IL MOD BK DI8 DO4-PAC

Inline, bus coupler, Modbus/RTU, D-SUB 9 socket, digital inputs: 8, 24 V DC, digital outputs: 4, 24 V DC, 500 mA

Data sheet
7258_en_06

1 Description

The bus coupler with integrated I/Os is intended for use within a Modbus RTU/ASCII network and represents the link to the Inline I/O system.
Up to 61 Inline devices can be connected to the bus coupler.
The bus coupler supports a maximum of 8 PCP devices.

Features

- Modbus connection via 9-pos. D-SUB socket
- Electrical isolation between Modbus interface and logic
- 8 digital inputs, 4 digital outputs onboard
- Data transmission speed in Modbus of 1.2 kbps to 115.2 kbps (configurable)
- Rotary coding switches for setting the Modbus address and for configuration
- Supported Modbus addresses from 1 to 99
- Automatic detection of the transmission speed in the local bus (500 kbps or 2 Mbps)
- Shipbuilding and UL approvals

Valid from firmware version 1.03.

WARNING: Explosion hazard when used in potentially explosive areas
When using the terminal in potentially explosive areas, observe the corresponding notes.

This data sheet is only valid in association with the IL SYS INST UM E user manual.

Make sure you always use the latest documentation.
It can be downloaded at: phoenixcontact.net/product/2878696

2 Table of contents

3 Ordering data

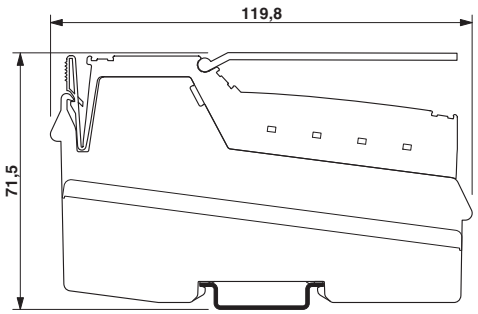
Description	Type	Order No.	Pcs./Pkt.
Inline, Bus coupler, Modbus/RTU, D-SUB-9 female connector, Digital inputs: 8, 24 V DC, connection method: 3-wire, Digital outputs: 4, 24 V DC, 500 mA, connection method: 3-wire, transmission speed in the local bus: 500 kbps / 2 Mbps, degree of protection: IP20, including Inline connectors and marking fields	IL MOD BK DI8 DO4-PAC	2878696	1

Accessories	Type	Order No.	Pcs./Pkt.
Quick mounting end clamp for NS 35/7,5 DIN rail or NS 35/15 DIN rail, with marking option, width: 9.5 mm, color: gray (Mounting)	CLIPFIX 35	3022218	50
Insert strip, Sheet, white, unlabeled, can be labeled with: Office printing systems: Laser printer, mounting type: insert, lettering field size: 62 x 46 mm (Marking)	ESL 62X46	0809502	5
Labeling field, width: 48.8 mm (Marking)	IB IL FIELD 8	2727515	10
Insert strip, Sheet, white, unlabeled, can be labeled with: Office printing systems: Laser printer, mounting type: insert, lettering field size: 62 x 10 mm (Marking)	ESL 62X10	0809492	1
Labeling field, width: 12.2 mm (Marking)	IB IL FIELD 2	2727501	10
Connector set, for Inline bus coupler with I/Os mounted in rows (Connector/Adapter)	IL BKDIO-PLSET	2878599	1
D-SUB connector, 9-pos., male connector, two cables to be fed in at 35°, bus system: for Inline Modbus RTU/ASCII bus coupler termination resistance can be connected via slide switch, pin assignment: 3, 5, 6, 8; screw connection terminal blocks (Connector/Adapter)	SUBCON-PLUS-MODBUS/IL/BK	2310808	1

Documentation	Type	Order No.	Pcs./Pkt.
Application note, English, Modbus information for the IL MOD BK DI8 DO4-PAC Inline bus coupler	AH EN IL MOD BK DI8 DO4-PAC - MODBUS	-	-
User manual, English, Automation terminals of the Inline product range	IL SYS INST UM E	-	-
Application note, German/English, I/O modules at bus couplers	AH IL BK IO LIST	-	-
Application note, English, Inline terminals for use in zone 2 potentially explosive areas	AH EN IL EX ZONE 2	-	-

4 Technical data

Dimensions (nominal sizes in mm)	



Width	80 mm
Height	119.8 mm
Depth	71.5 mm
Note on dimensions	Specfications with connectors

General data	
Color	green
Weight	320 g (with connectors)
Ambient temperature (operation)	-25 °C ... 60 °C
Ambient temperature (storage/transport)	-40 °C ... 85 °C
Permissible humidity (operation)	10 % ... 95 % (non-condensing)
Permissible humidity (storage/transport)	10 % ... 95 % (non-condensing)
Air pressure (operation)	70 kPa ... 106 kPa (up to 3000 m above sea level)
Air pressure (storage/transport)	70 kPa ... 106 kPa (up to 3000 m above sea level)
Degree of protection	IP20
Protection class	III, IEC 61140, EN 61140, VDE 0140-1

Connection data: Inline connector	
Connection method	Spring-cage connection
Conductor cross section solid / stranded	0.08 mm² ... 1.5 mm² / 0.08 mm² ... 1.5 mm²
Conductor cross section [AWG]	28 ... 16
Stripping length	8 mm

Connection data for UL approvals: Inline connector	
Connection method	Spring-cage connection
Conductor cross section solid / stranded	0.2 mm² ... 1.5 mm² / 0.2 mm² ... 1.5 mm²
Conductor cross section [AWG]	24 ... 16
Stripping length	8 mm

Interface: Modbus/RTU	
Number	1
Connection method	D-SUB-9 female connector
Note on the connection method	Electrically isolated supply, shielding directly connected to functional earth ground
Number of positions	9
Transmission speed	1.2 kBit/s ... 115.2 kBit/s (can be parameterized)

Interface: Inline local bus	
Connection method	Inline data jumper
Transmission speed	500 kbps / 2 Mbps (automatic detection, no combined system)

System limits of the bus coupler	
Number of supported devices	max. 63 (per station)
Number of local bus devices that can be connected	max. 61 (on board I/Os are two devices)
Number of devices with parameter channel	max. 8

Observe the logic current consumption of each device when configuring an Inline station! It is specified in every terminal-specific data sheet. The current consumption can differ depending on the individual terminal. The permissible number of devices that can be connected therefore depends on the specific station structure.

Bus coupler supply U_{BC}; Communications power U_L (7.5 V) and the analog supply U_{ANA} (24 V) are generated from the bus coupler supply.	
Supply voltage	24 V DC (via Inline connector)
Supply voltage range	19.2 V DC ... 30 V DC (including all tolerances, including ripple)
Current draw	min. 80 mA (without connected I/O terminal blocks) max. 0.98 A

Communications power (U_L)	
Supply voltage	7.5 V DC
Power supply unit	max. 0.8 A DC

Supply of analog modules (U_{ANA})	
Supply voltage	24 V DC
Supply voltage range	19.2 V DC ... 30 V DC (including all tolerances, including ripple)
Power supply unit	max. 0.5 A DC

Main circuit supply (U_M)	
Supply voltage	24 V DC
Supply voltage range	19.2 V DC ... 30 V DC (including all tolerances, including ripple)
Power supply unit	max. 8 A DC (sum of $U_M + U_S$)
Current draw	max. 8 A DC

Segment circuit supply (U_S)	
Supply voltage	24 V DC (via Inline connector)
Supply voltage range	19.2 V DC ... 30 V DC (including all tolerances, including ripple)
Power supply unit	max. 8 A DC (sum of $U_M + U_S$)
Current draw	min. 6 mA (without connected peripherals) max. 8 A DC

Power consumption	
Power consumption	typ. 1.7 W (entire device)

Protection

NOTE: Electronics may be damaged when overloaded

Provide external protection for the 24 V areas U_{BK}, U_M, and U_S. If you are using an external fuse, the power supply unit must be able to supply four times the nominal current of the fuse. This ensures that it trips in the event of an error.

