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Diagnostic and firmware functions

of the bus coupler S20-PB-BK

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1 Use of the safety instructions

1.1 Structure of the safety instructions

The safety instructions are structured as follows:

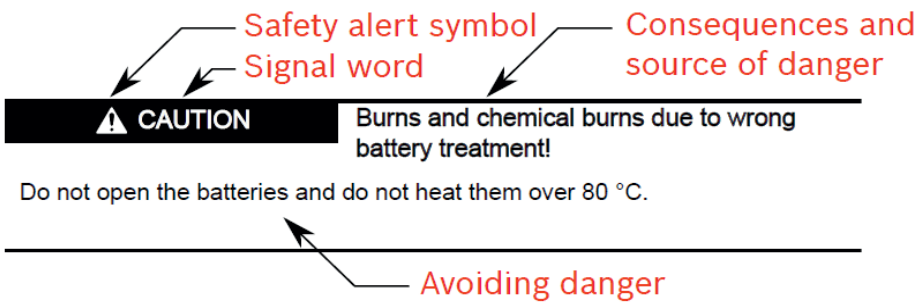

Abb. 1-1 Structure of the safety instructions

1.2 Explaining signal words and safety alert symbol

The safety instructions in this documentation contain specific signal words (danger, warning, caution, notice) and, if necessary, a safety alert symbol (according to ANSI Z535.6-2006).

The signal word is used to draw attention to the safety instruction and also provides information on the severity of the hazard.

The safety alert symbol (a triangle with an exclamation point), which precedes the signal words danger, warning and caution is used to alert the reader to personal injury hazards.

⚠ DANGER

In case of non-compliance with this safety instruction, death or serious injury **will** occur.

⚠ WARNING

In case of non-compliance with this safety instruction, death or serious injury **can** occur.

⚠ CAUTION

In case of non-compliance with this safety instruction, minor or moderate injury can occur.

NOTICE

In case of non-compliance with this safety instruction, material damage can occur.

Use of the safety instructions

1.3 Symbols used

Hints are represented as follows:

This is an information.

Tips are represented as follows:

This is a tip for the user.

1.4 Signal graphic explanation on the device

Prior to the installation and commissioning of the device, refer to the device documentation.

2 The PROFIBUS bus coupler

PROFIBUS bus coupler

The bus coupler is the link between a PROFIBUS network and the IndraControl S20 system.

Up to 63 IndraControl S20 devices can be connected to an existing PROFIBUS system using the bus coupler.

Features

- PROFIBUS connection via D-SUB 9 socket
- Interface physics RS-485 for PROFIBUS
- Electrical isolation between PROFIBUS interface and logic
- Up to 63 additional IndraControl S20 devices can be connected
- DP/V1 for Class 1 and Class 2 masters
- Data transmission speed of 9.6 kbps up to 12 Mbps (automatic detection)
- Rotary coding switches for setting the PROFIBUS address
- Supported PROFIBUS addresses 0 to 126
- Device description using GSD file
- I&M functions
- Typical cycle time of the IndraControl S20 local bus is around 10 µs
- Diagnostics and status indicators

In addition to this document, please also observe the information in the following documents:

- Module-specific data sheet
- “Rexroth IndraControl S20: System and Installation” application description, DOK-CONTRL-S20*SYS*INS-AP..-EN-P, MNR R911335988

These can be downloaded at: www.boschrexroth.com/electrics.

The PROFIBUS bus coupler

3 Diagnostics

The diagnostic concept for the bus coupler consists of two components. Firstly, diagnostic data is supplied to the control system via PROFIBUS in the form of diagnostic bytes. Secondly, local diagnostics are available, whereby the error type is indicated by specific flashing codes of the LEDs on the bus coupler.

3.1 Activating/deactivating the diagnostic formats

The diagnostic format can be set as a parameter on the module. You can either select display in common format, status PDU format or identifier-related format (ID-specific diagnostics). By default, common format is activated.

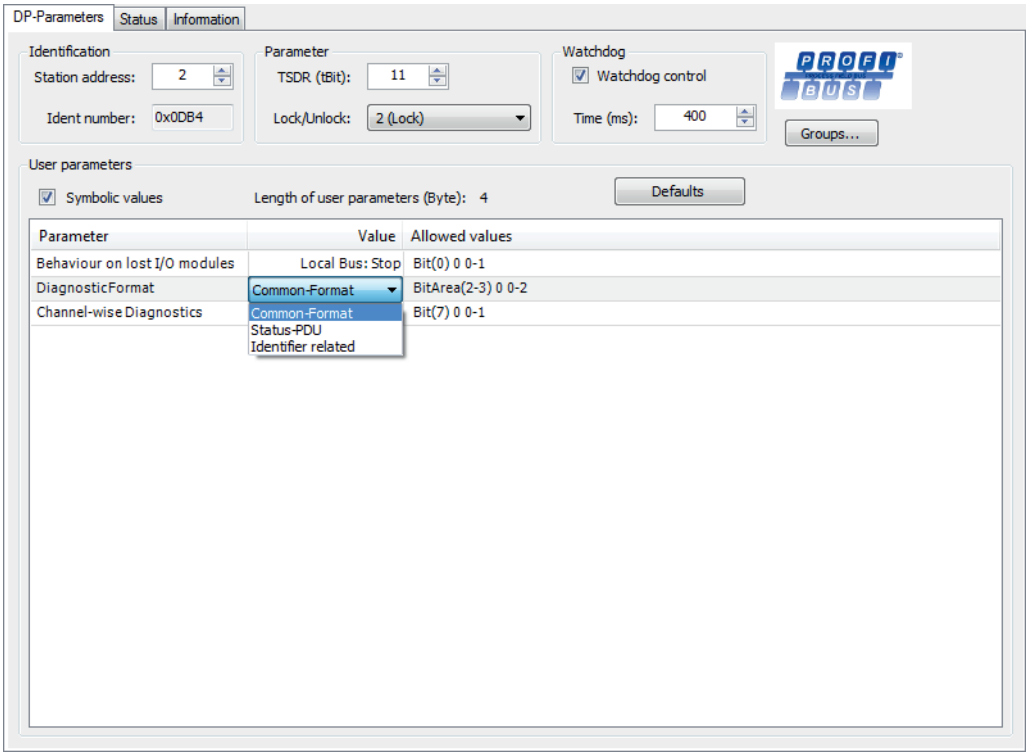

Fig. 3-1 Selection dialog - diagnostic formats

Diagnostics

3.1.1 Diagnostics in common format

This diagnostic format consists of the following blocks:

1 PROFIBUS standard diagnostics
2 ID-specific diagnostics
3 Status diagnostics (device status)
4 Channel-wise diagnostics
5 Revision diagnostics (manufacturer-specific)
6 Status-PDU (manufacturer-specific)

The diagnostic telegram is dynamic from block 2 onwards. The number of bytes in a block therefore depends on the station structure used.

The header bytes are used to distinguish between all blocks.

