technical information
pem-dd

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Raiffeisenweg 7 D-87743 Egg a.d. Günz ☎ (049) 08333 / 9204-0 Fax (049) 08333 / 4099

Level Prozessor Module

pem-dd

Program:	**pdd0000**
Version:	**V1.01**
Date:	**15.01.1997**

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1.1 General functions

pem-dd is a processor module for a wealth of measurement tasks in level sensing, compatible with pressure transducers having an analog output 0/4...20 mA. Via a second signal input, differential pressure sensing can be undertaken. A control input permits correction of the actual value. The display range can be freely defined via the front panel keypad. Further devices can be operated via the optional, freely adjustable analog output.

1.2 Features

- 4 1/2 digit seven-segment display
- all functions freely adjustable
- all settings saved on loss of power
- unit plate replaceable
- 2 analog inputs 0/4...20mA
- 2 switching outputs (MAX/MIN relay)
- 1 alarm relay
- analog output 0/4...20mA (optional)
- max 3 control inputs
- plug-in terminal block connections

1.3 Specification

Style	panel mount case 96x48x152mm, with 2 side fastener clips panel cutout 92x45mm, tol. -0.5 mm
Enclosure code	IP 65 bezel, IP 20 rear
Display	7-segment LED display red, 4-digit, 13 mm tall count -19999...19999
Ambient	operating temp. 0...+50°C shelf temp. -20...+70°C humidity 0...95% no condensate
Input	2 inputs 0/4-20mA (50W input imp) input range 0...±22mA
Accuracy	0.1%± 1 digit, 15 bit resolution+sign, temp. drift <0.0003%/K of input range
Switching output	2 relays, contact rating 250V/3A AC, switching function MIN-MAX, switchpoint, hysteresis, ON/OFF delay all freely adjustable
Alarm output	1 NOC, contact rating 250V/3A AC, relay opens on fault
Sensor supply	approx. 25V/max. 50 mA, output short-circuit proof
Supply voltage	230 V AC, approx. 7VA or 24 V DC ±10%/max. 0.3A
Control inputs	digital control input 0/24VDC, DC decoupled from current inputs LOW = 0...3 VDC, HIGH = 7...24 VDC

1.4 Options

Analog output	current 0/4...20mA, 12 bit resolution, max. 500W burden
Interface	for setting module using PC and configuration software **pdd3000** RS 232, connection via 9-pin subD receptacle RS 485, connection via 9-pin subD receptacle (available soon)

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1.5 Product description

pem-dd is a processor module for a wealth of measurement tasks in level sensing, configured for rack-and-panel mounting.
A maximum of 2 sensors (pressure transducers or capacitive sensing electrodes) can be connected to the module via a two-wire cable by which the sensors receive their supply voltage and the data is input as analog signals in the form of a load-independent current 4...20 mA. Connecting 3-wire sensors is also no problem.

The processed outputs furnished by **pem-dd** can be output via:

- the display
- relay outputs
- a current output (optional)
- the digital interface (optional)

As an additional input a control contact is provided for AUTO correction of the actual value.
pem-dd can be optimally adapted by user to individual sensing circumstances by simply entering parameters via the 5-key pad integrated in the front panel.

As a special feature **pem-dd** offers the possibility of tank linearisation. For this purpose the most popular tank dimensions are saved as a formula. Precise linearisation is done by entering the tank dimensions. There is, however, the possibility of producing a linearisation curve by means of the liter capacity gaging.

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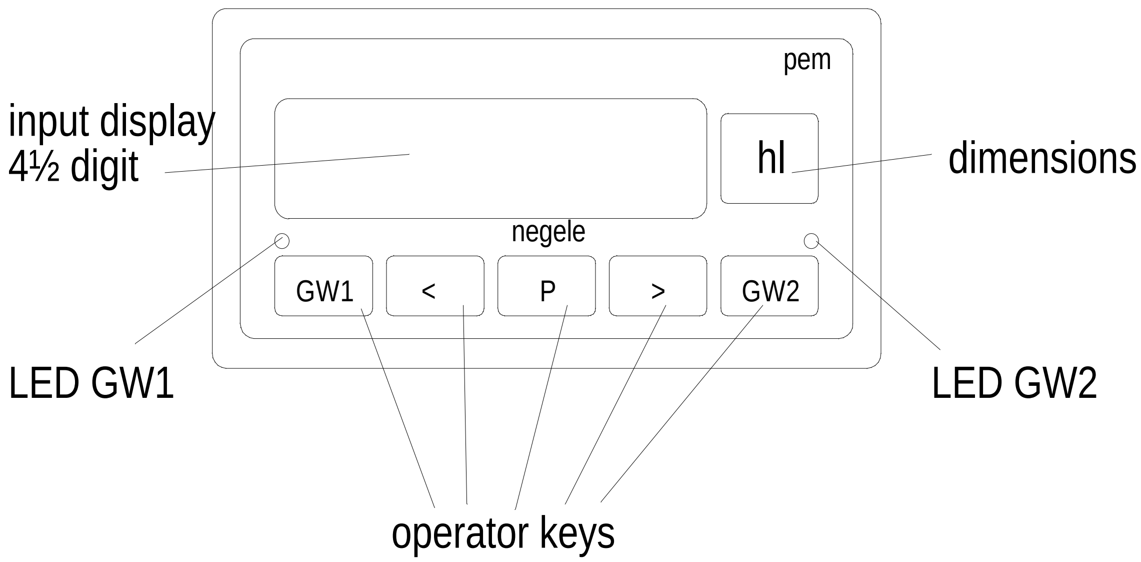
2 Display and controls

2.1 General

The module has a 4 1/2 digit red 7-segment display, 2 LEDs and 5 keys. The count of the 7-segment display is -19999 to 19999, text indication also being possible to a limited extent (e.g. parameter indications). Decimal point is floating. Depending on the mode selected each of the 5 keys have a different function.