Digital inputs	
Number of inputs	8
Connection method	Inline connector
Connection technology	3-wire
Input characteristic curve	IEC 61131-2 type 1
Nominal input voltage	24 V DC
Nominal input current	typ. 3 mA
Current flow	Limited to 3 mA, maximum
Input voltage range "0" signal	-30 V DC ... 5 V DC
Input voltage range "1" signal	15 V DC ... 30 V DC
Delay at signal change from 0 to 1	typ. 1.2 ms
Delay at signal change from 1 to 0	typ. 1.2 ms
Permissible conductor length to the sensor	100 m
Reverse polarity protection	Suppressor diode

Digital outputs	
Number of outputs	4
Connection method	Inline connector
Connection technology	3-wire
Nominal output voltage	24 V DC
Voltage difference with nominal current	< 1 V
Maximum output current per channel	500 mA
Maximum output current per device	2 A
Nominal load, ohmic	12 W
Nominal load, inductive	12 VA (1.2 H, 48 Ω)
Nominal load, lamp	12 W
Signal delay	typ. 1.2 ms
Maximum operating frequency with inductive nominal load	0.5 Hz (1.2 H, 48 Ω)

Digital outputs	
Behavior at voltage switch-off	The output follows the power supply without delay
Limitation of the voltage induced on circuit interruption	approx. -30 V
Output current when switched off	max. 10 µA (When not loaded, a voltage can be measured even at an output that is not set.)
Behavior with overload	Auto restart
Behavior with inductive overload	Output can be destroyed
Reverse voltage resistance to short pulses	Reverse voltage proof
Resistance to permanent reverse voltage	max. 2 A
Overcurrent shut-down	min. 0.7 A
Short-circuit and overload protection	Freewheeling circuit in the output driver

Error messages to the higher level control or computer system	
Short-circuit / overload of the digital outputs	Yes
Sensor supply failure	Yes
Failure of the actuator supply	Yes

Mechanical tests	
Vibration resistance in acc. with EN 60068-2-6/ IEC 60068-2-6	5g
Shock in acc. with EN 60068-2-27/IEC 60068-2-27	Operation: 25g, 11 ms duration, semi-sinusoidal shock impulse

Conformance with EMC Directive 2014/30/EU	
Noise immunity test in accordance with EN 61000-6-2	
Electrostatic discharge (ESD) EN 61000-4-2/IEC 61000-4-2	Criterion B, 6 kV contact discharge, 8 kV air discharge
Electromagnetic fields EN 61000-4-3/IEC 61000-4-3	Criterion A, Field intensity: 10 V/m
Fast transients (burst) EN 61000-4-4/IEC 61000-4-4	Criterion A, all interfaces 1 kV Criterion B, all interfaces 2 kV
Transient overvoltage (surge) EN 61000-4-5/IEC 61000-4-5	Criterion B, DC supply lines: 0.5 kV/1.0 kV (symmetrical/ asymmetrical), fieldbus cable shield: 1 kV
Conducted interference EN 61000-4-6/IEC 61000-4-6	Criterion A; Test voltage 10 V
Noise emission test as per EN 61000-6-4	Class A

Approvals

For the latest approvals, please visit phoenixcontact.net/products.

5 Internal circuit diagram

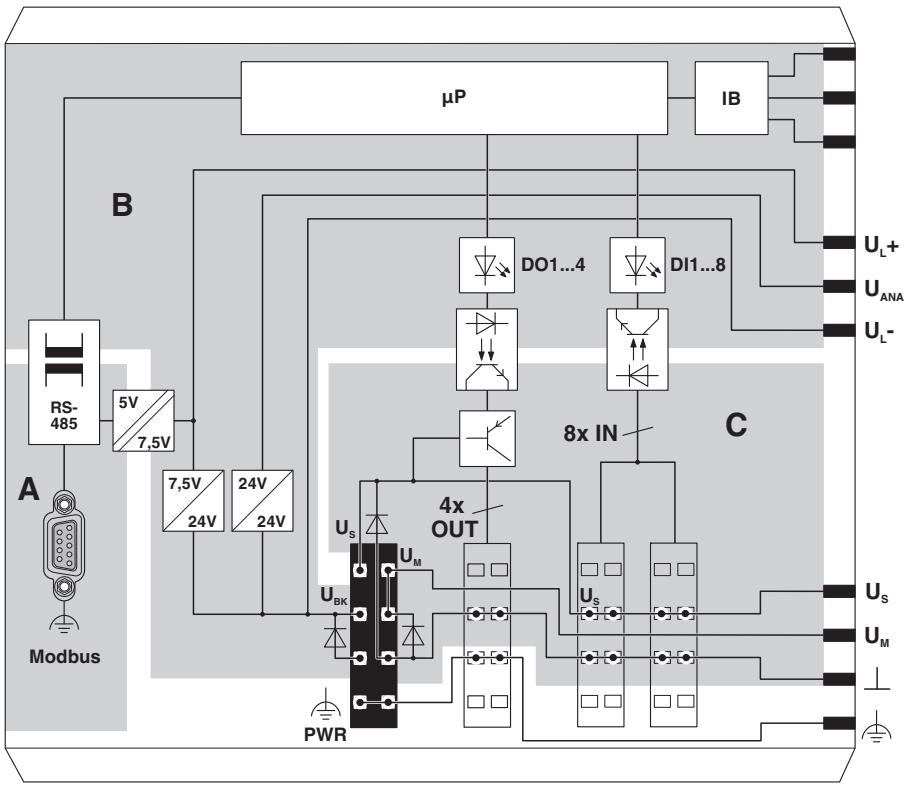


Figure 1 Internal wiring of the terminal points

Key:

µP — Microprocessor

IB — Protocol chip

LED

Optocoupler

Power supply unit with electrical isolation

Power supply unit

RS-485 — RS-485 interface with electrical isolation

PNP transistor

Electrically isolated areas

The gray areas in the basic circuit diagram represent the electrically isolated areas:

A: Modbus interface

B: Logic

C: I/O

6 Notes on using the terminal block in potentially explosive areas

WARNING: Explosion hazard

Please make sure that the following notes and instructions are observed.

Approval according to ATEX Directive 2014/34/EU

Ⓔx II 3 G Ex nA IIC T4 Gc X

Installation notes

The category 3 device is designed for installation in zone 2 potentially explosive areas.

The device meets the requirements of EN 60079–0:2012 + A11:2013 and EN 60079–15:2010.

- Observe the specified conditions for use in potentially explosive areas.
- At the time of installation, use an approved housing (minimum protection IP54), which meets the requirements of EN 60079-15. Within this context, observe the requirements of IEC 60079-14/EN 60079-14.
- The following work is only permitted in potentially explosive areas when the power is disconnected:
  - Snapping the device onto the DIN rail
  - Removing the device from the DIN rail
  - Connection and disconnection of cables
- Connect the DIN rail to the protective earth ground.
- For safe operation, the D-SUB connector must be screwed into the corresponding D-SUB socket. Repair any damaged connectors immediately.
- Only devices that are designed for operation in Ex Zone 2 and the conditions at the installation location may be connected to the circuits in Zone 2.
- Make sure that the maximum permissible current of 4 A flowing through potential jumpers U_M and U_S (total current) is not exceeded.
- When using the device in potentially explosive areas, observe the specifications in the application note AH DE IL EX ZONE 2 (German) / AH EN IL EX ZONE 2 (English).

