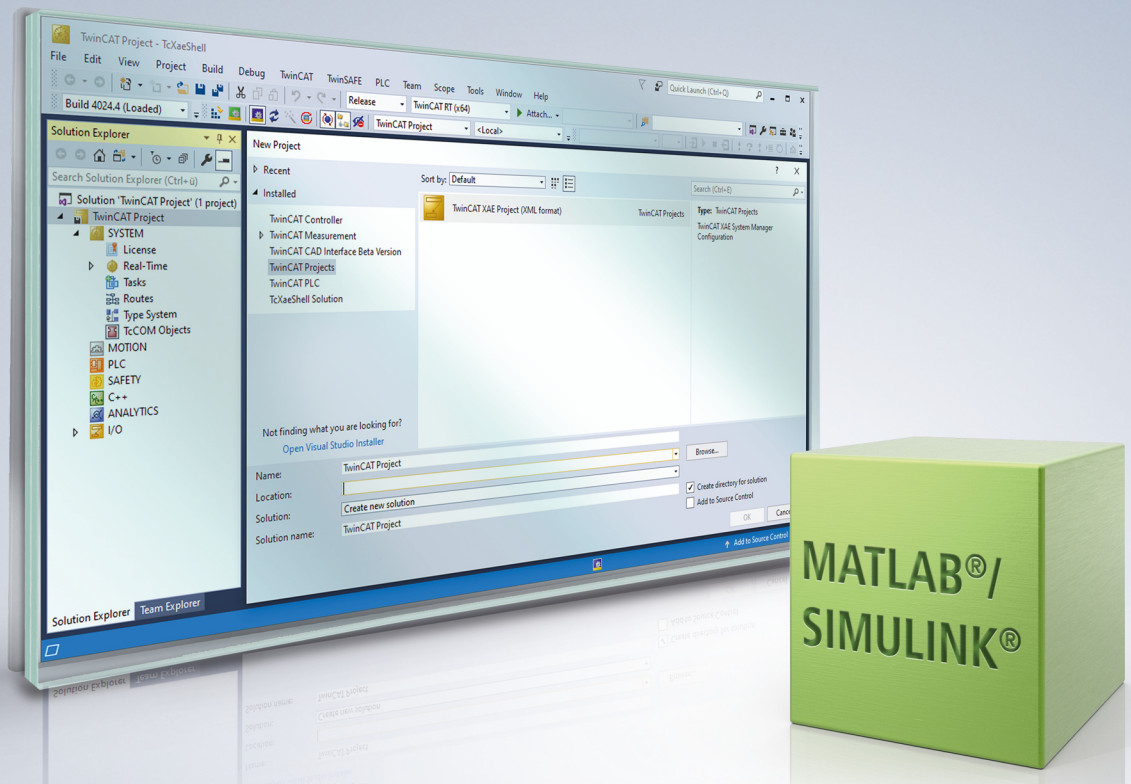
BECKHOFF New Automation Technology

Manual | EN

TE1401

TwinCAT 3 | Target for MATLAB®



2025-08-05 | Version: 1.3.0

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1 Foreword

1.1 Notes on the documentation

This description is intended exclusively for trained specialists in control and automation technology who are familiar with the applicable national standards.
The documentation and the following notes and explanations must be complied with when installing and commissioning the components.
The trained specialists must always use the current valid documentation.

The trained specialists must ensure that the application and use of the products described is in line with all safety requirements, including all relevant laws, regulations, guidelines, and standards.

Disclaimer

The documentation has been compiled with care. The products described are, however, constantly under development.
We reserve the right to revise and change the documentation at any time and without notice.
Claims to modify products that have already been supplied may not be made on the basis of the data, diagrams, and descriptions in this documentation.

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1.2 For your safety

Safety regulations

Read the following explanations for your safety.
Always observe and follow product-specific safety instructions, which you may find at the appropriate places in this document.

Exclusion of liability

All the components are supplied in particular hardware and software configurations which are appropriate for the application. Modifications to hardware or software configurations other than those described in the documentation are not permitted, and nullify the liability of Beckhoff Automation GmbH & Co. KG.

Personnel qualification

This description is only intended for trained specialists in control, automation, and drive technology who are familiar with the applicable national standards.

Signal words

The signal words used in the documentation are classified below. In order to prevent injury and damage to persons and property, read and follow the safety and warning notices.

Personal injury warnings

⚠ DANGER

Hazard with high risk of death or serious injury.

⚠ WARNING

Hazard with medium risk of death or serious injury.

⚠ CAUTION

There is a low-risk hazard that could result in medium or minor injury.

Warning of damage to property or environment

NOTICE

The environment, equipment, or data may be damaged.

Information on handling the product

This information includes, for example:
recommendations for action, assistance or further information on the product.

1.3 Notes on information security

The products of Beckhoff Automation GmbH & Co. KG (Beckhoff), insofar as they can be accessed online, are equipped with security functions that support the secure operation of plants, systems, machines and networks. Despite the security functions, the creation, implementation and constant updating of a holistic security concept for the operation are necessary to protect the respective plant, system, machine and networks against cyber threats. The products sold by Beckhoff are only part of the overall security concept. The customer is responsible for preventing unauthorized access by third parties to its equipment, systems, machines and networks. The latter should be connected to the corporate network or the Internet only if appropriate protective measures have been set up.

In addition, the recommendations from Beckhoff regarding appropriate protective measures should be observed. Further information regarding information security and industrial security can be found in our https://www.beckhoff.com/secguide.

Beckhoff products and solutions undergo continuous further development. This also applies to security functions. In light of this continuous further development, Beckhoff expressly recommends that the products are kept up to date at all times and that updates are installed for the products once they have been made available. Using outdated or unsupported product versions can increase the risk of cyber threats.

To stay informed about information security for Beckhoff products, subscribe to the RSS feed at https://www.beckhoff.com/secinfo.

1.4 Documentation issue status

Version	Changes
1.3.x	TwinCAT 3.1 Build 4026 • Brief information on installation [▶ 10] • Updated system requirements

2 Overview

TE1401 TwinCAT Target for MATLAB®

With the TwinCAT 3 Target for MATLAB®, it is possible to make use of the functions developed in the MATLAB® script language in TwinCAT 3. The functions are automatically transcoded in C/C++ code with the aid of the MATLAB® Coder™ and transformed into TwinCAT objects with the TwinCAT 3 Target for MATLAB®. These objects can be used seamlessly in the TwinCAT 3 Engineering, e.g. extended with PLC source code to make an overall project, debugged and linked with fieldbus devices. The automatically generated modules can be integrated in the TwinCAT solution as TcCOM objects on the one hand and as PLC function blocks on the other. The inserted modules are downloaded with the complete TwinCAT project into the TwinCAT 3 runtime, where they are executed within the real-time environment like all other objects. TwinCAT 3 Target for Simulink® supports targets with Windows 32-bit and 64-bit as well as TwinCAT/BSD.

Further Information

Technical short video

- TwinCAT Target for MATLAB

Product description

- https://www.beckhoff.com/TE1401

Web page for MATLAB® and Simulink® with TwinCAT 3

- https://www.beckhoff.com/matlab

3 Installation

System requirements

In the following, a distinction is made between the engineering PC and the runtime PC. The following definition applies: on the engineering PC, MATLAB® functions are converted to TwinCAT objects by using the Target for MATLAB®. Similarly, a TwinCAT solution can be created on this PC, which uses the created objects, but it does not have to be. The TwinCAT solution created is then loaded from the engineering PC onto a runtime PC in the TwinCAT runtime environment for project execution.

On the engineering PC

- MATLAB® R2019a or higher
  - MATLAB® and MATLAB® Coder™ Toolbox
- Visual Studio 2017 or higher (Professional, Ultimate or equivalent edition)
  - During installation, the option *Desktop development with C++* must be selected manually. The option can also be installed later.
- TwinCAT 3.1.4024.7 or higher
  - Install TwinCAT 3 XAE or Full Setup only after Visual Studio has been installed with *Desktop development with C++*.
- TwinCAT Tools for MATLAB® and Simulink® setup

On the runtime PC

- Supported operating systems
  - Windows 11, Windows 10, Windows Server (32-bit and 64-bit)
  - TwinCAT/BSD
- TwinCAT XAR version 3.1.4024.7 or higher

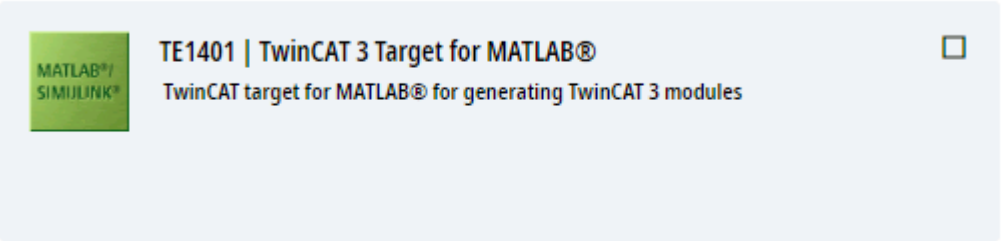
Built objects can be easily forwarded

TwinCAT objects built on an engineering PC (or Build Server) can be easily forwarded to other people. They only need the TwinCAT XAE development environment in order to use the created objects (TcCOM or PLC function blocks) in a TwinCAT solution.

Installation (TwinCAT 3.1 Build 4026)

The TE1401 | TwinCAT 3 Target for MATLAB® workload installs all dependencies required to create TwinCAT objects.

- Install one of the supported **Visual Studio** versions, if not already installed. Remember to install the *Desktop development with C++* option.
- Install the TwinCAT Package Manager.
- Install the following workload via the TwinCAT Package Manager:



Command line: `tcpkg install TE1401.TargetForMATLAB.XAE`

- Execute Integration in Visual Studio that you have installed with the *Desktop development with C++* option.

- Start MATLAB® as administrator and execute *C:\Program Files (x86)\Beckhoff\TwinCAT\Functions\TE14xx-ToolsForMatlabAndSimulink\SetupTE14xx.p* in MATLAB®.

If you want to create a TwinCAT project and use TwinCAT objects that have already been built, install the following workloads:

- TwinCAT Standard
  `tcpkg install TwinCAT.Standard.XAE`
- TwinCAT Block Diagram Classic
  `tcpkg install TwinCAT.XAE.BlockDiagramClassic`
- In some cases you will also need the following packages:
  `tcpkg install TwinCAT.XAE.TMX.MatSimUtilities`
  (for converting ITcVnImage to ARRAY)

Installation (TwinCAT 3.1 Build 4024)

✓ Install one of the supported **Visual Studio** versions, if not already installed. Remember to install the *Desktop development with C++* option.

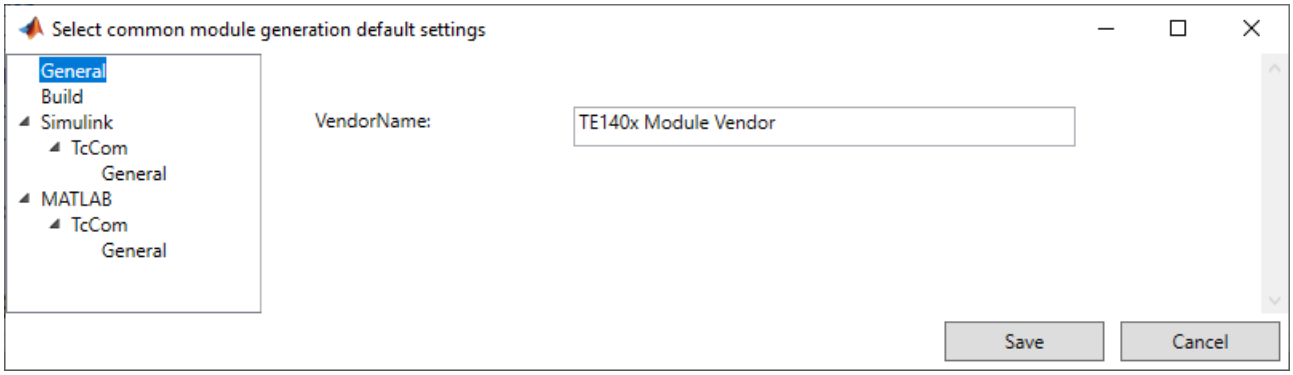
1. Start **TwinCAT 3 XAE or Full Setup** if these are not already installed.
   If Visual Studio and TwinCAT are already installed, but the Visual Studio version does not meet the above requirements (e.g. TwinCAT XAE Shell or Visual Studio without C++ option), you will need to install a suitable version of Visual Studio version first (install the C++ option, if necessary). Then run TwinCAT 3 setup to integrate TwinCAT 3 into the new (or modified) Visual Studio version.
2. If you have not yet installed **MATLAB®** on your system, install it. The order in which MATLAB® has been installed is irrelevant.
3. Start **TwinCAT Tools for MATLAB® and Simulink®** Setup to install the TE1401 TwinCAT Target for MATLAB®.
   ⇨ The TwinCAT Target for MATLAB® is installed within the TwinCAT folder structure, i.e. it is separate from the MATLAB® installation.
4. Start MATLAB® as administrator and run *%TwinCAT3Dir%.. \Functions\TE14xx-ToolsForMatlabAndSimulink\SetupTE14xx.p* in MATLAB®.

⇨ A setup window opens. See the following section.

Setting up the software

Version SetupTE14xx.p

After executing the p-file, a dialog opens in which you can save general default settings that will then apply to the system. You can make the settings directly or make/change them at a later time.



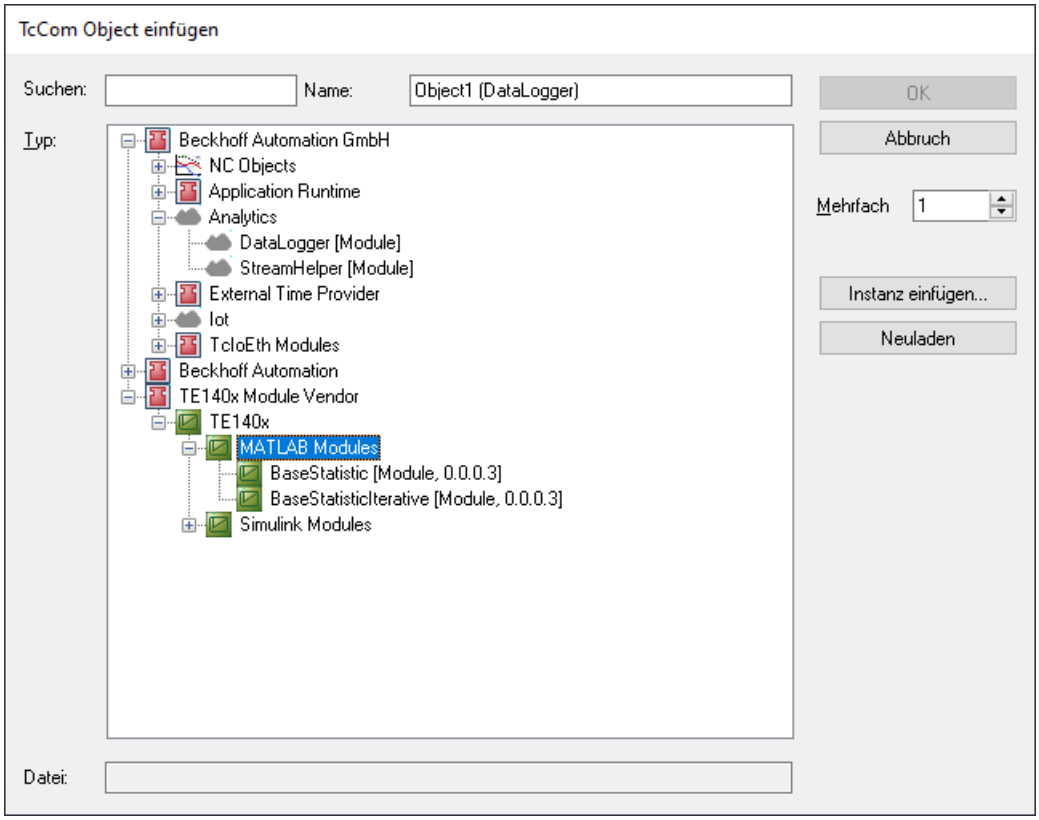
If you want to execute the p-file without this dialog, you can use the following command:

```
SetupTE140x('Silent', true);
```

Setting options in the dialog are:

VendorName, *GroupName* (MATLAB®) and *GroupName* (Simulink®)

These settings influence the hierarchy in which the generated TwinCAT objects are sorted. See diagram below. Here the entries VendorName "TE140x Module Vendor" and GroupName "TE140x|MATLAB Modules" are for MATLAB® and "TE140x|Simulink Modules" for Simulink®.



To change the default settings, you can access the dialog with `TwinCAT.ModuleGenerator.Settings.Edit` in the MATLAB® Console. Here you are also offered additional entries that you can store as default.

3.1 Initial setup of the software

3.1.1 Set up default settings and set MATLAB® path

Initial setup of the software

Setting MATLAB® paths

As described under Installation, the files SetupTE14xx.p must be executed after the software installation. This script adds the necessary paths to your MATLAB® path. MATLAB® administrator rights are required to save MATLAB® paths.

Run SetupTE14xx.p additionally after each product update

To ensure that all paths are set in the MATLAB® path, please also run the p-file after updating the product.

Set default settings

The script also opens a dialog in which you can save general default settings for the TwinCAT target. These settings then apply system-wide, i.e. for *all* installed MATLAB® versions.

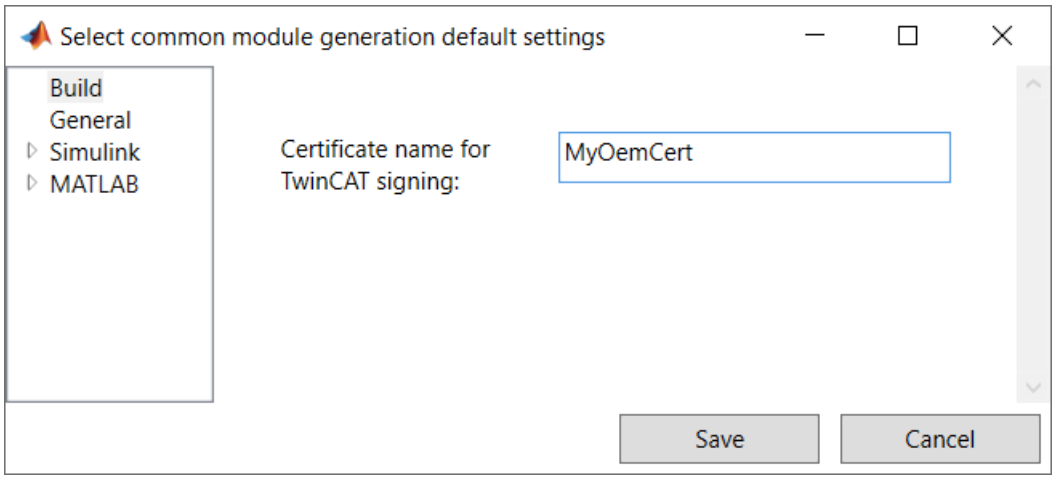
If you want to execute the p-file without this dialog, you can use the following command:

```
SetupTE14xx('Silent', true);
```

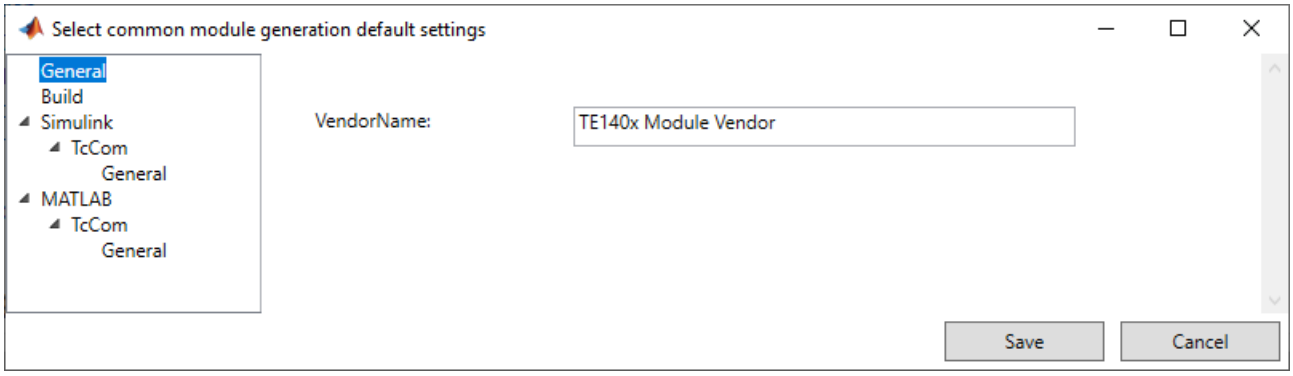
The default values of the dialog are set.

You can make the settings at this time or make/change them at a later time.

In the dialog under the **Build** tab, you can store a default certificate for driver signing. The setup options for driver signing are explained in full in the chapter Setting up driver signing [▶ 15].



The hierarchy of the generated TwinCAT objects can also be influenced in the dialog.

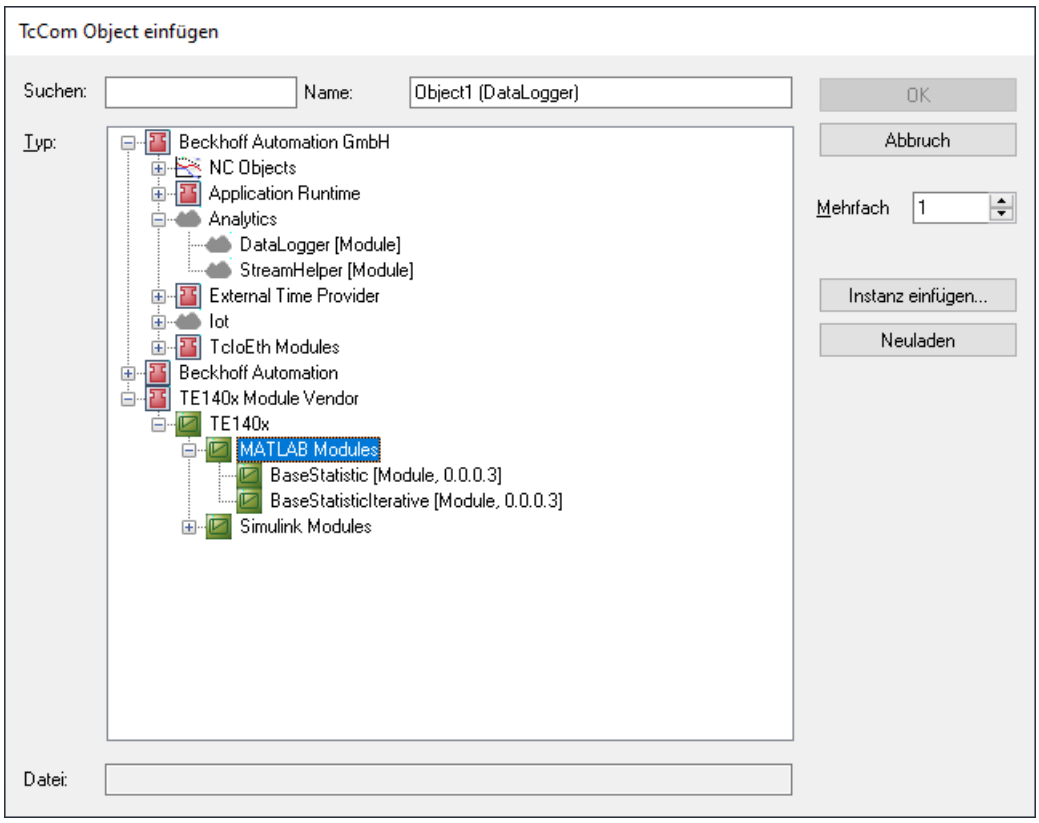


The following setting options are available in the dialog:

- *VendorName*
- *GroupName* (MATLAB®) and
- *GroupName* (Simulink®)

The hierarchy is shown in TwinCAT using the following example:

- VendorName “TE140x Module Vendor”
- GroupName “TE140x”
  - “MATLAB Modules” for MATLAB® and
  - “Simulink Modules” for Simulink®

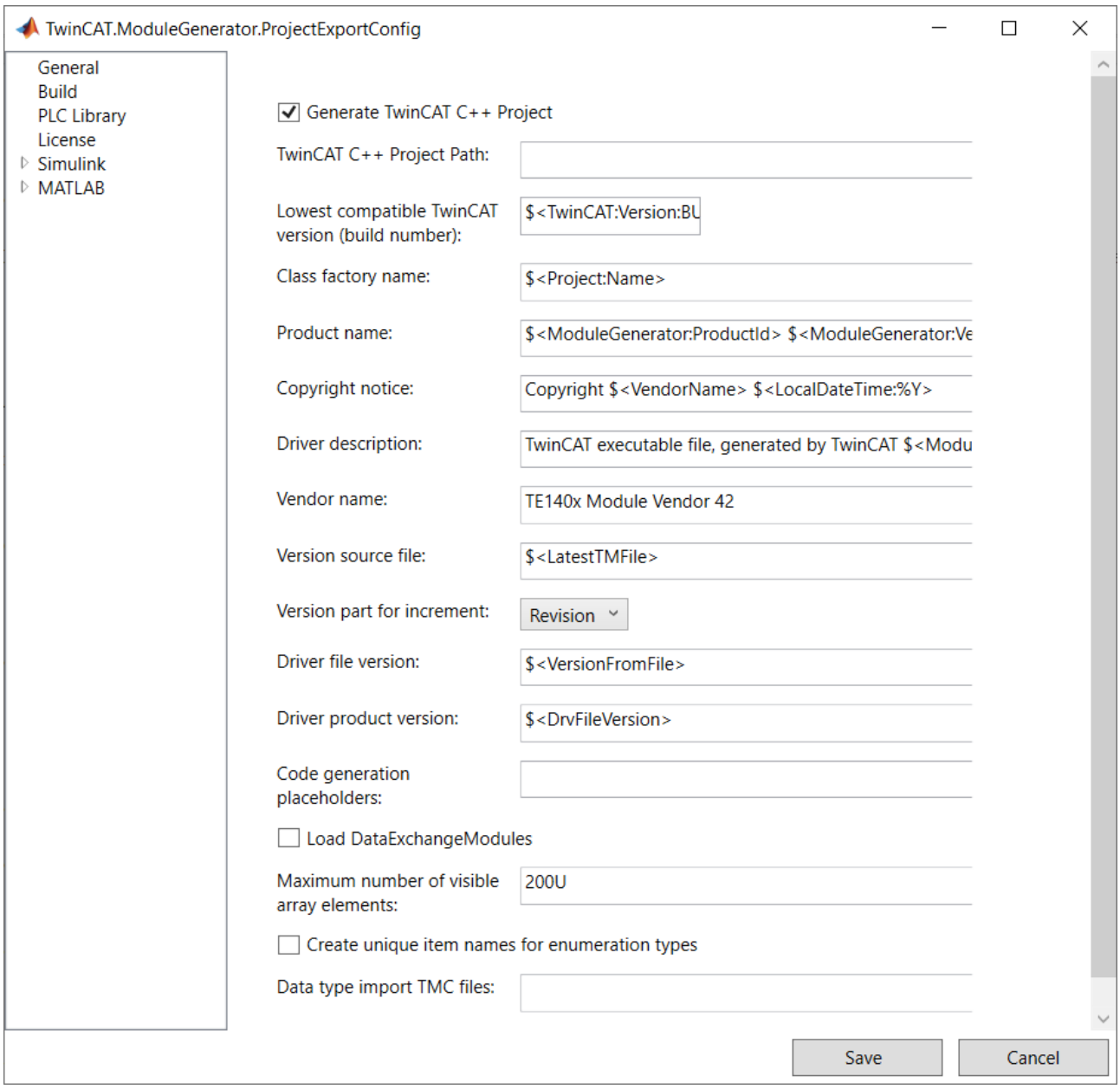


Change the software setup

To change the default settings of the TwinCAT target, you can access a dialog in the MATLAB® Console as follows:

```
TwinCAT.ModuleGenerator.Settings.Edit
```

Here you are offered various entries that you can store as default values.



Accept changes

1. Enter the new default settings in the dialog box.
2. Confirm with the **Save** button.
3. Restart MATLAB®.

⇨ The changes have been adopted.

3.1.2 Setting up driver signing

Create an OEM certificate level 2

TwinCAT objects generated from MATLAB® or Simulink® are based on a tmx driver (TwinCAT Module Executable), as are TwinCAT C++ objects. These drivers must be signed with a OEM certificate level 2 so that the driver can be loaded on the runtime PC during the TwinCAT runtime.

