far away from origin (0, 0), the data stored in the `GEODATA` entity helps to transform the data into the DXF WCS in modelspace units, if the DXF file has no geo location reference you have to stick with the large coordinates:

```
# 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:
```

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```
# Identity matrix for DXF files without geo reference data:
m = Matrix44()
```

Query the DXF entities to export:

```
m = Matrix44()
for track in msp.query('LWPOLYLINE'):
```

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 eздxf.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 eздxf.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 eздxf
from eздxf.addons import geo
from shapley.geometry import shape

# Load DXF document including HATCH entities.
doc = eздxf.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 eздxf.addons import geo
from eздxf.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 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.

### 6.5.1 DXF Document

#### Document Management

##### Create New Drawings

`ezdxf.new(dxversion='AC1027', setup=False, units=6)` → Drawing

Create a new Drawing from scratch, `dxversion` 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

- **dxversion** – 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: str, 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

Deprecated since version v0.14: argument *legacy\_mode*, use module `ezdxf.recover` to load DXF documents with structural flaws.

`ezdxf.read(stream: TextIO) → 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

Deprecated since version v0.14: argument `legacy_mode`, use module `ezdxf.recover` to load DXF documents with structural flaws.

`ezdxf.readzip(zipfile: str, filename: str = None, errors: str="surrogateescape")` → 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")` → 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 `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

<code>\$ACADVER</code>	DXF version
<code>\$TDCREATE</code>	date/time at creating the drawing
<code>\$FINGERPRINTGUID</code>	every drawing gets a GUID

### Header variables updated at saving

<code>\$TDUPDATE</code>	actual date/time at saving
<code>\$HANDSEED</code>	next available handle as hex string
<code>\$DWGCODEPAGE</code>	encoding setting
<code>\$VERSIONGUID</code>	every saved version gets a new GUID

### See also:

- Howto: [Set/Get Header Variables](#)
- Howto: [Set DXF Drawing Units](#)

## Drawing Object

**class** `ezdxf.document.Drawing`

The [Drawing](#) class manages all entities and tables related to a DXF drawing.

### `dxfversion`

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 `dxfversion`.

### `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`. 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*: str, *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 (modelspace included, always first name) in tab order.

**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, *format*: 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 *format* as string (pdf, dwf, dgn). The underlay definition is required to create an underlay reference.**Parameters**

- **filename** – underlay file name
- **format** – 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**() → Iterable[GenericLayoutType]

Iterate over all layouts (modelspace and paperspace) and all block definitions.

**chain\_layouts\_and\_blocks**() → Iterable[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)) → VPort

Set initial view/zoom location for the modelspace, this replaces the current “\*Active” viewport configuration.

**Parameters**

- **height** – modelspace area to view
- **center** – modelspace location to view in the center of the CAD application window.

**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) → boolSimple 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

## 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 = eздxf.readfile(name)
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: {name}.')
    sys.exit(2)
```

## 2. DXF file with minor flaws

DXF files have only minor flaws, like undefined resources:

```
try:
    doc = eздxf.readfile(name)
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: {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 = eздxf.readfile(name)
except IOError:
    print(f'Not a DXF file or a generic I/O error.')
    sys.exit(1)
# Catch all DXF errors:
except eздxf.DXFError:
    try: # Slow path including fixing low level structures:
        doc, auditor = recover.readfile(name)
    except eздxf.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()
```

## 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:
    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: str, 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: str, 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

## 6.5.2 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']`

```
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(classes: Iterable[DXFClass])
add_class(name: str)
    Register a known class by name.

get(name: str) → 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(name: str) → DXFClass
    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.

    dxft.name
        Class DXF record name.

    dxft.cpp_class_name
        C++ class name. Used to bind with software that defines object class behavior.
```

**dx<sub>f</sub>.app\_name**

Application name. Posted in Alert box when a class definition listed in this section is not currently loaded.

**dx<sub>f</sub>.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<sub>f</sub>.instance\_count**

Instance count for a custom class.

**dx<sub>f</sub>.was\_a\_proxy**

Set to 1 if class was not loaded when this DXF file was created, and 0 otherwise.

**dx<sub>f</sub>.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**

Generic *Table* object for *Linetype* objects

**styles**

*StyleTable* object for *Textstyle* objects

**dimstyles**

Generic *Table* object for *DimStyle* objects

**appids**Generic `Table` object for `AppID` objects**ucs**Generic `Table` object for `UCSTable` objects**views**Generic `Table` object for `View` objects**viewports**`ViewportTable` object for `VPort` objects**block\_records**Generic `Table` 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\_\_(self) → Iterable[BlockLayout]**

Iterable of all `BlockLayout` objects.

**\_\_contains\_\_(self, name: str) → bool**

Returns True if `BlockLayout` `name` exist.

**\_\_getitem\_\_(self, name: str) → BlockLayout**

Returns `BlockLayout` `name`, raises `DXFKeyError` if `name` not exist.

**\_\_delitem\_\_(self, name: str) → None**

Deletes `BlockLayout` `name` and all of its content, raises `DXFKeyError` if `name` not exist.

**get(self, name: str, default=None) → BlockLayout**

Returns `BlockLayout` `name`, returns `default` if `name` not exist.

**new(name: str, base\_point: Sequence[float] = (0, 0), dxftattribs: 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: Sequence[float] = (0, 0)) → 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 `safe` is `True`

`delete_all_blocks()`

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

`purge()`

Delete all unused blocks like `delete_all_blocks()`, but also removes unused anonymous blocks.

**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.

## 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__() → Iterable[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_underlay_def()`
- RASTERVARIABLES: `set_raster_variables()`
- WIPEOUTVARIABLES: `set_wipeout_variables()`

See also:

DXF Internals: *OBJECTS Section*

**class** ezdxf.sections.objects.**ObjectsSection**

**rootdict**

Root dictionary.

**\_\_len\_\_()** → int

Returns count of DXF objects.

**\_\_iter\_\_()** → Iterable[DXFObject]

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: Union[DXFObject, str])** → bool

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 = False)** → 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 = False)** → 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, *format*: str = 'pdf', *name*: str = None) → UnderlayDef

Add an *UnderlayDef* entity to the drawing (OBJECTS section). *filename* is the underlay file name as relative or absolute path and *format* as string (pdf, dwf, dgn). The underlay definition is required to create an underlay reference.

#### Parameters

- **filename** – underlay file name
- **format** – 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: ????

**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), public interface `set_wipeout_variables()`

## 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(entity: Union[str, DXFEntity]) → str
        Unified table entry key.

    has_entry(name: Union[str, DXFEntity]) → bool
        Returns True if an table entry name exist.

    __contains__(name: Union[str, DXFEntity]) → bool
        Returns True if an table entry name exist.

    __len__() → int
        Count of table entries.

    __iter__() → Iterable[DXFEntity]
        Iterable of all table entries.

    new(name: str, dxfattribs: dict = None) → DXFEntity
        Create a new table entry name.
```

#### Parameters

- **name** – name of table entry, case insensitive
- **dxfattribs** – additional DXF attributes for table entry

**get** (*name: str*) → DXFEntity

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*) → DXFEntity

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.

## Linetype Table

Generic table class of [Table](#).

Collection of [Linetype](#) objects.

## Style Table

**class** ezdxf.sections.table.StyleTable

Subclass of [Table](#).

Collection of [Textstyle](#) objects.

**get\_shx** (*shxname: str*) → Textstyle

Get existing shx entry, or create a new entry.

**Parameters** **shxname** – shape file name like ‘ltypeshp.lin’

**find\_shx** (*shxname: str*) → Optional[Textstyle]

Find .shx shape file table entry, by a case insensitive search.

A .shx shape file table entry has no name, so you have to search by the font attribute.

**Parameters** **shxname** – .shx shape file name

## DimStyle Table

Generic table class of [Table](#).

Collection of [DimStyle](#) objects.

## AppID Table

Generic table class of [Table](#).

Collection of [AppID](#) objects.

## UCS Table

Generic table class of [Table](#).

Collection of [UCSTable](#) objects.

## View Table

Generic table class of [Table](#).

Collection of [View](#) objects.

## 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`

**get\_config** (*self, name: str*) → List[[Viewport](#)]

Returns a list of [Viewport](#) objects, for the multi-viewport configuration *name*.

**delete\_config** (*name: str*) → None

Delete all [Viewport](#) objects of the multi-viewport configuration *name*.

## Block Record Table

Generic table class of [Table](#).

Collection of [BlockRecord](#) objects.

## 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`

`dxfs.handle`

DXF handle (feature for experts)

**dx<sub>f</sub>.owner**

Handle to owner (*LayerTable*).

**dx<sub>f</sub>.name**

Layer name, case insensitive and can not contain any of this characters: <>/\\";?\*|=` (str)

**dx<sub>f</sub>.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)

**dx<sub>f</sub>.color**

Layer color, but use property `Layer.color` to get/set color value, because color is negative for layer status *off* (int)

**dx<sub>f</sub>.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)

**dx<sub>f</sub>.linetype**

Name of line type (str)

**dx<sub>f</sub>.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

## Style

Defines a text style ([DXF Reference](#)), can be used by entities: `Text`, `Attrib` and `Attdef`.

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`

`dxfs.handle`

DXF handle (feature for experts).

`dxfs.owner`

Handle to owner ([StyleTable](#)).

`dxfs.name`

Style name (str)

`dxfs.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)

`dxfs.height`

Fixed height in drawing units, 0 for not fixed (float).

`dxfs.width`

Width factor (float), default is 1.

`dxfs.oblique`

Oblique angle in degrees, 0 is vertical (float).

`dxfs.generation_flags`

Text generations flags (int)

2	text is backward (mirrored in X)
4	text is upside down (mirrored in Y)

**dx<sub>f</sub>.last\_height**

Last height used in drawing units (float).

**dx<sub>f</sub>.font**

Primary font file name (str).

**dx<sub>f</sub>.bigfont**

Big font name, blank if none (str)

**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.

## 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****dx<sub>f</sub>.name**

Linetype name (str).

**dx<sub>f</sub>.owner**

Handle to owner ([Table](#)).

**dx<sub>f</sub>.description**

Linetype description (str).

**dx<sub>f</sub>.length**

Total pattern length in drawing units (float).

**dx<sub>f</sub>.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

    dxf.owner
        Handle to owner (Table).

    dxf.name
        Dimension style name.

    dxf.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) |

dxf.dimpost
        Prefix/suffix for primary units dimension values.

    dxf.dimapost
        Prefix/suffix for alternate units dimensions.

    dxf.dimblk
        Block type to use for both arrowheads as name string.

    dxf.dimblk1
        Block type to use for first arrowhead as name string.

    dxf.dimblk2
        Block type to use for second arrowhead as name string.

    dxf.dimscale
        Global dimension feature scale factor. (default=1)

    dxf.dimasz
        Dimension line and arrowhead size. (default=0.25)

    dxf.dimexo
        Distance from origin points to extension lines. (default imperial=0.0625, default metric=0.625)

    dxf.dimdli
        Incremental spacing between baseline dimensions. (default imperial=0.38, default metric=3.75)

    dxf.dimexe
        Extension line distance beyond dimension line. (default imperial=0.28, default metric=2.25)

    dxf.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.
```

`dxf.dimdle`  
Dimension line extension beyond extension lines. (default=0)

`dxf.dimtp`  
Upper tolerance value for tolerance dimensions. (default=0)

`dxf.dimtm`  
Lower tolerance value for tolerance dimensions. (default=0)

`dxf.dimtxt`  
Size of dimension text. (default imperial=0.28, default metric=2.5)

`dxf.dimcen`  
Controls placement of center marks or centerlines. (default imperial=0.09, default metric=2.5)

`dxf.dimtsz`  
Controls size of dimension line tick marks drawn instead of arrowheads. (default=0)

`dxf.dimaltf`  
Alternate units dimension scale factor. (default=25.4)

`dxf.dimlfac`  
Scale factor for linear dimension values. (default=1)

`dxf.dimtvp`  
Vertical position of text above or below dimension line if `dimtad` is 0. (default=0)

`dxf.dimtfac`  
Scale factor for fractional or tolerance text size. (default=1)

`dxf.dimgap`  
Gap size between dimension line and dimension text. (default imperial=0.09, default metric=0.625)

`dxf.dimaltrnd`  
Rounding value for alternate dimension units. (default=0)

`dxf.dimtol`  
Toggles creation of appended tolerance dimensions. (default imperial=1, default metric=0)

`dxf.dimlim`  
Toggles creation of limits-style dimension text. (default=0)

`dxf.dimtih`  
Orientation of text inside extension lines. (default imperial=1, default metric=0)

`dxf.dimtoh`  
Orientation of text outside extension lines. (default imperial=1, default metric=0)

`dxf.dimse1`  
Toggles suppression of first extension line. (default=0)

`dxf.dimse2`  
Toggles suppression of second extension line. (default=0)

`dxf.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<sub>f</sub>.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<sub>f</sub>.dimalt**

Enables or disables alternate units dimensioning. (default=0)

**dx<sub>f</sub>.dimaltd**

Controls decimal places for alternate units dimensions. (default imperial=2, default metric=3)

**dx<sub>f</sub>.dimtof1**

Toggles forced dimension line creation. (default imperial=0, default metric=1)

**dx<sub>f</sub>.dimsah**

Toggles appearance of arrowhead blocks. (default=0)

**dx<sub>f</sub>.dimtix**

Toggles forced placement of text between extension lines. (default=0)

**dx<sub>f</sub>.dimsoxd**

Suppresses dimension lines outside extension lines. (default=0)

**dx<sub>f</sub>.dimclrd**

Dimension line, arrowhead, and leader line color. (default=0)

**dx<sub>f</sub>.dimclre**

Dimension extension line color. (default=0)

**dx<sub>f</sub>.dimclrt**

Dimension text color. (default=0)

**dx<sub>f</sub>.dimadec**

Controls the number of decimal places for angular dimensions.

**dx<sub>f</sub>.dimunit**

Obsolete, now use DIMLUNIT AND DIMFRAC

**dx<sub>f</sub>.dimdec**

Decimal places for dimension values. (default imperial=4, default metric=2)

**dx<sub>f</sub>.dimtdec**

Decimal places for primary units tolerance values. (default imperial=4, default metric=2)

**dx<sub>f</sub>.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.dx<sub>f</sub>.dimzin](#)

**dx<sub>f</sub>.dimaltz**

Zero suppression for alternate units dimension values. (default=0)

**dx<sub>f</sub>.dimaltdz**

Zero suppression for alternate units tolerance values. (default=0)

**dx<sub>f</sub>.dimfit**  
Obsolete, now use DIMATFIT and DIMTMOVE

**dx<sub>f</sub>.dimupt**  
Controls user placement of dimension line and text. (default=0)

**dx<sub>f</sub>.dimatfit**  
Controls placement of text and arrowheads when there is insufficient space between the extension lines. (default=3)

**dx<sub>f</sub>.dimtxsty**  
Text style used for dimension text by name.

**dx<sub>f</sub>.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<sub>f</sub>.dimldrbblk**  
Specify arrowhead used for leaders by name.

**dx<sub>f</sub>.dimldrbblk\_handle**  
Specify arrowhead used for leaders by handle of referenced block. (use *DimStyle.dxf.dimldrbblk* to get/set arrowhead by name)

**dx<sub>f</sub>.dimblk\_handle**  
Block type to use for both arrowheads, handle of referenced block. (use *DimStyle.dxf.dimblk* to get/set arrowheads by name)

**dx<sub>f</sub>.dimblk1\_handle**  
Block type to use for first arrowhead, handle of referenced block. (use *DimStyle.dxf.dimblk1* to get/set arrowhead by name)

**dx<sub>f</sub>.dimblk2\_handle**  
Block type to use for second arrowhead, handle of referenced block. (use *DimStyle.dxf.dimblk2* to get/set arrowhead by name)

**dx<sub>f</sub>.dimlwd**  
Lineweight value for dimension lines. (default=-2, BYBLOCK)

**dx<sub>f</sub>.dimlwe**  
Lineweight value for extension lines. (default=-2, BYBLOCK)

**dx<sub>f</sub>.dimltype**  
Specifies the linetype used for the dimension line as linetype name, requires DXF R2007+

**dx<sub>f</sub>.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<sub>f</sub>.dimltext1**  
Specifies the linetype used for the extension line 1 as linetype name, requires DXF R2007+

**dx<sub>f</sub>.dimlex1\_handle**  
Specifies the linetype used for the extension line 1 as handle to LTYPE entry, requires DXF R2007+ (use *DimStyle.dxf.dimltext1* to get/set linetype by name)

**dx<sub>f</sub>.dimltext2**  
Specifies the linetype used for the extension line 2 as linetype name, requires DXF R2007+

**dx<sub>f</sub>.dimlex2\_handle**  
Specifies the linetype used for the extension line 2 as handle to LTYPE entry, requires DXF R2007+ (use *DimStyle.dxf.dimltext2* to get/set linetype by name)

**dx<sub>f</sub>.dimfxlon**

Extension line has fixed length if set to 1, requires DXF R2007+

**dx<sub>f</sub>.dimfxl**

Length of extension line below dimension line if fixed (`DimStyle.dxf.dimfxlon == 1`), `DimStyle.dxf.dimexen` defines the the length above the dimension line, requires DXF R2007+

**dx<sub>f</sub>.dimtfill**

Text fill 0=off; 1=background color; 2=custom color (see `DimStyle.dxf.dimtfillclr`), requires DXF R2007+

**dx<sub>f</sub>.dimtfillclr**

Text fill custom color as color index (1-255), requires DXF R2007+

**copy\_to\_header (dwg: Drawing) → None**

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: str = 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 “TOP”, “MIDDLE”, “BOTTOM”, 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+

**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.VPort`  
Subclass of [`DXFEntity`](#)

Defines a viewport configurations for the modelspace.

**dxft.owner**  
Handle to owner ([`ViewportTable`](#)).

**dxft.name**  
Viewport name

**dxft.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.lower\_left**

Lower-left corner of viewport

**dx.f.upper\_right**

Upper-right corner of viewport

**dx.f.center**View center point (in *DCS*)**dx.f.snap\_base**Snap base point (in *DCS*)**dx.f.snap\_spacing**

Snap spacing X and Y

**dx.f.grid\_spacing**

Grid spacing X and Y

**dx.f.direction\_point**View direction from target point (in *WCS*)**dx.f.target\_point**View target point (in *WCS*)**dx.f.height**

View height

**dx.f.aspect\_ratio****dx.f.lens\_length**

Lens focal length in mm

**dx.f.front\_clipping**

Front clipping plane (offset from target point)

**dx.f.back\_clipping**

Back clipping plane (offset from target point)

**dx.f.snap\_rotation**

Snap rotation angle in degrees

**dx.f.view\_twist**

View twist angle in degrees

**dx.f.status****dx.f.view\_mode****dx.f.circle\_zoom****dx.f.fast\_zoom****dx.f.ucs\_icon****dx.f.snap\_on****dx.f.grid\_on****dx.f.snap\_style**

**dx<sub>f</sub>.snap\_isopair****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. These 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	<code>ezdxf.entities.DXFEntity</code>
DXF type	'VIEW'
Factory function	<code>Drawing.views.new()</code>

**See also:**

DXF Internals: [VIEW Table](#)

**class ezdxf.entities.View****dx<sub>f</sub>.owner**

Handle to owner ([Table](#)).

**dx<sub>f</sub>.name**

Name of view.

**dx<sub>f</sub>.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)

**dx<sub>f</sub>.height**

View height (in DCS)

**dx<sub>f</sub>.width**

View width (in DCS)

**dx<sub>f</sub>.center\_point**

View center point (in DCS)

**dx<sub>f</sub>.direction\_point**

View direction from target (in WCS)

**dx<sub>f</sub>.target\_point**

Target point (in WCS)

**dx<sub>f</sub>.lens\_length**

Lens length

**dx<sub>f</sub>.front\_clipping**

Front clipping plane (offset from target point)

**dx<sub>f</sub>.back\_clipping**

Back clipping plane (offset from target point)

`dx.f.view_twist`  
Twist angle in degrees.

`dx.f.view_mode`  
View mode (see VIEWMODE system variable)

`dx.f.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.f.ucs`  
1 if there is a UCS associated to this view; 0 otherwise

`dx.f.ucs_origin`  
UCS origin as (x, y, z) tuple (appears only if `ucs` is set to 1)

`dx.f.ucs_xaxis`  
UCS x-axis as (x, y, z) tuple (appears only if `ucs` is set to 1)

`dx.f.ucs_yaxis`  
UCS y-axis as (x, y, z) tuple (appears only if `ucs` is set to 1)

`dx.f.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)

```
dxf.live_selection_handle  
Handle to live section object (optional)
```

```
dxf.visual_style_handle  
Handle to visual style object (optional)
```

```
dxf.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	Drawing.appids.new()

**class** `ezdxf.entities.AppID`

**dx<sub>f</sub>.owner**

Handle to owner ([Table](#)).

**dx<sub>f</sub>.name**

User-supplied (or application-supplied) application name (for extended data).

**dx<sub>f</sub>.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	<i>ezdxf.entities.DXFEntity</i>
DXF type	'UCS'
Factory function	Drawing.ucs.new()

**See also:**

[UCS](#) and [OCS](#)

**class** `ezdxf.entities.UCSTable`

**dx<sub>f</sub>.owner**

Handle to owner ([Table](#)).

**dx<sub>f</sub>.name**

UCS name (str).

**dx<sub>f</sub>.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)

**dx<sub>f</sub>.origin**

Origin as (x, y, z) tuple

**dx<sub>f</sub>.xaxis**

X-axis direction as (x, y, z) tuple

**dx<sub>f</sub>.yaxis**

Y-axis direction as (x, y, z) tuple

**ucs()** → UCSReturns 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<sub>f</sub>.owner**Handle to owner (`Table`).**dx<sub>f</sub>.name**

Name of associated BLOCK.

**dx<sub>f</sub>.layout**

Handle to associated DXFLayout, if paperspace layout or modelspace else 0

**dx<sub>f</sub>.explode**

1 for BLOCK references can be exploded else 0

**dx<sub>f</sub>.scale**

1 for BLOCK references can be scaled else 0

**dx<sub>f</sub>.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

**is\_active\_paperspace**

True if is “active” paperspace layout.

**is\_any\_paperspace**

True if is any kind of paperspace 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.

**is\_modelspace**

True if is the modelspace layout.

## 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

```
dxfl.handle
    BLOCK handle as plain hex string. (feature for experts)

dxfl.owner
    Handle to owner as plain hex string. (feature for experts)

dxfl.layer
    Layer name as string; default value is '0'

dxfl.name
    BLOCK name as string. (case insensitive)

dxfl.base_point
    BLOCK base point as (x, y, z) tuple, default value is (0, 0, 0)

    Insertion location referenced by the Insert entity to place the block reference and also the center of rotation and scaling.

dxfl.flags
    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<sub>f</sub>.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<sub>f</sub>.handle**

BLOCK handle as plain hex string. (feature for experts)

**dx<sub>f</sub>.owner**

Handle to owner as plain hex string. (feature for experts)

**dx<sub>f</sub>.layer**

Layer name as string; should always be the same as *Block.dx<sub>f</sub>.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, MINsert entity if > 1 (int)

**dx<sub>f</sub>.row\_spacing**  
Distance between two insert points (MINsert) in row direction (float)

**dx<sub>f</sub>.column\_count**  
Count of repeated insertions in column direction, MINsert entity if > 1 (int)

**dx<sub>f</sub>.column\_spacing**  
Distance between two insert points (MINsert) 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, MINsert (multi-insert) processing is required if *mcount* > 1.  
New in version 0.14.

**set\_scale(factor: float)**  
Set uniform scaling.

**block() → Optional[BlockLayout]**  
Returns associated *BlockLayout*.

**place(insert: Vertex = None, scale: Tuple[float, float, float] = None, rotation: float = None) → 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)) → 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) → Union[Attrib, AttDef, None]

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 = None, 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: Vertex = (0, 0), dxfattribs: dict = 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_pos(  
    (3, 7), align='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: Matrix44*) → 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.

New in version 0.13.

**translate** (*dx: float, dy: float, dz: float*) → Insert

Optimized INSERT translation about *dx* in x-axis, *dy* in y-axis and *dz* in z-axis.

New in version 0.13.

**virtual\_entities** (*skipped\_entity\_callback: Callable[[DXFGraphic, str], None] = None*) → Iterable[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[Insert]`

Yields a virtual INSERT entity for each grid element of a MINSERT entity (multi-insert).

New in version 0.14.

`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() → 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](#).

**dxfs.tag**

Tag to identify the attribute (str)

**dxfs.text**

Attribute content as text (str)

**is\_invisible**

Attribute is invisible (does not appear).

**is\_const**

This is a constant attribute.

**is\_verify**

Verification is required on input of this attribute. (CAD application feature)

**is\_preset**

No prompt during insertion. (CAD application feature)

## 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	<a href="#">ezdxf.entities.Text</a>
DXF type	'ATTDEF'
Factory function	<a href="#">ezdxf.layouts.BaseLayout.add_attdef()</a>
Inherited DXF attributes	<a href="#">Common graphical DXF attributes</a>

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](#).

**dxfs.tag**

Tag to identify the attribute (str)

**dxfs.text**

Attribute content as text (str)

**dxfs.prompt**

Attribute prompt string. (CAD application feature)

**dxfs.field\_length**

Just relevant to CAD programs for validating user input

**is\_invisible**

Attribute is invisible (does not appear).

**is\_const**

This is a constant attribute.

**is\_verify**

Verification is required on input of this attribute. (CAD application feature)

**is\_preset**

No prompt during insertion. (CAD application feature)

## Layouts

### Layout Manager

The layout manager is unique to each DXF drawing, access the layout manager as `layouts` attribute of the `Drawing` object.

**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\_\_ () → Iterable[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 () → Modelspace**

Returns the `Modelspace` layout.

**get (name: str) → 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, dxffattribs: dict = None) → Paperspace**

Returns a new `Paperspace` layout.

**Parameters**

- `name` – layout name as shown in tabs in `CAD` applications
- `dxffattribs` – 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**() → Paperspace

Returns the active paperspace layout.

**set\_active\_layout**(*name*: str) → NoneSet layout *name* as active paperspace layout.**get\_layout\_for\_entity**(*entity*: DXFEntity) → 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\_\_ () → Iterable[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.

**query (query: str = '\*') → EntityQuery**

Get all DXF entities matching the *Entity Query String*.

**groupby (dxftattrib: str = "", key: KeyFunc = None) → dict**

Returns a `dict` of entity lists, where entities are grouped by a `dxftattrib` or a `key` function.

**Parameters**

- **dxftattrib** – 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*: Vertex, *dxfattribs*: Dict[KT, VT] = None) → Point  
Add a *Point* entity at *location*.

#### Parameters

- **location** – 2D/3D point in *WCS*
- **dfattribs** – additional DXF attributes

**add\_line** (*start*: Vertex, *end*: Vertex, *dfattribs*: Dict[KT, VT] = None) → Line  
Add a *Line* entity from *start* to *end*.

#### Parameters

- **start** – 2D/3D point in *WCS*
- **end** – 2D/3D point in *WCS*
- **dfattribs** – additional DXF attributes

**add\_circle** (*center*: Vertex, *radius*: float, *dfattribs*: Dict[KT, VT] = 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
- **dfattribs** – additional DXF attributes

**add\_ellipse** (*center*: Vertex, *major\_axis*: Vertex = (1, 0, 0), *ratio*: float = 1, *start\_param*: float = 0, *end\_param*: float = 6.283185307179586, *dfattribs*: Dict[KT, VT] = 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
- **dfattribs** – additional DXF attributes

**add\_arc** (*center*: Vertex, *radius*: float, *start\_angle*: float, *end\_angle*: float, *is\_counter\_clockwise*: bool = True, *dfattribs*: Dict[KT, VT] = 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[Vertex]*, *dxfattribs*: *Dict[KT, VT]* = *None*) → Solid

Add a *Solid* entity, *points* is an iterable of 3 or 4 points.

#### Parameters

- **points** – iterable of 3 or 4 2D/3D points in *WCS*
- **dxfattribs** – additional DXF attributes for *Solid* entity

**add\_trace** (*points*: *Iterable[Vertex]*, *dxfattribs*: *Dict[KT, VT]* = *None*) → Trace

Add a *Trace* entity, *points* is an iterable of 3 or 4 points.

#### Parameters

- **points** – iterable of 3 or 4 2D/3D points in *WCS*
- **dxfattribs** – additional DXF attributes for *Trace* entity

**add\_3dface** (*points*: *Iterable[Vertex]*, *dxfattribs*: *Dict[KT, VT]* = *None*) → Face3d

Add a *3DFace* entity, *points* is an iterable 3 or 4 2D/3D points.

#### Parameters

- **points** – iterable of 3 or 4 2D/3D points in *WCS*
- **dxfattribs** – additional DXF attributes for *3DFace* entity

**add\_text** (*text*: str, *dxfattribs*: *Dict[KT, VT]* = *None*) → Text

Add a *Text* entity, see also *Style*.

#### Parameters

- **text** – content string
- **dxfattribs** – additional DXF attributes for *Text* entity

**add\_blockref** (*name*: str, *insert*: Vertex, *dxfattribs*: *Dict[KT, VT]* = *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 for *Insert* entity

**add\_auto\_blockref** (*name*: str, *insert*: Vertex, *values*: *Dict[str, str]*, *dxfattribs*: *Dict[KT, VT]* = *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 for *Insert* entity

**add\_attrib** (*tag*: str, *text*: str, *insert*: Vertex = (0, 0), *dxfattribs*: Dict[KT, VT] = None) → Attrib  
Add an *Attrib* as stand alone DXF entity.

#### Parameters

- **tag** – tag name as string
- **text** – tag value as string
- **insert** – insert location as 2D/3D point in *WCS*
- **dxfattribs** – additional DXF attributes for *Attrib* entity

**add\_attdef** (*tag*: str, *insert*: Vertex = (0, 0), *text*: str = "", *dxfattribs*: Dict[KT, VT] = None) → AttDef  
Add an *AttDef* as stand alone DXF entity.

