1 PROFIBUS-PA Interface

1.1 Synopsis

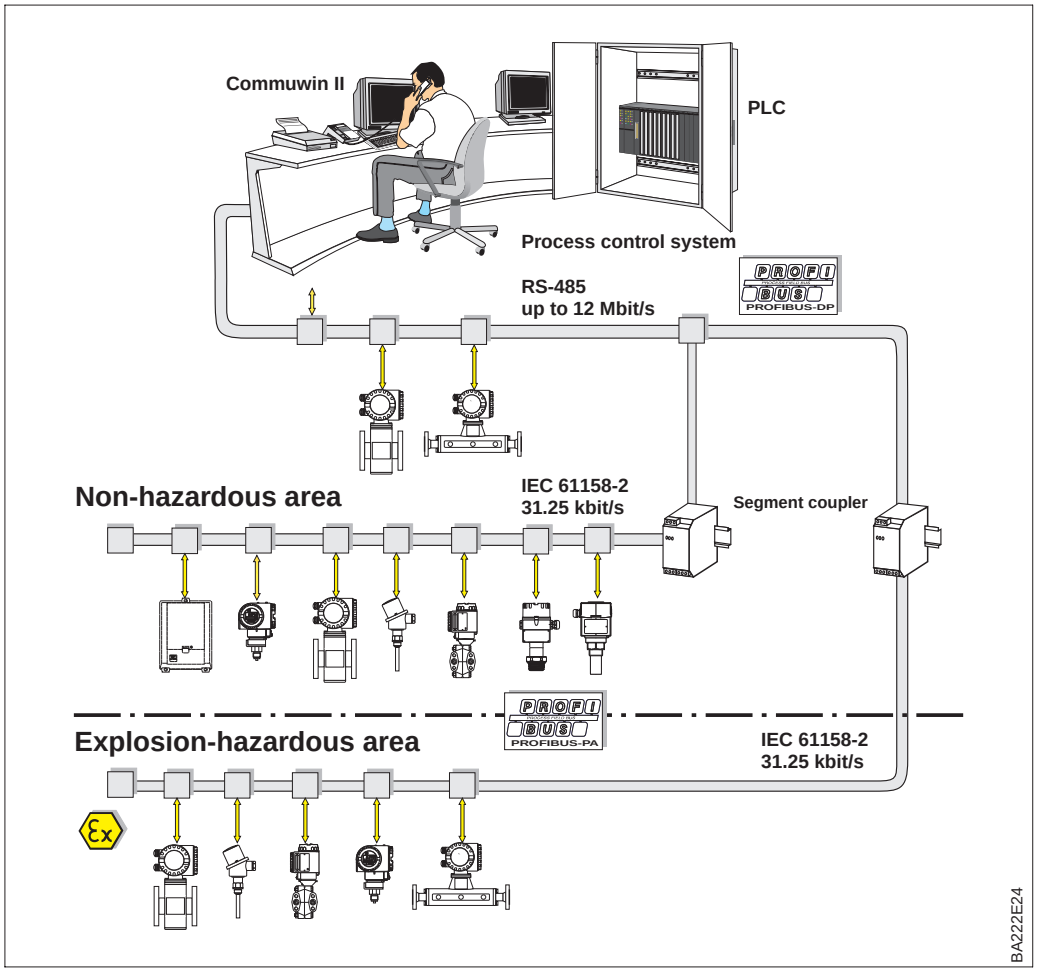


Figure 1.1
PROFIBUS-PA principle of operation

Note!

Additional planning information on the fieldbus PROFIBUS-PA can be found in the Operating Instructions BA 198F/00/en.

Note!

1.2 Setting the device address

Every PROFIBUS-PA device must be given an address. If the address is not set correctly, the device will not be recognised by the process control system.

- Valid device addresses are in the range 0 and 126. All devices are delivered from the factory with the software address 126.
- A device address may appear only once within a particular PROFIBUS-PA network, see BA 198F.

The default address can be used to check the function of the device and connect it to an operating PROFIBUS-PA system. Afterwards the address must be changed to allow other devices to be connected to the network.

There are two possibilities to set the address of the Cerabar M:

- remotely by using an operating program, e.g. Commuwin II, running as a PROFIBUS-DP Class 2 master
- locally at the device DIP-switches that are to be found behind the display.