See the following links for detailed documentation on how to create an OEM certificate for driver signing:

- General documentation on OEM certificates
- Application-related documentation for tmx driver signing

The most important facts in brief:

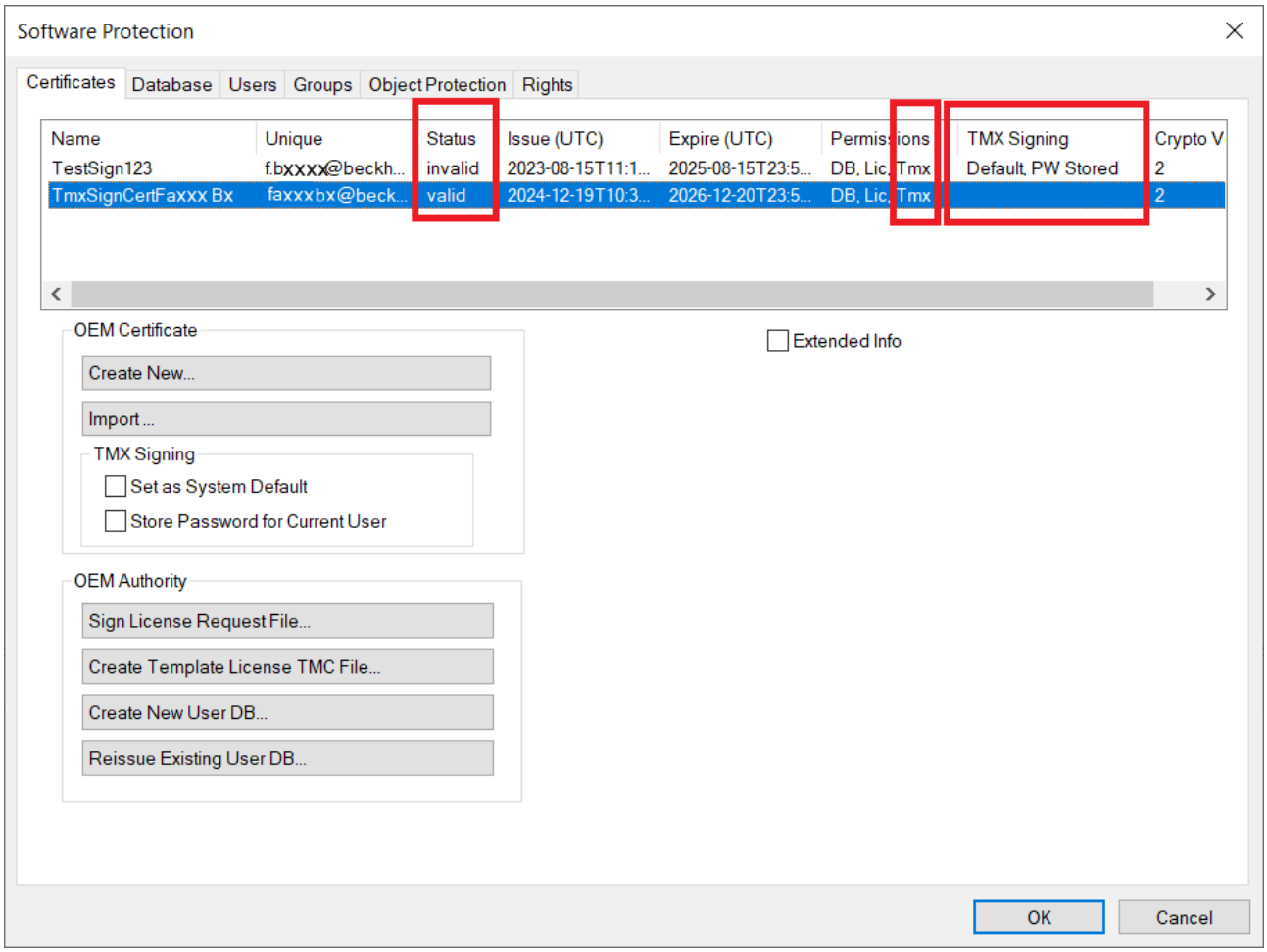
- You can create your own certificate. To do this, go to Visual Studio at:
  Menu bar > TwinCAT > Software Protection...
  - You need an OEM certificate Crypto Version 2 (option: *Sign TwinCAT C++ executables (*.tmx)*).
  - You will be prompted to create a password for your certificate.
- Drivers can also be created without signing and signed afterwards.
- For testing purposes in the development phase, a non-countersigned certificate is sufficient.
- Countersigned certificates can be ordered free of charge from Beckhoff (TC0008).

Set up OEM certificate level 2 under Software Protection

> **TwinCAT Build 4026: Requirement for the setup dialog**
>
> The following information on Software Protection only applies to TwinCAT 3.1 Build 4026. At least the TwinCAT Standard 4026.14 workload is required. If you are working with older versions, please continue reading “Setting up OEM certificate level 2 for driver signing without the Software Protection dialog” in the section below.

In the Software Protection interface (**Menu bar > TwinCAT > Software Protection...**) you can both create certificates (Create New...) and:

- Set a certificate as the system-wide default certificate for signing tmx files (optional).
- For each certificate, store the corresponding password for the logged-in Windows user (required).



The overview above contains two certificates as examples.

The first certificate "TestSign123" is not countersigned by Beckhoff, therefore it is classified as *invalid* in the status. Certificates that are not countersigned can still be used for signing. The target system must then be set into the test mode - see section Behavior of the TwinCAT runtime [▶ 18]. The "TmxSignCertFaxxxBx" certificate, on the other hand, is countersigned and therefore classified as *valid*. Both certificates are suitable

for signing tmx files, as can be seen under *Permissions*. In the "TMX Signing" column, "Default" indicates whether a certificate is set as the system-wide default certificate. The note "PW Stored" indicates that the password of the certificate is available/stored for the Windows user logged in.

Set certificate as system-wide default certificate (optional)

You can set a default certificate on an engineering PC, which is always used for TwinCAT C++, Target for MATLAB®, Target for Simulink®, etc., unless you explicitly specify a different certificate.

Select the certificate you want to use as the default certificate from the list in the *Software Protection* dialog and select the "Set as System Default" checkbox.

An environment variable with the name *TcSignTwinCatCertName* is then created. In Windows, environment variables are made known when a process is started. Therefore, restart MATLAB® if you are already running the process.

Further options for using certificates can be found later in this chapter.

Store password for a certificate (required)

For security reasons, the password of a certificate must not be entered in the project or source code in the Simulink® model or in the MATLAB® code. With "Store Password for Current User" you store the corresponding passwords for your certificates on your system.

The passwords are stored obfuscated in the registry of the Windows operating system. This means that the password for a specific certificate is known in the operating system (for the Current User) and is used automatically.

Select the certificate for which you want to store the corresponding password in the *Software Protection* dialog. Select "Store Password for Current User". You will be asked to enter your password. If it has been successfully checked and entered, the note "PW Stored" appears under "TMX Signing".

An **alternative variant** for storing a password is the command prompt with the TcSignTool (C:\Program Files (x86)\Beckhoff\TwinCAT\3.1\SDK\Bin).

The password is stored with the following call:

```
tcsigntool grant /f "C:\TwinCAT\3.1\CustomConfig\Certificates\MyCertificate.tccert" /p MyPassword
```

The obfuscated password is stored in the registry under:
`HKEY_CURRENT_USER\SOFTWARE\Beckhoff\TcSignTool\`

The password is deleted with the following call:

```
tcsigntool grant /f "C:\TwinCAT\3.1\CustomConfig\Certificates\MyCertificate.tccert" /r
```

Set up OEM certificate level 2 for driver signing without the Software Protection dialog

To sign tmx files, you need a certificate and a password associated with the certificate.

Available certificates can be found at:

Build 4026: C:\ProgramData\Beckhoff\TwinCAT\3.1\CustomConfig\Certificates
Build 4024: C:\TwinCAT\3.1\CustomConfig\Certificates

Handling of the certificate

There are four possible variants for signing tmx drivers.

Variant 1: System-wide default certificate for TwinCAT C++ and TE14xx

This variant is identical to the path via "Software Protection" > "Set as System Default".

Alternatively, you can also create a Windows environment variable manually for this variant. Create a new **environment variable** at **User > Variables** with:

Variable: *TcSignTwinCatCertName*

Value: Full path of the certificate

Variant 2: System-wide default certificate for MATLAB®

You can set a default certificate in your MATLAB® environment, which is always used for Target for MATLAB® and Target for Simulink® (**not** TwinCAT C++), unless you explicitly specify a different certificate.

Open the Common Settings dialog with *TwinCAT.ModuleGenerator.Settings.Edit* (MATLAB® Command line) and enter the desired default certificate under **Build > Certificate name for TwinCAT signing**. This certificate is stored in your user directory as default and is used by all MATLAB® versions on your system as default.

Variant 3: Certificate in the configuration of the Simulink® model

You can explicitly name a certificate for each build operation. For Variant 3 you do not have to make any further settings in advance. Before each build process, you can define a certificate of your choice for precisely this build process.

Target for Simulink®: **TC Build > Certificate for TwinCAT signing**

Target for MATLAB®: Property `SignTwinCatCertName`

Variant 4: Build without certificate and sign later with TcSignTool

You can build without a certificate and sign afterwards with the **TcSignTool**.

The TcSignTool is a command line program. For example, open the command prompt and execute `tcsigntool sign /?` to display the help. The program can be found here:

Build 4026: C:\Program Files (x86)\Beckhoff\TwinCAT\3.1\SDK\Bin

Build 4024: C:\TwinCAT\3.1\SDK\Bin

Operating TcSignTool from MATLAB®

From MATLAB®, the tool can be started with the command `system()` or with `!`.

Sample call for signing a tmx driver for TwinCAT:

```
TcSignTool sign /f "C:\TwinCAT\3.1\CustomConfig\Certificates\ MyCertificate.tccert" /p MyPassword
"C:\TwinCAT\3.1\Repository\TE140x Module Vendor\ModulName\0.0.0.1\TwinCAT RT (x64)\MyDriver.tmx"
```

Behavior of the TwinCAT runtime

If a TwinCAT object created from MATLAB® or Simulink® with a signed driver is used in a TwinCAT Solution and loaded onto a target system with **Activate Configuration**, the following must be observed:

Test mode for non-countersigned certificates

If you use a non-countersigned OEM certificate for signing, you must set your target system into test mode. To do this, run the following command as an administrator on the target system:

```
bcdedit /set testsigning yes
```

If you are using a countersigned OEM certificate, this step is not necessary.

Whitelist for certificates on target systems

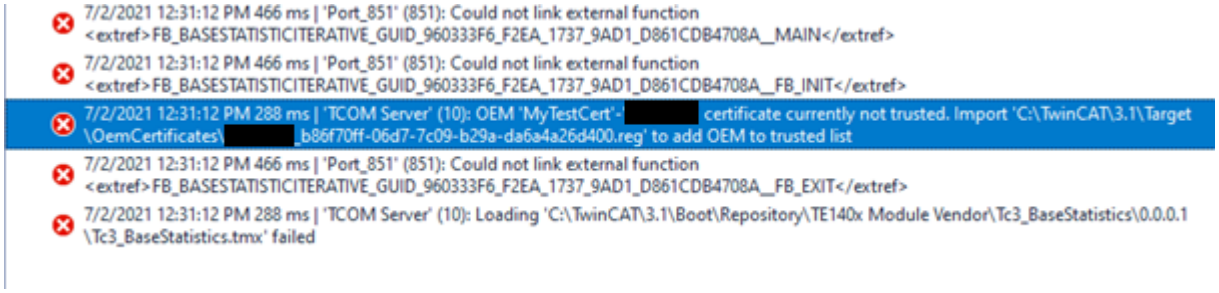
Each TwinCAT runtime (XAR) has its own whitelist of trusted certificates.

Behavior with TwinCAT Build 4026

The TwinCAT-XAE checks whether all certificates required to activate the configuration are in the whitelist on the runtime system. If this is not the case, a pop-up window appears. You can set the whitelist entries there.

Behavior with TwinCAT Build 4024

If the certificate used for signing is not included in this whitelist, the driver will not be loaded. A corresponding error message is output in TwinCAT Engineering (XAE).



The error message contains the instruction to execute a registry file, which was automatically created on the target system, on the target system as administrator. This process adds the used certificate to the whitelist.

Registry file is only dependent on the OEM certificate

The registry file can also be used on other target systems. It only contains information about the OEM certificate used and is not target system dependent.

4 Licenses

Two licenses are required to use the full functionality of the TE1401 TwinCAT Target for MATLAB®. On the one hand, the TE1401 engineering license for creating TwinCAT objects from MATLAB® functions and, on the other hand, a runtime license for executing these objects during the TwinCAT runtime.

Engineering license

The license *TE1401 Target for MATLAB®* is required for the **engineering system** to create TcCOM and PLC function blocks from MATLAB®. For testing purposes, the product can be used in demo mode without a license as a demo version.

A 7-day trial license with full functionality is not available for this product.

Restrictions in the demo version

Without a valid TE1401 license, the following restrictions must be observed:

- All cpp and header files from MATLAB® Coder™ must not exceed 50 kB in total.
- Function inputs and function outputs are limited to 5 variables.
- You cannot merge multiple MATLAB® functions into one PLC library.

Modules created with a demo license may only be used for non-commercial purposes!

Runtime license

The TC1320 or TC1220 licenses with included PLC license are required to start a TwinCAT configuration with a TwinCAT object generated from MATLAB®. Without activated license, the module and consequently the TwinCAT system cannot be started.

TC1320 contains the license for executing TwinCAT C++ objects as well as objects created via the Target for Simulink® and via the Target for MATLAB®.

TC1220 adds a PLC license to the above list of TC1320.

It is possible to create a 7-day trial license for the runtime licenses, which allows initial tests without purchasing the license.

5 Quick start

Starting with a simple MATLAB® function

✓ Feel free to use our built-in samples for first steps with the TwinCAT Target for MATLAB®. The MATLAB® Command Window provides a list of available samples via `TwinCAT.ModuleGenerator.Samples.List`

1. First select simple samples, e.g. *BaseStatistics* - can also be called directly with `TwinCAT.ModuleGenerator.Samples.Start('BaseStatistics').`

Beginner video

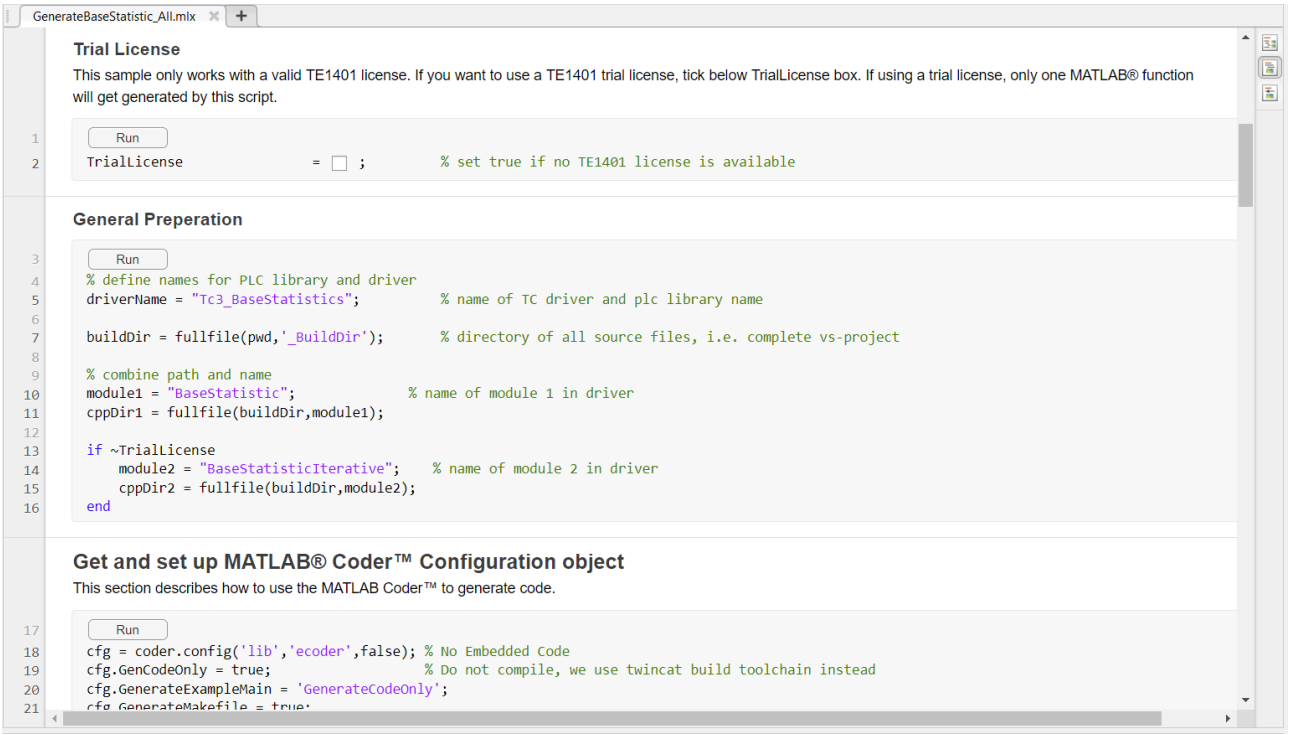
The following video (only available in English) can also be used as an introduction: TwinCAT Target for MATLAB®.

Getting started with the Base Statistics Sample

✓ Opening the Base Statistics Sample opens a MATLAB Live Script, which contains documentation parts as well as sections with code for execution.

1. Execute the Code Sections by clicking on the respective Run buttons.
2. Work your way through the sample step by step.

⇨ The sample shows how you can use the Target for MATLAB® to convert two MATLAB® functions into two TcCOM objects and two function blocks, bundling the function blocks in a common PLC library.



If you do not have a valid TE1401 license, you can activate the TrialLicense checkbox in the sample. This converts only one MATLAB® function into a TcCOM and a function block. The sample is then compliant with the demo terms [▶ 20] of the product.

Selection of components and paths

The *General Preparation* section of the sample states:

What should be the name of the created TwinCAT driver (tmx-file)?

Here *Tc3_BaseStatistics* is selected.
This name is then used in the following places:

- File path in the Engineering Repository:
  %TwinCATInstallDir% \3.1\Repository\<TE140x Module Vendor>**Tc3_BaseStatistics**\<Version>\
- Name of the created files *.tmx, *.tml, *.tmc and *.library
- Name of the created PLC library in TwinCAT, which then contains the two function blocks

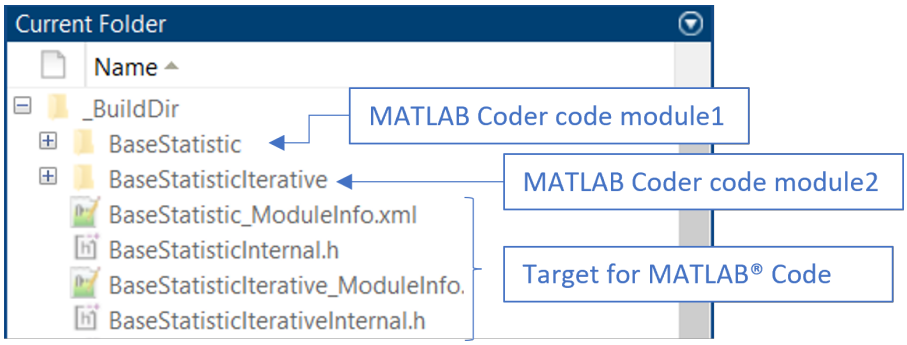
Where should all source files be stored?

`buildDir` specifies where the MATLAB® Coder™ and also the TwinCAT Target for MATLAB® should store all source files, log files and other meta information files. This folder contains all the information required to create the TwinCAT objects from here. In this case, a new folder `_ buildDir` is created in the current MATLAB® path.

Which MATLAB® functions should be made available in TwinCAT?

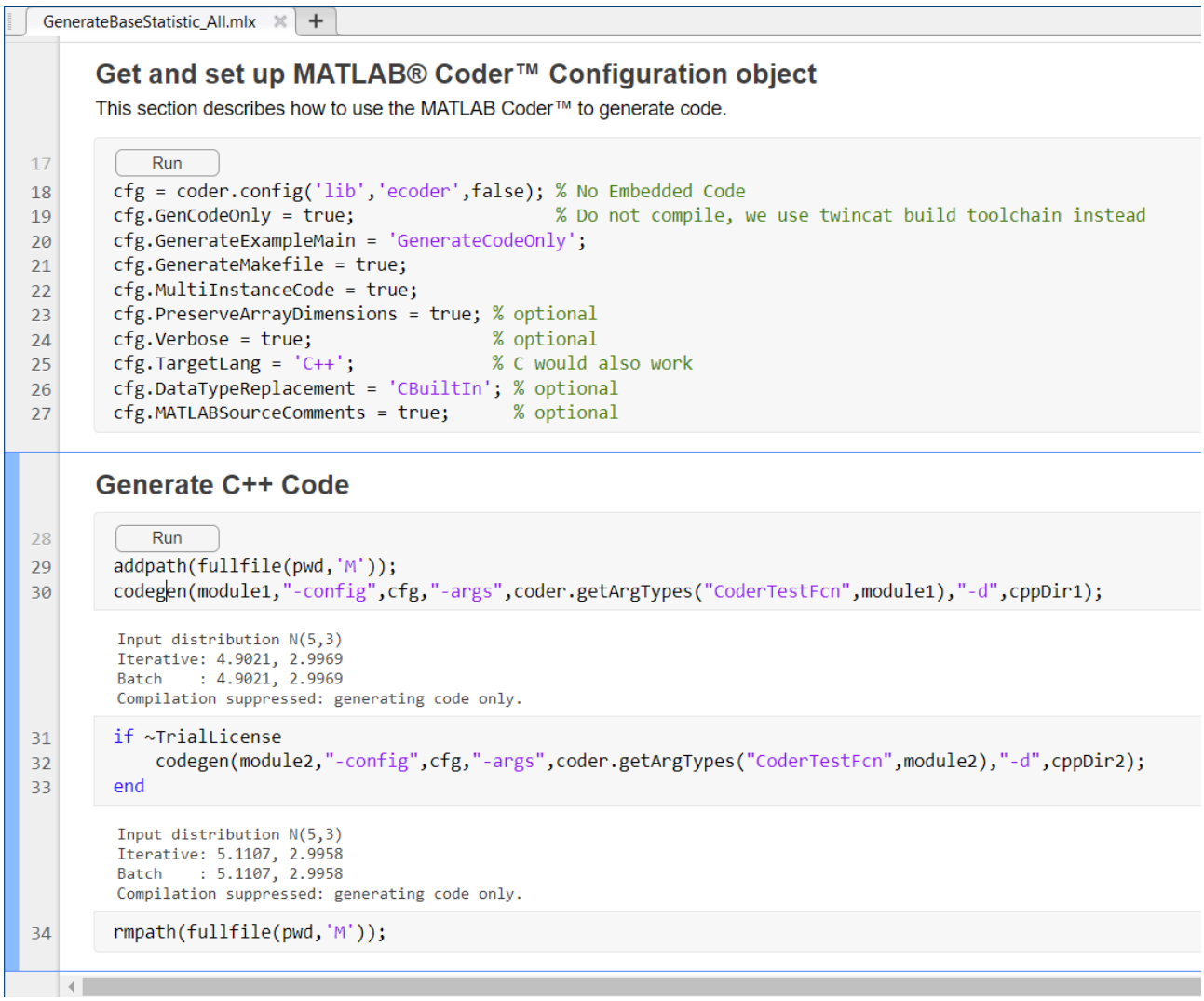
The MATLAB® functions are named here with the variables `module1` and `module2`; the two MATLAB® functions BaseStatistics and BaseStatisticsIteravtive (stored in subfolder M) are to be transferred to TwinCAT objects accordingly.

Each of these modules gets its own subfolder in `buildDir` which is named `cppDir1` and `cppDir2`. The C++ code is later generated into these subfolders by the MATLAB® Coder™.



Creating a MATLAB® Coder™ configuration

In the further course of the MATLAB® Live Script, a MATLAB® Coder™ configuration is created. This section does not contain any TwinCAT-specific components, i.e. only the MATLAB® Coder™ is used. For detailed MATLAB® Coder™ documentation, see the MATLAB® documentation.



When creating the Coder configuration `cfg`, please note:

- The Embedded Coder is not supported.
- Only the generated code is needed.

The `codegen` command then receives the Coder configuration and the corresponding MATLAB® function to be translated. The argument "-d", cppDir1 instructs the MATLAB® Coder™ to place the C++ code in the cppDir1 path.

Accordingly, after this step the generated C++ code of the function BaseStatistic.m and BaseStatisticIterarive.m are located in the folders _BuildDir/ BaseStatistic and _BuildDir\ BaseStatisticIterative.

Creating a Target for MATLAB® project export configuration

The following code segments in the MATLAB® Live Script apply only to the Target for MATLAB® and are independent of the MATLAB® Coder™ in that only C++ code already created by the MATLAB® Coder™ will be used.

Optionally, you can extract the MATLAB® code description from the m-file and display it later in TwinCAT XAE, see MATLAB Code in TcCOM [▶ 43].

```
TwinCAT.ModuleGenerator.Matlab.ExportMCodeRepresentation('MFile',module1,'BuildDir',cppDir1);
```

The m-file with the module1 function, i.e. BaseStatistics, must be located in the MATLAB® workspace. The information is then extracted from the BaseStatistics.m file and stored in the cppDir1 folder.

In the next step, a project export configuration is created by the TwinCAT module generator with

```
TwinCAT.ModuleGenerator.ProjectExportConfig('FullPath',FullPathToVcxproj);
```

The full path to the new Visual Studio project to be created is specified as the argument. In this case, it is ... _BuildDir\Tc3_BaseStatistics.vcxproj. After building, the naming of the Visual Studio project also defines the naming of the created files *.tmx, *.tmc, *.tml and *.library. See General settings BaseStatistics [▶ 21].

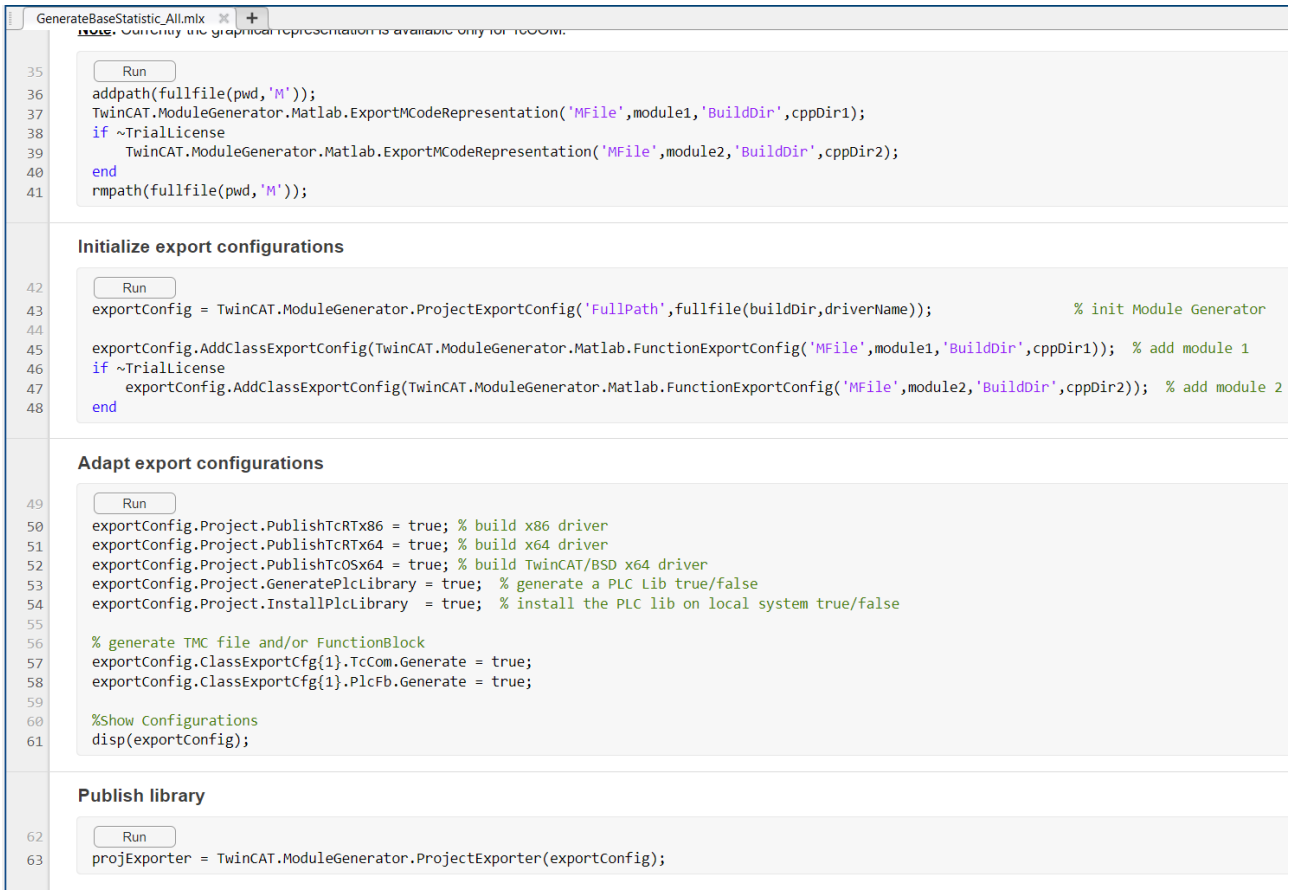


Fig. 1:

For each MATLAB® function, an export configuration must be created with `TwinCAT.ModuleGenerator.Matlab.FunctionExportConfig()`. AddClassExportConfig adds this export configuration to the project export configuration as a module.

```
exportConfig.AddClassExportConfig(TwinCAT.ModuleGenerator.Matlab.FunctionExportConfig('MFile',module
1,'BuildDir',cppDir1));
```

The path to the C++ code generated by MATLAB® Coder™ and the name of the m-file with the corresponding MATLAB® function are passed as arguments to FunctionExportConfig(). For example, module1 is then used to set that the TcCOM object to be created and the function block in the PLC library are called BaseStatistics or FB_BaseStatistics.

