

ecomat 300
AC5225

Device state: AF
IO-Link: v. 1.0
ifm firmware: v. 1.16
AS-i master profile: M4

English



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1 On this manual

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1.1 What do the symbols and formats mean?

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The following symbols or pictograms illustrate the notes in our instructions:


⚠ WARNING	
Death or serious irreversible injuries may result.	
⚠ CAUTION	
Slight reversible injuries may result.	
NOTICE	
Property damage is to be expected or may result.	
	Important notes concerning malfunctions or disturbances
	Other remarks
▶ ...	Request for action
> ...	Reaction, result
→ ...	"see"
abc	Cross-reference
123	Decimal number
0x123	Hexadecimal number
0b010	Binary number
[...]	Designation of pushbuttons, buttons or indications

1.2 What devices are described in this manual?

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This manual describes the AS-i IO-Link module AC5225 from **ifm electronic gmbh**.

This manual describes the IO-Link technology in connection with this device.

 about IO-Link → www.io-link.com.

1.3 How is this documentation structured?

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This documentation is a combination of different types of manuals. It is for beginners and also a reference for advanced users. This document is addressed to the programmers of the applications.

How to use this manual:

- Refer to the table of contents to select a specific subject.
- Using the index you can also quickly find a term you are looking for.
- At the beginning of a chapter we will give you a brief overview of its contents.
- Abbreviations and technical terms → Appendix.

In case of malfunctions or uncertainties please contact the manufacturer at:

→ www.ifm.com > Select your country > [Contact].

We want to become even better! Each separate section has an identification number in the top right corner. If you want to inform us about any inconsistencies, indicate this number with the title and the language of this documentation. Thank you very much for your support!

We reserve the right to make alterations which can result in a change of contents of the documentation. You can find the current version on **ifm's** website at:

→ www.ifm.com > Select your country > [Service] > [Download] > [Industrial communication]

1.4 History of the instructions

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What has been changed in this manual? An overview:

Date	Theme	Change
2009-06-30	New creation of the document	---
2016-06-02	Update to firmware version 1.16	<ul style="list-style-type: none"> • Documentation structure • Identification numbers of the text sections • Configuration of the process data image • IO-Link gateway configuration • Process data assignment

2 Safety instructions

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2.1 Please note

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No characteristics are warranted with the information, notes and examples provided in this manual. With the drawings, representations and examples given no responsibility for the system is assumed and no application-specific particularities are taken into account.

- ▶ The manufacturer of the machine/equipment is responsible for ensuring the safety of the machine/equipment.
- ▶ Follow the national and international regulations of the country in which the machine/installation is to be placed on the market!

WARNING

Non-observance of these instructions can lead to property damage or personal injury.

ifm electronic gmbh does not assume any liability in this regard.

- ▶ The acting person must have read and understood the safety instructions and the corresponding chapters in this manual before working on and with this device.
- ▶ The acting person must be authorised to work on the machine/equipment.
- ▶ The acting person must have the qualifications and training required to perform this work.
- ▶ Adhere to the technical data of the devices!
You can find the current data sheet on **ifm's** homepage at:
→ www.ifm.com > Select your country > [Data sheet search] > (article number.) > [Technical data in PDF format]
- ▶ Note the installation and wiring information as well as the functions and features of the devices!
→ supplied installation instructions or on **ifm's** homepage:
→ www.ifm.com > Select your country > [Data sheet search] > (article number.) > [Operating instructions]
- ▶ Please note the corrections and notes in the release notes for the existing documentation, available on the **ifm** website:
→ www.ifm.com > Select your country > [Data sheet search] > (article number.) > [Operating instructions]

2.2 What previous knowledge is required?

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This document is intended for people with knowledge of control technology and PLC programming with IEC 61131-3.

To program the PLC, the people should also be familiar with the CODESYS software.

The document is intended for specialists. These specialists are people who are qualified by their training and their experience to see risks and to avoid possible hazards that may be caused during operation or maintenance of a product. The document contains information about the correct handling of the product.

Read this document before use to familiarise yourself with operating conditions, installation and operation. Keep the document during the entire duration of use of the device.

Adhere to the safety instructions.

2.3 Start-up behaviour of the controller

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WARNING

Danger due to unintentional and dangerous start of machine or plant sections!

- ▶ When creating the program, the programmer must ensure that no unintentional and dangerous start of machines or plant sections after a fault (e.g. e-stop) and the following fault elimination can occur!
⇒ Realise restart inhibit.
- ▶ In case of an error, set the outputs concerned to FALSE in the program!

A restart can, for example, be caused by:

- voltage restoration after power failure
- reset after watchdog response because of too long a cycle time
- error elimination after an E-stop

To ensure a safe behaviour of the controller:

- ▶ Monitor the voltage supply in the application program.
- ▶ In case of an error switch off all relevant outputs in the application program.
- ▶ Monitor actuators which can cause hazardous movements in the application program (feedback).
- ▶ Monitor relay contacts which can cause hazardous movements in the application program (feedback).
- ▶ If necessary, ensure that welded relay contacts in the application project cannot trigger or continue hazardous movements.

2.4 Notes: serial number

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- ▶ In the user's production facility, draw a diagram of the controller network in the machine. Enter the serial number of each controller installed into the network diagram.
- ▶ Before downloading a software component, read out this serial number and check the network diagram to make sure that you are accessing the right controller.

2.5 Notes: TEST inputs

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- ▶ The TEST inputs of all the controllers in the machine should be wired individually and marked clearly so that they can be properly allocated to the controllers.
- ▶ During a service access only activate the TEST input of the controller to be accessed.



3 System description

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3.1 Information about the device

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Please also see the following documents:

→ separate operating instructions of the device:

→ www.ifm.com > Select your country > [Data sheet search] > (article no.) > [Further information].

This manual describes the AS-i IO-Link module AC5225 from **ifm electronic gmbh**.

Device status = AF

IO-Link = version 1.0

ifm firmware = version 1.16

required AS-i master profile = M4

This device provides the following functions:

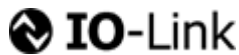
- Operate devices corresponding to the IO-Link standard (actuators, sensors, HMIs and other devices with diagnostic capabilities) mixed with standard devices.
- Connect all these devices with standard 3-pole cables.
- Set the parameters of the IO-Link devices of the fieldbus master via AS-i.
- Transfer cyclic and acyclic data between AS-i and IO-Link in both directions.
- Provide digital and analogue data of the IO-Link devices via AS-i to a higher-level fieldbus master.

3.2 What is IO-Link?

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 → www.io-link.com

3.2.1 Introduction

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For fieldbuses one master communicates with several slaves which the master distinguishes on the basis of the slave addresses. The sensors and actuators connected to the slaves perform either binary or analogue operation. The slaves have to be equipped correspondingly. The parameters of the sensors and actuators can be set during operation.

The IO-Link enables the operation of "smart" sensors and actuators on the existing fieldbus via special modules. IO-Link sensors provide additional diagnostic information on a 3-pole standard cable besides the normal switching output.

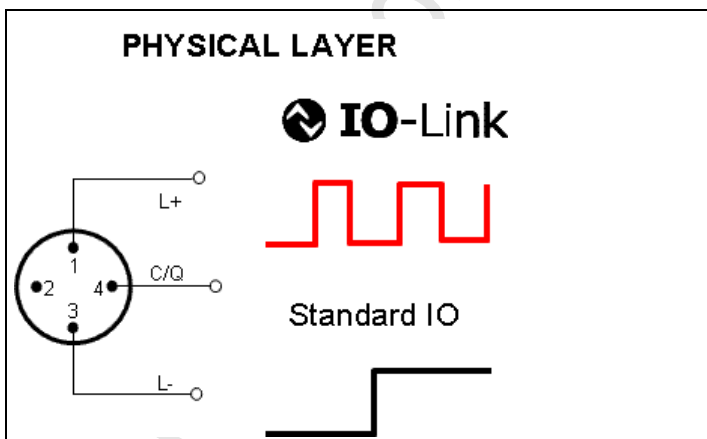
IO-Link is an open system: independent of the fieldbus and the manufacturer. The diagnostic interface is supported by all leading bus systems.

Only the serial communication between the master and the slave are features both of the IO-Link and the fieldbuses. Everything else is different:

- There is no address setting since the data are only exchanged between two participants.
- The IO-Link master communicates with the connected IO-Link device via a point-to-point connection.
- Remote parameter setting of the IO-Link device via the fieldbus is possible.

Advantages of the IO-Link system:

- existing cable topology (here: standard AS-i cables) remains unchanged,
- thanks to the point-to-point connection addressing of the devices is not necessary;
- transmission of diagnostic data without additional wiring: exchange of process data and service data between sensors / actuators and the controller,
- transmission of analogue values without conversion losses,
- fully compatible: Use in parallel to standard devices on the same bus.