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Meaning
Block 1									
1	X	X	X	X	X	X	X	X	Station status 1
2	X	X	X	X	X	X	X	X	Station status 2
3	X	X	X	X	X	X	X	X	Station status 3
4	X	X	X	X	X	X	X	X	PROFIBUS master address
5	0	0	0	0	1	1	0	1	Manufacturer ID, high byte (01_{hex})
6	1	1	0	0	0	1	0	0	Manufacturer ID, low byte ($1F_{hex}$)
Block 2									
7	0	1	Length of block						ID-specific diagnostics (header)
8	LD 8	LD 7	LD 6	LD 5	LD 4	LD 3	LD 2	LD 1	Local bus devices 1 ... 8
9	LD 16	LD 15	LD 14	LD 13	LD 12	LD 11	LD 10	LD 9	Local bus devices 9 ... 16
...	...	...	...	...	...	...	...	...	...
15	0	LD 63	LD 62	LD 61	LD 60	LD 59	LD 58	LD 57	Local bus devices 57 ... 63
Block 3									
16	0	0	Length of block						Status (header)
17	1	0	0	0	0	0	1	0	Status type = device status
18	0	0	0	0	0	0	0	0	Slot (= 0 = general status of the bus coupler)
19	0	0	0	0	0	0	SP	SP	Specifier
20	ST LD 4		ST LD 3		ST LD 2		ST LD 1		Status of local bus devices 1 ... 4
21	ST LD 8		ST LD 7		ST LD 6		ST LD 5		Status of local bus devices 5 ... 8
...	…	…	…	…	…	…	…	…	…
35	0		ST LD 63		ST LD 62		ST LD 61		Status of local bus devices 61 ... 63

Fig. 3-2 Diagnostics in common format

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Meaning
Block 4 (ten errors possible, maximum)									
36	1	0	Slot						Channel-wise diagnostics (header), error 1
37	IO		Channel						IN/OUT and channel number, error 1
38	CT			ET					Channel and error type, error 1
39	1	0	Slot						Channel-wise diagnostics (header), error 2
40	IO		Channel						IN/OUT and channel number, error 2
...	CT			ET					Channel and error type, error 2
...	...	...	...	...	...	...	...	...	...
63	1	0	Slot						Channel-wise diagnostics (header), error 10
64	IO		Channel						IN/OUT and channel number, error 10
65	CT			ET					Channel and error type, error 10
Block 5									
66	1	1	X	X	X	X	X	X	Revision (start with $C1_{hex}$)
Block 6									
67	0	0	0	0	1	1	0	1	Status (header) with block length 13
68	X	X	X	X	X	X	X	X	Status type (81_{hex})
69	Slot								Slot number of the module with the last reported error
70	0	0	0	0	0	0	SP	SP	Specifier
71	X	X	X	X	X	X	X	X	Error code, byte 3
72	X	X	X	X	X	X	X	X	Error code, byte 2
73	X	X	X	X	X	X	X	X	Error code, byte 1/error type
74	X	X	X	X	X	X	X	X	Error code, byte 0/error number
75	X	X	X	X	X	X	X	X	Local bus diagnostic status register 1
76	X	X	X	X	X	X	X	X	Local bus diagnostic status register 0
77	X	X	X	X	X	X	X	X	Local bus diagnostic parameter register 1
77	X	X	X	X	X	X	X	X	Local bus diagnostic parameter register 0
78	X	X	X	X	X	X	X	X	Number of accessible local bus devices

Fig. 3-2 Diagnostics in common format

Diagnostics

Block 1: PROFIBUS standard diagnostics

X: Value 1 is activated. Value 0 is deactivated.

M: Slave transmits 0, master adds if necessary.

7	6	5	4	3	2	1	0	
							M	Station does not exist
						X		Slave is not ready for data exchange
					X			Error in configuration telegram
				X				Extended diagnostics follows in the telegram
			X					Requested function is not supported by the slave
		M						Invalid response from slave
	X							Error in parameter telegram
M								Slave assigned to another master

Fig. 3-3 Byte 1: status 1

7	6	5	4	3	2	1	0	
							X	Slave must be reparameterized
						X		Static diagnostics
					1			Fixed to 1 for DP operation
				X				Watchdog activated
			X					Freeze command received
		X						Sync command received
	0							Reserved
M								Slave deactivated

Fig. 3-4 Byte 2: status 2

7	6	5	4	3	2	1	0	
	0	0	0	0	0	0	0	Reserved
X								Slave has more diagnostic information than displayed in the telegram

Fig. 3-5 Byte 3: status 3

7	6	5	4	3	2	1	0	
0 ... 125 (00_{hex} ... $7E_{hex}$)								Master address following parameterization, default address is 255 (FF_{hex})

Fig. 3-6 Byte 4: master address

7	6	5	4	3	2	1	0	
0 ... 225 (00_{hex} ... F_{hex})								ID number, high byte
0 ... 225 (00_{hex} ... F_{hex})								ID number, low byte

Fig. 3-7 Bytes 5 and 6: ID number

Block 2: ID-specific diagnostics

The table shows the faulty local bus devices. A “1” is entered for every faulty module.

In the first byte of the block, bits 0 to 5 specify the number of local bus devices and therefore the length L of the block (8 devices for each byte, maximum). The minimum length of this block is 2 bytes (1 byte header + 1 byte (8 devices, maximum)), the maximum length is 9 bytes (1 byte header + 8 bytes (63 devices, maximum)). The size of the ID-specific diagnostic block depends on the number of configured modules.

Block 3: status PDU (device status)

For every local bus device there are 2 bits for status coding:

ST LD x: 00 = module data is valid

ST LD x: 01 = module data is invalid due to an error

ST LD x: 10 = module data is invalid due to a wrong module being inserted

ST LD x: 11 = module data is invalid or no module is inserted (despite configuration)

The specifier (SP) equals 1 in the event of a faulty state. The specifier equals 2 if the module changes from a faulty state to an error-free state. If the specifier equals 0, the state has not changed.

SP: 0 = no evaluation

SP: 1 = error occurs (number > 0)

SP: 2 = error disappears (number = 0)

SP: 3 = reserved

In the first byte of the block, bits 0 to 5 specify the number of local bus devices and therefore the length of the status PDU block. The minimum length of this block is 5 (4 bytes header + 1 byte (4 devices, maximum)), the maximum length is 20 (4 bytes header + 16 bytes (63 devices, maximum)). The size of the status PDU block therefore depends on the number of configured modules.

Block 4: channel-wise diagnostics

Up to 10 channel errors are indicated here. There are 3 bytes per channel error, this block can be a maximum of 30 bytes in size. Each channel error should be considered individually. In order to display the channel errors, channel-wise diagnostics must be activated on the bus coupler.

During channel-wise diagnostics only the errors reported by the channel are indicated. Errors concerning the entire device are not indicated.

IO: 00_{bin} = reserved
IO: 01_{bin} = input
IO: 10_{bin} = output
IO: 11_{bin} = input and output

Channel: channel number of the relevant channel (0 ... 63)

CT: 000_{bin} = reserved
CT: 001_{bin} = 1 bit
CT: 010_{bin} = 2 bits
CT: 011_{bin} = 4 bits
CT: 100_{bin} = 1 byte
CT: 101_{bin} = 1 word
CT: 110_{bin} = 2 words
CT: 111_{bin} = reserved

ET: 0 = reserved
ET: 1 = short circuit
ET: 2 = undervoltage
ET: 3 = surge voltage
ET: 4 = overload
ET: 5 = overtemperature
ET: 6 = line break
ET: 7 = upper limit value exceeded
ET: 8 = lower limit value exceeded
ET: 9 = general error

Block 5: revision diagnostics

Indicates the firmware revision, e.g., $C3_{hex}$ = revision 3.

