BECKHOFF New Automation Technology

Manual | EN

TE1402

TwinCAT 3 | Target for Embedded Coder®



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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.

For installation and commissioning of the components, it is absolutely necessary to observe the documentation and the following notes and explanations.

The qualified personnel is obliged to always use the currently valid documentation.

The responsible staff must ensure that the application or use of the products described satisfies all requirements for safety, including all the relevant laws, regulations, guidelines, and standards.

Disclaimer

The documentation has been prepared 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. No claims to modify products that have already been supplied may 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 ma

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

Hazard with high risk of death or serious injury.				
Hazard with medium risk of death or serious injury.				
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.

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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 <u>https://www.beckhoff.com/secguide</u>.

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 <u>https://www.beckhoff.com/secinfo</u>.

1.4 Documentation issue status

Version	Modifications
1.0.0	First release

2 Overview

TwinCAT 3 TE1402 Target for Embedded Coder[®] is an extension of the TwinCAT 3 TE1400 Target for Simulink[®]. All features of the TwinCAT Target for Simulink[®] can be used.

In this documentation (TwinCAT 3 Target for Embedded Coder®) you will find restrictions and extensions of the TwinCAT Target for Simulink[®].

More Information

Documentation TwinCAT 3 TE1400 Target for Simulink®

3 Installation

The same installation and setup requirements apply as described in TwinCAT 3 Target for Simulink[®] for version 2.x.xxx.

Deviating and other installation requirements

- MATLAB[®] R2022b or higher
- MathWorks[®] Embedded Coder[™]

Installation for TwinCAT 3.1 Build 4026

Name in the UI: TE1402 | TwinCAT 3 Target for Embedded Coder®

Command line: tcpkg install TE1402.TargetForEmbeddedCoder.XAE

Installation for TwinCAT 3.1 Build 4024

The installation for TwinCAT 3.1 Build 4024 is part of the setup TwinCAT 3 Tools for MATLAB[®] and Simulink[®] and is installed automatically.

4 Licenses

In addition to the <u>TE1400 TwinCAT 3 Target for Simulink</u>[®] license, you need the TE1402 TwinCAT 3 Target for Embedded Coder[®] license on your **engineering PC**.

With regard to **TwinCAT runtimes**, the same licenses are required as for the TwinCAT 3 Target for Simulink[®]. This means that you do not need any additional runtime licenses if you already use TwinCAT objects in your runtime that were compiled with the TwinCAT 3 Target for Simulink[®] or TwinCAT 3 Target for MATLAB[®].

5 Parameterization in Simulink®

Using Embedded Coder® together with TwinCAT

Set the system target file to TwinCatErt.tlc.

Command Line Interface (CLI):

```
TwinCAT.ModuleGenerator.Simulink.ModelExportConfig.ShowModelParam(modelName,'Sys
temTargetFile','TwinCatErt.tlc');
```

Or in the User Interface (UI) via the *Configuration Parameters* in the Simulink[®] model at **Code Generation > System target file**.

© Configuration Parameters: sum_of_elements/Configuration (Active)							
Q Search							
Solver	Target selection						
Math and Data Types	System target file:	TwinCatErt.tlc		Browse			
 Diagnostics 	Description:	TwinCAT ERT Target					
Hardware Implementation	Shared coder dictionary:	<empty></empty>		Set up			
Model Referencing Simulation Target	Language:	C++		-			
▼ Code Generation	Language standard:	C++11 (ISO)		-			
Optimization Report Comments Identifiers Custom Code Interface Code Style Verification Templates Code Placement Data Tuno Benlacomont	Build process Generate code only Package code and ar Makefile configuration Generate makefile Template makefile: tcc Make command: make	tifacts ert_msbuild.tmf e_rtw					
TC General TC Build Code generation objectives							
TC PLC Library TC License TC TcCom General	Prioritized objectives: Un Check model before gene	ispecified erating code: Off	•	Set Objectives Check Model			
TC TcCom License TC TcCom Wrapper TC TcCom Additional s TC TcCom Interface TC TcCom External M •							
			OK Cancel	Help			

Sample in MATLAB®: SIMD instruction set extensions

In the "Simulink[®] Instruction Set Extensions" sample, you will learn how to create a Simulink[®] model with the TwinCAT 3 Target for Embedded Coder, which uses SIMD instruction set extensions to accelerate model execution time.

