BECKHOFF New Automation Technology

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Table of contents

1	Fore	word	5
	1.1	Notes on the documentation	5
	1.2	For your safety	5
	1.3	Notes on information security	7
2	Overview		
3	TwinCAT and Windows NT 10		10
4	TwinCAT connectivity features 12		12
5	User	Interface	14
	5.1	Menu of the TwinCAT System Service	15
	5.2	TwinCAT System Control	19

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 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.

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 <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>.

2 Overview

The TwinCAT system is the connecting element between Windows NT and TwinCAT. For example, the TwinCAT system carries out the TwinCAT start during the system start-up of Windows NT, or TwinCAT is safely stopped when Windows NT is shut down. Also, all accesses of the TwinCAT server to Windows NT services are executed by the TwinCAT system. The TwinCAT system consists of the TwinCAT System Service and the TwinCAT System Control.

Definitions:

TwinCAT - The Windows Control and Automation Technology

ADS - Automation Device Specification

AMS - Automation Message Specification

TwinCAT System Service

TwinCAT System Control

TwinCAT System Service

The TwinCAT System Service operates as Windows NT service in the local system account. In this way, the TwinCAT System Service is started by Windows NT before a user has logged on. As an activity symbol, the TwinCAT System Service incorporates its icon into the task bar of the desktop. In addition, the colour of the icon indicates the state of the TwinCAT system.

Colour of the icons:

Red:



TwinCAT is stopped.

Blue:



TwinCAT is in Config mode

Yellow:

<u>وم</u>

TwinCAT is being started.

Green:

¢.,

Fig. 1: TcSyst3

TwinCAT is started.

The TwinCAT System Service is primarily responsible for starting and stopping the TwinCAT run time system. It loads all configured servers and initialises them during the TwinCAT system start.

The context menu of the System Service is displayed with a mouse click (left or right) on the icon or the key combination <ALT-+>.

TwinCAT System Control

The TwinCAT run time system is parameterised with the TwinCAT System Control.

The following settings can be made:

- Adding TwinCAT servers
- Parameterising the TwinCAT system start
- Configuring remote connections
- · Parameterising the message router
- Parameterising the PLC run time systems

3 TwinCAT and Windows NT

Management of TwinCAT task execution und Windows process execution time

The following diagram illustrates an example of execution times of Windows NT based operating systems (Windows NT, Windows 2000, Windows XP,...)



The execution time for NT starts when task execution has finished, but at the latest halfway through the available period (50%). If execution of the task needs more time than the 50% that has been set, it is interrupted to give time to Windows NT, and completed in the following cycle. If no task is being run in any particular cycle, Windows NT can use 100% of the available computing time.

Management of TwinCAT task execution und Windows process execution time with various priorities

The following diagram illustrates an example of execution times with various priorities:



Task 1, which has higher priority, is run in every cycle. The remaining time available for task execution is used by Task 2 (which has lower priority). The execution time for Windows NT remains a constant 50% in each cycle.

System

4 TwinCAT connectivity features



This Beckhoff Information System chapter is about "Connectivity", see following parts:

TwinCAT ADS Reference

ADS Introduction / Overview

This first section is an introduction into the Beckhoff ADS technology. ADS stands for "Automation Device Specification" and describes a device- and Fieldbus-independent interface. This interface got designed by Beckhoff and is - including the protocol - in detail documented.

For integration into own applications resp. compilers and tools based on Microsoft Windows Operating systems (NT / Windows 2000 / XP / Vista .. and CE) there are ADS components (ADS-OCX / DLL / NET / ...) available from Beckhoff, free of charge.

The ADS components get installed together with TwinCAT and can be found in the following directory ".. \TwinCAT\Ads Api". Additionally, all named components are also available in the free of charge TwinCAT Supplement product **"TwinCAT ADS Communication Library"** (only exception is the ADS-OCX which belongs to the core components of TwinCAT).

TwinCAT ADS Device Documentation

Overview ADS Devices und their Services

ADS specifies the interface and communication between objects. This part of the documentation describes the ADS-Server implementations.

What ADS-Server are accessible via ADS? Which type of services do they provide?