Block 6: status PDU

The sixth block is also coded as status PDU.

Assignment of byte 2 to byte 8 corresponds to the assignment for diagnostics in status PDU format. This is described in Chapter 3.1.2, “Diagnostics in status PDU format” and can be used as additional information for blocks 2 and 3, if required.

Bytes 9 to 12 map the diagnostic status register and the diagnostic parameter register of the local bus.

Byte 13 indicates the number of available modules.

The bus coupler is always counted as a local bus device (LD). In the event of an error on the bus coupler, the corresponding bits for local bus device 1 are set in the diagnostics.

3.1.2 Diagnostics in status PDU format

This diagnostic format consists of the following blocks:

1 PROFIBUS standard diagnostics (see also 3.1.1 on page 8)
2 Status-PDU (manufacturer-specific)

Byte X	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Meaning
Block 1									
1	X	X	X	X	X	X	X	X	Station status 1
2	X	X	X	X	X	X	X	X	Station status 2
3	X	X	X	X	X	X	X	X	Station status 3
4	X	X	X	X	X	X	X	X	PROFIBUS master address
5	0	0	0	0	1	1	0	1	Manufacturer ID, high byte (01_{hex})
6	1	1	0	0	0	1	0	0	Manufacturer ID, low byte ($1F_{hex}$)
Block 2									
7	0	0	0	0	1	1	0	1	Status (header) with block length 13
8	X	X	X	X	X	X	X	X	Status type (81_{hex})
9	Slot								Slot number of the module with the last reported error code
10	0	0	0	0	0	0	SP	SP	Specifier
11	X	X	X	X	X	X	X	X	Error code, byte 1/error type
12	X	X	X	X	X	X	X	X	Error code, byte 0/error number
13	X	X	X	X	X	X	X	X	Module ID code, byte 3
14	X	X	X	X	X	X	X	X	Module ID code, byte 2
15	X	X	X	X	X	X	X	X	Module ID code, byte 1
15	X	X	X	X	X	X	X	X	Module ID code, byte 0

Fig. 3-8 Status PDU diagnostics including error codes

Diagnostics

Block 2: status PDU

Byte 8: Currently, only the standard status message is supported.

81_{hex}	Standard status message

Byte 11 and byte 12 provide more detailed information on the standard status message:

High byte	Error type
Low byte	Error number

For error descriptions, please refer to Chapter 3.2, “Error code representation” or the documentation of the individual module.

3.1.3 Diagnostics in identifier-related format (ID-specific diagnostics)

This diagnostic format consists of the following blocks:

1 PROFIBUS standard diagnostics (see also 3.1.1 on page 8)
2 ID-specific diagnostics (see also 3.1.1 on page 11)

Byte X	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Meaning
Block 1									
1	X	X	X	X	X	X	X	X	Station status 1
2	X	X	X	X	X	X	X	X	Station status 2
3	X	X	X	X	X	X	X	X	Station status 3
4	X	X	X	X	X	X	X	X	PROFIBUS master address
5	0	0	0	0	1	1	0	1	Module-ID, high byte (01_{hex})
6	1	0	1	1	0	1	0	0	Module ID, low byte ($1F_{hex}$)
Block 2									
7	0	1	X	X	X	X	X	X	Number of devices (values 0 ... 63)
8	X	X	X	X	X	X	X	X	Modules 1 ... 8 (values 0 ... 255)
9	X	X	X	X	X	X	X	X	Modules 9 ... 16 (values 0 ... 255)
10	X	X	X	X	X	X	X	X	Modules 17 ... 24 (values 0 ... 255)
11	X	X	X	X	X	X	X	X	Modules 25 ... 32 (values 0 ... 255)
12	X	X	X	X	X	X	X	X	Modules 33 ... 40 (values 0 ... 255)
13	X	X	X	X	X	X	X	X	Modules 41 ... 48 (values 0 ... 255)
14	X	X	X	X	X	X	X	X	Modules 49 ... 56 (values 0 ... 255)
15	X	X	X	X	X	X	X	X	Modules 57 ... 63 (values 0 ... 127)

Fig. 3-9 ID-specific (device) diagnostics

3.2 Error code representation

3.2.1 Local diagnostics indicators

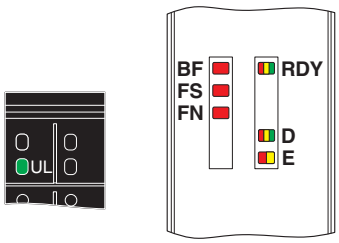

Fig. 3-10 Local diagnostics indicators on the bus coupler

For the meaning of the diagnostics indicators, please refer to the module-specific data sheet.

The error type and error number are indicated by flashing codes of the local diagnostic LEDs (FS LED and FN LED).

3.2.2 Error type and error number

In the controller, the error type and error number can be accessed via the status PDU diagnostics.

Error type:	FS ON, FN flashing
Error number:	FS OFF, FN flashing

Error type	Error number	Error cause	Error remedy
1		**Parameter errors on PROFIBUS**	
	1	A parameter block is faulty.	The number of modules does not correspond to the number of parameter blocks or the header byte of the module parameter is incorrect or the parameter block is incomplete.
	2	Too many data blocks for the station.	The number of modules does not correspond to the number of parameter blocks.
	3	The data length of the parameter block is too short.	Check the number of parameters.
	4	Reserved	
	5	The data block length was exceeded.	Check the number of modules.
	6	A parameter block is not complete.	Check the structure of the parameters for the modules.
	7	The number of parameter blocks is larger than the maximum number of modules in the station.	Check the configuration.
	8	Reserved	
	9	Reserved	

Fig. 3-11 Error type and error number (also FS/FN flashing codes)

Diagnostics

Error type	Error number	Error cause	Error remedy
2		**Configuration errors on PROFIBUS**	
	1	Less modules have been configured than are available in the station.	Add these modules to the configuration.
	2	More modules have been configured than are available in the station.	Delete the extra modules from your configuration.
	3	Configuration block is faulty.	Determine the exact error location using the device-specific diagnostics in your controller.
	4	The device type in the configuration does not correspond to that of the module.	Determine the exact error location using the device-specific diagnostics in your controller. Check the configuration in the hardware configurator.
	5	The configured length does not correspond to the actual length of the module.	Determine the exact error location using the device-specific diagnostics in your controller. Check the configuration in the hardware configurator.
	6	The data length of the configuration block is faulty.	Check the number of parameters. The parameter length must not be longer than the output data length of the relevant module.
	7	The PROFIBUS address set is larger than 126.	Check the PROFIBUS address of the S20-PB-BK. After the address is set, the bus coupler must be restarted.
	8	More than 244 bytes are required for the configuration.	Reduce the modules from the station.
3	**Configuration and parameter errors on the local bus**		
	1	General PDI parameterization failed.	Check the configuration of the station.
	2	Reserved	
	3	Module error occurred during initialization.	Try to restart the station.
	4	An error occurred in the I/O circuit (e.g., short circuit or overload at the actuator).	Remove the error from your I/O devices.
	5	Error in the module.	Activate channel-wise diagnostics when parameterizing the bus coupler in your controller and determine the exact error location and error cause.
	6	Reserved	
	7	More than 63 IndraControl S20 devices are connected.	Configure the station again and observe the maximum number of IndraControl S20 devices.
	8	Reserved	
	9	The sum of the process data in the local bus is greater than 244 bytes.	Check the amount of process data and reduce the number of devices in the station.
4	**Local bus error within the station**		
	1	Local bus was stopped.	Check the configuration of the station.