C Search	
Solver Data Import/Export Math and Data Types Diagnostics Hardware Implementation Model Referencing Simulation Target Code Generation Optimization Report Comments Identifiers Custom Code Interface Code Style Verification Templates Code Placement Data Type Replacement TC General TC Build TC PLC Library TC License TC TcCom General TC TcCom Interface TC TcCom Interface TC TcCom Interface	Default parameter behavior: Inlined Configure Target specific optimizations Leverage target hardware instruction set extensions: AVX Optimize reductions Optimize reductions Pass reusable subsystem outputs as: Individual argur SSE4.1 SSE2 Data initialization Remove root level I/O zero initialization Remove internal data zero initialization Optimization levels Levet: Maximum Priority: Balance RAM and speed Specify custom optimizations Details
	OK Cancel Help Appl

Make sure that the target system on which you want to execute the generated object supports the set instruction set extension. When the object is loaded, the TwinCAT runtime checks the availability of the instruction sets and compares them with the instruction sets used in the object. If the CPU does not meet the requirements, the object is not loaded and a corresponding error message is issued in TwinCAT XAE.

The model can be built after parameterization via **Apps > Embedded Coder > Generate Code**.

6 **Restrictions**

DSP System Toolbox™ AVX2 code replacement library

The DSP System Toolbox[™] AVX2 code replacement library requires the TwinCAT.XAE.PublicSDK >4.9.0 and is therefore limited to TwinCAT 3.1. Build 4026.

https://de.mathworks.com/help/dsp/ug/use-intel-avx2-code-replacement-library-to-generate-simd-code-from-simulink-blocks.html

SIMD for Arm[®]64 platforms

Neon instruction sets are only supported on MATLAB[®] R2024a. For R2014a, you must install the "Embedded Coder Support Package for Arm[®] Cortex[®]-A Processors" package via the MATLAB[®] Add-on Explorer (for Beckhoff Embedded PCs CX82xx and CX9240). From MATLAB[®] R2024b, it is no longer necessary to install the package separately.

Quick reference guide

1. Set the Device vendor and Device type to Arm[®] Compatible and Arm[®] Cortex[®]-A (64-bit) to generate the code specific for Beckhoff Embedded PCs CX82xx and CX9240.

🚳 Configuration Parameters: sum_of_elements/Configuration (Active) – 🗆 🗙						\times				
Q prodhw										
Solver Data Import/Export Math and Data Types	Hardware board: Determine by Code Generation system target file Code Generation system target file: <u>TwinCatErt.tlc</u>						•			
Diagnostics	Device vend	or: ARM	Compatible		•	Device type:	ARM Cortex-A	(64-bit)		•
Hardware Implementation	▼ Device de	tails								
Model Referencing Simulation Target	Number o	f bits					Largest atomic s	size		
▼ Code Generation	char:	8	short:	16	int:	32	integer:	LongLong		
Optimization Report	long:	64	long long:	64	float:	32	floating-point:	Double	Ŧ	
Comments	double:	64	native:	64	pointer	64				
Identifiers	size t	64	ptrdiff t	64						
Custom Code	0.20_0									
Interface	Byte ordering: Little Endian Signed integer division rou					ger division round	ds to: Zero	-		
Code Style	Shift right on a signed integer as arithmetic shift									
Verification										
lemplates	Suppo	nt long loi	ng							
Code Placement										
TC Build										
TC PLC Library										
TC License										
TC TcCom General										
TC TcCom License										
TC TcCom Wrapper										
TC TcCom Additional s										
TC TcCom Interface										
TC TcCom External M 👻										
							OK Car	ncel Help	Ар	ply

2. Select "Neon v7" as hardware instruction set extensions and activate "Optimize reductions".

Configuration Parameters: sum_of_							
Q prodhw							
Solver Data Import/Export Math and Data Types	Default parameter behavior: Inlined	Configure					
 Diagnostics Hardware Implementation Model Referencing Simulation Target Code Generation Optimization 	Leverage target hardware instruction set extensions: Neon v7 Optimize reductions Additional extensions: FMA	•					
Report Comments Identifiers Custom Code Interface Code Style	Pass reusable subsystem outputs as: Individual arguments Data initialization Remove root level I/O zero initialization Remove internal data zero initialization	•					
Verification Templates Code Placement Data Type Replacement TC General TC Build TC PLC Library TC License TC TcCom General TC TcCom License	Optimization levels Level: Maximum Priority: Balance RAM and speed Specify custom optimizations Details	T					
TC TcCom Wrapper TC TcCom Additional s TC TcCom Interface TC TcCom External M	OK Cancel Help	Apply					

3. Only select TwinCAT OS (Arm[®]V8-A) as the build platform.

Configuration Parameters: sum_of_elements/Configuration (Active)	_	×
Q prodhw		
Solver Data Import/Export Math and Data Types Diagnostics Hardware Implementation Model Referencing Simulation Target Code Generation Optimization Report Comments Identifiers Custom Code Interface Code Style Verification Templates Code Placement Data Type Replacement To E Build TC PLC Library TC ECom General TC TcCom Katernal M		
⇒ You can use this configuration to compile the Simulink [®] model.	тер	opiy

Ne10 Code Replacement Library

Currently not yet supported.

GenerateAllocFcn

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If Reusable code and GenerateAllocFcn=off are recognized, the Single Instance Limitation is activated. GenerateAllocFcn is set to off by default.

7 Support and Service

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