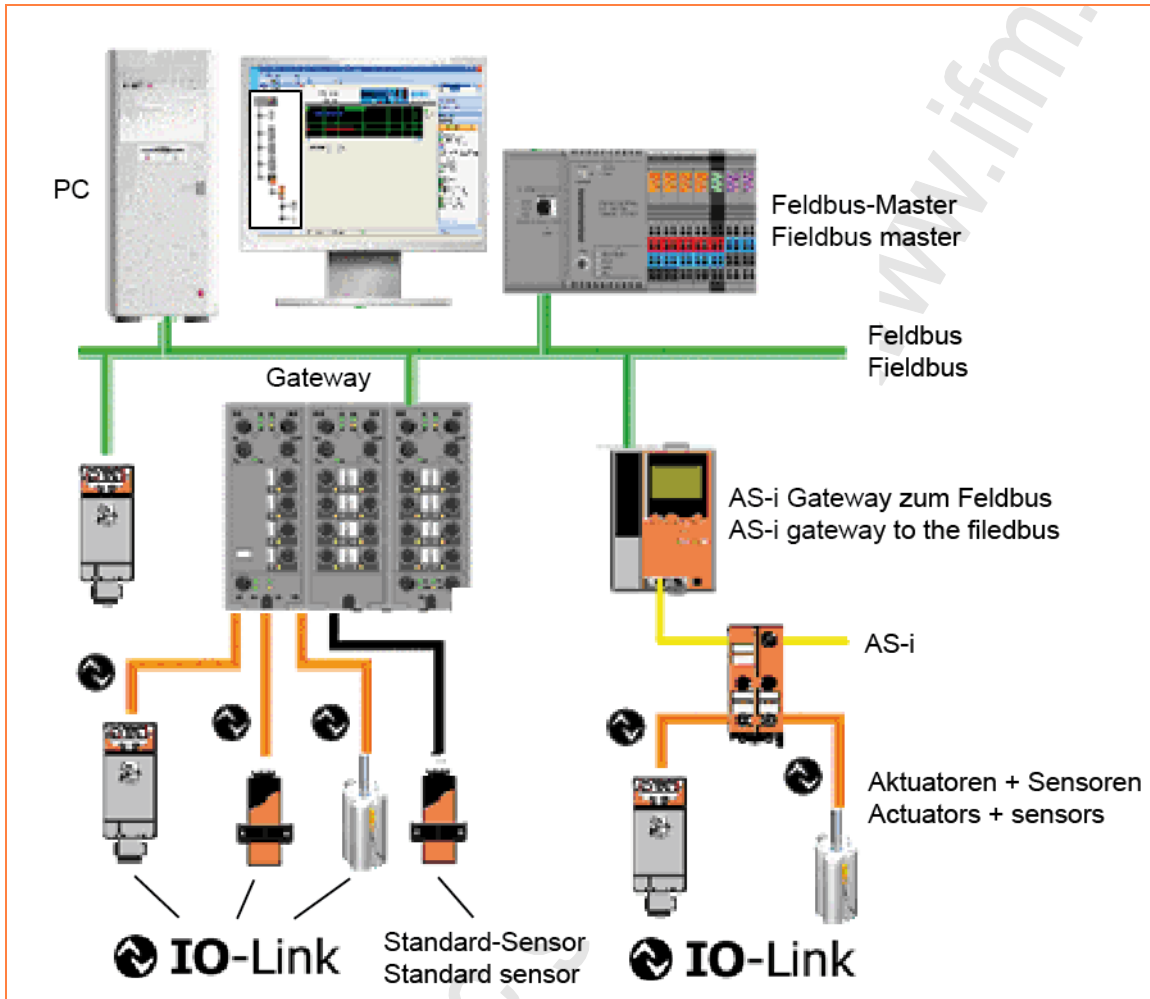
Graphics: Typical signal curve for operation as IO-Link (top) and as digitally-switching (bottom)

IO-Link communication by 24 V pulse modulation, standard UART protocol

3.2.2 IO-Link system architecture

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Example of an IO-Link system architecture:

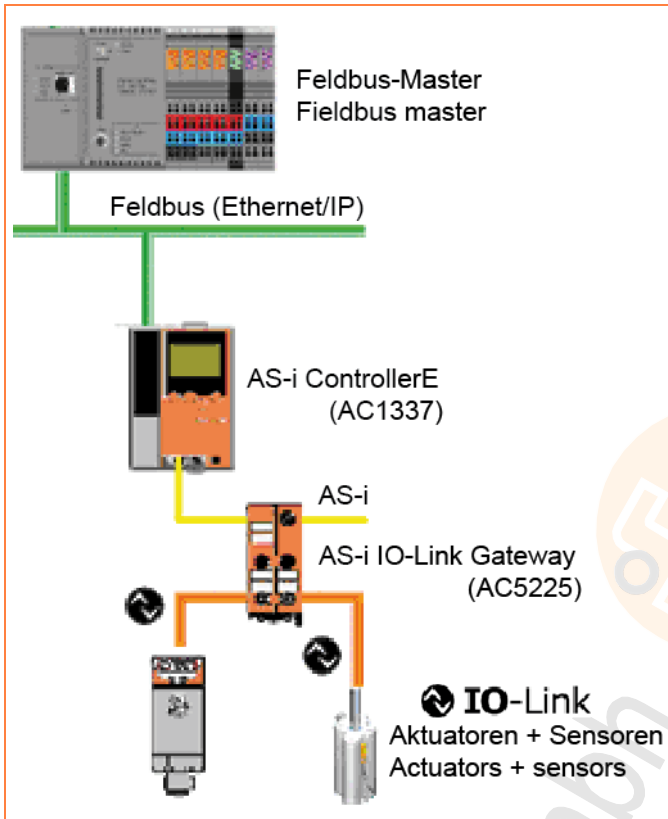


orange cable = IO-Link device
 black cable = standard device
 green cable = fieldbus device

3.2.3 IO-Link flow of information

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Example of IO-Link flow of information:



Graphics: IO-Link sensors communicate with the fieldbus master via an AS-i IO-Link gateway and an AS-i ControllerE.

- > Signal transmission from the IO-Link sensor to the IO-Link master (here: AC5225) via standard sensor cable (orange).
- > Protocol conversion in the IO-Link master to the AS-i slave (in the same device).
- > Data transmission via AS-i cable (yellow) to the AS-i master (here AC1337).
- > Evaluate data in the AS-i master.
- > Transfer result to the higher-level controller via Ethernet/IP (green).

3.3 Description of the device software

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3.3.1 User characteristics

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The presetting of the AS-i link gateway ensures operation of two sensors with two words of cyclic data (process data) each.

The IO-Link port configuration can be changed via function blocks in a higher-level controller or a configuration software on a service PC.

It is also possible to change the setting of the IO-Link devices via function blocks on the control level. To do so the data are to be sent to the AS-i module via AS-i function calls. Then the AS-i IO-Link gateway acts as a transparent transport channel*) and transfers the data to the connected device.

*) "transparent transport channel" means: The data are left unchanged over the whole communication line. Only the transfer protocol changes between the AS-i and the IO-Link systems.

3.3.2 System interface

5126

The system interface is a largely transparent communication interface between the AS-i and the IO-Link system. Transparency is restricted since the device is largely initiated automatically using default values.

3.3.3 User interface

5127

The device does not feature a user interface. It is indirectly available as function calls. Settings of the module and the connected IO-Link devices can be changed via these calls.

3.3.4 Software interface

5128

The device only runs on AS-I masters with master profile M4 complying with the AS-i specification V3.0 [AD5]. To be able to use all functions the master must also support the CTT2 protocol calls for device groups amended in revision 2.

(Overview of the specifications → chapter [Approvals, standards to IO-Link](#) (→ page [45](#)))

3.3.5 Communication interface

5130

The device has 2 communication interfaces:

- via an AS-i communication to the usual AS-i standard to specification V3.0 [AD5],
- via an IO-Link interface per port.
The IO-Link interface is implemented to specification 1.0 [AD1] or partly in anticipation of the specification 1.1 [AD2].

(Overview of the specifications → chapter **Approvals, standards to IO-Link** (→ page [45](#)))

3.3.6 Operating states

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The AS-i IO-Link gateway provides the following operating states:

- **Start-up**
During reset / switch-on the module verifies the identity of the connected IO-Link devices (manufacturer ID, device ID, function ID). In the "plug & comm" mode the identity check is not made. Then cyclic operation is started.
If the "plug & comm" mode is not active, a newly connected device has to be configured before its first use.
- **Cyclic operation**
On the AS-i side data are exchanged normally, i.e. cyclically and acyclically.
On the IO-Link side normal operation is cyclic.
The gateway application assigns the data...
 - referred to the port from AS-i to the IO-Link or
 - referred to the port from the IO-Link to AS-i.
- **Error state with non-compatible device**
If the connected device does not comply with the requirements, the gateway application signals this to the higher-level system and waits for the connection of the correct device.
- **Error in the IO-Link communication**
The faulty communication is displayed via a red LED on the respective IO-Link port. Errors, messages and warnings from the IO-Link application trigger a periphery fault in the AS-i part depending on the hardness set.
- **Removing and connecting the AS-i slave.**
During operation you may remove the AS-i slave from the bus and connect another one or the same one again. After connection of the AS-i slave rebooting is started in the same way as for start-up (→ above).
- **Removing and connecting IO-Link devices**
During operation you may remove IO-Link devices and connect others or the same one again. Connecting devices to the port is to be considered as an IO-Link start-up.

4 AS-i parameters

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4.1 Configuration of the process data image

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The process data image on the various AS-i transfer options are configured...

- via an acyclic command or
- via a defined default assignment.

The requested mode is selected via the AS-i parameter bit P0.

The IO-Link configuration can be set to the "plug & comm" mode by setting the AS-i parameter bit P2. In that mode...

- the ports are operated in the scan mode,
- checking of the connected IO-Link devices is deactivated,
- saving parameters is deactivated.

P0	Enable default data assignment
0	Assignment can be remanently overwritten by the command " Process data assignment (→ page 28)"
1	Default process data assignment is active. (preset) The overwriting of the process data assignment is blocked. The assignment is not changed.
P1	reserved
0	reserved
1	reserved
P2	"Plug & comm" mode activated
0	Configuration can be remanently overwritten via "IO-Link gateway configuration".
1	"Plug & comm" mode is activated. The overwriting of the IO-Link gateway configuration is blocked. The configuration is not changed.