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3 Keys

3.1 Key modes

Keying the module is very simple, for which four modes are available:

1) **RUN** mode: this displays actual inputs and a cyclic error indication
2) **PAGE** mode: this permits page selection
3) **SELECT** mode: this permit selecting and viewing page parameter
4) **EDIT** mode this permits changing parameters

For a better overview the parameters are grouped together into pages. Page selection is made in changing from the **RUN** mode to the **SELECT** mode. After having selected **PAGE** the module is in the **SELECT** mode- see also Enclosures A and B for more details.

3.2 RUN mode test functions

- GW1 GW1 alarm indication
- < no function
- P activate **PAGE** select
- > no function
- GW2 GW2 alarm indication

3.3 PAGE select mode test functions

- GW1 no function
- < no function
- P confirm **PAGE** select
- > select **PAGE**
- GW2 no function
- < and > return to **RUN** mode

3.4 SELECT mode test functions

- GW1 no function
- < indicate previous paramete
- P activate **EDIT** mode
- > show next parameter
- GW2 no function
- < and > return to **RUN** mode

3.5 EDIT mode test functions

- GW1 no function
- < shift blink digit left
- P accept set input
- > increment blink digit
- GW2 no function
- < and > no acceptance, quit and return to **SELECT** mode

Note: A safety feature ensures that the **EDIT** mode is automatically exited after 2 min when no key entry is made, the set value then **not** being accepted.

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3.6 PAGE select

Keying **PAGE** will page the parameters which are listed as follows:

Page	Parameter group
0	basic settings
1	switching output 1
2	switching output 2
3	tank dimensions
4	tank calibration
5	linearisation table
6	service
7	calibration (locked out)

How to select a **PAGE ?**

- You are in the **RUN** mode (input display)
- Strike the P key
- Display reads the **PAGE** text
- Select the page you want by pressing the > key
- Confirm selection by striking the P key
- Module now displays the first parameter of the selected page.

3.7 Parameter selection

After PAGE selection the module displays the first parameter, the indication automatically changing every 2 s between

- indication of parameter name (see List of parameter
- abbreviations)
- indication of parameter value.

In most cases the parameter value is a numerical value, but it may also be a text. Some parameters can be changed, these then being input values (e.g. indication of input current) or an information parameter.

Paging to the next or previous parameter in the page list is done by striking the keys

- > (next)
- < (previous)

These keys have an AUTO repeat function, i.e. when paging to another parameter it is always the name of the parameter that is first indicated.

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3.8 Changing parameters (editing)

After having selected the wanted parameter you may want to change it.

This is how to do this:

- You are in the **SELECT** mode.
- The wanted parameter is selected.
- You can only start editing when the value of the parameter is in the display.
- Strike the P key.
- The right-hand digit of the indicated value blinks, indicating this is the digit that can be changed. On selection texts the whole text will blink.
- By striking the > key you can increment the numeral or the select text blinking. For some parameters the value is maximized or minimized which when violated will cause the display to read **hi** (when max is violated) or **lo** (when min is violated), the value then being set to the corresponding limit
- By striking the < key you can decrement the numeral blinking (does not apply to select texts).
- Striking the P key will store the changed parameter. Module is then returned to the **SELECT** mode.
- You can quit editing the parameter by pressing the two keys < and > at the same time, the module then returning to the **SELECT** mode with the original value saved and indicated.

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4 Parameter list

4.1 Parameters on page 0 (basic settings)

Abbreviation	Description	Value range	Dimension	Factory setting	Your setting	Note
dens	density	0.100 .. 9.999	kg/dm³	1.000		
A.Art	display mode					
	• level 0 - 100% (fixed)	0		0		
	• level freely scaleable	1				
	• level freely scaleable	2				
	• mass freely scaleable	3				
A.dp	display decimal point	0000				1
		000.0		000.0		
		00.00				
		0.000				
A.An	display LO	-19999 .. +19999		000.0		1
A.En	display HI	-19999 .. +19999		100.0		1
A.Cor	display correction value	-1000 .. +1000		0000		1
A.Int	display integration time	00.0 .. 99.9	s	00.0		
Lin	linearisation mode or tank shape					
	• no linearisation	0		0		
	• via Table	1				
	• cyl, upright with dished ends top and bottom	2				
	• cyl, upright with dished end bottom and top end open	3				
	• cyl, upright with truncated cone top and bottom	4				
	• cyl, upright with truncated cone bottom, dished end top	5				
	• cyl, horizontal with dished ends on both sides	6				
	• ball tank	7				
SA.An	current output - LO	00.00 .. 20.00	mA	04.00		
SA.En	corrent output - HI	00.00 .. 20.00	mA	20.00		
S.Cor	probe correction					
	• inactive	0		0		
	• active	1				
S.t	probe correction delay time	0 .. 9	s	0		
S.Pos	probe position	000.0 .. 100.0	%	000.0		