Fig. 3-11 Error type and error number (also FS/FN flashing codes) [...]

4 Acyclic communication (DP/V1 and PDI)

DP/V1 DP/V1 extends the cyclic data exchange function according to IEC 61158 to include acyclic services. This makes it easy to operate even complex modules.

PDI PDI = parameters, diagnostics, and information

In addition to the process data, the IndraControl S20 system has a channel for transferring parameter and diagnostic data, as well as other information: the PDI channel. Each IndraControl S20 device has this channel and can use it independently of the process data.

Services can be used to access communication objects created on the IndraControl S20 slave over the PDI channel. In most cases, this is done automatically, e.g., when writing the start parameterization during the bus coupler's startup.

For additional PDI information, please refer to the "Rexroth IndraControl S20: System and Installation" application description, DOK-CONTRL-S20*SYS*INS-AP..-EN-P, MNR R911335988.
For information on the PDI objects of a module, please refer to the module-specific data sheet.

PDI and DP/V1 DP/V1 is a PROFIBUS mechanism, which corresponds to PDI. The S20-PB-BK bus coupler prepares the data records, which are sent via DP/V1 from the Class 1 or Class 2 master, for the PDI mechanism in the local bus. PDI data from the local bus is then converted into DP/V1 telegrams by the bus coupler.

Before programming the application, check whether your controller or configuration tool supports DP/V1.

The different communication types will be described in the following.

4.1 Acyclic communication via the Class 1 master (C1 master)

C1 master The C1 master carries out parameterization during slave startup and is also the master for cyclic data traffic. It may also be necessary, for example, to read a parameter acyclically from the module as an option using this C1 master.

Corresponding read and write access rights are therefore defined for the C1 master. As it already has a connection to the slave during cyclic data traffic, the C1 master does not have to establish an explicit connection (using "Initiate"), but can communicate with the slave directly via "Read" and "Write".

Acyclic communication (DP/V1 and PDI)

4.2 Acyclic communication via the Class 2 master (C2 master)

C2 master For communication in the C2 master, the data fields are identical to those for C1 communication, and it is only the SAPs (Service Access Points) which differ. Additional fields are “Initiate” and “Abort” to establish and release the connection via SAP49 and 50. If DP/V1 devices are already in use, the routines for connection management can be adapted easily. The C2 master can be implemented in various forms, for example, in the form of a display device or operator interface. In a display device, the data is retrieved from the slave on request if, for example, a specific parameter is to be read. Access to the operator interface is usually acyclic.

4.3 Acyclic communication in DP/V1 mode

Communication mechanism

Whenever data is accessed, a distinction must be made between accessing data from local bus devices and data from the S20-PB-BK bus coupler:

Data type	Access to I/O module	Access to S20-PB-BK	Slot	Index (dec)
Master control	–	x	0	4
Device activation	–	x	0	6
Device diagnostics	–	x	0	12
Cycle count	–	x	0	20
Cycle error count	–	x	0	21
I&M functions	–	x	0	255
PD OUT	–	x	1 ... 63	11
PD IN	–	x	1 ... 63	13
PDI access	x	–	1 ... 63	47

Fig. 4-1 Objects on the S20-PB-BK bus coupler

When accessing the S20-PB-BK bus coupler, use the DP/V1 format. Read and write accesses can be executed in one step (request -> response).

The PDI objects from I/O modules are usually addressed via 16-bit indices. DP/V1 only has fields for 8-bit indices. Additional parameters have therefore been added to the data block for use when accessing the local bus, as for PROFIDrive. A sequence involving two steps is used, which follows the PROFIDrive profile:

Read:

1. a) Send the request as DP/V1 write request (PDI read) to slot x
   b) Receive the DP/V1 write response - often performed automatically by the master
2. a) Send a DP/V1 read to slot x
   b) Receive the DP/V1 read response - usually performed automatically by the master

Write:

1. a) Send the request as DP/V1 write request (PDI write) to slot x
   b) Receive the DP/V1 write response - often performed automatically by the master
2. a) Send a DP/V1 read to slot x
   b) Receive the DP/V1 read response - usually performed automatically by the master

Note that when communicating with objects on local bus devices, the response should be fetched using “Read”. Otherwise the result will be overwritten during the next communication. Communication is always carried out via DP/V1 index 47, and the object index and assigned subindex of the I/O devices are transmitted as part of the data field.

Request and response

The section below provides additional information on the format of write and read access (request and response).

The format for all types of access (request and response (positive), read and write) in DP/V1 is:

<DP/V1 header> <Data (PDI / DP/V1)>

The DP/V1 header for a positive DP/V1 response always has the following format:

<DP/V1 service (positive)> <Slot> <DP/V1 index> <DP/V1 length>

In the event of a faulty response, the format is as follows:

- For a DP/V1 error:
  <DP/V1 service (negative)> <Error decode> <Error code 1> <Error code 2>
- For an I/O device error:
  <DP/V1 service (positive)> <Slot> <DP/V1 index> <DP/V1 length>
  <Error data (PDI / DP/V1)>

The <Data (PDI / DP/V1)> is optional depending on the service and has the following structure:

Access	Service	Data
Write objects (S20-PB-BK)	DP/V1 write request	Object data
	DP/V1 write response	None
Read objects (S20-PB-BK)	DP/V1 read request	None
	DP/V1 read response	Object data
Write objects (I/O device)	DP/V1 write request (PDI write)	Write PDI request/Reserved (00_{hex})/Index high/Index low/Subindex/PDI data length/x bytes of PDI object data
	DP/V1 write response	None
	DP/V1 read request	None
	DP/V1 read response	Write PDI ack/Reserved (00_{hex})/Status
Read objects (I/O device)	DP/V1 write request (PDI read)	Read PDI req/Reserved (00_{hex})/Index high/Index low/ Subindex
	DP/V1 write response	None
	DP/V1 read request	None
	DP/V1 read response	Read PDI ack/Reserved (00_{hex})/Status/ PDI data length/x bytes of PDI object data

Fig. 4-2 Structure of the data depending on the service

Acyclic communication (DP/V1 and PDI)

The meaning of the individual parameters is as follows:

