DIGIFORCE 9310
PROFIBUS manual

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1. User advice and safety instructions

1.1 Important information

It is essential that you read this chapter to ensure safe handling of electrical equipment.

This operating manual contains important information for proper use of our equipment with the PROFIBUS. It has been written for personnel who are qualified and trained in the handling of electrical equipment.

Qualified and trained personnel are people who satisfy at least one of the following three requirements:

- You are familiar with the safety designs used in automation engineering, and understand how to deal with them in your capacity as configuration engineer.

- You are an operator of automation systems and have been instructed in how to handle the system. You are familiar with the operation of the equipment described in this documentation.

- You are a commissioning or service engineer and have successfully completed a training course qualifying you to repair automation systems. In addition you are authorized to commission, ground and label circuits and equipment in accordance with safety engineering standards.

1.2 Proper use of the equipment

The equipment described in this manual must only be used for the applications intended in this manual.

burster equipment is supplied from the factory with a permanent hardware and software configuration. Changes can only be made according to the options documented in the manuals. Any other changes to the hardware or software, or improper use, exempt the burster company from the warranty and liability. Please contact our sales office if you require a modified or new hardware or software configuration.

Proper transportation, storage, installation and assembly plus careful operation and maintenance are essential for trouble-free and safe operation of the equipment.

1.3 Notes on equipment configuration and installation

Always observe the current safety and accident prevention regulations when commissioning the equipment.

Install the power, signal and sensor cables so as to prevent electromagnetic interference from impairing operation of the equipment.

Install automation engineering equipment and installations with sufficient protection against accidental actuation.
Take suitable precautions in both the hardware and software to prevent any undefined states of the automation installation in the event of an open circuit.

In installations where major damage to property or even personal injury may be caused by a malfunction, take suitable precautions to establish a safe operating state in the event of a fault. This may be achieved using limit switches, mechanical interlocks etc. for example.

1.4 Symbols

CAUTION:
This information must be observed to prevent damage to the equipment.

WARNING:
Indicates basic conditions that must be observed for fault-free operation.

ESD (Electrostatic Discharge)
Warning that components are at risk from electrostatic discharge. Take precautionary measures when handling components at risk from electrostatic discharge.

Note
Routines or advice for efficient use of the equipment and software optimization.

Further information
References to additional literature, manuals, data sheets and Internet pages.

1.5 Abbreviations

BF	Bus error
DGND	Data transfer potential (reference potential to VP)
GSD	Device description data
PNO	PROFIBUS user organization
RTS	Request To Send
RxD/TxD-N	Receive/Transmit Data -N, A-line
RxD/TxD-P	Receive/Transmit Data -P, B-line
VP	Positive supply voltage (+5 V) for the terminating resistors

2 Technical data

PROFIBUS DP system data	
Number of devices or modules	126 with repeaters
Transmission medium	Cu cable to EN 50 170
Max. bus segment length	100 m to 1200 m (dependent on baud rate/cable)
Data transfer rates	9.6 kbaud to 12 Mbaud (dependent on cable)

Type 9310 device data			
Supported transfer rates	9.6 kbit/s	187.5 kbit/s	3000 kbit/s
	19.2 kbit/s	500 kbit/s	6000 kbit/s
	93.75 kbit/s	1500 kbit/s	12,000 kbit/s
Bus connector	9 pin SUB-D socket (female)		
ID number	06E5 Hex		
GSD file	BUR_06E5.gsd		
Address range	0 to 126		

Electrical safety	
Reverse voltage protection	Yes
Air clearance/leakage paths	To DIN EN 61131-2 and DIN EN 50178 Overvoltage category II, Pollution degree 2
Electrical isolation	Between fieldbus and internal electronics
Withstand voltage	DC 500 V

Electromagnetic compatibility			
(see also the operating manual for DIGIFORCE® type 9310)			
Interference immunity to EN50082-2 : 1995			
EN 61000-4-2	4 kV/8 kV	(2/4)	B
EN 61000-4-3	10 V/m 80 % AM	(3)	A
EN 61000-4-4	2 kV	(3/4)	A
EN 61000-4-6	10 V/m 80 % AM	(3)	A
Emitted interference to EN50081-2 : 1994			
EN 55011	30 dBµV/m	(30 m)	
	37 dBµV/m		

Notes on CE labeling

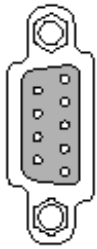
burster equipment carrying the CE mark meets the requirements of the EU directives and the harmonized European standards (EN) cited therein.

The EU declarations of conformity are available to the relevant authorities as specified in the directives. A copy of the declaration of conformity is included in the relevant equipment documentation.

3 Installation

3.1 Connection of fieldbus lines

burster devices with a PROFIBUS option have a **9-pin SUB-D female connector** for the fieldbus connection



			5	DGND
(CNTR-N)	NC*	9	4	NC* (CNTR-P)
RxD/TxD-N	RTS	8	3	RxD/TxD-P
(P24)	NC*	7	2	NC *(M24)
(Us terminating resistor)	VP	6	1	shield

Fig. 8.1: Connector pin assignment

* NC = not connected

3.1.1 Installation of fieldbus lines

For the PROFIBUS employing RS 485 transmission technology, all devices are connected in a line structure. The bus line is a shielded twisted pair cable.

The fieldbus line is specified in EN 50 170 as cable type A and must comply with specific cable parameters. Cable type B also specified in EN 50 170 is obsolete and should no longer be used.

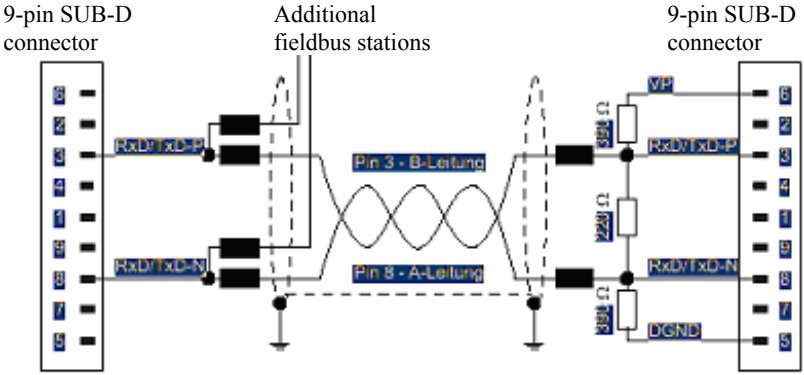
Parameter value	
Characteristic impedance in Ω	135 to 165 for 3 to 30 Mhz
Effective capacitance	< 30 pF/m
Loop impedance (Ω/km)	< 110
Wire diameter (mm) *)	>0.64
Wire cross-section (mm^2) *)	>0.34

*) the wire cross-sections used must be suitable for the connection options on the bus connector.

For cable type A, the maximum cable lengths for a bus segment depend on the transfer rate.

Transfer rate		**Max. bus segment length**
9.6 ... 93.75	kbaud	1200 m
187.5	kbaud	1000 m
500	kbaud	400 m
1500	kbaud	200 m
3000 / 6000 / 12000	kbaud	100 m

Commercially available connectors allow the incoming data cable to be connected directly to the outgoing data cable in the connector. This avoids stubs, and the bus connector can be connected to the bus or disconnected from the bus at any time without interrupting data traffic. These connectors include a bus termination that can be switched in or out. To avoid line reflections, connectors containing integral series inductors should be used to compensate for the capacitive load of the station. This is essential for transfer rates > 1.5 Mbaud.



Wiring of bus lines with bus termination

Note

Take care not to swap over the data lines when connecting the stations.

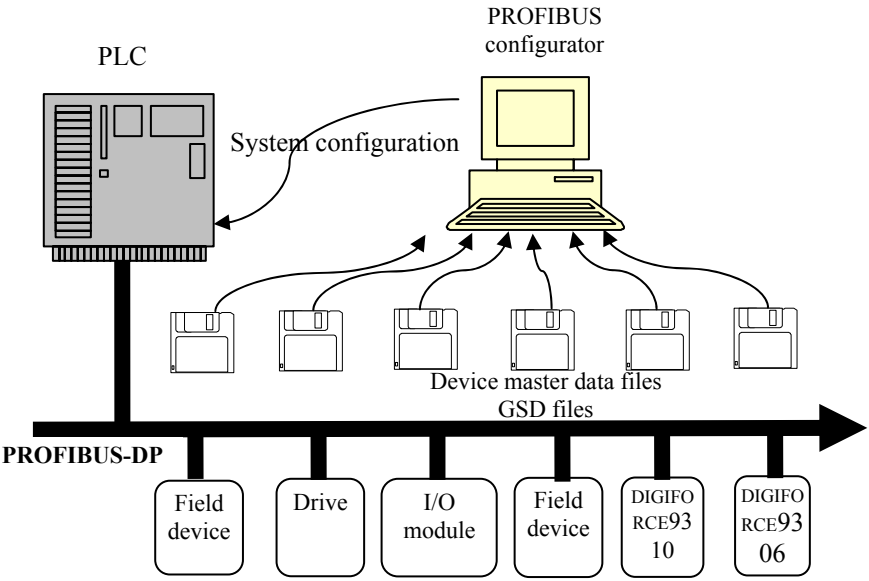
Always install the bus termination at the **start and end of the bus line**. The bus termination uses the supply voltage VP from the device, so ensure that the voltage supply to the slave device on which the bus termination is installed is always on.

Since the connectors contain built-in series inductors, avoid fitting connectors that are not connected to field devices, because the non-existent device capacitance may cause transmission errors.

It is essential to use a shielded PROFIBUS cable in order to achieve high system immunity to radiated electromagnetic interference. As far as possible, the shield should be connected at both ends to the protective ground via large-area shielding clamps providing good conducting contact. In addition, ensure that the cable is positioned as far as possible from all power cables. At data rates $\geq$1.5 Mbit/s, stubs must be avoided at all costs.

An equipotential bonding conductor must be installed to reduce potential differences introduced by different network input points from different parts of the system.