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Err.H	Error handling					
	• save actual current alarm relay unchanged	0				
	• current = 0 mA, alarm relay on idle	1		1		
	• current corr. to 0%, alarm relay on idle	2				
	• current corr. to 100%, alarm relay on idle	3				
	• current = 22mA, alarm relay on idle	4				
Err.E	Error handling input					
	• watchdog inactive	0				
	• 3.5 mA watchdog active	1		1		
	• 22 mA watchdog active	2				
	• 3.5 and 22 mA watchdog active	3				
Key	Code interrogate					
	• off	0		0		
	• on	1				
diff	Sensing mode select					
	• single presssure sensor	0		0		
	• diff. pressure sensing	1				

Note:
1) no parameter indication when display mode hard-wired to 0...100%

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4.2 Parameters on page 1 (switching output 1)

Abbreviation	Description	Value range	Dimension	Factory setting	Your setting	Note
S1.S	switchpoint	-19999 .. +19999		25.0		1
S1.H	hysteresis	1.. 19999		1.0		1
S1.An	ON delay	0.. 999.9	s	0		
S1.Ab	OFF delay	0.. 999.9	s	0		
S1.F	function (GW1)					
	• MIN	0		0		
	• MAX	1				
	• MIN inverted	2				
	• MAX inverted	3				

Note:
1) dec. point position same as A.DP

4.3 Parameters on page 2 (switching output 2)

Abbreviation	Description	Value range	Dimension	Factory setting	Your setting	Note
S2.S	switchpoint	-19999 .. +19999		75.0		1
S2.H	hysteresis	1.. 19999		1.0		1
S2.An	ON delay	0.. 999.9	s	0		
S1.Ab	OFF delay	0.. 999.9	s	0		
S2.F	function (GW2)					
	• MIN	0				
	• MAX	1		1		
	• MIN inverted	2				
	• MAX inverted	3				

Note:
1) dec. point position same as A.DP

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4.4 Parameters on page 3 (tank dimensions)

Abbreviation	Description	Value range	Dimension	Factory setting	Your setting	Note
d	outer diameter d	0,100 .. 19.999	m	1.000		1
h	outer height h	0,100 .. 19.999	m	1.000		1
d1	diameter d1	0 .. 19.999	m	1.000		1
h1	height h1	0 .. 19.999	m	1.000		1
d2	diameter d2	0 .. 19.999	m	1.000		1
h2	height h2	0 .. 19.999	m	1.000		1
len	outer length of horizontal tank	0 .. 19.999	m	1.000		1
T.Inh	tank content	0 .. 19999		0001		
T.Ein	volume unit of tank content	0 .. 3		0		
		0	mm^3			
		1	cm^3			
		2	dm^3			
		3	m^3			
Copy	copy tank content					2
	• no action	0		0		
	• value copied in HI display	1				
s	tank wall thickness	1 .. 50	mm	1		
Lage	sensor location	0.000 .. 1.000	m			

Note:
1) non-relevant parameters will be hidden, depending on set linearisation mode
2) copying only possible when display mode set to vol or mass proportional display

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4.5 Parameters on page 4 (tank calibration)

Abbreviation	Description	Value range	Dimension	Factory setting	Your setting	Note
Abgl	cal mode selection					1
	• in % with change in level	0		0		
	• in mA with no change in level	1				
nul1	zero cal with sensor 1 pressure zero	04.00 .. 20.00	mA			2
nul2	zero cal with sensor 2 pressure zero	04.00 .. 20.00	mA			2
leer	empty cal					
	• level in %	000.0 .. 100.0	%	000.0		
	• level in mA	00.00 .. 20.00	mA	04.00		3
Full	full cal					
	• level in %	000.0 .. 100.0	%	100.0		
	• level in mA	00.00 .. 20.00	mA	20.00		3

Note:
1) cal mode select possible only when operating with single pressure sensor
2) only on diff pressure sensing (2 sensors)
3) not on diff pressure sensing (2 sensors)

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4.6 Parameters on page 5 (linearisation table)

