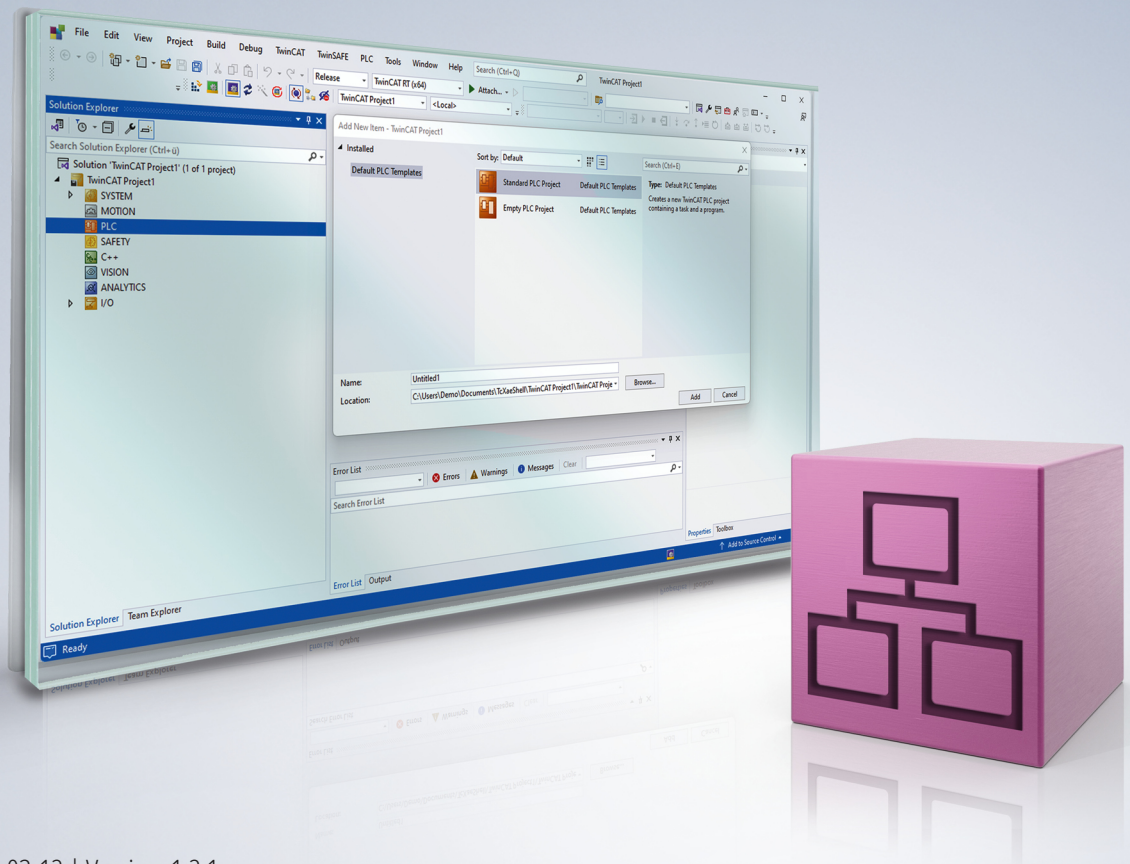
BECKHOFF New Automation Technology

Manual | EN

TF6225

TwinCAT 3 | EtherCAT External Sync



2026-03-12 | Version: 1.2.1

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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.
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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

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1.4 Documentation issue status

Version	Changes
1.2.x	TwinCAT 3.1 Build 4026 • Brief information on installation [▶ 10]

2 Overview

As a real-time software environment, TwinCAT offers the option of synchronization with an externally specified time, based on cycle/frequency or absolute time. Time access usually takes place via the EtherCAT fieldbus and the integrated distributed clocks functionality. The external time can be transferred to the TwinCAT system in different ways:

Method	Required devices
IEEE 1588, PTP	EL6688 EtherCAT Terminal
EtherCAT <-> EtherCAT	EL6692, EL6695 EtherCAT Terminal
Any clock pulse as electrical signal	EL1252 EtherCAT Terminal (as described in this document)
Other methods: See Beckhoff Information System	

The TwinCAT 3 EtherCAT External Sync function extends the TwinCAT EtherCAT master with the option of synchronizing the Beckhoff real-time with an external digital electrical clock signal and provides a library with various function blocks for this purpose. The signal must be connected to an EL1252 EtherCAT Terminal, which means that the EtherCAT fieldbus has to be used.

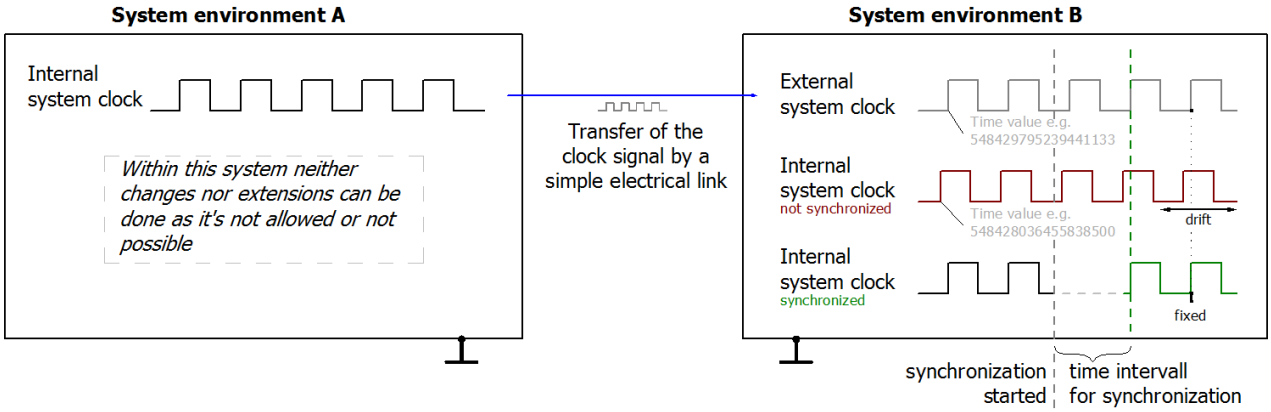
EtherCAT System Documentation

For further information on external synchronization see the Beckhoff Information System, section Fieldbus Components > EtherCAT Terminals > EtherCAT System Documentation

Application examples

- An existing system is to be expanded with an additional Beckhoff TwinCAT controller, which should be synchronized with the main controller. At the main controller, the clock signal that is picked up by the TwinCAT controller via the EL1252 can be generated by a toggling 24 V digital output, for example. (See Examples > EtherCAT External Sync [▶ 17])
- A TwinCAT system should generally run synchronously with an external cycle, e.g. a second pulse (PPS, pulses per second) or local time
- A TwinCAT system is to be supplied with the absolute time, in addition to the clock pulse. If an absolute time is also modulated onto an external PPS signal, e.g. via DCF77 coding, the TF6225 can be used in conjunction with a PLC function block to decode the DCF77 signal. The function blocks for coding/ decoding DCF77 are included in the sample program. Other time codings can be implemented in the PLC itself. (See Examples > DCF77 [▶ 21])

Application example: external synchronization of a system environment (B) from a non-modifiable system environment (A)



In the following sections, system environment (A) is regarded as the master system (from any manufacturer), system environment (B) is regarded as the slave system (TwinCAT only).

3 Installation

No separate setup is required for the function TF6225 TwinCAT 3 EtherCAT External Sync. It is available in the respective TwinCAT basic installation.

3.1 System requirements

Technical data	Requirements
Operating system	Windows 10 Windows 11 Windows CE TwinCAT/BSD
Target platform	x64, x86, Arm®
Minimum TwinCAT version	TwinCAT 3.1 Build 4020.32
Required TwinCAT license	TC1200 | TwinCAT 3 PLC

TF6225 TwinCAT 3 EtherCAT External Sync is installed with the TwinCAT Setup up to and including TwinCAT 3.1 Build 4024. Further installation details can be found in the instructions Installation up to TwinCAT 3.1 Build 4024.

From TwinCAT 3.1 Build 4026, TwinCAT products are installed via the TwinCAT Package Manager. Detailed instructions on installing products can be found in the chapter Managing TwinCAT software in the TwinCAT 3.1 Build 4026 installation instructions.