3.2 Configuring a PROFIBUS DP system



3.3 Configuration menu in DIGIFORCE® type 9310

Key	[Enter]	Display		
		Initial display “MEASUREMENT”		
	↵	MINIMUM SETUP MENU		
✥	↵ ↵	CONFIGURATION		
	↵ ↵	GENERAL SETTINGS		
	↵	PROFIBUS		
✥ or num. keys		ADDRESS	002	001 to 126
		WATCHDOG	OFF	ON – OFF*
		CONTROLLER	PROFIBUS	PLC - PROFIBUS
		DATA	MODE 9	1 - 9
		BAUD RATE	1.5 MBAUD	9.6 kB - 12 MB
		VERSION	200201	

* Internal watchdog The communications processor monitors the measurement processor and forwards the status to the PROFIBUS in the event of a fault (see page <17>)

4 PROFIBUS

4.1 Overview

PROFIBUS was developed as an open fieldbus. It was standardized in the German standard DIN 19 245 and was later incorporated in the European standard EN 50 170, Vol. 2. PROFIBUS is a medium for pure data transfer, like the RS232 standard for instance.

There are two different types of communication

- Cyclical services PROFIBUS DP (Distributed Peripheral)
- Acyclical services PROFIBUS DPV1 (optional services)

PROFIBUS DP (Distributed Peripheral) is a PROFIBUS version designed to satisfy the requirements of high-speed, efficient data transfer between a controller (PLC / PC) and remote peripheral devices.

Physical design: Similar to RS 485

A DP system normally consists of one master and up to 126 slaves with the use of repeaters. In systems employing multiple masters, each master has its own permanently assigned slaves.

Master: A DP master exchanges data with the slaves via PROFIBUS DP and monitors the bus. It transfers the data between the higher-level controller and the remote peripheral devices.

Slave: The DP slaves form the link to the measurement equipment. They condition the input data from the measurement application for communication with the master, and condition the output data (control signals) from the master for forwarding to the measurement electronics

The PROFIBUS uses the master-slave technique for data transfer. The master reads the input data cyclically from the slaves and writes the output data to the slaves.

PROFIBUS DP features:

- Transfer rate of 9.6 kbaud to 12 Mbaud
- Fast response times and high interference immunity
- Master and slave diagnostics
- Individual slaves can fail or be switched off without interfering with bus operation.
- The whole bus configuration is saved in the master.
- Each slave has a manufacturer-specific ID assigned by the PNO.
- The slaves are specified by the device description data (GSD file). This file is imported into the configuration software, simplifying slave configuration.

PROFIBUS DP data transfer

The master always transfers the same number of data bytes with each of its slaves in turn (always around a loop), thereby always keeping the total transfer time constant.

Each slave must respond within a fixed time slot.

Theoretically, 240 bytes are possible in each response.

The slave must always reply with the same data length.

In general, retrieving 240 bytes from a slave is too long for the user because it makes the total cycle time too long. This is why different modified response lengths ("modes" see page <>) are provided in the DIGIFORCE® type 9310 unit.

PROFIBUS DPV1 data transfer

With PROFIBUS DPV1, a master can use acyclical bus access to access individual device parameters, retrieve them or write new values for the parameter.

This bus access option **is not supported by DIGIFORCE® 9310**.

i **Further information**

The PROFIBUS user organization provides additional documents on the Internet.

(PNO) www.profibus.com

4.2 General information

For PROFIBUS DP (cyclical data traffic), one must define at the configuration stage how many bytes are transferred between master and slave during each cyclical access. (GSD file)

The device is controlled using the data transferred from master to slave. This data always consists of two bytes for the DIGIFORCE® type 9310 unit. The function of these two bytes is explained on page <>.

The data transferred in the opposite direction from slave to master contains the measurement results and status information. Since the DIGIFORCE® type 9310 is a highly complex piece of test equipment, there is an extremely large amount of data could be transferred in this case. This is not always practical however. For example, if one is only interested in the status information, it makes little sense to transfer more than 90 bytes of measurement results per access which the master makes no use of. On the other hand, there are applications in which the measurement results from a specific window need to be transferred; but this would not be possible if only the status information per interface is available.
Hence in order to satisfy as many customer requirements as possible, nine different combinations of different measurement results have been provided. These different options specify what information is sent to the master. The information content of the individual options ("modes") ranges from a simple short message (e.g. mode1 contains just PLC and status information; just 3 bytes are sent to the master in this case) to complex longer messages containing a large amount of information (e.g. mode9 contains PLC and status information, general curve data, entry and exit points, and minima and maxima of windows 1-3; 99 bytes are sent to the master in this case). When designing the system, the user can select the option that best meets his requirements so that he receives precisely the data that he needs.

4.3 GSD file

DIGIFORCE® equipment with the PROFIBUS option is supplied with a floppy disk. This disk includes the device description file BUR_06E5.gsd (GSD file). This GSD file describes the physical properties of the device (baud rate, specific bit times, sent/received bytes per cycle etc.).

The structure, contents and encoding of this device description data is standardized so that any DP slaves can be configured using configuration tools from various manufacturers.

The GSD file does not specify what data is transferred or how this data should be interpreted. The user must glean this information from the operating manual and program his master accordingly.

4.4 Data conversion

4.4.1 Description of the data formats in this manual

Data transfer for the various modes is described below. The terms PLC inputs and PLC outputs refer to the DIGIFORCE® 9310 unit. These terms are reversed when referred to the master.

The function of the PLC-In / PLC-Out bits is identical to the parallel PLC I/O ports on the unit itself and can be found from the DIGIFORCE® 9310 operating manual.

The floating-point numbers (“float”) mentioned are 4 bytes long (32 bits) and are based on the IEEE-754 standard (see appendix A).

Numbers that are not specifically labeled or are labeled with “d” or “dec” are *decimal numbers*. (Example: 1234, 1234dec, dec1234, 1234d.

Numbers that are labeled with “0x” or “hex” are *hexadecimal numbers*. (Example: 0x1234, hex1234, 1234hex, 1234h)

Numbers that are labeled with “b” or “bin” are *binary numbers*. (Example: b1100, bin1100, 1100b, 1100bin)

4.4.2 Handling problems that arise when reading floating-point numbers

This only concerns cases in which floating-point numbers need to be read from the DIGIFORCE® 9310 unit (in the cyclical protocol with Profimode >1).

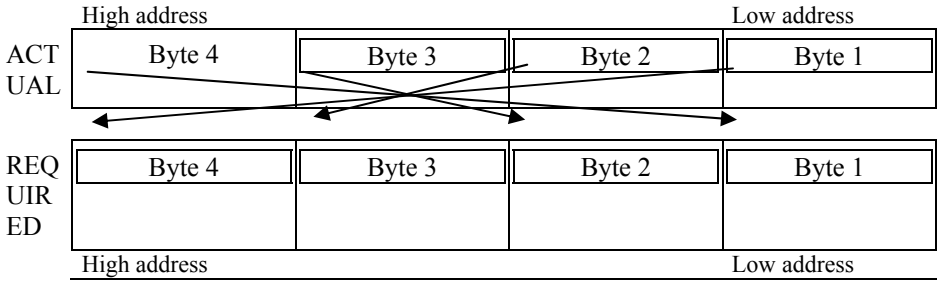
Floating-point numbers (data type REAL) are encoded as 4 bytes for transfer (see chapter "PROFIBUS transfer modes cyclical protocol" on page <>). This may create problems depending on the type of PLC used:

Cause

In the DIGIFORCE® 9310-PROFIBUS, the sign byte is transferred first. A Siemens S7, for example, expects this byte in the highest of the four addresses not in the lowest address. This inevitably leads to misinterpretation of the numeric value.

Remedial action

If a completely implausible result is obtained on decoding a floating-point number, the problem can be overcome by changing the order of the four bytes. Please see the hardware setting information in appendix B on page <>.



5. PROFIBUS DP data protocol

5.1 Transfer from master to slave

2 bytes of PLC-In data for the DIGIFORCE® is always transferred from the PROFIBUS master to the DIGIFORCE®. These bits have the same function as the parallel PLC inputs to the DIGIFORCE® type 9310 unit.

5.1.1 PLC inputs Byte 1

PLC inputs Byte 1 (Master → Slave)		
Valid values:	START	Bit 0 LSB
	TARA-Y	Bit 1
Set spare bits to '0'	TARA X	Bit 2
	RESET STATISTICS	Bit 3
	SENSORTEST	Bit 4
	spare	Bit 5
	spare	Bit 6
	spare	Bit 7 MSB

5.1.2 PLC inputs Byte 2

PLC inputs Byte 2 (Master → Slave)		
Valid values:	PROG_0	Bit 0 LSB
	PROG_1	Bit 1
Set spare bits to '0'	PROG_2	Bit 2
	STROBE	Bit 3
	AUTO	Bit 4
	spare	Bit 5
	spare	Bit 6
	spare	Bit 7 MSB

In all cyclical modes, 2 bytes are always transferred from master to slave. These two bytes are used to control the device via the PROFIBUS, and have the same meaning in all 9 modes.

5.2 Message structure / Transfer from slave to master

Mode	Contents	Length/bytes
1	PLC	3 bytes
2	PLC Min. general curve data	3 24 Σ 27 bytes
3	PLC Full general curve data	3 48 Σ 51 bytes
4	PLC W1E/E	3 16 Σ 19 Byte
5	PLC Full general curve data W1E/E	3 48 16 Σ 67 bytes
6	PLC W1-W2E/E	3 32 Σ 35 bytes
7	PLC Full general curve data W1-W2E/E	3 48 32 Σ 83 bytes
8	PLC W1-W3E/E	3 48 Σ 51 bytes
9	PLC Full general curve data W1-W3E/E	3 48 48 Σ 99 bytes

- Where WXE/E stands for Window X Entry/Exit (min/max values are not available with the type 9310)
- Minimum general curve data contains Ymin(x|y), Ymax(x|y) and End(x|y) → 24 bytes
- Full general curve data contains all available general curve data, i.e. Xmin(x|y), Xmax(x|y), Ymin(x|y), Ymax(x|y), Start(x|y) and End(x|y) → 48 bytes

These contents are specified in detail in section 5.5.