7 Connecting Modbus, the supply, actuators, and sensors

7.1 Connecting Modbus

Connect Modbus to the bus coupler via a 9-pos. D-SUB connector (see ordering data). For the pin assignment, please refer to the figure and the table.

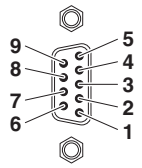


Figure 2 Pin assignment of the 9-pos. D-SUB female connector

Pin	Assignment
1	Reserved
2	Reserved
3	RxD/TxD-P (receive/transmit data +), cable B
4	CNTR-P (control signal for repeater), direction control
5	DGND (reference potential to 5 V)
6	V_{CC} (+5 V DC)
7	Reserved
8	RxD/TxD-N (receive/transmit data –), cable A
9	Reserved

7.2 Mains termination resistors

Using the SUBCON connector specified in the ordering data ensures that the cable termination meets the Modbus RTU/ ASCII specification.

7.3 Terminal point assignment of input and output connectors

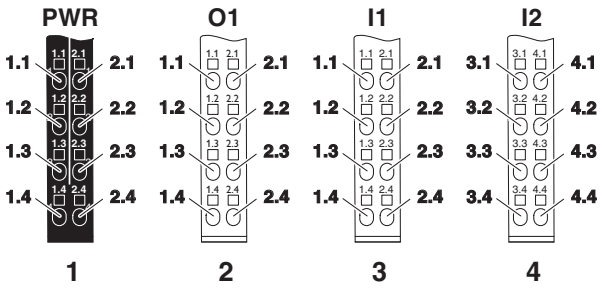


Figure 3 Terminal point assignment

Terminal point assignment of the power connector (1)

Terminal point	Assignment	Terminal point	Assignment
1.1	U_S	2.1	U_M
1.2	U_{BK}	2.2	U_M
1.3	GND U_{BK}	2.3	GND U_M, U_S
1.4	Functional earth ground (FE)	2.4	Functional earth ground (FE)

Terminal point	Assignment	Terminal point	Assignment
1.1	OUT01	2.1	OUT02
1.2	GND	2.2	GND
1.3	FE	2.3	FE
1.4	OUT03	2.4	OUT04

Terminal point assignment of the input connector (3)

Terminal point	Assignment	Terminal point	Assignment
1.1	IN01	2.1	IN02
1.2	U_S	2.2	U_S
1.3	GND	2.3	GND
1.4	IN03	2.4	IN04

Terminal point assignment of the input connector (4)

Terminal point	Assignment	Terminal point	Assignment
3.1	IN05	4.1	IN06
3.2	U_S	4.2	U_S
3.3	GND	4.3	GND
3.4	IN07	4.4	IN08

8 Connection example

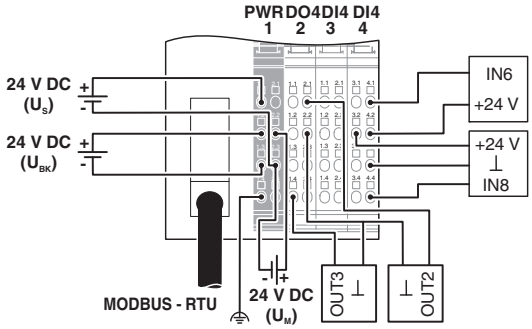


Figure 4 Connection example

9 Local status and diagnostic indicators

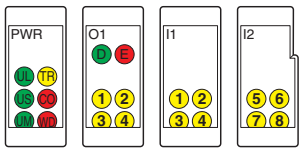


Figure 5 Local diagnostic and status indicators

Designation	Color	Meaning	State	Description
PWR				
UL	Green	**U**$_{\text{L}}$ogic	ON	24 V bus coupler supply/7.5 V communications power present
			OFF	24 V bus coupler supply/7.5 V communications power not present
US	Green	**U**$_{\text{S}}$egment	ON	24 V segment circuit supply present
			OFF	24 V segment circuit supply not present
UM	Green	**U**$_{\text{M}}$ain	ON	24 V I/O supply present
			OFF	24 V I/O supply not present
TR	Yellow	**Tr**affic	ON	Data exchange at the RTU/ASCII interface.
			OFF	No data exchange at the RTU/ASCII interface.
CO	Red	**Co**nfiguration	ON	The active configuration of the local bus differs from the saved configuration.
			OFF	The active configuration of the local bus matches the saved configuration.
WD	Red	**W**atch**d**og	ON	Time between two Modbus telegrams exceeded during active connection monitoring (Modbus telegram watchdog).
			Flashing (2 Hz)	On a power-on reset: new parameters are read in.
			Flashing (0.5 Hz)	On a power-on reset: new parameters have been applied successfully.
			Flashing (5 Hz)	On a power-on reset: new parameters have not been applied successfully.
			OFF	No error
O1				
D	Green	**D**iagnostics	ON	Data transmission active within the station
			Flashing	Data transmission not active within the station
E	Red	**E**rror	ON	I/O error, short-circuit/overload of outputs
			OFF	No I/O error
1 ... 4	Yellow	OUT01 ... OUT04	ON / OFF	Output is set/not set.
I1, I2				
1 ... 8	Yellow	IN01 ... IN08	ON / OFF	Input is set/not set.

10 Parameterization of the hardware

10.1 Address setting

The address is set using two rotary encoding switches. The left switch is used to set the position in tens and the right switch is used to set the position in units. Addresses can be set between 1 and 99. The figure shows the address setting 74.

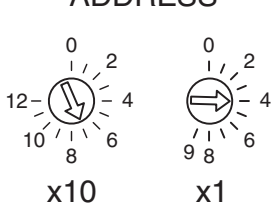


Figure 6 (ADDRESS) rotary encoding switches

A valid address is applied on power up. This cannot be modified during operation.

10.2 Parameterization via rotary coding switches

In addition to the address, you can also set various operating parameters via the rotary coding switches.

These operating parameters are only read in following a power-on reset.

If the address switch for tens is set to a position that is not valid for an address (≥ 10), the bus coupler detects this as “Parameter setting” mode.

Tens switch (x10)		Units switch (x1)		Default
Pos.	Meaning	Pos.	Meaning	
10	Mode	0	RTU	x
		1	ASCII	
		2	Factory configuration	
		3	Activate Plug and Play mode	
		4	Deactivate Plug and Play mode	
11	Baud rate (bps)	0	1200	
		1	2400	
		2	4800	
		3	9600	
		4	19200	x
		5	38400	
		6	57600	
		7	115200	
12	Data bits	0	7	
		1	8	x
13	Parity	0	None	
		1	Even	x
		2	Odd	
14	Stop bit	0	1	x
		1	2	
15	Watchdog	0	ON	x
		1	OFF	

By default upon delivery and after resetting to the factory configuration, the parameters that are marked default in the table are set.

On a power-on reset (voltage reset), the bus coupler only reads the operating parameter that is currently set and saves it. If you want to set several parameters, repeat this process for each individual parameter.

When a parameter is being read, the watchdog LED flashes quickly (2 Hz). If the parameter has been accepted, the watchdog LED flashes slowly (0.5 Hz). If the parameter is invalid, the watchdog LED flashes very quickly (5 Hz).