The project export configuration will be further adapted in the following. This defines the platforms for which a driver is to be built (here for Windows 32-bit, Windows 64-bit and TwinCAT/BSD 64-bit). A PLC library is also configured to be created and installed on the local TwinCAT XAE.

For each module added to the project export configuration, properties can be set individually. It is explicitly set here that, for the first added module, both a PLC function block and a TcCOM are to be generated.

You can use `disp(exportConfiguration)` to display an overview of the entire configuration.

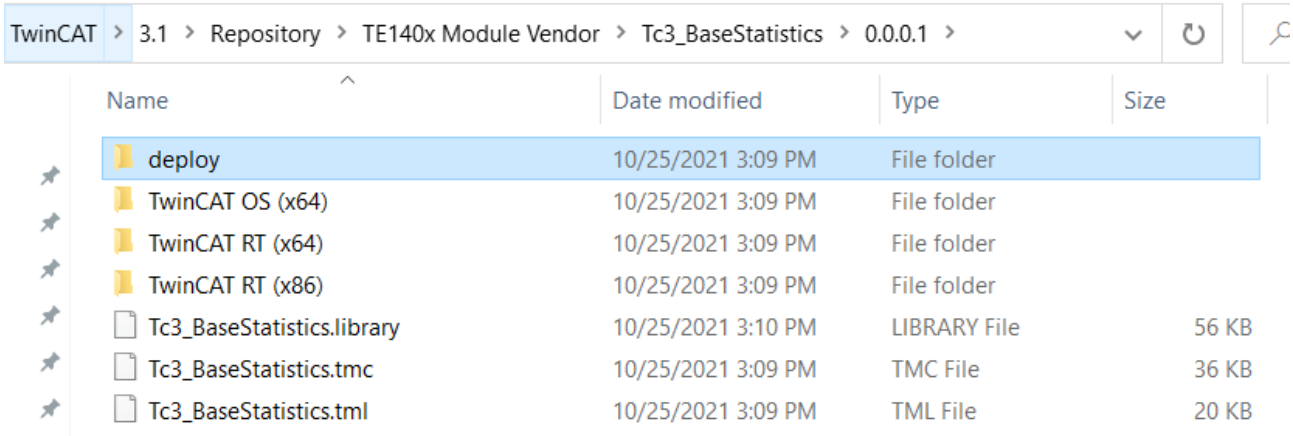
	Value	DataType	Options	DisplayNam
Project.FullPath	{["_BuildDir\Tc3_BaseStatistics"]}	"String"	""	"TwinCAT C++ Project Path"
Project.VendorName	{'TE140x Module Vendor' }	"String"	""	"VendorName"
Project.VersionSrc	{'$<LatestTMFile>' }	"String"	""	"Version source file"
Project.IncrementVersion	{'Revision' }	"Enum"	"None, Revision, Build, Minor, Major"	"Version part for increment"
Project.DrvFileVersion	{'$<VersionFromFile>' }	"String"	""	"DrvFileVersion"
Project.LowestCompatibleTcBuild	{'$<TwinCAT:Version:BUILD>' }	"Int"	""	"Lowest compatible TwinCAT vers
Project.MaxVisibleArrayElements	{'200U' }	"String"	""	"Maximum number of visible arra
Project.Publish	{'true' }	"Bool"	""	"Run the publish step after pro
Project.PublishPlatformtoolset	{'Auto' }	"Enum"	"Auto, Microsoft Visual C++ 14.1"	"Platform Toolset"
Project.PublishConfiguration	{'Release' }	"Enum"	"Release, Debug"	"Build configuration"
Project.PublishTcRTx86	{[1]}	"Bool"	""	"TwinCAT RT (x86)"
Project.PublishTcRTx64	{[1]}	"Bool"	""	"TwinCAT RT (x64)"
Project.PublishTcOSx64	{[1]}	"Bool"	""	"TwinCAT OS (x64)"
Project.SignTwinCatCertName	{0×0 char }	"String"	""	"Certificate name for TwinCAT s
Project.GeneratePlcLibrary	{[1]}	"Bool"	""	"Generate a PLC library"
Project.InstallPlcLibrary	{[1]}	"Bool"	""	"Install the generated PLC libr
Project.PreCodeGenerationCallbackFcn	{0×0 char }	"String"	""	"Pre code generation callback f
Project.PostCodeGenerationCallbackFcn	{0×0 char }	"String"	""	"Post code generation callback
Project.PostPublishCallbackFcn	{0×0 char }	"String"	""	"Post publish callback function
****** ClassExportCfg{1} (BaseStatistic) ******	{["************"]}	"************"	"************"	"************"
ClassExportCfg{1}.TcCom.Generate	{[1]}	"Bool"	""	"Generate TcCom Module (TwinCAT
ClassExportCfg{1}.TcCom.ClassName	{["BaseStatistic"]}	"String"	"<READONLY>"	"TcCOM module name"
ClassExportCfg{1}.TcCom.FpExceptionsForInit	{'CallerExceptions' }	"Enum"	"CallerExceptions, Exceptions, NoExceptions"	"Floatingpoint exception during
ClassExportCfg{1}.TcCom.FpExceptionsForUpdate	{'CallerExceptions' }	"Enum"	"CallerExceptions, Exceptions, NoExceptions"	"Floatingpoint exception during
ClassExportCfg{1}.TcCom.OnlineChange	{'false' }	"Bool"	""	"Online change support"
ClassExportCfg{1}.TcCom.GroupName	{'TE140x|MATLAB Modules' }	"String"	""	"GroupName"
ClassExportCfg{1}.TcCom.BlockDiagramExport	{'true' }	"Bool"	""	"Export BlockDiagram"
ClassExportCfg{1}.TcCom.ResolveMaskedSubsystems	{'false' }	"Bool"	""	"Resolve Masked Subsystems"
ClassExportCfg{1}.TcCom.BlockDiagramVariableAccess	{'AssignToParent' }	"Enum"	"AssignToParent, HideInBlockDiagram"	"Access to VariableGroup not re
ClassExportCfg{1}.TcCom.BlockDiagramDebugInfoExport	{'true' }	"Bool"	""	"Export BlockDiagram debug info
ClassExportCfg{1}.TcCom.MonitorExecutionTime	{'false' }	"Bool"	""	"Monitor ExecutionTime"
ClassExportCfg{1}.TcCom.InputInitValues	{'false' }	"Bool"	""	"Input: Initial values"

This provides an overview of the values set (Value), the data type used (DataType), suggested values (Options), and a short description (Displayname).

With `TwinCAT.ModuleGenerator.ProjectExporter(exportConfig)`, the build process of the configured platforms is triggered. This creates a folder on the local file system in the repository and stores the created drivers and description files.

The path description is:

%TwinCATInstallDir% \3.1\Repository\< VendorName >\<ProjectName>\<Version>

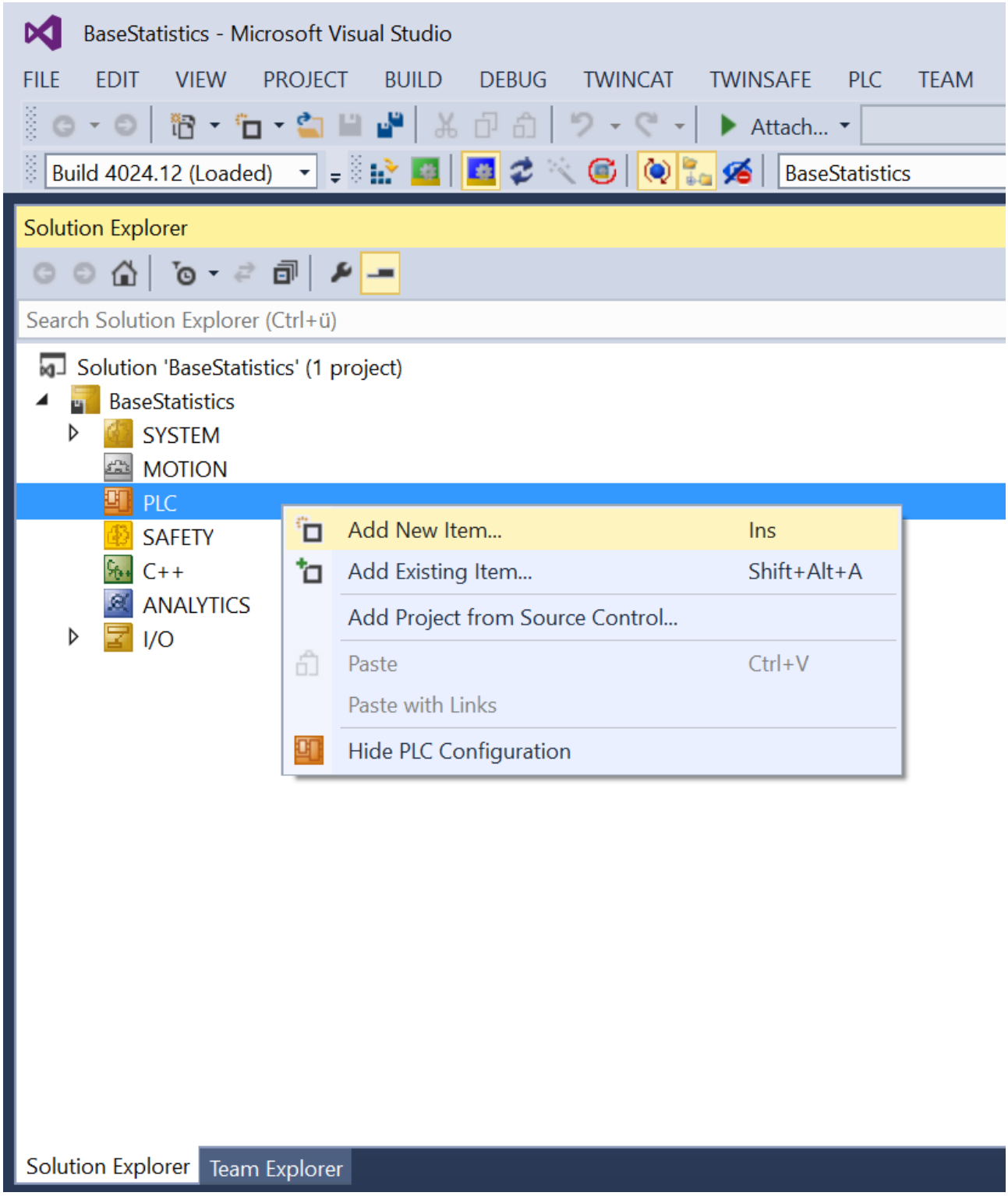


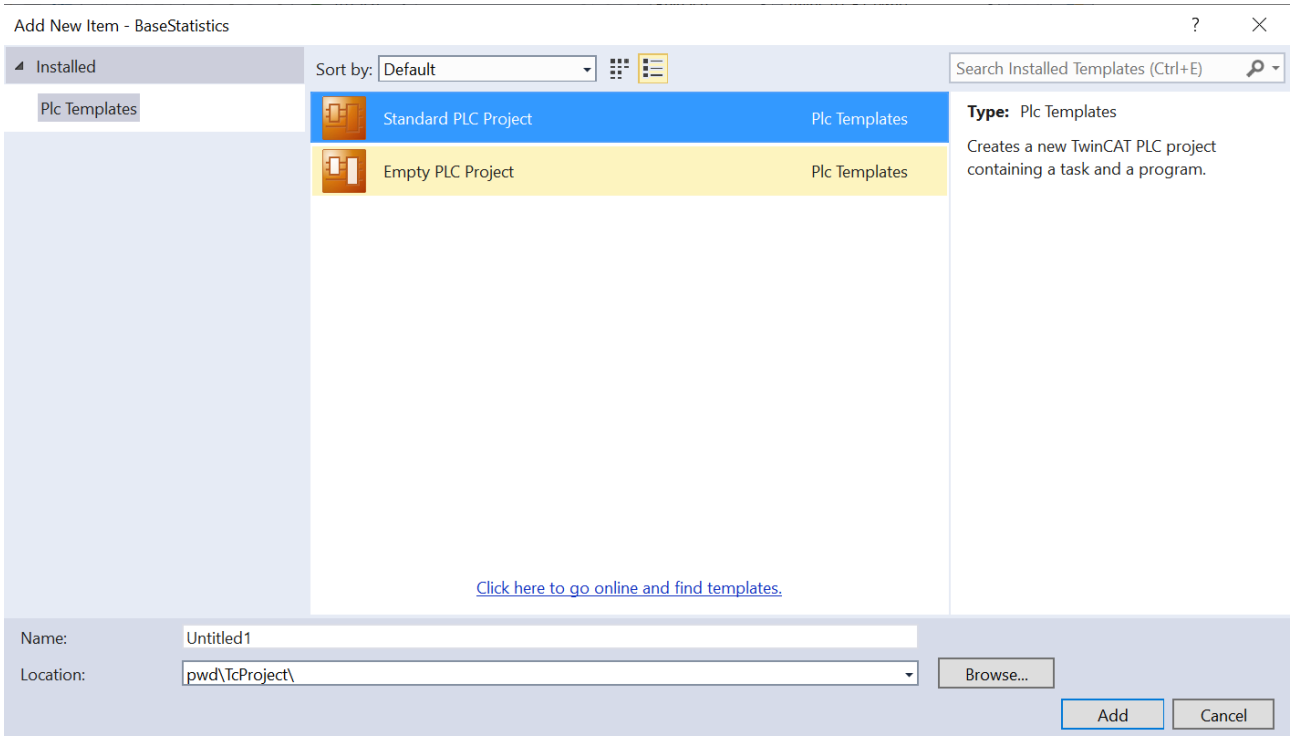
You can copy the folder to any number of TwinCAT XAE systems to make the modules available on those systems. Only the *.library must be installed in TwinCAT via the PLC library repository. Please note that the folder structure will not be changed during copying.

Use PLC library in TwinCAT 3

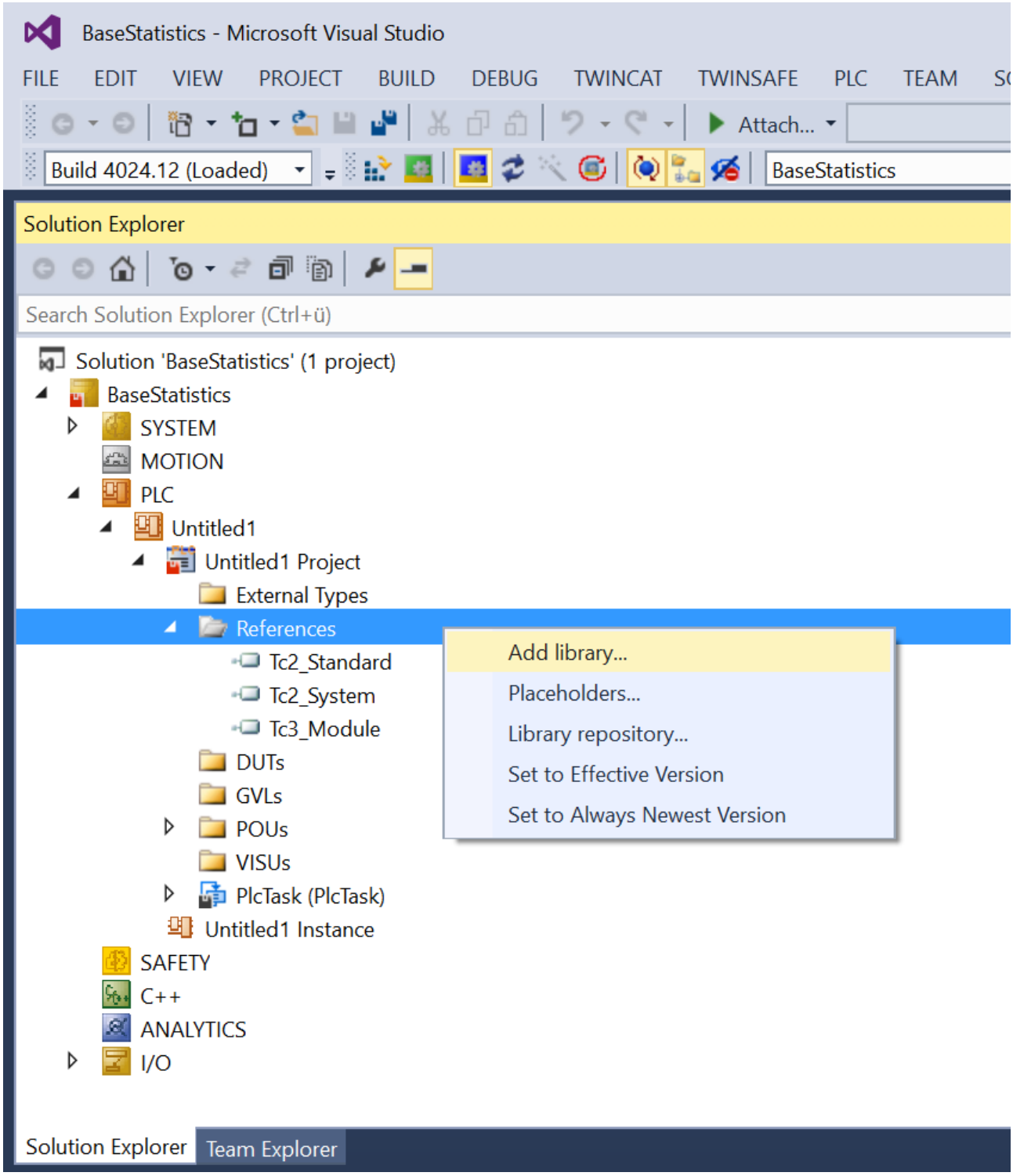
✓ Starting from a new TwinCAT solution, create a PLC project:

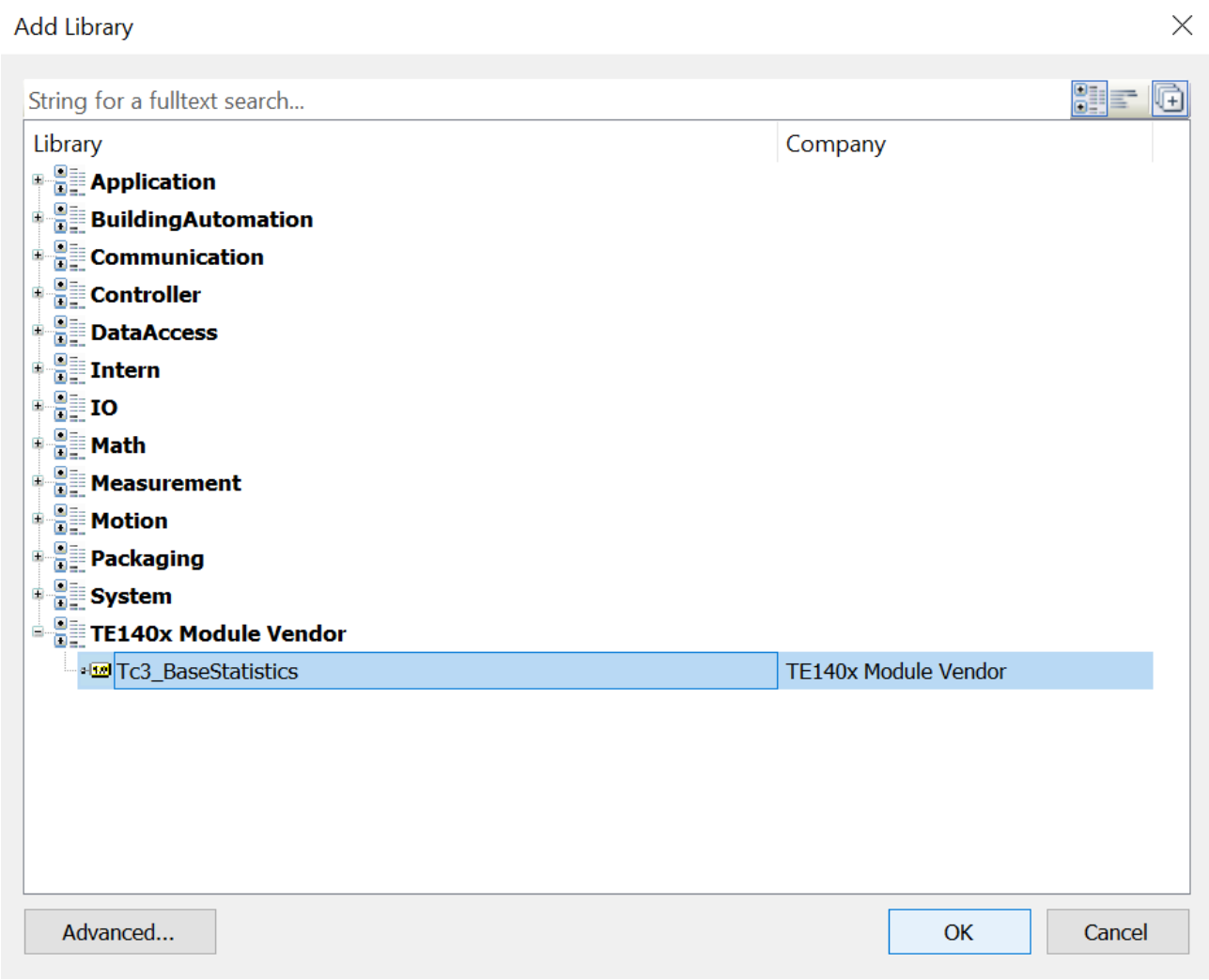
1. Perform the following menu steps.


BaseStatistics - Microsoft Visual Studio
FILE EDIT VIEW PROJECT BUILD DEBUG TWINCAT TWINSAFE PLC TEAM
Attach...
Build 4024.12 (Loaded)
BaseStatistics
Solution Explorer
Search Solution Explorer (Ctrl+ü)
Solution 'BaseStatistics' (1 project)
BaseStatistics
SYSTEM
MOTION
PLC
SAFETY
C++
ANALYTICS
I/O
Add New Item... Ins
Add Existing Item... Shift+Alt+A
Add Project from Source Control...
Paste Ctrl+V
Paste with Links
Hide PLC Configuration
Solution Explorer
Team Explorer

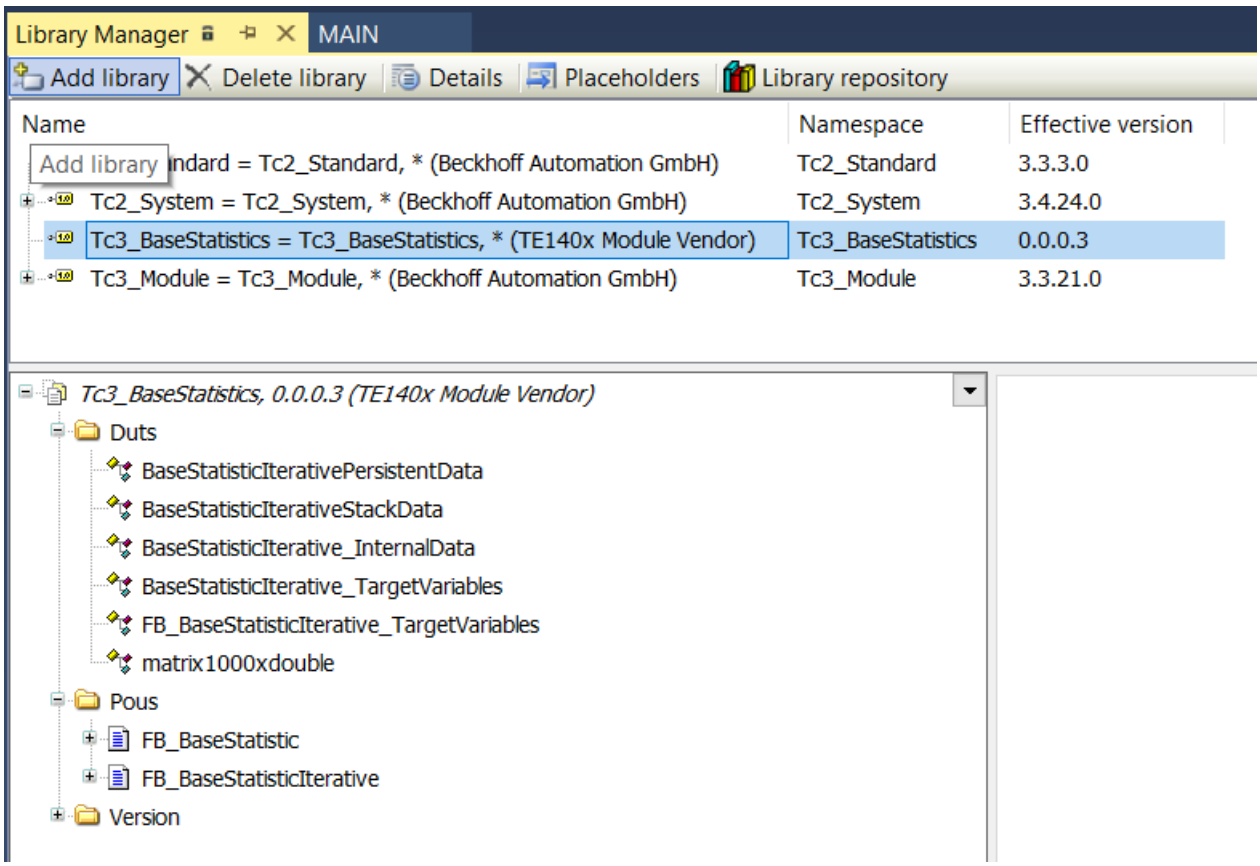


2. Then add the newly created (and already installed) PLC library:

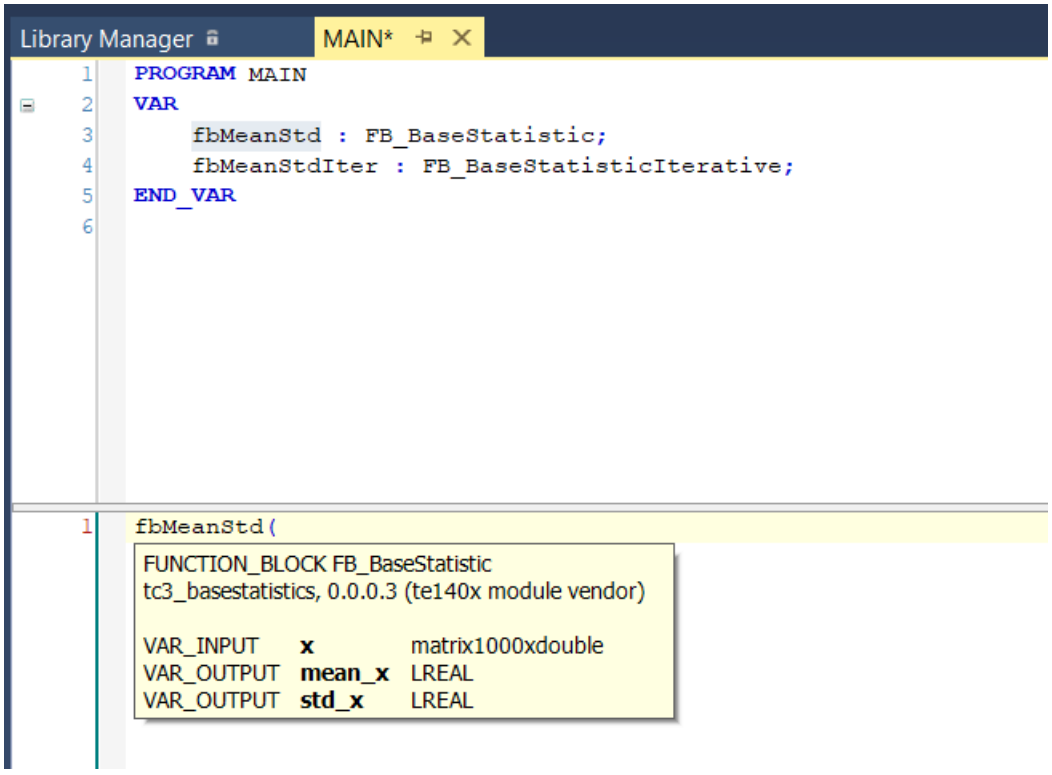

BaseStatistics - Microsoft Visual Studio
FILE EDIT VIEW PROJECT BUILD DEBUG TWINCAT TWINSAFE PLC TEAM
Attach...
Build 4024.12 (Loaded)
BaseStatistics
Solution Explorer
Search Solution Explorer (Ctrl+ü)
Solution 'BaseStatistics' (1 project)
BaseStatistics
SYSTEM
MOTION
PLC
Untitled1
Untitled1 Project
External Types
References
Tc2_Standard
Tc2_System
Tc3_Module
DUTs
GVLs
POUs
VISUs
PlcTask (PlcTask)
Untitled1 Instance
SAFETY
C++
ANALYTICS
I/O
Add library...
Placeholders...
Library repository...
Set to Effective Version
Set to Always Newest Version
Solution Explorer
Team Explorer