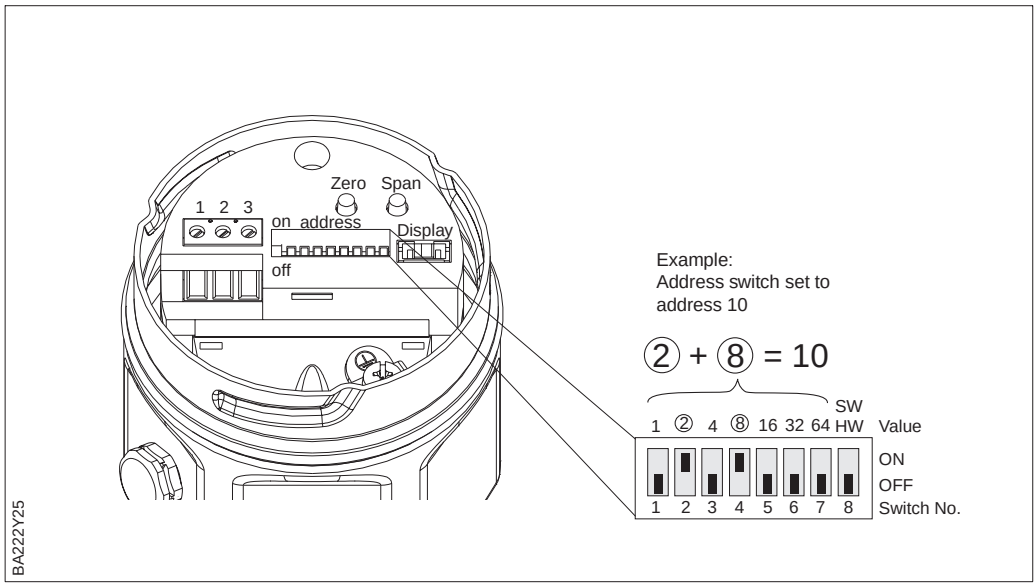


Figure 1.2
Cerabar M address switch

Addressing mode

Set the addressing mode at Switch 8:

- ON = software addressing via the bus system (default setting) (SW)
- OFF = hardware addressing at the device via DIP switches 1 to 7 (HW).

Hardware address

Proceed as follows to set a hardware address:

1. Set Switch 8 to OFF = hardware addressing.
2. Set a unique hardware address at Switches 1 to 7 according to the table below.
3. The address becomes effective 10 s after the switches have been changed.

Switch No.	1	2	3	4	5	6	7
Value in position "ON"	1	2	4	8	16	32	64
Value in position "OFF"	0	0	0	0	0	0	0

Software address

The procedure for changing a software address is described in BA 198F, Chapter 5.7.

1.3 Device database and type files

A device database file (GSD) contains a description of the properties of the PROFIBUS-PA device, e.g. the supported transmission rates and the type and format of the digital information output to the PLC. The bitmap files also belong to the GSD files. These allow the measuring point to be represented by an icon. The device database file and corresponding bitmaps are required by the network design tool of the PROFIBUS-DP network.

Every device is allocated an identity code by the PROFIBUS User Organisation (PNO). This appears in the device data base file name (.gsd). For Endress+Hauser devices, the identity code is always 15xx, where xx is device dependent.

Name of device	ID No.:	Data base file	Type file	Bitmaps
Cerabar M	151C (hex)	EH3x151C.gsd	EH3151Cx.200	EH151C_d.bmp EH151C_n.bmp EH151C_s.bmp

The full set of device data base files for Endress+Hauser devices can be obtained as follows:

- INTERNET:
  Endress+Hauser → http://www.endress.com (downloads)
  PNO → http://www.PROFIBUS.com (GSD library)
- As diskette direct from Endress+Hauser: Order No. 943157-0000

Note!

- The PNO also provides a universal database file with the designation PA_x9700.gsd for devices with one analogue output block. Should this be used instead of the Cerabar M file, then only the process value can be transmitted. The functions secondary (2nd Cyclic Value) and display value are not supported. The universal profile must also be selected in field V6H0 in Commuwin II.

Note!

Working with GSD files

The GSD files must be loaded into a specific subdirectory in the PROFIBUS-DP network design software of your PLC.

- GSD files and bitmaps that are located in the directory "Extended" are required for a planning software, for example, STEP7 used by the Siemens S7-300/400 PLC family.
- x.200 files and bitmaps that are located in the directory "Typdat5x" are required for the planning software COM ET200 for the Siemens S5.
- The GSD files located in the directory "standard" are for PLCs that support the "identifier byte" (0x94) but not the "identifier format". These are for use e.g. with the Allen-Bradley PLC5.

More details about the directories used for storing the GSD files can be found in Chapter 6.4 of BA 198F which describes the network design.