Example: the “Disable Plug and Play” and ASCII” operating parameters need to be set.

- Set “Disable Plug and Play”.
- Perform a voltage reset.
- Once the parameter has been accepted, set “ASCII”.
- Perform a voltage reset.

10.3 Parameterizing the bus coupler via Modbus registers

In addition to the described setting options using rotary coding switches, the configuration can be modified via the Modbus registers.

Index	Parameter	Value	Meaning	Default
2100	Transmission mode	0	RTU	x
		1	ASCII	
2101	Baud rate (bps)	0	1200	
		1	2400	
		2	4800	
		3	9600	
		4	19200	x
		5	38400	
		6	57600	
		7	115200	
2102	Data bits	0	7	
		1	8	x
2103	Parity	0	None	
		1	Even	x
		2	Odd	
2104	Stop bit	0	1	x
		1	2	
1280	Watchdog	0	Watchdog deactivated	
		xx	200 ms ... 65000 ms (1 ms increments)	
		10000	10000 ms	x
2002	Fault response mode	0	Standard fault mode	
		1	Reset fault mode	x
2006	Command register	0	Deactivate Plug and Play mode	
		1	Activate Plug and Play mode	x

All registers are 16-bit registers.

The new parameters are only applied following a positive response. This response is transmitted again with the “old” parameters. The next request is then made with the new parameters.

Following a power up, the last valid parameter record applies.

When you change the baud rate, the RTU framing also changes by default, i.e., times t 1.5 and t 3.5 are adjusted.

t 1.5 = maximum permissible gap between the bytes of a Modbus telegram

t 3.5 = minimum pause between two Modbus telegrams

For more detailed information, visit www.modbus.org.

10.4 Modbus telegram watchdog (connection monitoring)

The watchdog monitors Modbus telegrams and is triggered each time a Modbus telegram is received correctly. It can be enabled and disabled via rotary coding switches, see “Parameterization via rotary coding switches” section. The time can be set via register 1280 (0 = disabled; 200 ms to 65000 ms).

Actions after triggering the watchdog

The action taken when the watchdog is triggered depends on the set fault response mode. By default upon delivery, the fault response mode is set to reset fault mode.

The following applies for reset fault mode:

– Set digital outputs to zero
– Freeze analog outputs
– Watchdog LED on

Special feature when **disabling** the watchdog via write access to register 1280:

– Settings modified by write access (disable watchdog, modify monitoring time) are only applied following a power-up reset.

Watchdog **activation** via register 1280 is applied immediately during operation.

The Modbus telegram watchdog does not operate during Plug and Play mode.

10.5 Plug and Play mode

The bus coupler supports Plug and Play mode.

Plug and Play mode enables local bus modules connected in the field to be started up using the bus coupler without a higher-level computer (engineering system).

You can activate or deactivate Plug and Play mode via the “ADDRESS” rotary coding switches. The switch position is mapped to the command register (Modbus register 2006).

Plug and Play mode is activated by default upon delivery.

The Plug and Play mode status (activated or deactivated) is stored retentively on the bus coupler.

In Plug and Play mode, the connected local bus modules are detected and their function checked.

If this physical configuration is ready for operation, it is stored retentively on the bus coupler as a reference configuration.

Deactivate Plug and Play mode so that the reference configuration is not overwritten the next time the bus coupler is started.

The deactivation of Plug and Play mode both acknowledges the reference configuration and enables process data exchange.

When Plug and Play mode is deactivated, the reference configuration is compared to the physical configuration. If they are the same, the bus coupler is set to the RUN state on the first write access.

If the reference configuration and the physical configuration differ, the CO LED lights up red and process data exchange is no longer possible for safety reasons.

In order to operate the bus despite this, you have the following two options:

1. Restore the original configuration so that the reference configuration and the physical configuration are the same again.
2. Activate Plug and Play mode and restart the bus coupler so that the active physical configuration is accepted as the reference configuration.

If Plug and Play mode is **disabled**, the bus is only started up if the configuration of the connected bus matches the saved configuration.

If Plug and Play mode is **enabled**, the writing of process data is rejected by an exception. Read access to the process data is possible.

11 Modbus protocol

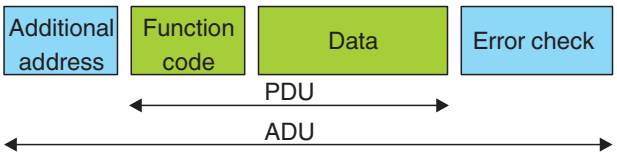


Figure 7 Modbus protocol

Key:

PDU	Protocol data unit
ADU	Application data unit (protocol frame)

The Modbus application protocol is created by the client that initiates a Modbus transmission.

The function code field of the protocol (1 byte) informs the server of which action it is to perform.

The data fields of messages, which are sent from a client to a server, contain additional information that the server uses in order to perform the action specified by the function code field. This includes, e.g., digital addresses and register addresses, the number of units to be managed, and the number of actual data bytes.

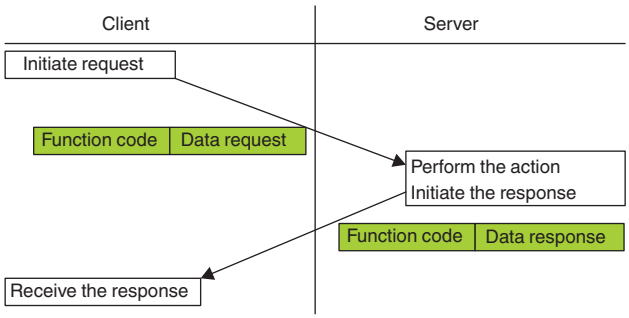


Figure 8 Modbus transmission (without errors)

Key:

Client	Control system
Server	Modbus devices

If no error occurs in a correctly received Modbus protocol for the requested Modbus function, the data field for a response from a server to a client contains the requested data.

When the server responds to the client, it uses the function code field to indicate either a normal (error-free) response or to indicate an error (this is also known as an exception response). For a normal response, the server returns the original function code to the request.

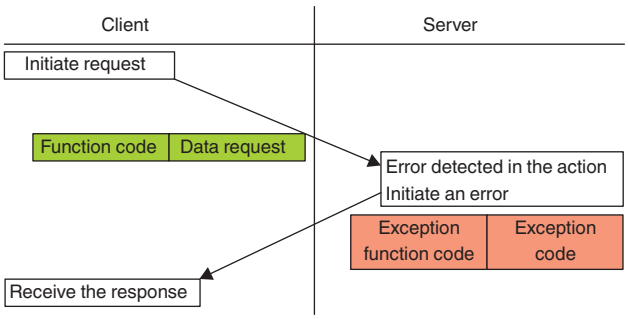


Figure 9 Modbus transmission (exception response)

Key:

Client	Control system
Server	Modbus devices

For an exception response, the server returns a code that corresponds to the original function code of the request PDU, whereby the MSB is set to logic 1.

There are two different transmission modes: RTU and ASCII. Both differ in terms of the type and form of information represented in a telegram. In a Modbus network, each device must have the same transmission mode.

Modbus/RTU

Modbus/RTU telegrams consist of the following parts:

Station address	Function	Data	CRC
1 byte	1 byte	0 - 252 bytes	2 bytes

Modbus/RTU telegrams are separated by breaks known as end of frame times. The time is at least 3.5 times the time of a sent character. It cannot be adjusted.

The advantage the RTU transmission mode offers over the ASCII transmission mode is a higher data throughput with the same baud rate.