3. Get an overview of the data types and function blocks:

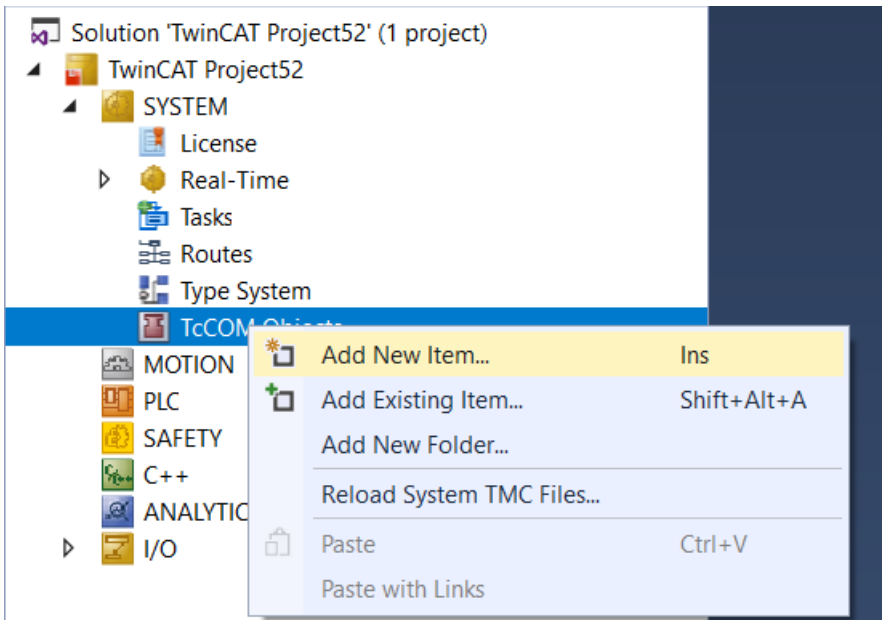


4. Insert instances of the function blocks into your PLC and use them in your application:

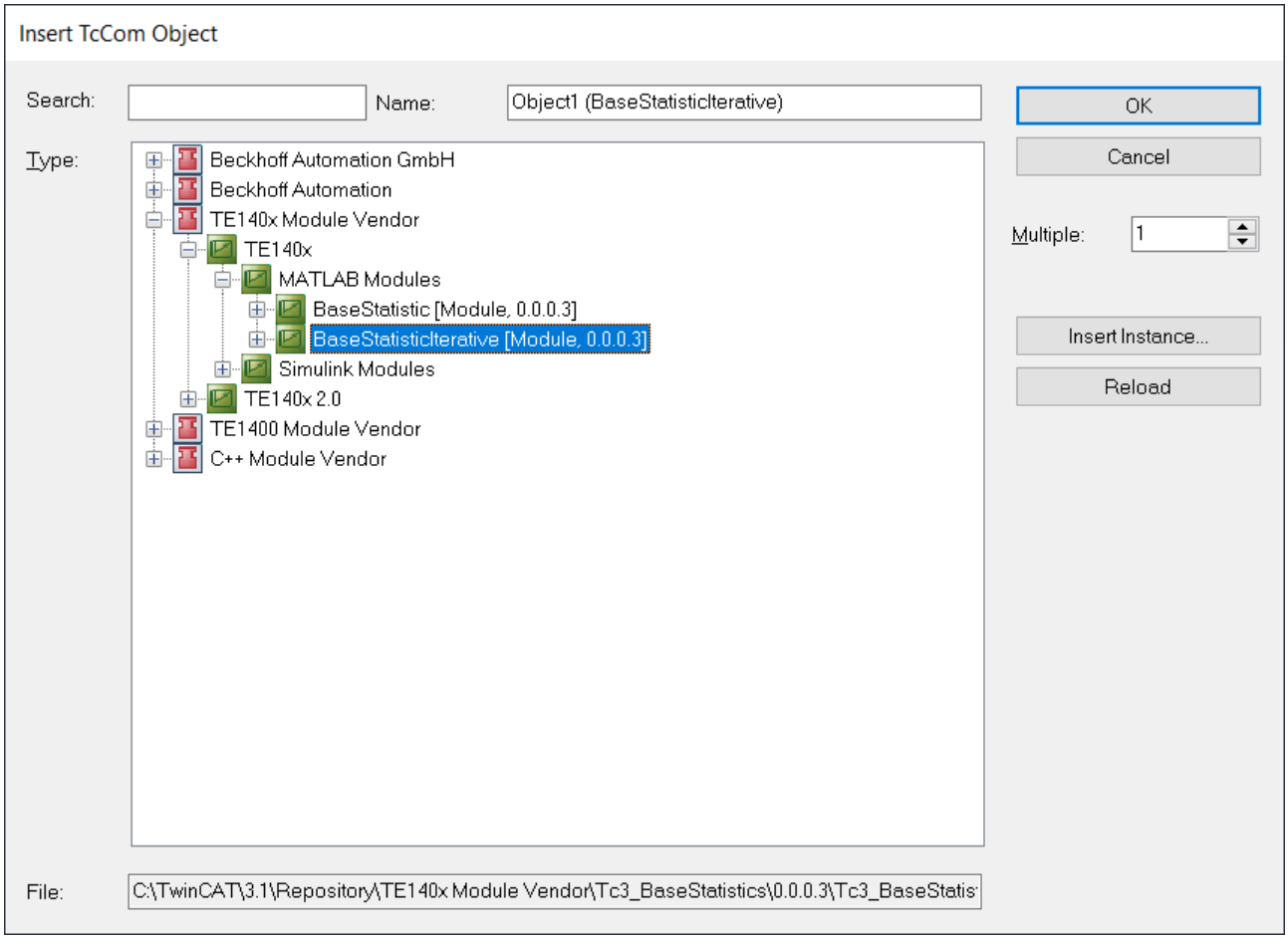


Using TcCOM objects in TwinCAT 3

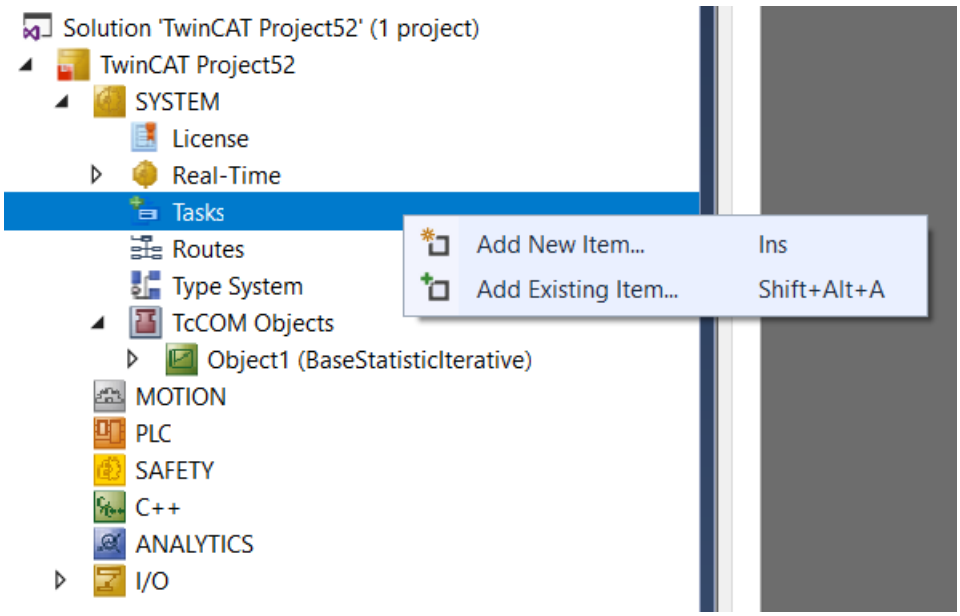
1. Insert a new TcCOM object.



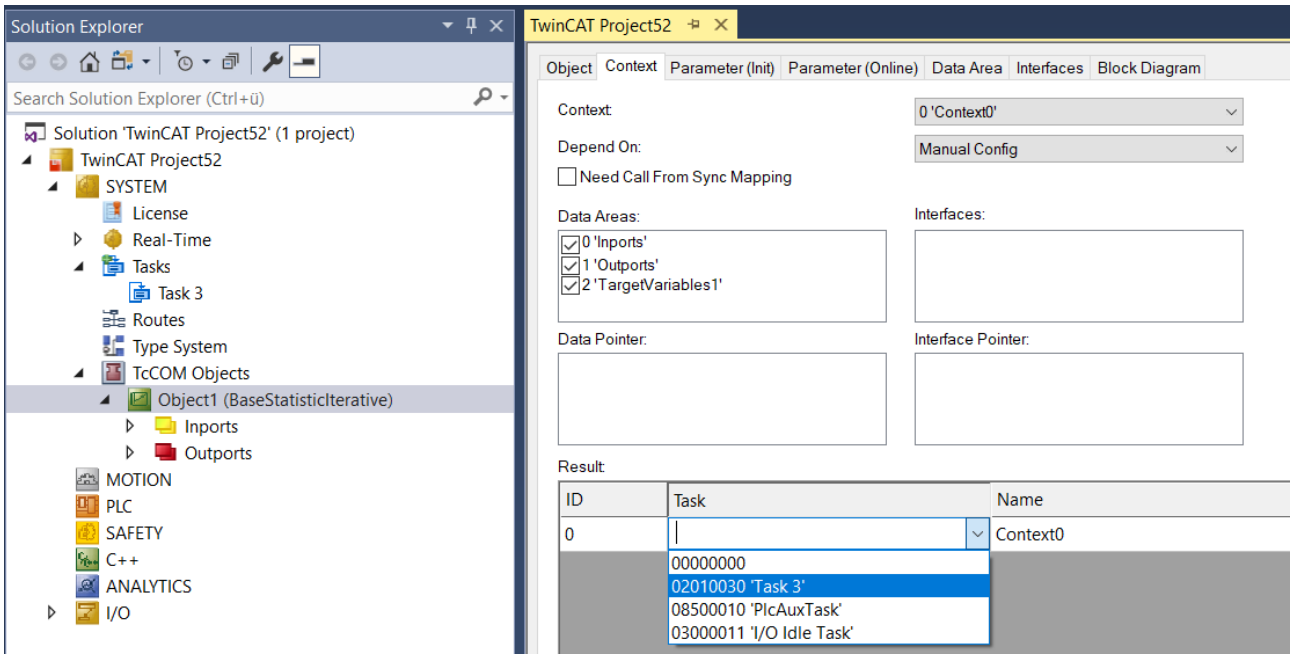
2. Select the corresponding TcCOM object:



3. Create a new cyclic task of type *TwinCAT Task*.



4. Assign the newly created task to the newly created TcCOM object. To do this, go to the instance of the TcCOM object and select the *Context* tab.



⇨ You can now activate the configuration. In order to connect the TcCOM object with other modules in your TwinCAT solution beforehand, you can use the process image to create mappings.

You can view the MATLAB® code on the Block Diagram tab and observe and scope values on the fly. See MATLAB code representation [▶ 43].

6 Overview of automatically generated files

If a build process is triggered via the TwinCAT module generator, some files and folders are created automatically. Where the files are located, what can be done with them and what the files mean - this is described below.

What are the categories of automatically generated files?

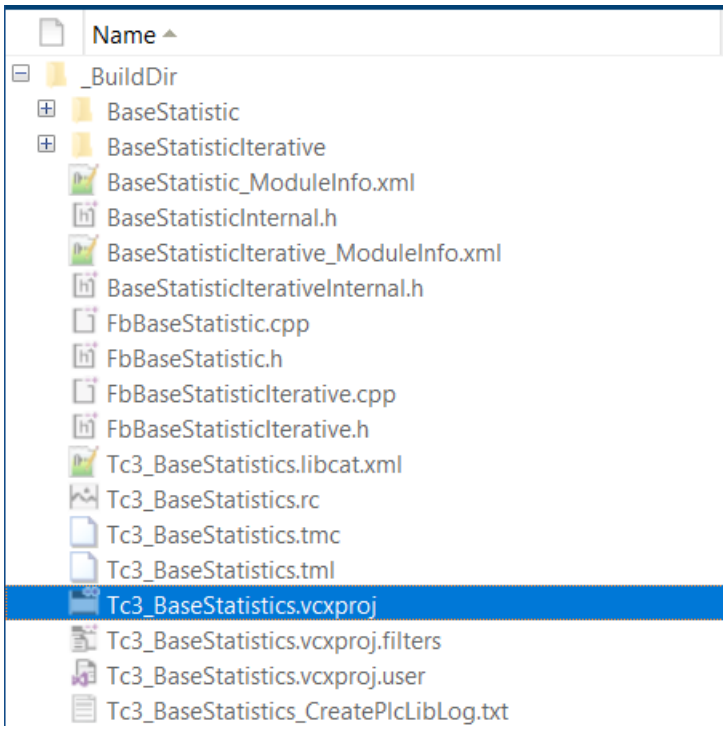
- Source code is generated.
- Log files are generated.
- The TwinCAT objects, drivers (*.tmx) and description files (*.tmc, *.library, ...), are created.

Generated source code

All source files required for the build, i.e. for creating the TwinCAT objects, are stored in the folder specified during initialization of the TwinCAT module generator. The location and name of the Visual Studio project to be generated are specified precisely here.

```
TwinCAT.ModuleGenerator.ProjectExportConfig('FullPath',FullPathToVcxproj);
```

For example, the following graphic shows the FullPath as *..._BuildDir\Tc3_BaseStatistics*.



The central file for the source code is *<ProjectName>.vcxproj*. This file can be used to create all TwinCAT objects. From MATLAB® you can, for example, trigger code generation only without a build process and run the build process on another system such as a build server. To do this, set `Project.Publish = false` in the TwinCAT module generator.

Generated log files

The generated log files are also collected in the folder mentioned above.

The log files created are the first place to look when debugging. If you request help from our support, please always send the following file with your request:

<ModelName>_ModuleGenerationLog.txt

Created TwinCAT objects

After a successful *build*, the binary files and description files created, which can be re-used in TwinCAT XAE, are stored in the so-called *Engineering Repository*, i.e. on the engineering PC at:

%TwinCATInstallDir% \3.1\Repository\<Module Vendor>\<ProjectName>\<Version>

This folder contains the tmc description file, the PLC library and the tmx drivers for the configured platforms as well as other description files.

If the order is copied to other PCs with TwinCAT XAE in the local *engineering repositories*, their users can use the created TwinCAT objects in their TwinCAT solutions.

Please note

Description of the generated C++ files and binary files

Versioned C++ projects

7 Settings of the TwinCAT module generator

Adds a project export configuration

```
exportConfig = TwinCAT.ModuleGenerator.ProjectExportConfig('FullPath',FullPathToVSproj);
```

The full path and name of the Visual Studio project to be created is passed to the 'FullPath' property.

Returns an object of the class TwinCAT.ModuleGenerator.ProjectExportConfig.

Sample call:

```
FullPathToVSproj = 'C:\BuildDir\MyMATLABFcn';
exportConfig = TwinCAT.ModuleGenerator.ProjectExportConfig('FullPath',FullPathToVSproj);
```

Methods of the class TwinCAT.ModuleGenerator.ProjectExportConfig

`AddClassExportConfig`	Adds an export configuration to the project. To create an export configuration, see section Creating an export configuration [▶ 39]. The export configuration is appended under Properties in the cell array ClassExportCfg. For an example call, see Module generator quick start [▶ 23].
`Save`	This creates a mat file and stores the project export configuration in it. The transfer argument is a path where the mat file is to be stored. Example call: `exportConfig.Save(pwd)` This saves the project export configuration in the current path.
`Load`	This loads a saved project export configuration. The transfer argument specifies the path of the mat file containing the saved configuration. Example call: `exportConfig.Load(pwd)` Loads the project export configuration from the current path.
`Edit`	Opens a graphical configuration interface for setting up the project export configuration.
`disp`	Gives an overview of the current project export configuration in the MATLAB® Command Window. See Module generator quick start [▶ 23]. Example call: `exportConfig.disp` alternatively `disp(exportConfig)`

	Value	DataType	Options	DisplayNam
Project.FullPath	{["_BuildDir\Tc3_BaseStatistics"]}	"String"	""	"TwinCAT C++ Project Path"
Project.VendorName	{'TE140x Module Vendor' }	"String"	""	"VendorName"
Project.VersionSrc	{'$<LatestTMFile>' }	"String"	""	"Version source file"
Project.IncrementVersion	{'Revision' }	"Enum"	"None, Revision, Build, Minor, Major"	"Version part for increment"
Project.DrvFileVersion	{'$<VersionFromFile>' }	"String"	""	"DrvFileVersion"
Project.LowestCompatibleTcBuild	{'$<TwinCAT:Version:BUILD>' }	"Int"	""	"Lowest compatible TwinCAT vers
Project.MaxVisibleArrayElements	{'200U' }	"String"	""	"Maximum number of visible arra
Project.Publish	{'true' }	"Bool"	""	"Run the publish step after pro
Project.PublishPlatformtoolset	{'Auto' }	"Enum"	"Auto, Microsoft Visual C++ 14.1"	"Platform Toolset"
Project.PublishConfiguration	{'Release' }	"Enum"	"Release, Debug"	"Build configuration"
Project.PublishTcRTx86	{[1]}	"Bool"	""	"TwinCAT RT (x86)"
Project.PublishTcRTx64	{[1]}	"Bool"	""	"TwinCAT RT (x64)"
Project.PublishTcOSx64	{[1]}	"Bool"	""	"TwinCAT OS (x64)"
Project.SignTwinCatCertName	{0×0 char }	"String"	""	"Certificate name for TwinCAT s
Project.GeneratePlcLibrary	{[1]}	"Bool"	""	"Generate a PLC library"
Project.InstallPlcLibrary	{[1]}	"Bool"	""	"Install the generated PLC libr
Project.PreCodeGenerationCallbackFcn	{0×0 char }	"String"	""	"Pre code generation callback f
Project.PostCodeGenerationCallbackFcn	{0×0 char }	"String"	""	"Post code generation callback
Project.PostPublishCallbackFcn	{0×0 char }	"String"	""	"Post publish callback function
****** ClassExportCfg{1} (BaseStatistic) ******	{["************"]}	"************"	"************"	"************"
ClassExportCfg{1}.TcCom.Generate	{[1]}	"Bool"	""	"Generate TcCom Module (TwinCAT
ClassExportCfg{1}.TcCom.ClassName	{["BaseStatistic"]}	"String"	"<READONLY>"	"TcCOM module name"
ClassExportCfg{1}.TcCom.FpExceptionsForInit	{'CallerExceptions' }	"Enum"	"CallerExceptions, Exceptions, NoExceptions"	"Floatingpoint exception during
ClassExportCfg{1}.TcCom.FpExceptionsForUpdate	{'CallerExceptions' }	"Enum"	"CallerExceptions, Exceptions, NoExceptions"	"Floatingpoint exception during
ClassExportCfg{1}.TcCom.OnlineChange	{'false' }	"Bool"	""	"Online change support"
ClassExportCfg{1}.TcCom.GroupName	{'TE140x|MATLAB Modules' }	"String"	""	"GroupName"
ClassExportCfg{1}.TcCom.BlockDiagramExport	{'true' }	"Bool"	""	"Export BlockDiagram"
ClassExportCfg{1}.TcCom.ResolveMaskedSubsystems	{'false' }	"Bool"	""	"Resolve Masked Subsystems"
ClassExportCfg{1}.TcCom.BlockDiagramVariableAccess	{'AssignToParent' }	"Enum"	"AssignToParent, HideInBlockDiagram"	"Access to VariableGroup not re
ClassExportCfg{1}.TcCom.BlockDiagramDebugInfoExport	{'true' }	"Bool"	""	"Export BlockDiagram debug info
ClassExportCfg{1}.TcCom.MonitorExecutionTime	{'false' }	"Bool"	""	"Monitor ExecutionTime"
ClassExportCfg{1}.TcCom.InputInitValues	{'false' }	"Bool"	""	"Input: Initial values"

Properties of the class TwinCAT.ModuleGenerator.ProjectExportConfig

`Project`

Structure with entries for configuring the build properties, the PLC library and the possible callbacks.

`Project.FullPath`

FullPath to the TwinCAT C++ project to be created.

`Project.VendorName`

Name of the Vendor. The Vendor Name is used to structure the TwinCAT objects. The vendor is created as a folder within the repository's path and becomes visible in the structure once the PLC library and the TcCOM object have been inserted.

`Project.IncrementVersion`

Possible values: "None", "Revision", "Build", "Minor", "Major"

Default value: "Revision"

This setting determines which of the four digits of the version number are incremented. The basis is the most recent version available on the engineering system (see `DrvFileVersion`).

`Project.DrvFileVersion`

Default: Search for the most recent version on the engineering system. If no existing version is found, it starts at 0.0.0.0.

Direct setting of a version: Can be set directly as a string, e.g. "1.52.32.0". `IncrementVersion` will then not be executed.

`Project.Publish`

If TRUE, the created TwinCAT C++ project is built for the configured platforms.

`Project.PublishPlatformtoolset`

This configures the Visual Studio version to use. This can be specified precisely or set to Auto (default).

`Project.PublishTcRTx86`

If TRUE, XAR is built on a Windows 32-bit platform.

`Project.PublishTcRTx64`

If TRUE, XAR is built on a Windows 64-bit platform.

`Project.PublishTcOSx64`

If TRUE, XAR is built on a TwinCAT/BSD platform.

`Project.SignTwinCatCertName`

A TwinCAT OEM certificate for driver signing can be specified here (not mandatory). The password is to be entered into the Windows Registry of the user with the TcSignTool. Detail see Initial setup of the software [▶ 12].

`Project.TmxArchive`

Enter a path and file name here as a string in order to create a TMX archive [▶ 39]. Example: Project.TmxArchive = “c:\archives\[Date]-[Time]-[LibName][LibVersion].exe” creates a self-extracting TMX archive under c:\archies. The placeholders are resolved in the module generator before the file is written.

`Project.GeneratePlcLibrary`

If TRUE, a PLC library (*.library) is created in the repository folder for the project.

`Project.InstallPlcLibrary`

If TRUE, the created PLC library is installed on the local TwinCAT XAE.

`Project.PreCodeGenerationCallbackFcn`

Here, a function can be called as a string to be called before code generation, i.e., before the TwinCAT C++ project is created.

For example, an m-file MyCallback.m can be created in the workspace with the following content:

```
function MyCallback(obj)
…
return
```

The PreCodeGenerationCallbackFcn property is then set to “MyCallback”. By default, the ProjectExporter object [▶ 39] is passed to the function, so that you have access to all data of the current project in the callback function.

`Project.PostCodeGenerationCallbackFcn`

Here, a function can be called as a string to be called after code generation, i.e., after the TwinCAT C++ project is created.

For example, an m-file MyCallback.m can be created in the workspace with the following content:

```
function MyCallback(obj)
…
return
```

The PostCodeGenerationCallbackFcn property is then set to “MyCallback”. By default, the ProjectExporter object [▶ 39] is passed to the function, so that you have access to all data of the current project in the callback function.

`Project.PostPublishCallbackFcn`

Here, a function can be called as a string to be called after the compilation, i.e., after the TwinCAT objects are created.

For example, an m-file MyCallback.m can be created in the workspace with the following content:

```
function MyCallback(obj)
…
return
```

The PostPublishCallbackFcn property is then set to “MyCallback”. By default, the ProjectExporter object [▶ 39] is passed to the function, so that you have access to all data of the current project in the callback function.

`Project.OemId` and `Project.OemLicenses`

Optionally, a generated TcCOM or a function block can be linked to an OEM license. This OEM license is checked when starting the object (in addition to the Beckhoff runtime license TC1220 or TC1320) in TwinCAT 3. If no valid license is available, the module does not start up and an error message appears.

Instructions for creating and managing OEM certificates can be found under **TwinCAT3 > TE1000 XAE > Technologies > Security Management**.

You can insert your OEM License Check by naming your OEM ID and your license ID or multiple license IDs to be queried. You can find your OEM ID in the Security Management Console (Extended Info activated). The license ID can be viewed by double-clicking on the corresponding license entry in TwinCAT under **System > License**. Both IDs are also included in the generated License Request File when a Request File is generated with your OEM license.

Example entry:

```
exportConfig.Project.OemId = '{ABBAABBA-AFFE-AFFE-AFFE-ABBABBAABBAA}';

exportConfig.Project.OemLicenses = '{11111111-0000-FEFE-CCCC-BBBBBBBBBBBB}';
```

`ClassExportCfg`

Cell array of the added export configurations. Each export configuration, i.e. each converted MATLAB® function or each converted Simulink® model, can be configured individually.

`TcCom.Generate`

If TRUE, a TcCOM object is created that can be used in the TwinCAT XAE.

`TcCom.FpExceptionsForInit`

Options: CallerExceptions, ThrowExceptions, SuppressExceptions, LogExceptions, LogAndHold, LogAndCatch, LogAndDump, LogHoldAndDump, LogCatchAndDump

More in Exception handling [▶ 55].

`TcCom.FpExceptionsForUpdate`

Options: CallerExceptions, ThrowExceptions, SuppressExceptions, LogExceptions, LogAndHold, LogAndCatch, LogAndDump, LogHoldAndDump, LogCatchAndDump

More in Exception handling [▶ 55].

CallerExceptions: The settings of the caller are adopted, e.g. the task, another TcCOM, or the PLC.

`TcCom.ExecutionInfoOutput`

If TRUE, another output is created at the TcCOM with information in case of occurring exceptions. More in Exception handling [▶ 55].

`TcCom.OnlineChange`

If TRUE, the TcCOM can be replaced by Online Change while TwinCAT XAR is in Run mode. See also Online Change for Target for Simulink®.

`TcCom.TcComWrapperFb`

If TRUE, a TcCOM-Wrapper-FB is created in the generated PLC library.

`TcCom.TcComWrapperFbProperties`

If TRUE, properties for module parameters are created at TcCOM-Wrapper-FB.

`TcCom.TcComWrapperFbPropertyMonitoring`

Options: NoMonitoring, CyclicUpdate, ExecutionUpdate

Specifies the monitoring attribute of the properties. In the default case, “No Monitoring” is set, i.e. no attribute is set.

Setting in MATLAB	Attribute on property
ExecutionUpdate	{attribute 'monitoring' := 'variable'}
CyclicUpdate	{attribute 'monitoring' := 'call'}

`PlcFb.Generate`

If TRUE, a function block is created in the PLC library that can be used in the TwinCAT XAE.

`PlcFb. FpExceptionsForInit`

Floating Point Exceptions within the function block during the init stage can be set.

Options: CallerExceptions, ThrowExceptions, SuppressExceptions, LogExceptions, LogAndHold, LogAndCatch, LogAndDump, LogHoldAndDump, LogCatchAndDump

More in Exception handling [▶ 55].

`PlcFb. FpExceptionsForUpdate`

Floating Point Exceptions within the function block during the update stage can be set.

Options: CallerExceptions, ThrowExceptions, SuppressExceptions, LogExceptions, LogAndHold, LogAndCatch, LogAndDump, LogHoldAndDump, LogCatchAndDump

More in Exception handling [▶ 55].

Creating and loading an export configuration

When using the TwinCAT Target for MATLAB®, the MATLAB® Coder™ is first used to generate C++ sources. These C++ sources can then be combined into an export configuration in the TwinCAT module generator by:

```
TwinCAT.ModuleGenerator.Matlab.FunctionExportConfig('MFile',Name,'BuildDir',cppDir)
```

The path to the C++ sources created by the MATLAB® Coder™ is passed as properties with `'BuildDir'` and the name of the MATLAB® function is passed with `'MFile'`. If, for example, BaseStatistics is selected as the name, the TcCOM object will have this name and the function block in the PLC will be given the name FB_BaseStatistics.