Set position and alignment by the idiom:

```
layout.add_attdef('NAME').set_pos((2, 3), align='MIDDLE_CENTER')
```

#### Parameters

- **tag** – tag name as string
- **insert** – insert location as 2D/3D point in *WCS*
- **text** – tag value as string
- **dxfattribs** – additional DXF attributes

**add\_polyline2d** (*points*: Iterable[Vertex], *dxfattribs*: Dict[KT, VT] = None, *format*: str = None) → Polyline  
Add a 2D *Polyline* entity.

#### Parameters

- **points** – iterable of 2D points in *WCS*
- **dxfattribs** – additional DXF attributes
- **format** – user defined point format like `add_lwpolyline()`, default is None

**add\_polyline3d** (*points*: Iterable[Vertex], *dxfattribs*: Dict[KT, VT] = None) → Polyline  
Add a 3D *Polyline* entity.

#### Parameters

- **points** – iterable of 3D points in *WCS*
- **dxfattribs** – additional DXF attributes

---

**add\_polymesh** (*size*: *Tuple[int, int]* =  $(3, 3)$ , *dxfattribs*: *Dict[KT, VT]* = *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 for *Polyline* entity

**add\_polyface** (*dxfattribs*: *Dict[KT, VT]* = *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*: *Vertex* =  $(0, 0)$ , *size*: *float* =  $1.0$ , *dxfattribs*: *Dict[KT, VT]* = *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[Vertex]*, *format*: *str* = 'xyseb', *dxfattribs*: *Dict[KT, VT]* = *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"
- **dxfattribs** – additional DXF attributes

**add\_mtext** (*text*: *str*, *dxfattribs*: *Dict[KT, VT]* = *None*) → MText

Add a multiline text entity with automatic text wrapping at boundaries as *MText* entity. (requires DXF R2000)

#### Parameters

- **text** – content string

- **dxfattribs** – additional DXF attributes

**add\_ray** (*start*: Vertex, *unit\_vector*: Vertex, *dfxattribs*: Dict[KT, VT] = 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)
- **dfxattribs** – additional DXF attributes

**add\_xline** (*start*: Vertex, *unit\_vector*: Vertex, *dfxattribs*: Dict[KT, VT] = 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)
- **dfxattribs** – additional DXF attributes

**add\_mline** (*vertices*: Iterable[Vertex] = None, *dfxattribs*: Dict[KT, VT] = None) → MLine

Add a [MLine](#) entity

#### Parameters

- **vertices** – MLINE vertices (in [WCS](#))
- **dfxattribs** – additional DXF attributes for [MLine](#) entity

**add\_spline** (*fit\_points*: Iterable[Vertex] = None, *degree*: int = 3, *dfxattribs*: Dict[KT, VT] = None) → Spline

→ Spline

Add a B-spline ([Spline](#) entity) defined by 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. (requires DXF R2000)

AutoCAD creates a spline through fit points by a proprietary algorithm. *ezdxf* can not reproduce the control point calculation. See also: [Tutorial for Spline](#).

#### Parameters

- **fit\_points** – iterable of fit points as (x, y[, z]) in [WCS](#), create ‘empty’ [Spline](#) if None
- **degree** – degree of B-spline
- **dfxattribs** – additional DXF attributes

**add\_spline\_control\_frame** (*fit\_points*: Iterable[Vertex], *degree*: int = 3, *method*: str = ‘chord’, *dfxattribs*: Dict[KT, VT] = None) → Spline

Add a [Spline](#) entity passing through given fit points by global B-spline interpolation, the new SPLINE entity is defined by a control frame and not by the fit points.

- “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.

**Parameters**

- **fit\_points** – iterable of fit points as (x, y[, z]) in [WCS](#)
- **degree** – degree of B-spline
- **method** – calculation method for parameter vector t
- **dxfattribs** – additional DXF attributes

**add\_open\_spline**(*control\_points*: Iterable[[Vertex](#)], *degree*: int = 3, *knots*: Iterable[float] = None, *dxfattribs*: Dict[KT, VT] = None) → 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
- **knots** – knot values as iterable of floats
- **dxfattribs** – additional DXF attributes

**add\_closed\_spline**(*control\_points*: Iterable[[Vertex](#)], *degree*: int = 3, *knots*: Iterable[float] = None, *dxfattribs*: Dict[KT, VT] = None) → Spline

Add a closed uniform [Spline](#) defined by *control\_points*. (requires DXF R2000)

Closed uniform B-splines is a closed curve start and end at the first control point.

**Parameters**

- **control\_points** – iterable of 3D points in [WCS](#)
- **degree** – degree of B-spline
- **knots** – knot values as iterable of floats
- **dxfattribs** – additional DXF attributes

**add\_rational\_spline**(*control\_points*: Iterable[[Vertex](#)], *weights*: Sequence[float], *degree*: int = 3, *knots*: Iterable[float] = None, *dxfattribs*: Dict[KT, VT] = None) → 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
- **knots** – knot values as iterable of floats
- **dxfattribs** – additional DXF attributes

**add\_closed\_rational\_spline**(*control\_points*: Iterable[[Vertex](#)], *weights*: Sequence[float], *degree*: int = 3, *knots*: Iterable[float] = None, *dxfattribs*: Dict[KT, VT] = None) → Spline

Add a closed 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.

Closed rational uniform B-splines start and end at the first control point.

#### Parameters

- **control\_points** – iterable of 3D points in [WCS](#)
- **weights** – weight values as iterable of floats
- **degree** – degree of B-spline
- **knots** – knot values as iterable of floats
- **dxfattribs** – additional DXF attributes

**add\_hatch** (*color*: int = 7, *dxfattribs*: Dict[KT, VT] = None) → Hatch

Add a [Hatch](#) entity. (requires DXF R2007)

#### Parameters

- **color** – ACI (AutoCAD Color Index), default is 7 (black/white).
- **dxfattribs** – additional DXF attributes

**add\_mesh** (*dxfattribs*: Dict[KT, VT] = None) → Mesh

Add a [Mesh](#) entity. (requires DXF R2007)

#### Parameters **dxfattribs** – additional DXF attributes

**add\_image** (*image\_def*: ImageDef, *insert*: Vertex, *size\_in\_units*: Tuple[float, float], *rotation*: float = 0.0, *dxfattribs*: Dict[KT, VT] = 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
- **dxfattribs** – additional DXF attributes

**add\_wipeout** (*vertices*: Iterable[Vertex], *dxfattribs*: Dict[KT, VT] = 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*: Vertex = (0, 0, 0), *scale*=(1, 1, 1), *rotation*: float = 0.0, *dxfattribs*: Dict[KT, VT] = 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
- **dxfattribs** – additional DXF attributes

`add_linear_dim(base: Vertex, p1: Vertex, p2: Vertex, location: Vertex = None, text: str = '<>', angle: float = 0, text_rotation: float = None, dimstyle: str = 'EZDXF', override: Dict[KT, VT] = None, dxfattribs: Dict[KT, VT] = 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:** `ezdxf` ignores some DIMSTYLE variables, so render results may differ from BricsCAD or AutoCAD.

---

### 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, " " (one 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 `Dimension` entity

Returns: `DimStyleOverride`

`add_multi_point_linear_dim(base: Vertex, points: Iterable[Vertex], angle: float = 0, ucs: UCS = None, avoid_double_rendering: bool = True, dimstyle: str = 'EZDXF', override: Dict[KT, VT] = None, dxfattribs: Dict[KT, VT] = 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:** `ezdxf` ignores some DIMSTYLE variables, so render results may differ from BricsCAD or AutoCAD.

---

## 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 *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: Vertex, p2: Vertex, distance: float, text: str = '<>', dimstyle: str = 'EZDXF',
                 override: Dict[KT, VT] = None, dxfattribs: Dict[KT, VT] = 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:** *ezdxf* ignores some DIMSTYLE variables, so render results may differ from BricsCAD or AutoCAD.

---

## 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, ” ” (one 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** – DXF attributes for *Dimension* entity

Returns: *DimStyleOverride*

```
add_radius_dim(center: Vertex, mpoint: Vertex = None, radius: float = None, angle: float = None,
                location: Vertex = None, text: str = '<>', dimstyle: str = 'EZ_RADIUS', override:
                Dict[KT, VT] = None, dxfattribs: Dict[KT, VT] = 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* ignores some DIMSTYLE variables, so render results may differ from BricsCAD or AutoCAD.

---

## 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, " " (one 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 *Dimension* entity

Returns: *DimStyleOverride*

**add\_radius\_dim\_2p**(*center*: Vertex, *mpoint*: Vertex, *text*: str = '<>', *dimstyle*: str = 'EZ\_RADIUS', *override*: Dict[KT, VT] = None, *dxfattribs*: Dict[KT, VT] = 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, " " (one 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 *Dimension* entity

Returns: *DimStyleOverride*

**add\_radius\_dim\_cra**(*center*: Vertex, *radius*: float, *angle*: float, *text*: str = '<>', *dimstyle*: str = 'EZ\_RADIUS', *override*: Dict[KT, VT] = None, *dxfattribs*: Dict[KT, VT] = 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, " " (one 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 *Dimension* entity

Returns: *DimStyleOverride*

**add\_diameter\_dim**(*center*: Vertex, *mpoint*: Vertex = None, *radius*: float = None, *angle*: float = None, *location*: Vertex = None, *text*: str = '<>', *dimstyle*: str = 'EZ\_RADIUS', *override*: Dict[KT, VT] = None, *dxfattribs*: Dict[KT, VT] = 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` ignores some DIMSTYLE variables, so render results may differ from BricsCAD or AutoCAD.

---

### 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, " " (one 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 `Dimension` entity

Returns: `DimStyleOverride`

(not implemented yet!)

`add_diameter_dim_2p(p1: Vertex, p2: Vertex, text: str = '<>', dimstyle: str = 'EZ_RADIUS', override: Dict[KT, VT] = None, dxfattribs: Dict[KT, VT] = 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, " " (one 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 `Dimension` entity

Returns: *DimStyleOverride*

**add\_leader** (*vertices*: *Iterable[Vertex]*, *dimstyle*: *str* = 'EZDXF', *override*: *Dict[KT, VT]* = *None*, *dxfattribs*: *Dict[KT, VT]* = *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 for *Leader* entity

**add\_body** (*acis\_data*: *str* = *None*, *dxfattribs*: *Dict[KT, VT]* = *None*) → *Body*

Add a *Body* entity. (requires DXF R2000)

#### Parameters

- **acis\_data** – ACIS data as iterable of text lines as strings, no interpretation by ezdxf possible
- **dxfattribs** – additional DXF attributes

**add\_region** (*acis\_data*: *str* = *None*, *dxfattribs*: *Dict[KT, VT]* = *None*) → *Region*

Add a *Region* entity. (requires DXF R2000)

#### Parameters

- **acis\_data** – ACIS data as iterable of text lines as strings, no interpretation by ezdxf possible
- **dxfattribs** – additional DXF attributes

**add\_3dsolid** (*acis\_data*: *str* = *None*, *dxfattribs*: *Dict[KT, VT]* = *None*) → *Solid3d*

Add a 3DSOLID entity (*Solid3d*). (requires DXF R2000)

#### Parameters

- **acis\_data** – ACIS data as iterable of text lines as strings, no interpretation by ezdxf possible
- **dxfattribs** – additional DXF attributes

**add\_surface** (*acis\_data*: *str* = *None*, *dxfattribs*: *Dict[KT, VT]* = *None*) → *Surface*

Add a *Surface* entity. (requires DXF R2007)

#### Parameters

- **acis\_data** – ACIS data as iterable of text lines as strings, no interpretation by ezdxf possible
- **dxfattribs** – additional DXF attributes

**add\_extruded\_surface** (*acis\_data*: *str* = *None*, *dxfattribs*: *Dict[KT, VT]* = *None*) → *Extruded-Surface*

Add a *ExtrudedSurface* entity. (requires DXF R2007)

**Parameters**

- **acis\_data** – ACIS data as iterable of text lines as strings, no interpretation by ezdxf possible
- **dxfattribs** – additional DXF attributes

**add\_lofted\_surface** (*acis\_data*: str = None, *dxfattribs*: Dict[KT, VT] = None) → LoftedSurface  
Add a *LoftedSurface* entity. (requires DXF R2007)

**Parameters**

- **acis\_data** – ACIS data as iterable of text lines as strings, no interpretation by ezdxf possible
- **dxfattribs** – additional DXF attributes

**add\_revolved\_surface** (*acis\_data*: str = None, *dxfattribs*: Dict[KT, VT] = None) → Revolved-Surface  
Add a *RevolvedSurface* entity. (requires DXF R2007)

**Parameters**

- **acis\_data** – ACIS data as iterable of text lines as strings, no interpretation by ezdxf possible
- **dxfattribs** – additional DXF attributes

**add\_swept\_surface** (*acis\_data*: str = None, *dxfattribs*: Dict[KT, VT] = None) → SweptSurface  
Add a *SweptSurface* entity. (requires DXF R2007)

**Parameters**

- **acis\_data** – ACIS data as iterable of text lines as strings, no interpretation by ezdxf possible
- **dxfattribs** – additional DXF attributes

## Layout

**class** eздxf.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\_extends** () → None

Reset extends.

**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)`) → None

Set plot window size in (scaled) paper space units.

**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 (dxftattribs: 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** **dxftattribs** – 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, extends 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

**rename** (*name: str*) → None

Rename layout to *name*, changes the name displayed in tabs by CAD applications, not the internal BLOCK name.

**viewports** () → List[DXFGraphic]

Get all VIEWPORT entities defined in the paperspace layout. Returns a list of *Viewport* objects, sorted by id, the first entity is always the paperspace view with an id of 1.

**add\_viewport** (*center: Vertex*, *size: Tuple[float, float]*, *view\_center\_point: Vertex*, *view\_height: float*, *dxftattribs: dict = None*) → Viewport

Add a new *Viewport* entity.

**reset\_viewports** () → None

Delete all existing viewports, and add a new main viewport.

**reset\_paper\_limits** () → None

Set paper limits to default values, all values in paperspace units but without plot scale (?).

**get\_paper\_limits** () → Tuple[Tuple[float, float], Tuple[float, float]]

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 ((x1, y1), (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.

**name**

name of the associated BLOCK and BLOCK\_RECORD entities.

**block**

the associated *Block* entity.

**endblk**

the associated *EndBlk* entity.

**dxfs**

DXF name space of associated *BlockRecord* table entry.

**can\_explode**

Set property to True to allow exploding block references of this block.

**scale\_uniformly**

Set property to True to allow block references of this block only scale uniformly.

**\_\_contains\_\_(entity: Union[DXFGraphic, str]) → bool**

Returns True if block contains *entity*.

**Parameters** **entity** – DXFGraphic object or handle as hex string

**attdefs() → Iterable[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[DXFGraphic]**

Returns attached Attdef entity by *tag* name.

**get\_attdef\_text(tag: str, default: str = None) → 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\_\_() → Iterable[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[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 paper space layout but not block)

**extend(entities: Iterable[DXFEntity]) → None**

Add *entities* to *DXFGroup*.

**clear() → None**

Remove all entities from *DXFGroup*, does not delete any drawing entities referenced by this group.

**audit(auditor: Auditor) → None**

Remove invalid handles from *DXFGroup*.

Invalid handles are: deleted entities, not all entities in the same layout or entities in a block 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\_\_() → int**

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\_\_(name: str) → bool**

Returns True if a group *name* exist.

**get(name: str) → DXFGroup**

Returns the group *name*. Raises DXFKeyError if group *name* does not exist.

**groups() → DXFGroup**

Iterable of all existing groups.

**new(name: str=None, description: str='', selectable: bool=True) → DXFGroup**

Creates a new group. If *name* is None an unnamed group is created, which has an automatically generated name like “\*Annnn”.

## Parameters

- **name** – group name as string
- **description** – group description as string
- **selectable** – group is selectable if True

**delete** (*group*: Union[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

**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
```

#### dxf

The DXF attributes namespace:

```
# set attribute value
entity.dxf.layer = 'MyLayer'

# get attribute value
linetype = entity.dxf.linetype

# delete attribute
del entity.dxf.linetype
```

#### dxf.handle

DXF *handle* is a unique identifier as plain hex string like F000. (feature for experts)

#### dxf.owner

Handle to *owner* as plain hex string like F000. (feature for experts)

#### doc

Get the associated [Drawing](#) instance.

#### is\_alive

Returns False if entity has been deleted.

#### is\_virtual

Returns True if entity is a virtual entity.

**is\_bound**

Returns True if entity is bound to DXF document.

**dxftype () → 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*.

Changed in version 0.12: added *drop* argument

**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.

**get\_extension\_dict ()** → ExtensionDict

Returns the existing ExtensionDict.

**Raises** AttributeError – extension dict does not exist

**new\_extension\_dict ()** → ExtensionDict

**has\_app\_data (appid: str)** → bool

Returns True if application defined data for *appid* exist.

**get\_app\_data (appid: str)** → 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)**

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)** → 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)**

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)** → 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)**

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)

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	<i>ezdxf.entities.DXFEntity</i>
-------------	---------------------------------

**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.

```
entity.rgb = (30, 40, 50)
r, g, b = entity.rgb
```

This is the recommend method to get/set RGB values, when ever possible do not use the DXF low level attribute `dxft.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.dxft.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()** → OCS

Returns object coordinate system (*OCS*) for 2D entities like `Text` or `Circle`, returns None for entities without OCS support.

### **get\_layout()** → 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.

New in version 0.13.

### **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)**

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, ltscale, true\_color and color\_name as `dxfattribs` dict.

New in version 0.12.

### **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: str = None, location: str = None)**

Set hyperlink of an entity.

**transform**(*t: Matrix44*) → DXFGraphicInplace transformation interface, returns *self* (floating interface).**Parameters** *m* – 4x4 transformation matrix (`ezdxf.math.Matrix44`)

New in version 0.13.

**translate**(*dx: float, dy: float, dz: float*) → DXFGraphicTranslate 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.

New in version 0.13.

**scale**(*sx: float, sy: float, sz: float*) → DXFGraphicScale entity inplace about *dx* in x-axis, *dy* in y-axis and *dz* in z-axis, returns *self* (floating interface).

New in version 0.13.

**scale\_uniform**(*s: float*) → DXFGraphicScale entity inplace uniform about *s* in x-axis, y-axis and z-axis, returns *self* (floating interface).

New in version 0.13.

**rotate\_x**(*angle: float*) → DXFGraphicRotate entity inplace about x-axis, returns *self* (floating interface).**Parameters** *angle* – rotation angle in radians

New in version 0.13.

**rotate\_y**(*angle: float*) → DXFGraphicRotate entity inplace about y-axis, returns *self* (floating interface).**Parameters** *angle* – rotation angle in radians

New in version 0.13.

**rotate\_z**(*angle: float*) → DXFGraphicRotate entity inplace about z-axis, returns *self* (floating interface).**Parameters** *angle* – rotation angle in radians

New in version 0.13.

**rotate\_axis**(*axis: Vec3, angle: float*) → DXFGraphicRotate entity inplace about vector *axis*, returns *self* (floating interface).**Parameters**

- **axis** – rotation axis as tuple or `Vec3`
- **angle** – rotation angle in radians

New in version 0.13.

## 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 = 256Constants 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.ltscal**

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, use `DXFGraphic.transparency` to get/set transparency as float value.

(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	<code>Common graphical DXF attributes</code>

**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.

`dxf.vtx0`

Location of 1. vertex (3D Point in `WCS`)

`dxf.vtx1`

Location of 2. vertex (3D Point in `WCS`)

`dxf.vtx2`

Location of 3. vertex (3D Point in `WCS`)

`dxf.vtx3`

Location of 4. vertex (3D Point in `WCS`)

`dxf.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: Matrix44) → Face3d`

Transform 3DFACE entity by transformation matrix `m` inplace.

New in version 0.13.

`wcs_vertices(close: bool=False) → List[Vec3]`

Returns WCS vertices, if argument `close` is `True`, last vertex == first vertex. Does **not** return duplicated last vertex if represents a triangle.

Compatibility interface to SOLID and TRACE, 3DFACE vertices are already WCS vertices.

New in version 0.15.

## Solid3d

3DSOLID ([DXF Reference](#)) created by an ACIS based geometry kernel provided by the Spatial Corp.  
`ezdxf` will never interpret ACIS source code, don't ask me for this feature.

Subclass of	<code>ezdxf.entities.Body</code>
DXF type	'3DSOLID'
Factory function	<code>ezdxf.layouts.BaseLayout.add_3dsolid()</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.Solid3d`

Same attributes and methods as parent class `Body`.

`dxfl.history_handle`

Handle to history object.

## Arc

ARC ([DXF Reference](#)) center at location `dxfl.center` and radius of `dxfl.radius` from `dxfl.start_angle` to `dxfl.end_angle`. ARC goes always from `dxfl.start_angle` to `dxfl.end_angle` in counter clockwise orientation around the `dxfl.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	<a href="#">Common graphical DXF attributes</a>

**Warning:** Do not instantiate entity classes by yourself - always use the provided factory functions!

**class** `ezdxf.entities.Arc`

`dxfl.center`

Center point of arc (2D/3D Point in [OCS](#))

`dxfl.radius`

Radius of arc (float)

`dxfl.start_angle`

Start angle in degrees (float)

`dxfl.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*) → Iterable[Vertex]  
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. Yields *Vec2* objects for 2D arcs and *Vec3* objects for 3D arcs.  
New in version 0.15.

**transform** (*m: Matrix44*) → Arc  
Transform ARC entity by transformation matrix *m* inplace.  
Raises NonUniformScalingError() for non uniform scaling.  
New in version 0.13.

**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  
New in version 0.13.

**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  
New in version 0.13.

**construction\_tool** () → ConstructionArc  
Returns 2D construction tool *ezdxf.math.ConstructionArc*, ignoring the extrusion vector.  
New in version 0.14.

**apply\_construction\_tool** (*arc: ConstructionArc*) → Arc  
Set ARC data from construction tool *ezdxf.math.ConstructionArc*, will not change the extrusion vector.  
New in version 0.14.

## Body

BODY (DXF Reference) created by an ACIS based geometry kernel provided by the Spatial Corp.

*ezdxf* will never interpret ACIS source code, don't ask me for this feature.

Subclass of	<i>ezdxf.entities.DXFGraphic</i>
DXF type	'BODY'
Factory function	<i>ezdxf.layouts.BaseLayout.add_body()</i>
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.Body

    dxf.version
        Modeler format version number, default value is 1

    dxf.flags
        Require DXF R2013.

    dxf.uid
        Require DXF R2013.

    acis_data
        Get/Set ACIS text data as list of strings for DXF R2000 to R2010 and binary encoded ACIS data for DXF R2013 and later as list of bytes.

    has_binary_data
        Returns True if ACIS data is of type List[bytes], False if data is of type List[str].

    tostring() → str
        Returns ACIS data as one string for DXF R2000 to R2010.

    tobytes() → bytes
        Returns ACIS data as joined bytes for DXF R2013 and later.

    set_text(text: str, sep: str = '\n') → None
        Set ACIS data from one string.
```

## 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	<i>Common graphical DXF attributes</i>

**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(angle:Iterable[float]) → Iterable[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[Vec3]

Approximate the circle by vertices in WCS, argument *segment* 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: Matrix44*) → Circle

Transform CIRCLE entity by transformation matrix *m* inplace.

Raises NonUniformScalingError () for non uniform scaling.

New in version 0.13.

**translate** (*dx: float, dy: float, dz: float*) → Circle

Optimized CIRCLE/ARC translation about *dx* in x-axis, *dy* in y-axis and *dz* in z-axis, returns *self* (floating interface).

New in version 0.13.

**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

New in version 0.13.

**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

New in version 0.13.

## 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*.

---

Subclass of	<code>ezdxf.entities.DXFGraphic</code>
DXF type	'DIMENSION'
factory function	see table below
Inherited DXF attributes	<code>Common graphical DXF attributes</code>

## 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()</code> (not implemented)
Angular 3P Dimension (DXF)	<code>add_angular_3p_dim()</code> (not implemented)
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.

#### `dxf.version`

Version number: 0 = R2010. (int, DXF R2010)

#### `dxf.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.

#### `dxf.dimstyle`

Dimension style (`DimStyle`) name as string.

#### `dxf.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 <code>geometry</code> 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 <code>dimtype</code> values if the dimension text has been positioned at a user-defined location rather than at the default location

#### `dxf.defpoint`

Definition point for all dimension types. (3D Point in `WCS`)

Linear and rotated dimension: `dxf.defpoint` specifies the dimension line location.

Arc and angular dimension: `dxf.defpoint` and `dxf.defpoint4` specify the endpoints of the line used to determine the second extension line.

**dxf.defpoint2**

Definition point for linear and angular dimensions. (3D Point in [WCS](#))

Linear and rotated dimension: The `dxf.defpoint2` specifies the start point of the first extension line.

Arc and angular dimension: The `dxf.defpoint2` and `dxf.defpoint3` specify the endpoints of the line used to determine the first extension line.

**dxf.defpoint3**

Definition point for linear and angular dimensions. (3D Point in [WCS](#))

Linear and rotated dimension: The `dxf.defpoint3` specifies the start point of the second extension line.

Arc and angular dimension: The `dxf.defpoint2` and `dxf.defpoint3` specify the endpoints of the line used to determine the first extension line.

**dxf.defpoint4**

Definition point for diameter, radius, and angular dimensions. (3D Point in [WCS](#))

Arc and angular dimension: `dxf.defpoint` and `dxf.defpoint4` specify the endpoints of the line used to determine the second extension line.

**dxf.defpoint5**

Point defining dimension arc for angular dimensions, specifies the location of the dimension line arc. (3D Point in [OCS](#))

**dxf.angle**

Angle of linear and rotated dimensions in degrees. (float)

**dxf.leader\_length**

Leader length for radius and diameter dimensions. (float)

**dxf.text\_midpoint**

Middle point of dimension text. (3D Point in [OCS](#))

**dxf.insert**

Insertion point for clones of a linear dimensions—Baseline and Continue. (3D Point in [OCS](#))

This value is used by CAD application (Baseline and Continue) and ignored by `ezdxf`.

**dxf.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

**dxf.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.f.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.f.actual\_measurement**

Actual measurement (float, DXF R2000), this is an optional attribute and often not present. (read-only value)

**dx.f.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.f.oblique\_angle**

Linear dimension types with an oblique angle have an optional `dx.f.oblique_angle`.

When added to the rotation `dx.f.angle` of the linear dimension, it gives the angle of the extension lines.

**dx.f.text\_rotation**

Defines is the rotation angle of the dimension text away from its default orientation (the direction of the dimension line). (float)

**dx.f.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() → DimStyleOverride**

Returns the `DimStyleOverride` object.

**render()**

Render graphical representation as anonymous block.

**transform(m: Matrix44) → Dimension**

Transform DIMENSION entity by transformation matrix `m` inplace.

Raises `NonUniformScalingError()` for non uniform scaling.

New in version 0.13.

**virtual\_entities() → Iterable[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_attrs
        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_attrs.

    __delitem__(key: str) → None
        Deletes DIMSTYLE attribute key from dimstyle_attrs, ignores KeyErrors silently.

    get(attribute: str, default: 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: Any = None) → Any
        Returns DIMSTYLE attribute from override dict dimstyle_attrs and removes this attribute from override dict.

    update(attrs: dict) → None
        Update override dict dimstyle_attrs.

        Parameters attrs – 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: str = None, blk1: str = None, blk2: str = None, ldrblk: str = None, size: 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: str = None, valign: str = None, vshift: 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: float = None, hfactor: float = None, align: str = 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 “TOP”, “MIDDLE”, “BOTTOM”
- **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

**set\_limits**(upper: float, lower: float, hfactor: float = None, 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, 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 = ”*, *suffix: str = ”*, *rnd: float = None*, *dec: int = None*, *sep: str = None*, *leading\_zeros: bool = None*, *trailing\_zeros: 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
- **suffix** – 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: int = None*, *linetype: str = None*, *lineweight: int = None*, *extension: float = None*, *disable1: bool = None*, *disable2: bool = None*)

Set dimension line properties

#### Parameters

- **color** – color index
- **linetype** – linetype as string
- **lineweight** – 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: int = None*, *lineweight: int = None*, *extension: float = None*, *offset: float = None*, *fixed\_length: float = None*)

Set common extension line attributes.

#### Parameters

- **color** – color index
- **lineweight** – 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
- **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
- **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: Vertex, 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 (Vertex)
- **leader** – create leader from text to dimension line
- **relative** – *location* is relative to default location.

**user\_location\_override** (*location: Vertex*) → 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.

Subclass of	<i>ezdxf.entities.Dimension</i>
DXF type	'ARC_DIMENSION'
factory function	<code>add_arc_dim()</code> (not implemented)
Inherited DXF attributes	<i>Common graphical DXF attributes</i>
Required DXF version	DXF R2004 ('AC1018')

**Warning:** Do not instantiate entity classes by yourself - always use the provided factory functions!

```
class ezdxf.entities.ArcDimension

    dxf.ext_line1_point
    dxf.ext_line2_point
    dxf.arc_center
    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	<i>Common graphical DXF attributes</i>
Required DXF version	DXF R2000 ('AC1015')

`class ezdxf.entities.Ellipse`

**dx<sub>f</sub>.center**

Center point of circle (2D/3D Point in [WCS](#))

**dx<sub>f</sub>.major\_axis**

Endpoint of major axis, relative to the `dxf.center` (`Vec3`), default value is `(1, 0, 0)`.

**dx<sub>f</sub>.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.

New in version 0.12.

**construction\_tool()** → `ConstructionEllipse`

Returns construction tool `ezdxf.math.ConstructionEllipse`.

New in version 0.13.

**apply\_construction\_tool(*e*: ConstructionEllipse) → Ellipse**

Set ELLIPSE data from construction tool `ezdxf.math.ConstructionEllipse`.

New in version 0.13.

**vertices(*params*: Iterable[float]) → Iterable[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[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: Matrix44*) → Ellipse

Transform ELLIPSE entity by transformation matrix *m* inplace.

New in version 0.13.

**translate** (*dx: float, dy: float, dz: float*) → Ellipse

Optimized ELLIPSE translation about *dx* in x-axis, *dy* in y-axis and *dz* in z-axis, returns *self* (floating interface).

New in version 0.13.

**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

- **layout** – modelspace- , paperspace- or block layout
- **replace** – replace (delete) source entity by SPLINE entity if True

New in version 0.13.

**classmethod from\_arc** (*entity: DXFGraphic*) → 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!

New in version 0.13.