Modbus ASCII

Modbus ASCII telegrams consist of the following parts:

Start	Station address	Function	Data	LRC	END
1 character (:)	2 characters	2 characters	0 - 2 x 252 characters	2 characters	2 characters (CR, LF)

The transmitted characters comprise the ASCII code and consist of 1 byte each.
The advantage the ASCII transmission mode offers over the RTU transmission mode is non-time-critical data transmission.
The frame start (:) and end (CR, LF) are specified using special characters. Gaps between the bytes of a frame are not important.

12 Modbus functions

The Modbus protocol functions determine whether data is to be written or read and what type of data is involved.

The following Modbus functions are supported:

Code No.	Function code	Description
fc1	Read coils	Read digital outputs
fc2	Read input discretes	Read digital inputs
fc3	Read multiple registers	Read a multiple register (e.g., read back analog output)
fc4	Read input registers	Read an input register (e.g., analog input)
fc5	Write coil	Write a digital output bit
fc6	Write single register	Write an output register (e.g., analog output)
fc15	Write multiple coils	Write multiple digital outputs
fc16	Write multiple registers	Write multiple output registers

13 Examples for Modbus functions

Function code fc1

Request

Function code	1 byte	01_{hex}
Start address	2 bytes	0000_{hex} ... $FFFF_{hex}$
Number of outputs	2 bytes	1 ... 2000 ($7D0_{hex}$)

Response

Function code	1 byte	01_{hex}
Number of bytes	1 byte	N*
Output status	n bytes	n = N or N+1

*N = (Number of outputs)/8; if the remainder is > 0: N = N+1

Error

Function code	1 byte	Function code + 80_{hex}
Exception code	1 byte	01 or 02 or 03 or 04

Example for a request to read digital outputs 20 ... 38 38

Request		**Response**	
Field name	(Hex)	Field name	(Hex)
Function	01	Function	01
Start address (high)	00	Number of bytes	03
Start address (low)	13	Output status 27 ... 20	CD
Number of outputs (high)	00	Output status 35 ... 28	6B
Number of outputs (low)	13	Output status 38 ... 36	05

Function code fc2

Request

Function code	1 byte	02_{hex}
Start address	2 bytes	0000_{hex} ... $FFFF_{hex}$
Number of outputs	2 bytes	1 ... 2000 ($7D0_{hex}$)

Response

Function code	1 byte	01_{hex}
Number of bytes	1 byte	N*
Output status	N* x 1 byte	

*N = (Number of inputs)/8; if the remainder is > 0: N = N+1

Error

Error code	1 byte	82_{hex}

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Exception code	1 byte	01 or 02 or 03 or 04

Example for a request to read digital inputs 197 ... 218

Request		Response	
Field name	(Hex)	Field name	(Hex)
Function	02	Function	02
Start address (high)	00	Number of bytes	03
Start address (low)	C4	Input status 27 ... 20	AC
Number of inputs (high)	00	Input status 35 ... 28	DB
Number of inputs (low)	16	Input status 38 ... 36	35

Function code fc3

Request

Function code	1 byte	03_{hex}
Start address	2 bytes	0000_{hex} ... $FFFF_{hex}$
Number of registers	2 bytes	1 ... 125 ($7D_{hex}$)

Response

Function code	1 byte	03_{hex}
Number of bytes	1 byte	2 x N*
Register values	N* x 1 byte	

*N = Number of registers

Error

Error code	1 byte	83_{hex}
Exception code	1 byte	01 or 02 or 03 or 04

Example for a request to read registers 108 ... 110

Request		Response	
Field name	(Hex)	Field name	(Hex)
Function	03	Function	03
Start address (high)	00	Number of bytes	06
Start address (low)	6B	Register value (high) (108)	02
Register number (high)	00	Register value (low) (108)	2B
Register number (low)	03	Register value (high) (109)	00
		Register value (low) (109)	00
		Register value (high) (110)	00
		Register value (low) (110)	64

Function code fc4

Request

Function code	1 byte	04_{hex}
Start address	2 bytes	0000_{hex} ... $FFFF_{hex}$
Number of input registers	2 bytes	0001_{hex} ... $007D_{hex}$

Response

Function code	1 byte	04_{hex}
Number of bytes	1 byte	2 x N*
Input registers	N* x 2 byte	

*N = Number of input registers

Error

Error code	1 byte	84_{hex}
Exception code	1 byte	01 or 02 or 03 or 04

Example for a request to read input register 9

Request		**Response**	
Field name	(Hex)	Field name	(Hex)
Function	04	Function	04
Start address (high)	00	Number of bytes	02
Start address (low)	08	Input register 9 (high)	00
Number of input registers (high)	00	Input register 9 (low)	0A
Number of input registers (high)	01		

Function code fc5

Request

Function code	1 byte	05_{hex}
Output address	2 bytes	0000_{hex} ... $FFFF_{hex}$
Output value	2 bytes	0000_{hex} ... $FF00_{hex}$

Response

Function code	1 byte	05_{hex}
Output address	2 bytes	0000_{hex} ... $FFFF_{hex}$
Output value	2 bytes	0000_{hex} ... $FF00_{hex}$

Error

Error code	1 byte	85_{hex}
Exception code	1 byte	01 or 02 or 03 or 04

Example for a request to write output 173 ON

Request		Response	
Field name	(Hex)	Field name	(Hex)
Function	05	Function	05
Output address (high)	00	Output address (high)	00
Output address (low)	AC	Output address (low)	AC
Output value (high)	FF	Output value (high)	FF
Output value (low)	00	Output value (low)	00

Function code fc6

Request

Function code	1 byte	06_{hex}
Register address	2 bytes	0000_{hex} ... $FFFF_{hex}$
Register value	2 bytes	0000_{hex} ... $FFFF_{hex}$

Response

Function code	1 byte	06_{hex}
Register address	2 bytes	0000_{hex} ... $FFFF_{hex}$
Register value	2 bytes	0000_{hex} ... $FFFF_{hex}$

Error

Error code	1 byte	86_{hex}
Exception code	1 byte	01 or 02 or 03 or 04

Example for a request to write register 2 to 0003_{hex}

Request		Response	
Field name	(Hex)	Field name	(Hex)
Function	06	Function	06
Register address (high)	00	Register address (high)	00
Register address (low)	01	Register address (low)	01
Register value (high)	00	Register value (high)	00
Register value (low)	03	Register value (low)	03

Function code fc15

Request PDU

Function code	1 byte	$0F_{hex}$
Start address	2 bytes	0000_{hex} ... $FFFF_{hex}$
Number of outputs	2 bytes	0001_{hex} ... $07B0_{hex}$
Byte counter	1 byte	N*
Output value	N* x 1 byte	

*N = (Number of outputs)/8; if the remainder is > 0: N = N+1

Response PDU

Function code	1 byte	$0F_{hex}$
Start address	2 bytes	0000_{hex} ... $FFFF_{hex}$
Number of outputs	2 bytes	0001_{hex} ... $07B0_{hex}$

Error

Error code	1 byte	$8F_{hex}$
Exception code	1 byte	01 or 02 or 03 or 04

Example for a request to write a series of 10 outputs, starting with output 20

The request data contains two bytes. The binary values are assigned to the outputs as follows:

Byte (hex)	CD								01							
Bit	1	1	0	0	1	1	0	1	0	0	0	0	0	0	0	1
Output	27	26	25	24	23	22	21	20							29	28

The first transmitted byte (CD_{hex}) addresses outputs 27 to 30, whereby the LSB in this setting addresses output 20.

The next transmitted byte (01_{hex}) addresses outputs 29 and 28, whereby the LSB in this setting addresses output 28. In the last data byte, unused bits should be filled with zeros.