Abbreviation	Description	Value range	Dimension	Factory setting	Your setting	Note
L.Aut	input mode selection					
	• enter level % and vol %	0		0		
	• measure level % enter vol %	1				
L.Inc	operator selection					
	• manual change level %/vol %	0		0		
	• AUTO change to next parameter after entering level % or vol %	1				
L.Ins	insert a ref. point	00 .. 24		0		
L.del	delete a ref. point	00 .. 24		0		
E-01	1.ref. point: level %	000.0 .. 100.0	%	5.0		1
A-01	1.ref. point: vol %	000.0 .. 100.0	%	5.0		
E-02	2.ref. point: level %	000.0 .. 100.0	%	10.0		1
A-02	2.ref. point: vol %	000.0 .. 100.0	%	10.0		
E-03	3.ref. point: level %	000.0 .. 100.0	%	15.0		1
A-03	3.ref. point: vol %	000.0 .. 100.0	%	15.0		
E-04	4.ref. point: level %	000.0 .. 100.0	%	20.0		1
A-04	4.ref. point: vol %	000.0 .. 100.0	%	20.0		
E-05	5.ref. point: level %	000.0 .. 100.0	%	25.0		1
A-05	5.ref. point: vol %	000.0 .. 100.0	%	25.0		
E-06	6.ref. point: level %	000.0 .. 100.0	%	30.0		1
A-06	6.ref. point: vol %	000.0 .. 100.0	%	30.0		
E-07	7.ref. point: level %	000.0 .. 100.0	%	35.0		1
A-07	7.ref. point: vol %	000.0 .. 100.0	%	35.0		
E-08	8.ref. point: level %	000.0 .. 100.0	%	40.0		1
A-08	8.ref. point: vol %	000.0 .. 100.0	%	40.0		
E-09	9.ref. point: level %	000.0 .. 100.0	%	45.0		1
A-09	9.ref. point: vol %	000.0 .. 100.0	%	45.0		
E-10	10.ref. point: level %	000.0 .. 100.0	%	50.0		1
A-10	10.ref. point: vol %	000.0 .. 100.0	%	50.0		
E-11	11.ref. point: level %	000.0 .. 100.0	%	55.0		1
A-11	11.ref. point: vol %	000.0 .. 100.0	%	55.0		
E-12	12.ref. point: level %	000.0 .. 100.0	%	60.0		1
A-12	12.ref. point: vol %	000.0 .. 100.0	%	60.0		
E-13	13.ref. point: level %	000.0 .. 100.0	%	65.0		1
A-13	13.ref. point: vol %	000.0 .. 100.0	%	65.0		
E-14	14.ref. point: level %	000.0 .. 100.0	%	70.0		1
A-14	14.ref. point: vol %	000.0 .. 100.0	%	70.0		
E-15	15.ref. point: level %	000.0 .. 100.0	%	75.0		1
A-15	15.ref. point: vol %	000.0 .. 100.0	%	75.0		
E-16	16.ref. point: level %	000.0 .. 100.0	%	80.0		1
A-16	16.ref. point: vol %	000.0 .. 100.0	%	80.0		
E-17	17.ref. point: level %	000.0 .. 100.0	%	85.0		1
A-17	17.ref. point: vol %	000.0 .. 100.0	%	85.0		
E-18	18.ref. point: level %	000.0 .. 100.0	%	90.0		1
A-18	18.ref. point: vol %	000.0 .. 100.0	%	90.0		

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E-19	19.ref. point: level %	000.0 .. 100.0	%	95.0		1
A-19	19.ref. point: vol %	000.0 .. 100.0	%	95.0		
E-20	20.ref. point: level %	000.0 .. 100.0	%	0		1
A-20	20.ref. point: vol %	000.0 .. 100.0	%	0		
E-21	21.ref. point: level %	000.0 .. 100.0	%	0		1
A-21	21.ref. point: vol %	000.0 .. 100.0	%	0		
E-22	22.ref. point: level %	000.0 .. 100.0	%	0		1
A-22	22.ref. point: vol %	000.0 .. 100.0	%	0		
E-23	23.ref. point: level %	000.0 .. 100.0	%	0		1
A-23	23.ref. point: vol %	000.0 .. 100.0	%	0		
E-24	24.ref. point: level %	000.0 .. 100.0	%	0		1
A-24	24.ref. point: vol %	000.0 .. 100.0	%	0		
E-25	25.ref. point: level %	000.0 .. 100.0	%	0		1
A-25	25.ref. point: vol %	000.0 .. 100.0	%	0		

Note:
parameter is hidden when L.Aut = 1

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4.7 Parameters on page 6 (service mode)

Abbreviation	Description	Value range	Dimension	Factory setting	Your setting	Note
Ein.1	current at input 1	00.00 .. 22.00	mA			1
Ein.2	current at input 2	00.00 .. 22.00	mA			1,2
I.Out	current output	00.00 .. 22.00	mA			1
Fuel	% fill	000.0 .. 100.0	%			1
uP.Er	last mp error	00 .. FFh				1
uP.Ec	mp error counter	0 .. 255				1
Pres	implement module reset					
	• no action	0		0		
	• reset errors only	1				
	• set parameters to factory setting	2				
	• set parameters to factory setting and delete tank calibration	3				
Pr-n	program name	(pdd)0000				1
Pr-r	program release (version No.)	1.01				1
baud	baud rate	2400 .. 19200	bit/s			3
	2400	2400	bit/s			
	4800	4800	bit/s			
	9600	9600	bit/s	9600		

Note:
1) display parameters only
2) only for diff. sensing (2 pressure sensors)
3) relevant only to option with interface

4.8 Parameters on page 7 (calibration)

Abbreviation	Description	Value range	Dimension	Factory setting	Your setting	Note
CAL	module calibration					1
	• no action	no		no		
	• start calibration	yes				

Note:
1) Calibration is a service function and permits a basic calibration of the module. Access is protected by a code.

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5 Parameter description and module adaptation

5.1 Parameters on page 0

5.1.1 Density

This is an indication of the density of the medium involved. The density value **dens** must agree with the actual density involved, especially for calibrating the tank via the change in level.

If, for instance, tank calibration is done with water, a density of 1.000 is to be set. After calibration the density of the corresponding medium is to be set.

This density is defined as

$$density = \frac{mass}{volume}\left[\frac{kg}{dm^3}\right]$$

Note: For all sensors, **not** based on a pressure measurement, you must set the density to 1.000.

5.1.2 Selecting display mode

A.Art selects the display mode, for which there are 4 possibilities:

Value	Meaning	Description
0	level-proportional display	Scope of display is scaled fixed to 0.0 - 100.0 percent and always relates to theactual level (even if linearisation is activated). The display parameters **A.AN, A.EN, A.DP, A.COR** are not accessiböe
1	evel-proportional display	Display always relates to the actual level (even if linearisation is activated). The display range is dictated by the freely scalable parameters **A.AN, A.EN, A.DP, A.COR**
2	volume-proportional display	Display reads the tank contents in a unit as established by you. With linearisation activated the shape of the tank is taken into account in computing the contents. The display range is dictated by the freely scalable parameters **A.AN, A.EN, A.DP, A.COR**
3	mass-proportional display	Display reads the tank contents in a unit as established by you. With linearisation activated the shape of the tank is taken into account in computing the contents. **Caution**: For a mass-proportional display only the volume related to 10%% level and a density of 1.000 must be entered as the display HI, since in computing the mass the density actually set is used in the calculation (mass = volume times density) thus making it possible of obtaining a correct mass indication for changing media simply be changing the density parameter.