5.3 Meaning of the contents of the different protocol modes

PLC-Out:
The data refers to the PLC output of the DIGIFORCE®. The data described here is the data transferred from the DIGIFORCE® type 9310 to the master. The function of the PLC-In / PLC-Out bits is identical to the parallel PLC I/O ports on the unit itself and can be found from the operating manual for the unit.

5.3.1 PLC outputs Byte 1 (PLC signal lines OK/NOK, Ready etc.)

PLC outputs Byte 1 (Slave → Master)		
Valid values:	S2	Bit 0 LSB
	S1	Bit 1
Spare bits to are set to '0'	NOK online	Bit 2
	NOK	Bit 3
	OK	Bit 4
	READY	Bit 5
	spare	Bit 6
	spare	Bit 7 MSB

5.3.2 PLC outputs Byte 2 (program addressing, switching points)

PLC outputs Byte 2 (Slave → Master)		
Valid values:	STROBE	Bit 0 LSB
	Prog0	Bit 1
Spare bits to are set to '0'	Prog1	Bit 2
	Prog2	Bit 3
	OK-STEST	Bit 4
	Test running	Bit 5
	spare	Bit 6
	spare	Bit 7 MSB

5.3.3 PLC outputs Byte 3 (device status)

PLC outputs Byte 3 (Slave → Master)		
Valid values:	Status 2^0	Bit 0 LSB
	Status 2^1	Bit 1
Spare bits to are set to '0'	Status 2^2	Bit 2
	Status 2^3	Bit 3
	Status 2^4	Bit 4
	Status 2^5	Bit 5
	general error	Bit 6
	internal comms error	Bit 7 MSB

Bit 0	device is in the profibus-menu (no communication)
Bits 1-5	give the current device status, where not all options are used yet.
Bit 6	provides the internal watchdog status between the communications card and the measurement processor.
Bit 7	identifies a general internal communication error (Block transfer)

5.4 Message structure / data break-down

5.4.1 Minimum general curve data:

Min. Y of whole curve (X-coordinate)	4-byte float number (see appendix A)
Min. Y of whole curve (Y-coordinate)	4-byte float number (")
Max. Y of whole curve (X-coordinate)	4-byte float number (")
Max. Y of whole curve (Y-coordinate)	4-byte float number (")
Last curve value (X-coordinate)	4-byte float number (")
Last curve value (X-coordinate)	4-byte float number (")

5.4.2 Full general curve data:

Min. X of whole curve (X-coordinate)	4-byte float number (see appendix A)
Min. X of whole curve (Y-coordinate)	4-byte float number (")
Max. X of whole curve (X-coordinate)	4-byte float number (")
Max. X of whole curve (Y-coordinate)	4-byte float number (")
Min. Y of whole curve (X-coordinate)	4-byte float number (")
Min. Y of whole curve (Y-coordinate)	4-byte float number (")
Max. Y of whole curve (X-coordinate)	4-byte float number (")
Max. Y of whole curve (Y-coordinate)	4-byte float number (")
First curve value (X-coordinate)	4-byte float number (")
First curve value (Y-coordinate)	4-byte float number (")
Last curve value (X-coordinate)	4-byte float number (")
Last curve value (X-coordinate)	4-byte float number (")

5.4.3 Entry/Exit:

For pass-through window, online window:

Window entry (X-coordinate)	4-byte float number (see appendix A)
Window entry (Y-coordinate)	4-byte float number (")
Window exit (X-coordinate)	4-byte float number (")
Window exit (Y-coordinate)	4-byte float number (")

For block window

Window entry (X-coordinate)	4-byte float number (see appendix A)
Window entry (Y-coordinate)	4-byte float number (")
Block value (X-coordinate)	4-byte float number (")
Block value (Y-coordinate)	4-byte float number (")

5.5 Byte reference list

5.5.1 Mode 1 (PLC-Out)

Data from master to slave

Byte	Function	Section	Comments
0	PLC inputs Byte 1	5.1.1	
1	PLC inputs Byte 2	5.1.2	

Data from slave to master

Byte	Function	Section	Comments
0	PLC outputs Byte 1	5.3.1	
1	PLC outputs Byte 2	5.3.2	
2	PLC outputs Byte 3	5.3.3	

5.5.2 Mode 2 (PLC-Out, min. general curve data)

Data from master to slave

Byte	Function	Section	Comments
0	PLC inputs Byte 1	5.1.1	
1	PLC inputs Byte 2	5.1.2	

Data from slave to master

Byte	Function	Section	Comments
0	PLC outputs (1st byte)	5.3.1	
1	PLC outputs (2nd byte)	5.3.2	
2	PLC outputs (3rd byte)	5.3.3	
3	AbsMinY; X-coord. (1st byte)	5.4.1	min. general curve data:
4	AbsMinY; X-coord. (2nd byte)	5.4.1	Min. Y of whole curve
5	AbsMinY; X-coord. (3rd byte)	5.4.1	X-coordinate
6	AbsMinY; X-coord. (4th byte)	5.4.1	(32-bit float)
7	AbsMinY; Y-coord. (1st byte)	5.4.1	min. general curve data:
8	AbsMinY; Y-coord. (2nd byte)	5.4.1	Min. Y of whole curve
9	AbsMinY; Y-coord. (3rd byte)	5.4.1	Y-coordinate
10	AbsMinY; Y-coord. (4th byte)	5.4.1	(32-bit float)
11	AbsMaxY; X-coord. (1st byte)	5.4.1	min. general curve data:
12	AbsMaxY; X-coord. (2nd byte)	5.4.1	Max. Y of whole curve
13	AbsMaxY; X-coord. (3rd byte)	5.4.1	X-coordinate
14	AbsMaxY; X-coord. (4th byte)	5.4.1	(32-bit float)

continued on next page

Byte	Function	Section	Comments
15	AbsMaxY; Y-coord. (1st byte)	5.4.1	min. general curve data:
16	AbsMaxY; Y-coord. (2nd byte)	5.4.1	Max. Y of whole curve
17	AbsMaxY; Y-coord. (3rd byte)	5.4.1	Y-coordinate
18	AbsMaxY; Y-coord. (4th byte)	5.4.1	(32-bit float)
19	Last Point; X-coord. (1st byte)	5.4.1	min. general curve data:
20	Last Point; X-coord. (2nd byte)	5.4.1	Last curve value
21	Last Point; X-coord. (3rd byte)	5.4.1	X-coordinate
22	Last Point; X-coord. (4th byte)	5.4.1	(32-bit float)
23	Last Point; Y-coord. (1st byte)	5.4.1	min. general curve data:
24	Last Point; Y-coord. (2nd byte)	5.4.1	Last curve value
25	Last Point; Y-coord. (3rd byte)	5.4.1	Y-coordinate
26	Last Point; Y-coord. (4th byte)	5.4.1	(32-bit float)

5.5.3 Mode 3 (PLC-Out, full general curve data)

Data from master to slave

Byte	Function	Section	Comments
0	PLC inputs (1st byte)	5.1.1	
1	PLC inputs (2nd byte)	5.1.2	

Data from slave to master

Byte	Function	Section	Comments
0	PLC outputs Byte 1	5.3.1	
1	PLC outputs Byte 2	5.3.2	
2	PLC outputs Byte 3	5.3.3	
3	AbsMinX; X-coord. (1st byte)	5.4.2	Full general curve data:
4	AbsMinX; X-coord. (2nd byte)	5.4.2	Min X of whole curve
5	AbsMinX; X-coord. (3rd byte)	5.4.2	X-coordinate
6	AbsMinX; X-coord. (4th byte)	5.4.2	(32-bit float)
7	AbsMinX; Y-coord. (1st byte)	5.4.2	Full general curve data:
8	AbsMinX; Y-coord. (2nd byte)	5.4.2	Min X of whole curve
9	AbsMinX; Y-coord. (3rd byte)	5.4.2	Y-coordinate
10	AbsMinX; Y-coord. (4th byte)	5.4.2	(32-bit float)
11	AbsMaxX; X-coord. (1st byte)	5.4.2	Full general curve data:
12	AbsMaxX; X-coord. (2nd byte)	5.4.2	Max X of whole curve
13	AbsMaxX; X-coord. (3rd byte)	5.4.2	X-coordinate
14	AbsMaxX; X-coord. (4th byte)	5.4.2	(32-bit float)
15	AbsMaxX; Y-coord. (1st byte)	5.4.2	Full general curve data:
16	AbsMaxX; Y-coord. (2nd byte)	5.4.2	Max X of whole curve
17	AbsMaxX; Y-coord. (3rd byte)	5.4.2	Y-coordinate
18	AbsMaxX; Y-coord. (4th byte)	5.4.2	(32-bit float)