Remote Access / Remote Control / Remote Diagnostics

Overview Remote Control

Speaking about (*Embedded*-)PC-based control, the topic Remote Access is very extensive. In this section, the Beckhoff Information System introduces some of the various possibilities.

- Pure IT solution (tools included in the Operating System resp. 3rd-Party software available on the market)
- TwinCAT network capabilities in local or Wide Area Networks and in pure Microsoft -based or heterogeneous networks
- Remote access via Modem
- Web-based diagnosis and configuration capabilities

TwinCAT Supplement Products

Overview Supplement Products

The TwinCAT System is, in a very flexible way, expandable via additional system software modules (TwinCAT Supplement products). For the <u>Connectivity section</u>, there are the following extensions available:

- TS6100 | TwinCAT OPC UA
 - <u>Client</u>
 - <u>Configurator</u>
 - <u>Gateway</u>
 - <u>Server</u>
- TS6250 | TwinCAT Modbus TCP Server
- TS6255 | TwinCAT PLC Modbus RTU
- TS6310 | TwinCAT TCP/IP Connection Server
- <u>TS6340 | TwinCAT PLC Serial Communication</u>
- TS6341 | TwinCAT PLC Serial Communication 3964R/RK512
- TS6350 | TwinCAT SMS/SMTP Server
- <u>TS650x | TwinCAT PLC Lib: IEC 60870-5-10x</u>

• ...

5 User Interface

The TwinCAT System Service is displayed as an icon in the Windows NT task bar.

Status of the system:

The main colour of the icon indicates the current state of the system.

🗭 Red: TwinCAT stopped.

🥺 Yellow: TwinCAT started.

💯 Green: TwinCAT running.

TwinCAT 2.9 has got a new system state, the TwinCAT config mode

Blue: TwinCAT Config mode is enabled

Real-time setting:

In addition, the current real-time setting is displayed via a tooltip when the system is running. In the example shown, the TwinCAT real-time system has a maximum of 50 % of the processor capacity available, but requires only 0 % of the processor capacity.



Context menu:

Clicking the mouse (left or right) on the TwinCAT system icon opens a context menu, via which the user can control the TwinCAT system. The listed functions can be selected via the mouse or keyboard.



The menu functions [\blacktriangleright 15] will be explained on the following pages.

TwinCAT System User intrface shortcut keys:

It is possible to call the TwinCAT System user intrface by pressing the keys: Alt and ([NUM] +). The navigation in the menu succeeds with the cursor buttions. the selected menu items cann be activated with the return button.

5.1 Menu of the TwinCAT System Service

The menu functions in detail:

About TwinCAT...:

A description of the installed TwinCAT version is called up with the menu line "About TwinCAT...". This information is needed by the user when, for example, contacting the TwinCAT Hotline.

TwinCAT System 🗙				
	TwinCAT System Ser	vice v2.7.0 (Build 118)	OK	
3	TwinCAT PLC			
	v2.7.0 (Build 45	0)		
	Copyright BECKHOFF	© 1996-1998		
	Benutzer: Benutzergruppe:	Administratoren		
	Registrierung: Name: Firma: RegSchlüssel.:	Beckhoff Industrie-Elektronik 47FE-4A13-37CE-9CFC		

Event display:

The event display is a programm to moniotor the events in the system. The event logging service starts automatically, if you execute Windows NT.

System Manager:

The TwinCAT System Manager is started by selecting "System Manager".

PLC Control:

The TwinCAT PLC Control is started by selecting "PLC Control".

Real-time:

The TwinCAT real-time system can also be configured via the context menu. However, this only applies to classification of the processor output.

Echtzeiteinstellung	jen					×
Zeitbasis: 1 ms					С АББ)K
CPU Nutzung/Lim	nit ——					
0%	5	i0 %				100 %
· · · ·	1.1	н н. Т	1	1	1	<u> </u>
				•	1	1
🕞 System Latenzzeit						
Aktuell:	Maxin	nal:		Melo	lung	bei:
Ομε	1	Ομε				0 🔆

Processor time can be assigned to the TwinCAT real-time system via the linear regulator in the figure above. A time basis of one millisecond is cur-rently defined for this purpose. In the example shown, TwinCAT is assigned a maximum of 30 % of the computer time. On a time basis of 1 ms, this means that TwinCAT has a maximum of 300 μ s available each milli-second. Conversely, it means that at least 700 μ s are available to Windows NT. When the TwinCAT real-time system switches to its idle task, the processor is returned to Windows NT. The bar in the linear regulator dis-plays the current utilisation level of the real-time system. The display is averaged over 256 cycles (ms).