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5.1.3 Assigning the value to the display

The display of the measurement value in the **RUN** mode is freely scalable and is done via the parameters **A.AN** and **A.EN** to which any numerical value can be assigned in the range 0...± 19999, the relationship being as follows:

with **A.COR** you can add a positive or negative value to the display.
The decimal point is freely adjustable by means of **A.DP**.
Note: selecting the decimal point applies also to the display of the switchpoints **S1.S** and **S2.S**.

Here½s an example for scaling the display range 0...200.0:

A.AN = 000.0
A.EN = 200.0
A.DP = 111.1
A.COR = 0000

level measured	display value	display value from example
0%	**A.AN + A.COR**	000.0 hl
100%	**A.EN + A.COR**	200.0 hl

With **A.INT** an integration time of 0...99.9 s can be set, this being of advantage in the case of a turbulent level surface. Important: integration is done immediately following input sensing, i.e. it affecting all subsequent evaluations (such as e.g. MAX/MIN values, current outputs and, of course, the display). This is why you must take care that the integration time is oriented to the actual filling and discharge times.

5.1.4 Selecting linearisation mode

LIN selects the linearisation curve. The most popular tank shapes are programmed as a formula and can be parameterized very simply:

LIN Linearisation mode:
0 no linearisation, level sensed is displayed linearl
1 linearisation via linearisation curve, this curve being freely programmable and comprising max. ref. values with indication of level % and volume %.
2 formula for a cylindrical, upright tank having a dished end top and bottom
3 formula for a cylindrical, upright tank having a dished bottom end top and open top
4 formula for a cylindrical, upright tank having a conical end top and bottom
5 formula for a cylindrical, upright tank having a conical bottom end top and dished top end
6 formula for a cylindrical, horizontal tank having dished ends
7 formula for a ball tank

5.1.5 Assigning the value to current output

The parameters **SA.AN, SA.EN** are used to adapt the current output to the levels 0 and 100%. The current output responds the same as the selected display mode (**A.ART**), 3 possibilities being provided:

- level proportional **A.ART** = 0 or 1
- volume proportional **A.ART** = 2
- mass proportional **A.ART** = 3

Between LO and HI a span of at least 1 mA must be entered. The characteristic can be programmed rising or falling.

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5.1.6 Probe correction

A probe additionally installed in the tank corrects the actual result of evaluation, this correction being effective every time the switch is opened and closed (control input is HI active).

Proceed as follows:

- Install probe and level sensor. Connect the switching output of the level sensor to the control input 1 (control input is terminal 1, GND is terminal 4).
- Tank calibration has already been done.
- Define mopunting position of probe (% value relative to max. level) with the parameter **S.POS**.
- Use parameter **S.COR** to activate probe correction.

Caution: If probe correction is done and the percentual level deviates from the percentual probe position by more than ±10% the display will read the error code (blinking):

0.0.0.8 error in correction of actual value.

Using the parameter **S.T** you can enter a delay (in seconds) for probe correction, i.e. the correction then not being done until time-out of the delay entered, thus preventing the correction of the actual value from being done on first-time contact of the probe in the case of a turbulent level surface.

5.1.7 Selecting error handling

Err.H permits programming the response of

- current output and
- switching output

in case of a disturbance.

Parameter	Current output	Switching output
0	store act. current	switching relay no change
1	0 mA	switching relay idle
2	current corr. to 0%	switching relay idle
3	current corr. to 100%	switching relay idle
4	22 mA	switching relay idle

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Err.E permits activating the current output watchdog:

0: watchdog OFF
1: inputs watchdogged for MIN violation of 3.5 mA
2: inputs watchdogged for MAX violation of 22 mA
3: inputs watchdogged for MIN **and** MAX violation of 3.5 mA and 22mA resp.

thus providing you with a loop current watchdog possibility, i.e. violation of the threshold current produces an error signal and the alarm relay opens the circuit.

error code blinking: **0.0.0.1** input 1 fault
error code blinking: **0.0.0.2** input 2 fault
error code blinking: **0.0.0.3** input 1 and 2 fault

Note: the watchdog for the 2nd current input is active only in differential pressure operation.

5.1.8 Activating key release

The **KEY** parameter activates locking out the module to prevent unauthorized changes to parameters.

KEY	Function	
0	inactive	key OFF, i.e. all parameters are freely accessible for change
1	active	key ON, i.e. all parameters can be seen but not edited until a release code has been entered. On return to the RUN mode, entry is locked out.

Example:
DENS density parameter to be changed.

- **KEY** is active (=1)
- **DENS** parameter on page 0 selected and indicated.
- Key P pressed to open editing.
- Since **KEY** is locked out, however, display first demands entry of the release code:

CODE **--->** **0000**

- Enter the correct code (code = 6090) and confirm with key P
- **FREE** signal materializes for release
- **DENS** parameter can now be edited (as well as all others on this page)
- Wrong code entry will cause the module to instantly return to the **RUN** mode
- On return to **RUN** editing is again locked out.