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Byte	Function	Section	Comments
19	AbsMinY; X-coord. (1st byte)	5.4.2	Full general curve data:
20	AbsMinY; X-coord. (2nd byte)	5.4.2	Min Y of whole curve
21	AbsMinY; X-coord. (3rd byte)	5.4.2	X-coordinate
22	AbsMinY; X-coord. (4th byte)	5.4.2	(32-bit float)
23	AbsMinY; Y-coord. (1st byte)	5.4.2	Full general curve data:
24	AbsMinY; Y-coord. (2nd byte)	5.4.2	Min Y of whole curve
25	AbsMinY; Y-coord. (3rd byte)	5.4.2	Y-coordinate
26	AbsMinY; Y-coord. (4th byte)	5.4.2	(32-bit float)
27	AbsMaxY; X-coord. (1st byte)	5.4.2	Full general curve data:
28	AbsMaxY; X-coord. (2nd byte)	5.4.2	Max. Y of whole curve
29	AbsMaxY; X-coord. (3rd byte)	5.4.2	X-coordinate
30	AbsMaxY; X-coord. (4th byte)	5.4.2	(32-bit float)
31	AbsMaxY; Y-coord. (1st byte)	5.4.2	Full general curve data:
32	AbsMaxY; Y-coord. (2nd byte)	5.4.2	Max. Y of whole curve
33	AbsMaxY; Y-coord. (3rd byte)	5.4.2	Y-coordinate
34	AbsMaxY; Y-coord. (4th byte)	5.4.2	(32-bit float)
35	First Point; X-coord. (1st byte)	5.4.2	Full general curve data:
36	First Point; X-coord. (2nd byte)	5.4.2	First curve value
37	First Point; X-coord. (3rd byte)	5.4.2	X-coordinate
38	First Point; X-coord. (4th byte)	5.4.2	(32-bit float)
39	First Point; Y-coord. (1st byte)	5.4.2	Full general curve data:
40	First Point; Y-coord. (2nd byte)	5.4.2	First curve value
41	First Point; Y-coord. (3rd byte)	5.4.2	Y-coordinate
42	First Point; Y-coord. (4th byte)	5.4.2	(32-bit float)
43	Last Point; X-coord. (1st byte)	5.4.2	Full general curve data:
44	Last Point; X-coord. (2nd byte)	5.4.2	Last curve value
45	Last Point; X-coord. (3rd byte)	5.4.2	X-coordinate
46	Last Point; X-coord. (4th byte)	5.4.2	(32-bit float)
47	Last Point; Y-coord. (1st byte)	5.4.2	Full general curve data:
48	Last Point; Y-coord. (2nd byte)	5.4.2	Last curve value
49	Last Point; Y-coord. (3rd byte)	5.4.2	Y-coordinate
50	Last Point; Y-coord. (4th byte)	5.4.2	(32-bit float)

5.5.4 Mode 4 (PLC-Out, Window 1 E/E)

Data from master to slave

Byte	Function	Section	Comments
0	PLC inputs (1st byte)	5.1.1	
1	PLC inputs (2nd byte)	5.1.2	

Data from slave to master

Byte	Function	Section	Comments
0	PLC outputs Byte 1	5.3.1	
1	PLC outputs Byte 2	5.3.2	
2	PLC outputs Byte 3	5.3.3	
3	Entry window 1; X-coord. (1st byte)	5.4.3	Window 1
4	Entry window 1; X-coord. (2nd byte)	5.4.3	Entry
5	Entry window 1; X-coord. (3rd byte)	5.4.3	X-coordinate
6	Entry window 1; X-coord. (4th byte)	5.4.3	(32-bit float)
7	Entry window 1; Y-coord. (1st byte)	5.4.3	Window 1
8	Entry window 1; Y-coord. (2nd byte)	5.4.3	Entry
9	Entry window 1; Y-coord. (3rd byte)	5.4.3	Y-coordinate
10	Entry window 1; Y-coord. (4th byte)	5.4.3	(32-bit float)
11	Exit window 1; X-coord. (1st byte)	5.4.3	Window 1
12	Exit window 1; X-coord. (2nd byte)	5.4.3	Exit
13	Exit window 1; X-coord. (3rd byte)	5.4.3	X-coordinate
14	Exit window 1; X-coord. (4th byte)	5.4.3	(32-bit float)
15	Exit window 1; Y-coord. (1st byte)	5.4.3	Window 1
16	Exit window 1; Y-coord. (2nd byte)	5.4.3	Exit
17	Exit window 1; Y-coord. (3rd byte)	5.4.3	Y-coordinate
18	Exit window 1; Y-coord. (4th byte)	5.4.3	(32-bit float)

5.5.5 Mode 5 (PLC-Out, Full general curve data, Window 1 E/E)

Data from master to slave

Byte	Function	Section	Comments
0	PLC inputs (1st byte)	5.1.1	
1	PLC inputs (2nd byte)	5.1.2	

Data from slave to master

Byte	Function	Section	Comments
0	PLC outputs Byte 1	5.3.1	
1	PLC outputs Byte 2	5.3.2	
2	PLC outputs Byte 3	5.3.3	
3	AbsMinX; X-coord. (1st byte)	5.4.2	Full general curve data:
4	AbsMinX; X-coord. (2nd byte)	5.4.2	Min X of whole curve
5	AbsMinX; X-coord. (3rd byte)	5.4.2	X-coordinate
6	AbsMinX; X-coord. (4th byte)	5.4.2	(32-bit float)
7	AbsMinX; Y-coord. (1st byte)	5.4.2	Full general curve data:
8	AbsMinX; Y-coord. (2nd byte)	5.4.2	Min X of whole curve
9	AbsMinX; Y-coord. (3rd byte)	5.4.2	Y-coordinate
10	AbsMinX; Y-coord. (4th byte)	5.4.2	(32-bit float)
11	AbsMaxX; X-coord. (1st byte)	5.4.2	Full general curve data:
12	AbsMaxX; X-coord. (2nd byte)	5.4.2	Max X of whole curve
13	AbsMaxX; X-coord. (3rd byte)	5.4.2	X-coordinate
14	AbsMaxX; X-coord. (4th byte)	5.4.2	(32-bit float)
15	AbsMaxX; Y-coord. (1st byte)	5.4.2	Full general curve data:
16	AbsMaxX; Y-coord. (2nd byte)	5.4.2	Max X of whole curve
17	AbsMaxX; Y-coord. (3rd byte)	5.4.2	Y-coordinate
18	AbsMaxX; Y-coord. (4th byte)	5.4.2	(32-bit float)
19	AbsMinY; X-coord. (1st byte)	5.4.2	Full general curve data:
20	AbsMinY; X-coord. (2nd byte)	5.4.2	Min Y of whole curve
21	AbsMinY; X-coord. (3rd byte)	5.4.2	X-coordinate
22	AbsMinY; X-coord. (4th byte)	5.4.2	(32-bit float)
23	AbsMinY; Y-coord. (1st byte)	5.4.2	Full general curve data:
24	AbsMinY; Y-coord. (2nd byte)	5.4.2	Min Y of whole curve
25	AbsMinY; Y-coord. (3rd byte)	5.4.2	Y-coordinate
26	AbsMinY; Y-coord. (4th byte)	5.4.2	(32-bit float)
27	AbsMaxY; X-coord. (1st byte)	5.4.2	Full general curve data:
28	AbsMaxY; X-coord. (2nd byte)	5.4.2	Max. Y of whole curve
29	AbsMaxY; X-coord. (3rd byte)	5.4.2	X-coordinate
30	AbsMaxY; X-coord. (4th byte)	5.4.2	(32-bit float)
31	AbsMaxY; Y-coord. (1st byte)	5.4.2	Full general curve data:
32	AbsMaxY; Y-coord. (2nd byte)	5.4.2	Max. Y of whole curve
33	AbsMaxY; Y-coord. (3rd byte)	5.4.2	Y-coordinate
34	AbsMaxY; Y-coord. (4th byte)	5.4.2	(32-bit float)

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Byte	Function	Section	Comments
35	First Point; X-coord. (1st byte)	5.4.2	Full general curve data:
36	First Point; X-coord. (2nd byte)	5.4.2	First curve value
37	First Point; X-coord. (3rd byte)	5.4.2	X-coordinate
38	First Point; X-coord. (4th byte)	5.4.2	(32-bit float)
39	First Point; Y-coord. (1st byte)	5.4.2	Full general curve data:
40	First Point; Y-coord. (2nd byte)	5.4.2	First curve value
41	First Point; Y-coord. (3rd byte)	5.4.2	Y-coordinate
42	First Point; Y-coord. (4th byte)	5.4.2	(32-bit float)
43	Last Point; X-coord. (1st byte)	5.4.2	Full general curve data:
44	Last Point; X-coord. (2nd byte)	5.4.2	Last curve value
45	Last Point; X-coord. (3rd byte)	5.4.2	X-coordinate
46	Last Point; X-coord. (4th byte)	5.4.2	(32-bit float)
47	Last Point; Y-coord. (1st byte)	5.4.2	Full general curve data:
48	Last Point; Y-coord. (2nd byte)	5.4.2	Last curve value
49	Last Point; Y-coord. (3rd byte)	5.4.2	Y-coordinate
50	Last Point; Y-coord. (4th byte)	5.4.2	(32-bit float)
51	Entry window 1; X-coord. (1st byte)	5.4.4	Window 1
52	Entry window 1; X-coord. (2nd byte)	5.4.4	Entry
53	Entry window 1; X-coord. (3rd byte)	5.4.4	X-coordinate
54	Entry window 1; X-coord. (4th byte)	5.4.4	(32-bit float)
55	Entry window 1; Y-coord. (1st byte)	5.4.4	Window 1
56	Entry window 1; Y-coord. (2nd byte)	5.4.4	Entry
57	Entry window 1; Y-coord. (3rd byte)	5.4.4	Y-coordinate
58	Entry window 1; Y-coord. (4th byte)	5.4.4	(32-bit float)
59	Exit window 1; X-coord. (1st byte)	5.4.4	Window 1
60	Exit window 1; X-coord. (2nd byte)	5.4.4	Exit
61	Exit window 1; X-coord. (3rd byte)	5.4.4	X-coordinate
62	Exit window 1; X-coord. (4th byte)	5.4.4	(32-bit float)
63	Exit window 1; Y-coord. (1st byte)	5.4.4	Window 1
64	Exit window 1; Y-coord. (2nd byte)	5.4.4	Exit
65	Exit window 1; Y-coord. (3rd byte)	5.4.4	Y-coordinate
66	Exit window 1; Y-coord. (4th byte)	5.4.4	(32-bit float)

5.5.6 Mode 6 (PLC-Out, Windows 1-2 E/E)

Data from master to slave

Byte	Function	Section	Comments
0	PLC inputs (1st byte)	5.1.1	
1	PLC inputs (2nd byte)	5.1.2	