System latency time:

In this case, the current and maximum latency times in the real-time sys-tem are shown. The time by which the central system tick arrives too late is measured. The maximum time is saved until the linear regulator is actuated or until the dialog is exited. The latency time is, of course, also measured if the above dialog is not opened

Message in the case of:

If the set maximum time is exceeded, a once-only message is output in the window and a logbook entry is generated. Calling up the above dialog en-ables the message to be reset, so that a message is again output the next time the time is exceeded.

Time basis:

Time basis for calculating the percentage classification. At present, a time basis of 1 millisecond is permanently set.

Router:

The TwinCAT Message Router can represent its internal memory admini-stration and port administration for diagnosis. This service can be called up via the context menu.



Info

MS Router Information	×
Arbeitsspeicher	
Gesamt: 2048	
Verfügbar: 1950	🗖 Mail debugging
Anmeldungen	
Ports: 46	
Server: 5	
Transports: 1	

User memory:

The displayed user memory is required in the TwinCAT system for AMS messages and for memory administration of the TwinCAT real-time envi-ronment. The entire memory is requested with Windows NT when the TwinCAT system is started. The memory size can be configured in the TwinCAT System Control. The user memory required by TwinCAT cannot be relocated.

Total user memory:

The user memory which was available at the system start of TwinCAT.

Available user memory:

The user memory which is currently available for TwinCAT.

Log-ons

All users of the TwinCAT Message System (AMS) must register with the router. TwinCAT servers have fixed port numbers (e.g. TwinCAT NC: 500, TwinCAT PLC LZS1: 801, ...). TwinCAT clients are assigned a port num-ber by the Message Router.

Ports

Number of registered ports

Server

Ports which are occupied by the TwinCAT servers

Transports

Internal only

Mail debugging

In conjunction with the TwinCAT Maildebugger, it is possible to record the entire TwinCAT message traffic. In this case, it must be noted that the message traffic is slowed down by the additional messages. The Maildebugger is not part of the TwinCAT standard scope of delivery.

Cleanup

Ports in the router which originate from no longer functional programs are released again with the "Cleanup" function of the router. This function is particularly appropriate in the development phase of the applications.

System:

If the TwinCAT system is not configured for an automatic start, the start can also be performed manually via the context menu. The configuration of the automatic start is carried out with the TwinCAT System Control. Only the functions which are appropriate in the current operating state are released in the context menu. In the example, the TwinCAT system is in the Stop state, which means that only Start is possible.

The functions in detail:

Start:

The TwinCAT system is started. All entered TwinCAT servers are loaded and initialised. The TwinCAT I/O subsystem is parameterised by the Twin-CAT I/O Manager in accordance with the configuration. All entered run time systems of the PLC subsystem are initialised. If a boot project is entered for a run time system, this is loaded and the PLC program is started. The remaining (retain) data is also loaded in accordance with the configuration. The boot project is generated with the TwinCAT PLC Control. The start behaviour (boot project, data remanence) of the PLC run time system can be configured via the TwinCAT System Control.

Stop:

The TwinCAT system is stopped. All entered TwinCAT servers are shut down and unloaded. After the TwinCAT system stops, there is only the TwinCAT Message Router still in the memory. The TwinCAT system can now be restarted via the "System -> Start".

Restart:

The TwinCAT system is first stopped and is then restarted. This function is useful in the event of changes to the system configuration, because in this way the configuration is again loaded by the restart.

The TwinCAT Message Router can represent its internal memory admini-stration and port administration for diagnosis. This service can be called up via the context menu.

IO:

The TwinCAT I/O subsystem can be reset via the TwinCAT System Ser-vice. For this, the corresponding function must be selected in the context menu. The reset applies to all connected field bus systems. For details, also refer to the documentation of the TwinCAT I/O Manager.

PLC:

A submenu for starting, stopping and resetting a (the) PLC run time sys-tem(s) is opened via PLC. Depending on the number of configured PLC run time systems, another submenu is opened for selecting the run time system.