! The "plug & comm" mode cannot be operated with digital outputs (actuators without IO-Link) and can only be used to a limited extent with digital inputs (signal frozen during cyclic wakeup).

P3	reserved
0	reserved
1	reserved

The IO-Link device parameters are always directly changed in the IO-Link device which usually saves this data non-volatily.

Deviations between the projected IO-Link configuration (manufacturer, device and function IDs) and the configuration of the connected devices (with the "plug & comm" mode deactivated) lead to a peripheral-fault message of the AS-i field module.

If one of these IDs is projected with 0x0000, the configuration of this ID is **not** checked.

Upcoming alarm events in the device also lead to a peripheral fault message of the AS-i field module. The type of treatment of unique events must be set beforehand in the service "gateway configuration".

4.2 Data assignment with P0=1

6210

With P0 = 1 (default) the device-specific default data assignment is used. In the following table we show how the input and output ports are supplied:

4.2.1 Transfer switching signals

6211

Port no.	Description
1	switching signal on D0
2	switching signal on D1

The data are transferred cyclically (typical: 5 ms).

4.2.2 Transfer values

6212

Max. 4 input words and 4 output words are available per 16 bits for the transmission of parameter values (depending on the device).

Port no.	Description of D0/D1	Description of the words
1	Bit 0 of the value on D0	words 1 + 2
2	Bit 0 of the value on D1	words 3 + 4

The data are transferred cyclically (typical: 160 ms per word).

5 IO-Link services

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5.1 Acyclic IO-Link services

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Code 16 – Acyclic standard read requests	17
Code 20 – Acyclic device group read requests.....	17
Code 21 – Acyclic device group write request services	18
Code 30 – Acyclic device group exchange request services	18

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 The numbers used in the following tables are decimal numbers unless they are marked differently.

5.1.1 Code 16 – Acyclic standard read requests

5136

Index no..	Description
0	ID object
1	diagnosis object
80	device group

5.1.2 Code 20 – Acyclic device group read requests

5137

Index no..	Description
0	device group ID object
1	device group diagnosis object
2	IO-Link gateway configuration
3	process data assignment
5	port configuration ports 1...2
21 / 22	acyclic input process data ports 1 / 2
31 / 32	acyclic output process data ports 1 / 2
41 / 42	directly addressable diagnosis dataset ports 1 / 2

5.1.3 Code 21 – Acyclic device group write request services

5138

Index no..	Description
2	IO-Link gateway configuration
3	process data assignment
5	port configuration ports 1...2
31 / 32	acyclic output process data port 1 / 2

5.1.4 Code 30 – Acyclic device group exchange request services

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Index no..	Description
51 / 52	write compact parameters ports 1 / 2
61 / 62	read compact parameters ports 1 / 2

5.2 Standard services

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5.2.1 Standard ID object

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This object range describes and identifies the AS-i slave. Identification with reference to

- manufacturer ID and
- device ID.

Request read standard ID object

Byte no.	Description
0	command code 16 = read standard
1	index 0 = ID object
2	length to be read = 5

Reply read standard ID object

Byte no.	Description
0	command code 80 = read standard OK
1	AS-i manufacturer ID (high) = 0x00
2	AS-i manufacturer ID (low) = 0x04
3	AS-i device ID (high) = 0x00
4	AS-i device ID (low) = 0x04
5	number of analogue AS-i inputs and outputs 0xDD (per 4 words transparent data)

5.2.2 Standard diagnosis object

5160

Query if module has an error on the AS-i side or functions without any error.

Request read standard diagnosis object

Byte no.	Description
0	command code 16 = read standard
1	index 1 = diagnosis object
2	length to be read = 1

Reply read standard diagnosis object

Byte no.	Description
0	command code 80 = read standard OK
1	standard diagnosis code: 0x00 = no error 0xFF = error, general

5.2.3 Standard device group object

5167

This object describes an AS-i slave having IO-Link capabilities.

Request read standard device group object

Byte no.	Description
0	command code 16 = read standard
1	index 80 = device group object
2	length to be read = 4

Reply read standard device group object

Byte no.	Description
0	command code 80 = read standard OK
1	device group ID (high byte) 0x00
2	device group ID (low byte) = 0x4E
3	device group specific type (high byte) = 0x00
4	device group specific type (low byte) = 0x00

0x4E means IO-Link device group

5.3 Device group services

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The AS-i specification provides various communication services within the CTT2 command structure.

The standard services are defined in the AS-i profiles and are binding for all CTT2 devices.

The meaning of the manufacturer-specific services is always linked to the manufacturer ID of the device and it is defined by the manufacturer.

Device-group services of the CTT2 are reserved for special AS-i slaves belonging to a certain device group and that are offered by different manufacturers. The device group services described in this manual refer to the device group of the IO-Link AS-i modules.

5.3.1 Device group ID object

5176

This object describes the characteristics of the IO-Link master (e.g. the number of ports).

Request read device group ID object

Byte no.	Description
0	command code 20 = read device group
1	index 0 = device group ID object
2	length to be read = 3

Reply read device group ID object

Byte no.	Description
0	command code 84 = read device group OK
1	number of IO-Link ports = 2
2	supported features
3	reserved

Supported features in the device group ID object

Lists the optional features supported by the IO-Link module. A feature is supported when the respective bit = 1.

Bit no.	Description
0	process data assignment can be changed
1	port configuration can be changed
2	access to IO-link diagnosis data possible
3	compact parameter access possible
4	reserved
5	extended parameter access possible
6	acyclic access to IO-Link process data possible
7	reserved

5.3.2 Device group diagnosis object

5184

The diagnosis object provides a diagnosis overview of the status of the AS-i IO-Link module and the connected IO-Link devices.

NOTE

The reading length can be shortened to the number of existing ports.
The reply of the module must always comprise the requested number of bytes.

Request read device-group diagnosis object

Byte no.	Description
0	command code 20 = read device group
1	index 1 = device group diagnosis object
2	length to be read = 4

Reply read device group diagnosis object

Byte no.	Description
0	command code 84 = read device group OK
1	standard diagnosis code → Standard diagnosis object (→ page 19))
2	diagnosis data flags for ports 1 and 2: - bit 0 for port 1, - bit 1 for port 2, - all other bits = 0. bit = 0 when there are no diagnosis data
3	port 1 Configuration status code (→ page 23)
4	port 2 Configuration status code (→ page 23)

Configuration status code

5189

Shows the device status and the result of the adjustment between projected configuration (manufacturer, device and function IDs) and the IO-Link devices connected to the port. Deviations are shown by "1".

Bit no.	Description
0	manufacturer ID not identical
1	device ID not identical
2	function ID not identical
3	reserved
4, 5	IO-Link production status (→ page 24)
6, 7	reserved

IO-Link device status

5195

The device status ensures an overview of the status of the connected IO-Link device without the reported events having to be evaluated. Depending on the value the directly addressable diagnosis dataset of the connected IO-Link device can be called to get more detailed information.

Production status			Description
0b00	0x0	OK	There is no device failure nor parameter setting failure, device status normal. Or: Device status is not supported by the device.
0b01	0x1	INFORMATION	Special device status, there is no failure. Example: configuration mode
0b10	0x2	WARNING	Device status critical but there is no fault. Example: maintenance recommended or required
0b11	0x3	ERROR	There is an application or device fault. Example: overtemperature, overload

5.3.3 IO-Link gateway configuration

5198

These calls enable the setting of the AS-i IO-Link module or reading back of the settings saved there.

! Since the changes are optional, a read process of the actual settings is required in a device-independent driver after a write request. "Write device group OK" does not acknowledge the requested settings but only the successful transmission.

! If the number of the analogue AS-i inputs and outputs is changed by writing the IO-Link gateway configuration (optional), this change will not become effective until after an AS-i slave reset. The setting of the event level is effective immediately. By setting all parameter bits (P0...P2) all of these settings are reset to default values.

Request read IO-Link gateway configuration

Byte no.	Description
0	command code 20 = read device group
1	index 2 = IO-Link gateway configuration
2	length = 2

Reply read IO-Link gateway configuration

Byte no.	Description
0	command code 84 = read device group OK
1	number of AS-i input and output words (→ Standard ID object (→ page 19))
2	Event level (→ page 25)

Request write IO-Link gateway configuration

Byte no.	Description
0	command code 21 = write device group
1	index 2 = IO-Link gateway configuration
2	length = 2
3	number of AS-i input and output words (default value = 0xDD)
4	Event level (→ page 25)

Reply write IO-Link gateway configuration

Byte no.	Description
0	command code 85 = write device group OK

Event level

5208

This parameter describes the reaction of the AS-i IO-Link module to the events of the IO-Link device.

Event level	Description
0	The AS-i periphery fault is set as long as at least one connected IO-Link device signals a current error state (default).
1	The AS-i periphery fault is not affected by events in the IO-Link device.
2	A new IO-Link event sets the AS-i periphery fault which is only reset by reading the diagnosis dataset of the respective port.

5.3.4 IO-Link port configuration

5213

Using the services described below the port configuration can be written or read by two IO-Link ports each. The port configuration comprises the operating parameters of the IO-Link port and the projected manufacturer, device and function IDs of the IO-Link device to be connected.