Data from slave to master

Byte	Function	Section	Comments
0	PLC outputs Byte 1	5.3.1	
1	PLC outputs Byte 2	5.3.2	
2	PLC outputs Byte 3	5.3.3	
3	Entry window 1; X-coord. (1st byte)	5.4.4	Window 1
4	Entry window 1; X-coord. (2nd byte)	5.4.4	Entry
5	Entry window 1; X-coord. (3rd byte)	5.4.4	X-coordinate
6	Entry window 1; X-coord. (4th byte)	5.4.4	(32-bit float)
7	Entry window 1; Y-coord. (1st byte)	5.4.4	Window 1
8	Entry window 1; Y-coord. (2nd byte)	5.4.4	Entry
9	Entry window 1; Y-coord. (3rd byte)	5.4.4	Y-coordinate
10	Entry window 1; Y-coord. (4th byte)	5.4.4	(32-bit float)
11	Exit window 1; X-coord. (1st byte)	5.4.4	Window 1
12	Exit window 1; X-coord. (2nd byte)	5.4.4	Exit
13	Exit window 1; X-coord. (3rd byte)	5.4.4	X-coordinate
14	Exit window 1; X-coord. (4th byte)	5.4.4	(32-bit float)
15	Exit window 1; Y-coord. (1st byte)	5.4.4	Window 1
16	Exit window 1; Y-coord. (2nd byte)	5.4.4	Exit
17	Exit window 1; Y-coord. (3rd byte)	5.4.4	Y-coordinate
18	Exit window 1; Y-coord. (4th byte)	5.4.4	(32-bit float)
19	Entry window 2; X-coord. (1st byte)	5.4.4	Window 2
20	Entry window 2; X-coord. (2nd byte)	5.4.4	Entry
21	Entry window 2; X-coord. (3rd byte)	5.4.4	X-coordinate
22	Entry window 2; X-coord. (4th byte)	5.4.4	(32-bit float)
23	Entry window 2; Y-coord. (1st byte)	5.4.4	Window 2
24	Entry window 2; Y-coord. (2nd byte)	5.4.4	Entry
25	Entry window 2; Y-coord. (3rd byte)	5.4.4	Y-coordinate
26	Entry window 2; Y-coord. (4th byte)	5.4.4	(32-bit float)
27	Exit window 2; X-coord. (1st byte)	5.4.4	Window 2
28	Exit window 2; X-coord. (2nd byte)	5.4.4	Exit
29	Exit window 2; X-coord. (3rd byte)	5.4.4	X-coordinate
30	Exit window 2; X-coord. (4th byte)	5.4.4	(32-bit float)
31	Exit window 2; Y-coord. (1st byte)	5.4.4	Window 2
32	Exit window 2; Y-coord. (2nd byte)	5.4.4	Exit
33	Exit window 2; Y-coord. (3rd byte)	5.4.4	Y-coordinate
34	Exit window 2; Y-coord. (4th byte)	5.4.4	(32-bit float)

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5.5.7 Mode 7 (PLC-Out, Full general curve data, Windows 1-2 E/E)

Data from master to slave

Byte	Function	Section	Comments
0	PLC inputs (1st byte)	5.1.1	
1	PLC inputs (2nd byte)	5.1.2	

Data from slave to master

Byte	Function	Section	Comments
0	PLC outputs Byte 1	5.3.1	
1	PLC outputs Byte 2	5.3.2	
2	PLC outputs Byte 3	5.3.3	
3	AbsMinX; X-coord. (1st byte)	5.4.2	Full general curve data:
4	AbsMinX; X-coord. (2nd byte)	5.4.2	Min X of whole curve
5	AbsMinX; X-coord. (3rd byte)	5.4.2	X-coordinate
6	AbsMinX; X-coord. (4th byte)	5.4.2	(32-bit float)
7	AbsMinX; Y-coord. (1st byte)	5.4.2	Full general curve data:
8	AbsMinX; Y-coord. (2nd byte)	5.4.2	Min X of whole curve
9	AbsMinX; Y-coord. (3rd byte)	5.4.2	Y-coordinate
10	AbsMinX; Y-coord. (4th byte)	5.4.2	(32-bit float)
11	AbsMaxX; X-coord. (1st byte)	5.4.2	Full general curve data:
12	AbsMaxX; X-coord. (2nd byte)	5.4.2	Max X of whole curve
13	AbsMaxX; X-coord. (3rd byte)	5.4.2	X-coordinate
14	AbsMaxX; X-coord. (4th byte)	5.4.2	(32-bit float)
15	AbsMaxX; Y-coord. (1st byte)	5.4.2	Full general curve data:
16	AbsMaxX; Y-coord. (2nd byte)	5.4.2	Max X of whole curve
17	AbsMaxX; Y-coord. (3rd byte)	5.4.2	Y-coordinate
18	AbsMaxX; Y-coord. (4th byte)	5.4.2	(32-bit float)
19	AbsMinY; X-coord. (1st byte)	5.4.2	Full general curve data:
20	AbsMinY; X-coord. (2nd byte)	5.4.2	Min Y of whole curve
21	AbsMinY; X-coord. (3rd byte)	5.4.2	X-coordinate
22	AbsMinY; X-coord. (4th byte)	5.4.2	(32-bit float)
23	AbsMinY; Y-coord. (1st byte)	5.4.2	Full general curve data:
24	AbsMinY; Y-coord. (2nd byte)	5.4.2	Min Y of whole curve
25	AbsMinY; Y-coord. (3rd byte)	5.4.2	Y-coordinate
26	AbsMinY; Y-coord. (4th byte)	5.4.2	(32-bit float)
27	AbsMaxY; X-coord. (1st byte)	5.4.2	Full general curve data:
28	AbsMaxY; X-coord. (2nd byte)	5.4.2	Max. Y of whole curve
29	AbsMaxY; X-coord. (3rd byte)	5.4.2	X-coordinate
30	AbsMaxY; X-coord. (4th byte)	5.4.2	(32-bit float)
31	AbsMaxY; Y-coord. (1st byte)	5.4.2	Full general curve data:
32	AbsMaxY; Y-coord. (2nd byte)	5.4.2	Max. Y of whole curve
33	AbsMaxY; Y-coord. (3rd byte)	5.4.2	Y-coordinate
34	AbsMaxY; Y-coord. (4th byte)	5.4.2	(32-bit float)

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Byte	Function	Section	Comments
35	First Point; X-coord. (1st byte)	5.4.2	Full general curve data:
36	First Point; X-coord. (2nd byte)	5.4.2	First curve value
37	First Point; X-coord. (3rd byte)	5.4.2	X-coordinate
38	First Point; X-coord. (4th byte)	5.4.2	(32-bit float)
39	First Point; Y-coord. (1st byte)	5.4.2	Full general curve data:
40	First Point; Y-coord. (2nd byte)	5.4.2	First curve value
41	First Point; Y-coord. (3rd byte)	5.4.2	Y-coordinate
42	First Point; Y-coord. (4th byte)	5.4.2	(32-bit float)
43	Last Point; X-coord. (1st byte)	5.4.2	Full general curve data:
44	Last Point; X-coord. (2nd byte)	5.4.2	Last curve value
45	Last Point; X-coord. (3rd byte)	5.4.2	X-coordinate
46	Last Point; X-coord. (4th byte)	5.4.2	(32-bit float)
47	Last Point; Y-coord. (1st byte)	5.4.2	Full general curve data:
48	Last Point; Y-coord. (2nd byte)	5.4.2	Last curve value
49	Last Point; Y-coord. (3rd byte)	5.4.2	Y-coordinate
50	Last Point; Y-coord. (4th byte)	5.4.2	(32-bit float)
51	Entry window 1; X-coord. (1st byte)	5.4.3	Window 1
52	Entry window 1; X-coord. (2nd byte)	5.4.3	Entry
53	Entry window 1; X-coord. (3rd byte)	5.4.3	X-coordinate
54	Entry window 1; X-coord. (4th byte)	5.4.3	(32-bit float)
55	Entry window 1; Y-coord. (1st byte)	5.4.3	Window 1
56	Entry window 1; Y-coord. (2nd byte)	5.4.3	Entry
57	Entry window 1; Y-coord. (3rd byte)	5.4.3	Y-coordinate
58	Entry window 1; Y-coord. (4th byte)	5.4.3	(32-bit float)
59	Exit window 1; X-coord. (1st byte)	5.4.3	Window 1
60	Exit window 1; X-coord. (2nd byte)	5.4.3	Exit
61	Exit window 1; X-coord. (3rd byte)	5.4.3	X-coordinate
62	Exit window 1; X-coord. (4th byte)	5.4.3	(32-bit float)
63	Exit window 1; Y-coord. (1st byte)	5.4.3	Window 1
64	Exit window 1; Y-coord. (2nd byte)	5.4.3	Exit
65	Exit window 1; Y-coord. (3rd byte)	5.4.3	Y-coordinate
66	Exit window 1; Y-coord. (4th byte)	5.4.3	(32-bit float)
67	Entry window 2; X-coord. (1st byte)	5.4.3	Window 2
68	Entry window 2; X-coord. (2nd byte)	5.4.3	Entry
69	Entry window 2; X-coord. (3rd byte)	5.4.3	X-coordinate
70	Entry window 2; X-coord. (4th byte)	5.4.3	(32-bit float)
71	Entry window 2; Y-coord. (1st byte)	5.4.3	Window 2
72	Entry window 2; Y-coord. (2nd byte)	5.4.3	Entry
73	Entry window 2; Y-coord. (3rd byte)	5.4.3	Y-coordinate
74	Entry window 2; Y-coord. (4th byte)	5.4.3	(32-bit float)

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Byte	Function	Section	Comments
75	Exit window 2; X-coord. (1st byte)	5.4.3	Window 2
76	Exit window 2; X-coord. (2nd byte)	5.4.3	Exit
77	Exit window 2; X-coord. (3rd byte)	5.4.3	X-coordinate
78	Exit window 2; X-coord. (4th byte)	5.4.3	(32-bit float)
79	Exit window 2; Y-coord. (1st byte)	5.4.3	Window 2
80	Exit window 2; Y-coord. (2nd byte)	5.4.3	Exit
81	Exit window 2; Y-coord. (3rd byte)	5.4.3	Y-coordinate
82	Exit window 2; Y-coord. (4th byte)	5.4.3	(32-bit float)