You can obtain a basic TwinCAT installation with the TF6225 function via the following workloads:

- TwinCAT.Standard.XAE (Engineering)
- TwinCAT.Standard.XAR (Runtime)

3.2 Licensing

The TwinCAT 3 function can be activated as a full version or as a 7-day test version. Both license types can be activated via the TwinCAT 3 development environment (XAE).

Licensing the full version of a TwinCAT 3 Function

A description of the procedure to license a full version can be found in the Beckhoff Information System in the documentation "TwinCAT 3 Licensing".

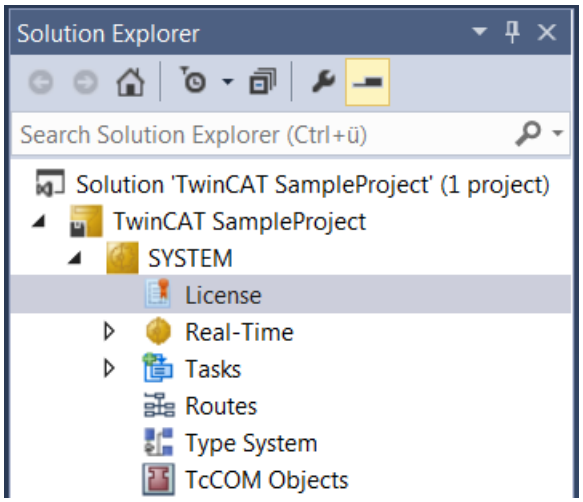
Licensing the 7-day test version of a TwinCAT 3 Function



A 7-day test version cannot be enabled for a TwinCAT 3 license dongle.

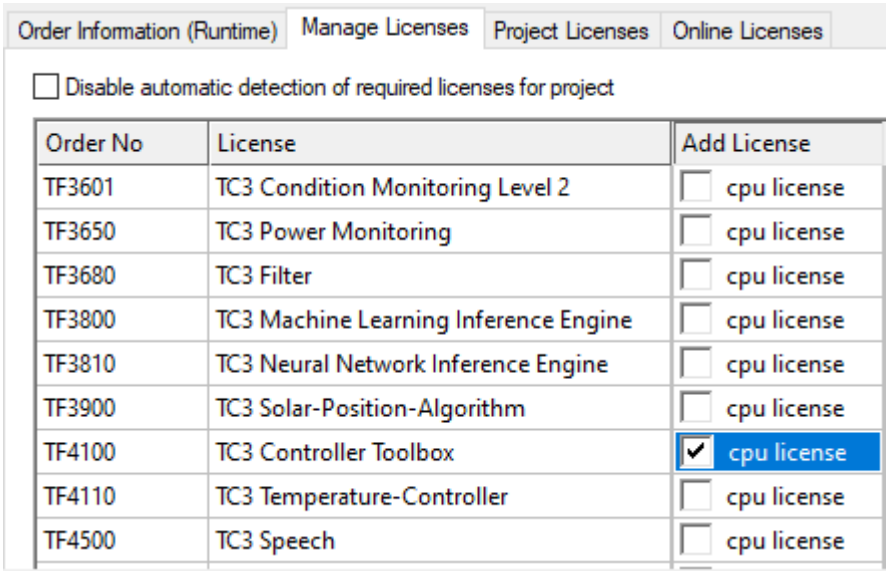
1. Start the TwinCAT 3 development environment (XAE).
2. Open an existing TwinCAT 3 project or create a new project.
3. If you want to activate the license for a remote device, set the desired target system. To do this, select the target system from the **Choose Target System** drop-down list in the toolbar.
   ⇨ The licensing settings always refer to the selected target system. When the project is activated on the target system, the corresponding TwinCAT 3 licenses are automatically copied to this system.

4. In the **Solution Explorer**, double-click **License** in the **SYSTEM** subtree.



⇨ The TwinCAT 3 license manager opens.

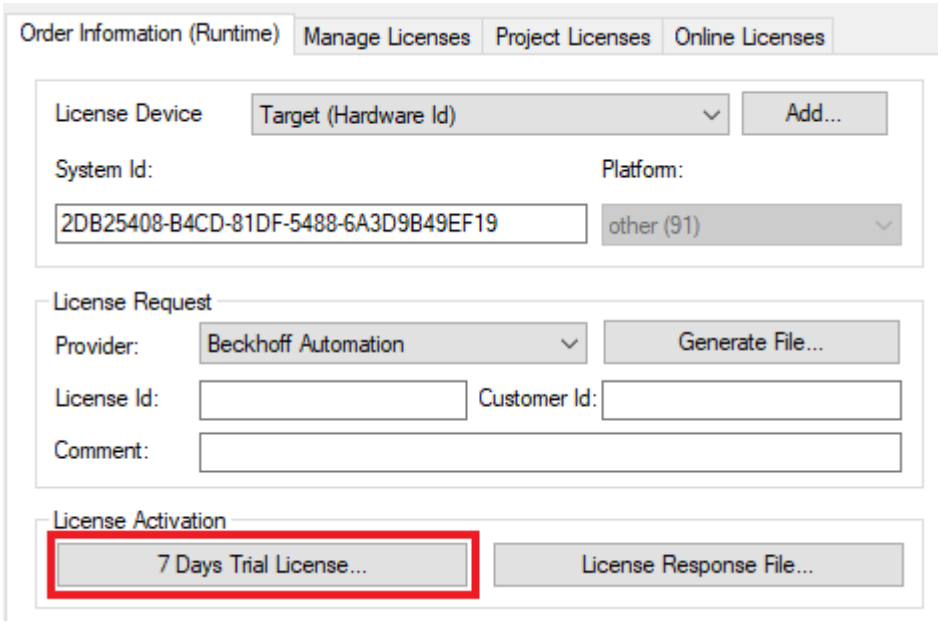
5. Open the **Manage Licenses** tab. In the **Add License** column, check the check box for the license you want to add to your project (e.g. "TF4100 TC3 Controller Toolbox").



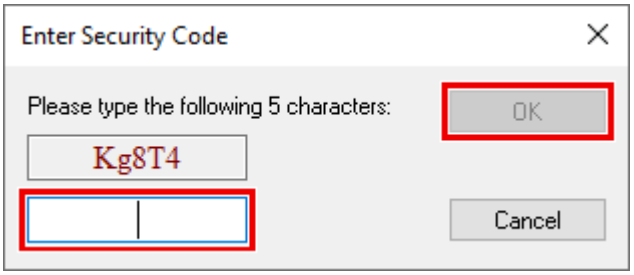
6. Open the **Order Information (Runtime)** tab.

⇨ In the tabular overview of licenses, the previously selected license is displayed with the status “missing”.

7. Click **7-Day Trial License...** to activate the 7-day trial license.



⇨ A dialog box opens, prompting you to enter the security code displayed in the dialog.



8. Enter the code exactly as it is displayed and confirm the entry.
9. Confirm the subsequent dialog, which indicates the successful activation.
   ⇨ In the tabular overview of licenses, the license status now indicates the expiry date of the license.
10. Restart the TwinCAT system.

⇨ The 7-day trial version is enabled.

4 Technical introduction

When external synchronization is applied, two system times meet:

1. The controlled/time-receiving TwinCAT system with its distributed clocks.
2. The time-sending system with its encoder clock.

Synchronization process:

- Two timestamps (one external and one internal) must be transferred periodically to the time-receiving TwinCAT system.
- To form a timestamp pair, the value of both times is recorded at the same time. The "internal clock" is always based on the system's own distributed clock time. The "external clock" is the time from the external, time-giving system.
- The timestamp pairs are determined periodically, e.g. every 100 ms.
- If these timestamp pairs are repeatedly sent to the receiving TwinCAT real-time system, the system is able to determine the deviation trend and can readjust itself until clock synchronization is achieved. The remaining offset is offered for linking through variables in the EtherCAT IO tree.

Essentially, TwinCAT synchronization is not designed to minimize or compensate the offset. If the initial difference between the two systems is large (weeks, months), this would mean a very long waiting time. The readjusting TwinCAT system therefore establishes clock synchronization within a few seconds and maintains the offset.