1.4 Cyclic data exchange

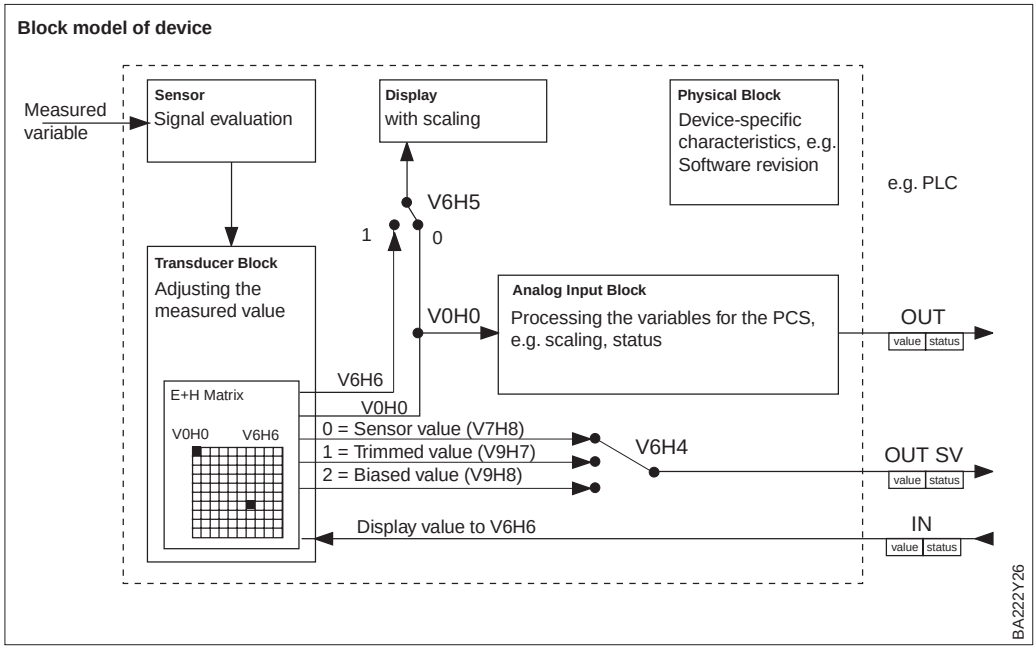


Figure 1.3
Block model of the Cerabar M with PROFIBUS-PA profile 3.0.

Fields in brackets apply to the matrix positions in Commuwin II.

Block model

Fig. 1.3 shows a block model of the Cerabar M. The primary value V0H0 is output by the transducer block and used as the process value for the analog input block. Here it is scaled, processed and rescaled before being output as cyclic data to the PLC as the variable OUT. This comprises a value and status.

The local display and matrix field V0H0 usually show the same value. However, the local display can also show a cyclical output value using the PLC. This is done by setting the Parameter Select V0H0 (matrix field V6H5) to "1". For example: if two Cerabar M are monitoring the pressure drop across a filter. The PLC is evaluated in the PLC and then displayed in matrix field V6H6.

Cerabar M can also output a secondary value to the PLC. The field V6H4 in Commuwin II allows one of two values to be selected.

Configuration

The data exchange is configured in the network design tool and Commuwin II.

1) Using the network design tool for your PLC, add the Cerabar M to the network, taking care that the address assigned corresponds to that set at the device.
2) Select the Cerabar M and call up the configuration tool: four options appear:
   – "Main Process Value", "2nd Cyclic Value", "Display Value", "FREE PLACE"
3) Select "Main Process Value".
   If no other values are required, close the configuration window, otherwise
4) Select "2nd Cyclic Value" or "FREE PLACE" (= function deactivated) ***and*** select "Display Value" or "FREE PLACE" (= function deactivated).
   Then close the configuration window.

5) Start Commuwin II and open the connection using the PA DPV1 server. Generate a live list, locate the device address and click on "Cerabar M".
6) Open the device menu and select the parameter matrix.
7) If a secondary value is to be output, select the type in V6H4:
   0 = Sensor value, 1 = Trimmed value, 2 = Biased value.
8) If a display value is to be shown at the device, set V6H5 = 1 (=display value).
9) The data exchange is now configured for the Cerabar M in question.

Cerabar M → PLC (input data)

A PLC can read the input data of Cerabar M from the response telegram of the Data_Exchange service. The cyclic data telegram has the following structure:

Index input data	Data	Access	Data format/remarks
0, 1, 2, 3	Primary value, pressure	read	32 bit floating point number (IEEE-754)
4	Status code for primary value	read	see status codes
5, 6, 7, 8	Secondary value, sensor value, trimmed value or biased value	read	32 bit floating point number (IEEE-754)
9	Status code for secondary value	read	see status codes

PLC → Cerabar M (output data)

The output data from the PLC for the local display are structured as follows:

Index output data	Data	Access	Data format/remarks
0, 1, 2, 3	Display value	write	32 bit floating point number (IEEE-754)
4	Status code	write	see status codes

Status codes

The following status codes are supported by the Cerabar M for the primary and secondary values.