5.5.8 Mode 8 (PLC-Out, Windows 1-3 E/E)

Data from master to slave

Byte	Function	Section	Comments
0	PLC inputs (1st byte)	**5.1.1**	
1	PLC inputs (2nd byte)	**5.1.2**	

Data from slave to master

Byte	Function	Section	Comments
0	PLC outputs Byte 1	5.3.1	
1	PLC outputs Byte 2	5.3.2	
2	PLC outputs Byte 3	5.3.3	
3	Entry window 1; X-coord. (1st byte)	5.4.3	Window 1
4	Entry window 1; X-coord. (2nd byte)	5.4.3	Entry
5	Entry window 1; X-coord. (3rd byte)	5.4.3	X-coordinate
6	Entry window 1; X-coord. (4th byte)	5.4.3	(32-bit float)
7	Entry window 1; Y-coord. (1st byte)	5.4.3	Window 1
8	Entry window 1; Y-coord. (2nd byte)	5.4.3	Entry
9	Entry window 1; Y-coord. (3rd byte)	5.4.3	Y-coordinate
10	Entry window 1; Y-coord. (4th byte)	5.4.3	(32-bit float)
11	Exit window 1; X-coord. (1st byte)	5.4.3	Window 1
12	Exit window 1; X-coord. (2nd byte)	5.4.3	Exit
13	Exit window 1; X-coord. (3rd byte)	5.4.3	X-coordinate
14	Exit window 1; X-coord. (4th byte)	5.4.3	(32-bit float)
15	Exit window 1; Y-coord. (1st byte)	5.4.3	Window 1
16	Exit window 1; Y-coord. (2nd byte)	5.4.3	Exit
17	Exit window 1; Y-coord. (3rd byte)	5.4.3	Y-coordinate
18	Exit window 1; Y-coord. (4th byte)	5.4.3	(32-bit float)
19	Entry window 2; X-coord. (1st byte)	5.4.3	Window 2
20	Entry window 2; X-coord. (2nd byte)	5.4.3	Entry
21	Entry window 2; X-coord. (3rd byte)	5.4.3	X-coordinate
22	Entry window 2; X-coord. (4th byte)	5.4.3	(32-bit float)

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Byte	Function	Section	Comments
23	Entry window 2; Y-coord. (1st byte)	5.4.3	Window 2
24	Entry window 2; Y-coord. (2nd byte)	5.4.3	Entry
25	Entry window 2; Y-coord. (3rd byte)	5.4.3	Y-coordinate
26	Entry window 2; Y-coord. (4th byte)	5.4.3	(32-bit float)
27	Exit window 2; X-coord. (1st byte)	5.4.3	Window 2
28	Exit window 2; X-coord. (2nd byte)	5.4.3	Exit
29	Exit window 2; X-coord. (3rd byte)	5.4.3	X-coordinate
30	Exit window 2; X-coord. (4th byte)	5.4.3	(32-bit float)
31	Exit window 2; Y-coord. (1st byte)	5.4.3	Window 2
32	Exit window 2; Y-coord. (2nd byte)	5.4.3	Exit
33	Exit window 2; Y-coord. (3rd byte)	5.4.3	Y-coordinate
34	Exit window 2; Y-coord. (4th byte)	5.4.3	(32-bit float)
35	Entry window 3; X-coord. (1st byte)	5.4.3	Window 3
36	Entry window 3; X-coord. (2nd byte)	5.4.3	Entry
37	Entry window 3; X-coord. (3rd byte)	5.4.3	X-coordinate
38	Entry window 3; X-coord. (4th byte)	5.4.3	(32-bit float)
39	Entry window 3; Y-coord. (1st byte)	5.4.3	Window 3
40	Entry window 3; Y-coord. (2nd byte)	5.4.3	Entry
41	Entry window 3; Y-coord. (3rd byte)	5.4.3	Y-coordinate
42	Entry window 3; Y-coord. (4th byte)	5.4.3	(32-bit float)
43	Exit window 3; X-coord. (1st byte)	5.4.3	Window 3
44	Exit window 3; X-coord. (2nd byte)	5.4.3	Exit
45	Exit window 3; X-coord. (3rd byte)	5.4.3	X-coordinate
46	Exit window 3; X-coord. (4th byte)	5.4.3	(32-bit float)
47	Exit window 3; Y-coord. (1st byte)	5.4.3	Window 3
48	Exit window 3; Y-coord. (2nd byte)	5.4.3	Exit
49	Exit window 3; Y-coord. (3rd byte)	5.4.3	Y-coordinate
50	Exit window 3; Y-coord. (4th byte)	5.4.3	(32-bit float)

5.5.9 Mode 9 (PLC-Out, Full general curve data, Windows 1-3 E/E)

Data from master to slave

Byte	Function	Section	Comments
0	PLC inputs (1st byte)	5.1.1	
1	PLC inputs (2nd byte)	5.1.2	

Data from slave to master

Byte	Function	Section	Comments
0	PLC outputs Byte 1	5.3.1	
1	PLC outputs Byte 2	5.3.2	
2	PLC outputs Byte 3	5.3.3	
3	AbsMinX; X-coord. (1st byte)	5.4.2	Full general curve data:
4	AbsMinX; X-coord. (2nd byte)	5.4.2	Min X of whole curve
5	AbsMinX; X-coord. (3rd byte)	5.4.2	X-coordinate
6	AbsMinX; X-coord. (4th byte)	5.4.2	(32-bit float)
7	AbsMinX; Y-coord. (1st byte)	5.4.2	Full general curve data:
8	AbsMinX; Y-coord. (2nd byte)	5.4.2	Min X of whole curve
9	AbsMinX; Y-coord. (3rd byte)	5.4.2	Y-coordinate
10	AbsMinX; Y-coord. (4th byte)	5.4.2	(32-bit float)
11	AbsMaxX; X-coord. (1st byte)	5.4.2	Full general curve data:
12	AbsMaxX; X-coord. (2nd byte)	5.4.2	Max X of whole curve
13	AbsMaxX; X-coord. (3rd byte)	5.4.2	X-coordinate
14	AbsMaxX; X-coord. (4th byte)	5.4.2	(32-bit float)
15	AbsMaxX; Y-coord. (1st byte)	5.4.2	Full general curve data:
16	AbsMaxX; Y-coord. (2nd byte)	5.4.2	Max X of whole curve
17	AbsMaxX; Y-coord. (3rd byte)	5.4.2	Y-coordinate
18	AbsMaxX; Y-coord. (4th byte)	5.4.2	(32-bit float)
19	AbsMinY; X-coord. (1st byte)	5.4.2	Full general curve data:
20	AbsMinY; X-coord. (2nd byte)	5.4.2	Min Y of whole curve
21	AbsMinY; X-coord. (3rd byte)	5.4.2	X-coordinate
22	AbsMinY; X-coord. (4th byte)	5.4.2	(32-bit float)
23	AbsMinY; Y-coord. (1st byte)	5.4.2	Full general curve data:
24	AbsMinY; Y-coord. (2nd byte)	5.4.2	Min Y of whole curve
25	AbsMinY; Y-coord. (3rd byte)	5.4.2	Y-coordinate
26	AbsMinY; Y-coord. (4th byte)	5.4.2	(32-bit float)
27	AbsMaxY; X-coord. (1st byte)	5.4.2	Full general curve data:
28	AbsMaxY; X-coord. (2nd byte)	5.4.2	Max. Y of whole curve
29	AbsMaxY; X-coord. (3rd byte)	5.4.2	X-coordinate
30	AbsMaxY; X-coord. (4th byte)	5.4.2	(32-bit float)
31	AbsMaxY; Y-coord. (1st byte)	5.4.2	Full general curve data:
32	AbsMaxY; Y-coord. (2nd byte)	5.4.2	Max. Y of whole curve
33	AbsMaxY; Y-coord. (3rd byte)	5.4.2	Y-coordinate
34	AbsMaxY; Y-coord. (4th byte)	5.4.2	(32-bit float)

continued on next page

Byte	Function	Section	Comments
35	First Point; X-coord. (1st byte)	5.4.2	Full general curve data:
36	First Point; X-coord. (2nd byte)	5.4.2	First curve value
37	First Point; X-coord. (3rd byte)	5.4.2	X-coordinate
38	First Point; X-coord. (4th byte)	5.4.2	(32-bit float)
39	First Point; Y-coord. (1st byte)	5.4.2	Full general curve data:
40	First Point; Y-coord. (2nd byte)	5.4.2	First curve value
41	First Point; Y-coord. (3rd byte)	5.4.2	Y-coordinate
42	First Point; Y-coord. (4th byte)	5.4.2	(32-bit float)
43	Last Point; X-coord. (1st byte)	5.4.2	Full general curve data:
44	Last Point; X-coord. (2nd byte)	5.4.2	Last curve value
45	Last Point; X-coord. (3rd byte)	5.4.2	X-coordinate
46	Last Point; X-coord. (4th byte)	5.4.2	(32-bit float)
47	Last Point; Y-coord. (1st byte)	5.4.2	Full general curve data:
48	Last Point; Y-coord. (2nd byte)	5.4.2	Last curve value
49	Last Point; Y-coord. (3rd byte)	5.4.2	Y-coordinate
50	Last Point; Y-coord. (4th byte)	5.4.2	(32-bit float)
51	Entry window 1; X-coord. (1st byte)	5.4.3	Window 1
52	Entry window 1; X-coord. (2nd byte)	5.4.3	Entry
53	Entry window 1; X-coord. (3rd byte)	5.4.3	X-coordinate
54	Entry window 1; X-coord. (4th byte)	5.4.3	(32-bit float)
55	Entry window 1; Y-coord. (1st byte)	5.4.3	Window 1
56	Entry window 1; Y-coord. (2nd byte)	5.4.3	Entry
57	Entry window 1; Y-coord. (3rd byte)	5.4.3	Y-coordinate
58	Entry window 1; Y-coord. (4th byte)	5.4.3	(32-bit float)
59	Exit window 1; X-coord. (1st byte)	5.4.3	Window 1
60	Exit window 1; X-coord. (2nd byte)	5.4.3	Exit
61	Exit window 1; X-coord. (3rd byte)	5.4.3	X-coordinate
62	Exit window 1; X-coord. (4th byte)	5.4.3	(32-bit float)
63	Exit window 1; Y-coord. (1st byte)	5.4.3	Window 1
64	Exit window 1; Y-coord. (2nd byte)	5.4.3	Exit
65	Exit window 1; Y-coord. (3rd byte)	5.4.3	Y-coordinate
66	Exit window 1; Y-coord. (4th byte)	5.4.3	(32-bit float)
67	Entry window 2; X-coord. (1st byte)	5.4.3	Window 2
68	Entry window 2; X-coord. (2nd byte)	5.4.3	Entry
69	Entry window 2; X-coord. (3rd byte)	5.4.3	X-coordinate
70	Entry window 2; X-coord. (4th byte)	5.4.3	(32-bit float)
71	Entry window 2; Y-coord. (1st byte)	5.4.3	Window 2
72	Entry window 2; Y-coord. (2nd byte)	5.4.3	Entry
73	Entry window 2; Y-coord. (3rd byte)	5.4.3	Y-coordinate
74	Entry window 2; Y-coord. (4th byte)	5.4.3	(32-bit float)