Offset step changes can occur if:

- The real-time behavior no longer permits tracking.
- Leap seconds/time changes etc. are received via the external time.

The readjusted control should be designed in such a way that it can cope with offset step changes.

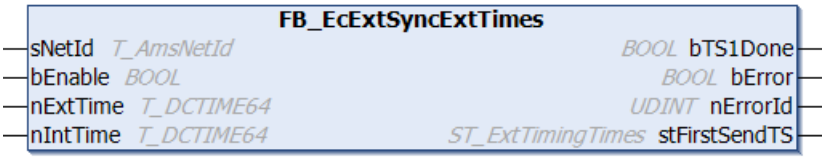
The quality of the time control that can be achieved depends, among other things, on how accurately the external clock can be read and how the "new signal" event can be fed into the time-receiving system. The jitter-free nature of this external timestamp must be magnitudes better than the intended control objective.

Example: The jitter associated with the edge output of commercially available direct DCF77 receivers (German radio time on longwave) can be such that the readjustment is disturbed up to the ms range, even taking into account the missing 59th second. This leads to step changes in the offset display.

5 PLC API

5.1 Function blocks

5.1.1 FB_EcExtSyncExtTimes



The function block FB_EcExtSyncExtTimes enables or disables the synchronization of the internal and external clocks. The function block FB_EcExtSyncIsSynchronized [▶ 15] can be used to check synchronization.

This function block is required for the synchronization.

- It enables or disables the synchronization of the internal and external clocks.
- It periodically sends the timestamp pair nExtTime and nIntTime to the TwinCAT real-time system via ADS.

The function block should be called at most every 2-5 ms. A new/fresh timestamp pair should be assigned to the function block every time it is called, otherwise the call is meaningless. The frequency of the function block call influences the quality of the time control. The more often the function block is called, the better the readjusted system can work. If the timestamp quality is good, one call per second, e.g. through a PPS signal (**P**ulse**P**er**S**econd), may be sufficient.

Inputs

```
VAR_INPUT
    sNetId   : T_AmsNetId;
    bEnable  : BOOL;
    nExtTime : T_DCTIME64;
    nIntTime : T_DCTIME64;
END_VAR
```

Name	Type	Description
sNetId	T_AMSNetId	String containing the AMS network ID of the EtherCAT master device.
bEnable	BOOL	bEnable = TRUE enables the synchronization. bEnable = FALSE disables the synchronization.
nExtTime	T_DCTIME64	External timestamp
nIntTime	T_DCTIME64	Internal timestamp

Outputs

```
VAR_OUTPUT
    bTS1Done      : BOOL;
    bError        : BOOL;
    nErrorId      : UDINT;
    stFirstSendTS : ST_ExtTimingTimes;
END_VAR
```

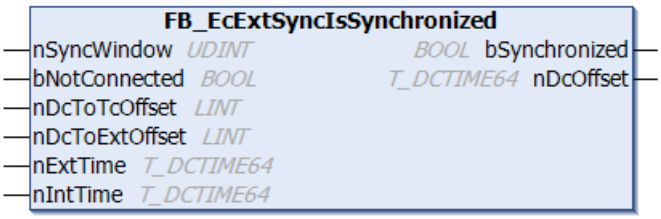
Name	Type	Description
bTS1Done	BOOL	This output is set when the synchronization is enabled for the first time and the internal and external timestamps are written to the EtherCAT master.
bError	BOOL	This output is set if an error occurs during command execution.
nErrorId	UDINT	This output returns the error code, if the bError output is set.

Name	Type	Description
stFirstSendTS	ST_ExtTimingTimes [▶ 16]	This output is set to the internal and external timestamps that are written to the EtherCAT master.

Requirements

Development environment	Target platform	PLC library to be integrated (category group)
TwinCAT v3.1.0	PC or CX (x86, x64, Arm®)	Tc3_EtherCATExtSync

5.1.2 FB_EcExtSyncIsSynchronized



This function block FB_EcExtSyncIsSynchronized checks whether the internal and external clocks are synchronized (bSynchronized). For this purpose, the system checks whether the difference between the clocks over 10 cycles is within the specified synchronization window nSyncWindow. In the event of invalid data (bNotConnected = TRUE), the synchronization is reported as failed.

The function block is not absolutely necessary for readjustment, but it can be used for information purposes.

Inputs

```
VAR_INPUT
    nSyncWindow    : UDINT;
    bNotConnected  : BOOL;
    nDcToTcOffset  : LINT;
    nDcToExtOffset : LINT;
    nExtTime       : T_DCTIME64;
    nIntTime       : T_DCTIME64;
END_VAR
```

Name	Type	Description
nSyncWindow	UDINT	Time window [ns] within which the internal and external time are regarded as synchronized.
bNotConnected	BOOL	TRUE, if the data is invalid (corresponds to the WcState of the EL6692)
nDcToTcOffset	LINT	Offset between the distributed clock time and the TwinCAT time [ns] from the InfoData of the EtherCAT master
nDcToExtOffset	LINT	Offset between the distributed clock time and the external time [ns] from the InfoData of the EtherCAT master
nExtTime	T_DCTIME64	External timestamp
nIntTime	T_DCTIME64	Internal timestamp

Outputs

```
VAR_OUTPUT
    bSychronized : BOOL;
    nDcOffset    : T_DCTIME64;
END_VAR
```

Name	Type	Description
bSynchronized	BOOL	TRUE if the difference between the internal and external time over at least 10 cycles is within the synchronization window.

Name	Type	Description
nDcOffset	T_DCTIME64	Magnitude of the current difference between the internal and external time [ns]

Requirements

Development environment	Target platform	PLC library to be integrated (category group)
TwinCAT v3.1.0	PC or CX (x86, x64, Arm®)	Tc3_EtherCATExtSync

5.2 Data types

5.2.1 ST_ExtTimingTimes

This structure defines the timestamps of the internal and external clock.

```
TYPE ST_ExtTimingStatus :
STRUCT
    nDcIntTs : T_DCTIME64;
    nDcExtTs : T_DCTIME64;
END_STRUCT
END_TYPE
```

Name	Type	Description
nDcIntTs	T_DCTIME64	Timestamp of the internal clock
nDcExtTs	T_DCTIME64	Timestamp of the external clock

6 Examples

6.1 EtherCAT External Sync

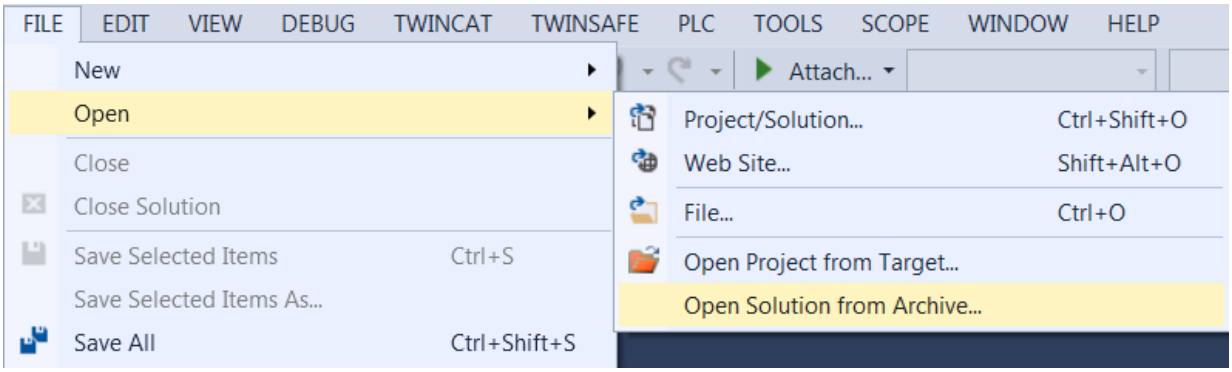
Using the sample programs

This document contains sample applications of our products for certain areas of application. The application notices provided here are based on typical features of our products and only serve as samples. The notices contained in this document explicitly do not refer to specific applications. The user is therefore responsible for assessing and deciding whether the product is suitable for a particular application. We accept no responsibility for the completeness and correctness of the source code contained in this document. We reserve the right to modify the content of this document at any time and accept no responsibility for errors and missing information.