- <DP/V1 service>:
  In the request there is a distinction between DP/V1 read ($5E_{hex}$) and DP/V1 write ($5F_{hex}$); in the error response there is a distinction between DE_{hex} (read error) and DF_{hex} (write error)
- <Slot>:
  The slot of the device to be addressed in the station. The bus coupler is addressed using slot = 0. Starting with the first connected device, the devices are addressed with slots 1 to 63.
- <DP/V1 index>:
  For access to the PDI objects of the local bus devices, PROFIBUS index 47_{dec} (= $2F_{hex}$) is to be used. The PDI index is then transmitted as part of the data field. For access to the bus coupler, the object index can be used directly.
- <DP/V1 length>:
  For write access, the length of the subsequent data is specified here, and for read access, the length of the expected data is specified. On a response, this parameter contains the actual length of the DP/V1 data.
- <Error decode>:
  80_{hex} indicates an error in DP/V1.
- <Error code 1> and <Error code 2>:
  Error codes from DP/V1 access (see “Error codes for DP/V1 communication” on page 28).
- <Write PDI / Read PDI>:
  This specifies whether the following object indices should be written or read. Read PDI = 06_{hex}; write PDI = 07_{hex}.
- <Object data>:
  This is only the contents of an object. The length and scope of the data have already been described by <DP/V1 length>.
- <Index high and index low>
  This specifies the object index of the addressed PDI object in two bytes. For example, for index 2300_{hex} the value 23_{hex} should be entered for index high and the value 00_{hex} for index low.
- <Subindex>:
  When working with a PDI object, the subindex can be used to select a specific element from an array or record.
- <PDI data length>
  This value specifies how many bytes of PDI object data (object contents) follow.
- <PDI object data>:
  This is the actual contents of a PDI object.
- <Status>:
  In the event of a positive PDI response, the status is = 00_{hex}, in the event of an error it is 44_{hex}.
- <Error data (PDI / DP/V1)>:
  The structure of error data is as follows: <PDI confirmation code> <Reserved (00_{hex})>
  <Status = 44_{hex}> <PDI error code (4 bytes)>.
  (PDI error code, see “Error codes for DP/V1 communication” on page 28).

When accessing PDI, please note the first byte in the DP/V1 data block. PDI read is executed using 06_{hex} and PDI write is executed using 07_{hex}.
Set reserved bits to 00_{hex}.

5 Dynamic configuration

Dynamic configuration is the specification and configuration of a maximum configuration. Any subgroup of this maximum configuration can be operated.

In addition to dynamic configuration, empty spaces can be reserved for future extensions.

5.1 Empty spaces

It can be helpful to reserve empty spaces for a station, which may be used at different configuration levels. You can configure the maximum configuration level and thus also reserve memory in the PLC. However, optional modules do not have to be connected. They can be deactivated in the configuration.

If the station is subsequently extended to include previously deactivated modules, the new modules can be connected and activated in the hardware configurator.

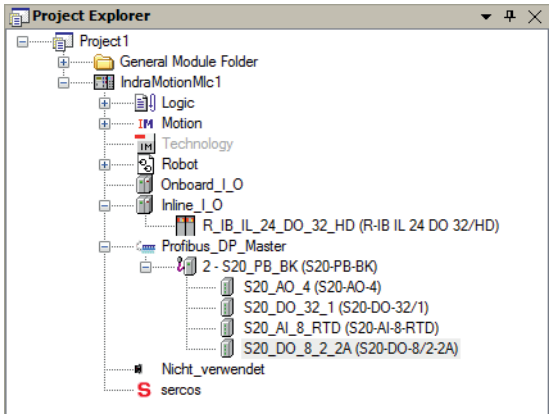

Fig. 5-1 Configuration table in the IndraWorks hardware configurator

Configuration in IndraWorks is carried out in the same way as for other modular slaves. The configuration can be created from the library using drag & drop, see Fig. 5-1.

Dynamic configuration

Open the “Properties” dialog by double-clicking on a module.

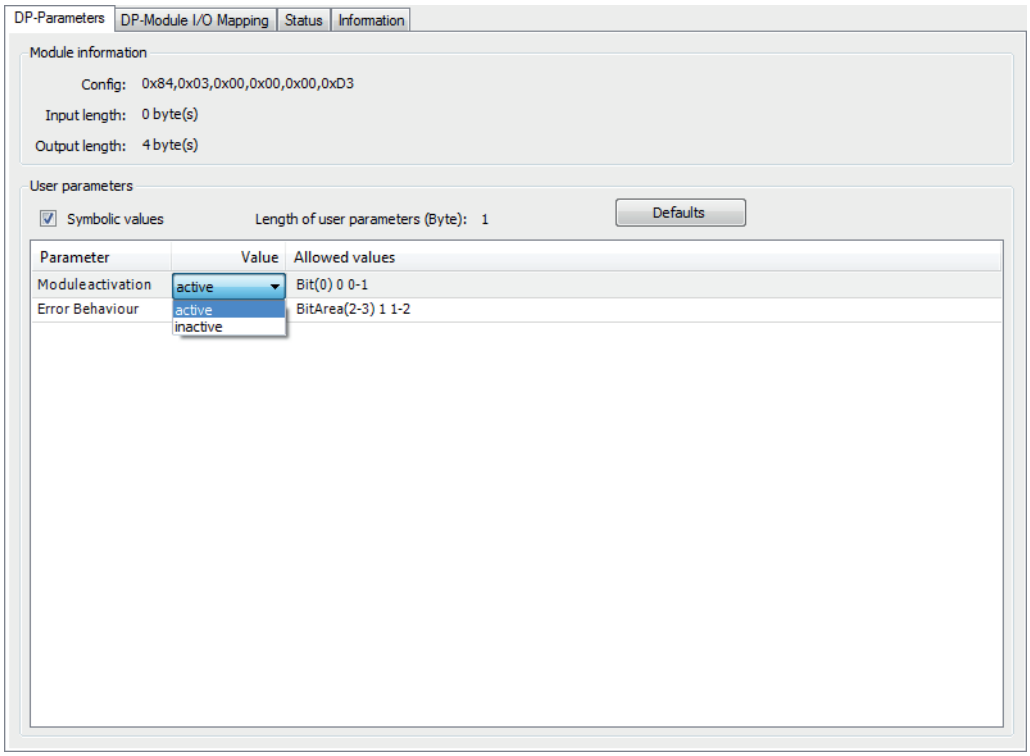

Fig. 5-2 “Properties” dialog

Use the “DP Parameter” tab to specify whether a device should be active or inactive, see Fig. 5-2.

Please note that a comparison between the configuration and the actual structure is also carried out for inactive modules. A message is displayed if deactivated modules are connected.

Following activation/deactivation, the configuration can be saved, translated, and downloaded as usual.

Depending on the module type, substitute values (DO and AO) to be output in the event of an error can also be set at this point, for example. Furthermore, inputs (AI) can be parameterized. This is also carried out via the dialog shown in Fig. 5-2.

5.2 Principle of dynamic configuration

In dynamic configuration, a maximum configuration is specified during configuration. The addresses are thus reserved in the PLC. Any subgroup of this maximum configuration can be operated. This type of subgroup can be selected and activated during configuration and runtime. The advantage is that the application can divide an identical hardware configuration into active and inactive modules.

Optional modules that are only required for additional functions do not have to be connected. They can simply be deactivated by the application.

If a subsequent extension is planned, the application can activate the new modules. The only requirement is that they are part of the maximum configuration.

All settings are stored in the volatile memory. This ensures easy replacement. The module does not have to be parameterized in advance.