Request write IO-Link port configuration

Byte no.	Description write request
0	command code 21 = write device group
1	index 5 = configuration ports 1 and 2
2	length = 18
3	projected port parameters port 1 = 0x00...0xFF (→ IO-Link port parameters (→ page 27))
4, 5	projected IO-Link manufacturer ID port 1
6...8	projected IO-Link device ID port 1
9, 10	projected IO-Link function ID port 1
11	projected port parameters port 2 = 0x00...0xFF (→ IO-Link port parameters (→ page 27))
12, 13	projected IO-Link manufacturer ID port 2
14...16	projected IO-Link device ID port 2
17, 18	projected IO-Link function ID port 2

Reply write IO-Link port configuration

Byte no.	Description reply to write request
0	command code 85 = write device group OK

Request read IO-Link port configuration

Byte no.	Description read request
0	command code: 20 = read device group
1	index: 5 = configuration ports 1 and 2
2	length: 18

Reply read IO-Link port configuration

Byte no.	Description reply to read request
0	command code 84 = read device group OK
1	current port parameter port 1 = 0x00...0xFF (→ IO-Link port parameters (→ page 27))
2, 3	projected IO-Link manufacturer ID port 1
4...6	projected IO-Link device ID port 1
7, 8	projected IO-Link function ID port 1
9	current port parameter port 2 = 0x00...0xFF (→ IO-Link port parameters (→ page 27))
10, 11	projected IO-Link manufacturer ID port 2
12...14	projected IO-Link device ID port 2
15, 16	projected IO-Link function ID port 2

IO-Link port parameters

5223

The projected port parameter defines the operating mode of the IO-Link port.

! NOTE

When the scan mode is defined, the IO-Link master looks for an IO-Link device and activates the respective COM mode as soon as a device has been found.

If a device is removed, the master sends a wake-up signal to detect new devices. To avoid this on connected digital sensors or actuators the respective operating mode has to be projected.

Invalid parameters are discarded.

! Since the changes are optional, a read process of the actual settings is required in a device-independent driver after a write request. "Write device group OK" does not acknowledge the requested settings but only the successful transmission.

Attribute	Coding [bin]	Value (write)	Value (read)
operating mode	nnnn 0001	digital input	digital input
	nnnn 0010	digital output	digital output
	nnnn 0011	scan mode	scan mode
	nnnn 0100	----	COM1 mode
	nnnn 0101	----	COM2 mode
	nnnn 0110	----	COM3 mode
	0000 0000	inactive	inactive
port cycle	nn00 nnnn	free	free

5.3.5 Process data assignment

Contents

Word process data assignment.....	29
Example: Process data assignment for analogue inputs	30
Example: Process data assignment for analogue outputs	30

5228

The type of the process data image is controlled via the AS-i parameter bit P0:

P0	Enable default data assignment
0	Assignment can be remanently overwritten via "Process data assignment (→ page 28)".
1	Default process data assignment is active. (preset) The overwriting of the process data assignment is blocked. The assignment is not changed.

The assignment preset via "process data assignment" is saved in the IO-Link master non-volatily. Changing from P0 = 0 to P0 = 1 deletes the saved assignment.

Request read IO-Link process data assignment

Byte no.	Description
0	Command code 20 = read device group
1	Index 3 = process data assignment for the ports 1 and 2
2	Length = 12

Reply read IO-Link process data assignment

Byte no.	Description
0	Command code 84 = read device group OK
1	reserved
2	reserved
3	reserved
4	reserved
5	Word data assignment analogue inputs port 1
6	Word data assignment analogue outputs port 1
7	reserved
8	reserved
9	reserved
10	reserved
11	Word data assignment analogue inputs port 2
12	Word data assignment analogue outputs port 2

Word process data assignment

5237

The word data assignment specifies the offset of the first word of the process data and the number of words. The write access described below enables setting of the process data assignment via a configuration software.

Request write IO-Link process data assignment

For the inputs and outputs the following applies:

- Sum of the assigned words of both ports:
permissible = 0...4
- Number of words for a port depends on the offset
permissible = 0...4
- Overlapping of the areas configured for port 1 and port 2 is prohibited.

Byte no.	Description
0	Command code 21 = write device group
1	Index 3 = process data assignment for the ports 1 and 2
2	Length = 12
3	= 0
4	= 0 (content is not controlled)
5	= 0 (content is not controlled)
6	= 0
7	Word data assignment analogue inputs port 1
8	Word data assignment analogue outputs port 1
9	= 0
10	= 0 (content is not controlled)
11	= 0 (content is not controlled)
12	= 0
13	Word data assignment analogue inputs port 2
14	Word data assignment analogue outputs port 2

For bytes 7, 8, 13, 14 the following applies:

Bits 7...4 = number of words assigned to a port

Bits 3...0 = word offset, the first word corresponds to the respective port

Reply write IO-Link process data assignment

Byte no.	Description
0	Command code 85 = write device group OK

Example: Process data assignment for analogue inputs

21791

Process data record is 4 words long.

Byte 7 =	0x30	3 words beginning with offset 0	for port 1
Byte 13 =	0x13	1 word beginning with offset 3	for port 2

This results in the following distribution:

Word 0	Word 1	Word 2	Word 3
analogue inputs for port 1	analogue inputs for port 1	analogue inputs for port 1	analogue inputs for port 2

Example: Process data assignment for analogue outputs

21792

Process data record is 4 words long.

Byte 8 =	0x11	1 word beginning with offset 1	for port 1
Byte 14 =	0x12	1 word beginning with offset 2	for port 2

This results in the following distribution:

Word 0	Word 1	Word 2	Word 3
---	analogue outputs for port 1	analogue outputs for port 2	---

5.3.6 Exchange acyclic process data

5244

IO-Link allows up to 32-byte process data in one IO-Link device. The connection of IO-Link devices with process data > 4 words is not the focus of the AS-i IO-Link gateway. Nevertheless access to these process data via the acyclic write / read requests described here is possible. Furthermore access to the process data are also possible for a configuration software, irrespective of the AS-i master used.

! NOTE

- ▶ Data set acyclically also have to be reset acyclically!
- Data set acyclically remain even if communication is interrupted.
Cyclic writing of data overwrites acyclically set values.

Write current output process data

6184

Request write output process data

Byte no.	Description
0	command code 21 = write device group
1	indices 31 / 32 = acyclic output process data ports 1 / 2
2	length = 2...29
3	IO-Link process data subindex: is required if more than 28 bytes or a data section have to be written systematically, otherwise = 0
4...31	up to 28 bytes IO-Link process data

Reply write output process data

Byte no.	Description
0	command code 85 = write device group OK

Read current output process data

5249

Request read output process data image

Byte no.	Description
0	command code 20 = read device group
1	indices 31 / 32 = acyclic output process data ports 1 / 2
2	length = 1...32

Reply read output process data image

Byte no.	Description
0	command code 84 = read device group OK
1...32	up to 32 IO-Link process data bytes

Read current input process data

5254

Request read input process data

Byte no.	Description
0	command code 20 = read device group
1	indices 21 / 22 = acyclic input process data ports 1 / 2
2	length = 1...32

Reply read input process data

Byte no.	Description
0	command code 84 = read device group OK
1...32	up to 32 IO-Link input process data bytes

5.3.7 Read diagnosis dataset

5258

If the diagnosis object refers to an event triggered by an IO-Link device, the detailed diagnosis information of the IO-Link device can be read (referred to the port) via the calls described below.

Request read IO-Link device diagnosis data

Byte no.	Description
0	command code 20 = read device group
1	indices 41 / 42 = diagnosis dataset ports 1 / 2
2	length = 1...20

Reply read IO-Link device diagnosis data

Byte no.	Description
0	command code 84 = read device group OK
1	Example event data (→ page 41)
2	Event status code (→ page 34) *)
3	Event identifier (→ page 36) 1
4, 5	Event code (→ page 37) 1
6	event identifier 2
7, 8	event code 2
9	event identifier 3
10, 11	event code 3
12	event identifier 4
13, 14	event code 4
15	event identifier 5
16, 17	event code 5
18	event identifier 6
19, 20	event code 6

*) If bit 7 in event status = 0 then there is no event identifier and no event code.

Event status code

6100

Event status code (without details)

Bit 7 = 0. The following code applies to bits 0...4:

Bit no.	Description
0	mode = PULSE, type = MESSAGE, instance = Application eventCode = A_MESSAGE
1	mode = PULSE, type = WARNING, instance = Application, eventCode = A_WARNING
2	mode = PULSE, type = ERROR, instance = Application eventCode = A_PARAMETER
3	mode = PULSE, type = ERROR, instance = Application eventCode = A_DEVICE
4	mode = PULSE, type = ERROR, instance = unknown eventCode = S_COMM
5	reserved = 0 In this IO-Link version bit has to be set to zero.
6	invalid process data 1 = device cannot provide valid process data.
7	event details: With this type of status code bit always has to be deleted. 0 = there is no event identifier and no event code.

Event status code (with details)

Bit 7 = 1. There is detailed information about each event as an event identifier and an event code. Bits 0...5 indicate one event each.

Bit no.	Description
0	event 1 0 = event entries in the diagnosis data bytes 3...5 are not (no longer) valid. 1 = event entries in the diagnosis data bytes 3...5 are valid.
1	event 2 0 = event entries in the diagnosis data bytes 6...8 are not (no longer) valid. 1 = event entries in the diagnosis data bytes 6...8 are valid.
2	event 3 0 = event entries in the diagnosis data bytes 9...11 are not (no longer) valid. 1 = event entries in the diagnosis data bytes 9...11 are valid.
3	event 4 0 = event entries in the diagnosis data bytes 12...14 are not (no longer) valid. 1 = event entries in the diagnosis data bytes 12...14 valid.
4	event 5 0 = event entries in the diagnosis data bytes 15...17 are not (no longer) valid. 1 = event entries in the diagnosis data bytes 15...17 are valid.
5	event 6 0 = event entries in the diagnosis data bytes 18...20 are not (no longer) valid. 1 = event entries in the diagnosis data bytes 18...20 are valid.
6	reserved
7	event details 1 = consider the event identifier and the event code.