5.1.9 Operating mode selection

Selecting the operating mode is a basic setting of the module. By means of a second current input the module can implement a differential pressure measurement, the parameter **diff** being available for this selection. This parameter should be set right at the beginning of parameterization.

diff	function
0	single current input evaluated (single pressure sensing)
1	two current inputs evaluated (differential pressure sensing)

Note: setting **diff** = 0 will suppress all parameters and evaluations for the 2nd current input.

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5.2 Parameters on Page 1 and 2

Note:
Setting the parameters for switching output 1 and 2 is the same for both and is to be found correspondingly on page 1 and 2 resp.

5.2.1 Setting switchpoint and hysteresis

Parameter **S1.S** defines the switchpoint for MAX/MIN 1. The decimal point is the same as defined by the parameter **A.DP**. The switching response is dictated by the parameter **S1.F.**

Parameter **S1.H** permits defining the hysteresis for MAX/MIN 1. The decimal point is the same as defined by the parameter **A.DP**.

5.2.2 Setting the delay

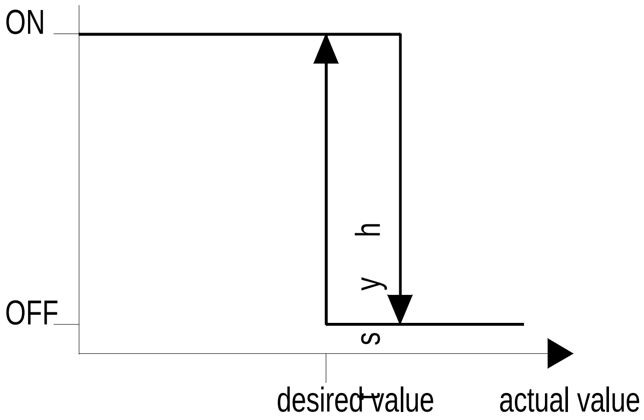
Parameter **S1.An** permits setting the ON delay, i.e. the relay not closing the circuit until timeout of the delay.

Parameter **S1.Ab** permits setting the OFF delay, i.e. the relay not opening the circuit until timeout of the delay.

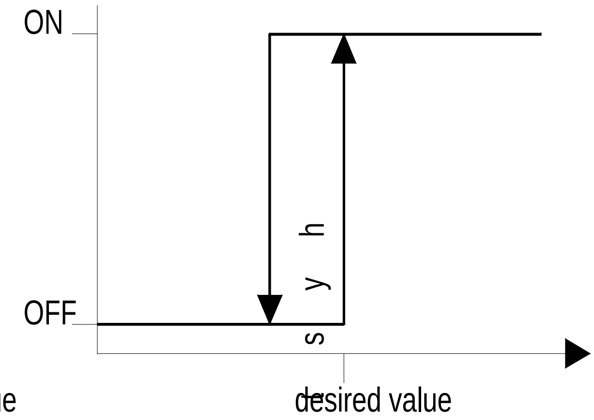
5.2.3 Switching output mode definition

Parameter S1.F defines the working mode of the switching output:

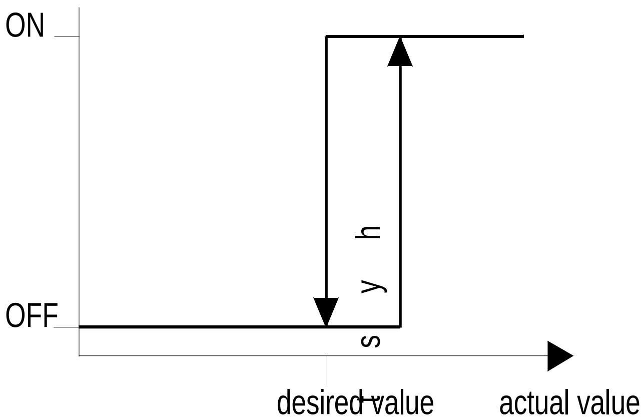
0:	MIN	relay closes the circuit when **MIN** violated (relay open-circuits when hysteresis violated)
1:	MAX	relay closes the circuit when **MAX** violated (relay open-circuits when hysteresis violated)
2:	MIN inverted	relay opens the circuit when **MIN** violated (relay close-circuits when hysteresis violated)
3:	MAX inverted	relay opens the circuit when **MAX** violated (relay close-circuits when hysteresis violated)



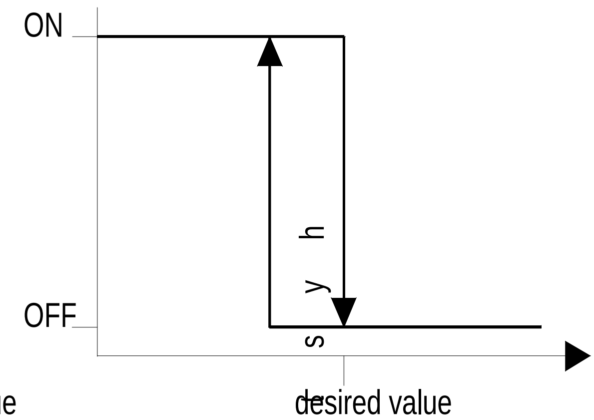
0: Minimum



1: Maximum



2: Minimum invertiert



3: Maximum invertiert

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5.3 Parameters on page 3

5.3.1 Inputting tank dimensions for linearisation

The dimensions of the tank to be linearised are entered by means of the parameters **d, d1, d2** and **h, h1, h2** and **len**, the parameter **s** entering the wall thickness of the tank in mm. In accordance with the tank shape selected various parameters are needed. The parameters not required are hidden.