## 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	<i>Common graphical DXF attributes</i>
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`

`dx.dxf.pattern_name`  
Pattern name as string

`dx.dxf.solid_fill`

1	solid fill, better use: <code>Hatch.set_solid_fill()</code>
0	pattern fill, better use: <code>Hatch.set_pattern_fill()</code>

`dx.dxf.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.dxf.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.

**has\_solid\_fill**

True if hatch has a solid fill. (read only)

**has\_pattern\_fill**

True if hatch has a pattern fill. (read only)

**has\_gradient\_data**

True if hatch has a gradient fill. A hatch with gradient fill has also a solid fill. (read only)

**bgcolor**

Property background color as (r, g, b)-tuple, rgb values in the range [0, 255] (read/write/del)

usage:

```
color = hatch.bgcolor # get background color as (r, g, b) tuple
hatch.bgcolor = (10, 20, 30) # set background color
del hatch.bgcolor # delete background color
```

**set\_pattern\_definition**(lines: Sequence[T\_co], factor: float = 1, angle: float = 0) → None

Setup hatch 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

Changed in version 0.13: added *angle* argument

**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 `dxfs.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

New in version 0.13.

**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 `dxfs.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

New in version 0.13.

**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` 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*: *RGB* = (0, 0, 0), *color2*: *RGB* = (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* 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 HATCH entity by transformation matrix *m* inplace.

New in version 0.13.

**associate** (*path*: *Union[PolylinePath, EdgePath]*, *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.
```

New in version 0.13.

## 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 eздxf.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[Union[PolylinePath, EdgePath]]**

Iterable of external paths, could be empty.

**outermost\_paths () → Iterable[Union[PolylinePath, EdgePath]]**

Iterable of outermost paths, could be empty.

**default\_paths** () → Iterable[Union[PolylinePath, EdgePath]]

Iterable of default paths, could be empty.

**rendering\_paths** (hatch\_style: int) → Iterable[Union[PolylinePath, EdgePath]]

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, is\_closed=1, flags=1) → PolylinePath

Create and add a new *PolylinePath* object.

#### Parameters

- **path\_vertices** – list 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=1) → EdgePath

Create and add a new *EdgePath* object.

#### Parameters **flags** – external(1) or outermost(16) or default (0)

**polyline\_to\_edge\_path** (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

**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.PolylinePath**  
A polyline as hatch boundary path.

**path\_type\_flags**  
(bit coded flags)

0	default
1	external
2	polyline, will be set by <i>ezdxf</i>
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*: Sequence[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* of *SplineEdge*. Make sure there are no gaps between edges. AutoCAD in this regard is very picky. *ezdxf* performs no checks on gaps between the edges.

**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, end) → 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, radius=1., start\_angle=0., end\_angle=360., ccw:bool=True) → ArcEdge**

Add an [ArcEdge](#).

**Parameters**

- **center** – center point of arc, (x, y)-tuple
- **radius** – radius of circle
- **start\_angle** – start angle of arc in degrees
- **end\_angle** – end angle of arc in degrees
- **ccw** – True for counter clockwise False for clockwise orientation

**add\_ellipse(center, major\_axis\_vector=(1., 0.), minor\_axis\_length=1., start\_angle=0., end\_angle=360., ccw:bool=True) → EllipsePath**

Add an [EllipseEdge](#).

**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 arc in degrees
- **end\_angle** – end angle of arc in degrees
- **ccw** – True for counter clockwise False for clockwise orientation

**add\_spline(fit\_points=None, control\_points=None, knot\_values=None, weights=None, degree=3, rational=0, periodic=0) → SplinePath**

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.LineEdge
Straight boundary edge.

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.

center
    Center point of arc as (x, y)-tuple. (read/write)

radius
    Arc radius as float. (read/write)

start_angle
    Arc start angle in degrees. (read/write)

end_angle
    Arc end angle in degrees. (read/write)

ccw
    True for counter clockwise arc else False. (read/write)

class ezdxf.entities.EllipseEdge
Elliptic arc as boundary edge.

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 degrees. (read/write)

end_angle
    Ellipse end angle in degrees. (read/write)

ccw
    True for counter clockwise ellipse else False. (read/write)

class ezdxf.entities.SplineEdge
Spline as boundary edge.
```

**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: Vertex = (0, 0), offset: Vertex = (0, 0), dash\_length\_items: 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

New in version 0.13.

**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*

## 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 a 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	<code>Common graphical DXF attributes</code>
Required DXF version	DXF R2000 ('AC1015')

**Warning:** Do not instantiate entity classes by yourself - always use the provided factory functions!

**class** ezdxf.entities.Image**dx<sub>f</sub>.insert**Insertion point, lower left corner of the image (3D Point in *WCS*).**dx<sub>f</sub>.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

**dx<sub>f</sub>.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

**dx<sub>f</sub>.image\_size**

Image size in pixels as (x, y) tuple

**dx<sub>f</sub>.image\_def\_handle**Handle to the image definition entity, see *ImageDef***dx<sub>f</sub>.flags**

<i>Image.dx<sub>f</sub>.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<sub>f</sub>.clipping**

Clipping state:

0	clipping off
1	clipping on

**dx<sub>f</sub>.brightness**

Brightness value (0-100; default = 50)

**dx<sub>f</sub>.contrast**

Contrast value (0-100; default = 50)

**dx<sub>f</sub>.fade**

Fade value (0-100; default = 0)

**dx<sub>f</sub>.clipping\_boundary\_type**

Clipping boundary type:

1	Rectangular
2	Polygonal

**dx<sub>f</sub>.count\_boundary\_points**Number of clip boundary vertices, maintained by *ezdxf*.**dx<sub>f</sub>.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[Vertex]) → 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[Vec3]**

Returns the boundary/clipping path in WCS coordinates.

New in version 0.14.

**transform(m: Matrix44) → Image**

Transform IMAGE entity by transformation matrix *m* inplace.

New in version 0.13.

## 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	<i>ezdxf.entities.DXFGraphic</i>
DXF type	'LEADER'
Factory function	<i>ezdxf.layouts.BaseLayout.add_leader()</i>
Inherited DXF attributes	<a href="#">Common graphical DXF attributes</a>
Required DXF version	DXF R2000 ('AC1015')

**class ezdxf.entities.Leader****dx.dxf.dimstyle**

Name of Dimstyle as string.

**dx.dxf.has\_arrowhead**

0	Disabled
1	Enabled

**dx<sub>f</sub>.path\_type**

Leader path type:

0	Straight line segments
1	Spline

**dx<sub>f</sub>.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<sub>f</sub>.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 has_hook_line)

**dx<sub>f</sub>.has\_hookline**

0	No hookline
1	Has a hookline

**dx<sub>f</sub>.text\_height**

Text annotation height in drawing units.

**dx<sub>f</sub>.text\_width**

Text annotation width.

**dx<sub>f</sub>.block\_color**

Color to use if leader's DIMCLRD = BYBLOCK

**dx<sub>f</sub>.annotation\_handle**

Hard reference (handle) to associated annotation ([MTText](#), Tolerance, or [Insert](#) entity)

**dx<sub>f</sub>.normal\_vector**

Extrusion vector? default = (0, 0, 1).

**.dx<sub>f</sub>.horizontal\_direction**

Horizontal direction for leader, default = (1, 0, 0).

**dx<sub>f</sub>.leader\_offset\_block\_ref**

Offset of last leader vertex from block reference insertion point, default = (0, 0, 0).

**dx<sub>f</sub>.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[Vertex])**

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.

New in version 0.13.

**virtual\_entities**() → Iterable[Union[Line, Arc]]

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.

New in version 0.14.

**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	<a href="#">Common graphical DXF attributes</a>

**Warning:** Do not instantiate entity classes by yourself - always use the provided factory functions!

**class** eздxf.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*: Matrix44) → Line

Transform LINE entity by transformation matrix *m* inplace.

New in version 0.13.

**translate** (*dx*: float, *dy*: float, *dz*: float) → Line

Optimized LINE translation about *dx* in x-axis, *dy* in y-axis and *dz* in z-axis.

New in version 0.13.

## LWPolyline

The LWPOLYLINE entity ([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 in *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*).

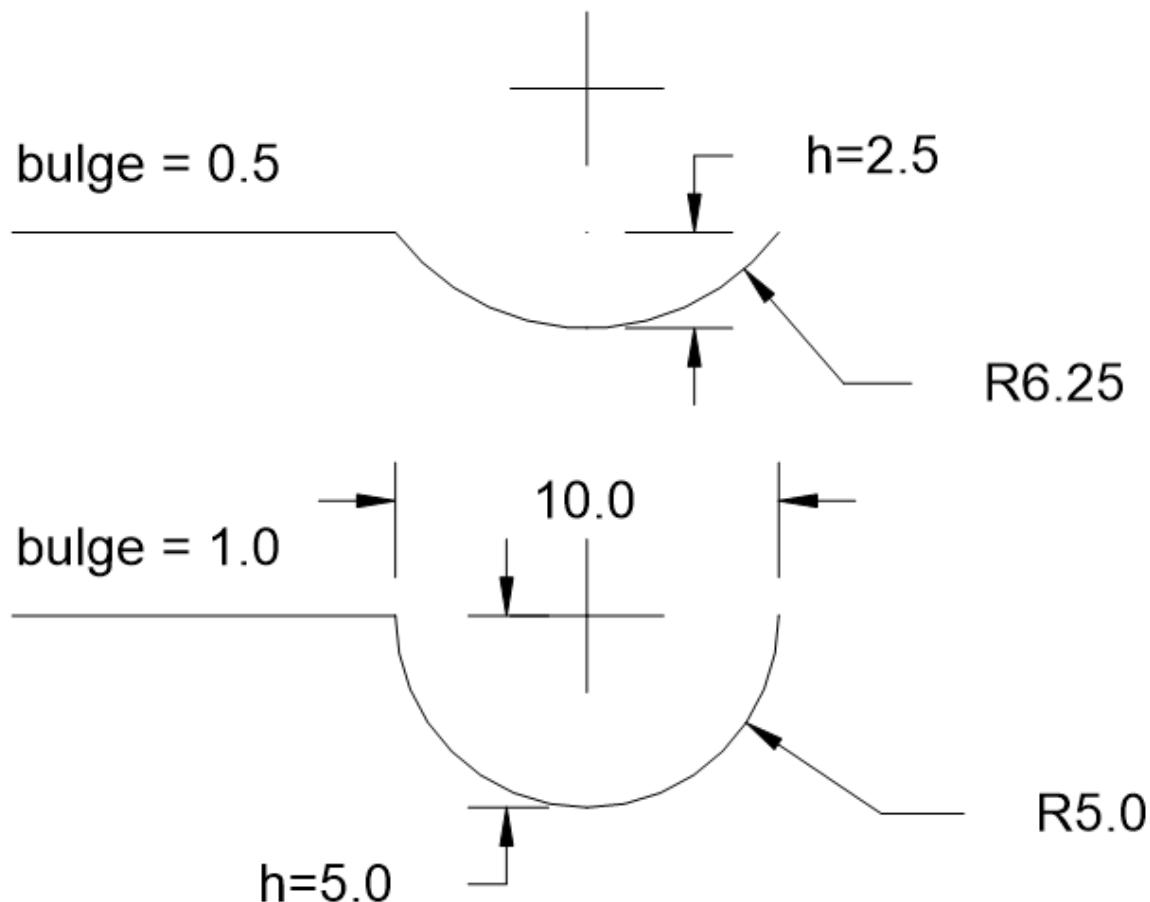
Subclass of	<i>ezdxf.entities.DXFGraphic</i>
DXF type	'LWPOLYLINE'
factory function	<i>add_lwpolyline()</i>
Inherited DXF attributes	<a href="#">Common graphical DXF attributes</a>
Required DXF version	DXF R2000 ('AC1015')

## Bulge value

The bulge value is used to create arc shaped line segments for *Polyline* and *LWPolyline* entities. The 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:

- positive value (> 0): bulge is right of line (counter clockwise)
- negative value (< 0): bulge is left of line (clockwise)
- 0 = no 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.f.elevation

OCS z-axis value for all polyline points, default=0

### dx.f.flags

Constants defined in ezdxf.lldxf.const:

dx.f.flags	Value	Description
LWPOLYLINE_CLOSED	1	polyline is closed
LWPOLYLINE_PLINEGEN	128	???

### dx.f.const\_width

Constant line width (float), default value is 0.

### dx.f.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\_\_() → Iterable[Tuple[float, float, float, float, float]]

Returns iterable of tuples (x, y, start\_width, end\_width, bulge).

**vertices** () → Iterable[Tuple[float, float]]

Returns iterable of all polyline points as (x, y) tuples in *OCS* (*dxf.elevation* is the z-axis value).

**vertices\_in\_wcs** () → Iterable[Vertex]

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 (*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') → 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*: `Matrix44`) → `LWPolyline`

Transform LWPOLYLINE entity by transformation matrix *m* inplace.

New in version 0.13.

**virtual\_entities** () → `Iterable[Union[Line, Arc]]`

Yields ‘virtual’ parts of LWPOLYLINE as LINE or ARC 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 LWPOLYLINE as LINE or ARC entities into target layout, if target layout is `None`, the target layout is the layout of the LWPOLYLINE.

Returns an [`EntityQuery`](#) container with all DXF parts.

**Parameters** `target_layout` – target layout for DXF parts, `None` for same layout as source entity.

## MLine

The MLINE entity ([DXF Reference](#)).

Subclass of	<code>ezdxf.entities.DXFGraphic</code>
DXF type	'MLINE'
factory function	<code>add_mline()</code>
Inherited DXF attributes	<a href="#">Common graphical DXF attributes</a>
Required DXF version	DXF R2000 ('AC1015')

**class** `ezdxf.entities.MLine`

`dxf.style_name`

`MLineStyle` name stored in `Drawing.mline_styles` dictionary, use `set_style()` to change the MLINESTYLE and update geometry accordingly.

`dxf.style_handle`

Handle of `MLineStyle`, use `set_style()` to change the MLINESTYLE and update geometry accordingly.

`dxf.scale_factor`

MLINE scaling factor, use method `set_scale_factor()` to change the scaling factor and update geometry accordingly.

`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() → Vec3**

Returns the start location of the reference line. Callback function for `dx.dxf.start_location`.

**get\_locations() → List[Vec3]**

Returns the vertices of the reference line.

**extend(vertices: Iterable[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)** → MLine

Transform MLINE entity by transformation matrix *m* inplace.

**virtual\_entities()** → Iterable[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 ezdxf.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**

```

dx.f.description
dx.f.flags
dx.f.fill_color
    AutoCAD Color Index (ACI) value of the fill color
dx.f.start_angle
dx.f.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	<i>Common graphical DXF attributes</i>
Required DXF version	DXF R2000 ('AC1015')

**See also:**

*Tutorial for Mesh* and helper classes: `MeshBuilder`, `MeshVertexMerger`

**class** `ezdxf.entities.Mesh`

**dxfs.version**  
Crease type  
0 = off, 1 = on

**dxfs.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()** → `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: Matrix44)** → `Mesh`  
Transform MESH entity by transformation matrix *m* inplace.  
New in version 0.13.

## 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)  
Each edge consist of exact two vertex indices (= index in `vertices`).

**edge\_collapse\_values**

A standard Python list of float values, one value for each edge. (read/write)

**add\_face** (*vertices*: *Iterable[Sequence[float]]*) → *Sequence[int]*

Add a face by coordinates, vertices is a list of (x, y, z) tuples.

**add\_edge** (*vertices*: *Sequence[Sequence[float]]*) → *Sequence[int]*

Add an edge by coordinates, vertices is a list of two (x, y, z) tuples.

**optimize** (*precision*: *int* = 6)

Try to reduce vertex count by merging near vertices. *precision* defines the decimal places for coordinate to be equal to merge two vertices.

**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](#)

Subclass of	<code>ezdxf.entities.DXFGraphic</code>
DXF type	'MTEXT'
Factory function	<code>ezdxf.layouts.BaseLayout.add_mtext()</code>
Inherited DXF attributes	<a href="#">Common graphical DXF attributes</a>
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`:

MText.dxf.flow_direction	Value	Description
MTEXT_LEFT_TO_RIGHT	1	left to right
MTEXT_TOP_TO_BOTTOM	3	top to bottom
MTEXT_BY_STYLE	5	by style (the flow direction is inherited from the associated text style)

**dx.f.style**

Text style (string); default = 'STANDARD'

**dx.f.text\_direction**

X-axis direction vector in [WCS](#) (3D Point); default value is (1, 0, 0); if dx.f.rotation and dx.f.text\_direction are present, dx.f.text\_direction wins.

**dx.f.rotation**

Text rotation in degrees (float); default = 0

**dx.f.line\_spacing\_style**

Line spacing style (int), see table below

**dx.f.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.f.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.f.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.f.bg\_fill\_color**

Background fill color as [AutoCAD Color Index \(ACI\)](#) (DXF R2007)

Better use set\_bg\_color()

**dx.f.bg\_fill\_true\_color**

Background fill color as true color value (DXF R2007), also dx.f.bg\_fill\_color must be present, else AutoCAD complains.

Better use set\_bg\_color()

**dx.f.bg\_fill\_color\_name**

Background fill color as name string (?) (DXF R2007), also dx.f.bg\_fill\_color must be present, else AutoCAD complains.

Better use `set_bg_color()`

#### `dxfs.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: Vertex, rotation: float = None, attachment_point: int = None) → MText`

Set attributes `dxfs.insert`, `dxfs.rotation` and `dxfs.attachment_point`, `None` for `dxfs.rotation` or `dxfs.attachment_point` preserves the existing value.

#### `get_rotation() → float`

Get text rotation in degrees, independent if it is defined by `dxfs.rotation` or `dxfs.text_direction`.

#### `set_rotation(angle: float) → ezdxf.entities.mtext.MText`

Set attribute rotation to `angle` (in degrees) and deletes `dxfs.text_direction` if present.

#### `set_bg_color(color: Union[int, str, Tuple[int, int, int], None], scale: float = 1.5)`

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.

#### Parameters

- **color** – color as *AutoCAD Color Index (ACI)*, string or RGB tuple
- **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.

#### `__iadd__(text: str) → MText`

Append `text` to existing content (`text` attribute).

#### `append(text: str) → MText`

Append `text` to existing content (`text` attribute).

#### `set_font(name: str, bold: bool = False, italic: bool = False, codepage: int = 1252, pitch: int = 0) → None`

Append font change (e.g. '`\Fkroeger|b0|i0|c238|p10`' ) to existing content (`text` attribute).

#### Parameters

- **name** – font name
- **bold** – flag
- **italic** – flag
- **codepage** – character codepage
- **pitch** – font size

#### `set_color(color_name: str) → None`

Append text color change to existing content, `color_name` as red, yellow, green, cyan, blue, magenta or white.

#### `add_stacked_text(upr: str, lwr: str, t: str = '^') → None`

Add stacked text `upr` over `lwr`, `t` defines the kind of stacking:

```
"^": 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
```

**plain\_text** (*split=False*) → Union[List[str], str]

Returns text content without formatting codes.

**Parameters** **split** – returns list of strings splitted at line breaks if `True` else returns a single string.

**transform** (*m: Matrix44*) → MText

Transform MTEXT entity by transformation matrix *m* inplace.

New in version 0.13.

## MText Inline Codes

Code	Description
\U	Start underline
\I	Stop underline
\O	Start overstrike
\o	Stop overstrike
\K	Start strike-through
\k	Stop strike-through
\P	New paragraph (new line)
\pxi	Control codes for bullets, numbered paragraphs and columns
\X	Paragraph wrap on the dimension line (only in dimensions)
\Q	Slanting (obliquing) text by angle - e.g. \Q30;
\H	Text height - e.g. \H3x;
\W	Text width - e.g. \W0.8x;
\F	Font selection e.g. \Fgdt;o - GDT-tolerance
\S	Stacking, fractions e.g. \SA^B or \SX/Y or \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>
\T	Tracking, char.spacing - e.g. \T2;
\~	Non-wrapping space, hard 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 MText:**

Constant	Description
UNDERLINE_START	start underline text ( <code>b += b.UNDERLINE_START</code> )
UNDERLINE_STOP	stop underline text ( <code>b += b.UNDERLINE_STOP</code> )
UNDERLINE	underline text ( <code>b += b.UNDERLINE % "Text"</code> )
OVERSTRIKE_START	start overstrike
OVERSTRIKE_STOP	stop overstrike
OVERSTRIKE	overstrike text
STRIKE_START	start strike trough
STRIKE_STOP	stop strike trough
STRIKE	strike trough text
GROUP_START	start of group
GROUP_END	end of group
GROUP	group text
NEW_LINE	start in new line ( <code>b += "Text" + b.NEW_LINE</code> )
NBSP	none breaking space ( <code>b += "Python" + b.NBSP + "3.4"</code> )

**Point**

POINT ([DXF Reference](#)) at location `dxf.location`.

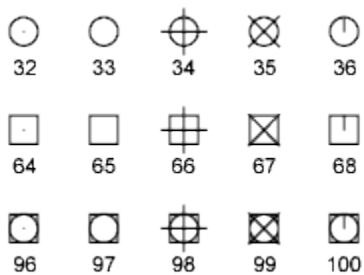
The POINT styling is a global setting, stored as header variable `$PDMODE`, this also means **all** POINT entities in a DXF document have the same styling:

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	<i>Common graphical DXF attributes</i>

**Warning:** Do not instantiate entity classes by yourself - always use the provided factory functions!

## `class ezdxf.entities.Point`

### `dxft.location`

Location of the point (2D/3D Point in [WCS](#))

### `dxft.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: Matrix44) → Point`

Transform POINT entity by transformation matrix *m* inplace.

New in version 0.13.

### `translate(dx: float, dy: float, dz: float) → Point`

Optimized POINT translation about *dx* in x-axis, *dy* in y-axis and *dz* in z-axis.

New in version 0.13.

### `virtual_entities(pysize: float = 1, pdmode: int = 0) → List[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.dxft.start.isclose(e.dxft.end)
```

if the rendering engine can't handle zero-length lines.

### Parameters

- **pysize** – point size in drawing units
- **pdmode** – point styling mode

New in version 0.15.

## 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	<code>Common graphical DXF attributes</code>

**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]
```

#### `dx.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).

#### `dx.dxf.flags`

Constants defined in `ezdxf.lldxf.const`:

<code>Polyline.dxf.flags</code>	Value	Description
POLYLINE_CLOSED	1	This is a closed Polyline (or a polygon mesh closed in the M direction)
POLYLINE_MESH_CLOSED_M_DIRECTION	1	equals POLYLINE_CLOSED
POLYLINE_CURVE_FIT_VERTICES_ADDED	2	Curve-fit vertices have been added
POLYLINE_SPLINE_FIT_VERTICES_ADDED	4	Spline-fit vertices have been added
POLYLINE_3D_POLYLINE	8	This is a 3D Polyline
POLYLINE_3D_POLYMESH	16	This is a 3D polygon mesh
POLYLINE_MESH_CLOSED_N_DIRECTION	32	The polygon mesh is closed in the N direction
POLYLINE_POLYFACE_MESH	64	This Polyline is a polyface mesh
POLYLINE_GENERATE_LINETYPE_PATTERN	128	The linetype pattern is generated continuously around the vertices of this Polyline

#### `dx.dxf.default_start_width`

Default line start width (float); default = 0

```

dx.f.default_end_width
    Default line end width (float); default = 0

dx.f.m_count
    Polymesh M vertex count (int); default = 1

dx.f.n_count
    Polymesh N vertex count (int); default = 1

dx.f.m_smooth_density
    Smooth surface M density (int); default = 0

dx.f.n_smooth_density
    Smooth surface N density (int); default = 0

dx.f.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** () → Iterable[ezdxf.math.\_vector.Vec3]

Returns iterable of all polyline vertices as (x, y, z) tuples, not as *Vertex* objects.

**append\_vertex** (*point: Vertex, dxfattribs: dict = None*) → None

Append a single *Vertex* entity at location *point*.

#### Parameters

- **point** – as (x, y[, z]) tuple
- **dfattribs** – dict of DXF attributes for *Vertex* class

**append\_vertices** (*points: Iterable[Vertex], dxfattribs: Dict[KT, VT] = None*) → None

Append multiple *Vertex* entities at location *points*.

#### Parameters

- **points** – iterable of (x, y[, z]) tuples
- **dfattribs** – dict of DXF attributes for *Vertex* class

**append\_formatted\_vertices** (*points: Iterable[Vertex], format: str = 'xy', dxfattribs: Dict[KT, VT] = 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](#)
- **dfattribs** – dict of DXF attributes for *Vertex* class

**insert\_vertices** (*pos: int, points: Iterable[Vertex], dxfattribs: dict = 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
- **dfattribs** – dict of DXF attributes for *Vertex* class

**transform**(*m*: Matrix44) → Polyline

Transform POLYLINE entity by transformation matrix *m* inplace.

New in version 0.13.

**virtual\_entities**() → Iterable[Union[Line, Arc]]

Yields ‘virtual’ parts of POLYLINE as LINE, ARC or 3DFACE 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 POLYLINE as DXF LINE, ARC or 3DFACE primitives into target layout, if the target layout is None, the target layout is the layout of the POLYLINE entity . Returns an *EntityQuery* container including all DXF primitives.

#### Parameters

- **target\_layout** – target layout for DXF primitives, None for same
- **as source entity.** (*layout*) –

## 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	<code>Common graphical DXF attributes</code>

**class** ezdxf.entities.Vertex

**dxfl.location**

Vertex location (2D/3D Point *OCS* when 2D, *WCS* when 3D)

**dxfl.start\_width**

Line segment start width (float); default = 0

**dxfl.end\_width**

Line segment end width (float); default = 0

**dxfl.bulge**

*Bulge value* (float); default = 0.

The bulge value is used to create arc shaped line segments.

**dxfl.flags**

Constants defined in `ezdxf.lldxf.const`:

Vertex.dxf.flags	Value Description
VTX_EXTRA_VERTEX	X1CREATED vertex created by curve-fitting
VTX_CURVE_FIT_TANGENT	curve-fit 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	X8CREATED vertex created by spline-fitting
VTX_SPLINE_FRAME_CONTROL_POINT	ICONTROL POINT control point
VTX_3D_POLYLINE_VERTEX	X3D polyline vertex
VTX_3D_POLYGON_MESH_VERTEX	MESH VERTEX polygon mesh
VTX_3D_POLYFACE_MESH_VERTEX	MESH VERTEX mesh vertex

**dx.dxf.tangent**

Curve fit tangent direction (float), used for 2D spline in DXF R12.

**dx.dxf.vtx1**

Index of 1st vertex, if used as face (feature for experts)

**dx.dxf.vtx2**

Index of 2nd vertex, if used as face (feature for experts)

**dx.dxf.vtx3**

Index of 3rd vertex, if used as face (feature for experts)

**dx.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: Vertex, dxfattribs: dict = 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.polyline.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]`) → `Vertex`

Get mesh vertex location as (x, y, z)-tuple.

**Parameters** `pos` – 0-based (row, col)-tuple.

**\_\_setitem\_\_** (`pos: Tuple[int, int], location: Vertex`) → `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	<code>ezdxf.entities.Polyline</code>
DXF type	'POLYLINE'
Factory function	<code>ezdxf.layouts.BaseLayout.add_polyface()</code>
Inherited DXF Attributes	<i>Common graphical DXF attributes</i>

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: Dict[KT, VT] = 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` entity

**append\_faces** (`faces: Iterable[FaceType], dxfattribs: Dict[KT, VT] = 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 `Vertex` entity

**faces()** → Iterable[List[`Vertex`]]

Iterable of all faces, a face is a tuple of vertices.

**Returns** [vertex, vertex, vertex, [vertex,] face\_record]

### Return type

**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: Matrix44) → Ray`

Transform XLINE/RAY entity by transformation matrix  $m$  inplace.

New in version 0.13.

`translate(dx: float, dy: float, dz: float) → Ray`

Optimized XLINE/RAY translation about  $dx$  in x-axis,  $dy$  in y-axis and  $dz$  in z-axis, returns *self* (floating interface).

New in version 0.13.

## Region

REGION ([DXF Reference](#)) created by an ACIS based geometry kernel provided by the Spatial Corp.

*ezdxf* will never interpret ACIS source code, don't ask me for this feature.