Event identifier

6102

If in the event status code bit 7 = 1, then there is detailed information about each event as an event identifier and an event code.

Device diagnostic data: Bytes 3, 6, 9, 12, 15, 18 for the event identifier:

Byte no.	Bit							
	7	6	5	4	3	2	1	0
	mode		type		res.	instance		

The event identifier for the **instance** have the following meaning:

Value [bin]	Value [hex]	Meaning
000	0	unknown
001	1	Phy
010	2	DL
011	3	AL
100	4	application
101	5	reserved
110	6	reserved
111	7	reserved

The event identifier for **mode** and **type** have the following meaning:

Value [bin]	Value [hex]	Meaning mode	Meaning type
00	0	reserved	reserved
01	1	event (once)	information
10	2	event terminated	warning
11	3	event arrived	error

Event code

6103

If in the event status code bit 7 = 1, then detailed information about each event is available as an event identifier and an event code.

The event code consists of 2 bytes. There are generally defined event codes and manufacturer-specific ones. Manufacturer-specific event codes are indicated in the operating instructions of the respective device.

The general event codes are divided into two classes:

- Special event codes consisting of two parts. The high byte is the **Diagnostic data error code** (→ page 37) and the low byte the **Other qualification** (→ page 38).
- Standard event codes referring to the application of the device. The generally defined codes are listed in **Supplementary error codes** (→ page 39).

Diagnosis data error code

6106

Type	Source	Name	Category	Mode	Value [hex.]	Description
PDU buffer overflow	device	S_PDU_BUFFER	error	pulse	52	Device buffer is too small to store the complete PDU.
PDU checksum error (master)	master	M_PDU_CHECK	error	pulse	56	Calculated PDU checksum in the master does not match the received SPDU.
PDU checksum error (device)	device	S_PDU_CHECK	error	pulse	56	Calculated PDU checksum in the device does not match the received SPDU.
PDU process control error	device	S_PDU_FLOW	error	pulse	56	Disturbed sequencing rule during the SPDU transfer between master and device.
illegal PDU basic service (master)	master	M_PDU_ILLEGAL	error	pulse	57	Unknown basic service or wrong reply, e.g. read reply to write request.
illegal PDU basic service (device)	device	S_PDU_ILLEGAL	error	pulse	58	Unknown basic service, e.g. different protocol revision.
communication error	master / device	COM_ERR		pulse	10	Negative service reply generated by communication error, e.g. IO-Link connection interrupted.
device application error	device	S_APP_DEV	error	pulse	80	Service PDU transferred but not executed due to device fault. Fault details in the additional code (→ next table)

device = IO-Link device
 master = IO-Link master

Other qualification

6108

Type	Value [hex]	Description
no details	00	
index not available	11	
subindex not available	12	
service currently not available	20	
service currently not available, local control	21	local operation in the device blocks access
service currently not available, local control	22	device status does not allow access, e.g. during the teach process or calibration
access denied	23	e.g. writing on read-only parameter
parameter value outside the permissible range	30	
parameter value too big	31	
parameter value too small	32	
interfering parameter	40	collision with other parameter values
application faulty	81	e.g. separate application and communication processors
application not ready	82	e.g. separate application and communication processors

Supplementary error codes

6110

The following table shows supplementary error codes describing the problem occurred in more detail. The indicated codes are supplements to the **Event identifier** (→ page 36) transferred by the IO-Link.

Code [hex]	Description
0000	no malfunction
1000	general malfunction
1800...1FFF	_general malfunction (manufacturer-specific)
4000	temperature
4100	_ambient temperature
4110	__ambient temperature too high
4120	__ambient temperature too low
4200	_device temperature
4210	__device temperature too high
4220	__device temperature too low
4300	_outside temperature
4310	__outside temperature too high
4320	__outside temperature too low
5000	device hardware
5010	_device hardware components malfunction
5100	_device supply
5110	__device supply undervoltage
5111	__device supply undervoltage U1 = supply +/- 15 V
5112	__device supply undervoltage U2 = supply + 24 V
5113	__device supply undervoltage U3 = supply + 5 V
5114...5119	__device supply undervoltage U4...U9 = manufacturer specific
5151	__device supply short circuit
5160	__device supply periphery
5200	_device controller
5300	_device control section
5400	_device power section
5410	__device power section output driver
5450	__device power section fuses
5451	___device power section fuses S1 = L1
5452	___device power section fuses S2 = L2
5453	___device power section fuses S3 = L3
5454...5459	___device power section fuses S4...S9 = manufacturer specific
5500	_device other communication
5510	__device communication interface 1
5520	__device communication interface 2
6000	device software
6010	_device software reset (watchdog)
6100	_device internal software

Code [hex]	Description
6300	_device software dataset
6310	__device software dataset: parameter loss
6320	__device software dataset: parameter fault
6330	__device software dataset: parameter not initialised
6340	__device software dataset: parameter not specific
6350	__device software dataset: parameter changed
8000	monitoring
8100	_monitoring of the communication
8110	__monitoring of the process data
8C00	_monitoring of the application
8C10	__monitoring of the application: process variable outside the range
8C20	__monitoring of the application: measuring range exceeded
8C30	__monitoring of the application: range for process variable too small
8C40	__monitoring of the application: special warning
8CA0...8CFF	__monitoring of the application: manufacturer-specific
8D00...8DFF	_monitoring, user-defined (customer-specific event assignment)
9000	external malfunction
FF00...FFFF	IO-Link-specific event codes

Example event data

5263

This table is to give an overview of the error messages to be expected (excerpt).

Type	Source	Category	Mode	Event code	Value [hex.]	Description
device PD invalid	device	error	displayed	PD_INVALID	FFF0	PD invalid event from the device
device PD invalid	device	error	disappears	PD_INVALID	FFF0	PD invalid event disappears from the unit
without details						
device message	device	message	pulse	DEVICE	FF80	
device warning	device	warning	pulse	DEVICE	FF80	
device error	device	error	pulse	DEVICE	FF80	
parameter error	device	error	pulse	PARAMETER	6320	from application listing
communication error		error	pulse	COMM	FF10	
with details						
Process data						
address increment error	device	error	pulse	PD_INCR	FFE1	PD address missing
access outside PD length	device	error	pulse	PD_LEN	FFE2	written or read PD too long
incomplete PD length	device	error	pulse	PD_SHORT	FFE3	written or read PD too short
reading on input length 0	device	error	pulse	NO_PDIN	FFE4	
writing on input length 0	device	error	pulse	NO_PDOUT	FFE5	
System administration						
display operating mode	master	message	pulse	NEW_SLAVE	FF21	
Unspecific						
wrong event display	master	error	pulse	Event	FF31	
Application/Machine						
save parameters	device	message	pulse	STORE_PAR	FF91	
restore parameters	device	message	pulse	RESTORE_PAR	FF92	
Com Startup request	device	message	pulse	RESTART_COM	FF98	detailed operating principle TBD
application specific	device	message / warning / error	pulse / appears / disappears		xxxx	for application listing

device = IO-Link device
 master = IO-Link master

5.3.8 Exchange device parameters

6187

Write device parameters

5273

Requirement: The AS-i parameter P2 = 0.

The call described here ensures direct writing access to parameters up to a length of 25 bytes with one single AS-i command.

Request write IO-Link device parameters

Byte no.	Exchange requirement
0	command code 30 = device group data exchange
1	indices 51 / 52 = parameter ports1 / 2
2	reading length = 1
3	writing length = 4...28
4, 5	index = 16 bits IO-Link index (8-bit services use only byte 5)
6	subindex = 8 bits IO-Link subindex (use only with special services)
7...31	up to 25 parameter bytes

Reply write IO-Link device parameters

Byte no.	Exchange reply
0	command code 94 = device group data exchange OK
1	status code (→ page 42) (= 0, if service was executed correctly)

Status code IO-Link device parameters

6094

Status	Definition
0x00	Service reply: - OK, data is valid - done - transfer stopped
0x02	Service is still active in IO-Link. ▶ Resend command.
0x80	Service PDU transferred, but not processed due to a device fault. → Error details in the additional code

Read device parameters

5276

The call enables direct reading access to parameters up to a length of 30 bytes using one single AS-i command.

! NOTE

If the IO-Link service of the IO-Link device provides more bytes than indicated in the reading length, the data length is shortened to the requested number of bytes (surplus bytes will be ignored).

If the IO-Link service of the IO-Link device provides fewer bytes than indicated in the reading length, the requested data length is returned with the surplus bytes being filled with 0.

Request read IO-Link device parameters

Byte no.	Exchange requirement
0	command code 30 = write device group data exchange
1	indices 61 / 62 = parameter page ports 1 / 2
2	reading length = 2...31
3	writing length = 3
4, 5	index = 16 bits IO-Link index (8-bit services use only byte 5)
6	subindex = 8 bits IO-Link subindex (use only with special services)

Reply read IO-Link device parameters

Byte no.	Read reply
0	command code 94 = device group data exchange OK
1	Status code IO-Link device parameters (→ page 42) (= 0, if service was executed correctly)
2...31	up to 30 parameter bytes

6 Troubleshooting

Contents

Check if green LED [PWR] lights	44
Check if red LED [FAULT] lights or is flashing	44
Test device supply voltage	44
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5287

To start with error analysis the following has to be taken into account:

- The AS-i slave has to be connected to the AS-i bus.
- All devices on the AS-i slave have to be removed.

6.1 Check if green LED [PWR] lights

5289

If this is not the case, the following reasons may be the cause:

- Voltage supply is not applied,
- voltage is too low.