Lin	**Linearisation type (tank shape)**	***d***	***h***	***d1***	***h1***	***d2***	***h2***	***len***	***s***	**Plausibility check (parameter OK when...)**	***Note***
0	no linearisation										
1	linearisation via Table										
2	cyl, upright with dished ends top and bottom	x	x						x	h > 0.4*d	
3	cyl, upright with dished end bottom and top end open	x	x						x	h > 0.2*d	
4	cyl, upright with truncated cone top and bottom	x	x	x	x	x	x		x	d1 ≤ d d2 ≤ d (h1 +h2 + 2*s) ≤ h	1
5	cyl, upright with truncated cone bottom, dished end top	x	x	x	x				x	d1 ≤ d (h1 +s +0.2*d) < h	2
6	cyl, horizontal with dished ends on both sides	x						x	x	len > 0.4*d	
7	ball tank	x							x		

Note:
1) several possibilities exist for tank shape 4:

h1 = 0	tank has flat bottom
h1 ≠ 0, d1 = 0	tank has a bottom circular cone
h1 ≠ 0, d1 > 0	tank has a bottom circular truncated cone
h2 = 0	tank has flat top
h2 ≠ 0, d2 = 0	tank has a top circular cone
h2 ≠ 0, d2 > 0	tank has a top circular truncated cone

2) several possibilities exist for tank shape 5:

h1 = 0	tank has flat bottom
h1 ≠ 0, d1 = 0	tank has a bottom circular cone
h1 ≠ 0, d1 > 0	tank has a bottom circular truncated cone

The assignment of the various tank dimensions can be seen from the enclosed tank drawings.

Note as regards the parameters:
diameter d, height h and length len are **external dimensions**. All other dimensions are internal dimensions.

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The **LAGE** parameter takes account of the sensor not being fitted at the lowest point in the tank (relative to the entered tank dimensions), it permitting entry of a positive height offset relative to the zero line to achieve correct linearisation of the tank.

Caution: In this case the display reading for "tank = empty" with linearisation activated will then precisely correspond to the remainder in the tank which is no longer sensed due to the positive height offset of the sensor.

The volume of the tank is calculated from the dimensions entered, this value being indicated via the parameters **T.Inh** and **T.Ein**.

T.Inh digitizes the volume of the tank in the display range 0...19999.
T.Ein identifies the unit of volume of the value calculated according to the following:

T.Ein	Unit	
0	mm^3	
1	cm^3	or ml
2	dm^3	or l
3	m^3	or l x 1000

Caution:
Should the display read **Err** on entering the tank dimension, this means that the parameter is implausible. Recheck the dimensions for correctness.
Note that **Err** produces the error code **1.0.0.0** and the wanted linearisation is **not** implemented (input signal is output proportional to level). Correct the parameters until the error code is reset.

If you have selected the display mode **A.ART** volume-proportional or mass proportional you can use the **Copy** parameter to copy the calculated volume into the display HI **A.EN** (incl. dec. point position **A.DP**). For this purpose the **Copy** parameter needs to be set to 1. Striking the **P** key will then produce the display **stor** indicating that the value has been copied. Do not forget to return the **copy** parameter to 0.

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5.4 Parameters on page 4

5.4.1 Selecting the calibration action

Parameter **ABGL** implements tank calibration in one of two modes:

ABGL	Calibration mode
0	calibration in % with change in level from sensing the input current
1	calibration in mA with no change in level from entering the currents

The following lists the procedure for tank calibration with a single sensor, two methods of calibration being available in this mode:

5.4.2 Empty and full calibration in % with change in level (1st method)

- Set the parameter **ABGL** to 0.
- Then proceed as follows for the empty calibration:
- Select the parameter **LEER**.
- Display reads the % level for "empty" last entered.
- Tank is empty (= 000.0%) or has been emptied to a known level (= xxx.x%).
- Enter the known level in % by striking the P key, after which the actual value of the current input is stored.

- Proceed as follows for the full calibration:
- Select the parameter **FULL**.
- Display reads the % level for "full" last entered.
- Fill the tank to the desired level (= xxx.x%).
- Enter the known level in % by striking the P key, after which the actual value of the current input is stored.

This concludes tank calibration. Note, however, that the difference between the currents for empty and full calibration must be at least 1 mA, otherwise the display will show an error code.

5.4.3 Empty and full calibration in mA with no change in level (2nd method)

This method defines two levels in mA corresponding to the levels 0% and 100%:

- Set the parameter **ABGL** to 1.
- Then proceed as follows for the empty calibration:
- Select the parameter **LEER**.
- Display reads the current last entered for level 0% (e.g. 04.00 mA).
- Open the new value for level 0% by striking the P key, after which the entered value of the current input is stored

- Proceed as follows for the full calibration:
- Select the parameter **FULL**.
- Display reads the current last entered for level 100% (e.g. 20.00 mA).
- Open the new value for level 100% by striking the P key, after which the entered value of the current input is stored.

This concludes tank calibration. Note, however, that the difference between the currents for empty and full calibration must be at least 1 mA, otherwise the display will show an error code.

Note: If calibration is first implemented **with a change in level** (**ABGL** = 0) display will read the sensing current converted to 0 or 100% for **LEER** and **FULL** respectively.