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`

```
dxf.insert
    Insertion location as (2D/3D Point in WCS)
```

```
dxf.name
    Shape name (str)
```

```
dxf.size
    Shape size (float)
```

```
dxf.rotation
    Rotation angle in degrees; default value is 0
```

```
dxf.xscale
    Relative X scale factor (float); default value is 1
```

```
dxf.oblique
    Oblique angle in degrees (float); default value is 0
```

```
transform(m: Matrix44) → Shape
    Transform SHAPE entity by transformation matrix m inplace.

    New in version 0.13.
```

## 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)`).

Subclass of	<a href="#">ezdxf.entities.DXFGraphic</a>
DXF type	'SOLID'
Factory function	<a href="#">ezdxf.layouts.BaseLayout.add_solid()</a>
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.Solid`

```
dxf.vtx0
    Location of 1. vertex (2D/3D Point in OCS)
```

```
dxf.vtx1
    Location of 2. vertex (2D/3D Point in OCS)
```

```
dxf.vtx2
    Location of 3. vertex (2D/3D Point in OCS)
```

```
dxf.vtx3
    Location of 4. vertex (2D/3D Point in OCS)
```

```
transform(m: Matrix44) → Solid
    Transform SOLID/TRACE entity by transformation matrix m inplace.

    New in version 0.13.
```

```
vertices(close: bool=False) → List[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[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.

### See also:

- Wikipedia article about B\_splines
- Department of Computer Science and Technology at the Cambridge University
- *Tutorial for Spline*

Since *ezdxf* v0.8.9 *Spline* stores fit- and control points, knots and weights as packed data (array.array).

Subclass of	<i>ezdxf.entities.DXFGraphic</i>
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	<i>add_spline()</i>
Spline control frame from fit points	<i>add_spline_control_frame()</i>
Open uniform spline	<i>add_open_spline()</i>
Closed uniform spline	<i>add_closed_spline()</i>
Open rational uniform spline	<i>add_rational_spline()</i>
Closed rational uniform spline	<i>add_closed_rational_spline()</i>

**class** *ezdxf.entities.Spline*

All points in *WCS* as (x, y, z) tuples

**dxfs.degree**

Degree of the spline curve (int).

**dxfs.flags**

Bit coded option flags, constants defined in *ezdxf.lldxf.const*:

dx.f.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.f.n\_knots**

Count of knot values (int), automatically set by *ezdxf* (read only)

**dx.f.n\_fit\_points**

Count of fit points (int), automatically set by *ezdxf* (read only)

**dx.f.n\_control\_points**

Count of control points (int), automatically set by *ezdxf* (read only)

**dx.f.knot\_tolerance**

Knot tolerance (float); default =  $1e-10$

**dx.f.fit\_tolerance**

Fit tolerance (float); default =  $1e-10$

**dx.f.control\_point\_tolerance**

Control point tolerance (float); default =  $1e-10$

**dx.f.start\_tangent**

Start tangent vector as (3D vector in *WCS*)

**dx.f.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 () → BSpline**

Returns construction tool `ezdxf.math.BSpline`.

New in version 0.13.

**apply\_construction\_tool**(*s: BSpline*) → Spline

Set SPLINE data from construction tool `ezdxf.math.BSpline` or from a `geomdl.BSpline`.  
Curve object.

New in version 0.13.

**flattening**(*distance: float, segments: int = 4*) → Iterable[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[Vertex], 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[Vertex], degree: int = 3*) → None

B-spline with uniform knot vector, does NOT start and end at your first and last control points.

**set\_closed**(*control\_points: Sequence[Vertex], degree=3*) → None

Closed B-spline with uniform knot vector, start and end at your first control point.

**set\_open\_rational**(*control\_points: Sequence[Vertex], weights: Sequence[float], degree: int = 3*)

→ None

Open rational B-spline with 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[Vertex], weights: Sequence[float], degree: int = 3*) → None

Rational B-spline with 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[Vertex], weights: Sequence[float], degree: int = 3*) → None

Closed rational B-spline with uniform knot vector, start and end at your first control point, and has additional control possibilities by weighting each control point.

**transform**(*m: Matrix44*) → Spline

Transform SPLINE entity by transformation matrix *m* inplace.

New in version 0.13.

**classmethod from\_arc**(*entity: DXFGraphic*) → Spline

Create a new SPLINE entity from 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!

New in version 0.13.

**Surface**

SURFACE ([DXF Reference](#)) created by an ACIS based geometry kernel provided by the Spatial Corp.

*ezdxf* will never interpret ACIS source code, don't ask me for this feature.

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.dxf.twist_angle
dx.dxf.scale_factor
dx.dxf.align_angle
dx.dxf.solid
dx.dxf.sweep_alignment
dx.dxf.align_start
dx.dxf.bank
dx.dxf.base_point_set
dx.dxf.sweep_entity_transform_computed
dx.dxf.path_entity_transform_computed
dx.dxf.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

One line TEXT entity ([DXF Reference](#)). `Text.dxf.height` in drawing units and defaults to 1, but it also depends on the font rendering of the CAD application. `Text.dxf.width` is a scaling factor, but the DXF reference does not define the base value to scale, in practice the `Text.dxf.height` is the base value, the effective text width depends on the font defined by `Text.dxf.style` and the font rendering of the CAD application, especially for proportional fonts, text width calculation is nearly impossible without knowledge of the used CAD application and their font rendering behavior. This is one reason why the DXF and also DWG file format are not reliable for exchanging exact text layout, they are just reliable for exchanging exact geometry.

See also:

[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	<code>Common graphical DXF attributes</code>

**Warning:** Do not instantiate entity classes by yourself - always use the provided factory functions!

```
class ezdxf.entities.Text
```

**dx<sub>f</sub>.text**

Text content. (str)

**dx<sub>f</sub>.insert**

First alignment point of text (2D/3D Point in *OCS*), relevant for the adjustments 'LEFT', 'ALIGN' and 'FIT'.

**dx<sub>f</sub>.align\_point**

second alignment point of text (2D/3D Point in *OCS*), if the justification is anything other than 'LEFT', the second alignment point specify also the first alignment point: (or just the second alignment point for 'ALIGN' and 'FIT')

**dx<sub>f</sub>.height**

Text height in drawing units (float); default value is 1

**dx<sub>f</sub>.rotation**

Text rotation in degrees (float); default value is 0

**dx<sub>f</sub>.oblique**

Text oblique angle in degrees (float); default value is 0 (straight vertical text)

**dx<sub>f</sub>.style**

*Textstyle* name (str); default value is 'Standard'

**dx<sub>f</sub>.width**

Width scale factor (float); default value is 1

**dx<sub>f</sub>.halign**

Horizontal alignment flag (int), use `set_pos()` and `get_align()`; 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 (int), use `set_pos()` and `get_align()`; default value is 0

0	Baseline
1	Bottom
2	Middle
3	Top

**dx<sub>f</sub>.text\_generation\_flag**

Text generation flags (int)

2	text is backward (mirrored in X)
4	text is upside down (mirrored in Y)

**set\_pos (p1: Vertex, p2: Vertex = None, align: str = None) → Text**

Set text alignment, valid alignments are:

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

Alignments 'ALIGNED' and 'FIT' are special, they require a second alignment point, text is aligned on the virtual line between these two points and has vertical alignment *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 `dx.dxf.height` attribute.
- 'MIDDLE': also a special adjustment, but the result is the same as for 'MIDDLE\_CENTER'.

### Parameters

- **p1** – first alignment point as (x, y[, z]) tuple
- **p2** – second alignment point as (x, y[, z]) tuple, required for 'ALIGNED' and 'FIT' else ignored
- **align** – new alignment, None for preserve existing alignment.

**get\_pos()** → Tuple[str, Vertex, Optional[Vertex]]

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.

**get\_align()** → str

Returns the actual text alignment as string, see also `set_pos()`.

**set\_align( $align: str = 'LEFT'$ )** → Text

Just for experts: Sets the text alignment without setting the alignment points, set adjustment points attr:`dx.insert` and `dx.dxf.align_point` manually.

**Parameters align** – test alignment, see also `set_pos()`

**transform( $m: Matrix44$ )** → Text

Transform TEXT entity by transformation matrix  $m$  inplace.

New in version 0.13.

**translate( $dx: float, dy: float, dz: float$ )** → Text

Optimized TEXT/ATTRIB/ATTDEF translation about  $dx$  in x-axis,  $dy$  in y-axis and  $dz$  in z-axis, returns *self* (floating interface).

New in version 0.13.

**plain\_text()** → str

Returns text content without formatting codes.

New in version 0.13.

## 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)`). I don't know the difference between

SOLID and TRACE.

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: Matrix44) → Trace`

Transform SOLID/TRACE entity by transformation matrix *m* inplace.

New in version 0.13.

`vertices(close: bool=False) → List[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[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

    dxf.insert
        Insertion point, lower left corner of the image in OCS.

    dxf.scale_x
        Scaling factor in x-direction (float)

    dxf.scale_y
        Scaling factor in y-direction (float)

    dxf.scale_z
        Scaling factor in z-direction (float)

    dxf.rotation
        ccw rotation in degrees around the extrusion vector (float)

    dxf.extrusion
        extrusion vector, default = (0, 0, 1)

    dxf.underlay_def_handle
        Handle to the underlay definition entity, see UnderlayDefinition

    dxf.flags
```

dxf.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

```
dxf.contrast
    Contrast value (20 - 100; default = 100)

dxf.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() → UnderlayDefinition
    Returns the associated DEFINITION entity. see UnderlayDefinition.
```

**set\_underlay\_def** (*underlay\_def*: *UnderlayDefinition*) → None

Set the associated DEFINITION entity. see *UnderlayDefinition*.

**reset\_boundary\_path()**

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`

#### `dxfl.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)

#### `dxfl.width`

Viewport width in paperspace units (float)

#### `dxfl.height`

Viewport height in paperspace units (float)

#### `dxfl.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

#### `dxfl.id`

Viewport id (int)

#### `dxfl.view_center_point`

View center point in modelspace stored as 2D point, but represents a [WCS](#) point. (Error in the DXF reference)

#### `dxfl.snap_base_point`

#### `dxfl.snap_spacing`

#### `dxfl.snap_angle`

#### `dxfl.grid_spacing`

#### `dxfl.view_direction_vector`

View direction (3D vector in [WCS](#)).

#### `dxfl.view_target_point`

View target point (3D point in [WCS](#)).

#### `dxfl.perspective_lens_length`

Lens focal length in mm as 35mm film equivalent.

#### `dxfl.front_clip_plane_z_value`

#### `dxfl.back_clip_plane_z_value`

#### `dxfl.view_height`

View height in [WCS](#).

#### `dxfl.view_twist_angle`

#### `dxfl.circle_zoom`

#### `dxfl.flags`

Viewport status bit-coded flags:

1 (0x1)	Enables perspective mode
2 (0x2)	Enables front clipping
4 (0x4)	Enables back clipping
8 (0x8)	Enables UCS follow
16 (0x10)	Enables front clip not at eye
32 (0x20)	Enables UCS icon visibility
64 (0x40)	Enables UCS icon at origin
128 (0x80)	Enables fast zoom
256 (0x100)	Enables snap mode
512 (0x200)	Enables grid mode
1024 (0x400)	Enables isometric snap style
2048 (0x800)	Enables hide plot mode
4096 (0x1000)	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)	kIsoPairRight. If set and kIsoPairTop is not set, then isopair right is enabled
16384 (0x4000)	Enables viewport zoom locking
32768 (0x8000)	Currently always enabled
65536 (0x10000)	Enables non-rectangular clipping
131072 (0x20000)	Turns the viewport off
262144 (0x40000)	Enables the display of the grid beyond the drawing limits
524288 (0x80000)	Enable adaptive grid display
1048576 (0x100000)	Enables subdivision of the grid below the set grid spacing when the grid display is adaptive
2097152 (0x200000)	Enables grid follows workplane switching

```
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.dxf.ucs\\_ortho\\_type](#) is non-zero). If not present and [Viewport.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****dx.dxf.visual\_style\_handle****dx.dxf.default\_lighting\_flag****dx.dxf.default\_lighting\_style**

0	One distant light
1	Two distant lights

**dx.dxf.view\_brightness****dx.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.
```

## 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	<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!

## XLine

```
class ezdxf.entities.XLine  
  
set_masking_area(vertices: Iterable[Vertex]) → 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	<i>ezdxf.entities.DXFGraphic</i>
DXF type	'XLINE'
Factory function	<i>ezdxf.layouts.BaseLayout.add_xline()</i>
Inherited DXF attributes	<i>Common graphical DXF attributes</i>
Required DXF version	DXF R2000 ('AC1015')

```
class ezdxf.entities.XLine

    dxf.start
        Location point of line as (3D Point in WCS)
    dxf.unit_vector
        Unit direction vector as (3D Point in WCS)
    transform(m: Matrix44) → XLine
        Transform XLINE/RAY entity by transformation matrix m inplace.
        New in version 0.13.
    translate(dx: float, dy: float, dz: float) → XLine
        Optimized XLINE/RAY translation about dx in x-axis, dy in y-axis and dz in z-axis, returns self (floating interface).
        New in version 0.13.
```

## DXF Objects

### DXFObject

Common base class for all non-graphical DXF objects.

```
class ezdxf.entities.DXFObject
    Subclass of ezdxf.entities.DXFEntity
```

### 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. At loading time the value could be a `str`, because at this time not all objects are already stored in the EntityDB, and have to be acquired later.

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
```

```
    dxf.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 *Dictionary* is hard owner of entities. Hard owned entities will be destroyed by deleting the dictionary.

**\_\_len\_\_ () → int**

Returns count of items.

**\_\_contains\_\_ (key: str) → bool**

Returns True if *key* exist.

**\_\_getitem\_\_ (key: str) → DXFEntity**

Return the value for *key*, raises a *DXFKeyError* if *key* does not exist.

**\_\_setitem\_\_ (key: str, value: DXFEntity) → None**

Add item as (*key*, *value*) pair to dictionary.

**\_\_delitem\_\_ (key: str) → None**

Delete entry *key* from the dictionary, raises *DXFKeyError* if *key* does not exist.

**keys () → KeysView**

Returns KeysView of all dictionary keys.

**items () → ItemsView**

Returns ItemsView for all dictionary entries as (*key*, *DXFEntity*) pairs.

**count () → int**

Returns count of items.

**get (key: str, default: Any = DXFKeyError) → DXFEntity**

Returns *DXFEntity* for *key*, if *key* exist, else *default* or raises a *DXFKeyError* for *default* = *DXFKeyError*.

**add (key: str, value: DXFEntity) → None**

Add entry (*key*, *value*).

**remove (key: str) → None**

Delete entry *key*. Raises *DXFKeyError*, if *key* does not exist. Deletes also hard owned DXF objects from OBJECTS section.

**discard (key: str) → None**

Delete entry *key* if exists. Does NOT raise an exception if *key* not exist and does not delete hard owned DXF objects.

**clear () → None**

Delete all entries from *Dictionary*, deletes hard owned DXF objects from OBJECTS section.

**add\_new\_dict (key: str, hard\_owned: bool = False) → Dictionary**

Create a new sub *Dictionary*.

**Parameters**

- **key** – name of the sub dictionary
- **hard\_owned** – entries of the new dictionary are hard owned

**get\_required\_dict** (*key: str*) → Dictionary  
Get entry *key* or create a new *Dictionary*, if *Key* not exist.

**add\_dict\_var** (*key: str, value: str*) → DictionaryVar  
Add new DictionaryVar.

#### Parameters

- **key** – entry name as string
- **value** – entry value as string

### 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

    dx.default
        Handle to default entry as hex string like FF00.

    get (key: str) → DXFEntity
        Returns DXFEntity for key or the predefined dictionary wide dx.default entity if key does not exist
        or None if default value also not exist.

    set_default (default: ezdxf.entities.dxentity.DXFEntity) → 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>

```
dx.schema
    Object schema number (currently set to 0)

dx.value
    Value as string.
```

### GeoData

The **GEODATA** entity is associated to the *Modelspace* object.

Subclass of	<code>ezdxf.entities.DXFObject</code>
DXF type	'GEODETA'
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`

`dx.dxf.version`

1	R2009
2	R2010

`dx.dxf.coordinate_type`

0	unknown
1	local grid
2	projected grid
3	geographic (latitude/longitude)

`dx.dxf.block_record_handle`

Handle of host BLOCK\_RECORD table entry, in general the `Modelspace`.

Changed in version 0.10: renamed from `dx.dxf.block_record`

`dx.dxf.design_point`

Reference point in `WCS` coordinates.

`dx.dxf.reference_point`

Reference point in geo coordinates, valid only when coordinate type is *local grid*. The difference between `dx.dxf.design_point` and `dx.dxf.reference_point` defines the translation from WCS coordinates to geo-coordinates.

`dx.dxf.north_direction`

North direction as 2D vector. Defines the rotation (about the `dx.dxf.design_point`) to transform from WCS coordinates to geo-coordinates

`dx.dxf.horizontal_unit_scale`

Horizontal unit scale, factor which converts horizontal design coordinates to meters by multiplication.

`dx.dxf.vertical_unit_scale`

Vertical unit scale, factor which converts vertical design coordinates to meters by multiplication.

`dx.dxf.horizontal_units`

Horizontal units (see `BlockRecord`). Will be 0 (Unitless) if units specified by horizontal unit scale is not supported by AutoCAD enumeration.

**dx.dxf.vertical\_units**

Vertical units (see [BlockRecord](#)). Will be 0 (Unitless) if units specified by vertical unit scale is not supported by AutoCAD enumeration.

**dx.dxf.up\_direction**

Up direction as 3D vector.

**dx.dxf.scale\_estimation\_method**

1	none
2	user specified scale factor
3	grid scale at reference point
4	prismoidal

**dx.dxf.sea\_level\_correction**

Bool flag specifying whether to do sea level correction.

**dx.dxf.user\_scale\_factor****dx.dxf.sea\_level\_elevation****dx.dxf.coordinate\_projection\_radius****dx.dxf.geo\_rss\_tag****dx.dxf.observation\_from\_tag****dx.dxf.observation\_to\_tag****dx.dxf.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 fist 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[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: Vec3, reference\_point: Vec3, north\_direction: Vec2=Y\_AXIS, crs: str=EPSG\_3395*)

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 this 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** `ezdxf.entities.ImageDef`

`dx.dxf.class_version`

Current version is 0.

`dx.dxf.filename`

Relative (to the DXF file) or absolute path to the image file as string.

`dx.dxf.image_size`

Image size in pixel as (x, y) tuple.

`dx.dxf.pixel_size`

Default size of one pixel in drawing units as (x, y) tuple.

`dx.dxf.loaded`

0 = unloaded; 1 = loaded, default = 1

`dx.dxf.resolution_units`

0	No units
2	Centimeters
5	Inch

Default = 0

**ImageDefReactor**

**class** `ezdxf.entities.ImageDefReactor`

`dx.dxf.class_version`

`dx.dxf.image_handle`

**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 <a href="#">Layouts</a> to manage layout objects.

**class** ezdxf.entities.**DXFLayout**dx<sub>f</sub>.nameLayout name as shown in tabs by *CAD* applications

TODO

## Placeholder

The ACDBPLACEHOLDER object for internal usage.

Subclass of	<i>ezdxf.entities.DXFObject</i>
DXF type	'ACDBPLACEHOLDER'
Factory function	<i>ezdxf.sections.objects.ObjectsSection.add_placeholder()</i>

**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 standalone entity.

Subclass of	<i>ezdxf.entities.DXFObject</i>
DXF type	'PLOTSETTINGS'
Factory function	internal data structure

**class** ezdxf.entities.**PlotSettings**dx<sub>f</sub>.page\_setup\_name

Page setup name

TODO

## Sun

SUN entity defines properties of the sun.

Subclass of	<i>ezdxf.entities.DXFObject</i>
DXF type	'SUN'
Factory function	creating a new SUN entity is not supported

**class** ezdxf.entities.**Sun**dx<sub>f</sub>.version

Current version is 1.

---

```

dxf.status
    on = 1 or off = 0

dxf.color
    AutoCAD Color Index (ACI) value of the sun.

dxf.true_color
    true color value of the sun.

dxf.intensity
    Intensity value in the range of 0 to 1. (float)

dxf.julian_day
    use calendardate() to convert dxf.julian_day to datetime.datetime object.

dxf.time
    Day time in seconds past midnight. (int)

dxf.daylight_savings_time

dxf.shadows

```

0	Sun do not cast shadows
1	Sun do cast shadows

```

dxf.shadow_type
dxf.shadow_map_size
dxf.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

    dxf.filename
        Relative (to the DXF file) or absolute path to the underlay file as string.

    dxf.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.

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
```

#### dx<sub>f</sub>.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.

### 6.5.3 Data Query

#### See also:

For usage of the query features see the tutorial: *Tutorial for getting data from DXF files*

#### Entity Query String

```
QueryString := EntityQuery ("[" AttribQuery "]" "i"?)*
```

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.

**first**

First entity or `None`.

**last**

Last entity or `None`.

**\_\_len\_\_()** → int

Returns count of DXF entities.

**\_\_getitem\_\_(item: int)** → DXFEntity

Returns DXFEntity at index `item`, supports negative indices and slicing.

**\_\_iter\_\_()** → Iterable[ezdxf.entities.dxfentity.DXFEntity]

Returns iterable of DXFEntity objects.

```
extend(entities: Iterable[DXFEntity], query: str = '*', unique: bool = True) → ezdxf.query.EntityQuery
Extent the EntityQuery container by entities matching an additional query.

remove(query: str = '*') → None
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: ParseException (pyparsing.py)

groupby(dxattrib: str = "", key: Callable[[DXFEntity], Hashable] = None) → Dict[Hashable, List[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

## The new() Function

```
ezdxf.query.new(entities: Iterable['DXFEntity'] = None, query: str = '*') → 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], dxattrib: str = "", key: KeyFunc = None) → Dict[Hashable, List[DXFEntity]]
Groups a sequence of DXF entities by a DXF attribute like 'layer', returns a dict with dxattrib values as key and a list of entities matching this dxattrib. 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 `dxattrib = '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
- **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.

## 6.5.4 Math Utilities

Utility functions and classes located in module `ezdxf.math`.

### Functions

`ezdxf.math.is_close_points(p1: Vertex, p2: Vertex, abs_tol=1e-10) → bool`

Returns True if `p1` is very close to `p2`.

#### Parameters

- **p1** – first vertex as `Vec3` compatible object
- **p2** – second vertex as `Vec3` compatible object
- **abs\_tol** – absolute tolerance

**Raises** `TypeError` – for incompatible vertices

`ezdxf.math.closest_point(base: Vertex, points: Iterable[Vertex]) → Vec3`

Returns 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[Vertex]) → float`

Returns the area of a polygon, returns the projected area in the xy-plane for 3D vertices.

`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.

## Bulge Related Functions

### See also:

Description of the *Bulge value*.

`ezdxf.math.bulge_center(start_point: Vertex, end_point: Vertex, 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: Vertex, end_point: Vertex, 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.arc_to_bulge(center: Vertex, 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_to_arc(start_point: Vertex, end_point: Vertex, bulge: float) → Tuple[Vec2, float, float, float]`

Returns arc parameters from bulge parameters.

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

`ezdxf.math.bulge_3_points(start_point: Vertex, end_point: Vertex, point: Vertex) → 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

## 2D Functions

`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

New in version 0.14.

`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

New in version 0.14.

`ezdxf.math.distance_point_line_2d(point: Vec2, start: Vec2, end: Vec2) → float`

Returns the normal distance from `point` to 2D line defined by `start`- and `end` point.

`ezdxf.math.point_to_line_relation(point: Vec2, start: Vec2, end: 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.is_point_on_line_2d(point: Vec2, start: Vec2, end: 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 line test

`ezdxf.math.is_point_left_of_line(point: Vec2, start: Vec2, end: 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_in_polygon_2d(point: Vec2, polygon: Iterable[Vec2], abs_tol=1e-10) → int`

Test if `point` is inside `polygon`.

#### Parameters

- **point** – 2D point to test as `Vec2`
- **polygon** – iterable 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.convex_hull_2d(points: Iterable[Vertex]) → List[Vertex]`

Returns 2D convex hull for `points`.

**Parameters** `points` – iterable of points as `Vec3` compatible objects, z-axis is ignored

`ezdxf.math.intersection_line_line_2d(line1: Sequence[Vec2], line2: Sequence[Vec2], virtual=True, abs_tol=1e-10) → Optional[Vec2]`

Compute the intersection of two lines in the xy-plane.

#### Parameters

- **line1** – start- and end point of first line to test e.g.  $((x_1, y_1), (x_2, y_2))$ .
- **line2** – start- and end point of second line to test e.g.  $((x_3, y_3), (x_4, y_4))$ .
- **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.rytz_axis_construction(d1: Vec3, d2: Vec3) → Tuple[Vec3, 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)

```
ezdxf.math.offset_vertices_2d(vertices: Iterable[Vertex], offset: float, closed: bool = False) →
    Iterable[Vec2]
```

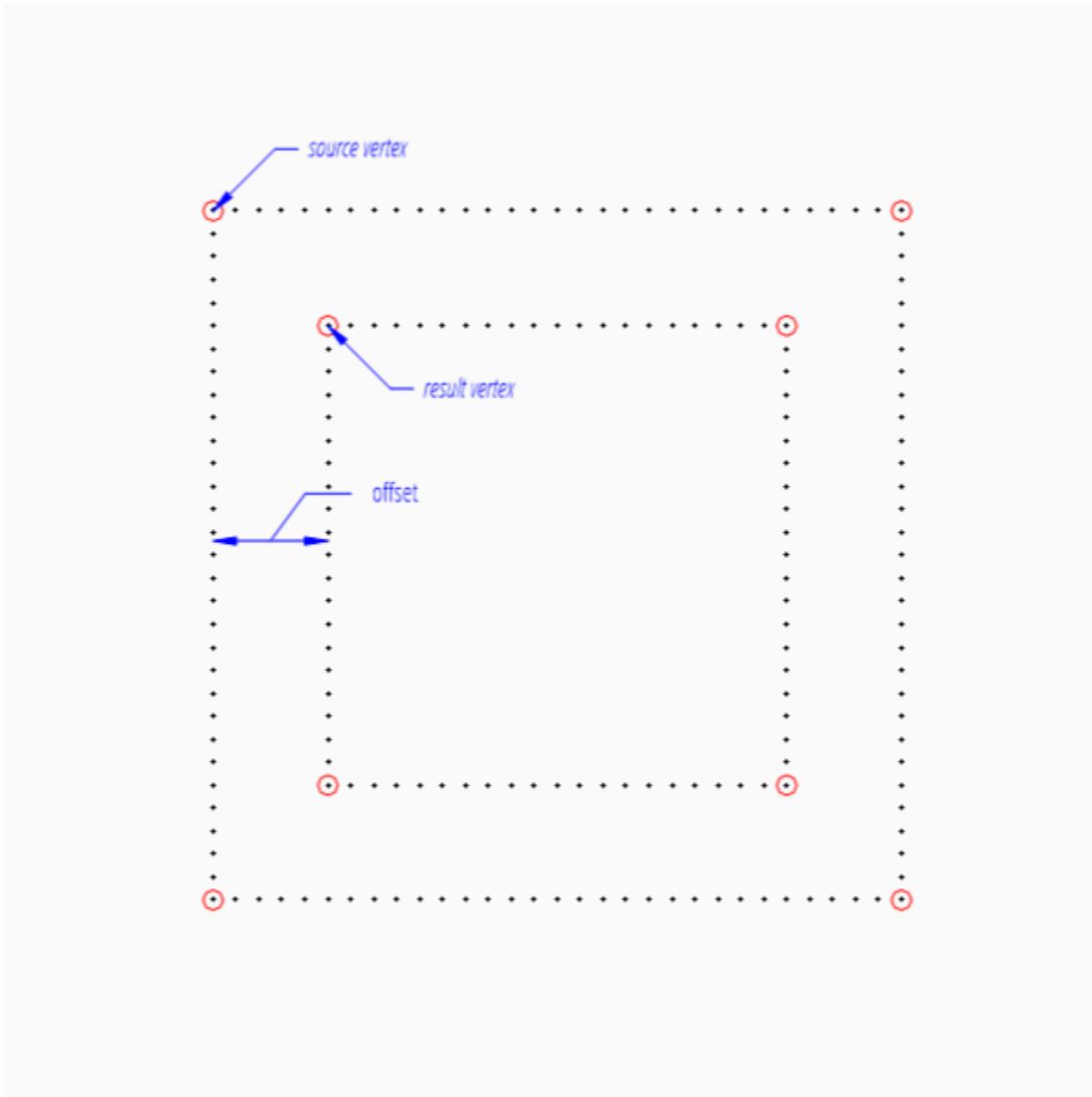
Yields vertices of the offset line to the shape defined by *vertices*. The source shape consist of straight segments and is located in the xy-plane, the z-axis of input vertices is ignored. Takes closed shapes into account if argument *closed* is True, which yields intersection of first and last offset 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

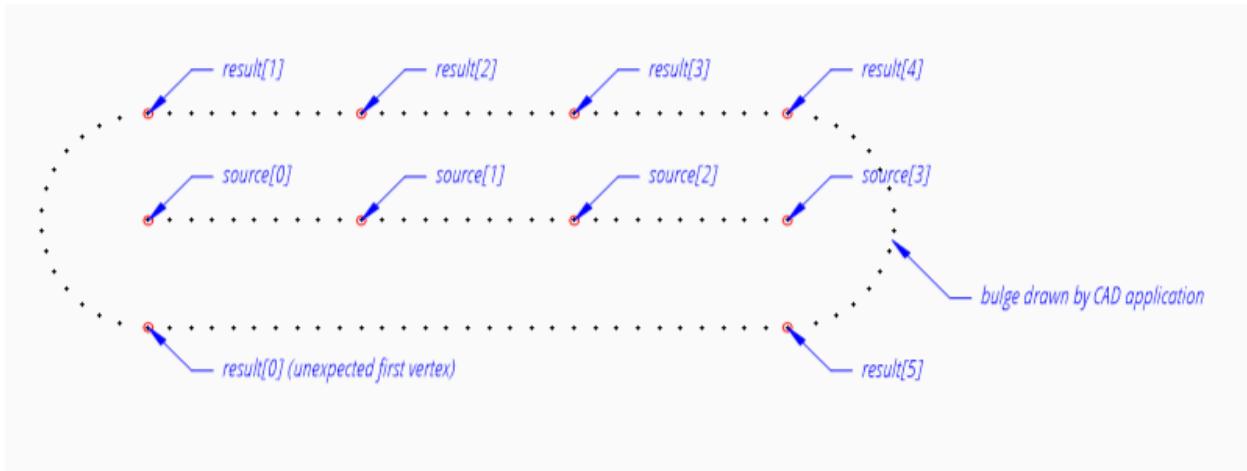
- **vertices** – source shape defined by vertices
- **offset** – line offset perpendicular to direction of shape segments defined by vertices order, offset > 0 is ‘left’ of line segment, offset < 0 is ‘right’ of line segment
- **closed** – True to handle as closed shape

```
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))
```



## 3D Functions

`ezdxf.math.normal_vector_3p(a: Vec3, b: Vec3, c: Vec3) → Vec3`

Returns normal vector for 3 points, which is the normalized cross product for:  $a \rightarrow b \times a \rightarrow c$ .

`ezdxf.math.is_planar_face(face: Sequence[Vec3], abs_tol=1e-9) → 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.subdivide_face(face: Sequence[Union[Vec3, Vec2]], quads=True) → Iterable[List[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[Vec3, Vec2]]]) → Iterable[List[Vec3]]`

Yields only triangles or quad faces, subdivides ngons into triangles.

### Parameters **faces** – iterable of faces as sequence of `Vec2` and `Vec3` objects

`ezdxf.math.distance_point_line_3d(point: Vec3, start: Vec3, end: Vec3) → float`

Returns the normal distance from `point` to 3D line defined by `start`- and `end` point.

`ezdxf.math.intersection_ray_ray_3d(ray1: Tuple[Vec3, Vec3], ray2: Tuple[Vec3, Vec3], abs_tol=1e-10) → Sequence[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 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.estimate_tangents(points: List[Vec3], method: str = '5-points', normalize = True) →
    List[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.estimate_end_tangent_magnitude(points: List[Vec3], method: str = 'chord') →
    List[Vec3]
```

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.fit_points_to_cad_cv(fit_points: Iterable[Vertex], degree: int = 3, method='chord',
                                  tangents: Iterable[Vertex] = None) → BSpline
```

Returns the control vertices and knot vector configuration for DXF SPLINE entities defined only by 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 limited to 2 or 3, a stored degree of >3 is ignored, this limit exist only 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.

#### Parameters

- **fit\_points** – points the spline is passing through

- **degree** – degree of spline, only 2 or 3 is supported by BricsCAD, default = 3
- **method** – knot parametrization method, default = ‘chord’
- **tangents** – start- and end tangent, default is autodetect

**Returns** *BSpline*

New in version 0.13.

