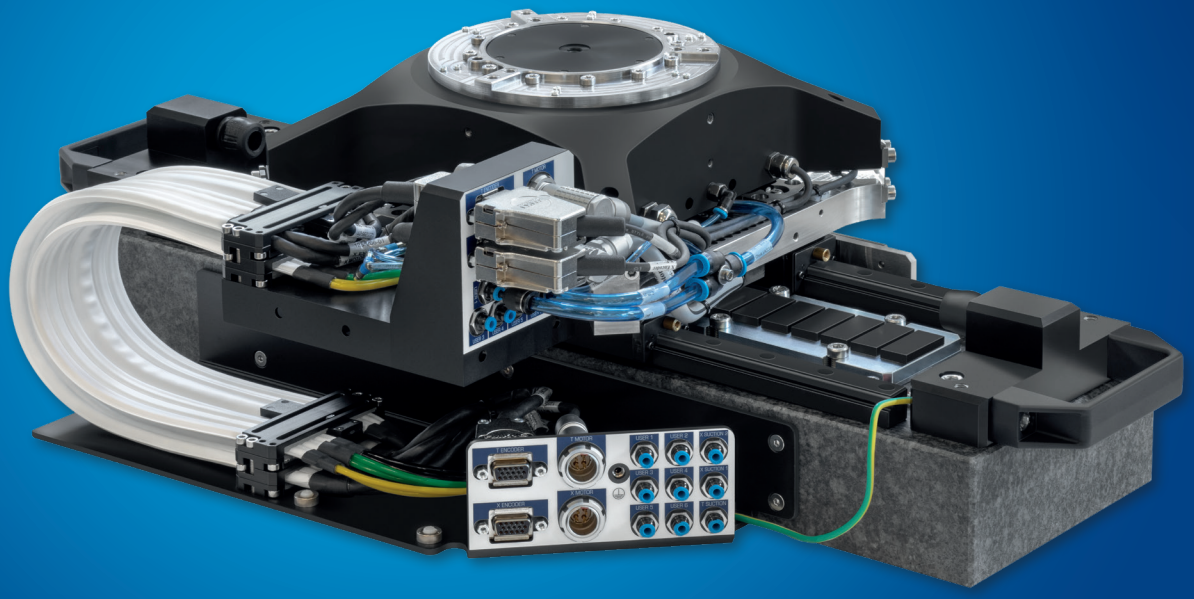

XT
Application Programming Interface

User's Manual

Version B

ETEL

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Table of contents

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Record of revisions:

Document revisions		
Version	**Date**	**Main modifications**
Ver A	21.06.19	First version (with XT 1.00A)
Ver B	27.08.21	Updated version (with XT 1.01A): - Update of supported Windows Operating Systems, .NET framework and development environment (refer to §3)

Documentation concerning the XT Application Programming Interface:

• **User's Manual**	**XT Application Programming Interface**
• HTML Reference Manual	XT API complete list of functions available
• Readme_XT10_w32/64_vs2019_c/net	Guidelines for installation and compilation
• EDI4 User's Manual	ETEL Device Interface principle of operation

Remark: The HTML documentation is generated for each XT release, being its most up-to-date reference manual.

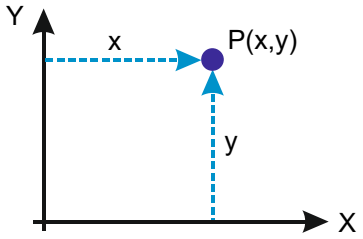
1. Introduction

The XT API (Application Programming Interface) provides utility functions for the XT motion system. The primary functionality is to facilitate conversion between wafer Cartesian coordinates to XT Polar coordinates. This functionality enables the consuming application to place a given point on the wafer directly under the camera by setting the target positions of the **linear axis (X)** and **rotary axis (T)** of the XT motion system.

2 Definitions and acronyms

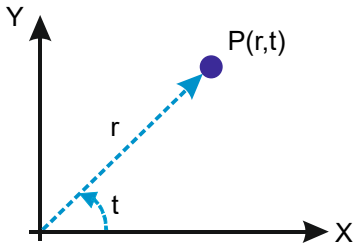
2.1 Definitions

- **XT**: an ETEL motion system composed of a **rotary axis (T)** that is stacked on a **linear axis (X)**.
- **2-D Cartesian coordinate system**: a 2-D coordinate system that specifies each point P uniquely by a pair (x, y) of numerical coordinates which are signed distances from two fixed perpendicular lines X and Y.