Download: https://infosys.beckhoff.com/content/1033/tf6225_tc3_ethercat_external_sync/Resources/3864740235.zip

Load the sample program (tnzip file/TwinCAT 3)

1. Save the ZIP archive locally on your hard disk and extract the file.
2. Open TwinCAT 3 Engineering.
3. In the **File > Open** menu, select the command **Open Solution from Archive.**



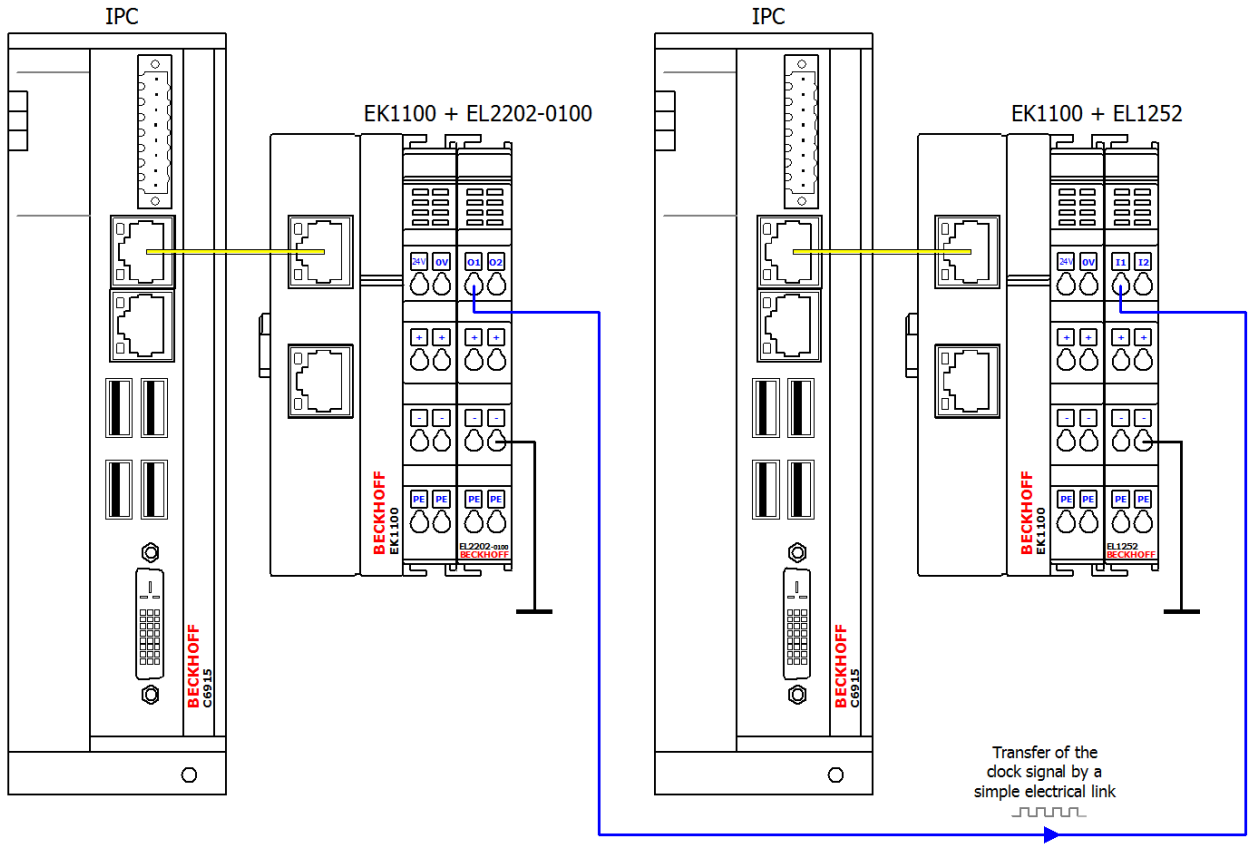
4. In the **Open** dialog that opens, select the previously unpacked .tnzip file (sample program) and confirm the dialog with **Open**.
   ⇨ The **Select folder for new solution** selection window opens.
5. Select a destination directory for saving the project and confirm the dialog with **Select folder**.
   ⇨ The Tc3_EtherCATExtSyncSample solution is loaded.

Further information on the general procedure for commissioning the PLC or starting the program can be found in the terminal documentation and in the EtherCAT System Documentation.

6.1.1 Configuration

Sample configuration for TF6225 TC3 EtherCAT External Sync

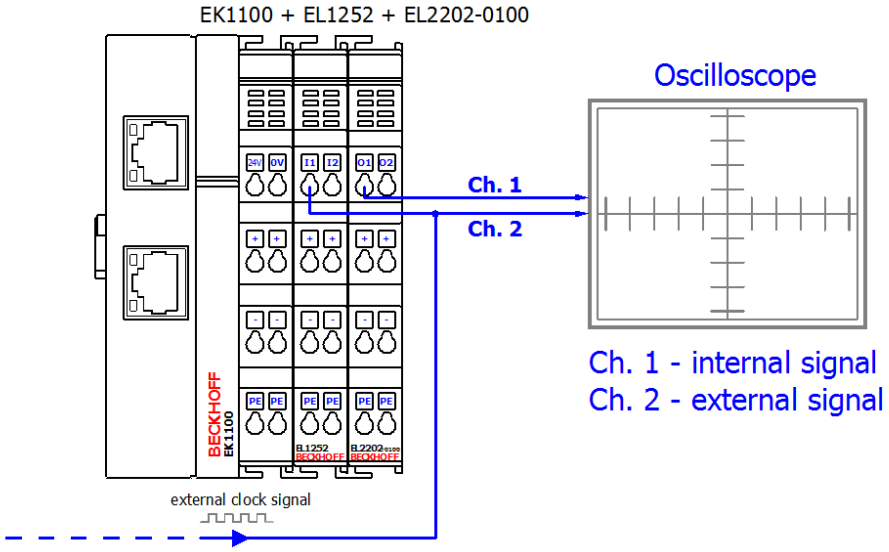
The operating principle of the TF6225 can be illustrated through the configuration of two independent IPC systems. The diagram shows the hardware structure of the master system (clock generator) on the left and the slave system (clock receiver) on the right.



Recording of the internal and external clock with an oscilloscope

After commissioning the system, you can monitor the synchronization via the TwinCAT 3 Scope View, for example.