```
ezdxf.math.global_bspline_interpolation(fit_points: Iterable[Vertex], degree: int = 3, tangents: Iterable[Vertex] = None, method: str = 'chord') → BSpline
```

B-spline interpolation by 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(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.local_cubic_bspline_interpolation(fit_points: Iterable[Vertex], method: str = '3-points', tangents: Iterable[Vertex] = 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.rational_spline_from_arc(center: Vec3 = (0, 0), radius: float = 1, start_angle: float = 0, end_angle: float = 360, segments: int = 1) → 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), 1 for as few as needed.

New in version 0.13.

```
ezdxf.math.rational_spline_from_ellipse(ellipse: ConstructionEllipse, segments: int = 1) → 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 ( $\pi/2$ ), 1 for as few as needed.

New in version 0.13.

```
ezdxf.math.cubic_bezier_from_arc(center: Vec3 = (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.

New in version 0.13.

```
ezdxf.math.cubic_bezier_from_ellipse(ellipse: ConstructionEllipse, segments: int = 1) → Iterable[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.

New in version 0.13.

`ezdxf.math.cubic_bezier_interpolation(points: Iterable[Vertex]) → List[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

New in version 0.13.

## Transformation Classes

### OCS Class

`class ezdxf.math.OCS(extrusion: Vertex = 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: Vertex) → Vertex`

Returns OCS vector for WCS *point*.

`points_from_wcs(points: Iterable[Vertex]) → Iterable[Vertex]`

Returns iterable of OCS vectors from WCS *points*.

`to_wcs(point: Vertex) → Vertex`

Returns WCS vector for OCS *point*.

`points_to_wcs(points: Iterable[Vertex]) → Iterable[Vertex]`

Returns iterable of WCS vectors for OCS *points*.

`render_axis(layout: BaseLayout, length = 1, colors: Tuple[int, int, int] = (1, 3, 5))`

Render axis as 3D lines into a *layout*.

### UCS Class

`class ezdxf.math.UCS(origin: Vertex = (0, 0, 0), ux: Vertex = None, uy: Vertex = None, uz: Vertex = 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`: `ux = (1, 0, 0)`, `uy = (0, 1, 0)`, `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[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[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\_ocs (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[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: Matrix44) → UCS**

General inplace transformation interface, returns *self* (floating interface).

**Parameters** **m** – 4x4 transformation matrix ([ezdxf.math.Matrix44](#))

New in version 0.14.

**rotate** (*axis: Vertex, 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: Vertex*) → UCS

Shifts current UCS by *delta* vector and returns *self*.

#### Parameters **delta** – shifting vector

**moveto** (*location: Vertex*) → 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: Vertex, axis: Vertex, point: Vertex*) → 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: Vertex, axis: Vertex, point: Vertex*) → 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: Vertex, axis: Vertex, point: Vertex*) → 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: Vertex, axis: Vertex, point: Vertex*) → 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: Vertex, axis: Vertex, point: Vertex*) → 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: Vertex, axis: Vertex, point: Vertex*) → 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: float = 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 pure Python implementation for 4x4 transformation matrices, to avoid dependency to big numerical packages like numpy, before binary wheels, installation of these packages wasn't always easy on Windows.

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 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**() → Matrix44

Returns a copy of same type.

**\_\_copy\_\_**() → Matrix44

Returns a copy of same type.

**classmethod scale**(*sx: float, sy: float = None, sz: float = None*) → Matrix44Returns 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*) → Matrix44Returns a translation matrix for translation vector (*dx, dy, dz*).**classmethod x\_rotate**(*angle: float*) → Matrix44

Returns a rotation matrix about the x-axis.

**Parameters** **angle** – rotation angle in radians**classmethod y\_rotate**(*angle: float*) → Matrix44

Returns a rotation matrix about the y-axis.

**Parameters** **angle** – rotation angle in radians**classmethod z\_rotate**(*angle: float*) → Matrix44

Returns a rotation matrix about the z-axis.

**Parameters** **angle** – rotation angle in radians**classmethod axis\_rotate**(*axis: Vertex, angle: float*) → Matrix44Returns 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*) → 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 perspective_projection(left: float, right: float, top: float, bottom: float, near: float, far: float) → 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) → 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: Iterable[Matrix44]) → Matrix44
```

Compose a transformation matrix from one or more *matrices*.

```
static ucs(ux: Vertex, uy: Vertex, uz: Vertex) → 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__() → Iterable[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: Matrix44*) → Matrix44  
 Returns a new matrix as result of the matrix multiplication with another matrix.

**\_\_imul\_\_** (*other: Matrix44*) → Matrix44  
 Inplace multiplication with another matrix.

**transform** (*vector: Vertex*) → ezdxf.math.\_vector.Vec3  
 Returns a transformed vertex.

**transform\_direction** (*vector: Vertex, normalize=False*) → ezdxf.math.\_vector.Vec3  
 Returns a transformed direction vector without translation.

**transform\_vertices** (*vectors: Iterable[Vertex]*) → Iterable[ezdxf.math.\_vector.Vec3]  
 Returns an iterable of transformed vertices.

**transform\_directions** (*vectors: Iterable[Vertex], normalize=False*) → Iterable[ezdxf.math.\_vector.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.

## Construction Tools

### 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)
```

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```
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**

True for `Vec3(0, 0, 0)`.

**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__()`** → Iterable[float]  
Returns iterable of x-, y- and z-axis.

**`__abs__()`** → float  
Returns length (magnitude) of vector.

**`replace(x: float = None, y: float = None, z: float = None)`** → Vec3  
Returns a copy of vector with replaced x-, y- and/or z-axis.

**`classmethod generate(items: Iterable[Vertex])`** → Iterable[`Vec3`]  
Returns an iterable of `Vec3` objects.

**`classmethod list(items: Iterable[Vertex])`** → List[`Vec3`]  
Returns a list of `Vec3` objects.

**`classmethod tuple(items: Iterable[Vertex])`** → Sequence[`Vec3`]  
Returns a tuple of `Vec3` objects.

**`classmethod from_angle(angle: float, length: float = 1.)`** → 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.)`** → 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: Vertex, factor=.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*, *abs\_tolr*=*1e-12*) → bool  
Returns True if *self* and *other* are parallel to vectors.

**project** (*other*: *Vertex*) → *Vec3*  
Returns projected vector of *other* onto *self*.

**normalize** (*length*: *float* = 1.) → *Vec3*  
Returns normalized vector, optional scaled by *length*.

**reversed**() → *Vec3*  
Returns negated vector (-*self*).

**isclose** (*other*: *Vertex*, *abs\_tol*: *float* = *1e-12*) → bool  
Returns True if *self* is close to *other*. Uses math.isclose() to compare all axis.

**\_\_neg\_\_**() → *Vec3*  
Returns negated vector (-*self*).

**\_\_bool\_\_**() → bool  
Returns True if vector is not (0, 0, 0).

**\_\_eq\_\_** (*other*: *Vertex*) → bool  
Equal operator.

**Parameters** **other** – *Vec3* compatible object

**\_\_lt\_\_** (*other*: *Vertex*) → bool  
Lower than operator.

**Parameters** **other** – *Vec3* compatible object

**\_\_add\_\_** (*other*: *Vertex*) → *Vec3*  
Add *Vec3* operator: *self* + *other*.

**\_\_radd\_\_** (*other*: *Vertex*) → *Vec3*  
RAdd *Vec3* operator: *other* + *self*.

**\_\_sub\_\_** (*other*: *Vertex*) → *Vec3*  
Sub *Vec3* operator: *self* - *other*.

**\_\_rsub\_\_** (*other*: *Vertex*) → *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*: *Vertex*) → float  
Dot operator: *self* . *other*

**Parameters** **other** – *Vec3* compatible object

**cross** (*other*: *Vertex*) → *Vec3*  
Dot operator: *self* x *other*

**Parameters** **other** – *Vec3* compatible object

**distance** (*other*: *Vertex*) → float  
Returns distance between *self* and *other* vector.

**angle\_about** (*base*: *Vec3*, *target*: *Vec3*) → 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*: *Vertex*) → 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[*Vertex*]) → *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** eздxf.math.**Vec2** (*v*: Any, *y*: float = 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*: Vec3, *b*: Vec3, *c*: Vec3) → Plane

Returns a new plane from 3 points in space.

**classmethod** **from\_vector** (*vector*) → Plane

Returns a new plane from a location vector.

**copy** () → Plane

Returns a copy of the plane.

**signed\_distance\_to** (*v*: 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*: Vec3) → float

Returns absolute (unsigned) distance of vertex *v* to plane.

**is\_coplanar\_vertex** (*v*: Vec3, *abs\_tol*=1e-9) → bool

Returns True if vertex *v* is coplanar, distance from plane to vertex *v* is 0.

**is\_coplanar\_plane** (*p*: Plane, *abs\_tol*=1e-9) → bool

Returns True if plane *p* is coplanar, normal vectors in same or opposite direction.

## BoundingBox

**class** ezdxf.math.**BoundingBox** (*vertices*: Iterable[Vertex] = 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

**center**

Returns center of bounding box.

**extend** (*vertices*: Iterable[Vertex]) → None

Extend bounds by *vertices*.

**Parameters** **vertices** – iterable of (x, y, z) tuples or Vec3 objects

**has\_data**

Returns True if data is available

**inside** (*vertex*: *Vertex*) → bool  
 Returns True if *vertex* is inside bounding box.

**size**  
 Returns size of bounding box.

## BoundingBox2d

**class** `ezdxf.math.BoundingBox2d(vertices: Iterable[Vertex] = 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

**center**  
 Returns center of bounding box.

**extend** (*vertices*: *Iterable[Vertex]*) → None  
 Extend bounds by *vertices*.

**Parameters** **vertices** – iterable of (x, y[, z]) tuples or *Vec3* objects

**has\_data**  
 Returns True if data is available

**inside** (*vertex*: *Vertex*) → bool  
 Returns True if *vertex* is inside bounding box.

**size**  
 Returns size of bounding box.

## ConstructionRay

**class** `ezdxf.math.ConstructionRay(p1: Vertex, p2: Vertex = None, angle: 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** (*self, other: ConstructionRay*) → bool  
Returns True if rays are parallel.

**intersect** (*other: ConstructionRay*) → Vec2  
Returns the intersection point as (x, y) tuple of *self* and *other*.  
**Raises** ParallelRaysError – if rays are parallel

**orthogonal** (*location: 'Vertex'*) → 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: Vertex, end: Vertex*)

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.

**\_\_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: Vertex) → 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: Vertex, 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: Vertex, 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: Vertex, p2: Vertex, p3: Vertex) → 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*) → NoneMove 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*) → Vec2Returns point on circle at *angle* as *Vec2* object.**Parameters** **angle** – angle in radians**inside** (*point: Vertex*) → boolReturns True if *point* is inside circle.**tangent** (*angle: float*) → ConstructionRayReturns tangent to circle at *angle* as *ConstructionRay* object.**Parameters** **angle** – angle in radians**intersect\_ray** (*ray: ConstructionRay, abs\_tol: float = 1e-10*) → Sequence[Vec2]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\_circle** (*other: ConstructionCircle, abs\_tol: float = 1e-10*) → Sequence[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 ezdxf.math.ConstructionArc(center: Vertex = (0, 0), radius: float = 1, start_angle: float = 0, end_angle: float = 360, 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) → 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) → ConstructionArc

Scale arc inplace uniform about *s* in x- and y-axis, returns *self* (floating interface).

**rotate\_z** (*angle*: float) → ConstructionArc

Rotate arc inplace about z-axis, returns *self* (floating interface).

**Parameters** **angle** – rotation angle in degrees

**classmethod** **from\_2p\_angle** (*start\_point*: Vertex, *end\_point*: Vertex, *angle*: float, *ccw*: bool = True) → 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*: Vertex, *end\_point*: Vertex, *radius*: float, *ccw*: bool = True, *center\_is\_left*: bool = True) → 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*: Vertex, *end\_point*: Vertex, *def\_point*: Vertex, *ccw*: bool = True) → 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: UCS = None, dxffattribs: dict = None`) → `Arc`  
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
- **dxffattribs** – additional DXF attributes for the DXF `Arc` entity

## ConstructionEllipse

```
class ezdxf.math.ConstructionEllipse(center: Vertex = Vec3(0.0, 0.0, 0.0), major_axis: Vertex = Vec3(1.0, 0.0, 0.0), extrusion: Vertex = 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, 2pi).

**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 = 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. 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[Vertex]) → 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: Vertex=(0, 0, 0), radius: float = 1, extrusion: Vertex=(0, 0, 1), 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*: Matrix44)

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*: dict = None) → Ellipse

Add ellipse as DXF *Ellipse* entity to a layout.

#### Parameters

- **layout** – destination layout as *BaseLayout* object
- **dxfattribs** – additional DXF attributes for DXF *Ellipse* entity

## ConstructionBox

**class** ezdxf.math.**ConstructionBox**(center: Vertex = (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[Vec2]  
Iterable of box corners as `Vec2` objects.

**\_\_getitem\_\_** (corner) → 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: Vertex, p2: Vertex) → 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: Vertex) → bool  
Returns True if `point` is inside of box.

**is\_any\_corner\_inside** (other: ConstructionBox) → bool  
Returns True if any corner of `other` box is inside this box.

**is\_overlapping** (other: ConstructionBox) → bool  
Returns True if this box and `other` box do overlap.

**border\_lines** () → Sequence[ConstructionLine]  
Returns border lines of box as sequence of `ConstructionLine`.

**intersect** (line: ConstructionLine) → List[Vec2]  
Returns 0, 1 or 2 intersection points between `line` and box border lines.

**Parameters** `line` – line to intersect with border lines

#### Returns

list of intersection points

list size	Description
0	no intersection
1	line touches box at one corner
2	line intersects with box

## Shape2d

```
class ezdxf.math.Shape2d(vertices: Iterable[Vertex] = 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) → Vec2
        Get vertex by index item, supports list like slicing.

    append (vertex: Vertex) → 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: Vertex) → 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: Vertex = None) → None
        Rotate shape around rotation center about angle in degrees.

    rotate_rad (angle: float, center: Vertex = 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[Vertex], order: int = 4, knots: Iterable[float] = None, weights: Iterable[float] = None)
```

Representation of a B-spline curve, using an uniform open knot vector (“clamped”).

### 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

#### `control_points`

Control points as list of `Vec3`

#### `count`

Count of control points, ( $n + 1$  in text book notation).

#### `degree`

Degree ( $p$ ) of B-spline = order - 1

#### `order`

Order of B-spline = degree + 1

#### `max_t`

Biggest knot value.

#### `is_rational`

Returns True if curve is a rational B-spline. (has weights)

#### `knots() → List[float]`

Returns a list of knot values as floats, the knot vector **always** has order + count values ( $n + p + 2$  in text book notation).

#### `normalize_knots()`

Normalize knot vector into range [0, 1].

#### `weights() → List[float]`

Returns a list of weights values as floats, one for each control point or an empty list.

#### `params(segments: int) → Iterable[float]`

Yield evenly spaced parameters from 0 to max\_t for given segment count.

#### `reverse() → BSpline`

Returns a new BSpline with reversed control point order.

#### `transform(m: Matrix44) → BSpline`

Transform B-spline by transformation matrix  $m$  inplace.

New in version 0.13.

#### `approximate(segments: int = 20) → Iterable[Vec3]`

Approximates curve by vertices as `Vec3` objects, vertices count = segments + 1.

#### `flattening(distance: float, segments: int = 4) → Iterable[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) → Vec3

Returns point for parameter *t*.

**Parameters** **t** – parameter in range [0, max\_t]

**points** (*t*: float) → List[Vec3]

Yields points for parameter vector *t*.

**Parameters** **t** – parameters in range [0, max\_t]

**derivative** (*t*: float, *n*: int=2) → List[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[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) → None

Insert additional knot, without altering the curve shape.

**Parameters** **t** – position of new knot  $0 < t < \text{max\_t}$

**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[Vertex], *degree*: int=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[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*: 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 >= 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* != None)
- **segments** – absolute count of approximation segments

**Returns** Yields control points of cubic Bézier curves as *Bezier4P* objects

## BSplineU

**class** eздxf.math.BSplineU (*control\_points*: Iterable[Vertex], *order*: int = 4, *knots*: Iterable[float] = None, *weights*: Iterable[float] = None)

Representation of an uniform (periodic) B-spline curve (open curve).

## BSplineClosed

**class** eздxf.math.BSplineClosed (*control\_points*: Iterable[Vertex], *order*: int = 4, *knots*: Iterable[float] = None, *weights*: Iterable[float] = None)

Representation of a closed uniform B-spline curve (closed curve).

## Bezier

**class** eздxf.math.Bezier (*defpoints*: Iterable[Vertex])

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()** → Bezier

Returns a new Bézier-curve with reversed control point order.

**transform(*m*: Matrix44)** → Bezier

General transformation interface, returns a new *Bézier* curve.

**Parameters** *m* – 4x4 transformation matrix (`ezdxf.math.Matrix44`)

New in version 0.14.

**approximate(*segments*: int = 20)** → Iterable[Vec3]

Approximates curve by vertices as `Vec3` objects, vertices count = segments + 1.

**flattening(*distance*: float, *segments*: int=4)** → Iterable[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 (C<sub>n</sub>) to the center of the linear (C<sub>1</sub>) 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)** → Vec3

Returns a point for parameter *t* in range [0, 1] as `Vec3` object.

**points(*t*: Iterable[float])** → Iterable[Vec3]

Yields multiple points for parameters in vector *t* as `Vec3` objects. Parameters have to be in range [0, 1].

**derivative(*t*: float)** → Tuple[Vec3, Vec3, Vec3]

Returns (point, 1st derivative, 2nd derivative) tuple for parameter *t* in range [0, 1] as `Vec3` objects.

**derivatives(*t*: Iterable[float])** → Iterable[Tuple[Vec3, Vec3, Vec3]]

Returns multiple (point, 1st derivative, 2nd derivative) tuples for parameter vector *t* as `Vec3` objects.  
Parameters in range [0, 1]

## Bezier4P

**class eздxf.math.Bezier4P(*defpoints*: Sequence[Vertex])**

Implements an optimized cubic Bézier curve for exact 4 control points.

A Bézier curve is a parametric curve, parameter *t* goes from 0 to 1, where 0 is the first control point and 1 is the fourth control point.

Special behavior:

- 2D control points in, returns 2D results as `Vec2` objects
- 3D control points in, returns 3D results as `Vec3` objects
- Object is immutable.

**Parameters** **defpoints** – iterable of definition points as `Vec2` or `Vec3` compatible objects.

**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*: 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[Union[Vec3, Vec2]]

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[Vec3, Vec2]]

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) → Union[Vec3, Vec2]

Returns point for location *t* at the Bézier-curve.

**Parameters** *t* – curve position in the range [0, 1]

**tangent**(*t*: float) → Union[Vec3, Vec2]

Returns direction vector of tangent for location *t* at the Bézier-curve.

**Parameters** *t* – curve position in the range [0, 1]

## BezierSurface

**class** eздxf.math.BezierSurface(*defpoints*: List[List[Vertex]])

`BezierSurface` defines a mesh of *m* x *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) → eздxf.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) → Vec3

Get tangent at distance *t* as :class:`Vec3` object.

**distance** (*radius*: float) → float

Get distance L from origin for *radius*.

**point** (*t*: float) → Vec3

Get point at distance *t* as :class:`Vec3`.

**circle\_center** (*t*: float) → Vec3

Get circle center at distance *t*.

Changed in version 0.10: renamed from *circle\_midpoint*

**approximate** (*length*: float, *segments*: int) → Iterable[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') → 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*

## Linear Algebra

## Functions

`ezdxf.math.gauss_jordan_solver (A: Iterable[Iterable[float]], B: Iterable[Iterable[float]]) → Tuple[Matrix, 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

New in version 0.13.

`ezdxf.math.gauss_jordan_inverse (A: Iterable[Iterable[float]]) → 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

New in version 0.13.

`ezdxf.math.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

New in version 0.13.

`ezdxf.math.gauss_matrix_solver (A: Iterable[Iterable[float]], B: Iterable[Iterable[float]]) → 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  $[[a_{11}, a_{12}, \dots, a_{1n}], [a_{21}, a_{22}, \dots, a_{2n}], [a_{21}, a_{22}, \dots, a_{2n}], \dots [a_{n1}, a_{n2}, \dots, a_{nn}]]$
- **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

**Raises** `ZeroDivisionError` – singular matrix

New in version 0.13.

```
ezdxf.math.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  $[[a_{0..an-1}], [b_{0..bn-1}], [c_{0..cn-1}]]$

```
[[b0, c0, 0, 0, ...],
[a1, b1, c1, 0, ...],
[0, a2, b2, c2, ...],
... ]
```

- **B** – iterable of floats  $[[b_1, b_1, \dots, b_n]]$

**Returns** list of floats

**Raises** `ZeroDivisionError` – singular matrix

New in version 0.13.

```
ezdxf.math.tridiagonal_matrix_solver(A: Iterable[Iterable[float]], B: Iterable[Iterable[float]]) → 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  $[[a_{0..an-1}], [b_{0..bn-1}], [c_{0..cn-1}]]$

```
[[b0, c0, 0, 0, ...],
[a1, b1, c1, 0, ...],
[0, a2, b2, c2, ...],
... ]
```

- **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

**Raises** `ZeroDivisionError` – singular matrix

New in version 0.13.

`ezdxf.math.banded_matrix(A: Matrix, check_all=True) → Tuple[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.detect_banded_matrix(A: 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.compact_banded_matrix(A: Matrix, m1: int, m2: int) → 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.freeze_matrix(A: Union[MatrixData, Matrix]) → Matrix`

Returns a frozen matrix, all data is stored in immutable tuples.

## Matrix Class

`class eздxf.math.Matrix(items: Any = None, shape: Tuple[int, int] = None, matrix: List[List[float]] = None)`

Basic matrix implementation without any optimization for speed of 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

New in version 0.13.

#### 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) → List[float]**

Returns row *index* as list of floats.

**iter\_row (index) → Iterable[float]**

Yield values of row *index*.

**col (index) → List[float]**

Return column *index* as list of floats.

**iter\_col (index) → Iterable[float]**

Yield values of column *index*.

**diag (index) → 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) → Iterable[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, Iterable[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** () → Matrix  
Returns a new transposed matrix.

**inverse** () → Matrix  
Returns inverse of matrix as new object.

**determinant** () → float  
Returns determinant of matrix, raises `ZeroDivisionError` if matrix is singular.

**freeze** () → Matrix  
Returns a frozen matrix, all data is stored in immutable tuples.

**lu\_decomp** () → 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: `Matrix`) → bool  
Returns True if matrices are equal, tolerance value for comparision is adjustable by the attribute `Matrix.abs_tol`.

**\_\_add\_\_** (other: `Union[Matrix, float]`) → Matrix  
Matrix addition by another matrix or a float, returns a new matrix.

**\_\_sub\_\_** (other: `Union[Matrix, float]`) → Matrix  
Matrix subtraction by another matrix or a float, returns a new matrix.

**\_\_mul\_\_** (other: `Union[Matrix, float]`) → Matrix  
Matrix multiplication by another matrix or a float, returns a new matrix.

## LUdecomposition Class

**class** `ezdxf.math.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 `[[a11, a12, ..., a1n], [a21, a22, ..., a2n], [a31, a32, ..., a3n], ... [an1, an2, ..., ann]]`

**Raises** `ZeroDivisionError` – singular matrix

New in version 0.13.

### 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 . x = B`, right-hand side quantities as vector `B` with n elements.

**Parameters** `B` – vector `[b1, b2, ..., bn]`

**Returns** vector as list of floats

**solve\_matrix** (*B*: Iterable[Iterable[float]]) → Matrix

Solves the linear equation system given by the 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

**inverse** () → 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.BandedMatrixLU` (*A*: *ezdxf.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 . x = B, right-hand side quantities as vector B with n elements.

**Parameters** *B* – vector [b1, b2, ..., bn]

**Returns** vector as list of floats

**solve\_matrix** (*B*: Iterable[Iterable[float]]) → 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.

## 6.5.5 Miscellaneous

## Global Options

Global options stored in `ezdxf.options`

`ezdxf.options.default_text_style`

Default text styles, default value is OpenSans.

`ezdxf.options.default_dimension_text_style`

Default text style for Dimensions, default value is OpenSansCondensed-Light.

`ezdxf.options.filter_invalid_xdata_group_codes`

Check for invalid XDATA group codes, default value is False

`ezdxf.options.log_unprocessed_tags`

Log unprocessed DXF tags for debugging, default value is True

`ezdxf.options.load_proxy_graphics`

Load proxy graphics if True, default is False.

`ezdxf.options.store_proxy_graphics`

Export proxy graphics if True, default is False.

`ezdxf.options.write_fixed_meta_data_for_testing`

Enable this option to always create same meta data for testing scenarios, e.g. to use a diff like tool to compare DXF documents.

`ezdxf.options.preserve_proxy_graphics()`

Enable proxy graphic load/store support.

## 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

## Tools

### 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.

New in version 0.14.

`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.int2rgb(value: int) → Tuple[int, int, int]`  
Split RGB integer *value* into (*r*, *g*, *b*) tuple.

`ezdxf.rgb2int(rgb: Tuple[int, int, int]) → int`  
Combined integer value from (*r*, *g*, *b*) tuple.

`ezdxf.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.

`ezdxf.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.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.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.uuid1()`.

`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.

## 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.reorderascending (entities: Iterable[DXFGraphic], mapping: Union[Dict[KT, VT], Iterable[Tuple[str, str]]] = None) → Iterable[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.reorderdescending (entities: Iterable[DXFGraphic], mapping: Union[Dict[KT, VT], Iterable[Tuple[str, str]]] = None) → Iterable[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.

## 6.6 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 produces a HTML file *your\_dxf\_file.html* with a nicer layout than a plain DXF file and DXF handles as links between DXF entities, this simplifies the navigation between the DXF entities.

Changed in version 0.8.3: Since *ezdxf v0.8.3*, a script called `dxfpp` will be added to your Python script path:

```
usage: dxfpp [-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.

---

## 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))
```

## 6.6.2 DXF Viewer

### A360 Viewer Problems

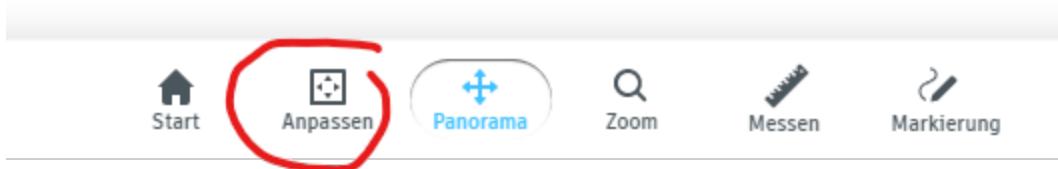
AutoDesk web service [A360](#) seems to be more picky than the AutoCAD desktop applications, may be it helps to use the latest DXF version supported by ezdxf, which is DXF R2018 (AC1032) in the year of writing this lines (2018).

### 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

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))
```

### 6.6.3 DXF Content

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)
```

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```
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 RGB values of the AutoCAD default colors are not officially documented, but an accurate translation table is included in `ezdxf`:

```
from ezdxf.colors import DXF_DEFAULT_COLORS, int2rgb

# 24 bit value RRRRRRRGGGGGGGGBBBBBBB
rgb24 = DXF_DEFAULT_COLORS[aci]
print(f'RGB Hex Value: #{rgb24:06X}')
r, g, b = int2rgb(rgb24)
print(f'RGB Channel Values: R={r:02X} G={g:02X} B={b:02X}')
```

The ACI value 7 has a special meaning, it is white on dark backgrounds and white 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`:

```
# set true color value to red
entity.dxf.true_color = 0xFF0000
```

The `rgb` property of the `DXFGraphic` entity add support to get/set RGB value as (r, g, b)-tuple:

```
# set true color value to red
entity.rgb = (255, 0, 0)
```

If `color` and `true_color` values are set, BricsCAD and AutoCAD use the `true_color` value as display color for the entity.

## 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.

## 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:
```

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```
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()
```

## 6.7 FAQ

### 6.7.1 What is the Relationship between `ezdxf`, `dxfwrite` and `dxfgrabber`?

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 `dxfgrabber`, 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 `dxfgrabber` and much more, but with a different API. So `ezdxf` is not a drop-in replacement for `dxfgrabber` or `dxfwrite`.

Since `ezdxf` can do all the things that `dxfwrite` and `dxfgrabber` can do, I focused on the development of `ezdxf`, `dxfwrite` and `dxfgrabber` are in maintenance mode only and will not get any new features, just bugfixes.

There are no advantages of `dxfwrite` over `ezdxf`, `dxfwrite` has the 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 `dxfgrabber` over `ezdxf` for normal DXF files the smaller memory footprint of `dxfgrabber` 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/>

## 6.8 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

#### 6.8.1 Spline

Render a B-spline as 2D/3D `Polyline`, can be used with DXF R12. The advantage over `R12Spline` is the real 3D support which means the B-spline curve vertices has not to be in a plane and no hassle with `UCS` for 3D placing.

```
class ezdxf.render.Spline
```

```
    __init__(points: Iterable[Vertex] = None, segments: int = 100)
```

##### Parameters

- `points` – spline definition points as `Vec3` or `(x, y, z)` tuple
- `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: 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
- **dxfattribs** – DXF attributes for `Polyline`

`render_open_bspline(layout: BaseLayout, degree: int = 3, dxfattribs: dict = None) → None`  
 Render an open uniform BSpline 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_uniform_bspline(layout: BaseLayout, degree: int = 3, dxfattribs: dict = None) → None`  
 Render a uniform BSpline 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_closed_bspline(layout: BaseLayout, degree: int = 3, dxfattribs: dict = None) → None`  
 Render a closed uniform BSpline 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: 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: dict = None) → None`  
 Render a rational 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_closed_rbspline(layout: BaseLayout, weights: Iterable[float], degree: int = 3, dxfattribs: dict = None) → None`  
 Render a rational 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*

## 6.8.2 R12Spline

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*).