If the TwinCAT Target for Simulink® is used, the approach is somewhat different. Start the build process from Simulink® with the "Run the publish step after project generation" option disabled. Then load the created <modelname>_tcgrt folder as follows in order to add the C++ sources of the Simulink® model to the project export configuration.

```
TwinCAT.ModuleGenerator.ProjectExportConfig.Load(<modelname>_tcgrt);
```

Creating TwinCAT objects with the Module Generator

```
TwinCAT.ModuleGenerator.ProjectExporter()
```

`TwinCAT.ModuleGenerator.ProjectExporter()` triggers the build process for the platforms set in the `Project` property. The object of the class TwinCAT.ModuleGenerator.ProjectExportConfig is passed as argument. This creates a folder on the local file system in the repository and stores the created drivers and description files.

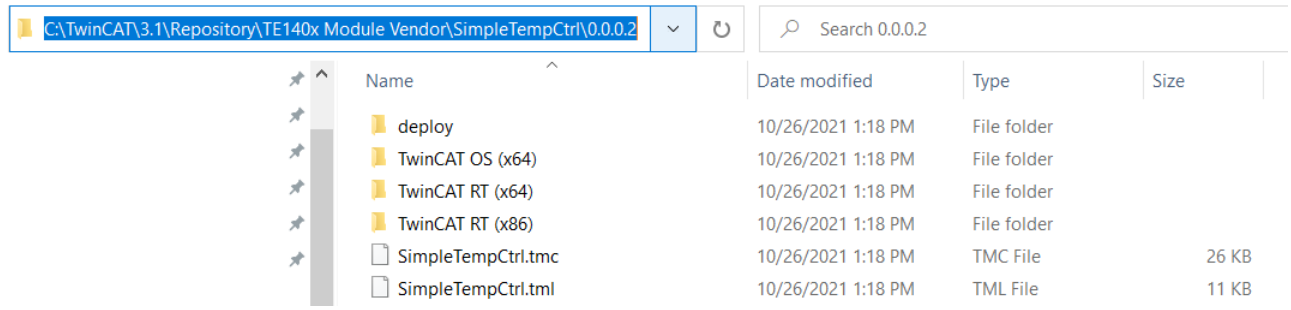
Example call:

```
projExporter = TwinCAT.ModuleGenerator.ProjectExporter(exportConfig);
```

7.1 Creating TMX archives

In order to be able to work with the created TwinCAT objects (TcCOM and PLC library) in TwinCAT XAE, they must be available in the repository folder on the local engineering PC and the PLC library must be installed in the local PLC Library Repository

For example the SimpleTempCtrl in version 0.0.0.2 is located here:



Manual copying to engineering PCs is error-prone. It is therefore easier to create a so-called TMX archive. The TMX archive is an archive of a newly created project, for example the SimpleTempCtrl in version 0.0.0.2. Only the archive has to be copied to an engineering PC and executed. It is a self-extracting archive, which then automatically copies all files to the correct location.

You can specify the path and name of the TMX archive under TC Build to have it created with the next build.

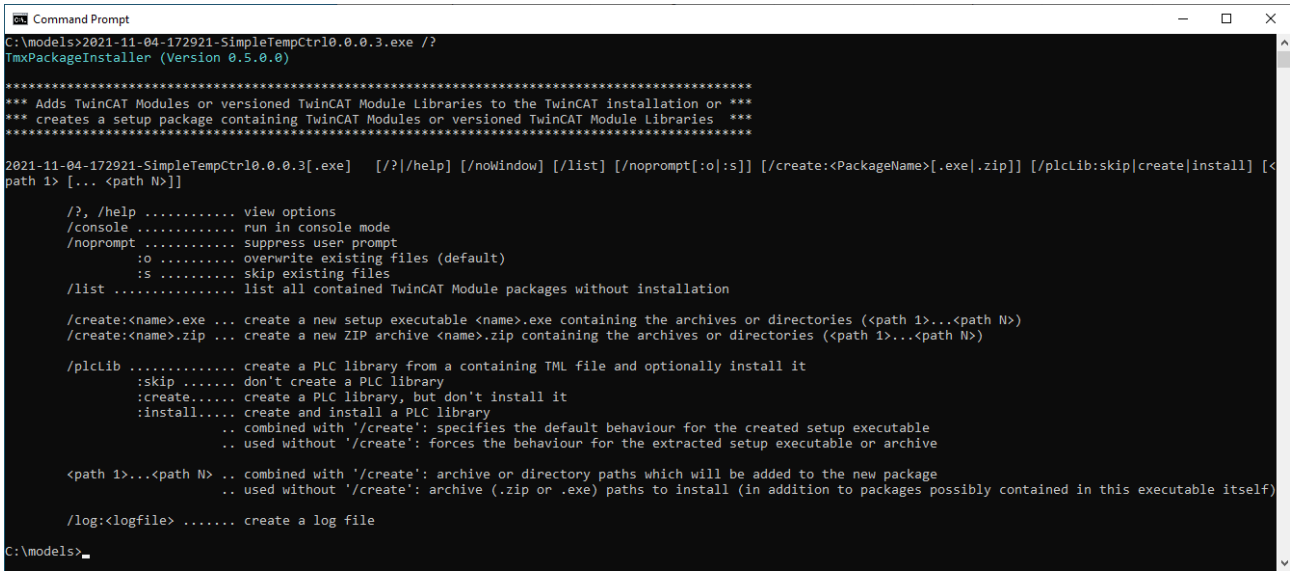
To do this, use the Project property of the module generator:

```
Project.TmxArchive = "c:\archives\[Date]-[Time]-[LibName][LibVersion].exe"
```

You can also use placeholders for the path and name as shown in the sample above. Result of this setting is e.g. a TMX archive 2021-11-04-172921-SimpleTempCtrl0.0.0.3.exe (new build, therefore revision incremented).

You can then copy the TMX archive to any path on an engineering PC and execute it. This will copy the files in the archive to the correct location in your repository.

You can also use the Command prompt, for example, and use other options:



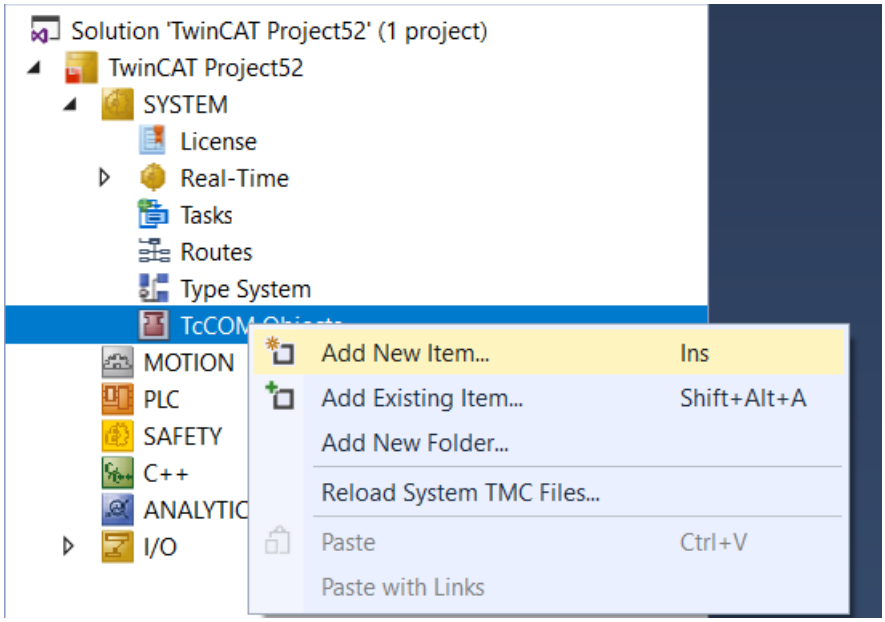
For example, the <tmxarchive>.exe /plclib:install command creates (from the *.tml file) and installs the PLC library on your local engineering PC.

8 Application of modules in TwinCAT

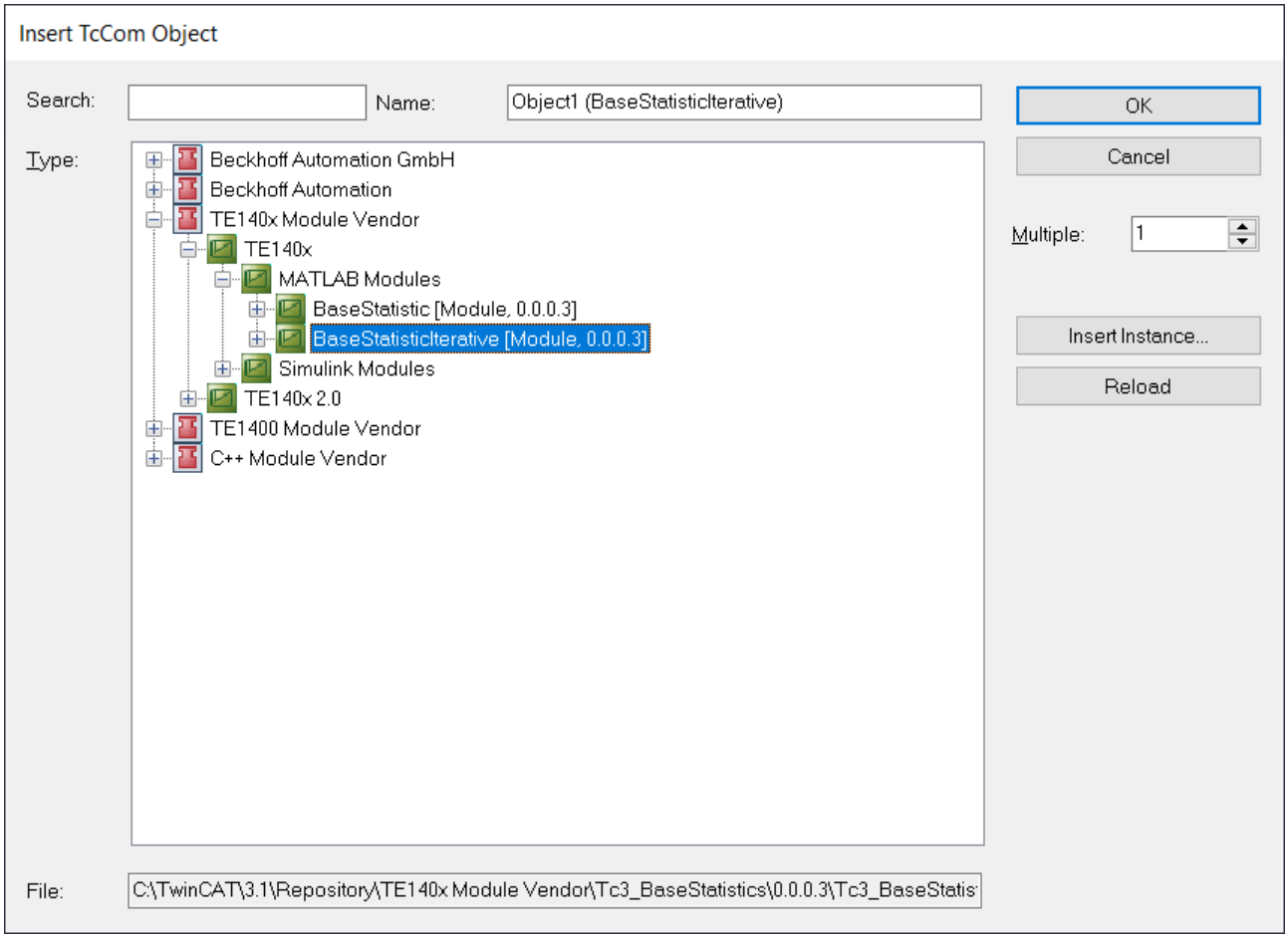
8.1 Working with the TcCOM module

Using TcCOM objects in TwinCAT 3

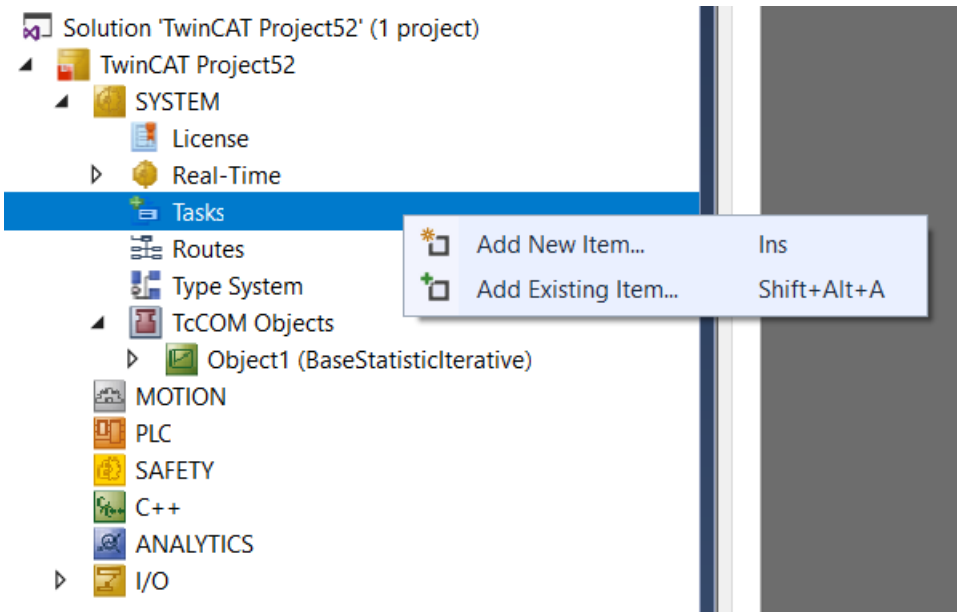
1. Insert a new TcCOM object.



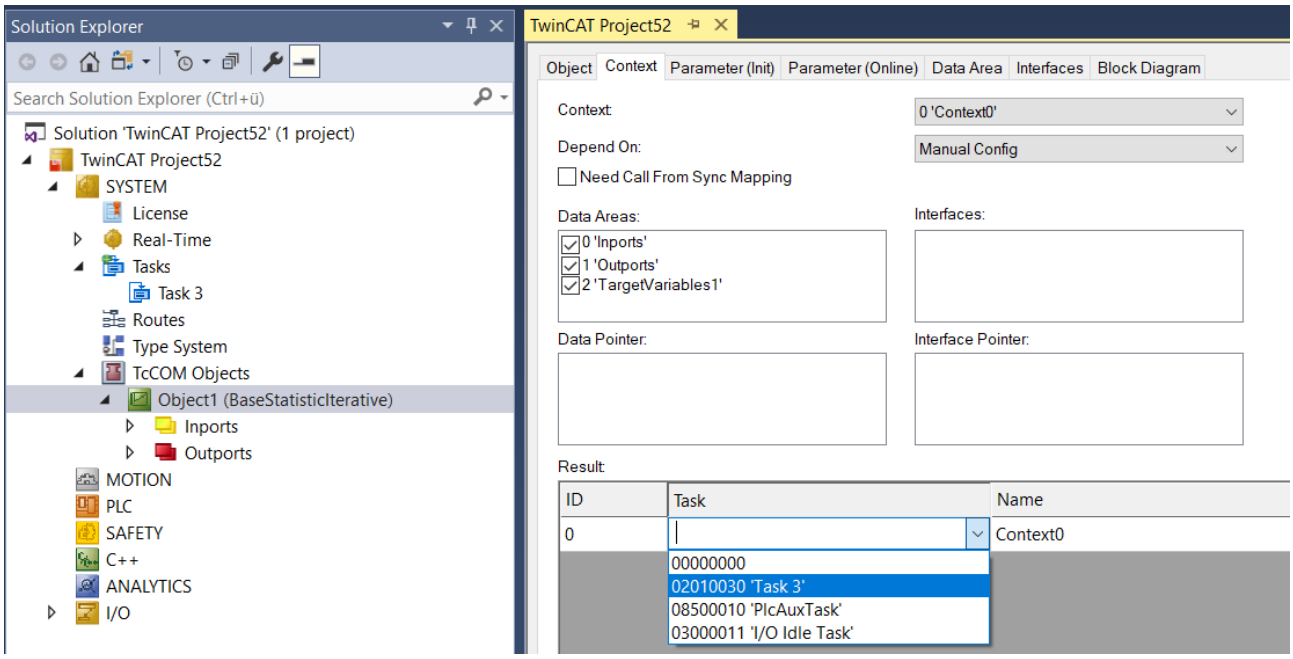
2. Select the corresponding TcCOM object:



3. Create a new cyclic task of type *TwinCAT Task.*



4. Assign the newly created task to the newly created TcCOM object. To do this, go to the instance of the TcCOM object and select the *Context* tab.



⇨ You can now activate the configuration. In order to connect the TcCOM object with other modules in your TwinCAT solution beforehand, you can use the process image to create mappings.

You can view the MATLAB® code on the Block Diagram tab and observe and scope values on the fly. See MATLAB code representation [▶ 43].

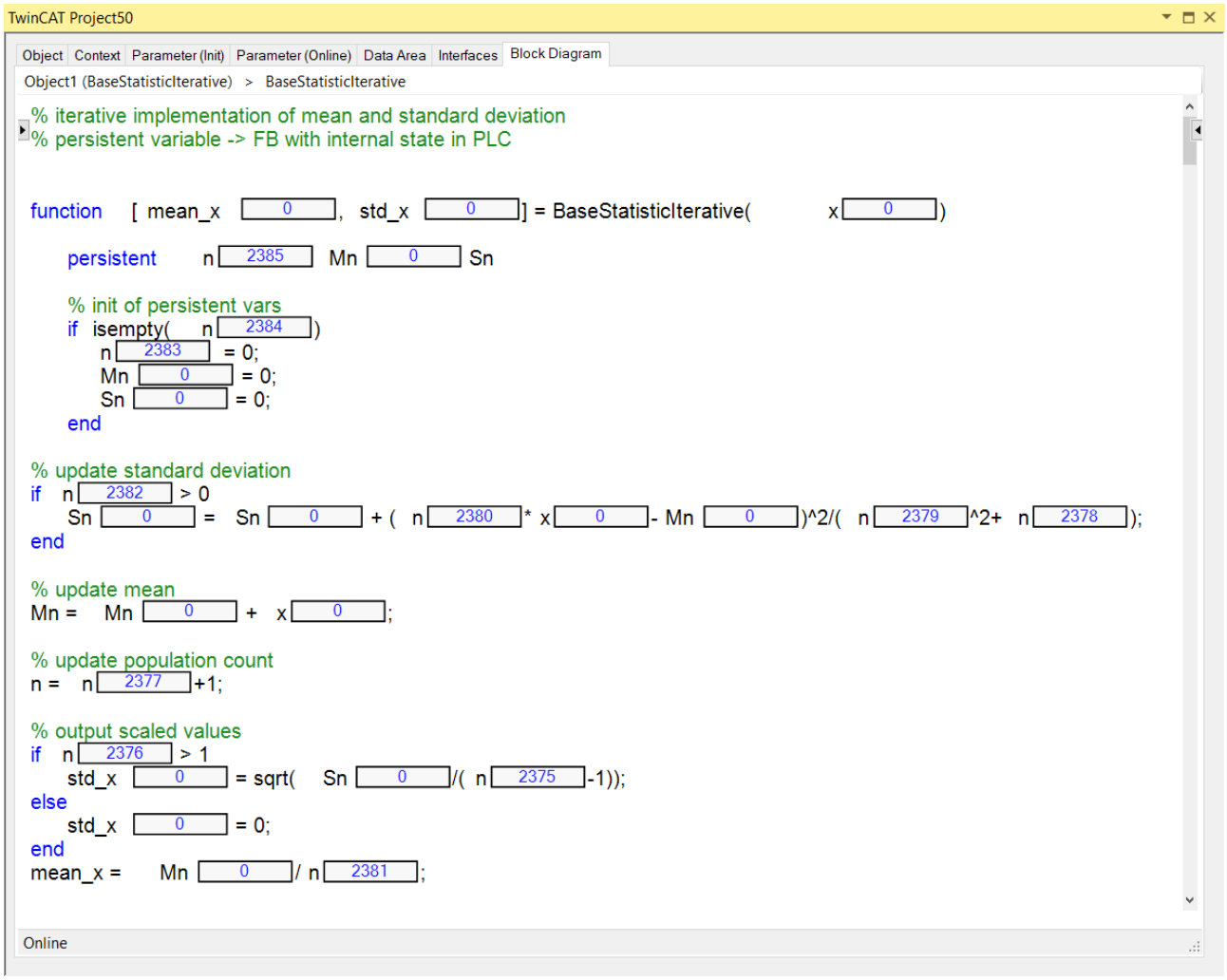
You can also call the TcCOM object from the PLC via the TcCOM wrapper FB or even instantiate it dynamically. For more, see: Calling a TcCOM object from the PLC [▶ 51].

Besides working with a TcCOM object, you can also use the functions created in MATLAB® directly as a PLC function block (PLC-FB) without having to worry about a TcCOM object. See: Working with the PLC library [▶ 46].

8.1.1 MATLAB code representation

8.1.1.1 MATLAB®-TcCOM

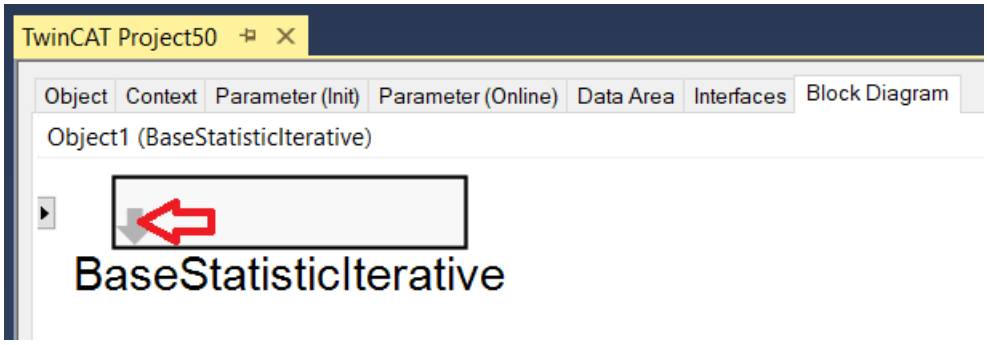
If a TwinCAT object was created with the TwinCAT Target for MATLAB® and the MATLAB® code export was executed, the MATLAB® code of the MATLAB® function can be displayed as a control in TwinCAT XAE.



8.1.1.1.1 Operation of the block diagram window

The export of the MATLAB® code can be configured during generation of a TcCOM module from MATLAB®. If the export was enabled, the code can be found in the TwinCAT development environment under the **Block Diagram** tab of the module instance.

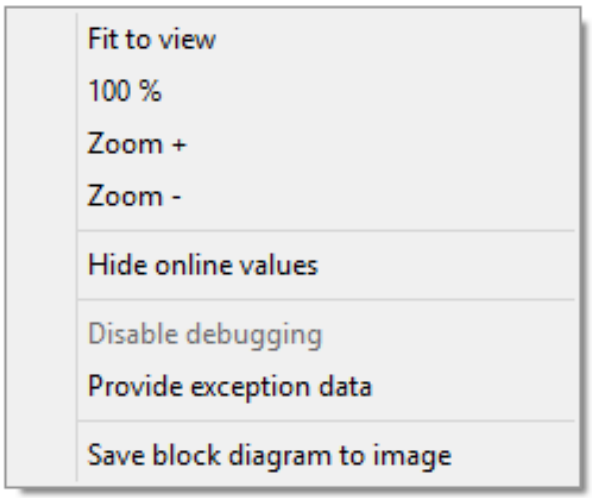
On the top level you will find the created module in block representation. Select the gray arrow in the block to display the content.



Shortcut functions:

Shortcut	Function
Space	Zoom to current size of the block diagram tab
Backspace	Switch to the next higher hierarchical level
ESC	Switch to the next higher hierarchical level
CTRL + "+"	Zoom in
CTRL + "-"	Zoom out
F5	Attach Debugger (*System- > Real-Time -> C++ Debugger -> Enable C++ Debugger* must be activated)

Context menu functions:

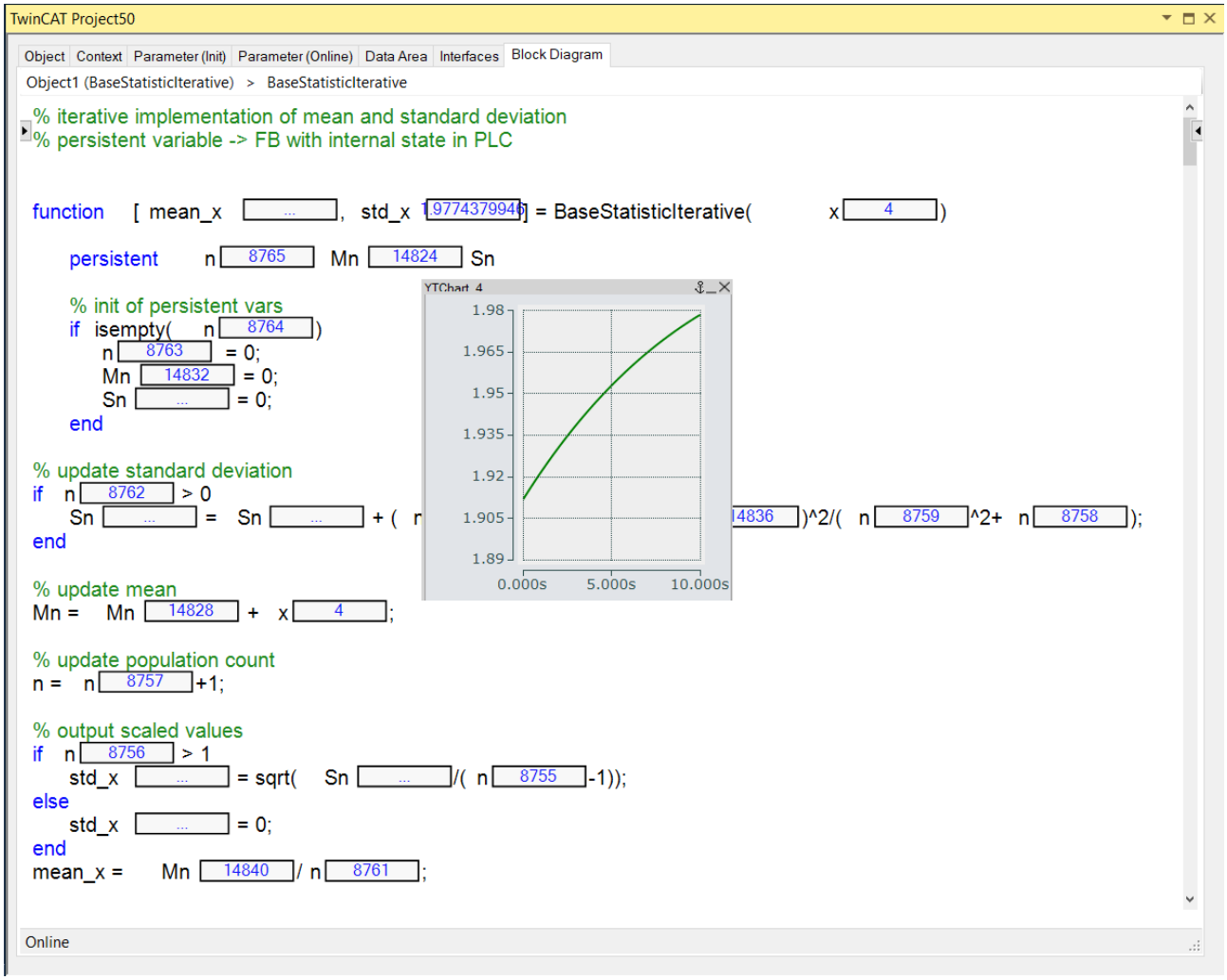


8.1.1.1.2 Display of signal curves

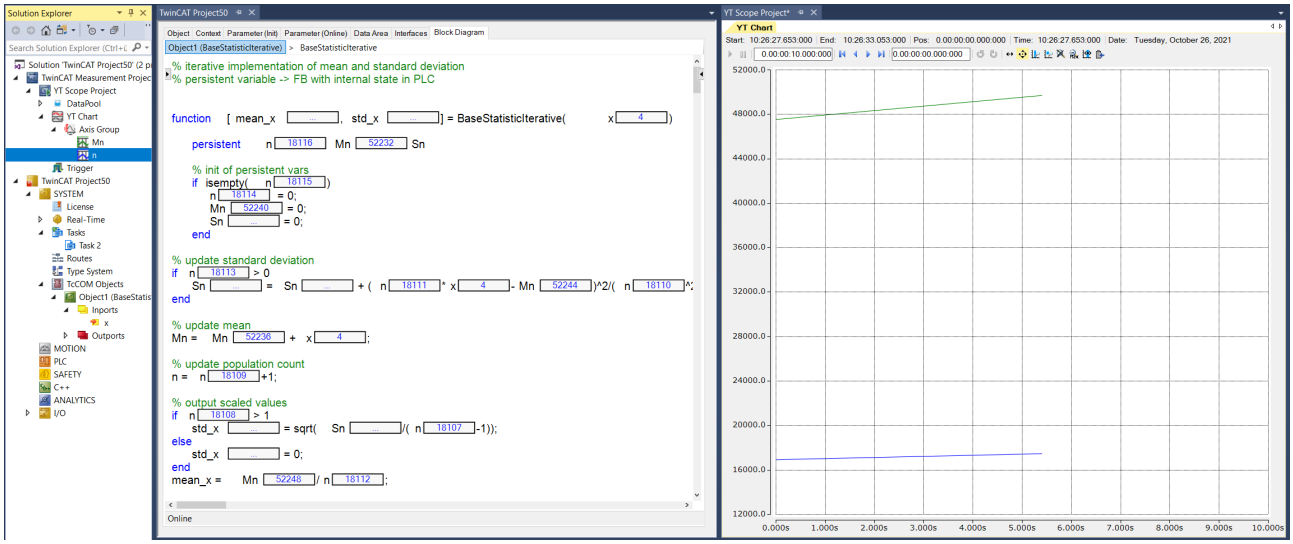
Selected variables can be retrieved in TwinCAT XAE via ADS. It is therefore possible to display them in a mini-scope within the block diagram, or with the TwinCAT Scope within a measurement project.