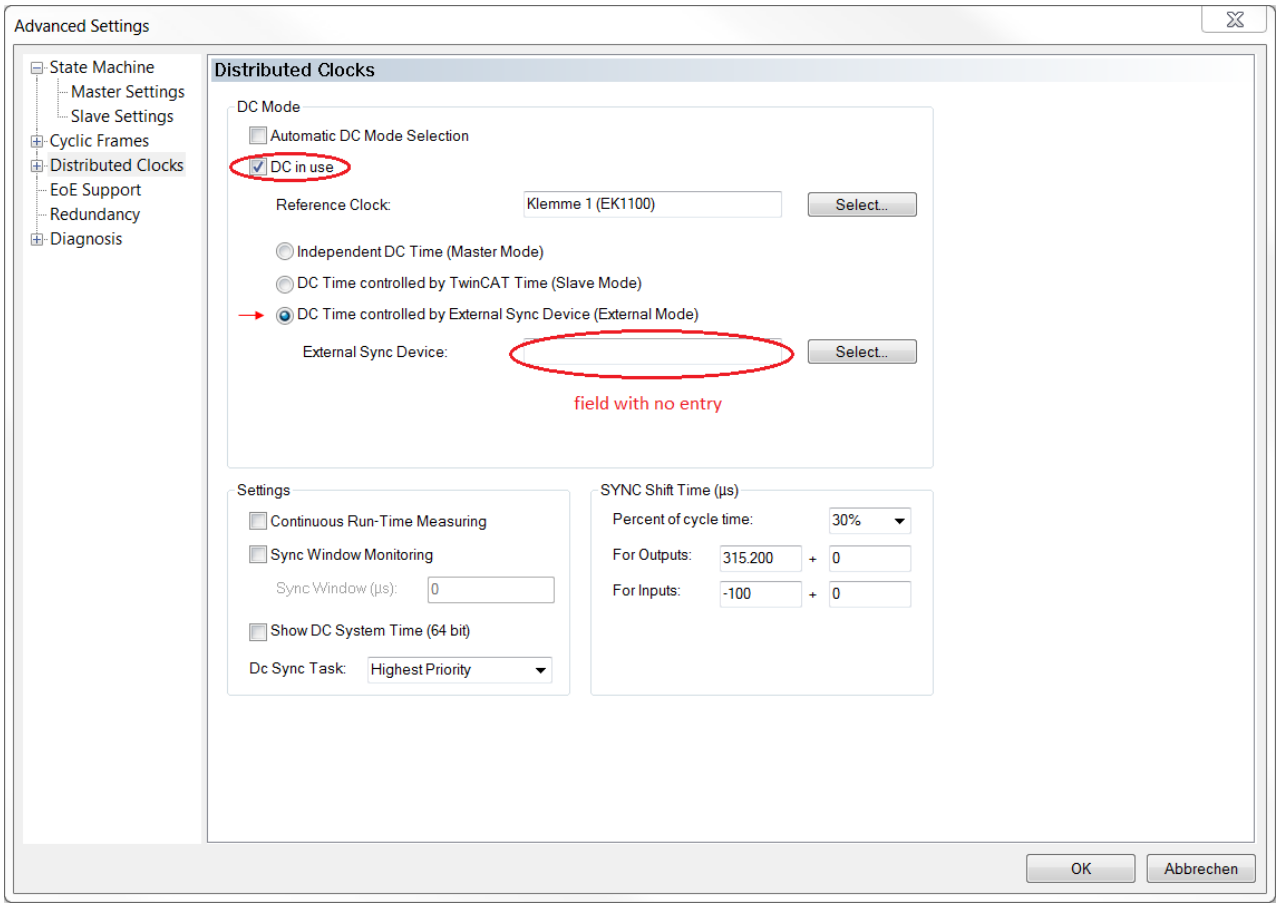
You can also use an oscilloscope to record the internal and external clocks on a time base. To do this, add an EL2202-0100 EtherCAT Terminal to the slave system. The external clock of the master system can be recorded via the input of the EL1252 EtherCAT Terminal and can serve as a reference (trigger), for example. The internal clock of the slave system can be output via a toggling bit at the additionally connected EL2202-0100 EtherCAT Terminal. If external synchronization is not active, the time drift can be recognized by the fact that the two signals are not fixed in time relative to each other.



The EL2202-0100 EtherCAT Terminal is the extended distributed clocks version of the EL2202. It can be obtained from Beckhoff, or it may be possible to set it up by reprogramming the EL2202. Further information can be found in the documentation EL2202, EL2252 – two-channel digital output terminal.

EtherCAT master configuration of the slave system for external DC synchronization via the EL1252 in TwinCAT 3 Engineering

The EtherCAT master of the slave system for external synchronization can be configured in TwinCAT 3 Engineering under advanced device settings. To open the advanced settings, double-click on the EtherCAT device in the TwinCAT project tree. Select the **EtherCAT** tab and click **Advanced Settings…** Select the **Distributed Clocks** entry in the navigation tree in the dialog that opens. Configure the EtherCAT master of the slave system according to the following diagram.



6.1.2 Notes

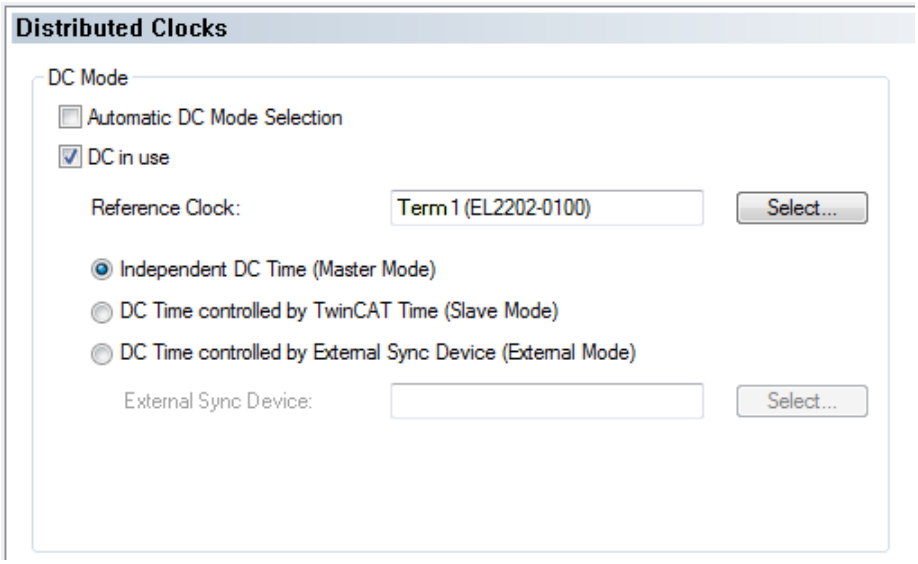
Notes on the sample program of the slave system

- The sample program shows the slave system (system environment B). This requires a controller with an EL1252 EtherCAT Terminal. You can either use an Embedded PC, to which the terminal is connected on the right-hand side, or an IPC with an EtherCAT connection, e.g. an RJ-45 connection to the EK1100 Coupler with the terminal. (See also Configuration [▶ 17])
- If necessary, read in the I/O configuration again and link the variables as follows:
  - nIntTime → EL1252, PDO: Latch/ LatchPos1
  - aEcMasterAmsNetId → device (EtherCAT), PDO: InfoData/ AmsNetId
  - bOut → (optional) EL2202-0100, PDO: Channel 1/ output

- In the sample program, the internal time value (nExtTime) is incremented according to the expected input signal (50 ms period → rEventTimeStep = $5 \cdot 10^7$) when an incoming positive edge event is detected at the EL1252 input. Select the appropriate value for rEventTimeStep, depending on the expected cycle duration:
  `nExtTime := nExtTime + LREAL_TO_ULINT(rEventTimeStep);`
  The addition of a constant time value to a base time value for the time stamp of the external time depends on an incoming (positive) edge. This causes an external time stamp to be mapped by the external clock. An edge is always determined by comparing the current internal time stamp supplied by the EL1252 with the last time stamp in each task run:
  `IF(current_intTimeSatmp<>last_intTimeSatmp) THEN`
- Optionally, you can add a YT-Scope-View to visualize the project and record the following variables from the MAIN program:
  - nDcOffset (the result of FB_EcExtSyncIsSynchronized from nExtTime and nIntTime)
  - bExtTime_Digits and bIntTime_Digits for visualizing the temporal drift or synchronous operation after activation of the synchronization process
  - bSynchronized to show that the synchronization has taken place
- The variable bEnableExtSync can be set to TRUE at a desired time.

General information on the master system

- The master system is not included in this sample. In principle, any timer that can provide a 24 V square wave signal could be used as a master system. The master system shown in the diagram has enabled distributed clocks (DC) for the EL2202-0100 EtherCAT Terminal and set a corresponding task cycle time of 25 ms for an output signal with T = 50 ms. The following code line in the (POU) MAIN is used for generating the output signal: `bOut := NOT bOut;`
- The EtherCAT master of the master system has distributed clocks (DC) enabled. Further information regarding the setting can be found in the EtherCAT System Documentation in the Setup section under TwinCAT System Manager > Notes on Distributed Clocks.
  An EL2202-0100 EtherCAT Terminal in the master system acts as DC timer and also issues the output signal.