The result is not better than *Spline*, it is also just a POLYLINE entity, but as with all tools, you never know if someone needs it some day.

```
class ezdxf.render.R12Spline
```

```
    __init__(control_points: Iterable[Vertex], degree: int = 2, closed: bool = True)
```

### Parameters

- **control\_points** – B-spline control frame vertices as (x, y) tuples or *Vec3* objects
- **degree** – degree of B-spline, 2 or 3 are valid values
- **closed** – True for closed curve

```
    render(layout: BaseLayout, segments: int = 40, ucs: UCS = None, dxfattribs: dict = None) → Polyline
```

Renders the B-spline into *layout* as 2D *Polyline* entity. Use an *UCS* to place the 2D spline in 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: UCS = None) → List[Vertex]
```

Approximate 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 maybe 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

### 6.8.3 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.

```
class ezdxf.render.Bezier
```

```
start (point: Vertex, tangent: Vertex) → None
```

Set start point and start tangent.

#### Parameters

- **point** – start point as [Vec3](#) or (x, y, z) tuple
- **tangent** – start tangent as vector, example: (5, 0, 0) means a horizontal tangent with a length of 5 drawing units

```
append (point: Vertex, tangent1: Vertex, tangent2: Vertex = None, segments: int = 20)
```

Append a control point with two control tangents.

#### Parameters

- **point** – control point as [Vec3](#) or (x, y, z) tuple
- **tangent1** – first control tangent as vector “left” of control point
- **tangent2** – second control tangent as vector “right” of control point, if omitted *tangent2* = -*tangent1*
- **segments** – count of line segments for polyline approximation, count of line segments from previous control point to appended control point.

```
render (layout: BaseLayout, force3d: bool = False, dxffattribs: dict = None) → None
```

Render bezier curve as 2D/3D [Polyline](#).

#### Parameters

- **layout** – [BaseLayout](#) object
- **force3d** – force 3D polyline rendering
- **dxffattribs** – DXF attributes for [Polyline](#)

### 6.8.4 EulerSpiral

Render an [euler](#) spiral as 3D Polyline or [Spline](#).

This is a parametric curve, which always starts at the origin (0, 0).

```
class ezdxf.render.EulerSpiral
```

```
__init__ (curvature: float = 1)
```

#### Parameters **curvature** – Radius of curvature

```
render_polyline (layout: BaseLayout, length: float = 1, segments: int = 100, matrix: Matrix44 = None, dxffattribs: 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`
- **dxfattribs** – DXF attributes for `Polyline`

**Returns** `Polyline`

`ezdxf.render.spline(layout: BaseLayout, length: float = 1, fit_points: int = 10, degree: int = 3, matrix: Matrix44 = None, dxfattribs: 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`
- **dxfattribs** – DXF attributes for `Spline`

**Returns** `Spline`

## 6.8.5 Random Paths

Random path generators for testing purpose.

`ezdxf.render.random_2d_path(steps=100, max_step_size=1, max_heading=pi/2, retarget=20) → Iterable[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  $\pm max\_heading/2$  in radians
- **retarget** – specifies steps before changing global walking target

`ezdxf.render.random_3d_path(steps=100, max_step_size=1, max_heading=pi/2, max_pitch=pi/8, retarget=20) → Iterable[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  $\pm max\_heading/2$ , rotation about the z-axis in radians
- **max\_pitch** – limit pitch angle change per step to  $\pm max\_pitch/2$ , rotation about the x-axis in radians
- **retarget** – specifies steps before changing global walking target

## 6.8.6 Forms

This module provides functions to create 2D and 3D forms as vertices or mesh objects.

### 2D Forms

- `circle()`
- `square()`
- `box()`
- `ellipse()`
- `euler_spiral()`
- `ngon()`
- `star()`
- `gear()`

### 3D Forms

- `cube()`
- `cylinder()`
- `cylinder_2p()`
- `cone()`
- `cone_2p()`
- `sphere()`

### 3D Form Builder

- `extrude()`
- `from_profiles_linear()`
- `from_profiles_spline()`
- `rotation_form()`

## 2D Forms

Basic 2D shapes as iterable of `Vec3`.

```
ezdxf.render.forms.circle(count: int, radius: float = 1, elevation: float = 0, close: bool = False)
    → Iterable[Vec3]
```

Create polygon vertices for a `circle` with `radius` and `count` corners, `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.square(size: float = 1.) → Tuple[Vec3, Vec3, Vec3, Vec3]`

Returns 4 vertices for a square with a side length of `size`, lower left corner is  $(0, 0)$ , upper right corner is  $(size, size)$ .

`ezdxf.render.forms.box(sx: float = 1., sy: float = 1.) → Tuple[Vec3, Vec3, Vec3, Vec3]`

Returns 4 vertices for a box `sx` by `sy`, lower left corner is  $(0, 0)$ , upper right corner is  $(sx, sy)$ .

`ezdxf.render.forms.ellipse(count: int, rx: float = 1, ry: float = 1, start_param: float = 0, end_param: float = 2 * pi, elevation: float = 0) → Iterable[Vec3]`

Create polygon vertices for an `ellipse` with `rx` as x-axis radius and `ry` for y-axis radius with `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[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.ngon(count: int, length: float = None, radius: float = None, rotation: float = 0., elevation: float = 0., close: bool = False) → Iterable[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 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.star(count: int, r1: float, r2: float, rotation: float = 0., elevation: float = 0., close: bool = False) → Iterable[Vec3]`

Returns corner vertices for star shapes.

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`.

#### 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

`ezdxf.render.forms.gear(count: int, top_width: float, bottom_width: float, height: float, outside_radius: float, elevation: float = 0, close: bool = False) → Iterable[Vec3]`

Returns `gear` (cogwheel) corner vertices.

**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

## 3D Forms

Create 3D forms as `MeshTransformer` objects.

`ezdxf.render.forms.cube(center: bool = True) → 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.cylinder(count: int, radius: float = 1., top_radius: float = None, top_center: Vertex = (0, 0, 1), caps=True, ngons=True) → 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 bottom cap and top cap (as N-gons)
- **ngons** – use ngons for caps if `True` else subdivide caps into triangles

Returns: `MeshTransformer`

`ezdxf.render.forms.cylinder_2p(count: int = 16, radius: float = 1, base_center=(0, 0, 0), top_center=(0, 0, 1))` → `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

Returns: `MeshTransformer`

`ezdxf.render.forms.cone(count: int, radius: float, apex: Vertex = (0, 0, 1), caps=True, ngons=True)`  
→ `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 if `True`
- **ngons** – use ngons for caps if `True` else subdivide caps into triangles

Returns: `MeshTransformer`

`ezdxf.render.forms.cone_2p(count: int, radius: float, apex: Vertex = (0, 0, 1))` → `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

Returns: `MeshTransformer`

`ezdxf.render.forms.sphere(count: int = 16, stacks: int = 8, radius: float = 1, quads=True)` → `MeshTransformer`

Create a `sphere` as `MeshTransformer` object, center is fixed at origin (0, 0, 0).

**Parameters**

- **count** – longitudinal slices
- **stacks** – latitude slices
- **radius** – radius of sphere
- **quads** – use quads for body faces if True else triangles

Returns: *MeshTransformer*

**3D Form Builder**

`ezdxf.render.forms.extrude(profile: Iterable[Vertex], path: Iterable[Vertex], close=True) → MeshTransformer`  
Extrude a *profile* polygon along a *path* polyline, vertices of profile should be in counter clockwise order.

**Parameters**

- **profile** – sweeping profile as list of (x, y, z) tuples in counter clock wise order
- **path** – extrusion path as list of (x, y, z) tuples
- **close** – close profile polygon if True

Returns: *MeshTransformer*

`ezdxf.render.forms.from_profiles_linear(profiles: Iterable[Iterable[Vertex]], close=True, caps=False, ngons=True) → MeshTransformer`  
Create MESH entity by linear connected *profiles*.

**Parameters**

- **profiles** – list of profiles
- **close** – close profile polygon if True
- **caps** – close hull with bottom cap and top cap
- **ngons** – use ngons for caps if True else subdivide caps into triangles

Returns: *MeshTransformer*

`ezdxf.render.forms.from_profiles_spline(profiles: Iterable[Iterable[Vertex]], subdivide: int = 4, close=True, caps=False, ngons=True) → MeshTransformer`

Create MESH entity 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
- **caps** – close hull with bottom cap and top cap
- **ngons** – use ngons for caps if True else subdivide caps into triangles

Returns: *MeshTransformer*

```
ezdxf.render.forms.rotation_form(count: int, profile: Iterable[Vertex], angle: float = 2 * pi, axis:  
                                  Vertex = (1, 0, 0)) → MeshTransformer
```

Create MESH entity 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

Returns: *MeshTransformer*

## 6.8.7 MeshBuilder

The *MeshBuilder* is a helper class to create *Mesh* entities. Stores a list of vertices, a list of edges where an edge is a list of indices into the vertices list, and a faces list where each face is a list of indices into the vertices list.

The *MeshBuilder.render()* method, renders the mesh into a *Mesh* entity. The *Mesh* entity supports ngons in AutoCAD, ngons are polygons with more than 4 vertices.

The basic *MeshBuilder* class does not support transformations.

```
class ezdxf.render.MeshBuilder
```

#### **vertices**

List of vertices as *Vec3* or (x, y, z) tuple

#### **edges**

List of edges as 2-tuple of vertex indices, where a vertex index is the index of the vertex in the *vertices* list.

#### **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.

#### **copy()**

Returns a copy of mesh.

#### **faces\_as\_vertices()** → Iterable[List[Vec3]]

Iterate over all mesh faces as list of vertices.

#### **edges\_as\_vertices()** → Iterable[Tuple[Vec3, Vec3]]

Iterate over all mesh edges as tuple of two vertices.

#### **add\_vertices(vertices: Iterable[Vertex])** → 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

**add\_edge** (*vertices*: *Iterable[Vertex]*) → None

An edge consist of two vertices [v1, v2], each vertex is a (x, y, z) tuple or a *Vec3* object. The new vertex indices are stored as edge in the *edges* list.

**Parameters** **vertices** – list of 2 vertices : [(x1, y1, z1), (x2, y2, z2)]

**add\_face** (*vertices*: *Iterable[Vertex]*) → 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*=None, *faces*=None, *edges*=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*, *edges* 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
- **edges** – list of edges, an edge is a list of vertex indices
- **mesh** – another mesh entity

**has\_none\_planar\_faces** () → bool

Returns True if any face is none planar.

**render** (*layout*: *BaseLayout*, *dxfattribs*: *dict* = 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\_polyface** (*layout*: *BaseLayout*, *dxfattribs*: *dict* = None, *matrix*: *Matrix44* = None, *ucs*: *UCS* = None)

Render mesh as *Polyface* entity into *layout*.

New in version 0.11.1.

**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\_3dfaces** (*layout*: *BaseLayout*, *dxfattribs*: *dict* = None, *matrix*: *Matrix44* = None, *ucs*: *UCS* = None)

Render mesh as *Face3d* entities into *layout*.

New in version 0.12.

#### 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: BaseLayout, length: float = 1, relative=True, dxfattribs: dict = 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}`

**classmethod from\_mesh** (`other`) → `ezdxf.render.mesh.MeshBuilder`

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]`) → `MeshBuilder`

Create new mesh from a `Polyface` or `Polymesh` object.

New in version 0.11.1.

**classmethod from\_builder** (`other: MeshBuilder`)

Create new mesh from other mesh builder, faster than `from_mesh()` but supports only `MeshBuilder` and inherited classes.

## 6.8.8 MeshTransformer

Same functionality as `MeshBuilder` but supports inplace transformation.

**class** `ezdxf.render.MeshTransformer`

Subclass of `MeshBuilder`

**subdivide** (`level: int = 1, quads=True, edges=False`) → `MeshTransformer`

Returns a new `MeshTransformer` object with subdivided faces and edges.

#### Parameters

- **level** – subdivide levels from 1 to max of 5
- **quads** – create quad faces if True else create triangles
- **edges** – also subdivide edges if True

**transform** (`matrix: Matrix44`)

Transform mesh inplace by applying the transformation `matrix`.

**Parameters** `matrix` – 4x4 transformation matrix as `Matrix44` object

**translate** (*dx: float = 0, dy: float = 0, dz: float = 0*)

Translate mesh inplace.

#### Parameters

- **dx** – translation in x-axis
- **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: Vertex, 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

### 6.8.9 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. Location of merged vertices is the location of the first vertex with the same key.

This class is intended as intermediate object to create a compact meshes and convert them to [MeshTransformer](#) objects to apply transformations to the mesh:

```
mesh = MeshVertexMerger()

# create your mesh
mesh.add_face(...)
```

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```
# 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 and for all vertices with the same key look at the [MeshAverageVertexMerger](#) class.

**Parameters** **precision** – floating point precision for vertex rounding

## 6.8.10 MeshAverageVertexMerger

This is an extended version of [MeshVertexMerger](#). Location of merged vertices is the average location of all vertices with the same key, this needs extra memory and runtime in comparision 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

## 6.8.11 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.

Accepts 3D input, but z-axis is ignored.

**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[Vec2, Vec2, Vec2, Vec2]]

Yields all faces as 4-tuples of `Vec2` objects.

**virtual\_entities(dxftype='TRACE', dxfattribs: Dict[KT, VT] = None, doc: Drawing = None) → 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\_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.

#### 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__(item)`

**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: Vertex, start\_width: float, end\_width: 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[Vec2, Vec2, Vec2, 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: Dict[KT, VT] = None, doc: Drawing = None) →  
    Union[Solid, Trace, Face3d]
```

Yields faces as SOLID, TRACE or 3DFACE entities with DXF attributes given in `dfattribs`.

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”
- **dfattribs** – 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[Vec2, Vec2, Vec2, Vec2]]
```

Yields all faces as 4-tuples of `Vec2` objects.

```
virtual_entities (dxftype='TRACE', dxfattribs: Dict[KT, VT] = None, doc: Drawing = None) →  
    Union[Solid, Trace, Face3d]
```

Yields faces as SOLID, TRACE or 3DFACE entities with DXF attributes given in `dfattribs`.

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”
- **dfattribs** – 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

### 6.8.12 Path

This module implements a geometrical *Path* supported by several render backends, with the goal to create such paths from LWPOLYLINE, POLYLINE and HATCH boundary paths and send them to the render backend, see `ezdxf.addons.drawing`.

Minimum common interface:

- **matplotlib: PathPatch**

- matplotlib.path.Path() codes:
- MOVETO
- LINETO
- CURVE4 - cubic Bézier-curve

- **PyQt: QPainterPath**

- moveTo()
- lineTo()
- cubicTo() - cubic Bézier-curve

- **PyCairo: Context**

- move\_to()
- line\_to()
- curve\_to() - cubic Bézier-curve

- **SVG: SVG-Path**

- “M” - absolute move to
- “L” - absolute line to
- “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.

```
class ezdxf.render.path.Path

start
    Path start point, resetting the start point of an empty path is possible.

end
    Path end point.

is_closed
    Returns True if the start point is close to the end point.

classmethod from_lwpolyline(lwpolyline: LWPolyline) → Path
    Returns a Path from a LWPolyline entity, all vertices transformed to WCS.

classmethod from_polyline(polyline: Polyline) → Path
    Returns a Path from a Polyline entity, all vertices transformed to WCS.
```

```
classmethod from_spline(spline: Spline, level: int = 4) → Path
    Returns a Path from a Spline.
```

```
classmethod from_ellipse(ellipse: Ellipse, segments: int = 1) → Path
    Returns a Path from a Ellipse.
```

```
classmethod from_arc(arc: Arc, segments: int = 1) → Path
    Returns a Path from an Arc.
```

```
classmethod from_circle(circle: Circle, segments: int = 1) → Path
    Returns a Path from a Circle.
```

```
classmethod from_hatch_boundary_path(boundary: Union[PolylinePath, EdgePath], ocs: OCS = None, elevation: float = 0) → Path
    Returns a Path from a Hatch polyline- or edge path.
```

```
classmethod from_hatch_polyline_path(polyline: PolylinePath, ocs: OCS = None, elevation: float = 0) → Path
    Returns a Path from a Hatch polyline path.
```

```
classmethod from_hatch_edge_path(edge: EdgePath, ocs: OCS = None, elevation: float = 0) → Path
    Returns a Path from a Hatch edge path.
```

```
control_vertices()
    Yields all path control vertices in consecutive order.
```

```
has_clockwise_orientation() → bool
    Returns True if 2D path has clockwise orientation, ignores z-axis of all control vertices.
```

```
line_to(location: Vec3)
    Add a line from actual path end point to location.
```

```
curve_to(location: Vec3, ctrl1: Vec3, ctrl2: Vec3)
    Add a cubic Bézier-curve from actual path end point to location, ctrl1 and ctrl2 are the control points for the cubic Bézier-curve.
```

```
close() → None
    Close path by adding a line segment from the end point to the start point.
```

```
clone() → Path
    Returns a new copy of Path with shared immutable data.
```

```
reversed() → Path
    Returns a new Path with reversed segments and control vertices.
```

```
clockwise() → Path
    Returns new Path in clockwise orientation.
```

```
counter_clockwise() → Path
    Returns new Path in counter-clockwise orientation.
```

```
add_curves(curves: Iterable[Bezier4P])
    Add multiple cubic Bézier-curves to the path.

    Auto-detect if the path end point is connected to the start- or end point of the curves, if none of them is close to the path end point a line from the path end point to the curves start point will be added.
```

```
add_ellipse(ellipse: ConstructionEllipse, segments=1)
    Add an elliptical arc as multiple cubic Bézier-curves, use from\_arc\(\) constructor of class ConstructionEllipse to add circular arcs.

    Auto-detect connection point, if none is close a line from the path end point to the ellipse start point will be added (see add\_curves\(\)).
```

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

- **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

**add\_spline** (`spline: BSpline, level=4`)

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 connection point, if none is close a line from the path end point to the spline start point will be added (see [add\\_curves \(\)](#)).

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

- **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

**transform** (`m: Matrix44`) → Path

Returns a new transformed path.

#### Parameters **m** – transformation matrix of type `Matrix44`

**approximate** (`segments: int=20`) → Iterable[Vec3]

Approximate path by vertices, `segments` is the count of approximation segments for each cubic bezier curve.

**flattening** (`distance: float, segments: int=16`) → Iterable[Vec3]

Approximate path by vertices and use adaptive recursive flattening to approximate cubic 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.

#### 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

### 6.8.13 Point Rendering

Helper function to render `Point` entities as DXF primitives.

```
ezdxf.render.point.virtual_entities (point: Point, pdszie: float = 1, pdmode: int = 0) →
    List[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.

## 6.9 Add-ons

### 6.9.1 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 ezdxf import recover
from ezdxf.addons.drawing import RenderContext, Frontend
from ezdxf.addons.drawing.matplotlib import MatplotlibBackend

# Safe loading procedure (requires ezdxf 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 ezdxf.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:
doc, auditor = recover.readfile('your.dxf')
if not auditor.has_errors:
    matplotlib.qsave(doc.modelspace(), 'your.png')
```

## MatplotlibBackend

```
class eздxf.addons.drawing.matplotlib.MatplotlibBackend

    __init__(ax: plt.Axes, *, adjust_figure: bool = True, font: FontProperties, use_text_cache: bool =
        True, params: Dict = None)
```

## PyQtBackend

```
class eздxf.addons.drawing.pyqt.PyQtBackend

    __init__(scene: qw.QGraphicsScene = None, *, use_text_cache: bool = True, debug_draw_rect: bool
        = False, params: Dict = None)
```

### Backend Options *params*

Additional options for a backend can be passed by the *params* argument of the backend constructor `__init__()`. Not every option will be supported by all backends and currently most options are only supported by the matplotlib backend.

**pdszie** size for the POINT entity:

- 0 for 5% of draw area height
- < 0 specifies a percentage of the viewport size
- > 0 specifies an absolute size

**pemode** see [Point](#) class documentation

**linetype\_renderer**

- “internal” uses the matplotlib linetype renderer which is oriented on the output medium and dpi setting. This method is simpler and faster but may not replicate the results of CAD applications.
- “eздxf” replicate AutoCAD linetype rendering oriented on drawing units and various Itscale factors. This rendering method break lines into small segments which causes a longer rendering time!

**linetype\_scaling** Overall linetype scaling factor. Set to 0 to disable linetype support at all.

**lineweight\_scaling** Overall linewidth scaling factor. Set to 0 to disable linewidth support at all. The current result is correct, in SVG the line width is 0.7 points for 0.25mm as required, but this often looks too thick.

**min\_lineweight** Minimum linewidth.

**min\_dash\_length** Minimum dash length.

**max\_flattening\_distance** Maximum flattening distance in drawing units for curve approximations.

**show\_defpoints**

- 0 to disable defpoints (default)
- 1 to show defpoints

**show\_hatch**

- 0 to disable HATCH entities
- 1 to show HATCH entities

**hatch\_pattern**

- 0 to disable hatch pattern
- 1 to use predefined matplotlib pattern by pattern-name matching, or a simplified pattern in the PyQt backend. The PyQt support for hatch pattern is not good, it is often better to turn hatch pattern support off and disable HATCHES by setting **show\_hatch** to 0 or use a solid filling.
- 2 to draw HATCH pattern as solid fillings.

**Default Values**

Backend Option	MatplotlibBackend	PyQtBackend
point_size	2.0	1.0
point_size_relative	True	not supported
linetype_renderer	“internal”	“internal”
linetype_scaling	1.0	1.0
lineweight_scaling	1.0	2.0
min_lineweight	0.24	0.24
min_dash_length	0.1	0.1
max_flattening_distance	0.01	0.01
show_hatch	1	1
hatch_pattern	1	1

**Properties**

```
class ezdxf.addons.drawing.properties.Properties
```

**LayerProperties**

```
class ezdxf.addons.drawing.properties.LayerProperties
```

**RenderContext**

```
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

- Line types and hatch patterns/gradients are ignored by the `PyQtBackend`
- 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
- No support for `MULTILEADER`
- The style which `POINT` entities are drawn in are not stored in the dxf file and so cannot be replicated exactly
- only basic support for:
  - infinite lines (rendered as lines with a finite length)
  - viewports (rendered as rectangles)
  - 3D (some entities may not display correctly in 3D (see possible improvements below)) however many things should already work in 3D.
  - vertical text (will render as horizontal text)
  - multiple columns of text (placement of additional columns may be incorrect)

## Future Possible Improvements

- pass the font to backend if available
- text formatting commands could be interpreted and broken into text chunks which can be drawn with a single font weight or modification such as italics

## 6.9.2 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). Supports “MultiPoint”, “MultiLineString”, “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 as “Polygon”, holes are supported

**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[DXFGraphic, Iterable[DXFGraphic]], distance=0.1,
force_line_string=False) → 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=1, dxfattribs: Dict = None) → Iterable[DXFGraphic]
```

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.

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)
- **dxfattribs** – dict with additional DXF attributes

```
ezdxf.addons.geo.gfilter(entities: Iterable[DXFGraphic]) → Iterable[DXFGraphic]
```

Filter DXF entities from iterable `entities`, which are incompatible to the `__geo_reference__` interface.

## GeoProxy Class

**class** ezdxf.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[DXFGraphic, Iterable[DXFGraphic]]*, *distance=0.1*, *force\_line\_string=False*) → `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=1*, *dxfattribs: Dict = None*) → `Iterable[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.

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)
- **dfattribs** – dict with additional DXF attributes

**copy** () → `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: 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: 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[[Vec3], 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[[Vec3], 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[[Vec3], 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: Vec3) → Vec3`

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** – `Vec3` 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: Vec3, tol=1e-6) → Vec3`

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** – `Vec3` 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.

### 6.9.3 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 ezdxf
from ezdxf.addons import Importer

sdoc = ezdxf.readfile('original.dxf')
tdoc = ezdxf.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** ezdxf.addons.importer.**Importer**(source: Drawing, target: Drawing)

The `Importer` class is central element for importing data from other DXF drawings.

#### Parameters

- **source** – source Drawing
- **target** – target Drawing

#### Variables

- **source** – source drawing
- **target** – target drawing
- **used\_layer** – 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 import by importing required table entries and block definition, without finalization the target drawing is maybe invalid for AutoCAD. Call [`finalizer\(\)`](#) as last step of the import process.

**import\_block(block\_name: str, rename=True)** → str

Import one block definition. If block already exist the block will be renamed if argument `rename` is True, else the existing target block will be used instead of the source block. Required name resolving for imported block references (INSERT), will be done in [`Importer.finalize\(\)`](#).

To replace an existing block in the target drawing, just delete it before importing: `target.blocks.delete_block(block_name, safe=False)`

#### Parameters

- **block\_name** – name of block to import
- **rename** – rename block if exists in target drawing

Returns: block name (renamed)

**Raises** `ValueError` – source block not found

**import\_blocks(block\_names: Iterable[str], rename=False)** → None

Import all block definitions. If block already exist the block will be renamed if argument `rename` is True, else the existing target block will be used instead of the source block. Required name resolving for imported block references (INSERT), will be done in [`Importer.finalize\(\)`](#).

#### Parameters

- **block\_names** – names of blocks to import
- **rename** – rename block if exists in target drawing

**Raises** `ValueError` – source block not found

**import\_entities(entities: Iterable[DXFEntity], target\_layout: BaseLayout = None)** → None

Import all `entities` into `target_layout` or the modelspace of the target drawing, if `target_layout` is 'None'.

#### Parameters

- **entities** – Iterable of DXF entities
- **target\_layout** – any layout (modelspace, paperspace or block) from the target drawing

**Raises** `DXFStructureError` – `target_layout` is not a layout of target drawing

**import\_entity(entity: DXFEntity, target\_layout: BaseLayout = None)** → None

Imports a single DXF `entity` into `target_layout` or the modelspace of the target drawing, if `target_layout` is `None`.

#### Parameters

- **entity** – DXF entity to import
- **target\_layout** – any layout (modelspace, paperspace or block) from the target drawing

**Raises** `DXFStructureError` – `target_layout` is not a layout of target drawing

**import\_modelspace(target\_layout: BaseLayout = None)** → None

Import all entities from source modelspace into `target_layout` or the modelspace of the target drawing, if `target_layout` is `None`.

**Parameters** `target_layout` – any layout (modelspace, paperspace or block) from the target drawing

**Raises** DXFStructureError – *target\_layout* is not a layout of target drawing

**import\_paperspace\_layout** (*name*: str) → Layout

Import paperspace layout *name* into target drawing. Recreates the source paperspace layout in the target drawing, renames the target paperspace if already a paperspace with same *name* exist and imports all entities from source paperspace into 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\_layouts** () → None

Import all paperspace layouts and their content into target drawing. Target layouts will be renamed if already a layout with same name exist. Layouts will be imported in original tab order.

**import\_shape\_files** (*fonts*: Set[str]) → None

Import shape file table entries from source drawing into target drawing. 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 source drawing into target drawing.

**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 already existing table entry else ignore existing entry

**Raises** **TypeError** – unsupported table type

**import\_tables** (*table\_names*: Union[str, Iterable[str]] = '\*', *replace=False*) → None

Import DXF tables from source drawing into target drawing.

**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 drawing. The layout will be renamed if *name* already exist in the target drawing. Returns target modelspace for layout name “Model”.