Status-Code	Device status	Significance	Primary value	Secondary value
0F Hex	BAD	Non-specific	x	x
1F Hex	BAD	Out-of-service (target mode)	x	
47 Hex	UNCERTAIN	Last usable value (fail-safe mode active)	x	
4B Hex	UNCERTAIN	Substitute set (fail-safe mode active)	x	
4F Hex	UNCERTAIN	Initial value (fail-safe mode active)	x	
5C Hex	UNCERTAIN	Configuration error (limits not set correctly)	x	
80 Hex	GOOD	OK	x	x
84 Hex	GOOD	Active block alarm (static revision counterincremented)	x	
89 Hex	GOOD	LOW_LIM (alarm active)	x	
8A Hex	GOOD	HI_LIM (alarm active)	x	
8D Hex	GOOD	LOW_LOW_LIM (alarm active)	x	
8E Hex	GOOD	HI_HI_LIM (alarm active)	x	

1.5 Acyclic data exchange

The device parameters in the physical block, transducer block and analog input block, see Fig. 1.3, as well as the device management can be accessed by a Class 2 PROFIBUS-DP master using the acyclic data services. Figs. 1.4 and 1.5 show block diagrams of the transducer and analog input blocks. A full description of the device management, standard parameters and the physical block is to be found in Chapter 7 of Operating Instructions BA 198F.

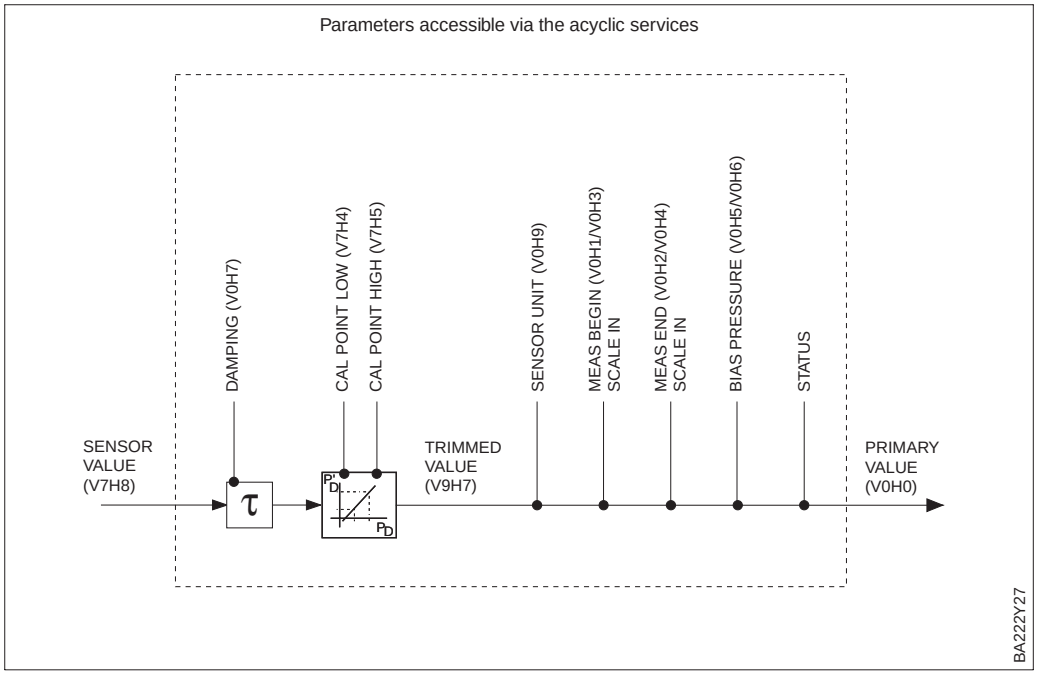


Figure 1.4
Schematic diagram of the Cerabar M transducer block. Parameters with information about a matrix field (in brackets) can also be accessed using Commuwin II.

Note!
The pressure acting is transmitted in the units to be found on the nameplate.