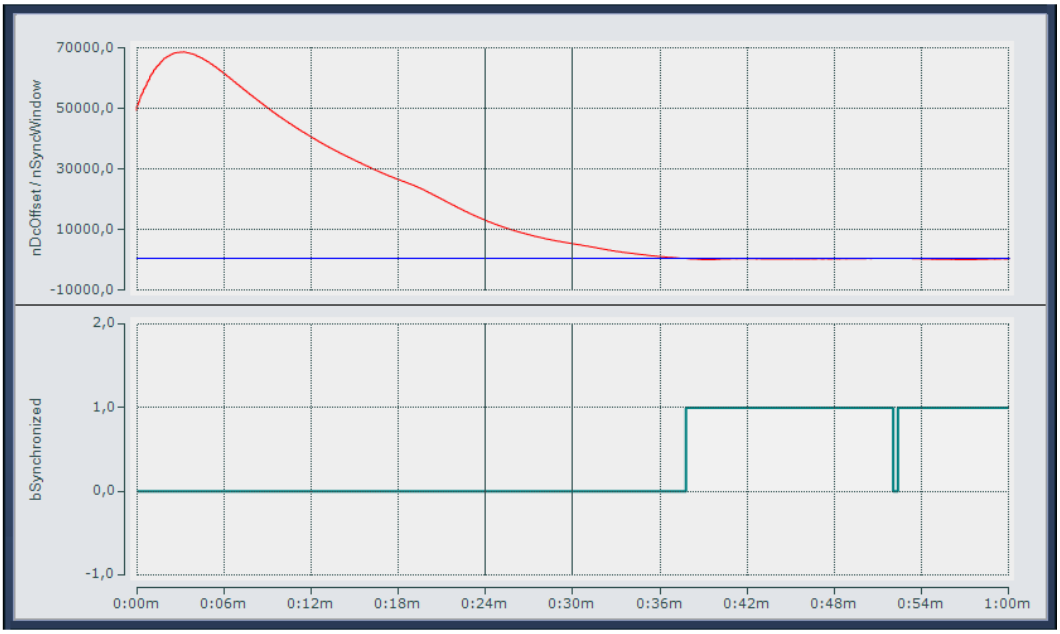


- Larger cycle durations, e.g. 1 s, can be converted using a counter variable.

6.1.3 Results

ScopeView recording

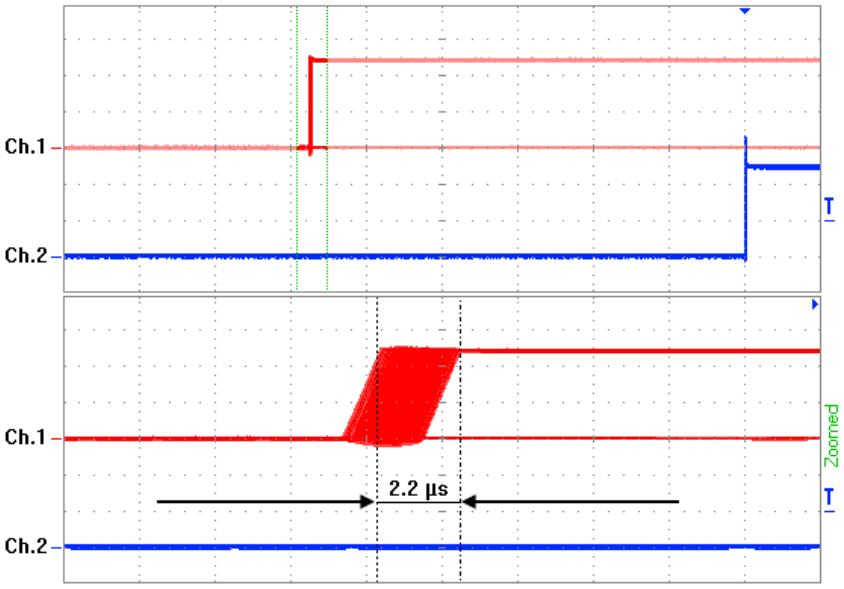
After the activation of the external synchronization on the part of the slave system (`TRUE => bEnableExtSync`), the deviation between the internal and external time values (nDcOffset), the synchronization window nSyncWindow and the actual synchronization is recorded with ScopeView (bSynchronized):



Oscilloscope recording

The upper part of the following diagram shows the time offset between the two signals. The lower part shows an enlarged section relating to channel 1, to illustrate the remaining jitter of the sample slave system. In this example a clock synchronization of < ±1.5 µs is achieved.

- Channel 1: Internal slave PLC clock pulse
- Channel 2: External master PLC clock pulse



6.2 DCF77

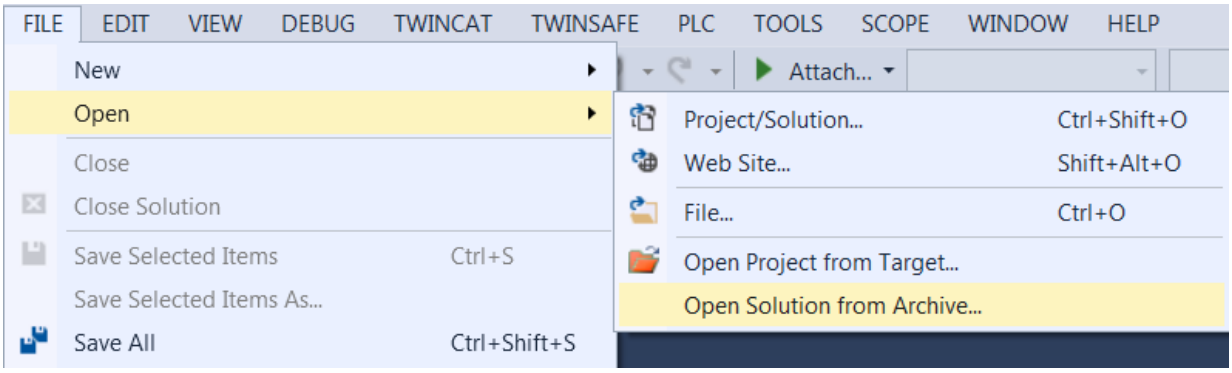
Using the sample programs

This document contains sample applications of our products for certain areas of application. The application notices provided here are based on typical features of our products and only serve as samples. The notices contained in this document explicitly do not refer to specific applications. The user is therefore responsible for assessing and deciding whether the product is suitable for a particular application. We accept no responsibility for the completeness and correctness of the source code contained in this document. We reserve the right to modify the content of this document at any time and accept no responsibility for errors and missing information.

Download: https://infosys.beckhoff.com/content/1033/tf6225_tc3_ethercat_external_sync/Resources/4001783435.zip

Load the sample program (tnzip file/TwinCAT 3)

1. Save the ZIP archive locally on your hard disk and extract the file.
2. Open TwinCAT 3 Engineering.
3. In the **File > Open** menu, select the command **Open Solution from Archive.**



4. In the **Open** dialog that opens, select the previously unpacked .tnzip file (sample program) and confirm the dialog with **Open**.
   ⇨ The **Select folder for new solution** selection window opens.
5. Select a destination directory for saving the project and confirm the dialog with **Select folder**.
   ⇨ The Tc3_EtherCATExtSyncSample solution is loaded.

Further information on the general procedure for commissioning the PLC or starting the program can be found in the terminal documentation and in the EtherCAT System Documentation.

7 Appendix

7.1 ADS Return Codes

Grouping of error codes:
Global error codes: 0x0000 [▶ 23]... (0x9811_0000 ...)
Router error codes: 0x500 [▶ 23]... (0x9811_0500 ...)
General ADS errors: 0x700 [▶ 24]... (0x9811_0700 ...)
RTime error codes: 0x1000 [▶ 25]... (0x9811_1000 ...)