In this case, the 4 PLC run time systems are configured for the TwinCAT system. Each run time system can be controlled separately.

Properties:

The TwinCAT System Control is started by selecting "Properties".

5.2 TwinCAT System Control

The TwinCAT System Control is a dialog-based application with a separate side for each supported system area.

The tabs:

- <u>General [▶ 19]</u>
- <u>System [▶ 20]</u>
- <u>AMS Router [22]</u>
- <u>PLC [▶ 25]</u>
- <u>Registeration [26]</u>

"General" tab:

General

TwinCAT System Prope	rties	×
General System AMS	8 Router PLC Registration	1
TwinCAT v2.10.0 (System Control Build 153)	
₩ TwinC/ v2.10.0	AT NC I D (Build 1251)	
time limite Copyright	ed to: 20.04.2006, 08:20:07 t BECKHOFF © 1996-2002	
Registration: Name:	Beckhoff	
Company: RegKey:	Beckholf Automation GmbH ????-????-????-????	
	DK Cancel App	ly

On the first side, the user can find general information on the installed TwinCAT version. Whenever contacting TwinCAT Hotline, please always state the data entered here.

"System" tab:

TwinCAT Server	
Tclo TcNc TcNcl TcPlc TcPlc TcRTime	
Add	<u>Bemove</u> <u>Properties</u>
Auto Boot:	C Disable C Enable C Config Mode
Auto Logon	
User Name	
o cor riamo	

This page shows the basic configuration of the TwinCAT system. Here, TwinCAT servers can be added and removed, and the automatic system start can be activated.

Enable Auto Logon:

Here you select 'Enable Auto Logon' and enter your user name and your password. Windows NT accepts this setting once you confirm with 'OK'. If you do not enter a password at this stage, the automatic login will only function once (this is a property of Windows NT).

Cancelling automatic logging in:

In order to stop automatic logging in although the setting has been made, it is necessary to hold the shift key pressed during the login. This interrupts the Auto Logon, and you can then log into Windows NT in the usual way.

TwinCAT can be extended by additional servers. These can be cam switch mechanisms, linear pass controls or other software units. The modularity of TwinCAT now enables this server to be loaded into the TwinCAT system by simple configuration. However, a condition is that the server was compiled with the TwinCAT Server Framework. For Windows NT, TwinCAT servers can be used as unit drivers, thereby enabling the operating state of the TwinCAT server to also be checked in the Windows NT units list.

Important:

Changes on the system side should only be carried out by experienced TwinCAT users or in accordance with the instructions from the TwinCAT Support.

Add TwinCAT servers

This function is necessary when a TwinCAT server is not reported with the system by the standard installation. This can be the case with application-specific TwinCAT servers.

Name

This is the Windows NT unit name. This name addresses the TwinCAT server of Windows NT. In the case of TwinCAT servers, the unit name corresponds to the file name of the TwinCAT server.

Display name

Only used for displaying the Windows NT system, and can be freely issued.

File path

Path to the binary file of the TwinCAT server.

Туре

At present, only Windows NT drivers can function as TwinCAT servers. "DriverType" must therefore be entered here. In future, Win32 services will also be able to operate as TwinCAT servers.

Start mode

TwinCAT servers are started by the TwinCAT System Service. The standard setting is therefore "manual" in this case. A start via Windows NT could be necessary for special TwinCAT servers, which means that the start mode can be changed here.

Remove TwinCAT Server:

When this dialog is acknowledged with OK, the TwinCAT server is removed from the TwinCAT system and from Windows NT. The binary file of the TwinCAT server is, however, not deleted from the hard disk.

TwinCAT	System Control
?	Wollen Sie wirklich TcRTime aus der TwinCAT Server Liste entfernen?
	CK Abbrechen

Properties of a TwinCAT server

Double clicking on the server name in the server list or pressing the "Properties" button opens the above dialog.

In this dialog, the properties of a TwinCAT server (e.g. the path) can be adapted later.

"AMS Router" tab:

AMS Router

The local machine address, the reserved memory and the connections to other TwinCAT systems are defined in the settings for the AMS Message Router.