6.2 Check if red LED [FAULT] lights or is flashing

5290

Red LED [Fault]	Cause	Remedy
Lights	Communication to master is disturbed.	
Flashing	There is a periphery fault.	Reading the diagnosis object via the AS-i master possible to get information about the IO-Link fault.
	Supply voltage on the IO-Link port can be too low for the connected devices.	Connect the AS-i power supply so that voltage loss due to the cable length is minimised. Use repeater, if necessary.

6.3 Test device supply voltage

5291

- ▶ Measure the device supply voltage from VDD_Out1 and VDD_Out2 between pins 1 and 3 of the M12 output socket.

The voltage must be in a range of 20...30 V.

6.4 Connect the unit

5293

Standard IO device	When the switching output of the sensor is active, the yellow port communication LED has to light.
IO-Link device	The green port communication LED has to light.

7 Approvals, standards for IO-Link

5294

Revision: 2009-05-26

The following specifications are met:

Ref.	Title
[AD1]	IO-Link Specification 1.0
[AD2]	IO-Link Specification 1.1
[AD3]	ParServer_DB 1.0
[AD4]	Port configuration 1.0
[AD5]	AS-i specification 3.0 rev.2
[AD6]	IO-Link integration in AS-i 0.9
[AD7]	IO-Link amendment to specification 1.0 [AD1]
[AD8]	

8 Glossary of Terms

A

A/B slave

AS-i slave with an A or B being appended to its address number and which may therefore be present twice on the →master.

Acyclic data transmission

In general data from the → master are transmitted once per → cycle to one each of the → slaves (= → cyclic data transmission).

Data transmission only at certain events (e.g. when the device is switched on or when values have been changed) is called acyclic data transmission.

Address

This is the "name" of the bus participant. All participants need a unique address so that the signals can be exchanged without problem.

Application software

Software specific to the application, implemented by the machine manufacturer, generally containing logic sequences, limits and expressions that control the appropriate inputs, outputs, calculations and decisions.

Architecture

Specific configuration of hardware and/or software elements in a system.

AS-i

The AS-Interface (AS-i = Actuator Sensor Interface) is a standard for fieldbus communication to EN 50295 and IEC 62026-2. It was developed for the connection of actuators and sensors with a simple wiring to replace the conventional parallel wiring.

An unscreened two-wire yellow flat cable (max. 500 m) serves for data transmission as well as for voltage supply (24...30 V DC) for the communication electronics and for participants with a low current requirement. Loads with a greater energy requirement additionally receive a separate (black) flat cable for energy supply with 24 V DC.

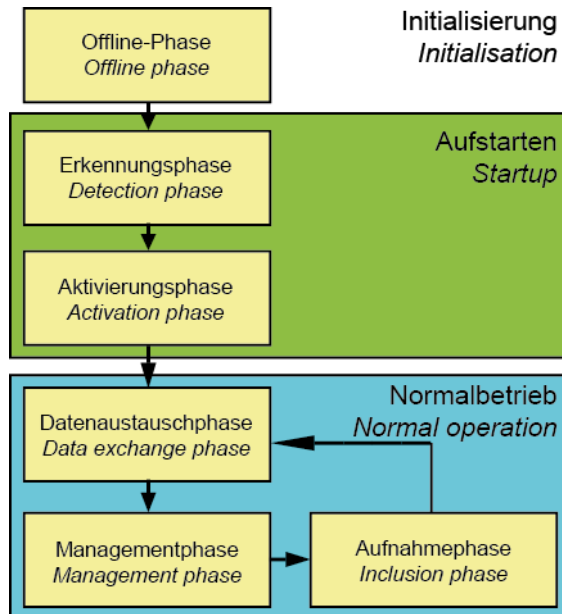
AS-Interface is a single master system. Up to 62 slaves can be connected per master. Each of these slaves needs an unambiguous address. The master cyclically polls (→Polling) all projected slaves and exchanges the up to 248 input data and 186 output data with them.

 → www.as-interface.net AS-International Association (user association)

AS-i cycle

An AS-i cycle contains the data exchange of up to 31 slaves plus a telegram inclusion phase plus, if required, a telegram management phase (→ **AS-i phases (status machine)** (→ page 46)). In the case of the extended addressing mode, two AS-i cycles are required for data transfer to all A/B slaves.

AS-i phases (status machine)



- Offline phase: No AS-i data traffic takes place during initialisation.
- Detection phase: In the detection phase, the AS-i master first of all searches for existing slaves - irrespective of whether they are projected or not.
- Activation phase: In this phase, the found slaves are activated depending on the operating mode.
- Data exchange phase: The AS-i master carries out cyclical data exchange with the activated slaves.
- Management phase: At the end of a cycle the AS-i master goes into the management phase, during which the master can send a command to a specific slave (if requested).
- Inclusion phase: After this, the AS-i master goes into the inclusion phase, during which it sends a command to a free slave address to detect new slaves.

ASIsafe

The name for 'Safety at Work' used by Siemens.

Assembly Instance

Assembly Instances are parameters of a logical connection (→Connection). They describe which data at which length are to be transmitted between the communication nodes.

The following Assembly Instances exist:

- Input
- Output
- Configuration

In a logical connection each of these Assembly Instances can only be used **once**. The Assembly Instance type Configuration must only be used once in an Assembly Instance for one and the same communication node.

B

Baud

Baud, abbrev.: Bd = unit for the data transmission speed. Do not confuse baud with "bits per second" (bps, bits/s). Baud indicates the number of changes of state (steps, cycles) per second over a transmission length. But it is not defined how many bits per step are transmitted. The name baud can be traced back to the French inventor J. M. Baudot whose code was used for telex machines.
1 MBd = 1024 x 1024 Bd = 1 048 576 Bd

Burst errors

Burst errors are → faults occurring depending on others. The class indicates the maximum permissible number of burst errors:

Class 1 = high protection,

Class 2 = lower protection etc.

Bus

Serial data transmission of several participants on the same cable.

C

CCDI

CCDI = **CTT Configuration Data Image** = current CTT configuration
Configuration of 7.4 and 7.5 slaves currently determined by the AS-i master:

- Manufacturer ID,
- Vendor ID,
- Device ID,
- Device Group ID.

CDI

CDI = **Configuration Data Image** = current AS-i configuration

The configuration of the connected AS-i slaves determined by the AS-i master:

LDS and AS-i profiles (IO, ID, ID1, ID2)

CIP

CIP = **Common Industrial Protocol**

Object-oriented description of a communication protocol for industrial requirements. Presently used for the fieldbus systems DeviceNet, ControlNet and EtherNet/IP.

CODESYS

CODESYS® is a registered trademark of 3S – Smart Software Solutions GmbH, Germany.

'CODESYS for Automation Alliance' associates companies of the automation industry whose hardware devices are all programmed with the widely used IEC 61131-3 development tool CODESYS®.

Homepage → www.codesys.com

Connection

Describes the logical connection between 2 application objects.

ControllerE

Master in the AS-i bus system of the generation E.

CTT

e.g. CTT2 = Combined Transaction Type 2

→ **Combined transaction – Use of analogue channels in the gateway depending on the slave profile**

Cycle time

This is the time for one cycle. The following happens:

- PLC cycle: The PLC program performs one complete run.
- AS-i cycle: all AS-i slaves are updated (5...10 ms).
The cycle time mainly depends on the AS-i slaves involved in the data exchange. Message errors and management phase may extend the cycle time (⇒ no constant cycle time).

Cyclic data transmission

Data are transmitted to one slave at a time by the master once per cycle.

Cyclical polling

AS-i master cyclically polls the data of all →slaves in the →bus (see above). The data is updated in the →master after max. 5 ms. If →A/B slaves are used, the →cycle time can be extended to 10 ms.

D

Data image (AS-i)

See →process image; sum of all digital and analogue input and output data.

As regards the time, the data image represents the current condition of each individual slave and NOT a consistent image of the entire AS-i network at an exact point in time.

Data type

Depending on the data type, values of different sizes can be stored.

Data type	min. value	max. value	size in the memory
BOOL	FALSE	TRUE	8 bits = 1 byte
BYTE	0	255	8 bits = 1 byte
WORD	0	65 535	16 bits = 2 bytes
DWORD	0	4 294 967 295	32 bits = 4 bytes
SINT	-128	127	8 bits = 1 byte
USINT	0	255	8 bits = 1 byte
INT	-32 768	32 767	16 bits = 2 bytes
UINT	0	65 535	16 bits = 2 bytes
DINT	-2 147 483 648	2 147 483 647	32 bits = 4 bytes
UDINT	0	4 294 967 295	32 bits = 4 bytes
REAL	$-3.402823466 \cdot 10^{38}$	$3.402823466 \cdot 10^{38}$	32 bits = 4 bytes
ULINT	0	18 446 744 073 709 551 615	64 Bit = 8 Bytes
STRING			number of char. + 1

DeviceNet

Fieldbus system for larger data volumes based on →CAN technology, requires special cables, complex connection technology. Can be used e.g. as a supplier for AS-i over longer distances. Corresponding →gateways are available.

DHCP

DHCP = **D**ynamic **H**ost **C**onfiguration **P**rotocol = protocol for the dynamic configuration by the →host. DHCP is a protocol that provides dynamic configuration of IP addresses and associated information. The protocol supports use of IP addresses which are only available in limited number by a centralised management of the address assignment. The participant logs on to a server with this service when it is switched on in a network for the first time. The server assigns a local free →IP address to the participant.

Diagnosis

During the diagnosis, the "state of health" of the device is checked. It is to be found out if and what →faults are given in the device.

Depending on the device, the inputs and outputs can also be monitored for their correct function.