The position of a point on a wafer is typically represented by this coordinate system.

- **2-D Polar coordinate system**: a 2-D coordinate system that specifies each point P uniquely by a pair (r, t) which is a distance r from a reference point and an angle t from a reference direction.



2.2 Acronyms

API: Application Programming Interface
EDI: ETEL Device Interface
FOV: Field Of View

3 XT characteristics

- XT API is developed in C and can be used from other common programming languages (e.g. C++ and C#).
- XT uses EDI; as such applications using XT require the presence of EDI for execution.
- XT does not command axes. It only facilitates coordinate conversion. The consuming application must use EDI for commanding axes.
- XT API functions are not thread-safe. A multi-threaded consuming application has to implement thread safety.

PC configuration	
Machine requirements	• Minimum 2 GB of memory • Current generation of processors • Windows 10 32/64-bit
Library & compilation requirements	• 32/64-bit compatible library • Visual Studio 2019 • C library for a C/C++ customer applications • C# library for C# customer applications (.NET framework version 4.8 required) • XT is not a thread-safe library
EDI	• Version 4.25A or later • Customer application must be linked to EDI dsa40.dll

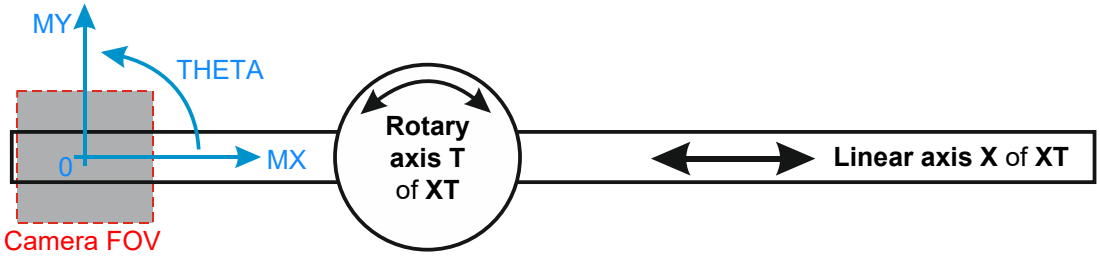
Remark: XT API may run on other Windows operating system versions. However, the qualification of the XT API has been realized under the conditions listed in the qualification environment table presented below. ETEL cannot guarantee full technical support for issues occurring under different operating system conditions.
ETEL does not support operating systems that are no longer supported by their respective vendors.

Qualification environment	
Operating system	Windows 10 Enterprise 64-bit, version 1909
Processor type	Intel® Xeon® W-2125 CPU @ 4.00Ghz 4-core, ID 50654
System memory (RAM)	16 GB
Development environment	Visual Studio 2019
Application type	64-bit application, linked to EDI 4.25A