**Parameters** **name** – layout name as string

**Raises** **KeyError** – if source layout *name* not exist

## 6.9.4 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], drawing='doc') → Code`

**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

**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.dxf2code.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.

## 6.9.5 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():
```

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```

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 = eздxf.new()
msp = newdoc.modelspace()
# 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 eздxf.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.итердхф(filename: str, errors: str='surrogateescape')` → 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.iterdx.modelspace(filename: str, types: Iterable[str]=None, errors: str='surrogateescape') → Iterable[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_models(stream: BinaryIO, types: Iterable[str]=None, errors: str='surrogateescape') → Iterable[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.iterdxf.IterDXF`

**export** (`name: str`) → `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[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.iterdxf.IterDXFWriter`

**write** (`entity: 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.

## 6.9.6 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:
    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:          [<class          'typ-
                    <class
'ezdxf.addons.r12writer.BinaryDXFWriter'>],
                    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 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:  $(m_0, n_0), (m_0, n_1), (m_0, n_2), (m_1, n_0), (m_1, n_1), (m_1, n_2), \dots$

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.

### 6.9.7 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

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.exec_path`  
Path to installed ODA File Converter executable, default is "C:\Program Files\ODA\ODAFileConverter\ODAFileConverter.exe".

`ezdxf.addons.odafc.temp_path`  
Path to a temporary folder by default the system temp folder defined by environment variable TMP or TEMP.

`ezdxf.addons.odafc.readfile(filename: str, version: str = None, audit=False) → Drawing`  
Use 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

`ezdxf.addons.odafc.export_dwg(doc: Drawing, filename: str, version: str = None, audit=False, replace=False) → None`

Use an installed ODA File Converter to export a DXF document `doc` as a DWG file.

Saves a temporary DXF file and convert this DXF file into a DWG file 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** – export filename of DWG file, extension will be changed to “.dwg”
- **version** – export file as specific version, 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

Changed in version 0.15: added *replace* option

## 6.9.8 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 ezdxf.addons.pyCSG import CSG

# create new DXF document
doc = ezdxf.new()
msp = doc.modelspace()

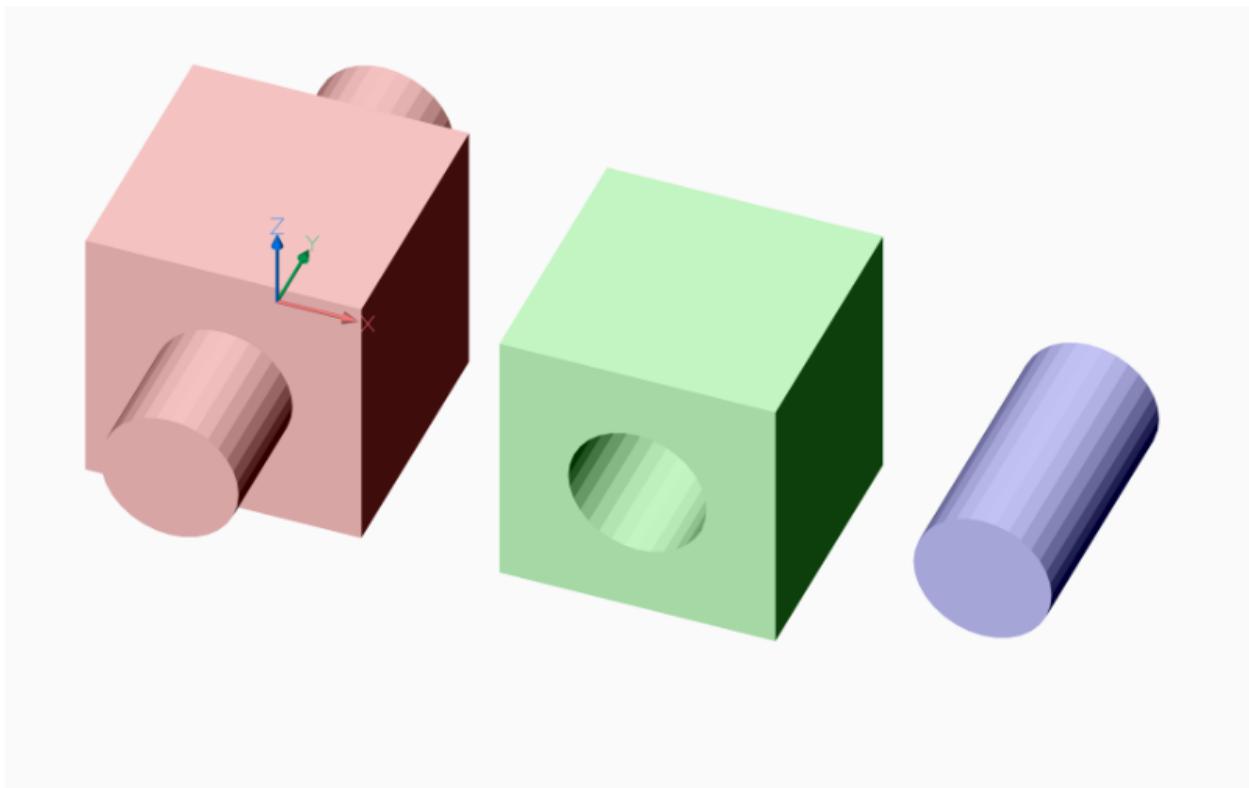
# create same geometric primitives as MeshTransformer() objects
cube1 = cube()
cylinder1 = cylinder_2p(count=32, base_center=(0, -1, 0), top_center=(0, 1, 0),  
                        radius=.25)

# build solid union
union = CSG(cube1) + CSG(cylinder1)
# convert to mesh and render mesh to modelspace
union.mesh().render(msp, dxftattribs={'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, dxftattribs={'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, dxftattribs={'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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```

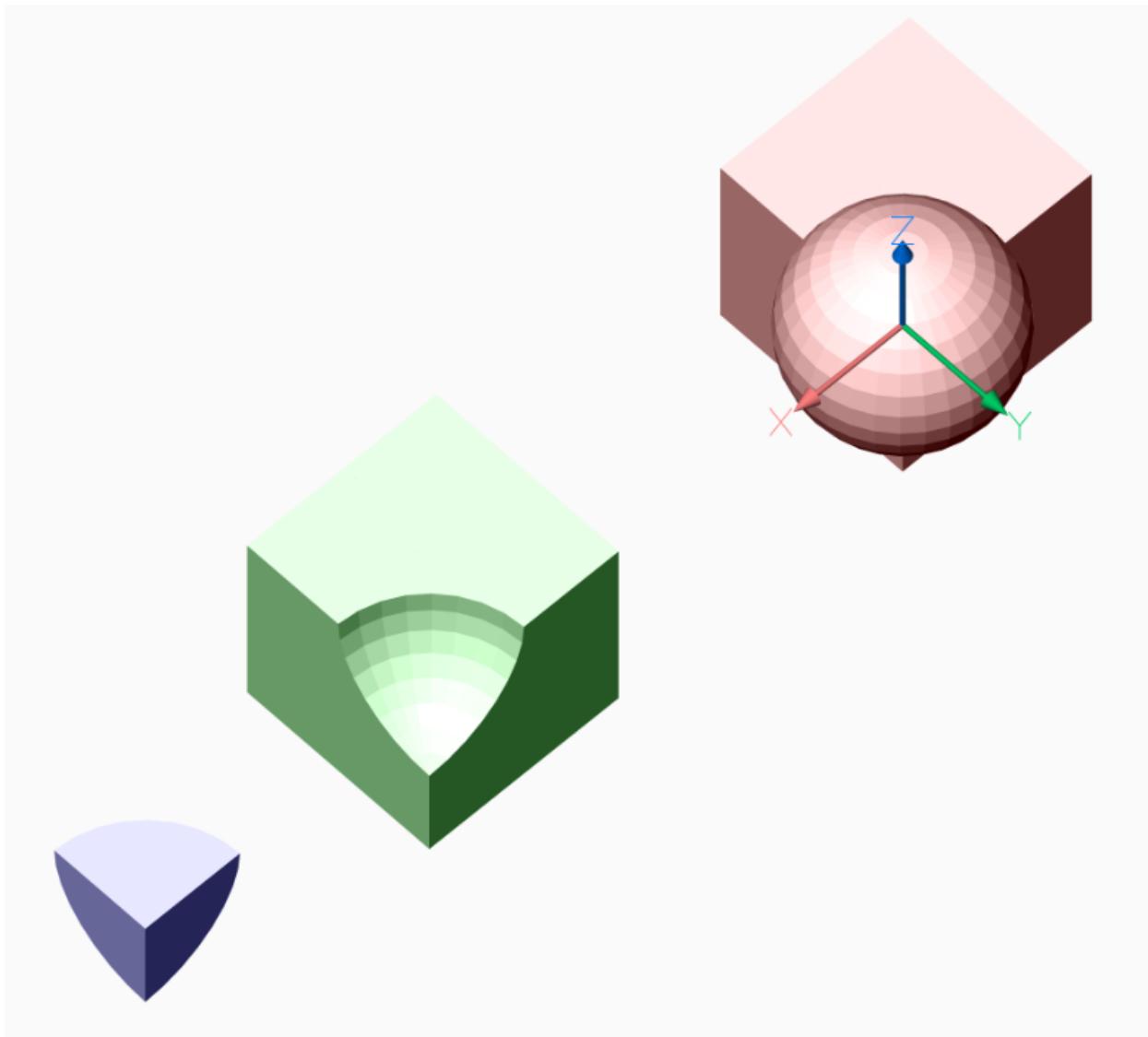
cube1 = cube().translate(-.5, -.5, -.5)
sphere1 = sphere(count=32, stacks=16, radius=.5, quads=True)

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!

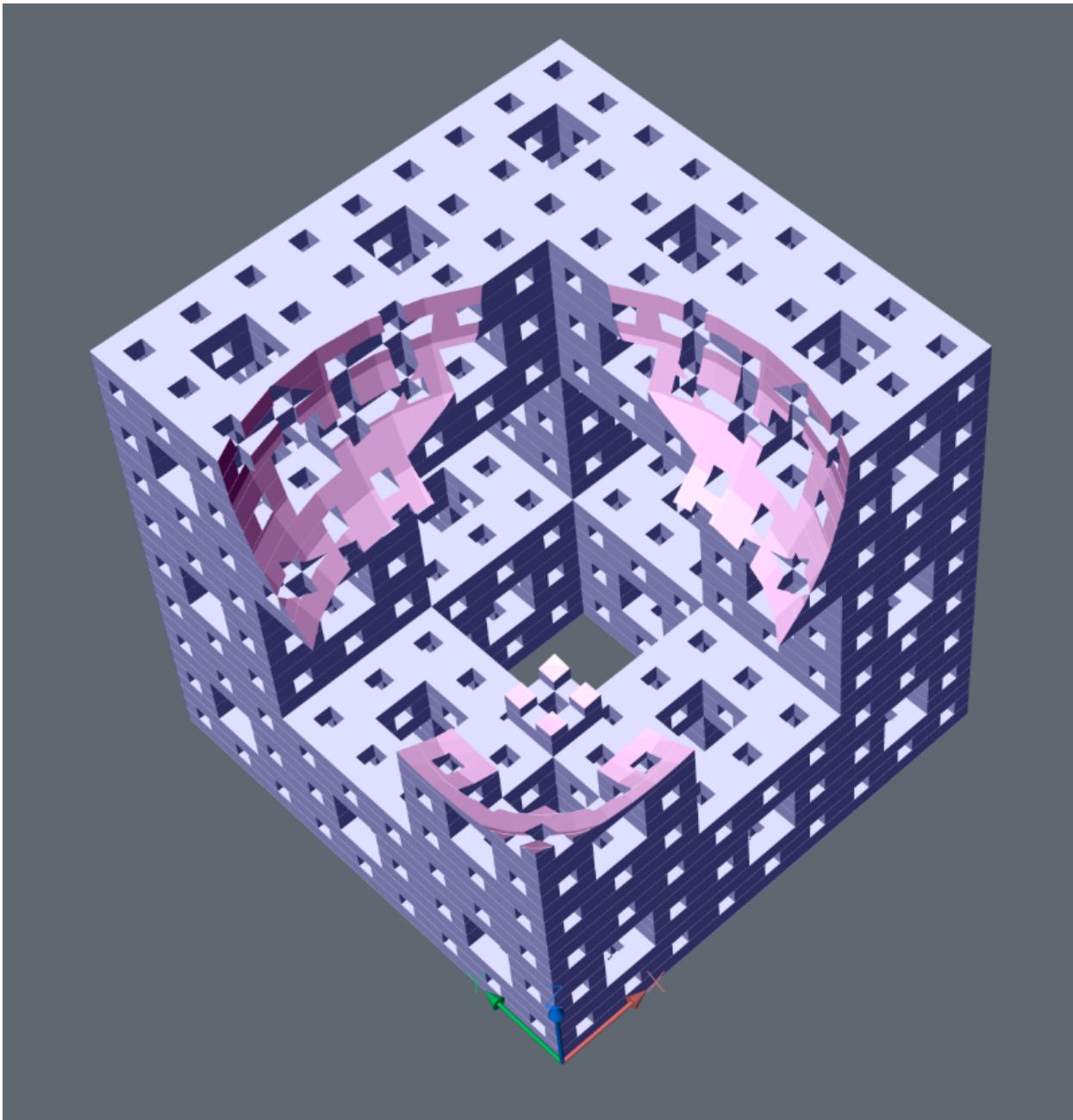
```
from ezdxf.render.forms import sphere
from ezdxf.addons import MengerSponge
from ezdxf.addons.pycsg import CSG

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*) → MeshTransformerReturns a `ezdxf.render.MeshTransformer` object.**Parameters** **meshid** – individual mesh ID, 0 is default**union** (*other: CSG*) → CSGReturn 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)

```
+-----+      +-----+
|       |      |
|   A   |      |
| +---+---+ =  | +---+---+
+---+---+      |      +---+
|       |      |
|   B   |      |
|       |      |
+-----+      +-----+
```

**\_\_add\_\_** (*other: CSG*) → CSG

union = A + B

**subtract** (*other: CSG*) → CSGReturn 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)

```
+-----+      +-----+
|       |      |
|   A   |      |
| +---+---+ =  | +---+
+---+---+      |      +---+
|       |      |
|   B   |      |
|       |      |
+-----+
```

**\_\_sub\_\_** (*other: CSG*) → CSG

difference = A - B

**intersect** (*other: CSG*) → CSGReturn 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)

```
+-----+
|       |
|   A   |
| +---+---+ =  +---+
+---+---+      |      +---+
|       |      |
|   B   |      |
|       |      |
+-----+
```

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```
+-----+  
|       |
```

**mul** (*other: CSG*) → CSG

```
intersection = A * B
```

**inverse** () → 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.

## 6.9.9 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[ColorDependentPlotStyles, NamedPlotStyles]  
Load the CTB or STB file *filename* from file system.

`ezdxf.addons.acadctb.new_ctb()` → ColorDependentPlotStyles  
Create a new CTB file.

Changed in version 0.10: renamed from `new()`

`ezdxf.addons.acadctb.new_stb()` → 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) → PlotStyle**

Returns `PlotStyle` for *AutoCAD Color Index (ACI)* *aci*.

**\_\_iter\_\_() → Iterable[PlotStyle]**

Iterable of all plot styles.

**new\_style(aci: int, data: dict = None) → 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(filename: str) → None**

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) → PlotStyle**

Returns *PlotStyle* by *name*.

### **\_\_delitem\_\_(name: str)**

Delete plot style *name*. Plot style 'Normal' is not deletable.

### **\_\_iter\_\_() → Iterable[str]**

Iterable of all plot style names.

### **new\_style(name: str, localized\_name: str = None, data: dict = None) → 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 *lineweight* in the linewidth table or append *lineweight* to linewidth table.

### **get\_table\_lineweight(index: int) → float**

Returns linewidth in millimeters of linewidth table entry *index*.

**Parameters** **index** – linewidth table index = *PlotStyle.lineweight*

**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.lineweight*

- **lineweight** – in millimeters
- save** (*filename: str*) → None  
Save STB file as *filename* to the file system.
- write** (*stream: BinaryIO*) → None  
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)

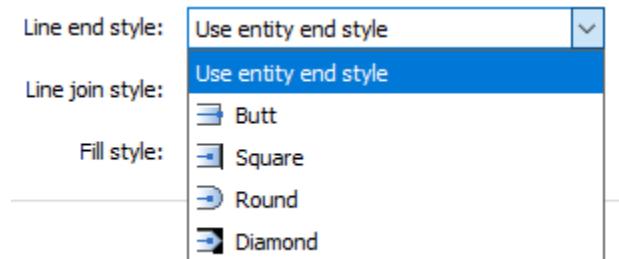
## Default Line Weights

#	[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

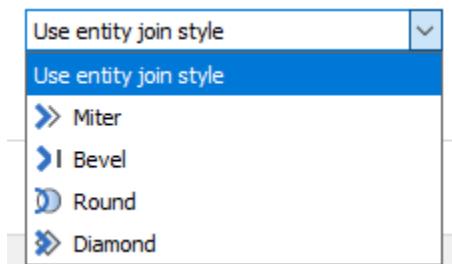
```
ezdxf.addons.acadctb.AUTOMATIC
ezdxf.addons.acadctb.OBJECT_LINEWEIGHT
ezdxf.addons.acadctb.OBJECT_LINETYPE
ezdxf.addons.acadctb.OBJECT_COLOR
ezdxf.addons.acadctb.OBJECT_COLOR2
```

## Line End Style



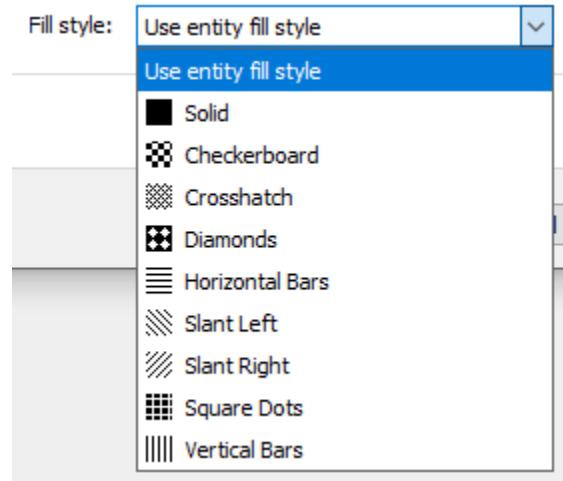
END_STYLE_BUTT	0
END_STYLE_SQUARE	1
END_STYLE_ROUND	2
END_STYLE_DIAMOND	3
END_STYLE_OBJECT	4

## Line Join Style



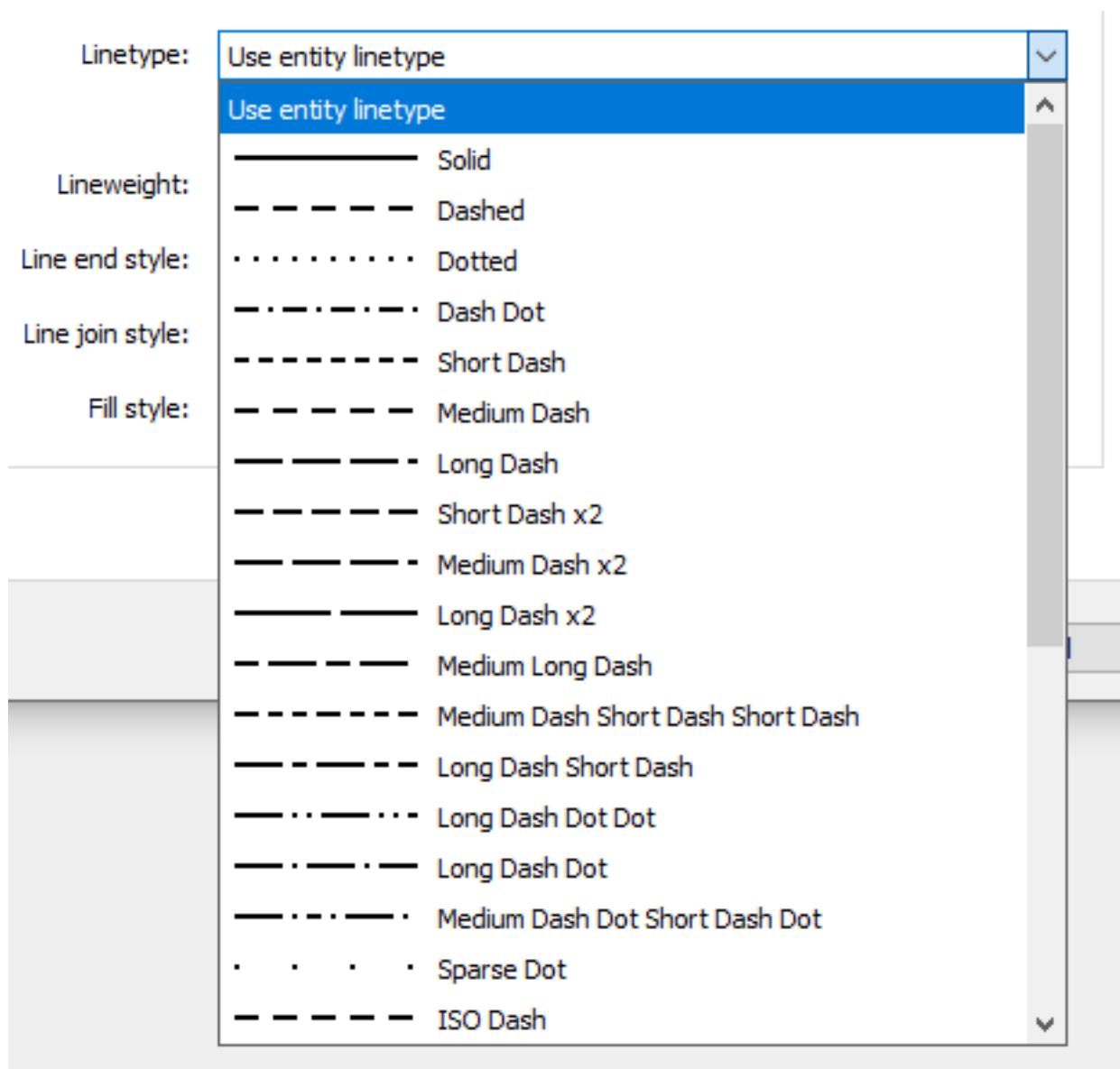
JOIN_STYLE_MITER	0
JOIN_STYLE_BEVEL	1
JOIN_STYLE_ROUND	2
JOIN_STYLE_DIAMOND	3
JOIN_STYLE_OBJECT	5

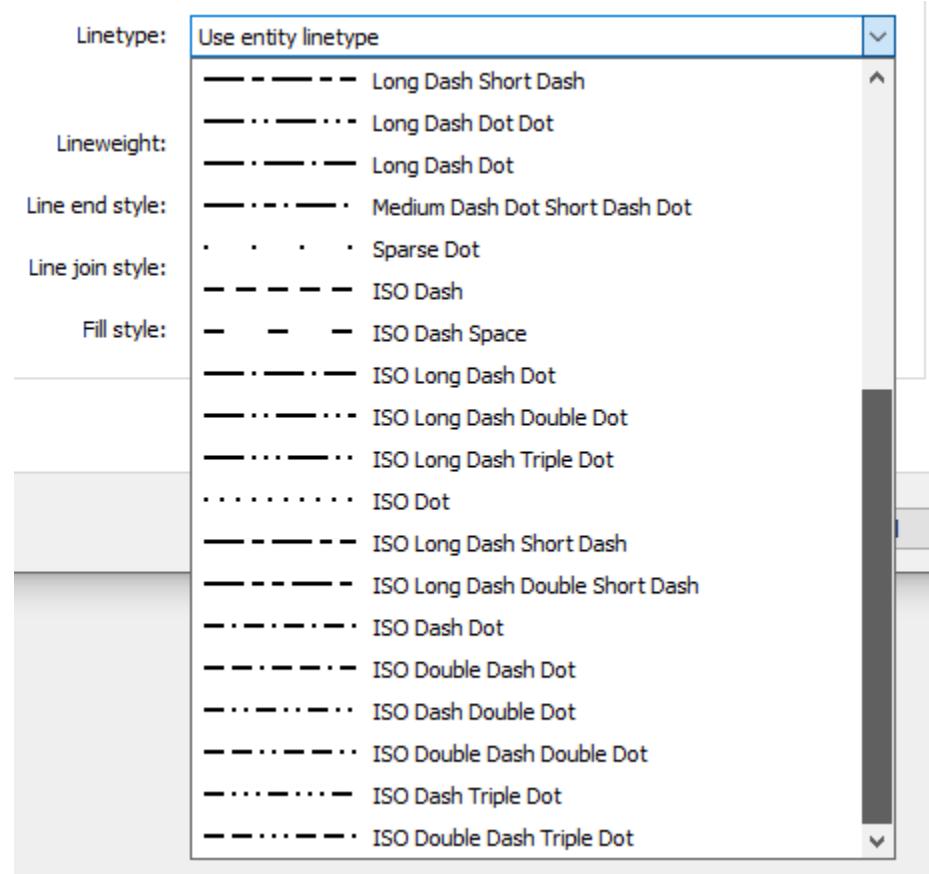
## Fill Style



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

## 6.9.10 Showcase Forms

### MengerSponge

Build a 3D Menger sponge.

```
class ezdxf.addons.MengerSponge (location: Vertex = (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: dict = None, matrix: Matrix44 = None, ucs: 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

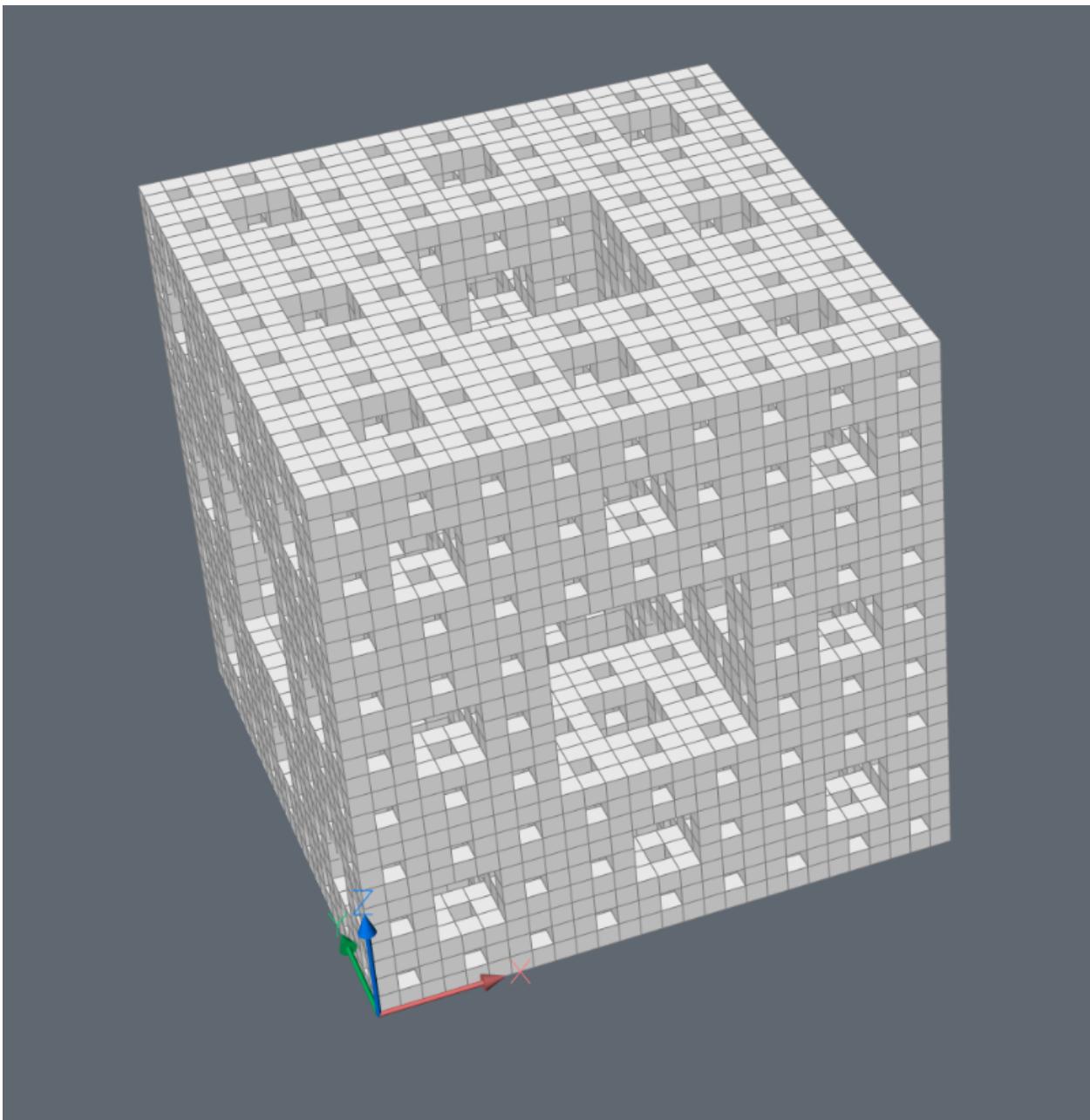
```
cubes () → Iterable[ezdxf.render.mesh.MeshTransformer]
```

Yields all cubes of the menger sponge as individual `MeshTransformer` objects.

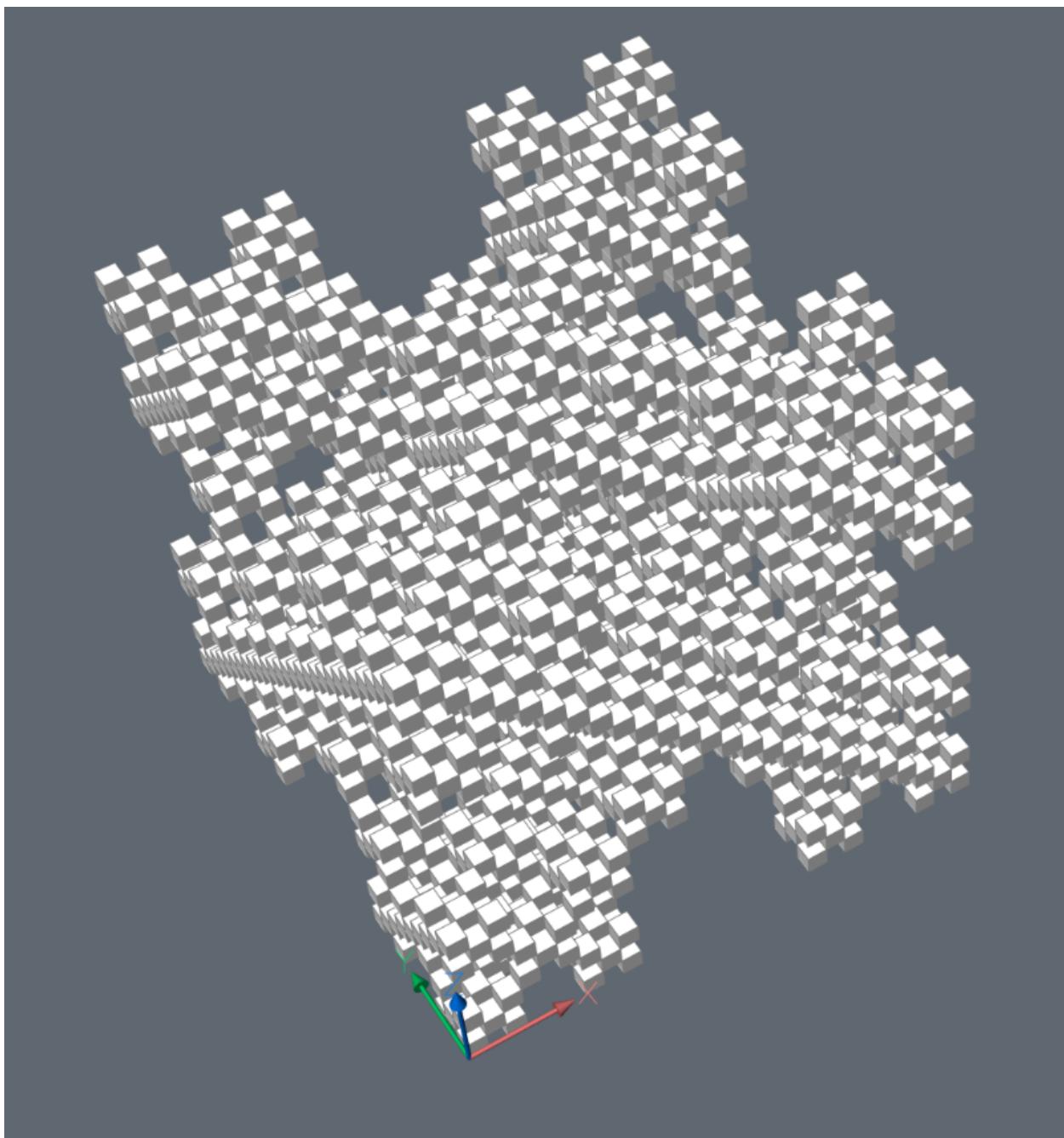
**mesh () → ezdxf.render.mesh.MeshTransformer**

Returns geometry as one MeshTransformer object.