Global error codes

Hex	Dec	HRESULT	Name	Description
0x0	0	0x98110000	ERR_NOERROR	No error.
0x1	1	0x98110001	ERR_INTERNAL	Internal error.
0x2	2	0x98110002	ERR_NORTIME	No real time.
0x3	3	0x98110003	ERR_ALLOCLOCKEDMEM	Allocation locked – memory error.
0x4	4	0x98110004	ERR_INSERTMAILBOX	Mailbox full – the ADS message could not be sent. Reducing the number of ADS messages per cycle will help.
0x5	5	0x98110005	ERR_WRONGRECEIVEHMSG	Wrong HMSG.
0x6	6	0x98110006	ERR_TARGETPORTNOTFOUND	Target port not found – ADS server is not started, not reachable or not installed.
0x7	7	0x98110007	ERR_TARGETMACHINENOTFOUND	Target computer not found – AMS route was not found.
0x8	8	0x98110008	ERR_UNKNOWNCMDID	Unknown command ID.
0x9	9	0x98110009	ERR_BADTASKID	Invalid task ID.
0xA	10	0x9811000A	ERR_NOIO	No IO.
0xB	11	0x9811000B	ERR_UNKNOWNAMSCMD	Unknown AMS command.
0xC	12	0x9811000C	ERR_WIN32ERROR	Win32 error.
0xD	13	0x9811000D	ERR_PORTNOTCONNECTED	Port not connected.
0xE	14	0x9811000E	ERR_INVALIDAMSLENGTH	Invalid AMS length.
0xF	15	0x9811000F	ERR_INVALIDAMSNETID	Invalid AMS Net ID.
0x10	16	0x98110010	ERR_LOWINSTLEVEL	Installation level is too low –TwinCAT 2 license error.
0x11	17	0x98110011	ERR_NODEBUGINTAVAILABLE	No debugging available.
0x12	18	0x98110012	ERR_PORTDISABLED	Port disabled – TwinCAT system service not started.
0x13	19	0x98110013	ERR_PORTALREADYCONNECTED	Port already connected.
0x14	20	0x98110014	ERR_AMSSYNC_W32ERROR	AMS Sync Win32 error.
0x15	21	0x98110015	ERR_AMSSYNC_TIMEOUT	AMS Sync Timeout.
0x16	22	0x98110016	ERR_AMSSYNC_AMSERROR	AMS Sync error.
0x17	23	0x98110017	ERR_AMSSYNC_NOINDEXINMAP	No index map for AMS Sync available.
0x18	24	0x98110018	ERR_INVALIDAMSPORT	Invalid AMS port.
0x19	25	0x98110019	ERR_NOMEMORY	No memory.
0x1A	26	0x9811001A	ERR_TCPSEND	TCP send error.
0x1B	27	0x9811001B	ERR_HOSTUNREACHABLE	Host unreachable.
0x1C	28	0x9811001C	ERR_INVALIDAMSFRAGMENT	Invalid AMS fragment.
0x1D	29	0x9811001D	ERR_TLSSEND	TLS send error – secure ADS connection failed.
0x1E	30	0x9811001E	ERR_ACCESSDENIED	Access denied – secure ADS access denied.

Router error codes

Hex	Dec	HRESULT	Name	Description
0x500	1280	0x98110500	ROUTERERR_NOLOCKEDMEMORY	Locked memory cannot be allocated.
0x501	1281	0x98110501	ROUTERERR_RESIZEMEMORY	The router memory size could not be changed.
0x502	1282	0x98110502	ROUTERERR_MAILBOXFULL	The mailbox has reached the maximum number of possible messages.
0x503	1283	0x98110503	ROUTERERR_DEBUGBOXFULL	The Debug mailbox has reached the maximum number of possible messages.

Hex	Dec	HRESULT	Name	Description
0x504	1284	0x98110504	ROUTERERR_UNKNOWNPORTTYPE	The port type is unknown.
0x505	1285	0x98110505	ROUTERERR_NOTINITIALIZED	The router is not initialized.
0x506	1286	0x98110506	ROUTERERR_PORTALREADYINUSE	The port number is already assigned.
0x507	1287	0x98110507	ROUTERERR_NOTREGISTERED	The port is not registered.
0x508	1288	0x98110508	ROUTERERR_NOMOREQUEUES	The maximum number of ports has been reached.
0x509	1289	0x98110509	ROUTERERR_INVALIDPORT	The port is invalid.
0x50A	1290	0x9811050A	ROUTERERR_NOTACTIVATED	The router is not active.
0x50B	1291	0x9811050B	ROUTERERR_FRAGMENTBOXFULL	The mailbox has reached the maximum number for fragmented messages.
0x50C	1292	0x9811050C	ROUTERERR_FRAGMENTTIMEOUT	A fragment timeout has occurred.
0x50D	1293	0x9811050D	ROUTERERR_TOBEREMOVED	The port is removed.

General ADS error codes

Hex	Dec	HRESULT	Name	Description
0x700	1792	0x98110700	ADSERR_DEVICE_ERROR	General device error.
0x701	1793	0x98110701	ADSERR_DEVICE_SRVNOTSUPP	Service is not supported by the server.
0x702	1794	0x98110702	ADSERR_DEVICE_INVALIDGRP	Invalid index group.
0x703	1795	0x98110703	ADSERR_DEVICE_INVALIDOFFSET	Invalid index offset.
0x704	1796	0x98110704	ADSERR_DEVICE_INVALIDACCESS	Reading or writing not permitted. Several causes are possible. For example, an incorrect password was entered when creating routes.
0x705	1797	0x98110705	ADSERR_DEVICE_INVALIDSIZE	Parameter size not correct.
0x706	1798	0x98110706	ADSERR_DEVICE_INVALIDDATA	Invalid data values.
0x707	1799	0x98110707	ADSERR_DEVICE_NOTREADY	Device is not ready to operate.
0x708	1800	0x98110708	ADSERR_DEVICE_BUSY	Device is busy.
0x709	1801	0x98110709	ADSERR_DEVICE_INVALIDCONTEXT	Invalid operating system context. This can result from use of ADS blocks in different tasks. It may be possible to resolve this through multitasking synchronization in the PLC.
0x70A	1802	0x9811070A	ADSERR_DEVICE_NOMEMORY	Insufficient memory.
0x70B	1803	0x9811070B	ADSERR_DEVICE_INVALIDPARM	Invalid parameter values.
0x70C	1804	0x9811070C	ADSERR_DEVICE_NOTFOUND	Not found (files, ...).
0x70D	1805	0x9811070D	ADSERR_DEVICE_SYNTAX	Syntax error in file or command.
0x70E	1806	0x9811070E	ADSERR_DEVICE_INCOMPATIBLE	Objects do not match.
0x70F	1807	0x9811070F	ADSERR_DEVICE_EXISTS	Object already exists.
0x710	1808	0x98110710	ADSERR_DEVICE_SYMBOLNOTFOUND	Symbol not found.
0x711	1809	0x98110711	ADSERR_DEVICE_SYMBOLVERSIONINVALID	Invalid symbol version. This can occur due to an online change. Create a new handle.
0x712	1810	0x98110712	ADSERR_DEVICE_INVALIDSTATE	Device (server) is in invalid state.
0x713	1811	0x98110713	ADSERR_DEVICE_TRANSMODENOTSUPP	AdsTransMode not supported.
0x714	1812	0x98110714	ADSERR_DEVICE_NOTIFYHNDINVALID	Notification handle is invalid.
0x715	1813	0x98110715	ADSERR_DEVICE_CLIENTUNKNOWN	Notification client not registered.
0x716	1814	0x98110716	ADSERR_DEVICE_NOMOREHDLS	No further handle available.
0x717	1815	0x98110717	ADSERR_DEVICE_INVALIDWATCHSIZE	Notification size too large.
0x718	1816	0x98110718	ADSERR_DEVICE_NOTINIT	Device not initialized.
0x719	1817	0x98110719	ADSERR_DEVICE_TIMEOUT	Device has a timeout.
0x71A	1818	0x9811071A	ADSERR_DEVICE_NOINTERFACE	Interface query failed.
0x71B	1819	0x9811071B	ADSERR_DEVICE_INVALIDINTERFACE	Wrong interface requested.
0x71C	1820	0x9811071C	ADSERR_DEVICE_INVALIDCLSID	Class ID is invalid.
0x71D	1821	0x9811071D	ADSERR_DEVICE_INVALIDOBJID	Object ID is invalid.
0x71E	1822	0x9811071E	ADSERR_DEVICE_PENDING	Request pending.
0x71F	1823	0x9811071F	ADSERR_DEVICE_ABORTED	Request is aborted.
0x720	1824	0x98110720	ADSERR_DEVICE_WARNING	Signal warning.
0x721	1825	0x98110721	ADSERR_DEVICE_INVALIDARRAYIDX	Invalid array index.
0x722	1826	0x98110722	ADSERR_DEVICE_SYMBOLNOTACTIVE	Symbol not active.
0x723	1827	0x98110723	ADSERR_DEVICE_ACCESSDENIED	Access denied. Several causes are possible. For example, a unidirectional ADS route is used in the opposite direction.