continued on next page

Byte	Function	Section	Comments
75	Exit window 2; X-coord. (1st byte)	5.4.3	Window 2
76	Exit window 2; X-coord. (2nd byte)	5.4.3	Exit
77	Exit window 2; X-coord. (3rd byte)	5.4.3	X-coordinate
78	Exit window 2; X-coord. (4th byte)	5.4.3	(32-bit float)
79	Exit window 2; Y-coord. (1st byte)	5.4.3	Window 2
80	Exit window 2; Y-coord. (2nd byte)	5.4.3	Exit
81	Exit window 2; Y-coord. (3rd byte)	5.4.3	Y-coordinate
82	Exit window 2; Y-coord. (4th byte)	5.4.3	(32-bit float)
83	Entry window 3; X-coord. (1st byte)	5.4.3	Window 3
84	Entry window 3; X-coord. (2nd byte)	5.4.3	Entry
85	Entry window 3; X-coord. (3rd byte)	5.4.3	X-coordinate
86	Entry window 3; X-coord. (4th byte)	5.4.3	(32-bit float)
87	Entry window 3; Y-coord. (1st byte)	5.4.3	Window 3
88	Entry window 3; Y-coord. (2nd byte)	5.4.3	Entry
89	Entry window 3; Y-coord. (3rd byte)	5.4.3	Y-coordinate
90	Entry window 3; Y-coord. (4th byte)	5.4.3	(32-bit float)
91	Exit window 3; X-coord. (1st byte)	5.4.3	Window 3
92	Exit window 3; X-coord. (2nd byte)	5.4.3	Exit
93	Exit window 3; X-coord. (3rd byte)	5.4.3	X-coordinate
94	Exit window 3; X-coord. (4th byte)	5.4.3	(32-bit float)
95	Exit window 3; Y-coord. (1st byte)	5.4.3	Window 3
96	Exit window 3; Y-coord. (2nd byte)	5.4.3	Exit
97	Exit window 3; Y-coord. (3rd byte)	5.4.3	Y-coordinate
98	Exit window 3; Y-coord. (4th byte)	5.4.3	(32-bit float)

6. Glossary

Alarm model:	Optional PROFIBUS service for acyclical data traffic. Not supported by the DIGIFORCE® type 9310.
ASIC:	User-specific IC containing either part or all of the PROFIBUS protocol enabling PROFIBUS interfacing using just a few additional components. The SPC 42 (SIEMENS PROFIBUS Controller) ASIC is used in the DIGIFORCE® type 9310.
ASPC2:	Advanced Siemens PROFIBUS Controller for 12 Mbaud PROFIBUS-ASIC for master applications
Bus segment:	For physical reasons, the PROFIBUS is divided into segments connected via repeaters to expand the PROFIBUS to its full size and achieve the maximum number of stations.
DP:	Distributed Peripheral. PROFIBUS protocol whose strengths lie in high-speed cyclical data transfer.
DU:	Data Unit (net data to be transferred, value range 1 to 244 bytes/message).
EN 50 170	Binding Europe-wide standard for PROFIBUS DP and FMS-. Successor to the German standard DIN 19245.
FDL:	Fieldbus Data Link, also called Layer 2.
FMS:	Fieldbus Message Specification. Transmission protocol on the PROFIBUS whose strengths tend to lie in object-oriented data transfer because of the powerful services it offers. FMS can be used in common with DP.
Freeze mode:	This command is used to make a slave "freeze" the inputs. Often used for synchronization purposes. Not supported by the DIGIFORCE® type 9310.
GSD file:	The GSD file contains the device description data for the product, which must be supplied by the device manufacturer. The GSD file is usually supplied on floppy disk with the device and contains the technical specification of the device. This file is needed for configuration.
ID number:	A 16-bit number assigned by the PROFIBUS user organization that uniquely identifies a product. It provides a reference to the GSD file. For modular devices or devices that can be described in the same GSD file, one ID number can be assigned to a whole device series. The DIGIFORCE® type 9310 has the number 0x06E5 Hex

ISO:	International Organization for Standardization
LSPM2, SPM2:	PROFIBUS ASICs for simple slave applications.
Mandatory services:	These are the services that every PROFIBUS station must support.
Master class 1:	A master that implements the transfer of the user data. Usually a PLC or a PC.
Master class 2:	Master for control/commissioning and configuration tasks. In general it can support not only DP cyclical services but also DVP1 acyclical services.
Min_Slave_ Interval	Time between 2 poll cycles in master/slave communication. A typical value used to be about 2 ms, but the use of powerful ASICs has since reduced this time to the region of a few μs. The user can also employ the Min_Slave_Interval to control time-intensive user processes.
max_{tsdr}:	The latest time within which the slave must respond to a request by the master. In this case the value lies between 60 and 800 Tbit depending on the baud rate.
min_{tsdr}:	The time that the slave must wait before it is allowed to respond to a request by the master. Specified as 11 Tbit in the standard.
Octet:	Term used in EN 50 170. An octet equals exactly eight bits.
OLM:	Optical Link Module. OLMs can be used to set up redundant transmission paths. They can also be used for switching between RS-485 and optical fiber technology.
Optional services:	These services may be performed by a PROFIBUS station in addition to the mandatory services (see SYNC and FREEZE).
OSI:	Open Systems Interconnection
PROFIBUS DP	PROFIBUS Decentralized Peripherals. PROFIBUS protocol whose strengths lie in high-speed cyclical data transfer. (Cyclical data transfer only)
PROFIBUS DPV1	PROFIBUS DP with additional functions. Includes the DP functions but also recognizes acyclical data transfer in addition to cyclical data transfer. This mode is relatively complex for the programmer of the master.
PROFIBUS FMS	Field Message Specification. Transmission protocol on the PROFIBUS whose strengths tend to lie in object-oriented data transfer because of the powerful services it offers. FMS can be used in common with DP. Not supported by the DIGIFORCE® type 9310.

PROFIBUS PA:	Process Automation. PROFIBUS definition for process automation in accordance with IEC 1158-2 and DIN E 19245 Part 14. The protocol is very similar to PROFIBUS DP but has a different physical bus design. Typically used in the chemicals industry. Not supported by the DIGIFORCE® type 9310.
PDU:	Process Data Unit. The net data to be transferred is specified in the PDU.
PI:	PROFIBUS International
Piggy back:	Electronic module that is plugged into another board to provide specific functions. In this case it refers to a PROFIBUS interface.
PNO:	PROFIBUS user organization based in Karlsruhe, Germany. Non-profit association representing the interests of PROFIBUS suppliers.
Repeater:	Used for signal conditioning when linking together the individual bus segments.
SAP:	Service Access Point providing unique identification of the data to be transferred and requested within a message. Each message contains a Source SAP and a Destination SAP (exception: data is transferred via the default SAP)
PLC:	Programmable Logic Controller
State machine:	Describes how a PROFIBUS station is to respond in every situation.
Sync mode:	This command is used to make a slave "hold" the outputs. This mode is an optional service and is often used for synchronization purposes. Not supported by the DIGIFORCE® type 9310.
TBit:	Unit of time e.g. for transferring a bit on the PROFIBUS (reciprocal of the baud rate, e.g. 1 TBit at 12 Mbaud → 1/12000000 bits/sec → 83 ns).
Token:	The active station (master station) holding the token can exchange data with the slaves (passive station) that it has parameterized and configured. At the end of a data cycle, the active station passes the token to the next active station.
Certification test:	The PROFIBUS certification test is performed by experts (PROFIBUS user organization) and tests for non-compliance of the device. Plug and Play only works with certified units.

7. Appendix A: Representation of floating-point values

Floating-point numbers from measurement results are transferred as 4-byte float values as specified in IEEE-754-1985. The following examples explain how the 4 bytes are interpreted in order to obtain the floating-point values.

What components make up a float number?

A floating-point number represented as a 4-byte float value consists of three elements: the sign bit (*sign*), the exponent (*ex*) and the mantissa (*mant*).

How is a floating-point number constructed from the three components?