Three indices on the bus coupler are used for handling:

Index 4: general control bits

Access:	Write
Function:	Details under “Slot 0” on page 33. Please observe bit 0 and bit 3 during dynamic configuration.
Structure:	Length of 1 byte

Bit 0: Restart local bus

Bit 3: Unlock dynamic configuration

Index 6: activation/deactivation of devices and slots

Access:	Read and write
Function:	Indicates which devices are active/inactive. Deactivation via the parameter telegram (reservation of empty spaces) is also indicated here.
Structure:	Length of 8 bytes

Byte 1								Byte 2								Bytes 3 ... 7	Byte 8							
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	...	57	58	59	60	61	62	63	x

Bit = 0: module and slot inactive

Bit = 1: module and slot active

Dynamic configuration

5.3 Startup

5.3.1 Planning the configuration

Fig. 5-3 shows an example of the maximum configuration, as provided. All modules are activated by default.

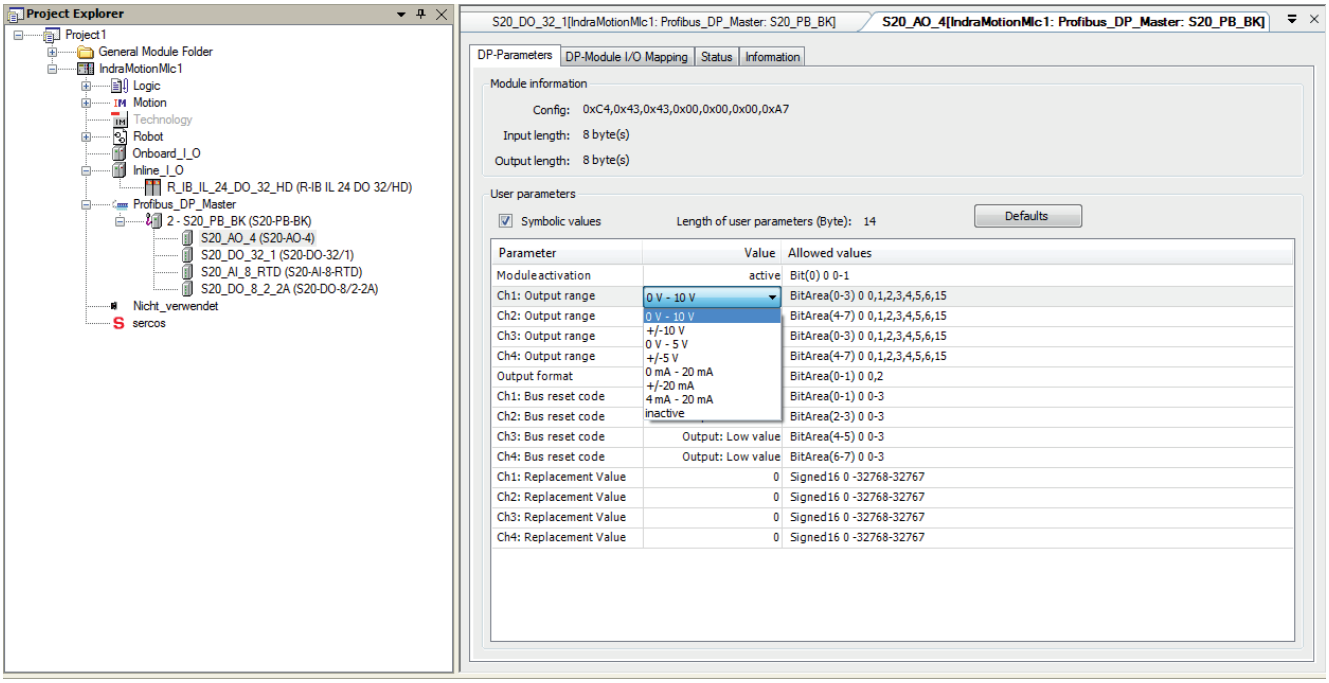

Fig. 5-3 Configuration in the IndraWorks hardware configurator

Configure the modules in IndraWorks via the module object properties as usual.

5.3.2 Options for specifying the active configuration

In the following example, the 8-channel digital modules should not be part of the station, i.e., these devices are part of the maximum configuration, but should be deactivated at this station.

There are two options for startup:

1 Deactivating modules in the hardware configuration by default
   - This option can be implemented easily. After setting the “Module activation” parameter to “inactive”, the configuration can be downloaded to the controller as usual, see “Following activation/deactivation, the configuration can be saved, translated, and downloaded as usual.” on page 22.

2 Via DP/V1 with maximum configuration and subsequent specification in the application
   - Specify the maximum configuration in the hardware configuration and download.
   - Switch to cyclic data exchange.
   - On the I/O modules, no data is exchanged as long as the connected configuration does not correspond to the available, activated modules.
   - Specify the configuration connected to the station in a non-volatile memory via index 6.
   - Data exchange is started.

For the second option, the example from Fig. 5-3 on page 24 is used and two DO 32/3 modules are deactivated via DP/V1. In each case, the data to be written is indicated. For detailed information on the protocol, please refer to Chapter “Acyclic communication in DP/V1 mode” on page 18. Here, you will find further examples for communication via DP/V1. The individual indices are explained in Chapter “Slot 0” on page 33.

Dynamic configuration

5.3.3 Specifying the active configuration via DP/V1

For DP/V1, the activation status can be accessed via index 6.

Access via index 6

Please observe the structure of index 6 during access:

Byte 1								Byte 2								Bytes 3 ... 7	Byte 8							
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	...	57	58	59	60	61	62	63	x

Bit = 0: module and slot inactive

Bit = 1: module and slot active

In this example, there are 7 connected modules. Modules 1, 2, 3, 4, and 7 should be active. Modules 5 and 6 are inactive.

The resulting data for object 6 is as follows:

$F2_{hex}$, 00_{hex}, 00_{hex}, 00_{hex}, 00_{hex}, 00_{hex}, 00_{hex}, 00_{hex}
These 8 data bytes are transmitted via DP/V1 in the following.

If a new activation status is described via index 6, it only becomes valid when the bus is restarted.

Two corresponding examples:

If, as described in this example, the configuration and the available modules differ, because, for example, two modules are not connected, the bus is read in continuously until it matches the configuration. The activation status on index 6 is evaluated automatically.

If the active bus configuration is extended and if previously inactive modules are attached at the end, these modules are to be activated first via index 6. Next time the bus is started, the new modules are integrated in the data traffic. The bus can be started via index 4, bit 0. Please note that during a restart the module output data is reset to its module-specific reset values.

Data (8 words VC1)	Data structure
5F 00 06 08 F2 00 00 00 00 00 00 00	Write/Slot/Index/Total length of data/ Length/8 bytes of object data

Write request (master -> slave)

Data (8 words VC1)	Data structure
5F 00 06 08	Write/Slot/Index/Length

Write response (slave -> master)

5.3.4 Summary

Depending on the task and requirements in the controller, the illustrated services can be used to specify the configuration actually used by the application. In this example, the modules have been deactivated with the illustrated services and therefore must not be connected. For additional information and examples regarding communication via DP/V1, please refer to Chapter “Acyclic communication (DP/V1 and PDI)” on page 17.