4 Frames of reference

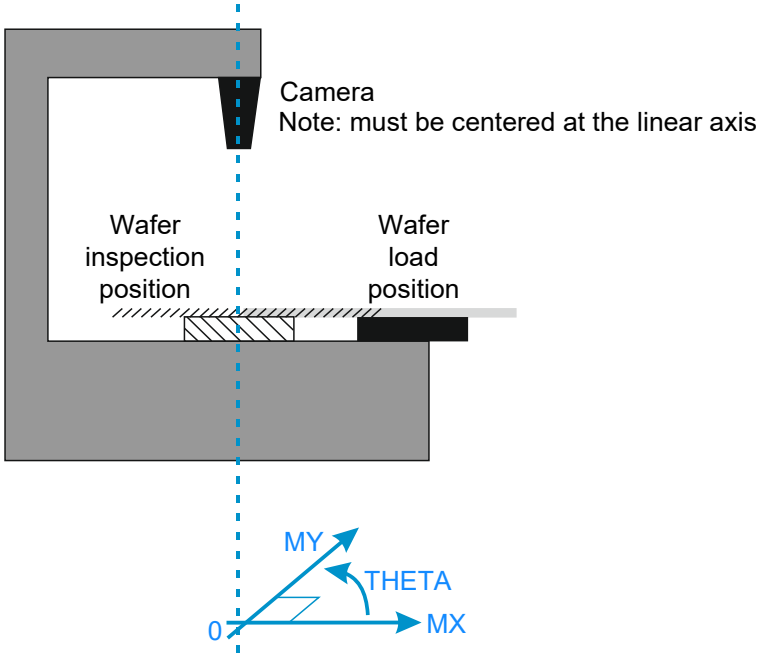
4.1 Machine frame of reference

The machine frame of reference is represented by the orthogonal axis **MX** and **MY**. The direction of **MX** is the direction of movement of the **linear axis (X)**. The origin of the frame of reference is at the zero position of the **linear axis (X)**.



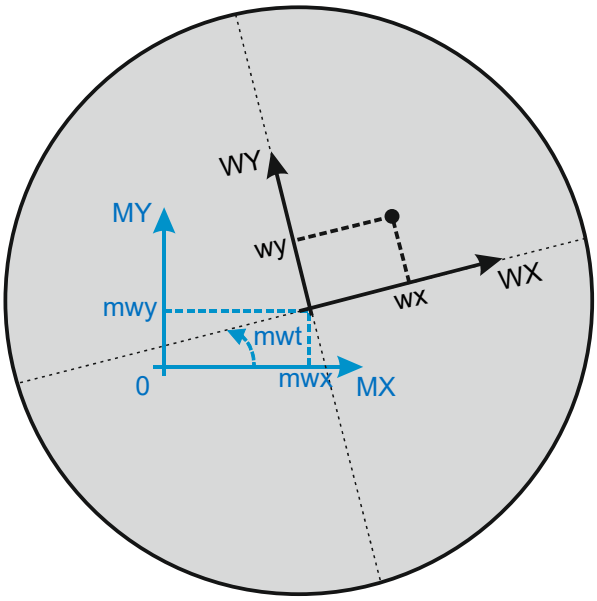
4.2 Camera frame of reference

The origin of the camera frame of reference is assumed to be directly above the origin of the machine frame of reference. In other words, the camera is inspecting a point on the wafer that lies at the origin of the machine frame of reference.



4.3 Wafer frame of reference

The wafer frame of reference is represented by the orthogonal axis **WX** and **WY**. A point on the wafer is represented with respect to this reference by the coordinates (***wx, wy***). When the position of the **linear axis (X)** is zero and the position of the **rotary axis (T)** is zero, the wafer frame of reference (**WX**, **WY**) is not necessarily aligned to the machine frame of reference (**MX**, **MY**). There is possibly a position offset (***mwx, mwy***) and an angle offset (***mwt***) of the wafer frame of reference with respect to the machine frame of reference.



5 XT usage

5.1 Creating the XT_SYSTEM object

Before the coordinate transformation functionalities of the XT API can be used, an *XT_SYSTEM* object is to be created by the consuming application using the *xt_create* function.

```
XT_SYSTEM *xt_system = NULL;
int err;

if (err = xt_create(&xt_system)) {
     XT_EXT_DIAG(err, xt_system);
     goto _error;
}
```

Remarks: Before calling the *xt_create* function, the pointer to the *XT_SYSTEM* object must be assigned to a *NULL* value.

If the function is not successful, a non-zero value is returned. The *XT_EXT_DIAG* macro can be used to display the error details.

5.2 Initializing the XT_SYSTEM object

Before the coordinate transformation functionalities of the XT API can be used, the *DSA_DRV* objects of the **linear axis (X)** and the **rotary axis (T)** have to be associated to the *XT_SYSTEM* object using the *xt_system_init* function.

```
if (err = xt_system_init(xt_system,
                         x_drv, t_drv,
                         x_cart_offset, y_cart_offset, theta_cart_offset)){
          XT_EXT_DIAG(err, xt_system);
          goto _error;
}
```