Request		**Response**	
Field name	(Hex)	Field name	(Hex)
Function	0F	Function	0F
Start address (high)	00	Start address (high)	00
Start address (low)	13	Start address (low)	13
Number of outputs (high)	00	Number of outputs (high)	00
Number of outputs (low)	0A	Number of outputs (low)	0A
Byte counter	02		
Output value (high)	CD		
Output value (low)	01		

Function code fc16

Request

Function code	1 byte	10_{hex}
Start address	2 bytes	0000_{hex} ... $FFFF_{hex}$
Number of registers	2 bytes	0001_{hex} ... 0078_{hex}
Byte counter	1 byte	2 x N*
Register value	N* x 2 bytes	Value

*N = Number of registers

Response

Function code	1 byte	10_{hex}
Start address	2 bytes	0000_{hex} ... $FFFF_{hex}$
Number of registers	2 bytes	1 ... 123 (78_{hex})

Error

Error code	1 byte	90_{hex}
Exception code	1 byte	01 or 02 or 03 or 04

Example for a request to write two registers, starting with 2 to $000A_{hex}$ and 0102_{hex}

Request		**Response**	
Field name	(Hex)	Field name	(Hex)
Function	10	Function	10
Start address (high)	00	Start address (high)	00
Start address (low)	01	Start address (low)	01
Number of registers (high)	00	Number of registers (high)	00
Number of registers (low)	02	Number of registers (low)	02
Byte counter	04		
Register value (high)	00		
Register value (low)	0A		
Register value (high)	01		
Register value (low)	02		

14 Modbus tables

14.1 Process data

The Modbus register tables provide information about the location of process data in the control system. Generally, the **bit**-oriented process data appears first in the registers followed by the **byte**-oriented process data.

Static table

Modbus register table	Digital Modbus inputs table	Digital Modbus outputs table	Internal IL MOD BK tables	Function codes that can be used
0 - 191 (16-bit word)	0 - 3071 (bits)	–	Digital inputs	fc2
192 - 383 (16-bit word)	–	–	Analog inputs	fc4
384 - 575 (16-bit word)	–	0 - 3071 (bits)	Digital outputs	fc1, fc5, fc15
576 - 767 (16-bit word)	–	–	Analog outputs	fc3, fc6, fc16

Assignment of the process data in static tables

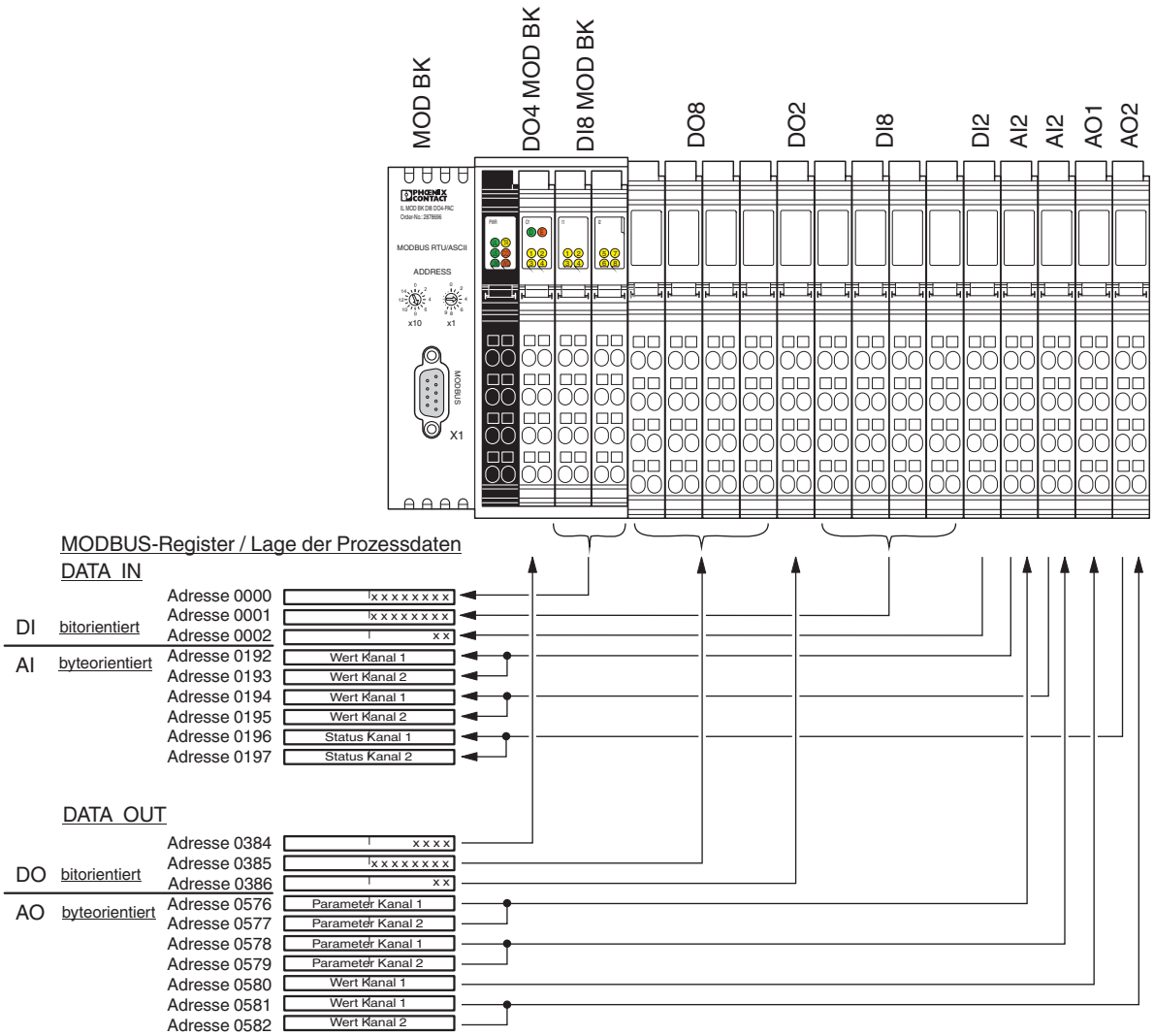

Figure 10 Example for the location of process data in static tables

Dynamic table

For dynamic tables, there is no fixed assignment of the register areas. Depending on the structure of the Inline station, the following general order of the process data applies:

– DATA IN (bit-oriented)
– DATA IN (byte-oriented)
– DATA OUT (bit-oriented)
– DATA OUT (byte-oriented)

Modbus register table	Internal IL MOD BK tables	Function codes that can be used
8000 - 8192 (16-bit word)	Dynamic process data table	fc2 to fc16