Variables that can be displayed in scope have a trailing black frame in the code display. In this frame, the values are displayed in blue during operation.

Drag&Drop a "blue variable" onto the block diagram window to open a Mini.Scope.



By dragging and dropping a "blue variable" onto the Axis Group of a chart in the TwinCAT Measurement project, the variables are added to the TwinCAT Scope.



Which variables are visible as "blue variables" in TwinCAT XAE?

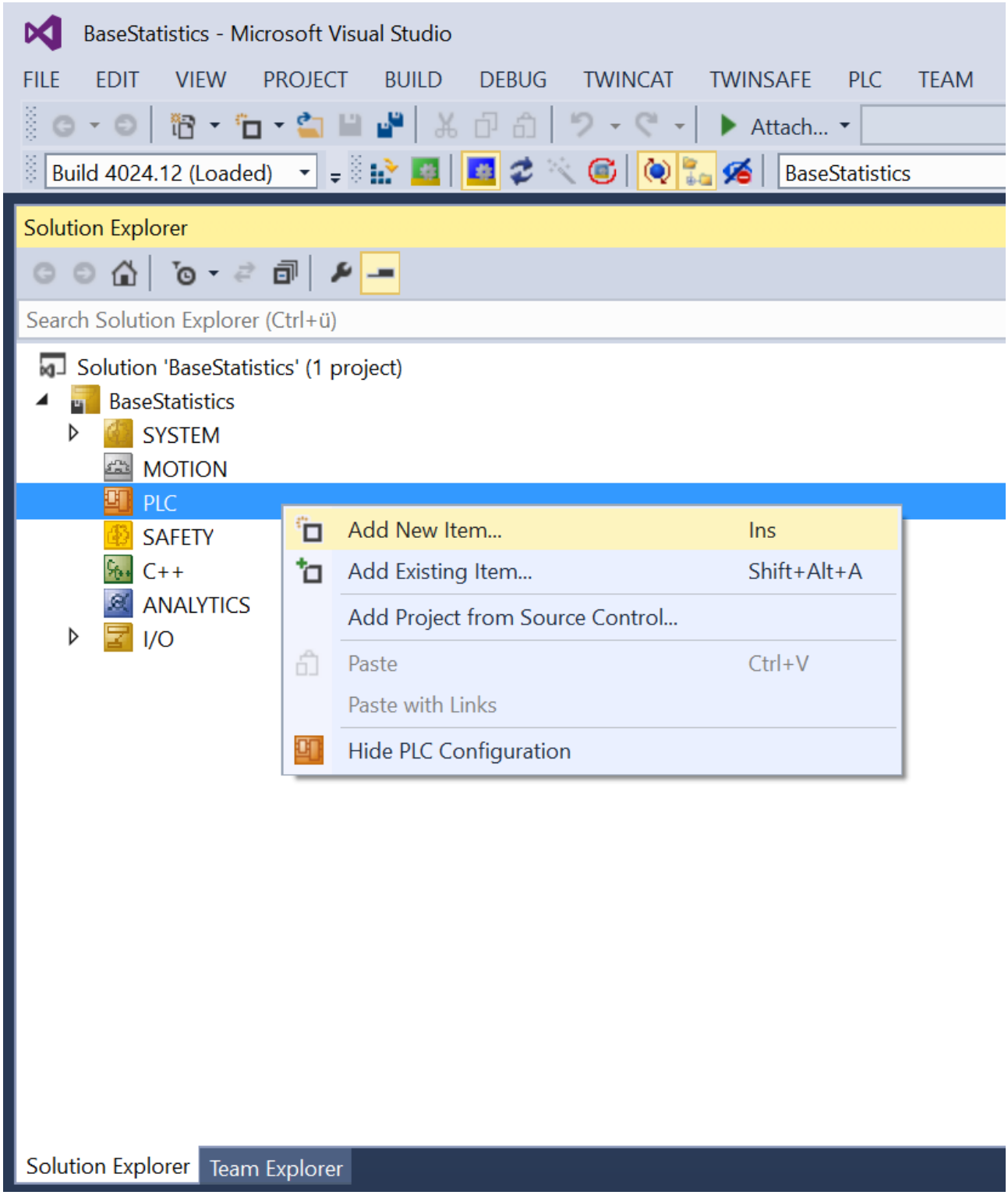
- The input variables
- The output variables
- Persistent variables (MATLAB definition `persistent var1 … varN`)

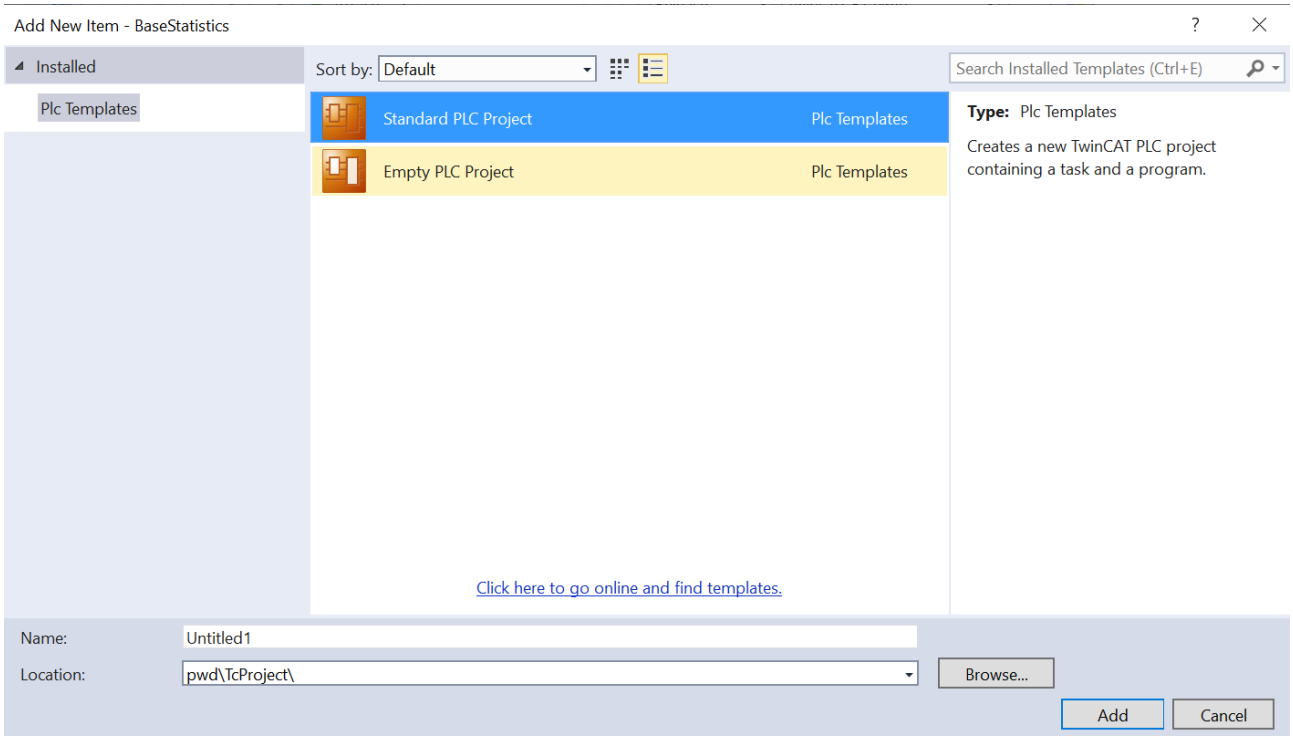
8.2 Working with the PLC library

Use PLC library in TwinCAT 3

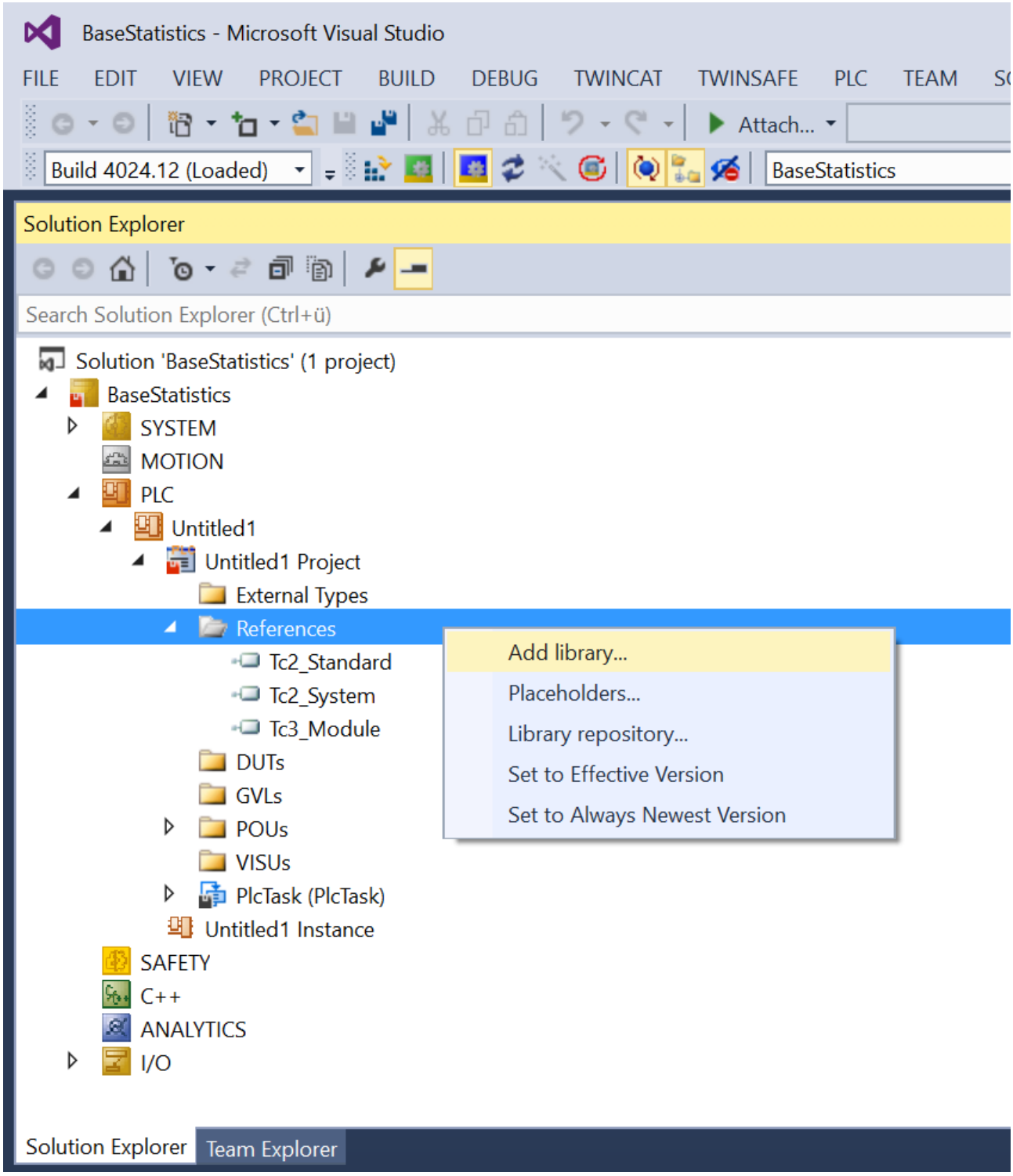
✓ Starting from a new TwinCAT solution, create a PLC project:

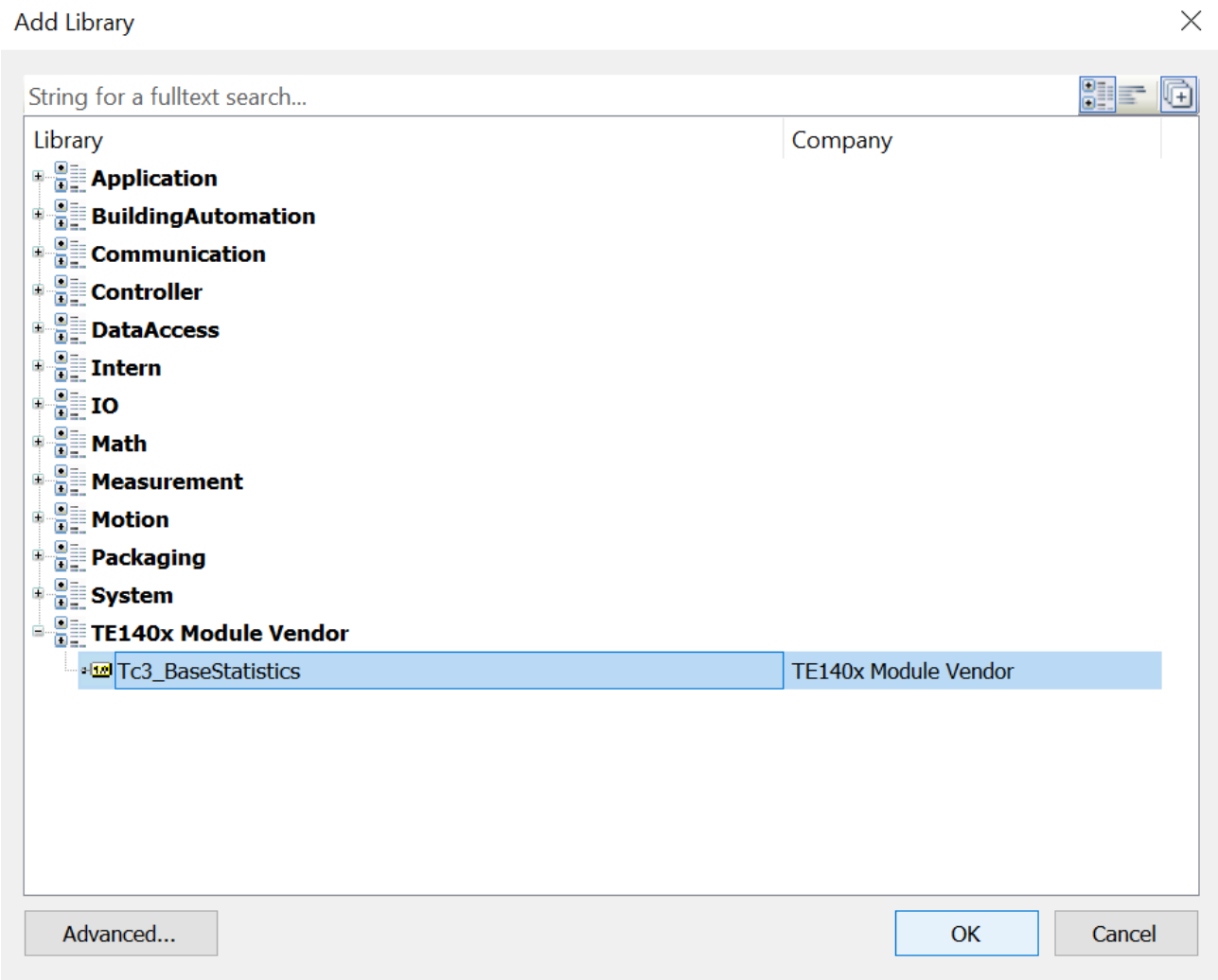
1. Perform the following menu steps.



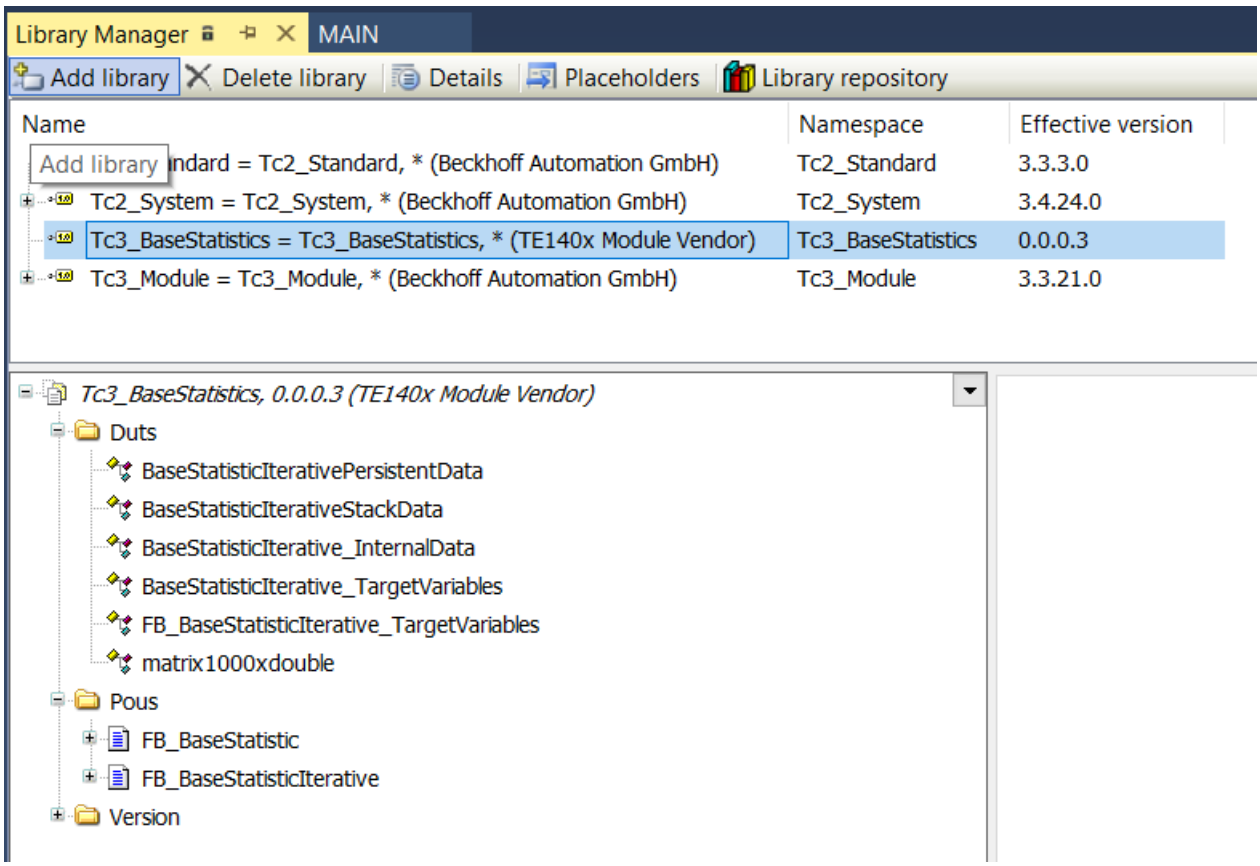


2. Then add the newly created (and already installed) PLC library:

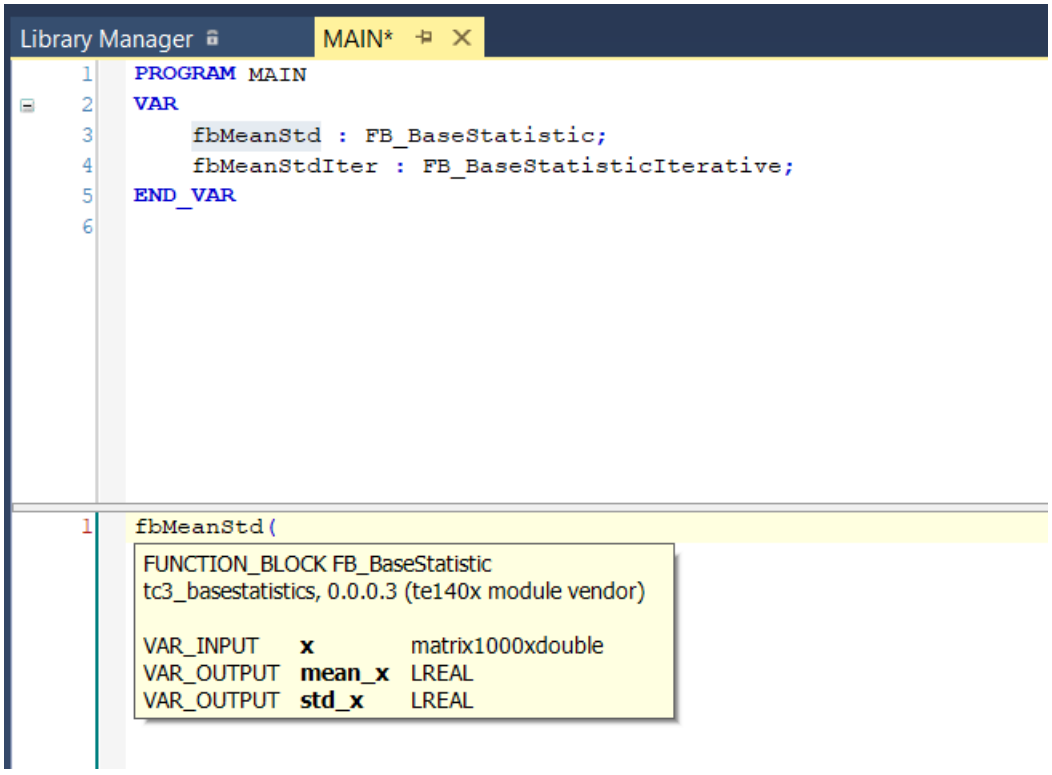

BaseStatistics - Microsoft Visual Studio
FILE EDIT VIEW PROJECT BUILD DEBUG TWINCAT TWINSAFE PLC TEAM
Attach...
Build 4024.12 (Loaded)
BaseStatistics
Solution Explorer
Search Solution Explorer (Ctrl+ü)
Solution 'BaseStatistics' (1 project)
BaseStatistics
SYSTEM
MOTION
PLC
Untitled1
Untitled1 Project
External Types
References
Tc2_Standard
Tc2_System
Tc3_Module
DUTs
GVLs
POUs
VISUs
PlcTask (PlcTask)
Untitled1 Instance
SAFETY
C++
ANALYTICS
I/O
Add library...
Placeholders...
Library repository...
Set to Effective Version
Set to Always Newest Version
Solution Explorer
Team Explorer



3. Get an overview of the data types and function blocks:



4. Insert instances of the function blocks into your PLC and use them in your application:



8.2.1 Online change of the PLC library

While TwinCAT is in run mode, you can exchange the PLC library version in TwinCAT XAE and load it into the running application via Online Change. This means that all function blocks in a PLC library can be updated without a TwinCAT restart.

Step-by-step procedure:

1. Create a first PLC library version with the TwinCAT Target for MATLAB®.
2. Include this PLC library version in a PLC project.
3. Activate your TwinCAT configuration with the first PLC library version (e.g. version 0.0.0.1).
4. Adapt your MATLAB function(s) and create a PLC library version (0.0.0.2) from it.
5. Select the newly created PLC library version in TwinCAT - PLC - **References** (you may have to install the new library on the XAE system).
6. Select **Build > Build Solution** to rebuild the project.
7. Select **Login > Login with online change** (more information in the PLC documentation).

8.2.2 Calling a TcCOM object from the PLC

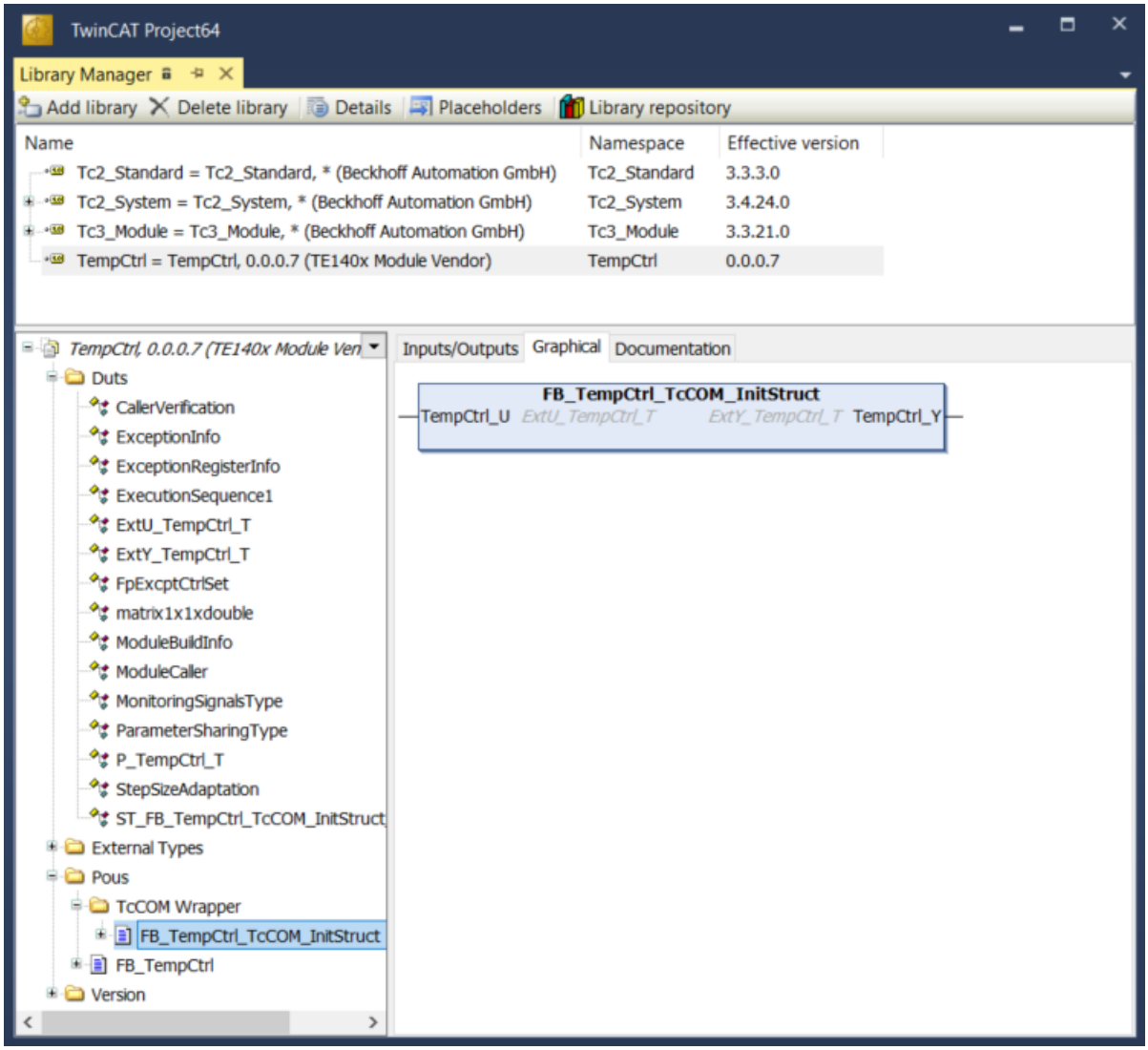
Creating a TcCOM wrapper FB

Set in the export configuration:

```
TcCom.TcComWrapperFb = 'true';
TcCom.TcComWrapperFbProperties = 'true'; % optional
```

Create instance of the TcCOM Wrapper function block

1. Create a PLC project.
2. Add the desired library under **References**.



⇨ Under **Pous/TcCOM Wrapper** you get a function block that you can instantiate in the PLC. In addition, necessary data types are created in the *Duts* folder.