6 Appendix: error codes and parameter telegram

6.1 Error codes for acyclic communication

Error code (hex)	Meaning	Meaning	Reason	Remedy
0602	Hardware fault	Access to the object failed due to a hardware fault.	For example, I/O voltage not present.	Remove the hardware fault.
0603	Object access denied	The object has limited access rights.	It may be a read-only object or it may be password-protected.	Check the access rights in the object description.
0605	Object attribute inconsistent	A service parameter was specified with an impermissible value.	For example, an incorrect length specification or invalid subindex.	Refer to the object description to check the parameters and send the service again with the corrected values.
Communication error messages				
0606	Object access unsupported	The service used cannot be applied to this object.	For example, a program sequence can be started or stopped, but not read.	Check the object description to find out which services are supported for this object.
0607	Object non-existent	The object does not exist.	The “Index” parameter probably has an invalid value.	Refer to the object description to check the object index and send the service again.
0608	Type conflict	A bool type with <>0 or <>FF was written.		
Other error messages				
0800	Application error	Module-specific error message; no communication error		Refer to the module description.

Fig. 6-4 Error codes for acyclic communication

Depending on the I/O module, other specific error codes may also be used. These codes are listed in the relevant data sheet.

6.2 Error codes for DP/V1 communication

Always observe the individual representations in your working environment.

DP/V1 errors:

Function code (response) = DE_{hex} (Read error)
or function code (response) = DF_{hex} (Write error)

Error decode = 80_{hex} (DP/V1 communication)

Error with reference to I/O module:

Status 44_{hex} indicates an error

- For DP/V1 on byte 3 of the data block
- For VC1 byte 2 in the response

Error_Code_1	Error_Code_2	Meaning
$B0_{hex}$	0	Invalid index
$B1_{hex}$	0	Invalid data length when writing
$B2_{hex}$	0	Invalid device number
$B5_{hex}$	0	Status conflict, last read/write not finished yet
$B6_{hex}$	0	Access to device or index not permitted
$B7_{hex}$	0	Invalid parameter
$C3_{hex}$	0	(Internal) resource not available
$D2_{hex}$	0	Access to the service is not supported
$D4_{hex}$	0	Incorrect service code
DC_{hex}	0	(Internal) timeout when reading
DD_{hex}	0	(Internal) error when sending a request
DE_{hex}	0	(Internal) error when receiving a service

Fig. 6-5 Error codes for DP/V1 and VC1 communication

6.3 Format of the parameter telegram

A detailed description of the parameter format for the bus coupler and the input and output modules is given below. This may be useful when setting parameters using acyclic services or if there is no user interface for the simple selection of parameters.

Byte	Bit	Meaning
Bytes 1 ... 7		DP standard
Bytes 8 ... 10		DP/V1 standard
Byte 11		Control byte
	Bit 7	0: hide channel-wise diagnostics 1: show channel-wise diagnostics
	Bit 6	Reserved (set to 0)
	Bit 5	0: SET_PRM does not overwrite dynamic configuration 1: SET_PRM overwrites dynamic configuration
	Bit 4	Reserved (set to 0)
	Bits 3 ... 2	Diagnostics 0: common format 1: status PDU format 2: identifier-related format
	Bit 2	Reserved (set to 0)
	Bit 1	Reserved (set to 0)
	Bit 0	0: stop local bus in the event of a module failure 1: operate local bus with available modules

Fig. 6-6 Parameters for the bus coupler

The data for the configuration and the failsafe value can be found in the module-specific data sheets.

Format of the parameter telegram

Byte	Bit	Meaning
Byte 1	Bit 7 ... bit 6	00: start block ID for device
	Bit 5 ... bit 4	Configuration 00: no configuration 01: configuration of Input_Filter object ($FF8F_{hex}$) 10: configuration of Packed object ($00F0_{hex}$)
	Bit 3 ... bit 2	Failsafe value 00: no failsafe value (e.g., DI) 01: output zero 10: hold value 11: apply value from data field
	Bit 1	Extended functions 0: no function block 1: function block (also several)
	Bit 0	Activation 0: activated 1: deactivated

Fig. 6-7 Parameters for the I/O devices, byte 1

Following a configuration block:

Byte x	Bit 7 ... bit 6	01: configuration block ID
	Bit 5 ... bit 0	Data block length
Byte x+1 ... n		n data bytes

Following a failsafe block:

Byte x	Bit 7 ... bit 6	10: failsafe block ID
	Bit 5 ... bit 0	Data block length
Byte x+1 ... n		n data bytes

If one or more function blocks are present, a header byte for the function block follows:

Byte x	Bit 7 ... bit 6	11: function block ID
	Bit 5 ... bit 0	Entire function block length
		An additional byte is automatically used if the total length of the function block is exceeded. This byte specifies the actual length of the function block. The first byte (header byte for the function blocks) is set to FF_{hex}.

After that the function blocks are decoded:

PDI function block

Byte x+1	Bit 7 ... bit 6	01: PDI function block
	Bit 5 ... bit 0	PDI function block length
Byte x+2		Reserved (set to 00_{hex})
Byte x+3		Index high byte
Byte x+4		Index low byte
Byte x+5		Subindex
Byte x+6 ... x+6+n		n data bytes

Format of the parameter telegram

7 Appendix B: object dictionaries

Due to the complexity of the station, the station is divided into slots 0 to 63. The slots represent the individual slots of the station. Slot 0 represents the bus coupler, and slot 1 to slot 63 the additional bus devices.

To parameterize the station, each slot offers one or more object references, which can be used to acyclically parameterize the bus coupler and the bus devices. In the following chapters, these objects are explained in more detail in reference to the slots.

7.1 Slot 0

The following station-related indices are implemented on slot 0:

Index 4:	**Master control**
Function:	Control bits for station
Access:	Write
Length:	1 byte
Structure:	Bit 0: restart local bus
	Bit 1: reserved (set to 0)
	Bit 2: update diagnostics (evaluation of index 18)
	Bit 3: unlock dynamic configuration
	Bit 4: reserved (set to 0)
	Bit 5: reserved (set to 0)
	Bit 6: reserved (set to 0)
	Bit 7: reserved (set to 0)

Bit 0 can be used to restart the local bus at any time. If a new activation status has been specified via index 6, it is used for this restart. Please note that during a re-start the module output data is reset to its module-specific reset values.

Set bit 2 if the diagnostics of all connected modules are to be read in again.

Bit 3 can be used in the context of dynamic configuration. If a new activation status is specified via index 6, it is mandatory. If the connection to the PROFIBUS master is then interrupted and the original parameterization is transmitted by the master during restart, the activation status is maintained. Dynamic configuration does not have to be executed again.

However, if the activation status is to be reset during a restart, set bit 3 once following dynamic configuration via index 6.