- wire break,
- short circuit,
- value outside range.

For diagnosis, configuration and log data can be used, created during the "normal" operation of the device.

The correct start of the system components is monitored during the initialisation and start phase.

Errors are recorded in the log file.

For further diagnosis, self-tests can also be carried out.

DRAM

DRAM = **D**ynamic **R**andom **A**ccess **M**emory.

Technology for an electronic memory module with random access (Random Access Memory, RAM). The memory element is a capacitor which is either charged or discharged. It becomes accessible via a switching transistor and is either read or overwritten with new contents. The memory contents are volatile: the stored information is lost in case of lacking operating voltage or too late restart.

E

EDS

EDS = **E**lectronic **D**ata **S**heet

An EDS is a device description file in ASCII format, comparable to the GSD or the GSDML file of Profibus or Profinet.

EMC

EMC = **E**lectro **M**agnetic **C**ompatibility.

According to the EC directive (2004/108/EEC) concerning electromagnetic compatibility (in short EMC directive) requirements are made for electrical and electronic apparatus, equipment, systems or components to operate satisfactorily in the existing electromagnetic environment. The devices must not interfere with their environment and must not be adversely influenced by external electromagnetic interference.

Ethernet

Ethernet is a widely used, manufacturer-independent technology which enables data transmission in the network at a speed of 10...10 000 million bits per second (Mbps). Ethernet belongs to the family of so-called "optimum data transmission" on a non exclusive transmission medium. The concept was developed in 1972 and specified as IEEE 802.3 in 1985.

Explicit Messaging

Acyclic data exchange between → I/O scanner and → I/O adapter based on the TCP/IP communication protocol.

F

FC

FC = flat cable. The yellow or black AS-i cable is meant.

FE – functional earth

Functional earth is a reference potential which is not connected to protective earth or only connected when special measures are taken. The functional earth serves as equalisation of potential for an ungrounded installation (e.g. →SELV).

Fieldbus

A →bus for industrial applications: mechanically extremely robust and excellent data protection.

Firmware

System software, basic program in the device, virtually the →runtime system.

The firmware establishes the connection between the hardware of the device and the application program. The firmware is provided by the manufacturer of the controller as a part of the system and cannot be changed by the user.

Flash memory

Flash ROM (or flash EPROM or flash memory) combines the advantages of semiconductor memory and hard disks. Similar to a hard disk, the data are however written and deleted blockwise in data blocks up to 64, 128, 256, 1024, ... bytes at the same time.

Advantages of flash memories

- The stored data are maintained even if there is no supply voltage.
- Due to the absence of moving parts, flash is noiseless and insensitive to shocks and magnetic fields.

Disadvantages of flash memories

- A storage cell can tolerate a limited number of write and delete processes:
 - Multi-level cells: typ. 10 000 cycles
 - Single level cells: typ. 100 000 cycles
- Given that a write process writes memory blocks of between 16 and 128 Kbytes at the same time, memory cells which require no change are used as well.

FMEA

FMEA = **F**ailure **M**ode and **E**ffects **A**nalysis.

Method of reliability engineering, to find potential weak points. Within the framework of quality or security management, the FMEA is used preventively to prevent faults and increase the technical reliability.

FRAM

FRAM, or also FeRAM, means **F**erroelectric **R**andom **A**ccess **M**emory. The storage operation and erasing operation is carried out by a polarisation change in a ferroelectric layer.

Advantages of FRAM as compared to conventional read-only memories:

- non-volatile,
- compatible with common EEPROMs, but:
- access time approx. 100 ns,
- nearly unlimited access cycles possible.

G

Gateway

Gateway = access, coupler.

Gateways enable connection of completely different systems. Gateways are used when two incompatible network types are to be connected by converting the protocol of one system to the protocol of the other system.

Example: connection between AS-i and higher-level fieldbus systems such as →Ethernet DP, →DeviceNet, Interbus-S or other interfaces, e.g. RS-485. The device includes an AS-i master which is directly coupled to the →host interface (e.g. Ethernet DP slave).

Gateway transfer time

The time that is needed for the input data in the DP-RAM of the AS-i master to be copied into the output data of the netX, and vice versa. The distance from DP-RAM to DP-RAM is decisive.

GSD

Generic **S**tation **D**escription

Describes the interface to the device to be connected to the fieldbus.

You can find the current version of the GSD file on the **ifm** homepage:

→ www.ifm.com > Select your country > [Service] > [Download] > [Industrial communication]

e.g. for AC1375:

→ GSD file for SmartLink AC1375

→ download the file ifm...07E5.gsd (... = version)

GSDML

GSDML = **G**eneric **S**tation **D**escription **M**arkup **L**anguage.

Description language which can describe the characteristics of a device family across several levels.

In this XML scheme, as much as possible of the semantics of the →GSD was adopted.

H

HMI

HMI = **H**uman **M**achine **I**nterface

Host

The controller in the hierarchy above the AS-i master, e.g. a PLC or a processor.

I

I&M

I&M = **I**dentification & **M**aintenance

→ chapter **I&M data**

→ Profibus Profile Guidelines Part 1:
Identification & Maintenance Functions

I/O adapter

Decentralised device in an EtherNet/IP network (e.g. AC1421/AC1422)

I/O scanner

Coupling element for the connection of decentralised devices to an EtherNet/IP controller.

ID

ID = **I**dentifier

Name to differentiate the devices / participants connected to a system or the message packets transmitted between the participants.

IEC 61131

Standard: Basics of programmable logic controllers

- Part 1: General information
- Part 2: Production equipment requirements and tests
- Part 3: Programming languages
- Part 5: Communication
- Part 7: Fuzzy Control Programming

Implicit Messaging

Cyclic data exchange between → I/O scanner and → I/O adapter based on the UDP/IP communication protocol. Works based on the Producer-Consumer model, i.e. both communication nodes know the structure of the data to be exchanged before data transmission starts.

Instructions

Superordinate word for one of the following terms:

installation instructions, data sheet, user information, operating instructions, device manual, installation information, online help, system manual, programming manual, etc.

Intended use

Use of a product in accordance with the information provided in the instructions for use.

IO-Link

Point-to-point connection between 2 devices. The following transmission is possible:

- binary signals or
- greater data fields for parameter setting.

 → www.io-link.com

IP address

IP = Internet Protocol.

The IP address is a number which is necessary to clearly identify an internet participant. For the sake of clarity the number is written in 4 decimal values, e.g. 127.215.205.156.

J

Jitter

Jitter means a slight fluctuation in accuracy in the transmission cycle when transmitting digital signals. More generally, jitter in transmission technology means an abrupt and undesired change of the signal characteristics.

L

LAS

List of Active → Slaves.

In this slave list the AS-i master enters the slaves detected as active for this →master.

LDS

List of Detected → Slaves.

In this slave list the AS-i master enters the slaves detected as present for this →master.

LED

LED = Light Emitting Diode.

Light emitting diode, also called luminescent diode, an electronic element of high coloured luminosity at small volume with negligible power loss.

LFS

List of Failed Slaves = list of →slaves with configuration errors.

In this slave list the AS-i master enters the slaves with a projection error on this →master.

Link

A link is a cross-reference to another part in the document or to an external document.

LKCS

LKCS = List of Known CTT Slaves

In this list the CTT slaves (profile 7.4 and 7.5) which are indicated in the LDS and whose CTT configuration has already been read are entered. This list is independent of the LDS, LPS, LAS and LNACS.

LNACS

LNACS = List of **Not Activated CTT Slaves**

In this list, the CTT slaves (profiles 7.4 and 7.5) which have been detected as CTT slaves but not activated are entered. As soon as the slave is entered in the LAS, it is deleted from this list. These slaves only take part in the data exchange until the CTT configuration has been read.

LPS

List of **Projected →Slaves**.

In this slave list the AS-i master enters the slaves projected for this →master.

LSB

Least **S**ignificant **B**it/Byte

M

MAC-ID

MAC = **M**anufacturer's **A**ddress **C**ode
= manufacturer's serial number.

→ID = **I**dentifier

Every network card has a MAC address, a clearly defined worldwide unique numerical code, more or less a kind of serial number. Such a MAC address is a sequence of 6 hexadecimal numbers, e.g. "00-0C-6E-D0-02-3F".

Master

Handles the complete organisation on the bus. The master decides on the bus access time and polls the →slaves cyclically.

Master-slave communication

AS-i strictly operates to the master-slave principle. The master polls all slaves one after the other in always the same order. Only one master per network line is allowed (→cyclical polling).

MBd

MegaBaud

Baud, abbrev.: Bd = unit for the data transmission speed. Do not confuse baud with "bits per second" (bps, bits/s). Baud indicates the number of changes of state (steps, cycles) per second over a transmission length. But it is not defined how many bits per step are transmitted. The name baud can be traced back to the French inventor J. M. Baudot whose code was used for telex machines.

1 MBd = 1024 x 1024 Bd = 1 048 576 Bd

MMI

→ **HMI** (→ page [52](#))

Modbus

The Modbus protocol is a communication protocol based on a →master/slave architecture and was generated by Modicon (since 1994: Groupe Schneider) in 1979 for communication with its PLCs. In the industry, Modbus has become a de facto standard.

Modbus/TCP is based on →Ethernet TCP/IP. Modbus/TCP ports the protocol defined for the serial interface to TCP. The →IP address clearly identifies each device in a network. Therefore the slave address was used to identify one of several logical units (unit IDs) in a physical device. To do so, the extended IP addressing is used.

Example: 192.168.83.28.1 means unit ID 1 on IP address 192.168.83.28.