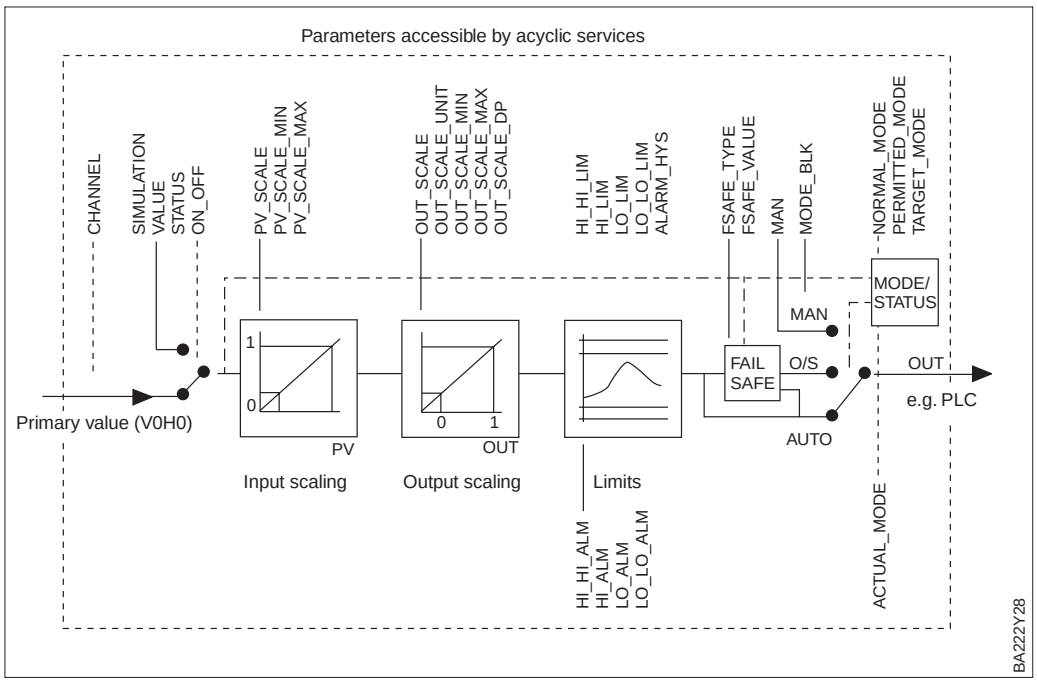


Figure 1.5
Schematic diagram of the Cerabar M analog input block

Slot/index tables

The device parameters are listed in the following tables. The parameters are accessed via the slot and index number. The analog output, transducer and physical blocks contain standard parameters, block parameters and manufacturer-specific parameters.

If Commuwin II is the operating programm used, then the matrix and the graphical operation are available as the user interface. If the standard operating parameters are to be found in any of the device blocks, then any changes made to them are automatically mapped to the block parameters. The dependencies are indicated in the column "E+H matrix". See also Figs. 1.4 and 1.5.

Device management

Parameter	E+H matrix	Slot	Index	Size bytes	Type	Read	Write	Storage Class
Directory object header		1	0	12	Array of UNSIGNED16	X		C
Composite list directory entries		1	1	24	Array of UNSIGNED16	X		C
GAP directory continuous		1	2-8					
GAP reserved		1	9-15					

Analog input block

Parameter	E+H matrix	Slot	Index	Size bytes	Type	Read	Write	Storage class
Standard parameters								
AI Block data		1	16	20	DS-32*	X		C
Static revision		1	17	2	UNSIGNED16	X		N
Device tag	VAH0	1	18	32	OSTRING	X	X	S
Strategy		1	19	2	UNSIGNED16	X	X	S
Alert key		1	20	1	UNSIGNED8	X	X	S
AI Target mode		1	21	1	UNSIGNED8	X	X	S
AI Mode block		1	22	3	DS-37*	X		D/N/C
AI Alarm summary		1	23	8	DS-42*	X		D
Batch		1	24	10	DS-67*	X	X	S
Gap		1	25					
Block parameters								
OUT	V6H2/3	1	26	5	DS-33*	X		D
PV scale		1	27	8	Array of FLOAT	X	X	S
OUT scale		1	28	11	DS-36*	X	X	S
Linearisation type		1	29	1	UNSIGNED8	X	X	S
Channel		1	30	2	UNSIGNED16	X	X	S
Gap		1	31					
PV FTIME		1	32	4	FLOAT	X	X	S
Fail safe type		1	33	1	UNSIGNED8	X	X	S
Fail safe value		1	34	4	FLOAT	X	X	S
Alarm Hysteresis		1	35	4	FLOAT	X	X	S
Gap		1	36					
HI HI Limit		1	37	4	FLOAT	X	X	S
Gap		1	38					
HI Limit		1	39	4	FLOAT	X	X	S
Gap		1	40					
LO Limit		1	41	4	FLOAT	X	X	S
Gap		1	42					
LO LO Limit		1	43	4	FLOAT	X	X	S
Gap		1	44-45					
HI HI Alarm		1	46	16	DS-39*	X		D
HI Alarm		1	47	16	DS-39*	X		D
LO Alarm		1	48	16	DS-39*	X		D
LO LO Alarm		1	49	16	DS-39*	X		D
Simulate		1	50	6	DS-50*	X	X	S
OUT unit text		1	51	16	OSTRING	X	X	S
Gap reserved		1	52-60					
Gap		1	61-65					