Remarks: x_drv is the DSA_DRIVE for the **linear axis (X).**

t_drv is the DSA_DRIVE for the **rotary axis (T).**

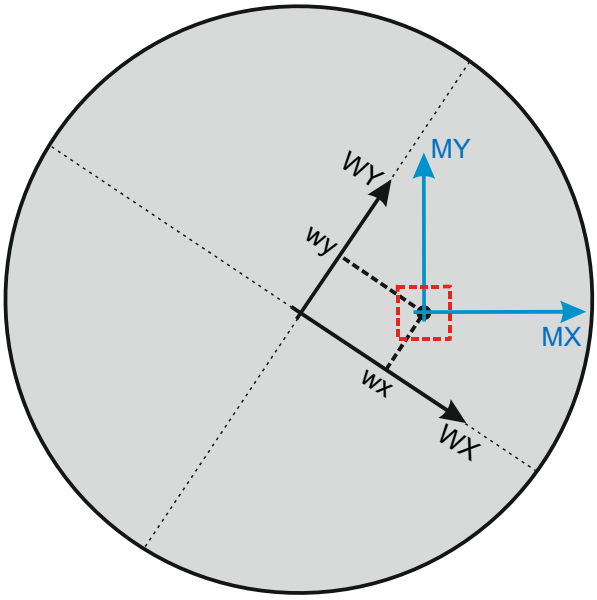
x_cart_offset and y_cart_offset are the position offsets (***mwx, mwy***) of the wafer frame of reference with respect to the machine frame of reference.

theta_cart_offset is the angle offset (***mwt***) of the wafer frame of reference with respect to the machine frame of reference.

The position and angle offset of the wafer frame of reference with respect to the machine frame of reference can be changed subsequently using the *xt_cart_offset_update* function.

```
if (err = xt_cart_offset_update(xt_system,
                                x_cart_offset,y_cart_offset,theta_cart_offset)) {
          XT_EXT_DIAG(err, xt_system);
          goto _error;
}
```

5.3 Converting wafer Cartesian coordinates to XT Polar coordinates



If a Cartesian position (***wx, wy***) in the wafer frame of reference has to be brought directly under the camera (i.e. to the origin of the machine frame of reference), then the **linear axis (X)** and **rotary axis (T)** have to be moved to a target polar position (***x, t***).

The conversion of these Cartesian coordinates (***wx, wy***) to Polar coordinates (***x, t***) can be done through the *xt_convert_cartesian_to_polar* function. This function does not move the axes; if performs only the coordinate transformation. The consuming application must use EDI to command the movement on the axes.

```
if (err = xt_convert_cartesian_to_polar(xt_system,
                                        x_cart_pos,y_cart_pos,
                                        &x_polar_pos, &theta_polar_angle,
                                        &camera_angle)) {
        XT_EXT_DIAG(err, xt_system);
        goto _error;
}
```

Remarks: x_cart_pos and y_cart_pos are the point (***wx, wy***) on the wafer in wafer frame of reference.

x_polar_pos is the value returned for the target position ***x*** of the **linear axis (X).**

theta_polar_angle is the value returned for the target position ***t*** of the **rotary axis (T).**

camera_angle is the value returned for the target angle of the camera. If the camera, for example, is mounted on a rotary motor, this angle can be used to align the camera along the axis **WX** of the wafer.

5.4 Converting XT Polar coordinates to wafer Cartesian coordinates

The function *xt_convert_polar_to_cartesian* can be used to convert the Polar coordinate position (***x, t***) of the **linear axis (X)** and the **rotary axis (T)** into the Cartesian position (***wx, wy***) on the wafer.

```
if (err = xt_convert_polar_to_cartesian(xt_system,
                                        x_polar_pos, theta_polar_angle,
                                        &x_cart_pos, &y_cart_pos)) {
        XT_EXT_DIAG(err, xt_system);
        goto _error;
}
```

Remarks: x_polar_pos is the position ***x*** of the **linear axis (X)**

theta_polar_angle is position ***t*** of the **rotary axis (T)**

x_cart_pos and y_cart_pos are the returned values of the point ***(wx, wy)*** on the wafer in wafer frame of reference

5.5 Destroying the XT_SYSTEM object

Before the consuming application is terminated, the XT_SYSTEM object must be destroyed to release all assigned resources. This is achieved through the *xt_destroy* function.

```
xt_destroy(&xt_system);
```

6 Service and support

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