In this way, both options are available:

- Restart with original configuration
- Restart with last dynamic configuration

Slot 0

Index 6: **Module activation**
Function: Activation/deactivation of I/O modules
Access: Read and write
Length: 8 bytes
Structure: See below

Byte 1								Byte 2								Bytes 3 ... 7	Byte 8							
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	...	57	58	59	60	61	62	63	x
7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0									

Bit = 0: module and slot inactive

Bit = 1: module and slot active

Index 12: **Module diagnostics**
Function: Station diagnostics starting from byte 7 (without standard diagnostics)
Access: Read
Length: 72 bytes, maximum
Structure: As described in Chapter “Diagnostics” on page 7

Module diagnostics can only be used via the acyclic services of DP/V1.

Index 20: **Cycle count**
Function: Average cycle time (frame and cycle)
Access: Read
Length: 8 bytes
Remark: Bytes 0 ... 3: frame time (ns)
Bytes 4 ... 7: cycle time (ns)

Index 21: **Cycle error count**
Function: Cycle counter (all faulty cycles)
Access: Read and write
Length: 12 bytes
Remark: For write access, all counters are set to 0.
Bytes 0, 1: invalid frame counter
Bytes 2, 3: coding error counter
Bytes 4, 5: frame start error counter
Bytes 6, 7: length error counter
Bytes 8, 9: CRC error counter
Bytes 10, 11: CRC stat error counter

The objects on slot 0 can be read and written with a single access operation via DP/V1.

Slot 0

Index 255:	**Identification and maintenance functions**
Function:	Read and write I&M functions
Access:	Read and write
Length:	64 bytes
Remark:	Only possible via DP/V1

For this object, each access operation - read or write - should be implemented in two stages (according to specification IEC 61158-6, Chapter 6.1).

Each PROFIBUS device is equipped with an electronic name plate for unique identification. This name plate can be accessed, for example, during startup or for maintenance purposes. Depending on the selected I&M function, either read-only or read/write access is possible.

The following I&M functions are supported:

I&M basic data	Access	Description
Header		
Manufacturer specification	Read	S20-PB-BK
I&M block		
MANUFACTURER_ID	Read	Manufacturer identification Bosch Rexroth = $011F_{hex}$
ORDER_ID	Read	MNR of the module R911173247
SERIAL_NUMBER	Read	Production serial number for clear identification
HARDWARE_REVISION	Read	Hardware revision $XXXX_{hex}$
SOFTWARE_REVISION	Read	Software revision $XXXX_{hex}$
REVISION_COUNTER	Read	Number of revisions $XXXX_{hex}$
PROFILE_ID	Read	$F600_{hex}$
PROFILE_SPECIFIC_TYPE	Read	0003_{hex}
IM_VERSION	Read	0101_{hex}
IM_SUPPORTED	Read	$001E_{hex}$

Fig. 7-8 I&M functions (basic data)

I&M1 (option)	Access	Description
Header		
Manufacturer specification	Read	S20-PB-BK
I&M block		
TAG_FUNCTION	Read/write	Specify a system-wide unique identification for the module here.
TAG_LOCATION	Read/write	Enter the module installation location.

Fig. 7-9 I&M1 functions (option)

Slot 0

I&M2 (option)	Access	Description
Header		
Manufacturer specification	Read	S20-PB-BK
I&M block		
INSTALLATION_DATE	Read/write	Enter the date when the module was installed in the system.
RESERVED	Read/write	Currently not assigned.

Fig. 7-10 I&M2 functions (option)

I&M3 (option)	Access	Description
Header		
Manufacturer specification	Read	S20-PB-BK
I&M block		
DESCRIPTOR	Read/write	Enter a general comment for the module.

Fig. 7-11 I&M3 functions (option)

I&M4 (option)	Access	Description
Header		
Manufacturer specification	Read	S20-PB-BK
I&M block		
SIGNATURE (security)	Read/write	The hardware configurator can be used to store a security code as a reference for certain parameterizations. The signature parameters enable access to the module together with the system identification consisting of MANUFACTURER_ID, ORDER_ID and SERIAL_ID.

Fig. 7-12 I&M4 functions (option)

Example:

Read I&M1

1. a) Send the request as a DP/V1 write request (I&M read call) to slot 0
   b) Receive the DP/V1 write response
2. a) Send a DP/V1 read to slot 0
   b) Receive the DP/V1 read response

Write I&M1

1. a) Send the request as a DP/V1 write request (I&M write call) to slot 0
   b) Receive the DP/V1 write response
2. a) Send a DP/V1 read to slot 0
   b) Receive the DP/V1 read response

Please note that the internal non-volatile memory of the device is accessed when writing to I&M functions I&M1 to I&M4. The memory is designed for a maximum of 100,000 write access operations.

7.2 Slots 1 to 63

On slots 1 to 63, indices are implemented with regard to I/O modules that can be connected:

Index 11:	**PD OUT**
Function:	Output data of the module connected to the slot
Access:	Read
Length:	0 ... 128 bytes

Index 13:	**PD IN**
Function:	Input data of the module connected to the slot
Access:	Read
Length:	0 ... 128 bytes

Index 47:	**PDI access**
Function:	Read and write PDI data on connected module via DP/V1
Access:	Read and write
Length:	Depends on the command and PDI object
Structure:	See Chapter 4.3 from page 18 onwards.

Slots 1 to 63

8 Disposal

8.1 General information

Dispose the products according to the respective valid national standard.

8.2 Return

For disposal, our products can be returned free of charge. However, the products must be free of remains like oil and grease or other impurities.

Furthermore, the products returned for disposal must not contain any undue foreign substances or components.

Send the products free of charge to the following address:

Bosch Rexroth AG
Electric Drives and Controls
Bürgermeister-Dr.-Nebel-Straße 2
D-97816 Lohr am Main, Germany

8.3 Packaging

The packaging material consists of cardboard, plastics, wood or styrofoam. Packaging material can be recycled anywhere.

For ecological reasons, please do not return empty packages.

8.4 Batteries and accumulators

Batteries and accumulators can be labelled with this symbol.

The symbol indicating "separate collection" for all batteries and accumulators is the crossed-out wheeled bin.

The end user within the EU is legally obligated to return used batteries. Outside the validity of the EU Directive 2006/66/EC keep the stipulated directives.

Used batteries can contain hazardous substances, which can harm the environment or the people´s health when they are improper stored or disposed of.

After use, the batteries or accumulators contained in Rexroth products have to be disposed of according to the country-specific collection system.

Disposal

9 Service and support

Our worldwide service network provides an optimized and efficient support. Our experts offer you advice and assistance should you have any queries.
You can contact us **24/7**.

Service Germany

Our technology-oriented Competence Center in Lohr, Germany, is responsible for all your service-related queries for electric drive and controls.

Contact the **Service Hotline** and **Service Helpdesk** under:

Phone:	**+49 9352 40 5060**
Fax:	**+49 9352 18 4941**
E-mail:	service.svc@boschrexroth.de
Internet:	http://www.boschrexroth.com

Additional information on service, repair (e.g. delivery addresses) and training can be found on our internet sites.

Service worldwide

Outside Germany, please contact your local service office first. For hotline numbers, refer to the sales office addresses on the internet.

Preparing information

To be able to help you more quickly and efficiently, please have the following information ready:

- Detailed description of malfunction and circumstances
- Type plate specifications of the affected products, in particular type codes and serial numbers
- Your contact data (phone and fax number as well as your e-mail address)

Service and support

Notes

The Drive & Control Company

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Bosch Group

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