MRAM

MRAM = **M**agneto**r**esistive **R**andom **A**ccess **M**emory

The information is stored by means of magnetic storage elements. The property of certain materials is used to change their electrical resistance when exposed to magnetic fields.

Advantages of MRAM as compared to conventional RAM memories:

- non volatile (like FRAM), but:
- access time only approx. 35 ns,
- unlimited number of access cycles possible.

MSB

Most **S**ignificant **B**it/**B**yte

O

OSC

OSC = **O**nline **S**upport **C**enter → **O**nline **S**upport **C**enter (**OSC**)

Help system in the device

OSSD

OSSD = **O**utput **S**ignal **S**witching **D**evice

= output signal of a safety switching device, e.g. SafetySwitch, AS-i safety monitor.

P

Password

AS-i controllerE: in the menu [System Setup], menu item [Password] the handling can be restricted or enabled. When delivered, the device is in the user mode. By entering an invalid password (e.g. 1000) all menu items which can change settings are blocked.

PCCD

PCCD = **P**rojected **C**TT **C**onfiguration **D**ata.

Configuration data for the 7.4 and 7.5 slaves stored in the device:

- manufacturer ID,
- vendor ID,
- device ID,
- device group ID.

PCD

PCD = **Projected Configuration Data**

Configuration data stored in the device: → LPS and AS-i profile (IO, ID, ID1, ID2)

PDM

PDM = **Process and Dialogue Module**.

Device for communication of the operator with the machine / plant.

PELV

PELV = **Protective Extra Low Voltage**

Functional extra low voltage with safe separation, grounded variant of →SELV. The specification as PELV system to IEC 364-4-41 covers a measure to protect against direct and indirect contact with dangerous voltages by a "safe separation" between primary and secondary side in the device (e.g. power supply to PELV specification).

For this reason no separate PE conductor is required in a PELV system. It is allowed to ground circuits and / or bodies in a PELV system.

Pictogram

Pictograms are figurative symbols which convey information by a simplified graphic representation.

(→ chapter **What do the symbols and formats mean?** (→ page 4))

PLC configuration

Part of the CODESYS user interface.

- ▶ The programmer tells the programming system which hardware is to be programmed.
- > CODESYS loads the corresponding libraries.
- > Reading and writing the periphery states (inputs/outputs) is possible.

Polling

to poll = to count votes

The controller master fetches the data from every participant in the system successively:

1. Master calls participant 1.
2. Participant 1 replies with its current data (actual values).
3. Master transfers more data (target values) to participant 1, if needed.
4. Participant 1 acknowledges reception of the data.

etc. the same procedure for each further participant.

AS-i, →cyclical polling: AS-i master cyclically polls the data of all →slaves in the →bus (see above).

The data is updated in the →master after max. 5 ms. If →A/B slaves are used, the →cycle time can be extended to 10 ms.

Power-on delay time

The time required by the controller K6 from the application of the voltage supply until all of the following targets are reached:

- both AS-i networks have reached normal operation
- the master has read the configuration data of the CTTx slaves
- the field buses can use the gateway (optional)
- the PLC program was started (optional).

Process image

Process image is the status of the inputs and outputs the PLC operates with within one →cycle.

- At the beginning of the cycle the PLC reads the conditions of all inputs into the process image. During the cycle the PLC cannot detect changes to the inputs.
- During the cycle the outputs are only changed virtually (in the process image).
- At the end of the cycle the PLC writes the virtual output states to the real outputs.

Profibus

PROFIBUS (**Process Field Bus**) is a standard for →fieldbus communication in automation technology. There are two versions of PROFIBUS, DP being the one most widely used.

- PROFIBUS-DP (decentralised periphery) for the control of sensors and actuators by a central controller in manufacturing engineering and for networking of several controllers among each other. Data rates up to 12 Mbits/s on twisted two-wire cables and/or fibre optics are possible.
- PROFIBUS-PA (process automation) is used for the control of measurement devices by a process control system in process technology and is suited for hazardous areas (zones 0 and 1). Only a limited current flows on the bus cables in an intrinsically safe circuit so that even in case of a problem no explosive sparks can occur. A disadvantage of PROFIBUS-PA is the relatively slow data transfer rate of 31.25 Kbits/s.



→ www.profibus.com (umbrella organisation)

Profinet

PROFINET (**Process Field Network**) is the open Industrial Ethernet Standard of Profibus & Profinet International (PI) for automation. Profinet uses TCP/IP and IT standards, is real-time Ethernet compatible and enables the integration of fieldbus systems.

The Profinet concept has a modular design, so that the user can choose the functionality himself. This is basically different as regards the type of data exchange, to meet the requirements regarding the speed.

For Profinet, there are the two perspectives Profinet-CBA and Profinet-IO:

- Profinet-CBA (Component Based Automation) is intended for the component-based communication via TCP/IP and the real-time communication for real-time requirements in modular plant construction. Both ways of communication can be used in parallel.
- Profinet-IO has been created for real-time (RT) and synchronous communication IRT (IRT = isochronous real-time) with the decentralised periphery. The designations RT and IRT only describe the real-time characteristics in the communication within Profinet-IO.



→ www.profibus.com (umbrella organisation)

R

Redundant

Redundancy is the presence of more than the necessary means so that a function unit performs a requested function or that data can represent information.

Several kinds of redundancy are distinguished:

- Functional redundancy aims at designing safety-related systems in multiple ways in parallel so that in the event of a →failure of one component the others ensure the task.
- In addition it is tried to separate redundant systems from each other with regard to space. Thus the →risk that they are affected by a common interference is minimised.
- Finally, components from different manufacturers are sometimes used to avoid that a systematic fault causes all redundant systems to fail (→diverse redundancy).

The software of redundant systems should differ in the following aspects:

- specification (different teams),
- specification language,
- programming (different teams),
- programming language,
- compiler.

remanent

Remanent data is protected against data loss in case of power failure.

The →runtime system for example automatically copies the remanent data to a →flash memory as soon as the voltage supply falls below a critical value. If the voltage supply is available again, the runtime system loads the remanent data back to the RAM memory.

The data in the RAM memory of a controller, however, is volatile and normally lost in case of power failure.

RPI

RPI = Requested Packet Intervall

RTC

RTC = Real Time Clock

Provides (batter-backed) the current date and time. Frequent use for the storage of error message protocols.

RTS

RTS = Runtime System

Runtime systems are basic versions of applications. These minimum versions are supplied with certain products to meet the prerequisites for the execution of the actual product or to be able to look at or use results generated by this product on other processors: making available all routines required to execute a program in a programming language, e.g. interactions with the →runtime system, memory requirements, error routines, inputs and outputs.

Runtime system

Basic program in the device, establishes the connection between the hardware of the device and the application program.

S

SD card

An SD memory card (short for **Secure Digital Memory Card**) is a digital storage medium that operates to the principle of →flash storage.

Self-test

Test program that actively tests components or devices. The program is started by the user and takes a certain time. The result is a test protocol (log file) which shows what was tested and if the result is positive or negative.

SELV

SELV = **S**afety **E**xtra **L**ow **V**oltage

Active parts of safety extra low voltage circuits must neither be connected to ground nor to protective wires of other circuits. They must be safely separated from active parts with higher voltage.

SELV circuit = secondary circuit (output voltage) which is rated and protected so that its voltages do not exceed a safe value in case of correct operation (of the power supply) or in case of a single →fault (of the power supply).

SELV circuits are separated from the input voltage (mains voltage) by double or enhanced insulation. The voltage value must not exceed 60 V DC (or 42.4 V AC).

Single slave

→Slave whose address number may only occur once on the →master.

Slave

Passive participant on the bus, only replies on request of the →master. Slaves have a clearly defined and unique →address in the bus.

Slave configuration

The following terms need to be distinguished...

- AS-i projected configuration (→**PCD** (→ page [56](#))),
- AS-i current configuration (→**CDI** (→ page [48](#))),
- CTT projected configuration (→**PCCD** (→ page [56](#))),
- CTT current configuration (→**CCDI** (→ page [48](#))).

Symbols

Pictograms are figurative symbols which convey information by a simplified graphic representation. (→ chapter **What do the symbols and formats mean?** (→ page [4](#)))

System variable

Variable to which access can be made via IEC address or symbol name from the PLC.

T

Target

The target contains the hardware description of the target device for CODESYS, e.g.: inputs and outputs, memory, file locations.

Corresponds to an electronic data sheet.

TCP

The **T**ransmission **C**ontrol **P**rotocol is part of the TCP/IP protocol family. Each TCP/IP data connection has a transmitter and a receiver. This principle is a connection-oriented data transmission. In the TCP/IP protocol family the TCP as the connection-oriented protocol assumes the task of data protection, data flow control and takes measures in the event of data loss. (compare: →UDP)

U

UDP

UDP (**U**ser **D**atagram **P**rotocol) is a minimal connectionless network protocol which belongs to the transport layer of the internet protocol family. The task of UDP is to ensure that data which is transmitted via the internet is passed to the right application.

At present network variables based on →CAN and UDP are implemented. The values of the variables are automatically exchanged on the basis of broadcast messages. In UDP they are implemented as broadcast messages, in CAN as →PDOs.

According to the protocol, these services are unconfirmed data transmission: it is not checked whether the receiver receives the message. Exchange of network variables corresponds to a "1 to n connection" (1 transmitter to n receivers).

Unit ID

→Modbus

Use, intended

Use of a product in accordance with the information provided in the instructions for use.

W

Watchdog

In general the term watchdog is used for a component of a system which watches the function of other components. If a possible malfunction is detected, this is either signalled or suitable program branchings are activated. The signal or branchings serve as a trigger for other co-operating system components to solve the problem.

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