Assignment of the process data in dynamic tables

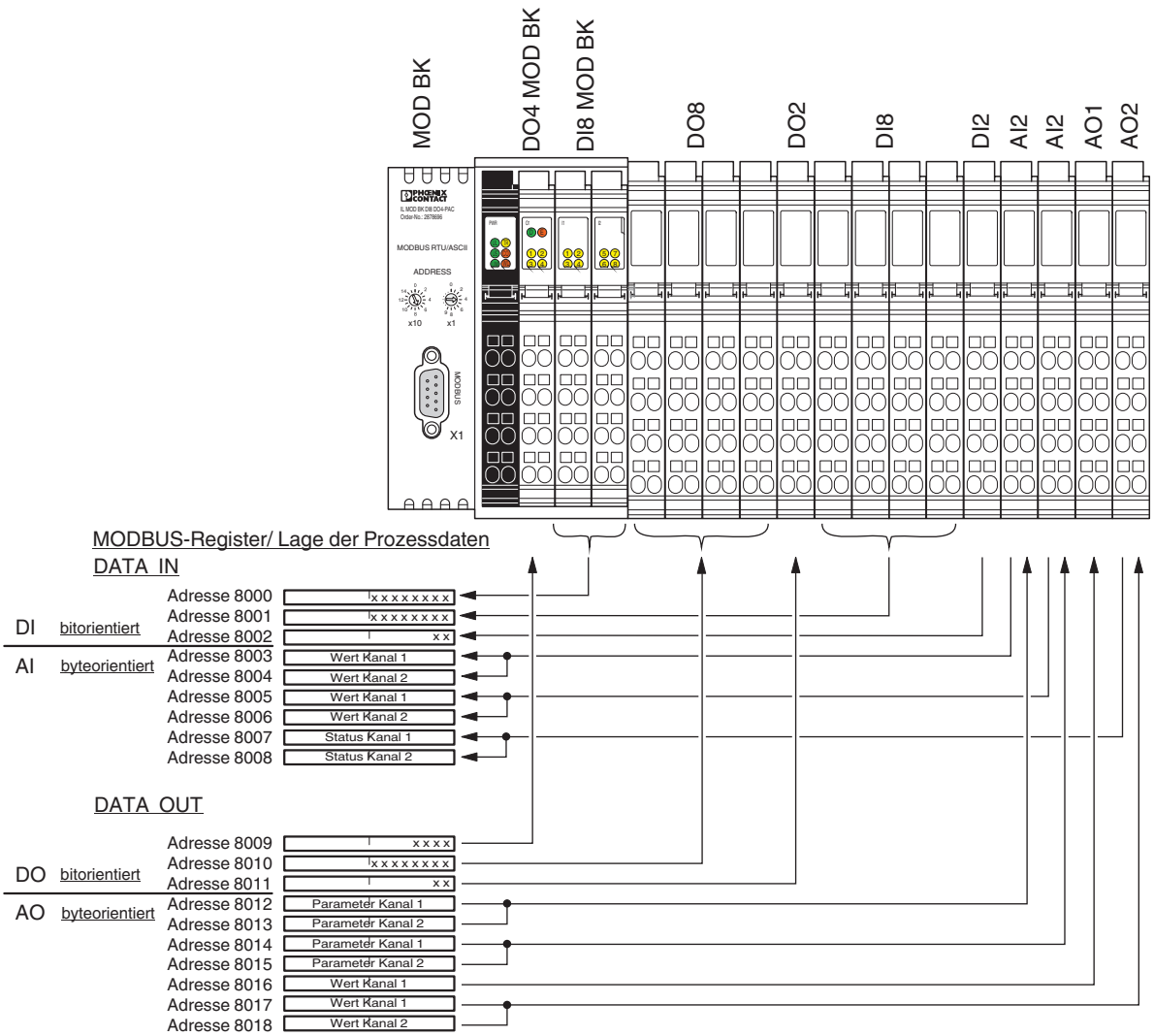

Figure 11 Example for the location of process data in dynamic tables

14.2 Special registers

Modbus register table	Access	Internal IL MOD BK tables
1280 (16-bit word)	Read/write	Modbus telegram watchdog (connection monitoring), (default = 10000 ms)
1400 – 1463 (16-bit word)	Read	Up to 1400: Number of local bus devices Above 1401: ID code of the relevant device
2002 (16-bit word)	Read/write	Fault response mode (default = reset fault mode)
2004 (16-bit word)	Read	Net Fail reason
2006 (16-bit word)	Read/write	Command register (command word)
2100 (16-bit word)	Write	Transmission mode: RTU, ASCII (default = 0 = RTU mode) see table in the data sheet
2101 (16-bit word)	Write	Baud rate: 1200 ... 115200 (Default = 4 = 19200), see table in the data sheet
2102 (16-bit word)	Write	Data bits: 7, 8 (default = 1 = 8 bits), see table in the data sheet
2103 (16-bit word)	Write	Parity: None, even, odd (default = 1 = even parity), see table in the data sheet
2104 (16-bit word)	Write	Stop bits: 1, 2 (default = 0 = 1 stop bit), see table in the data sheet
6020 - 6093 (16-bit word)	Write	PCP
7996 (16-bit word)	Read	Status register (status word)
7997 (16-bit word)	Read	Local bus diagnostic status register
7998 (16-bit word)	Read	Local bus diagnostic parameter register 1
7999 (16-bit word)	Read	Local bus diagnostic parameter register 2

14.3 Description of special registers

Modbus telegram watchdog (connection monitoring), (1280)

Valid values for the register are 0; 200 ms to 65000 ms.

The watchdog monitors Modbus telegrams and is triggered each time a Modbus telegram is received correctly. It can be enabled and disabled via the rotary encoding switches, see data sheet. The time can be set via register 1280 (0 = disabled; 200 ms to 65000 ms).

Actions after triggering the watchdog:

The action taken when the watchdog is triggered depends on the set fault response mode. By default upon delivery, the fault response mode is set to reset fault mode. For reset fault mode, the following applies:

– Set digital outputs to zero
– Freeze analog outputs
– Watchdog LED ON

Special feature when disabling the watchdog via write access to register 1280:

Settings modified by write access (disable watchdog, modify monitoring time) are only applied following a power up reset. Watchdog activation via register 1280 is applied immediately during operation.

Fault response mode, (2002)

Fault response mode	Value	Function
Standard fault mode	**0**	All outputs are set to "0".
Reset fault mode (default)	**1**	The digital outputs are set to "0" and the analog outputs are held at the last value.
Hold last state mode	**2**	All outputs are held at their last value.

Net Fail reason, (2004)

This register can be used to read the reason after the Net Fail signal has been triggered. For the IL MOD BK DI8 DO4-PAC there can only be one reason: the connection monitoring watchdog has failed. In Net Fail Reason register 2004, the value $000D_{hex}$ appears.

Command register (command word), (2006)

Activation/deactivation of Plug and Play mode is performed in the least significant bit of the command word.
Bit 0 = "0" -> Plug and Play mode deactivated.
Bit 0 = "1" -> Plug and Play mode activated.
If a Net Fail occurred, it can be acknowledged by setting bit 1 in the command word. If the Net Fail has been acknowledged successfully, bit 1 is reset to "zero".

If a peripheral fault occurred, it can be acknowledged by setting bit 2 in the command word. If the peripheral fault has been acknowledged successfully, bit 2 is reset to 0.

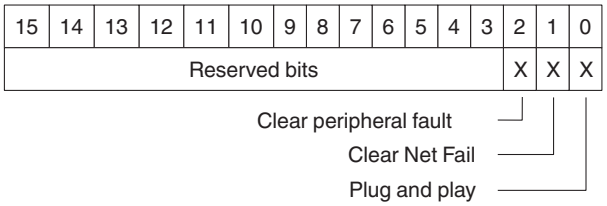

Figure 12 Command word

Status register (status word), (7996)

Only the two least significant bits have a function. If bit 0 = "0", this means that an error (e.g., a bus error) has occurred. If bit 0 = "1", no error has occurred. Bit 1 indicates whether a Net Fail occurred (bit 1 = 1) or not (bit 1 = 0).