The number is composed from this formula:

$$x = (-1)^{sign} * 2^{(ex-127)} * (1.0 + mant)$$

Equation 36.1

The mantissa is saved without the leading "1",
hence the term (1.0 + *mant*)
The exponent is represented with a bias offset,
hence the term (*ex*-127)

Examples:

x = -6.0 is represented as $-1.5 * 2^2$, i.e.

sign bit (*sign*):	1 (negative)		
exponent (*ex*):	129	→ 129 – 127	= 2
mantissa (*mant*):	0.5	→ 0.5 + 1.0	= 1.5

giving:

$$x = (-1)^1 * 2^{(129-127)} * (1.0 + 0.5) = (-1) * 2^2 * 1.5 = -1.5 * 4 = -6.0$$

x = 3.0 is represented as $1.5 * 2^1$, i.e.

sign bit (*sign*):	0 (positive)		
exponent (*ex*):	128	→ 128 – 127	= 1
mantissa (*mant*):	0.5	→ 0.5 + 1.0	= 1.5

giving:

$$x = (-1)^0 * 2^{(128-127)} * (1.0 + 0.5) = (+1) * 2^1 * 1.5 = 1.5 * 2 = 3.0$$

x = -2,25 is represented as $-1.125 * 2^1$, i.e.

sign bit (*sign*):	1 (negative)		
exponent (*ex*):	128	→ 128 – 127	= 1
mantissa (*mant*):	0.125	→ 0.125+ 1,0	= 1.125

giving:

$$x = (-1)^1 * 2^{(128-127)} * (1.0 + 0.125) = (-1) * 2^1 * 1.125 = -1.125 * 2 = -2.25$$

x = -0,25 is represented as $-1.0 * 2^{-2}$, i.e.

sign bit (*sign*):	1 (negative)		
exponent (*ex*):	125	→ 125 − 127	= -2
mantissa (*mant*):	0.0	→ 0.0 + 1.0	= 1.0

giving:

$$x = (-1)^1 * 2^{(125-127)} * (1.0 + 0.0)$$

$$= (-1) * 2^{-2} * 1.0$$

$$= -1.0 * \frac{1}{2^2}$$

$$= -1.0 * \frac{1}{4}$$

$$= -0.25$$

Encoding of the three formula components in the four bytes

1st byte (first byte)							
Bit 7 MSB	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0 LSB
S	E_7	E_6	E_5	E_4	E_3	E_2	E_1

2nd byte (second byte)							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
E_0	M_{22}	M_{21}	M_{20}	M_{19}	M_{18}	M_{17}	M_{16}

3rd byte (third byte)							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
M_{15}	M_{14}	M_{13}	M_{12}	M_{11}	M_{10}	M_9	M_8

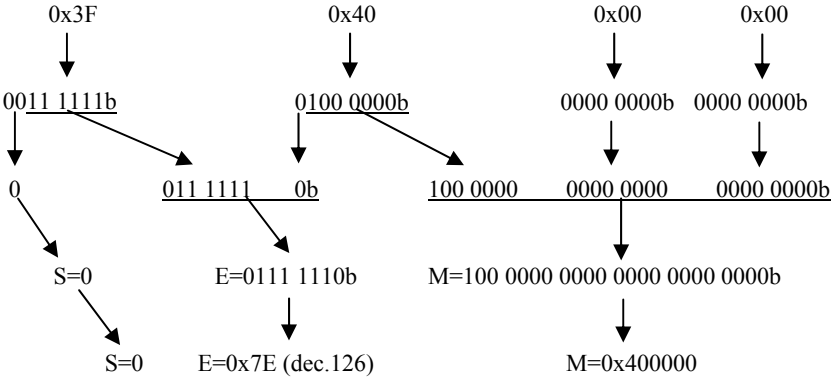
4th byte (fourth byte)							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
M_7	M_6	M_5	M_4	M_3	M_2	M_1	M_0

- The bit S in the first byte contains the sign bit
- The bits E_7 – E0 in bytes 1 and 2 form the exponent
- The bits M22 – M0 in bytes 2 - 4 form the mantissa

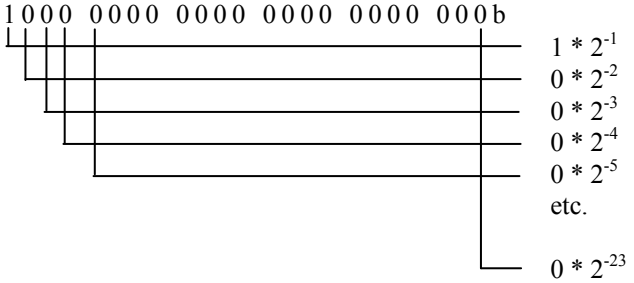
The following 4 bytes were received:

(Byte 1) (Byte 2) (Byte 3) (Byte 4)

(first byte received) (last byte received)



The value in the mantissa field is interpreted as places after the decimal point in the following way:



The float value can now be calculated using equation <>:

$$x = (-1)^0 * 2^{(126-127)} * (1.0 + 0.5)$$

$$x = 1 * 2^{-1} * 1.5$$

$$x = \frac{1}{2^1} * 1.5$$

$$x = \frac{1}{2} * 1.5 = \underline{0.75}$$

The byte combination 0x3F 0x40 0x00 0x00 equals float value +0.75.

Calculation tip

This calculation can be performed relatively easily by bit manipulation directly at the binary level using the following sequence of operations:
First, as described above, the three components of sign bit, exponent and mantissa must be obtained from the four bytes by copying and masking bits.
Example: As described above, the bytes 0x3F,0x40,0x00,0x00 become
sign=0, exponent=0x7E(126dec), mantissa =100 0000 0000 0000 0000 0000b or (0x400000)

Calculating the exponent value
by subtracting 0x7F (127dec) from the contents of the exponent field
Example: Contents_ExponentField – 127dec = Exponent value
126dec – 127dec = -1

Adding the 1.0 i.e. inserting a 1 and a decimal point in front of the mantissa
Example: Mantissa was 100 0000 0000 0000 0000 0000b
new mantissa is 1.100 0000 0000 0000 0000 0000b

Taking into account the exponent.
A negative exponent shifts the decimal point to the left, a positive exponent to the right. Thus, if an exponent of -3 was calculated, the decimal point is shifted three places to the left; for an exponent of +1 the decimal point moves one place to the right.
Example: Mantissa was: 1.100 0000 0000 0000 0000 0000b
Exponent was: -1
new mantissa with exponent is: 0.1100 0000 0000 0000 0000 0000b

Calculating the integer positions
The integer positions (places in front of the decimal point) are interpreted in a similar way to above as positive powers of two which are added together:
Example: integer position of: 0.1100 0000 0000 0000 0000 0000b
is 0b

$$0*2^0 + [0*2^1 + 0*2^2 + 0*2^3 \ldots] = \underline{0}$$

Calculating the decimal positions
Like the integer positions, the decimal positions also represent powers of two, but in this case negative powers.

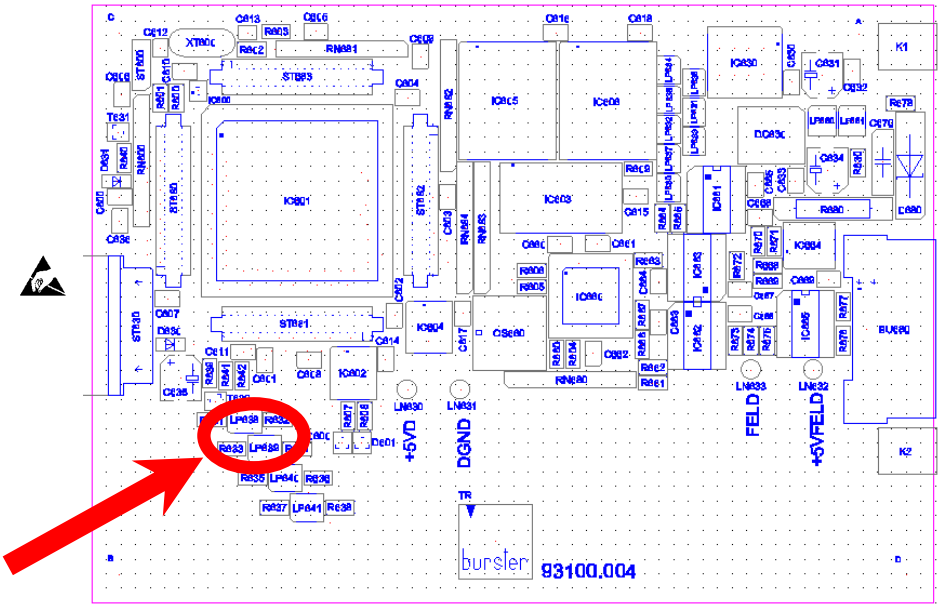
example : decimal position of: : 0.1100 0000 0000 0000 0000 0000b
is 1100 0000 0000 0000 0000 0000b

$$1*2^{-1} + 1*2^{-2} + 0*2^{-3} + [0*2^{-4} + 0*2^{-5} + .. = 1*0.5 + 1*0.25 + 0*0.125 [...] = \underline{0.75}$$

8. Appendix B: Byte sequence of float values

In the DIGIFORCE 9310, one can reverse the order of the 4 bytes making up a float number as specified in IEEE-754 by breaking and resoldering solder bridges on the PROFIBUS board. Normally this is not necessary; however there are PROFIBUS masters whose conversion routine expects a different sequence. Please follow the instructions below for changing the order.

The unit must only be opened by qualified personnel. Observe the relevant safety instructions.
Pull out the mains connector before opening the unit. The warranty does not cover any damage caused by improper handling. In case of doubt, please contact our customer services before opening the unit; tel. +49 (0) 7224 / 645-0 or info@burster.de.



(1) Remove all connectors from the unit.
Disconnect the unit from the power supply.

(2) Use a TORX screwdriver (size 02) to undo the four screws on the rear of the unit.

(3) Pull out the rear panel together with all four circuit boards from the unit.

(4) Undo the two Phillips screws holding the PROFIBUS board in place. You can now remove the board for better access.

(5) Locate solder bridge LP638 on the board (see drawing)

(6) The rectangular solder pad identifies pad 1 of the solder bridge. Pads 1 and 2 are connected as standard, 3 is not connected.
Use a scalpel (knife) to break the connection between pad 1 and 2, ensuring that there is no longer any electrical contact between the two pads.

(7) Use a soldering iron and tin-lead solder to make the connection between pads 2 and 3.

(8) Refit the board in the rear panel and slide this back into the enclosure. Make sure that the boards are running on the correct guide rails.

(9) Secure the enclosure by fastening the TORX screws.

(10) Reconnect the cables/connectors to the unit.

(11) After power-up, the unit software detects the changes made to the solder bridge. The float values are sent in the reverse order.