AMS Net Id

This is the address of the local computer in the TwinCAT network. The "AMS Net Id" consists of 6 bytes and is represented in a point notation. The "Net Ids" must be issued by the project supervisor and must not be repeated in the TwinCAT network. A standard + "1.1" is generated from the installation of an AMS Net Id from the IP address of the system (if present). If no IP address can be determined during installation. the AMS Net Id ".1.1.1.1.1" is generated.

Remote Computer

List of TwinCAT systems which can be reached in the TwinCAT network.

Add remote connection

ld Remote (onnection		
Name:	I		OK
AMS Net Id:			Cancel
Address:			Browse
Transport:	TCP/IP	🚽 🗖 Sid	w Connection

New connections to other TwinCAT systems can be configured with the aid of this dialog.

Browse:

Computer suchen	? ×
Wählen Sie einen Rechner aus der Liste	
Waller de cherrice des der Liste	
🕀 🧶 Gesamtes Netzwerk	
📃 🗐 АСНІММ-NВ	
ACHSENTEST	
ALFONST	
ANDREAG	
ANDREAK1	
ANDREASB-1	
ANDREASS	
ANDREAST-1	_
OK Abbred	chen

It is possible to search for the remote computer via this dialog. After selecting the remote computer, the IP address is fetched and the AMS Net Id is automatically generated. This Net Id corresponds to the standard Net Id following installation.

Remote Verbindung hinzufügen 🔀				
Name:	ACHSENTEST		ОК	
AMS Net Id:	172.16.2.210.1.1		Abbruch	
Adresse:	172.16.3.0		Browse	
Transport:	TCP/IP	🗌 Langsa	me Verbindung	

Name

Symbolic name of the TwinCAT system removed. This name can be freely issued.

AMS Net Id

Address of the removed TwinCAT system.

Address

System address referred to the relevant transport shift. In the above example, TCP/IP is used as the transport shift, whereby the address is interpreted as the IP address.

Transport

The transport shift with which the AMS messages are carried. At present, only TCP/IP is supported as the transport shift.

Slow connection(Langsame Verbindung)

mark up as slow connection

Remove a system from the remote list

After acknowledgement of the dialog, "Machine" is irrevocably removed from the remote list.

TwinCAT	System Control		
?	Wollen Sie wirklich Maschine aus der Remote Liste entfernen?		
	OK Abbrechen		

Properties of the remote connection

Eigenschaften	der Remote Verbindu	ing	×
Remote Name:	Maschine2		OK
AMS Net Id:	0.0.0.0.0		Abbruch
Adresse:	1		
Transport:	TCP/IP	🗖 Langsa	me Verbindung

A remote connection can be subsequently adapted with this dialog.

Further information of the remote connection are described in the <u>documentation TwinCAT Remote Access</u> <u>Service</u>.

"PLC" tab:

neral System AMS Router PLC Registration umber of Run-Time Systems: 1 😤
umber of Run-Time Systems: 1
oot Proiect Path:
:\TwinCAT\Boot Browse
oot Project:
1. Run-Time System (Port: 801)
oad/Store Retain Data:
1. Run-Time System (Port: 801)

The PLC subsystem is configured with the PLC side of the TwinCAT System Control.

Number of run-time systems

The TwinCAT PLC subsystem supports up to 4 run-time systems. The number of run-time systems is set via the above control element.

Boot project path

A separate boot project can be generated for each PLC run-time system. the path from which the boot project should be loaded must be configured here.

Search

To support the user, the boot project path can also be entered via this dialog



Boot project

The loading of a boot project can be activated separately for each run-time system. The boot project of a run-time system is activated or deactivated by a mouse click on the corresponding line. To generate a boot project, start the TwinCAT PLC Control. In the Online menu you will find the selec-tion "Generate a boot project".

Load/store of the retain data

If a boot project is selected for a run-time system, remanent data can also be loaded or written for this runtime system. This option can be selected and deselected via the adjacent selection box.

"TwinCAT registration":

TwinCAT registration

TwinCAT Version

Existing product version

System Id

Unambiguous identification of the local system. State this combination of numbers when registering TwinCAT.

Registration

The registration key which matches the TwinCAT version and the defined system ID. This key is obtained when TwinCAT is registered.

Online

Currently not supported.

Fon

Call number for registering TwinCAT

More Information: www.beckhoff.com/automation

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