This results in the following values for the status word:

– 0: An error occurred (e.g., bus error)
– 1: No error occurred
– 2: A Net Fail occurred

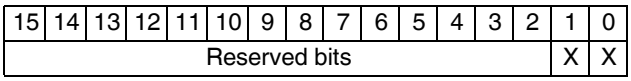

Figure 13 Status word

Local bus diagnostic status register (7997)

Each bit in the local bus diagnostic status register is assigned a state of the local bus master on the bus coupler. The states in the error bits (USER, PF, BUS, CTRL) are described in greater detail using the diagnostic parameter register. Whenever one of the error bits described above is set, the diagnostic parameter register is rewritten. Otherwise, the diagnostic parameter register has the value 0000_{hex}.

Bit	Constant	Meaning
0	USER_BIT	Application program error
1	PF_BIT	Local bus device detected a peripheral fault
2	BUS_BIT	Error on local bus
3	CTRL_BIT	Local bus master has an internal error
4	DETECT_BIT	Error localization ("LOOK FOR FAIL")
5	RUN_BIT	Exchanging data cycles
6	ACTIVE_BIT	Local bus master ACTIVE
7	READY_BIT	Local bus master READY, selftest completed

Local bus diagnostic parameter register 1 (7998)

For detected local bus errors, the local bus diagnostic parameter register contains the error location:

Error location, e.g., device number 0.3

Device number of a device, e.g., "0.3" for bus segment 0; device 3

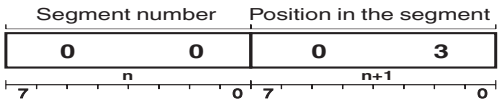

Figure 14 Contents of the local bus diagnostic parameter register (example)

Local bus diagnostic parameter register 2 (7999)

Local bus diagnostic parameter register 2 contains additional information about the error codes.

For additional information about local bus diagnostics, please refer to the IBS SYS FW G4 UM E user manual.

PCP registers (6020 - 6093)

The PCP registers are divided into two classes:

1. Communication registers for exchanging data with the desired PCP device
2. Configuration registers for selecting the invoke ID, index, and subindex of the PCP device

For additional information about PCP communication, please refer to the IBS SYS PCP G4 UM E user manual.

The terminal supports eight PCP devices, therefore eight communication registers and 24 configuration registers are supported.

PCP registers

Communi-cation reference	Communi-cation register	Configura-tion register	Remark
CR 2	6020		
		6021	Index
		6022	Subindex
		6023	Invoke ID
		6024 - 6029	Reserved
CR 3	6030		
		6031	Index
		6032	Subindex
		6033	Invoke ID
		6034 - 6039	Reserved
CR 4	6040		
		6041	Index
		6042	Subindex
		6043	Invoke ID
		6044 - 6049	Reserved
CR 5	6050		
		6051	Index
		6052	Subindex
		6053	Invoke ID
		6054 - 6059	Reserved
CR 6	6060		
		6061	Index
		6062	Subindex
		6063	Invoke ID
		6064 - 6069	Reserved
CR 7	6070		
		6071	Index
		6072	Subindex
		6073	Invoke ID
		60724 - 6079	Reserved
CR 8	6080		
		6081	Index
		6082	Subindex
		6083	Invoke ID
		6084 - 6089	Reserved
CR 9	6090		
		6091	Index
		6092	Subindex
		6093	Invoke ID
		6094 - 6099	Reserved

Example:

In order to read object $5FE0_{hex}$ of an IB IL RS 232-PAC with communication reference 4, first set the configuration registers (6041 - 6043) to the desired values with the FC 16 command (e.g., 6041 index: $5FE0_{hex}$, 6042 subindex: 0_{hex}, 6043 invoke ID: 0_{hex}). The fc3 command can then be used to read 29 words via communication register 6040.

A Modbus function is only ever used for read/write access to a PCP index. For example, the fc3 command cannot be used to read 20 words from registers 6020 to 6039.

The communication register contains a different value range due to the selected values of the register and the terminal used. Therefore, the IB IL RS 232-PAC terminal, for example, has three different PCP objects: two objects are one word long, but the third is 29 words long. The three configuration registers can be read/written with a single Modbus command. An attempt to access a reserved register generates an exception response.

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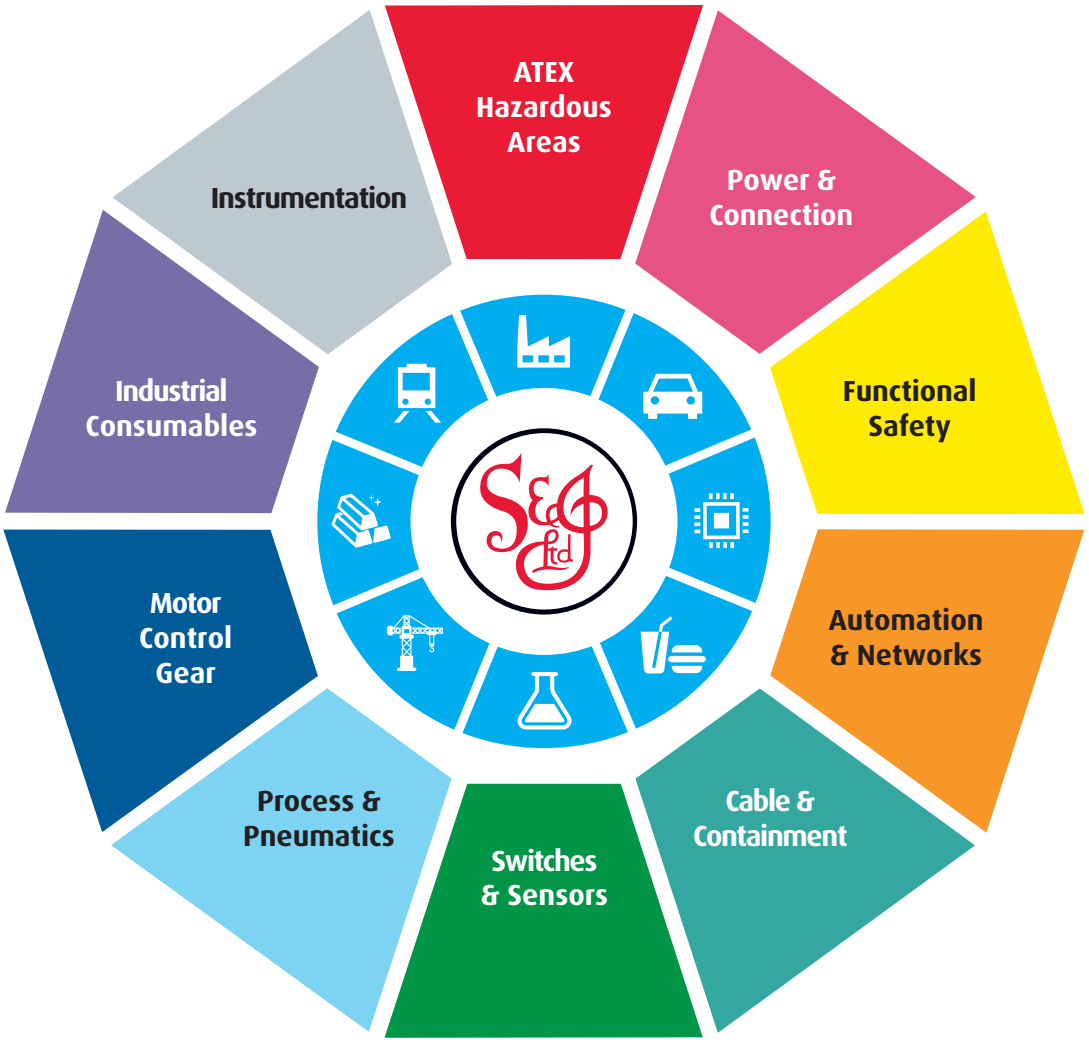

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