Hex	Dec	HRESULT	Name	Description
0x724	1828	0x98110724	ADSERR_DEVICE_LICENSENOTFOUND	Missing license.
0x725	1829	0x98110725	ADSERR_DEVICE_LICENSEEXPIRED	License expired.
0x726	1830	0x98110726	ADSERR_DEVICE_LICENSEEXCEEDED	License exceeded.
0x727	1831	0x98110727	ADSERR_DEVICE_LICENSEINVALID	Invalid license.
0x728	1832	0x98110728	ADSERR_DEVICE_LICENSESYSTEMID	License problem: System ID is invalid.
0x729	1833	0x98110729	ADSERR_DEVICE_LICENSENOTIMELIMIT	License not limited in time.
0x72A	1834	0x9811072A	ADSERR_DEVICE_LICENSEFUTUREISSUE	Licensing problem: time in the future.
0x72B	1835	0x9811072B	ADSERR_DEVICE_LICENSETIMETOLONG	License period too long.
0x72C	1836	0x9811072C	ADSERR_DEVICE_EXCEPTION	Exception at system startup.
0x72D	1837	0x9811072D	ADSERR_DEVICE_LICENSEDUPLICATED	License file read twice.
0x72E	1838	0x9811072E	ADSERR_DEVICE_SIGNATUREINVALID	Invalid signature.
0x72F	1839	0x9811072F	ADSERR_DEVICE_CERTIFICATEINVALID	Invalid certificate.
0x730	1840	0x98110730	ADSERR_DEVICE_LICENSEOEMNOTFOUND	Public key not known from OEM.
0x731	1841	0x98110731	ADSERR_DEVICE_LICENSERESTRICTED	License not valid for this system ID.
0x732	1842	0x98110732	ADSERR_DEVICE_LICENSEDEMODENIED	Demo license prohibited.
0x733	1843	0x98110733	ADSERR_DEVICE_INVALIDFNCID	Invalid function ID.
0x734	1844	0x98110734	ADSERR_DEVICE_OUTOFRANGE	Outside the valid range.
0x735	1845	0x98110735	ADSERR_DEVICE_INVALIDALIGNMENT	Invalid alignment.
0x736	1846	0x98110736	ADSERR_DEVICE_LICENSEPLATFORM	Invalid platform level.
0x737	1847	0x98110737	ADSERR_DEVICE_FORWARD_PL	Context – forward to passive level.
0x738	1848	0x98110738	ADSERR_DEVICE_FORWARD_DL	Context – forward to dispatch level.
0x739	1849	0x98110739	ADSERR_DEVICE_FORWARD_RT	Context – forward to real-time.
0x740	1856	0x98110740	ADSERR_CLIENT_ERROR	Client error.
0x741	1857	0x98110741	ADSERR_CLIENT_INVALIDPARM	Service contains an invalid parameter.
0x742	1858	0x98110742	ADSERR_CLIENT_LISTEMPTY	Polling list is empty.
0x743	1859	0x98110743	ADSERR_CLIENT_VARUSED	Var connection already in use.
0x744	1860	0x98110744	ADSERR_CLIENT_DUPLINVOKEID	The called ID is already in use.
0x745	1861	0x98110745	ADSERR_CLIENT_SYNCTIMEOUT	Timeout has occurred – the remote terminal is not responding in the specified ADS timeout. The route setting of the remote terminal may be configured incorrectly.
0x746	1862	0x98110746	ADSERR_CLIENT_W32ERROR	Error in Win32 subsystem.
0x747	1863	0x98110747	ADSERR_CLIENT_TIMEOUTINVALID	Invalid client timeout value.
0x748	1864	0x98110748	ADSERR_CLIENT_PORTNOTOPEN	Port not open.
0x749	1865	0x98110749	ADSERR_CLIENT_NOAMSADDR	No AMS address.
0x750	1872	0x98110750	ADSERR_CLIENT_SYNCINTERNAL	Internal error in Ads sync.
0x751	1873	0x98110751	ADSERR_CLIENT_ADDHASH	Hash table overflow.
0x752	1874	0x98110752	ADSERR_CLIENT_REMOVEHASH	Key not found in the table.
0x753	1875	0x98110753	ADSERR_CLIENT_NOMORESYM	No symbols in the cache.
0x754	1876	0x98110754	ADSERR_CLIENT_SYNCRESINVALID	Invalid response received.
0x755	1877	0x98110755	ADSERR_CLIENT_SYNCPORTLOCKED	Sync Port is locked.
0x756	1878	0x98110756	ADSERR_CLIENT_REQUESTCANCELLED	The request was canceled.

RTime error codes

Hex	Dec	HRESULT	Name	Description
0x1000	4096	0x98111000	RTERR_INTERNAL	Internal error in the real-time system.
0x1001	4097	0x98111001	RTERR_BADTIMERPERIODS	Timer value is not valid.
0x1002	4098	0x98111002	RTERR_INVALIDTASKPTR	Task pointer has the invalid value 0 (zero).
0x1003	4099	0x98111003	RTERR_INVALIDSTACKPTR	Stack pointer has the invalid value 0 (zero).
0x1004	4100	0x98111004	RTERR_PRIOEXISTS	The request task priority is already assigned.
0x1005	4101	0x98111005	RTERR_NOMORETCB	No free TCB (Task Control Block) available. The maximum number of TCBs is 64.
0x1006	4102	0x98111006	RTERR_NOMORESEMAS	No free semaphores available. The maximum number of semaphores is 64.
0x1007	4103	0x98111007	RTERR_NOMOREQUEUES	No free space available in the queue. The maximum number of positions in the queue is 64.
0x100D	4109	0x9811100D	RTERR_EXTIRQALREADYDEF	An external synchronization interrupt is already applied.
0x100E	4110	0x9811100E	RTERR_EXTIRQNOTDEF	No external sync interrupt applied.

Hex	Dec	HRESULT	Name	Description
0x100F	4111	0x9811100F	RTERR_EXTIRQINSTALLFAILED	Application of the external synchronization interrupt has failed.
0x1010	4112	0x98111010	RTERR_IRQLNOTLESSOREQUAL	Call of a service function in the wrong context
0x1017	4119	0x98111017	RTERR_VMXNOTSUPPORTED	Intel® VT-x extension is not supported.
0x1018	4120	0x98111018	RTERR_VMXDISABLED	Intel® VT-x extension is not enabled in the BIOS.
0x1019	4121	0x98111019	RTERR_VMXCONTROLSMISSING	Missing function in Intel® VT-x extension.
0x101A	4122	0x9811101A	RTERR_VMXENABLEFAILS	Activation of Intel® VT-x fails.

Specific positive HRESULT Return Codes:

HRESULT	Name	Description
0x0000_0000	S_OK	No error.
0x0000_0001	S_FALSE	No error. Example: successful processing, but with a negative or incomplete result.
0x0000_0203	S_PENDING	No error. Example: successful processing, but no result is available yet.
0x0000_0256	S_WATCHDOG_TIMEOUT	No error. Example: successful processing, but a timeout occurred.

TCP Winsock error codes

Hex	Dec	Name	Description
0x274C	10060	WSAETIMEDOUT	A connection timeout has occurred - error while establishing the connection, because the remote terminal did not respond properly after a certain period of time, or the established connection could not be maintained because the connected host did not respond.
0x274D	10061	WSAECONNREFUSED	Connection refused - no connection could be established because the target computer has explicitly rejected it. This error usually results from an attempt to connect to a service that is inactive on the external host, that is, a service for which no server application is running.
0x2751	10065	WSAEHOSTUNREACH	No route to host - a socket operation referred to an unavailable host.
More Winsock error codes: Win32 error codes			

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Beckhoff Headquarters

Beckhoff Automation GmbH & Co. KG

Huelshorstweg 20
33415 Verl
Germany

Phone:	+49 5246 963-0
e-mail:	info@beckhoff.com
web:	www.beckhoff.com

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More Information:
www.beckhoff.com/tf6225

Beckhoff Automation GmbH & Co. KG
Hülshorstweg 20
33415 Verl
Germany
Phone: +49 5246 9630
info@beckhoff.com
www.beckhoff.com