*See data types. C = constant, N = non-volatile (remains stored), S = static (is counted), D = dynamic

Physical block

Parameter	E+H matrix	Slot	Index	Size bytes	Type	Read	Write	Storage Class
Standard parameters								
PB Block data		1	66	20	DS-32*	X		C
Static revision		1	67	2	UNSIGNED16	X		N
Device tag	VAH0	1	68	32	OSTRING	X	X	S
Strategy		1	69	2	UNSIGNED16	X	X	S
Alert key		1	70	1	UNSIGNED8	X	X	S
PB Target mode		1	71	1	UNSIGNED8	X	X	S
PB Mode block		1	72	3	DS-37*	X		D/N/C
PB Alarm summary		1	73	8	DS-42*	X		D
Block parameters								
Software revision		1	74	16	OSTRING	X		C
Hardware revision		1	75	16	OSTRING	X		C
Device manufacturer identity		1	76	2	UNSIGNED16	X		C
Device identity		1	77	16	OSTRING	X		C
Device serial number	VAH2	1	78	16	OSTRING	X		C
Diagnosis		1	79	4	OSTRING	X		D
Diagnosis extension		1	80	6	OSTRING	X		D
Diagnosis mask		1	81	4	OSTRING	X		C
Diagnosis mask extension		1	82	6	OSTRING	X		C
Device certification		1	83	32	OSTRING	X		N
Security locking	V9H9	1	84	2	UNSIGNED16	X	X	N
Factory reset	V9H2	1	85	2	UNSIGNED16		X	S
Descriptor		1	86	32	OSTRING	X	X	S
Device message	VAH1	1	87	32	OSTRING	X	X	S
Device installation date		1	88	16	OSTRING	X	X	S
Gap reserved		1	89					
Identification number	V6H0	1	90	1	UNSIGNED 8	x	x	S
HW write protection		1	91	1	UNSIGNED 8	x		D
Gap reserved		1	92-98					
Gap		1	99-103					
Matrix error code	V2H0	1	104	2	UNSIGNED16	X		D
Matrix last error code	V2H1	1	105	2	UNSIGNED16	X	X	D
UpDown features supported		1	106	1	OSTRING	X		C
UpDown control		1	107	1	UNSIGNED8		X	D
UpDown data		1	108	20	OSTRING	X	X	D
Bus address	V9H4	1	109	1	UNSIGNED8	X		D
Matrix device software number	V2H2	1	110	2	UNSIGNED16	X		C
PA set unit to bus	V6H1	1	111	1	UNSIGNED 8	x	x	S
PA input value	V6H6	1	112	6	FLOAT+U8+U8	x		D
PA select V0H0	V6H5	1	113	1	UNSIGNED8	x	x	S
PA profile revision	V6H7	1	114	16	OSTRING	x		C
Gap		1	115-119					
PA select second cyclic value	V6H4	1	120	1	UNSIGNED8	x	x	S
PA identity number		1	121	2	UNSIGNED16	x		D
PA identity string		1	122	32	OSTRING	x		C
PA DP status		1	123	1	UNSIGNED8	x		D
Gap		1	124-128					

*See data types. C = constant, N = non-volatile (remains stored), S = static (is counted), D = dynamic

View_1 parameters

Parameter	E+H matrix	Slot	Index	Size bytes	Type	Read	Write	Storage class
View 1 Physical block		1	205	17	OSTRING	X		D/N/C
Gap reserved		1	206-210					
View 1 Transducer block		1	211	22	OSTRING	X		D/N/C
Gap reserved		1	212-216					
View 1 Analog Input block		1	217	18	OSTRING	X		D/N/C
Gap reserved		1	218-222					