Version 1: referencing a static module instance

The function block can be used to access module instances previously created in the XAE, e.g. under **System > TcCOM Objects**. For this static case, the object ID of the corresponding module instance must be transferred during declaration of the function block instance.

- The instance of the TcCOM object and the calling PLC must run in the same task.
- On the instance of the TcCOM object, make sure that under Parameter (Init) the entry *ModuleCaller* is set to *Module* and not to *CyclicTask.*
- In this case, the required memory for the TcCOM is obtained from the *non paged pool* of the system.

Declaration

```
// link wrapper with a static instance
InitStrStatic      : ST_FB_TempCtrl_TcCOM_InitStruct := (noid := 16#01010010);   // OID from object1
 in System > TcCOM Objects
fbTempCtrStatic    : FB_TempCtrl_TcCOM_InitStruct(InitStrStatic);
Inputs             : ST_TempCtrl_U_T;      // data type defined in TempCtrl library
Outputs            : ST_TempCtrl_Y_T;
```

Execution code

```
fbTempCtrStatic(stTempCtrl_U := Inputs, stTempCtrl_Y => Outputs);
```

Version 2: dynamic instantiation and referencing from the PLC

The function block can also be used in such a way that a TcCOM object is generated from the PLC and linked to the wrapper.

- The TaskOid of the PLC task must be used to specify the real-time task in which the wrapper is called.
- The ModuleCaller must also be set to *Module* here (via the Init structure).
- In this case, the required memory for the TcCOM is obtained from the router memory.

Declaration

```
// dynamic instance: create TcCOM from PLC
InitStrDyn          : ST_FB_TempCtrl_TcCOM_InitStruct := (
                        nTaskOid      := 16#02010030,             // take TaskOID of PlcTask
                        eModuleCaller   := E_ModuleCaller.Module );      // set module caller to "ca
ll by module"
fbTempCtrDyn        : FB_TempCtrl_TcCOM_InitStruct(InitStrDyn);
OutputsDyn          : ST_TempCtrl_Y_T;
```

Execution code

```
fbTempCtrDyn(stTempCtrl_U := Inputs, stTempCtrl_Y => OutputsDyn);
```

The source code for the graph shown above is available in MATLAB® via the Command Window

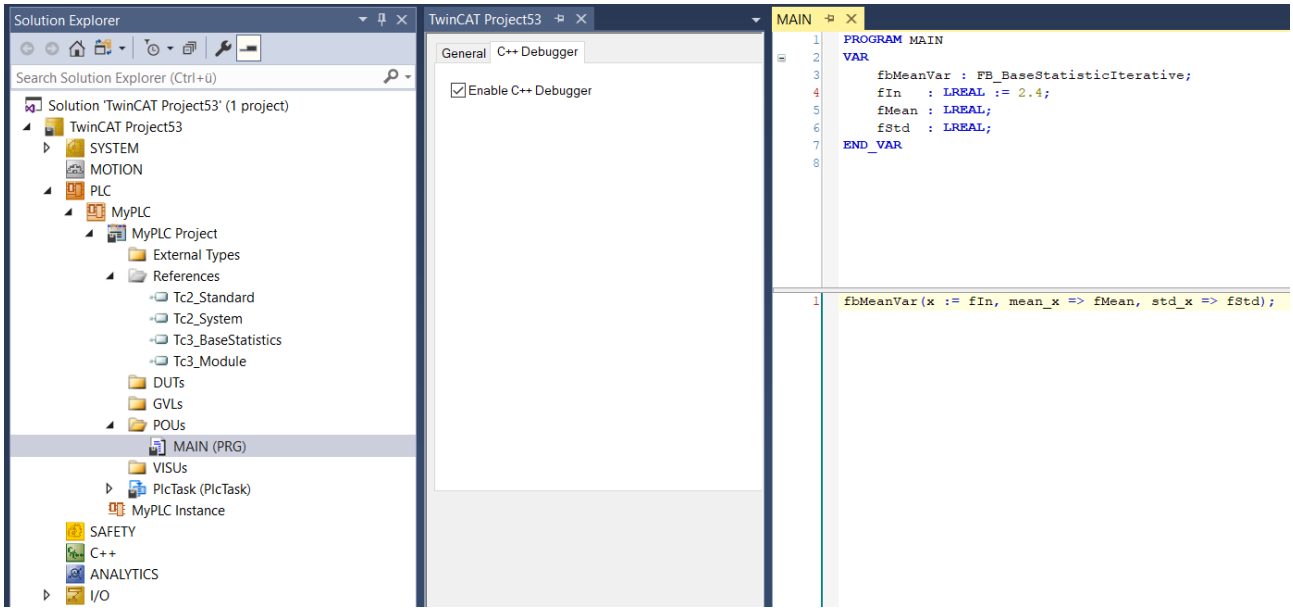
```
TwinCAT.ModuleGenerator.Samples.Start("TcCOM Wrapper Function Blocks")
```

8.3 Debugging

The following step-by-step instructions apply to the use of both TcCOM objects and function blocks created using the Target for MATLAB®. The following shows the debugging for a PLC function block.

✓ Step-by-step procedure:

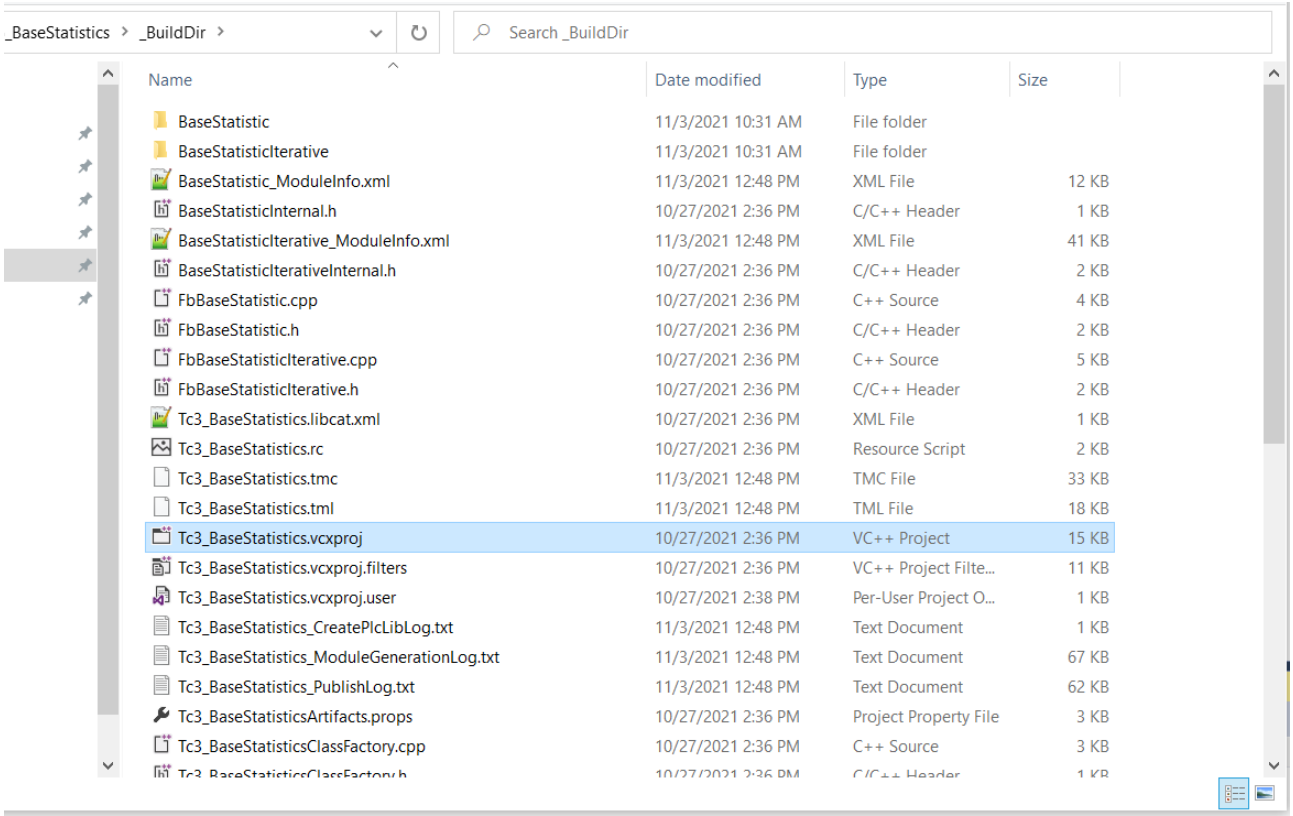
1. Make sure that your TwinCAT application has been activated with the C++ debugger enabled.



2. Open the TwinCAT C++ project created during code generation that belongs to the module you want to debug.

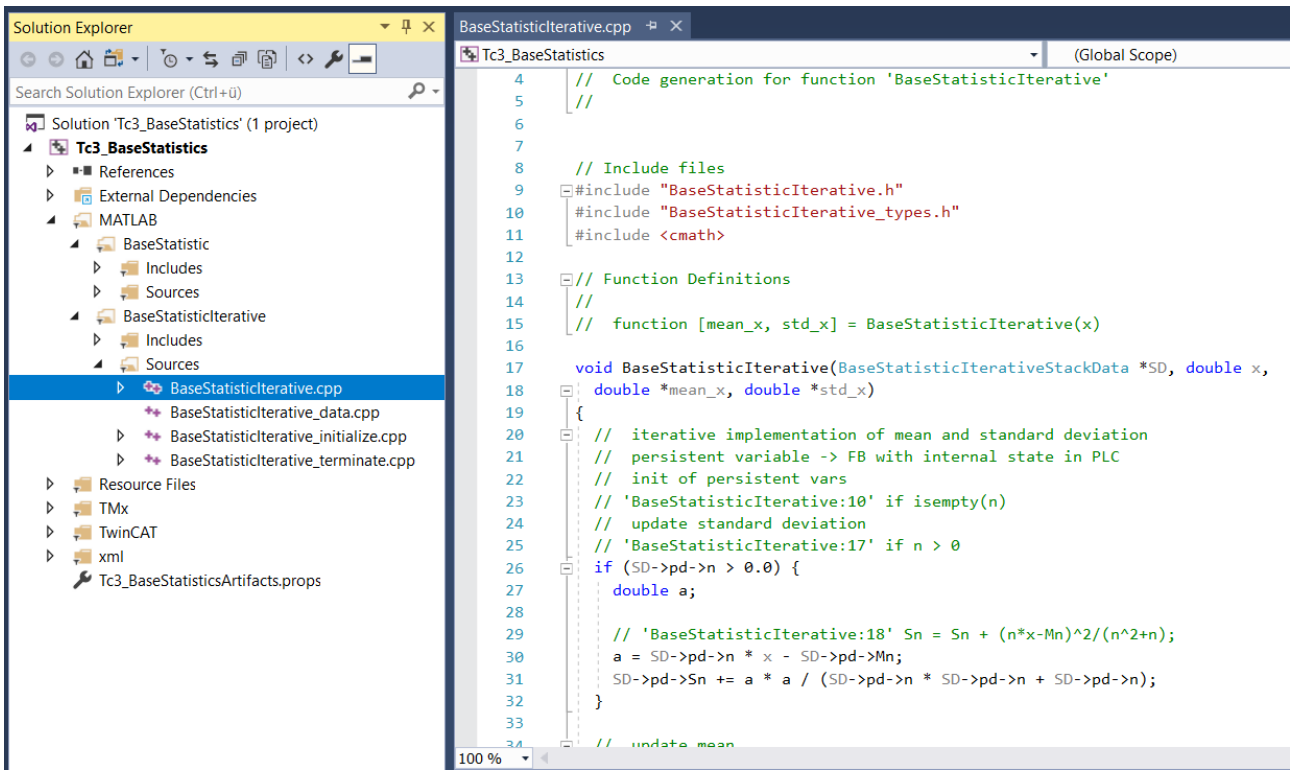
   ⇨ You specified the project location when initializing the project export configuration, see Generated Code TE1401 [▶ 33].

   ⇨ You can open the Visual Studio project directly or add it to your TwinCAT solution under C++ with “Add existing Item”.

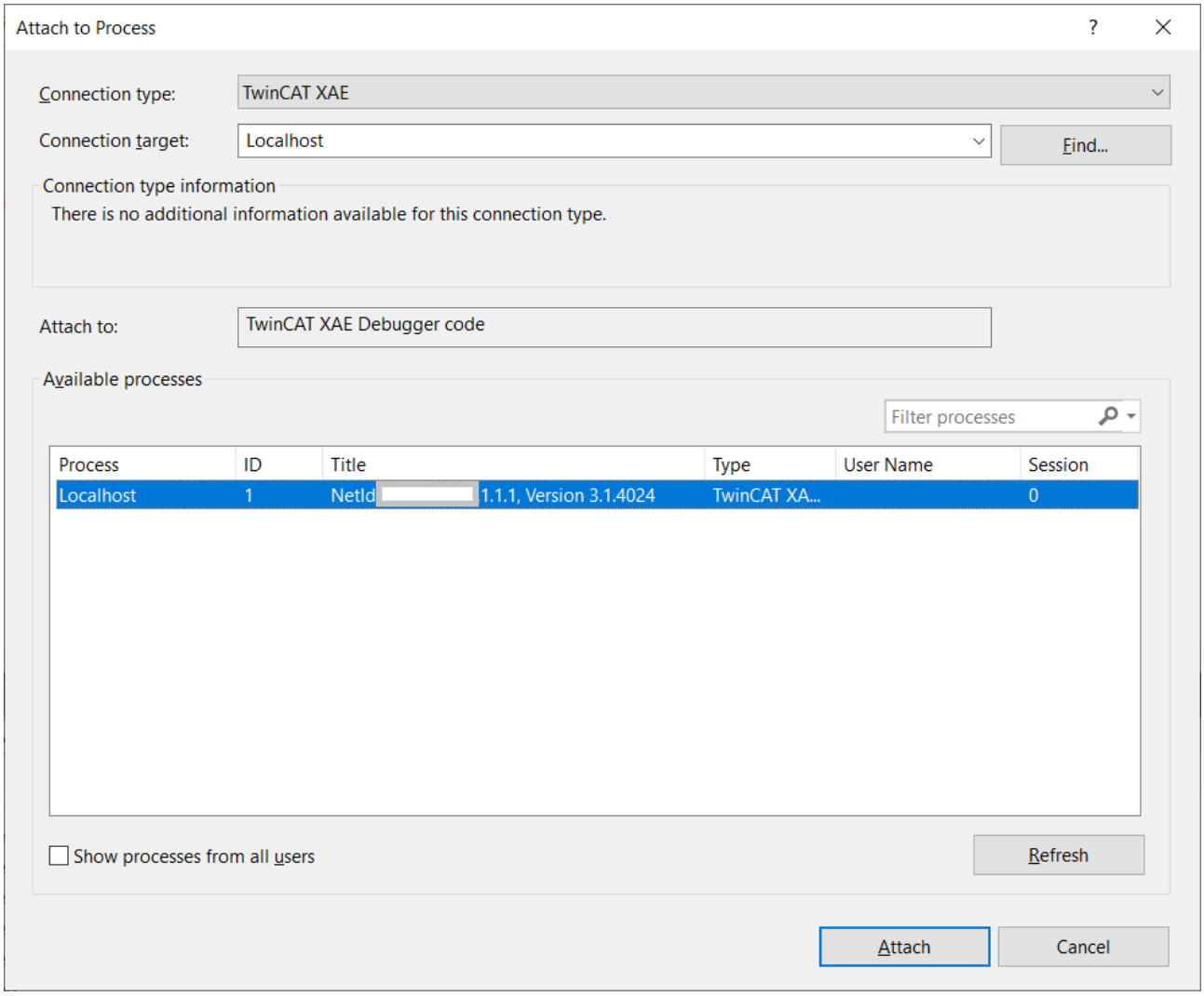


3. In the MATLAB® folder in the Visual Studio solution, view the subfolders that bear the name of the MATLAB® function created.

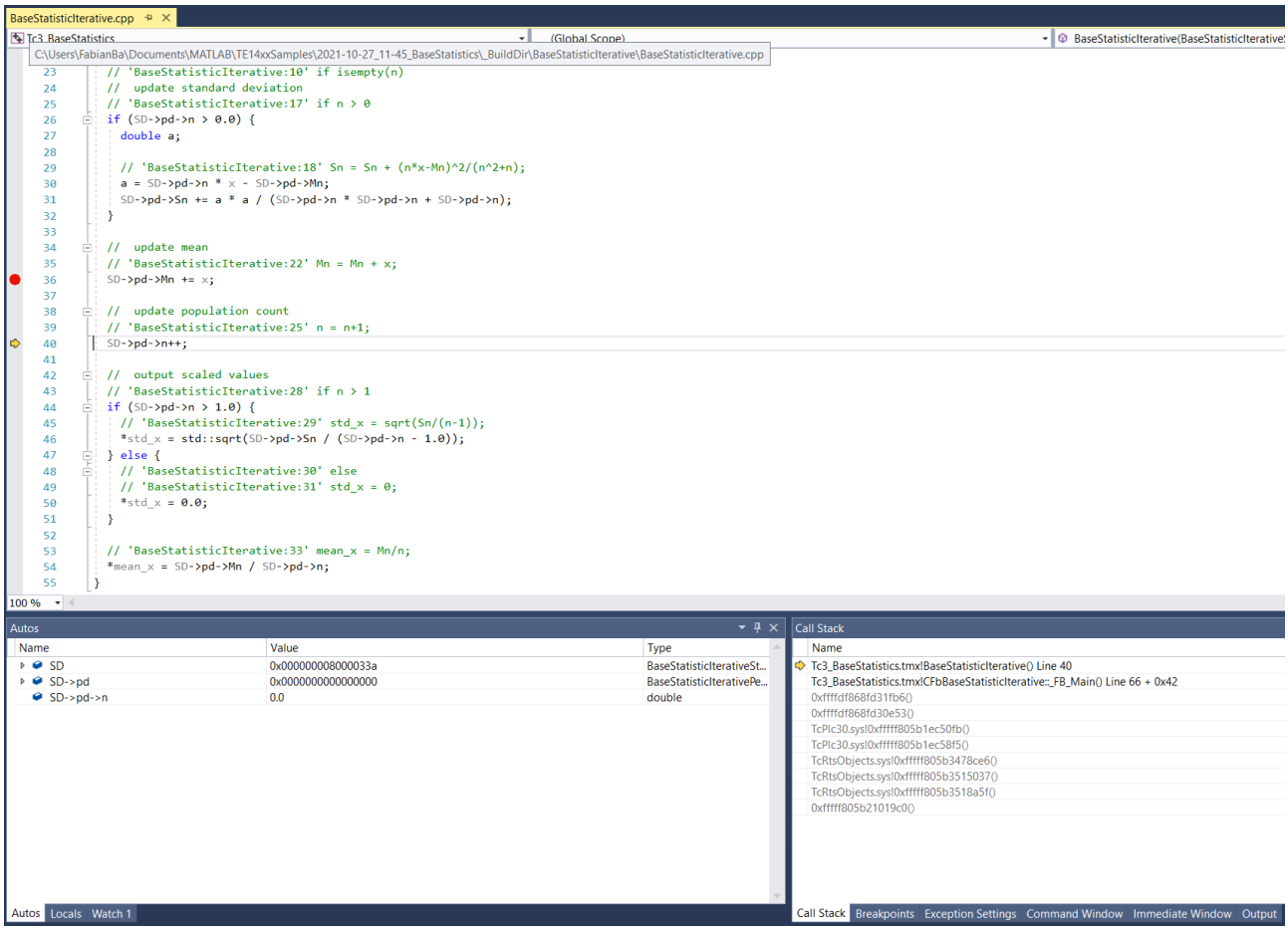
   ⇨ In the Sources sub-folder, you can find the executed code generated by MATLAB® Coder™.



4. Select **Debug > Attach to Process** in the menu bar, select “TwinCAT XAE” as the Connection Type, and the desired target system under Connection target. Then select **Attach**.



5. Set breakpoints in your C++ code and step through your code as usual.



8.4 Exception handling

When processing the C++ code autogenerated from MATLAB® or Simulink® in TwinCAT, floating point exceptions can occur at runtime, for example if an unexpected value is passed into a function during programming. The handling of such exceptions is described below.

What is a floating point exception?

A floating point exception occurs when an arithmetically not exactly executable operation is instructed in the floating point unit of the CPU. IEEE 754 defines these cases: *inexact, underflow, overflow, divide-by-zero, invalid-operation*. If one of these cases occurs, a status flag is set, which indicates that the arithmetic operation cannot be executed exactly. It is further defined that each arithmetic operation must return a result – one that in the majority of cases leads to the possibility of ignoring the exception.

For example, a division by zero results in +inf or -inf. If a value is divided by inf in the further code, this results in zero, so that no consequential problems are to be expected. However, if inf is multiplied or other arithmetic operations are performed with inf, these are *invalid operations,* whose result is represented as a Not-a-Number (NaN).

How does the TwinCAT Runtime react in case of exceptions?

TwinCAT C++ Debugger not active

The following explanations only apply if the C++ debugger is **not** activated on the TwinCAT runtime system. When the C++ debugger is enabled, exceptions are caught by the debugger and can be handled, see Debugging.

Default behavior

Default setting in TwinCAT is that at "divide-by-zero" and "invalid-operation" the execution of the program is stopped and TwinCAT issues an error message.

Task setting: Floating Point Exceptions

This default setting can be changed on the level of each TwinCAT task. If the checkbox "Floating Point Exception" is unchecked, an exception **does not** lead to a TwinCAT stop and **no** error message is issued. This setting is then valid for all objects that are called by this task. As a consequence, care must be taken in the application that NaN and inf values are handled accordingly in the program code.

Check for NaN and Inf

If, for example, a NaN is passed on via mapping to a TwinCAT object that has activated floating point exceptions, an arithmetic operation with NaN naturally leads to an exception in this object and subsequently to a TwinCAT stop. Therefore, NaN or inf must be checked directly after mapping. In the PLC, corresponding functions are available in the Tc2_Utilities library, e.g. LrealIsNaN.

Try-Catch statement

Another way to handle exceptions is to embed them in a try-catch statement. In the PLC the instructions __TRY, __CATCH, __FINALLY, __ENDTRY are available for this purpose. If floating point exceptions are enabled on the calling task and an exception occurs within the Try-Catch, it is caught in the Catch branch and can be handled. Accordingly, no variables are set to inf or NaN in this approach. However, it is also important to note that the code in the Try branch is run through only up to the point of the exception and then a jump is made to the Catch branch. In the application code, it should be noted that internal states in the Try branch may not be consistent.

Dump Files

From TwinCAT 3.1.4024.22 (XAR), dump files can be created at runtime in case of exceptions in the TcCOM object.

Specification of the behavior in case of exceptions on object level

In addition to the possibility of influencing the behavior in the event of exceptions at task level, the behavior can also be specified at the level of a TwinCAT object, i.e. the generated TcCOM or the generated PLC function block.

On the object level, a wealth of possibilities can be realized with the TwinCAT Target for Simulink®. Basically, however, all the options presented below are based on the above principles.

Optional ExecutionInfo Output

If exceptions are handled at object level, it makes sense to make corresponding information about occurred exceptions accessible at the object output. This output can be used to query whether an exception has occurred, what kind of exception it was, whether a dump file has been written, etc.

For the TcCOM object you can activate an additional output "ExecutionInfo [▶ 36]":

```
exportConfig.ClassExportCfg{nModuleCount}.TcCom.ExecutionInfoOutput = true;
```

ExecutionInfo Output for PLC-FB

Currently the ExecutionInfo is only available for the TcCOM object. If you want to call the code from the PLC, use the TcCOM-Wrapper-FB.

The ExecutionInfo output is a structure with the following entries:

ExcecutionInfo structure

Entry	Data type	Meaning
CycleCount	ULINT	Current cycle count (independent of an exception)
ExceptionCount	ULINT	Number of exceptions that have occurred so far
ActException	TcMgSdk.ExceptionInfo	More detailed explanation of the current exception (only first exception in the current cycle)

TcMgSdk.ExceptionInfo

ExceptionCode	DINT	Code of the exception, cf. Microsoft Help
TmxName	STRING(127)	Name of the tmx driver that threw the exception.
TmxVersion	ARRAY[0..3] OF UDINT	Version of the tmx driver that threw the exception.
InstructionAddr	UDINT	Relative address in memory; location where the exception occurred.
ReturnAddr	ARRAY[0..3] OF UDINT	Return addresses
DumpCreated	BOOLEAN	TRUE if a dump file was created for the exception.

With the *InstructionAddr* it is possible to judge if the exception with the given *ExceptionCode* always occurs at the same place in the source code. If the *InstructionAddr* is the same for repeating exceptions, it always occurs at the same point in the code. Via *ReturnAddr* you can see where the calls came from that led to the location of the exception. So you can judge if the call that leads to the exception always takes the same call path. If the code is called from outside the Tmx driver, there is a 0 in the *ReturnAddr*.

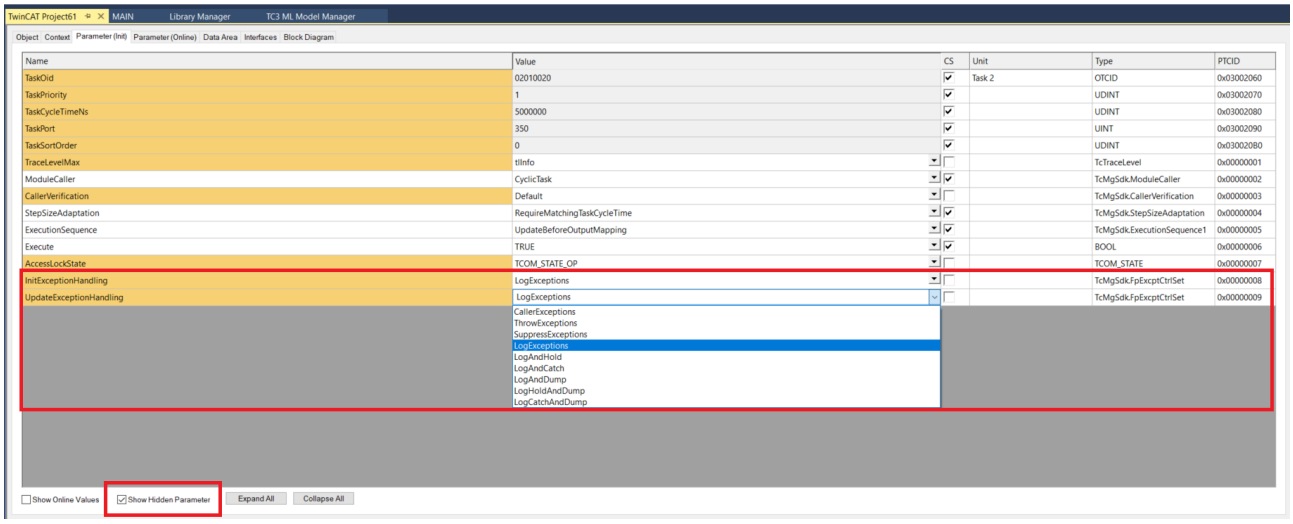
Definition of the object behavior in case of occurring exceptions

The behavior of a TcCOM object in case of exceptions can be set separately for the initialization phase and for the update phase under the properties of the class TwinCAT.ModuleGenerator.ProjectExportConfig:

```
exportConfig.ClassExportCfg{ nModuleCount }.TcCom.UpdateExceptionHandling = 'CallerExceptions';
exportConfig.ClassExportCfg{ nModuleCount }.TcCom.InitExceptionHandling = 'CallerExceptions';
```

Options are: `CallerExceptions, ThrowExceptions, SuppressExceptions, LogExceptions, LogAndHold, LogAndCatch, LogAndDump, LogHoldAndDump, LogCatchAndDump`.

If you are working with an already compiled TcCOM in TwinCAT, you can also change the settings on the object instance afterwards. To do this, use the tab **Parameters (Init)** and select **Show hidden Parameters**.



The settings for the PLC-FB FB_<ModelName> in the PLC library are independent of the settings for the TcCOM object.

`exportConfig.ClassExportCfg{nModuleCount}.PlcFb.UpdateExceptionHandling`

`exportConfig.ClassExportCfg{nModuleCount}.PlcFb.InitExceptionHandling`

Note that the other PLC function block (FB_<ModelName>_TcCOM) is a wrapper for a TcCOM object [▶ 51] and therefore the exception settings from the TcCOM section are valid when it is used.

A total of 9 different settings are available.

A total of 9 different settings are available.