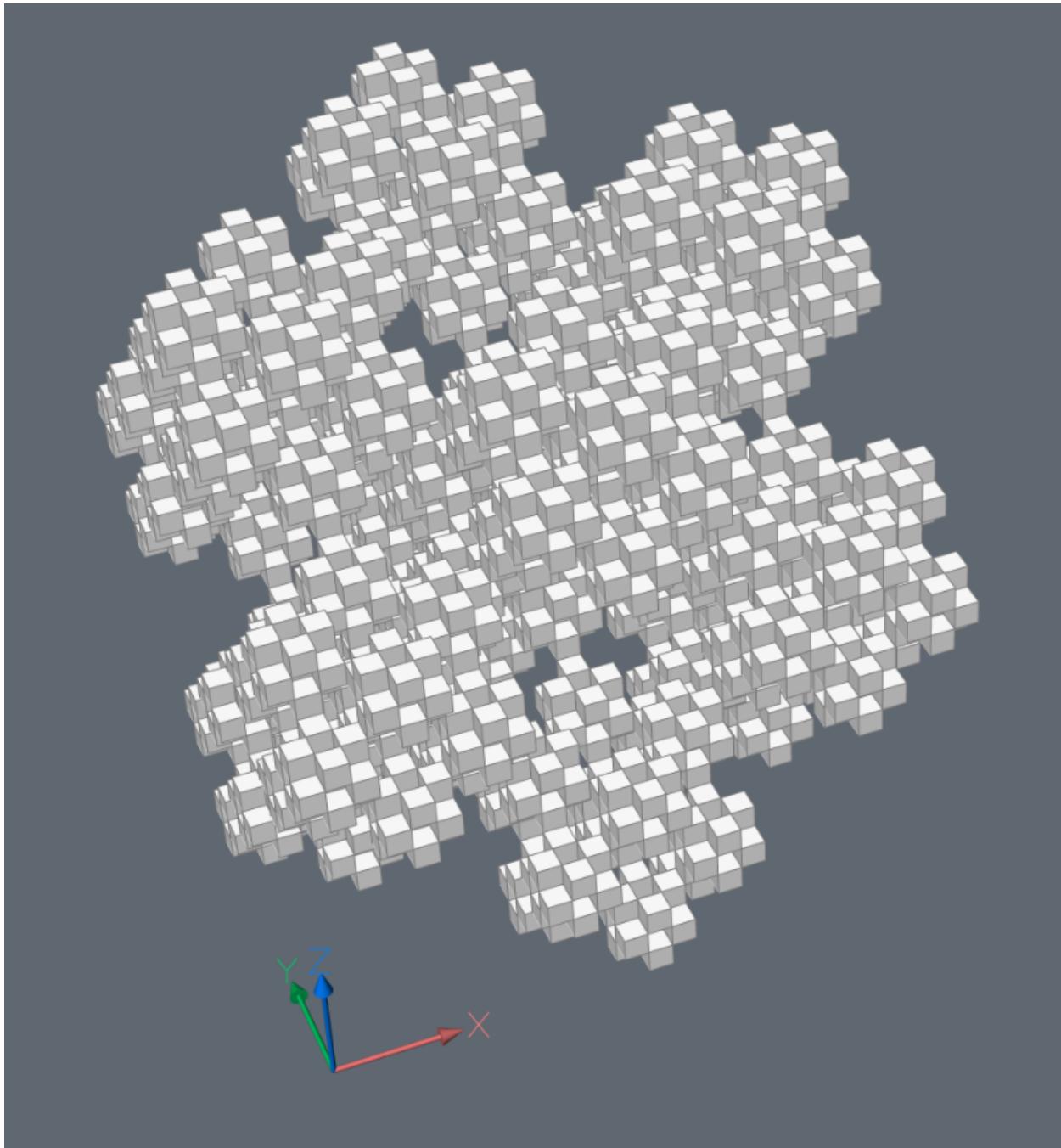
Menger Sponge kind=0:



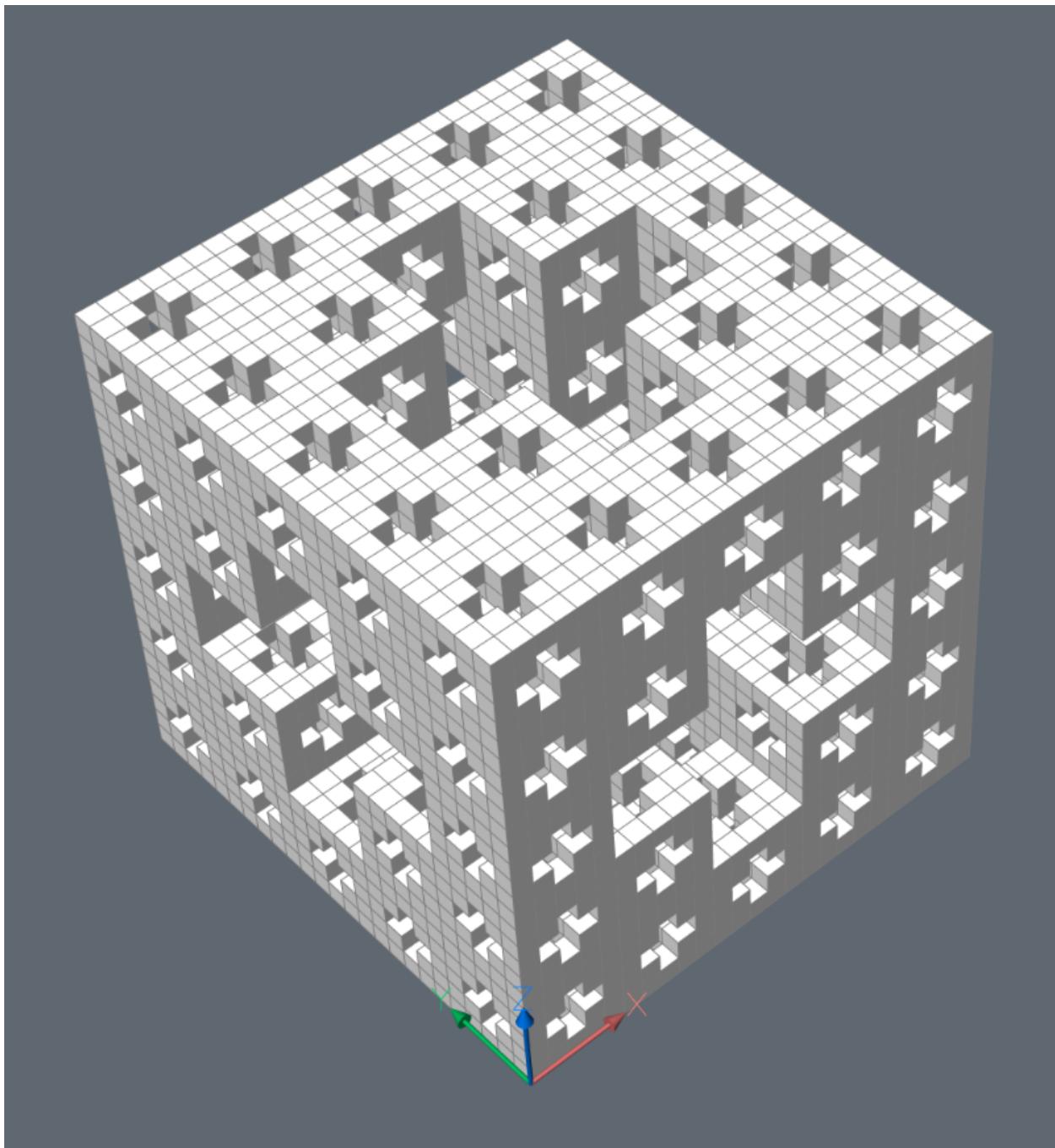
Menger Sponge kind=1:



Menger Sponge kind=2:



Jerusalem Cube kind=3:



## SierpinskyPyramid

Build a 3D Sierpinsky Pyramid.

```
class ezdxf.addons.SierpinskyPyramid(location: Vertex = (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: dict = None, matrix: Matrix44 = None, ucs: 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
- **dfattribs** – DXF attributes for the MESH entities
- **matrix** – apply transformation matrix at rendering
- **ucs** – apply UCS at rendering

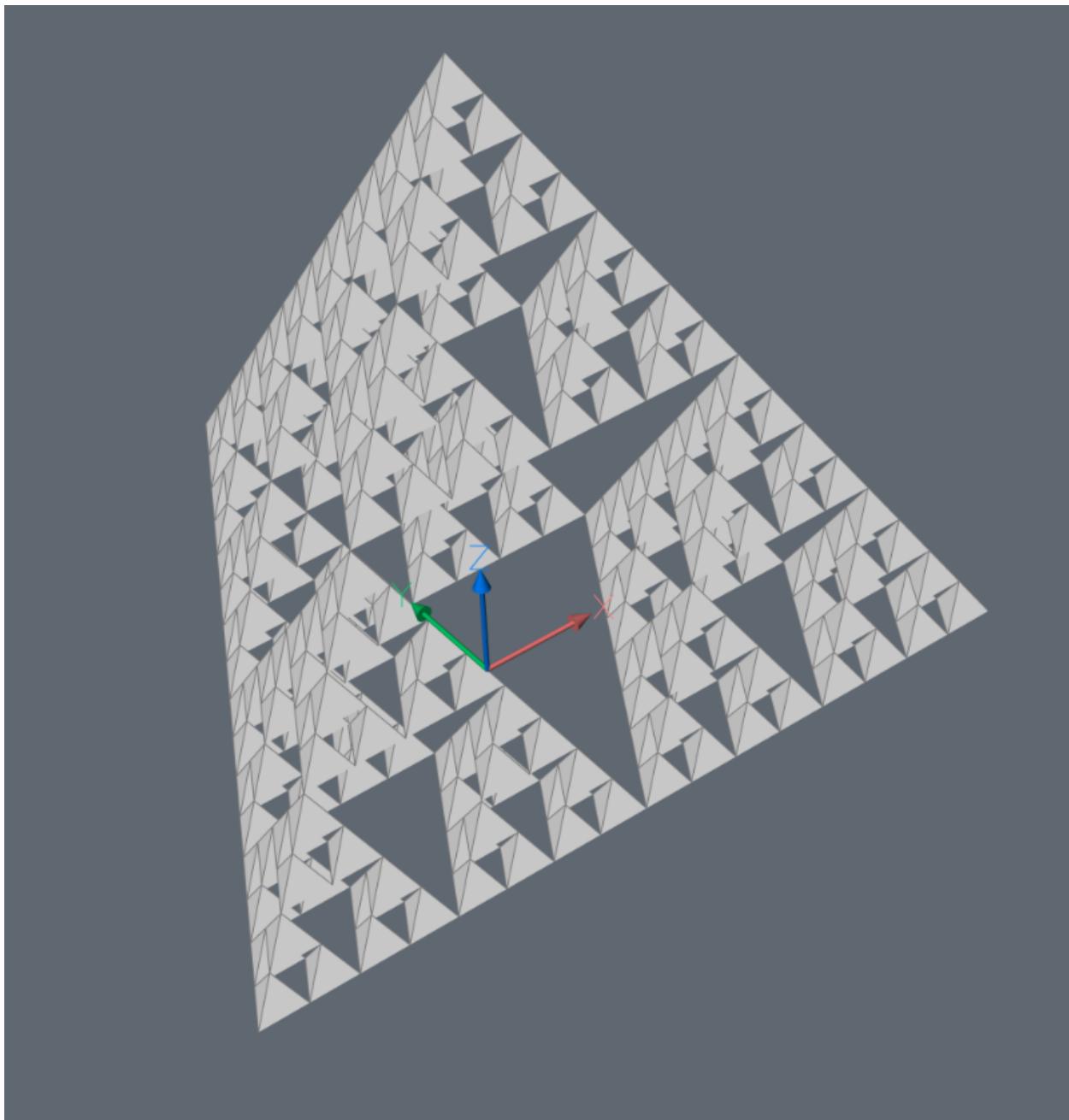
**pyramids()** → Iterable[ezdxf.render.mesh.MeshTransformer]

Yields all pyramids of the sierpinsky pyramid as individual MeshTransformer objects.

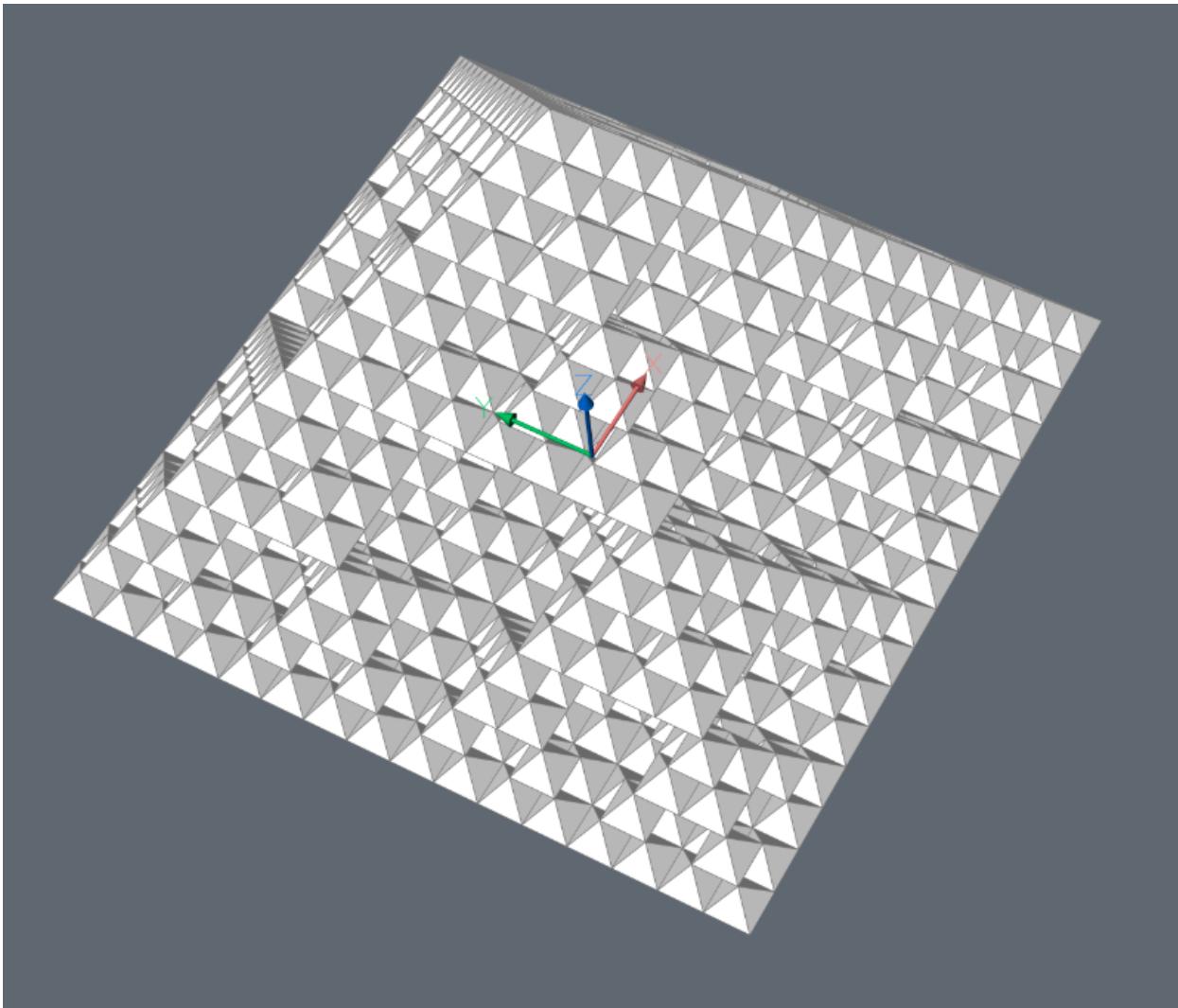
**mesh()** → ezdxf.render.mesh.MeshTransformer

Returns geometry as one MeshTransformer object.

Sierpinsky Pyramid with triangle base:



Sierpinsky Pyramid with square base:



## 6.10 DXF Internals

- [DXF Reference](#) provided by Autodesk.
- [DXF Developer Documentation](#) provided by Autodesk.

### 6.10.1 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).

Group codes are indicating the value type:

Group Code	Value Type
0-9	String (with the introduction of extended symbol names in DXF R2000, the 255-character limit has been increased to 1024)
10-39	Double precision 3D point value
40-59	Double-precision floating-point value
40-59	Double-precision floating-point value
60-79	16-bit integer value
90-99	32-bit integer value
100	String (255-character maximum, less for Unicode strings)
102	String (255-character maximum, less for Unicode strings)
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

Table 2 – continued from previous page

Group Code	Value Type
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 (same limits as indicated with 0-9 code range)
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 most entities)
21-28	Other Y coordinates
30	Primary Z coordinate. 3n values always correspond to 1n and 2n values and immediately follow them in the file (expected by most entities)
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)

Table 3 – continued from previous page

Group Code	Meaning
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

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 data but ends **before** *Embedded Objects*.

But extended group codes ( $\geq 1000$ ) 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.
1011, 1021, 1031	Unlike a simple 3D point, the world space coordinates are moved, scaled, rotated, mirrored, and stretched along with the parent entity to which the extended data belongs.
1012, 1012, 1022	Also a 3D point that is scaled, rotated, and mirrored along with the parent (but is not moved or stretched)
1013, 1023, 1033	Also a 3D point that is scaled, rotated, and mirrored along with the parent (but is not moved or stretched)
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.

ezdxf on 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 ezdxf registers an encoding codec `dxf_backslash_replace`, defined in `ezdxf.lldxf.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:

- Embedded object start with (101, "Embedded Object") tag
- Embedded object is appended to the encapsulated object
- (101, "Embedded Object") tag is the end of the encapsulating object, also of its *Extended Data*
- Embedded object tags can contain any group code except the DXF structure tag (0, ...)

### Unconfirmed assumptions:

- The encapsulating object can contain more than one embedded object.
- Embedded objects separated by (101, "Embedded Object") tags
- every entity can contain embedded objects
- XDATA sections replaced by embedded objects, at least for the MTEXT entity

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\b0\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
73
```

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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
```

## 6.10.2 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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```

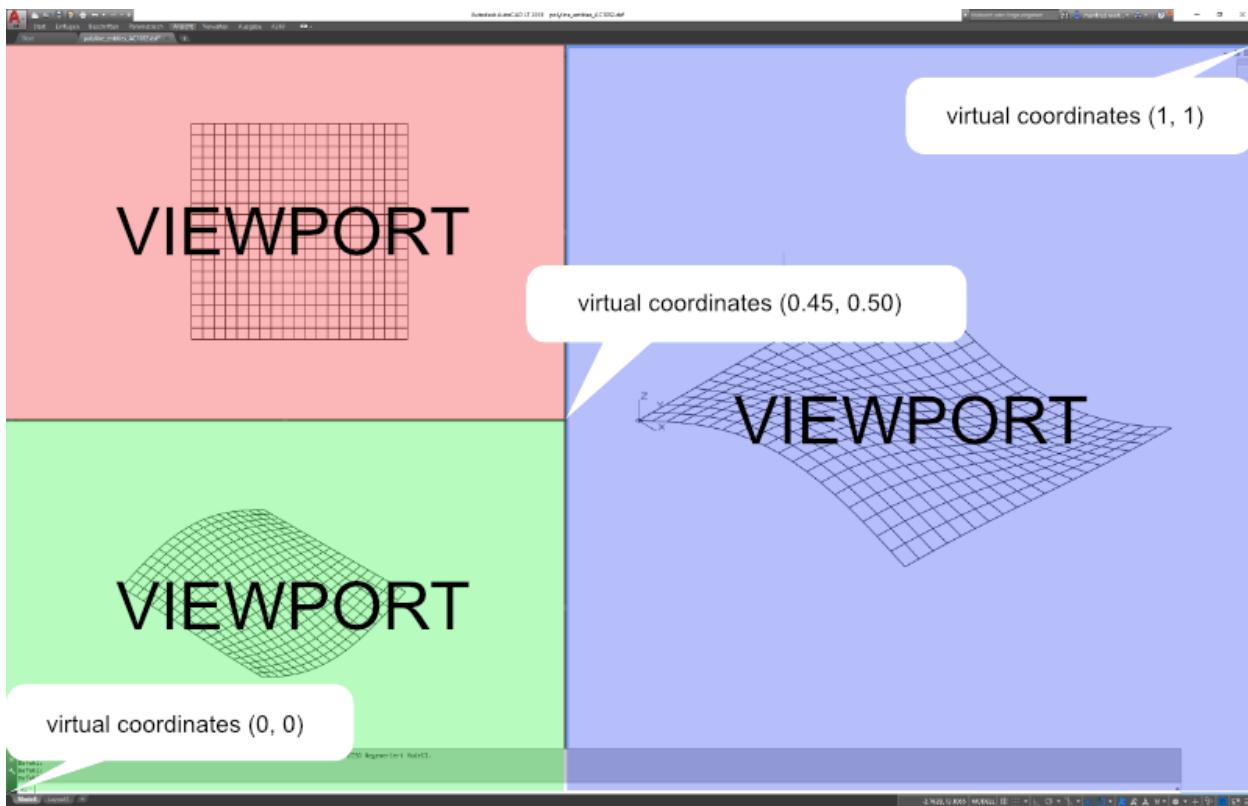
0.0
71
0
281    <<< render mode 0-6 (... too much options)
0      <<< 0= 2D optimized (classic 2D)
72      <<< UCS associated (0/1 = no/yes)
0      <<< 0 = no

```

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    <<<      viewport aspect ratio
0.99    <<<      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    <<<      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----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	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. <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	Assigns colors to dimension lines, arrowheads, and dimension leader lines. <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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(continued from previous page)

```
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 <b>453</b></li> <li>• 3 = Positions the text above and aligned with the first extension line</li> </ul>
<b>6.10. DXF Internals</b>		

## **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 Control Panel settings for decimal separator and number grouping symbols)</li> </ul>
<b>6.10. DXF Internals</b>		455

## 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.

### DXF Entities

#### DIMENSION Entity

See also:

- DXF Reference: [DIMENSION](#)
- DXFInternals: [DIMSTYLE Table](#)

### DXF Objects

TODO

## 6.10.3 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
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
```

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(continued from previous page)

```

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

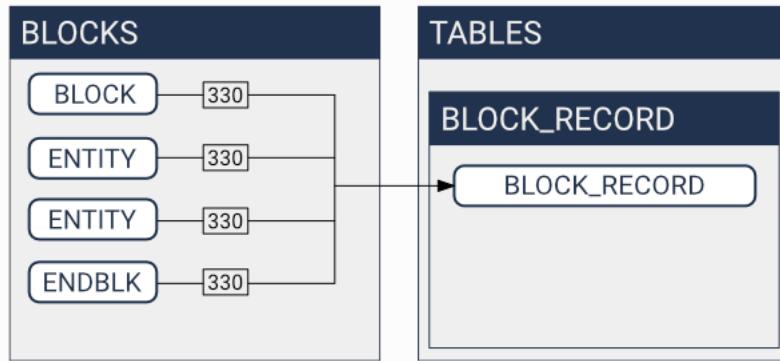
```

## 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
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!

```

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```

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
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

```

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```

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
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

```

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```

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\_Spacennn”, 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

```

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```

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
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)

```

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```

...
    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
-0.25   <<<     y value, distance of the bottom paper margin from the plot
...
    origin-y, in plot paper units and by scale (e.g. x50 for 1:50)
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
...
    origin-x, in plot paper units and by scale (e.g. x50 for 1:50)
21     <<<     group code for y value
8.25    <<<     y value, distance of the top paper margin from the plot
...
    origin-y, in plot paper units and by scale (e.g. x50 for 1:50)
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

```

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```

14      <<< minimum extents for this layout (defined by EXTMIN while this
...
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
...
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
...
1B9
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).

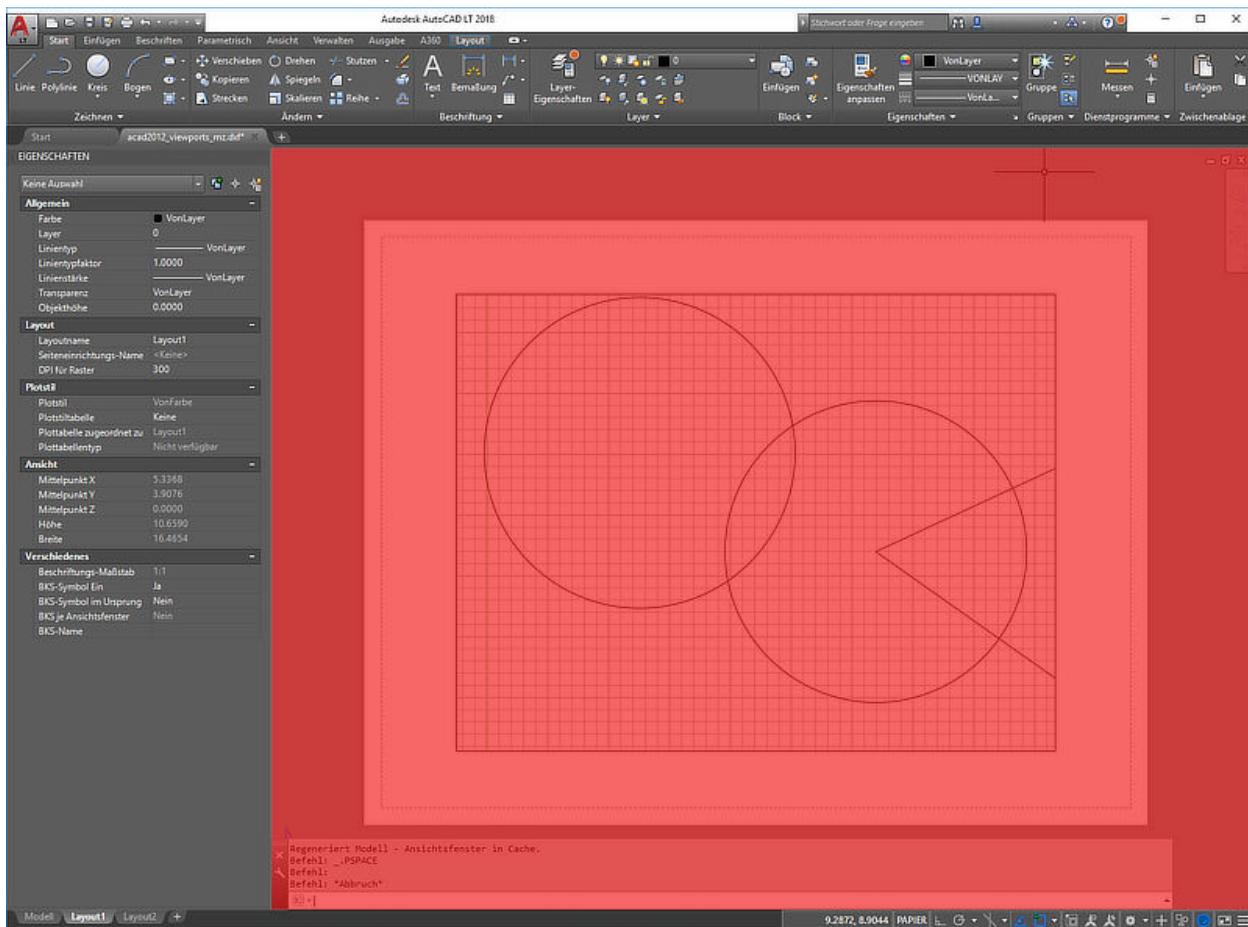
## Main VIEWPORT Entity for LAYOUT

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
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

```

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```

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
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

```

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```

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
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

```

## 6.11 Developer Guides

Information about *ezdxf* internals.

### 6.11.1 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

## 6.11.2 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__() → Iterable[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.

## Entity Space

**class ezdxf.entitydb.EntitySpace (entities=None)**

An *EntitySpace* is a collection of *DXFEntity* objects, that stores only references to *DXFEntity* objects.

The *Modespace*, 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: TagValue) → 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, TagValue]]) → Iterable[ezdxf.lldxf.types.DXFTag]`

Returns an iterable if :class: *DXFTag* or inherited, accepts an iterable of (code, value) tuples as input.

## DXFTag

**class** `ezdxf.lldxf.types.DXFTag(code: int, value: TagValue)`  
Immutable DXFTag class - immutable by design, not by implementation.

### Parameters

- **code** – group code as int
- **value** – tag value, type depends on group code

### Variables

- **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\_\_ () → Iterable[T\_co]

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.

**dxfstr** () → str

Returns the DXF string e.g. '`0\nLINE\n`'

## DXFBinaryTag

**class** `ezdxf.lldxf.types.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.lldxf.types.**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

**dxftype** () → str

Returns the DXF string for all vertex components.

**dxftags** () → Iterable[ezdxf.lldxf.types.DXFTag]

Returns all vertex components as single *DXFTag* objects.

## NONE\_TAG

**ezdxf.lldxf.types.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.lldxf.tags.**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 DTTYPE.

**Args:** *data*: iterable of DXF tag values.

**DTTYPE**

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\_\_()** → Iterable[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)

### 6.11.3 Documentation Guide

#### Formatting Guide

This section is only for me, 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`.

New in version 0.9: New feature `flag`

Changed in version 0.10: The new meaning of `flag` is …

Deprecated since version 0.11: `flag` is obsolete

### set\_axis(axis)

axis as (x, y, z) tuple

**Args:** axis: (x, y, z) tuple

### example\_method(flag=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

## 6.12 Glossary

**ACI** AutoCAD Color Index (ACI)

**ACIS** The 3D ACIS Modeler (ACIS) is a geometric modeling kernel developed by Spatial Corp. ® (formerly Spatial Technology), part of Dassault Systems.

**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 ®.

**STB** Named plot style table (`NamedPlotStyles`)

**true color** RGB color representation, a combination red, green and blue values to define a color.

## 6.13 Indices and tables

- `genindex`
- `search`

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## Python Module Index

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