Transducer block

Parameter	E+H matrix	Slot	Index	Size bytes	Type	Read	Write	Storage class
Standard parameters								
TB Block data		1	129	20	DS-32*	X		C
Static revision		1	130	2	UNSIGNED16	X		N
Device tag	VAH0	1	131	32	OSTRING	X	X	S
Strategy		1	132	2	UNSIGNED16	X	X	S
Alert key		1	133	1	UNSIGNED8	X	X	S
TB Target mode		1	134	1	UNSIGNED8	X	X	S
TB Mode		1	135	3	DS-37*	X		D/N/C
TB Alarm summary		1	136	8	DS-42*	X		D
Block parameters								
Sensor value	V7H8	1	137	4	FLOAT	X		D
Sensor high limit	V7H7	1	138	4	FLOAT	X		N
Sensor low limit	V7H6	1	139	4	FLOAT	X		N
Calibration point high	V7H5	1	140	4	FLOAT	X	X	S
Calibration point low	V7H4	1	141	4	FLOAT	X	X	S
Calibration minimum span		1	142	4	FLOAT	X		N
Sensor unit	V0H9	1	143	2	UNSIGNED16	X	X	N
Trimmed value	V9H7	1	144	5	DS-33*	X		D
Sensor type		1	145	2	UNSIGNED16	X		N
Sensor serial number	VAH3	1	146	4	UNSIGNED32	X		N
Primary value	V0H0	1	147	5	DS-33*	X		D
Primary value unit	V0H9	1	148	2	UNSIGNED16	X	X	S
Primary value type		1	149	2	UNSIGNED16	X	X	S
Gap		1	150-157					
Secondary value 1		1	158	5	DS-33*	X		D
Secondary value 1 unit	V0H9	1	159	2	UNSIGNED16	X	X	S
Secondary value 2		1	160	5	DS-33*	X		D
Secondary value 2 unit	V0H9	1	161	2	UNSIGNED16	X	X	S
Linearisation type		1	162	1	UNSIGNED8	X	X	S
Scale in	V0H1/2	1	163	2*4	Array of FLOAT	X	X	S
Gap		1	164-177					
Gap reserved		1	178-187					
Endress+Hauser parameters								
Measure begin	V0H1	1	188	4	FLOAT	X	X	S
Measure end	V0H2	1	189	4	FLOAT	X	X	S
Automatically measure begin	V0H3	1	190	1	UNSIGNED8	X	X	S
Automatically measure end	V0H4	1	191	1	UNSIGNED8	X	X	S
Bias pressure	V0H5	1	192	4	FLOAT	X	X	S
Automatically bias pressure	V0H6	1	193	1	UNSIGNED8	X	X	S
Damping	V0H7	1	194	4	FLOAT	X	X	S
Sensor tab index	V2H7	1	195	1	UNSIGNED8	X	X	S
Sensor tab value	V2H8	1	196	4	FLOAT	X	X	S
Sensor trim off	V9H5	1	197	4	FLOAT	X		S
Sensor trim off value	V9H6	1	198	4	FLOAT	X		S
Biased pressure	V9H8	1	199	4	FLOAT	X		D
Gap	VAH6	1	200-204					

See data types.
C = constant,
N = non-volatile (remains stored),
S = static (is counted),
D = dynamic

1.6 Data formats

IEEE 754 float

The measured value is transmitted as a IEEE 754 floating point number, whereby

$$\text{Measured value} = (-1)^{\text{Sign}} \times 2^{(E-127)} \times (1 + F)$$

D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
Sign	Exponent (E)								Fraction (F)						
	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0	2^{-1}	2^{-2}	2^{-3}	2^{-4}	2^{-5}	2^{-6}	2^{-7}
Fraction (F)															
2^{-8}	2^{-9}	2^{-10}	2-11	2^{-12}	2^{-13}	2^{-14}	2^{-15}	2^{-16}	2^{-17}	2^{-18}	2^{-19}	2^{-20}	2^{-21}	2^{-22}	2^{-23}

Figure 1.6
IEEE-754 floating point number

Example

40 F0 00 00 hex = 0**100 0000 1**111 0000 0000 0000 0000 0000 binary

$$\text{Value} = (-1)^0 \times 2^{(129-127)} \times (1 + 2^{-1} + 2^{-2} + 2^{-3})$$
$$= 1 \times 2^2 \times (1 + 0.5 + 0.25 + 0.125)$$
$$= 1 \times 4 \times 1.875$$
$$= 7.5$$

Note!

Note!
- Not all PLCs support the IEEE 754 format. For this reason a conversion module must often be used or written.
- Depending on how the data are stored in the PLC (MSB or LSB), it might be necessary to use a byte swapping routine in the PLC.