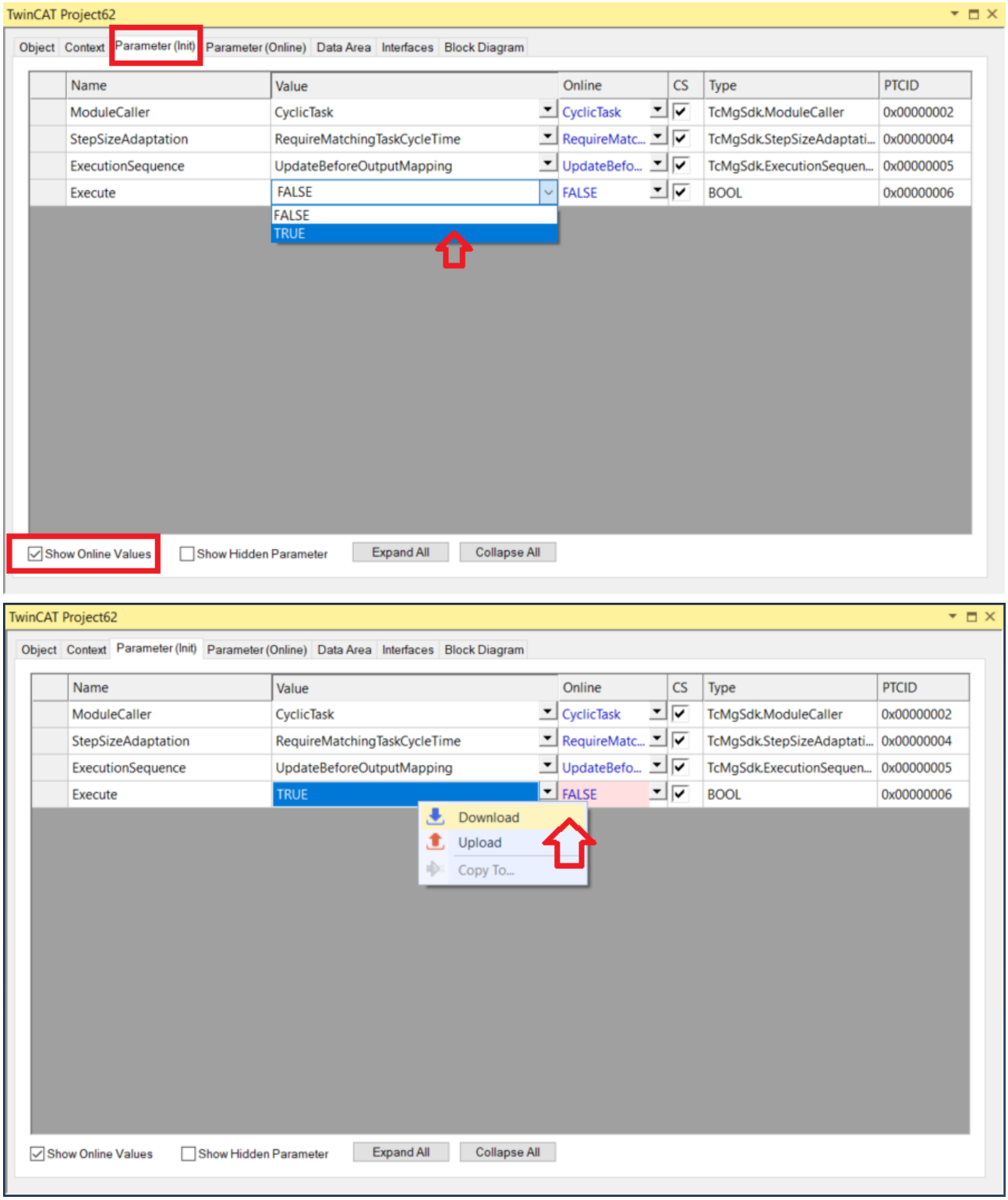
- **CallerExceptions** (default): Exceptions are thrown as configured at the calling task.
- **ThrowExceptions**: Exceptions in the TwinCAT object are thrown in any case, regardless of how the task is configured.
  - An exception causes a TwinCAT error message and a TwinCAT stop
- **SuppressExceptions**: Exceptions are not thrown, regardless of how the task is configured.
  - An exception does not cause a TwinCAT stop.
  - Outputs or internal states can be NaN or inf.
- **LogExceptions**: Exceptions are thrown, but do not lead to a TwinCAT stop.
  - An exception does not cause a TwinCAT stop.
  - Outputs or internal states can be NaN or inf.
  - The ExecutionInfo output is filled with information about an exception in the current cycle. If several exceptions occur in one cycle, only the first exception is displayed at the output. When the TwinCAT object is called again, the information is reset.
- **LogAndHold**: Exceptions are thrown. The execution of the TwinCAT object is stopped.
  - An exception does not cause a TwinCAT stop.
  - Outputs or internal states can be NaN or inf.
  - The ExecutionInfo output is filled with information about an exception in the current cycle. If several exceptions occur in one cycle, only the first exception is displayed at the output. When the TwinCAT object is called again, the information is reset.
  - The execution of the TwinCAT object is stopped after an exception occurs. TwinCAT itself remains in run mode. Restart execution: .
- **LogAndCatch**: Exceptions are caught with try-catch in the TwinCAT object. The execution of the TwinCAT object is stopped.
  - An exception does not cause a TwinCAT stop.
  - Outputs or internal states **cannot** contain NaN or inf.
  - The ExecutionInfo output is filled with information about an exception in the current cycle.
  - The execution of the code ends at the point of the exception. From there, the program jumps to the catch junction, i.e. internal states can be inconsistent.
  - The execution of the TwinCAT object is stopped after an exception occurs. TwinCAT itself remains in run mode. Restart execution: .
- **LogAndDump, LogHoldAndDump and LogCatchAndDump**
  - Behavior like LogExceptions
  - Additionally a dump file is stored on the runtime system in the TwinCAT folder *Boot*. For more on dump files, see here [▶ 61].

Handle execution stop of a TwinCAT object

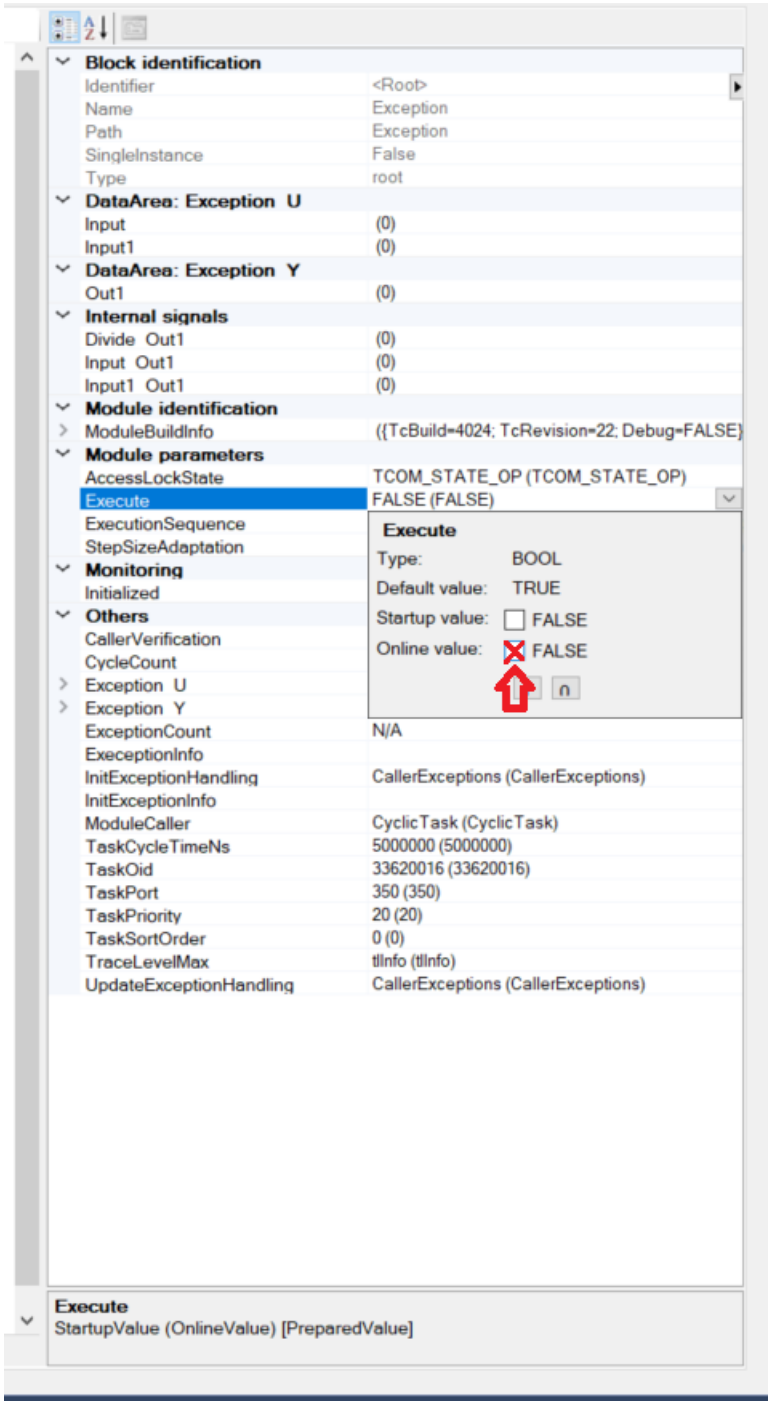
LogAndHold and LogHoldAndDump

In the event of an exception, execution of the code in the TcCOM object concerned is stopped by setting the Execute parameter to FALSE. The parameter can be read or written from the XAE and via ADS.

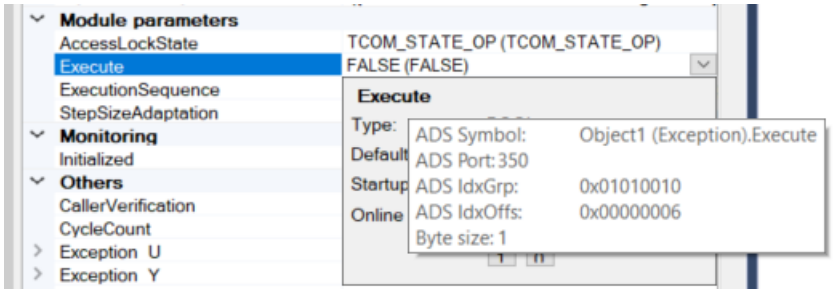
In the XAE, you can display and change the online values of the TcCOM object under Parameters (Init).



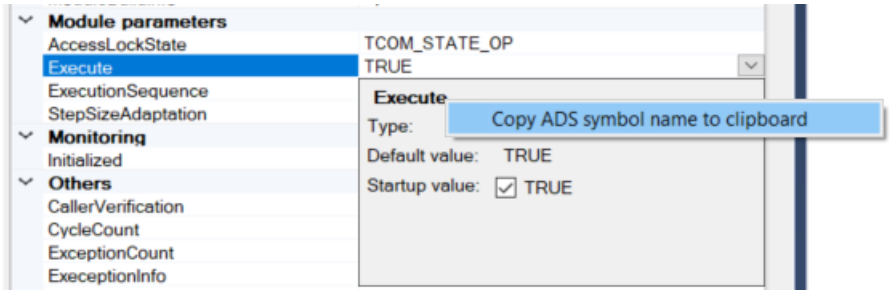
In the block diagram the parameter is offered to you under *Module parameters*.



If you move the mouse over the Execute name in the change dialog, you will be shown the ADS address of the parameter, as with all other parameters. This allows you to set the parameter also by ADS.



By right-clicking on the name **Execute** you can also save the ADS symbol information to the clipboard. This also applies to all other parameters.



LogAndCatch and LogCatchAndDump

In addition to the parameter *Execute*, the online parameter *Initialized* also changes to FALSE in the case of LogAndCatch and LogCatchAndDump. The module must be reinitialized before the module can perform a calculation again. This is necessary because internal states can no longer be consistent. Reinitialization can only be performed by returning the TcCOM object to the "Init" state and moving it to OP again.

At runtime, only TcCOM objects that have no mappings can be shut down, otherwise active mappings would block the shutdown. A new initialization is only possible by restarting the entire TwinCAT Runtime.

A more flexible alternative is to use the TcCOM-Wrapper-FB [▶ 51] in the PLC. This can be used to call the TcCOM from the PLC and does not require any mappings to access its inputs and outputs. Accordingly, the TcCOM object can also be reinitialized during runtime.

```
PROGRAM MAIN
VAR
   stInitTemp : ST_FB_SimpleTempCtrl_TcCOM_InitStruct := (nOid := 16#01010010);
   fbTempCtr  : FB_SimpleTempCtrl_TcCOM_InitStruct(stInitTemp);
   Inputs     : ST_ExtU_SimpleTempCtrl_T;
   Outputs    : ST_ExtY_SimpleTempCtrl_T;
   ExecutionOut : ST_ExecutionInfo2;
END_VAR
```

```
// check if TcCOM is in OP mode and all set
IF fbTempCtr.bExecute = TRUE AND fbTempCtr.bInitialized = TRUE AND fbTempCtr.nObjectState = TCOM_STA
TE.TCOM_STATE_OP THEN

    // call the module
    fbTempCtr(stSimpleTempCtrl_U := Inputs, stSimpleTempCtrl_Y => Outputs, stExecutionInfo => Execut
ionOut);

    // handle exceptions
    IF ExecutionOut.ActException.ExceptionCode <> 0 THEN
       // collect exception information
       (* ..... *)

       // reinit TcCOM
       fbTempCtr.Reinit(stReInit := stInitTemp);
    END_IF

 END_IF
```

Note that the ReInit method is executed synchronously, i.e. depending on the cycle time and the time required to reinitialize, cycle overruns may occur.

Dump files

Writing the dump file may take a few cycles. It is best to use a separate task for the TcCOM object or the PLC-FB in question that does not block any important tasks.

Dump files are only written with a TwinCAT XAR version >= 3.1.4024.22, otherwise you get a corresponding warning.

In the case of *LogAndDump* the execution of the code is continued cyclically after the occurrence of an exception, accordingly exceptions can occur cyclically which could lead to persistent cycle timeouts. Therefore, the online value of the parameter *UpdateExceptionHandling* is set to *LogExceptions* after the dump file has been written, i.e. the writing of dump files is deactivated, but can subsequently be switched on again, e.g. by ADS or intervention via the XAE under parameter (Init).

The created dump file is stored on the runtime PC in the boot folder and can be copied from there to another PC for analysis. If you use a TwinCAT version lower than 3.1.4024.x you can open the dump files with WinDbg and start your analysis.

8.5 Using Realtime Monitor time stamps

MATLAB® commands, such as tic and toc, are popular ways to analyze the performance of code sections in MATLAB®. These commands are not usable in this form during TwinCAT runtime.

For this purpose, TwinCAT provides the TwinCAT Realtime Monitor, which evaluates time stamps in the source code and displays them for analysis. Setting Realtime Monitor time stamps is supported in MATLAB® code, i.e. the time stamps are set in MATLAB® and can be evaluated by the Realtime Monitor after code generation and instantiation in TwinCAT. Running time stamps in MATLAB® results in output to the MATLAB® console.

Class: TwinCAT.ModuleGenerator.Realtime.LogMark

Methods: Start, Stop and Mark

MATLAB® documentation: `doc("TwinCAT.ModuleGenerator.Realtime.LogMark")`

Example in MATLAB®

```
TwinCAT.ModuleGenerator.Samples.Start("BaseStatisticsLogMark")
```

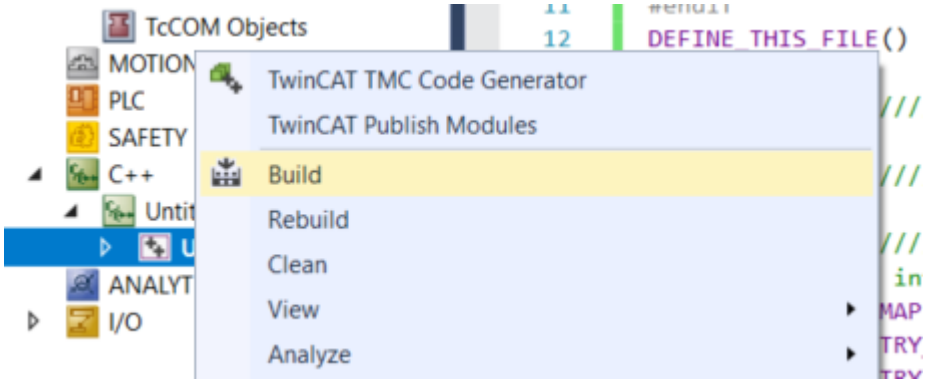
9 FAQ

9.1 Build of a sample fails

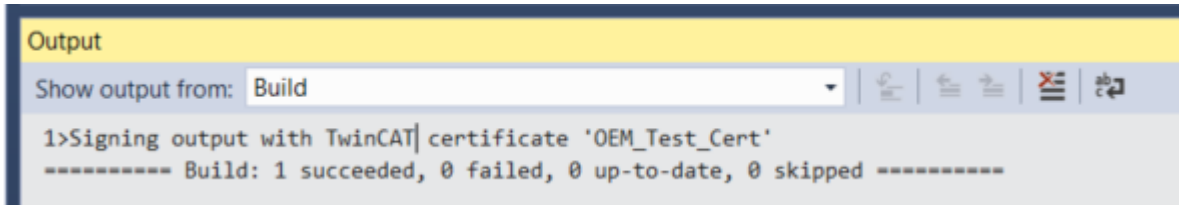
All samples supplied (list by `TwinCAT.ModuleGenerator.Samples.List` in the MATLAB® Command Window) have been checked by tests at Beckhoff Automation. If a build of a sample still does not run successfully, it is likely that something needs to be adjusted during setup on your engineering PC.

✓ To test the platform toolset without the influence of MATLAB® please create a TwinCAT Versioned C++ project in TwinCAT (open TwinCAT in Visual Studio) .

1. Right-click **Add New Item** on C++ Tree Item.
2. Then select **TwinCAT Module Class with Cyclic Caller**.
   ⇨ A C++ project appears in the TwinCAT Tree under C++.
3. Build the C++ project and view the Output Window in TwinCAT.



⇨ The output window should return "1 succeeded" for the build process. If this is not the case, check whether you have installed the **Desktop development with C++** option in Visual Studio.



9.2 Are there limitations with regard to executing modules in real-time?

Not all access operations possible in MATLAB® under non-real-time conditions can be performed in the TwinCAT real-time environment. Known limitations are described below.

- **Direct file access:**: Access to the IPC file system is restricted within the TwinCAT runtime. To read and write files from TwinCAT, use: fopen, fclose, fread and fwrite. See the example: `TwinCAT.ModuleGenerator.Samples.Show('FileAccess')`.
- **Direct hardware access**: Direct access to devices/interfaces requires a corresponding driver, e.g. RS232, USB, network interface card, etc. It is not possible to access the device drivers of the operating system from the real-time context. However, TwinCAT offers a wide range of communication options for linking external devices, see TwinCAT 3 Connectivity TF6xxx.
- **Access to the operating system API**: The operating system's API cannot be used directly from within the TwinCAT runtime. An example is the integration of *windows.h* in C/C++ code.
- **Precompiled libraries**: During code generation by the MATLAB® Coder™, it is possible that no platform-independent C/C++ code is generated, but precompiled libraries are included. Real-time execution in TwinCAT is not possible in these cases. The coder.HardwareImplementation setting helps determine if generic C/C++ code can be generated. For example

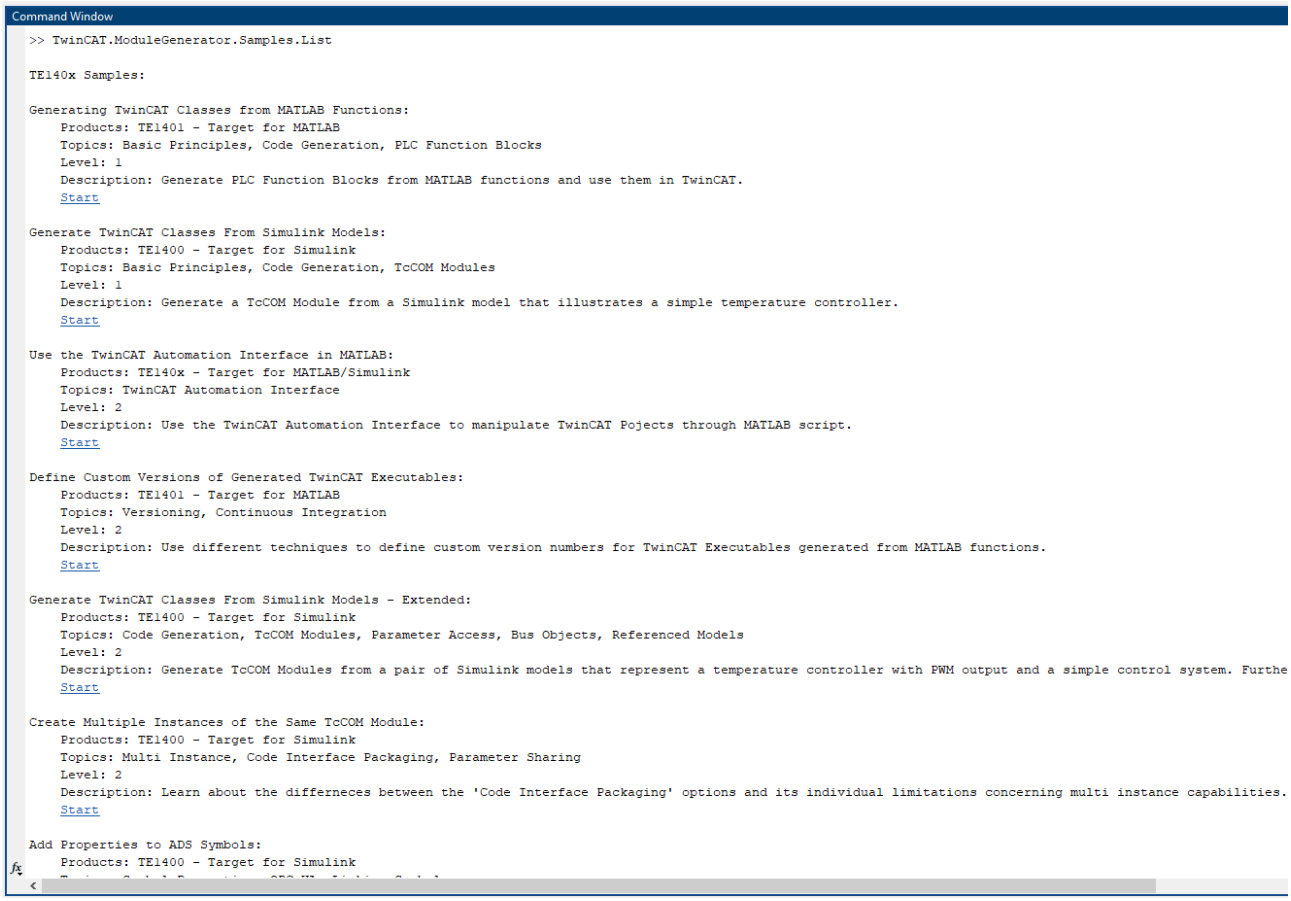
```
coder.HardwareImplementation.ProdHWDeviceType = 'Generic->32-bit x86
compatible'; and coder.HardwareImplementation.TargetHWDeviceType = 'Generic-
>32-bit x86 compatible';
```

10 Samples

Samples provided by Beckhoff Automation are installed on your system with the *TwinCAT Tools for MATLAB and Simulink* setup.

You can use the following command to display all available samples:

```
TwinCAT.ModuleGenerator.Samples.List
```



You can access the samples by clicking on the blue Start link. To do this, the sample code is copied to your user directory so that you do not change the original sample. You can work with the copy of the sample accordingly and try it out.

Also available are

```
TwinCAT.ModuleGenerator.Samples.Show(SampleName)
```

```
TwinCAT.ModuleGenerator.Samples.Start(SampleName)
```

For displaying and starting individual samples. The argument SampleName is to be passed as a string, e.g.

```
TwinCAT.ModuleGenerator.Samples.Start('BaseStatistics')
```

10.1 TwinCAT Automation Interface: use in MATLAB®

Short description of the Automation Interface

TwinCAT XAE configurations can be automatically generated and edited via programming/script codes using the TwinCAT Automation Interface. The automation of a TwinCAT configuration is available thanks to so-called Automation Interfaces, which can be accessed via all COM-capable programming languages (e.g. C++ or .NET) and also via dynamic script languages such as Windows PowerShell, IronPython or even the (obsolete) Vbscript. Use from the MATLAB® environment is also possible.

Detailed documentation of the product can be found here: TwinCAT Automation Interface

Use in MATLAB®

The Automation Interface can be made visible in MATLAB® through the command NET.addAssembly. This will enable you to use the interfaces (Automation Interface API) described in the product documentation. You can also find many programming samples for use from C# and PowerShell (Automation Interface Configuration).

In order to simplify the entry from MATLAB® for you, you can find below a sample implementation for MATLAB® on the basis of a MATLAB® class, which you can use, modify and expand.

10.1.1 Sample: Tc3AutomationInterface

Overview

The sample code consists of two m-files:

- *Tc3AutomationInterface.m*: MATLAB® class that implements several frequently used methods.
- *Tc3AutomationInterfaceGuide.mlx*: MATLAB live script that calls the MATLAB® class as an example.

> **Call sample with MATLAB®**
>
> The TwinCAT Tool for MATLAB® and Simulink® Setup installs the sample on your system. Call the sample with the MATLAB® Command Window:
> `TwinCAT.ModuleGenerator.Samples.Start('AutomationInterface').`

The MATLAB® script

The MATLAB® script provides a sample of how you can generate a TwinCAT solution, scan the EtherCAT master for I/Os, instantiate two TcCOM modules, link them and activate the project on a target.

In order to be able to run the script, the two TcCOMs used must be present in your *publish directory %TwinCATDir%\\CustomConfig\Modules*. For this, download the Temperature Controller sample from the TE1400 | Target for MATLAB®/Simulink®. Then copy the file folder from the directory . *\TE1400Sample_TemperatureController_PrecompiledTcComModules\Actual TwinCAT versions* into the *publish directory*.

Run the m-file *Tc3AutomationInterface_Testbench.m*. The latest Visual Studio instance available on your system is opened in the background and the TwinCAT solution is configured, saved and activated.

The MATLAB® class

The properties

All variables and interfaces belonging to the instance of the class are contained in the properties of the *Tc3AutomationInterface* class. Hence, several TwinCAT solutions can be built up in a MATLAB® script by generating an instance of the class for each solution. There are then no overlaps.

The constructor

```
function this = Tc3AutomationInterface
```

The constructor loads all necessary assemblies and, if successful, sets the AssembliesLoaded property to TRUE. The loaded assemblies are:

- EnvDTE and EnvDTE80: libraries for the Visual Studio Core Automation. Necessary for the configuration of Visual Studio.
- TCatSysManagerLib: TwinCAT Automation Interface library for the configuration of a TwinCAT solution in Visual Studio.
- TwinCAT.Ads: ADS library, e.g. for reading and changing the XAR state.
- System.Xml: library for parsing XML files.

Selected methods of the class

```
function TcComObject = CreateTcCOM(this, Modelname)
```

Use the MATLAB® help functions in order to view the function and the parameters of the method.

```
>> help Tc3_AI.CreateTcCOM
--- help for Tc3AutomationInterface/CreateTcCOM ---

  CreateTcCOM  creates a new instance of a TcCOM

    TcComObject = CreateTcCOM(Modelname)
    Instanciates the TcCOM with the specified name (Modelname).
    Also a task with a matching cycle time is created and linked to
    the TcCOM-Object.

    set properties: TcCOM

    see also:
    Beckhoff Infosys
```

A link to the Beckhoff Infosys is also offered with some methods. These refer to documentation examples from the TwinCAT Automation Interface documentation, so that you can directly view a comparison of the implementation in MATLAB®, C# and PowerShell. You can also find a link to the Beckhoff Infosys in the comment in some sections, allowing you to view the source of the information.

The CreateTcCOM method initially begins with the parsing of the *<modelname>.tmc* file, from which the ClassID, the task cycle time and the task priority are extracted with *System.Xml*. A corresponding TcCOM is then instantiated and one (or more) associated tasks generated with the Automation Interface. Finally, the task is/tasks are assigned to the TcCOM.

```
function ActivateOnDevice(this, AmsNetId)
```

TwinCAT ADS is used in order to query or change the current status of a TwinCAT runtime, e.g. config or run. In the ActivateOnDevice method the XAR is initially switched to the config mode with the specified AmsNetId and the current TwinCAT configuration is then activated and the system started. Pauses are entered between the individual steps, as this procedure may need a little time.

Static methods

Static methods are also available even without an instance of the class.

```
function vsVersions = GetInstalledVisualStudios
```

A function that detects and lists the Visual Studio installations available on the system via the Register Key entries is prepared here. The implementation is limited to VS 2010 to VS 2017.

Documents about this

https://infosys.beckhoff.com/content/1033/te1401_tc3_target_Matlab/Resources/5776206091.zip

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