Data strings

The data types marked with an asterisk in the slot/index table. e.g. DS-36, are data strings that are structured according to the PROFIBUS-PA specification Part 1, Version 3.0. They comprise several elements that can be addressed via the slot, index and subindices, as shown in the following two examples:

Parameter type	Slot	Index	Element	Sub-index	Type	Size
DS-33	1	26	OUT value	1	FLOAT	4
			OUT status	5	UNSIGNED8	1

Parameter type	Slot	Index	Element	Sub-index	Type	Size
DS-36		27	OUT Scale Max.	1	FLOAT	4
			OUT Scale Min	5	FLOAT	4
			OUT Scale Unit.	9	UNSIGNED16	2
			OUT Scale DP (decimal point).	11	INTEGER8	1

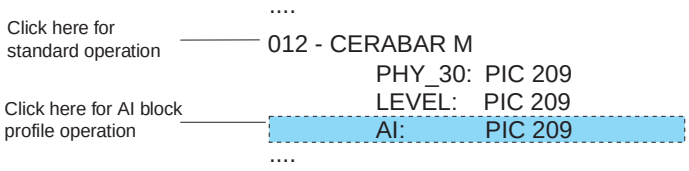
1.7 Configuration of profile parameters

The block parameters can be accessed by a PROFIBUS-DP Class 2 master, for example, Commuwin II. Commuwin II runs on an IBM-compatible computer or laptop. The computer must be equipped with a PROFIBUS interface, i.e. PROFIBOARD for PCs and PROFICARD for laptops. During the system integration, the computer is registered as a Class 2 master.

Operation

The PA-DPV1 server must be installed. The connection to Commuwin II is opened from the PA-DPV1 server.

- Generate a live list with "Tags"



- E+H operation is selected by clicking on the device name, e.g. Cerabar M.
- Profile operation is selected by clicking on the appropriate tag, e.g. AI: PIC 209 = Analog input block Cerabar M, or by selecting the appropriate device profile in the E+H graphic template.
- The settings are entered in the device menu.

Device menu

The device menu allows matrix or graphical operation to be selected.

- In the case of matrix operation, the device or profile parameters are displayed in a matrix. A parameter can be changed when the corresponding matrix field is selected.
- In the case of graphical operation, the operating sequence is shown in a series of templates with parameters. For profile operation, the pictures Diagnosis, Scaling, Simulation and Block are of interest.

Output scaling

The Cerabar M display and the digital output operate completely independently of each other. The output value is transmitted in the units stated on the nameplate. To ensure that the display and output have the same value, the values in the Analog Input Block for the lower and upper limit of PV_SCALE and OUT_SCALE must be the same or else confirmed as described in the Operating Instructions BA 222P, Section 5.2 of the parameter "Set Unit to Bus". The output can be scaled in the graphical support mode using the template shown in Fig. 1.7.

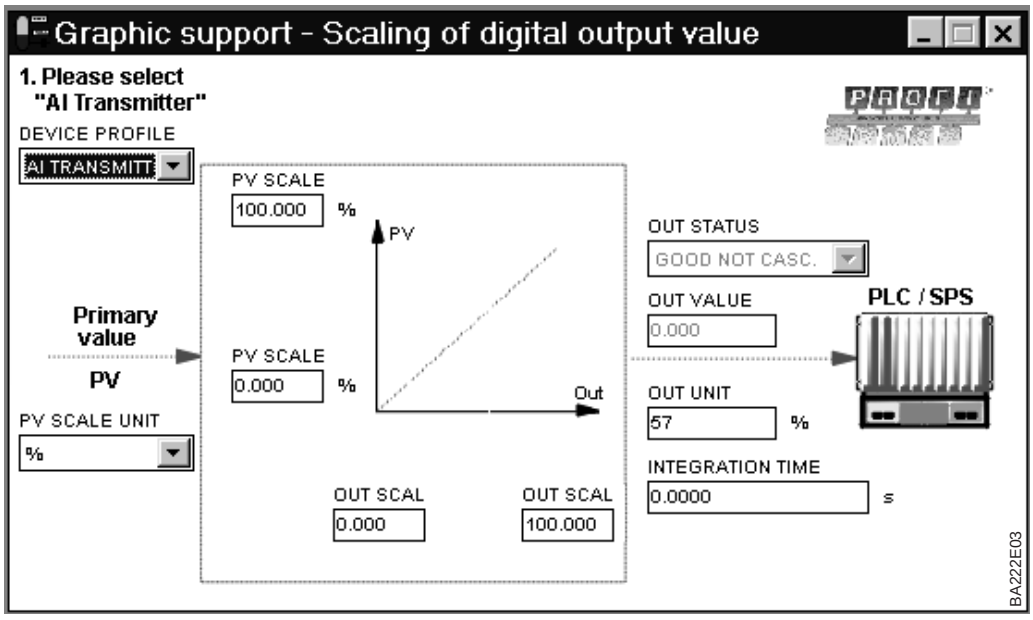


Figure 1.7
Template for graphical operation of the output scaling