5.4.4 Tank calibration for differential pressure sensing

In differential pressure sensing two pressure sensors are connected to the module **pem-dd**, permitting level sensing when the tank is pressurized. Set the mode to differential pressure sensing (**DIFF = 1** in page 6).

sensor 1 senses the hydrostatic level pressure plus overpressure
sensor 2 senses the overpressure

The calibration procedure is then as follows:

Calibrating sensor zero:
- Tank must be empty and at zero pressure
- Select the parameter **nul1**
- Display then reads the current of sensor 1
- Press the **P** key to store the indicated current, display then briefly reading
- This concludes zero calibration of sensor 1
- Select the parameter **nul2**
- Display then reads the current of sensor 2
- Press the **P** key to store the indicated current, display then briefly reading
- This concludes zero calibration of sensor 2

Calibrating for overpressure:
- Tank must be exposed to the overpressure (see drawing in Enclosure E)
- Select the parameter **LEER**
- Display then reads the current of sensor 1
- Tank is empty (level = 000.0%)
- Press the **P** key to store the overpressure.

Calibrating for FULL:
- Select the parameter **FULL**.
- Display reads the % level last entered for "full"
- Fill tank to desired level (=xxx.x%)
- Display then reads the current of sensor 1
- Press the **P** key and </> accordingly to enter the known level in %
- Press the **P** key to store the FUll calibration.
- Note that the display must show **STOR.**

This concludes calibration

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5.5 Parameters on page 5

5.5.1 Entering the linearisation table

Using the **pem-dd** you can freely program a linearisation curve with a maximum of 25 reference points.

Selecting the entry mode is defined with **L.AUT**

L.AUT entry mode
0 for entering level % and volume %
1 for sensing the level %, the corresponding vol % being entered (liter capacity gaging method)

The parameter **L.INC** permits AUTO incrementing of the parameters following entry:

L.INC mode
0 AUTO incrementing OFF
1 AUTO incrementing ON, i.e. mode automatically switches to the next parameter following each level or vol % entry (manual select remains possible, however)

The procedure for the **L.AUT** (0) entry method is as follows

- **LIN** parameter must be 0 (= linear)
- Tank calibration must already have been done.
- Program display to 000.0 to 100.0% or select display **FUEL** (= % level) in page 6.
- Fill or discharge tank incrementally with a partial volume
- Read level % from display and enter in linearisation protocol
- Repeat this procedure until the desired number of sensing points has been established.

or:

- Establish and note level % and vol % theoretically
- Enter the established level % in the parameters **E-01..E-25** (E standing for input of the Table)
- Enter the established vol % in the parameters **A-01..A-25** (A standing for output of the Table)

You must observe the following as regards method 1 (= liter capacity gaging method):

- **LIN** parameter must be 0 (= linear)
- Tank calibration must already have been done.
- Tank must be **filled** incrementally with partial volumes
- The partial volumes must be converted into vol % and entered for the corresponding reference points
- After having entered the vol % (A01...A25) the actual input current is sensed, converted into level % and stored together with the vol % as a pair of ref. points.

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Calculating the vol %

$$vol\% = \frac{100\% * partialvolumen}{totalolumen}$$

Caution

- The pair of ref. points **E-01/A01** must not be 0.
- The linearisation curves must always be concluded with 100.0%. This can be done following any reference value. The first 100.0% value concludes the linearisation curve, i.e. values following this are no longer relevant.
- It is mandatory that after entering, the linearisation curve has a rising characteristic, otherwise the display will read ERR and the error code set.
- Level % established by method 1 can be corrected with method 0.

Should the display show **Err** following entry of the linearisation curve, then either the curve has no monotony or the ref point end 100% is missing.
In this case the error code **1.0.0.0** is set and the desired linearisation is **not** implemented (sensing signal is output level proportional). The parameters of the curve then need to be corrected until the error code is reset.

The parameter **LIN** = 1 activates linearisation according to the Table.

L.INS can be used subsequently to insert a further ref. point in an existing Table. For this purpose set the parameter to the desired ref. point and confirm by striking the **P** key. All existing ref. point pairs will then be shifted one place to the rear, including those selected.

Example (An additional value is to be inserted in ref. point 5):

- Set parameter **L.INS** to 5
- Confirm input.

Index	Value before	Value after
1	5	5
2	30	30
3	50	50
4	70	70
5	95	95
6	100	95
7		100

Caution:
Since on insertion, the values of the selected ref. point are duplicated, the profile of the curve is no longer monotonous. This will produce an error code. This will disappear, however, as soon as the vacated ref. point has been filled with a corresponding value.

L.DEL can be used to delete a ref. point. For this purpose set the parameter to the desired ref. point and confirm by striking the **P** key. All subsequent ref. point pairs will then be shifted one place to the front.

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Example (Ref. point 5 is to be deleted):

- Set parameter **L.DEL** to 5
- Confirm input.

Index	Value before	Value after
1	5	5
2	30	30
3	50	50
4	70	70
5	85	95
6	95	100
7	100	

5.6 Parameters on page 6

5.6.1 Display parameters of page 6

Parameter **EIN.1** displays the current of sensor 1.

Parameter **EIN.2** displays the current of sensor 2.
This parameter is only accessible when the diff. pressure mode (see **DIFF**) has been selected.

Parameter **I.OUT** displays the scaled output current.

Parameter **FUEL** displays the % level (range: 0...100.0%).

Parameter **up.ER** displays the processor error having last occured.
Ideally this error indication should be 0. When, however, a fault results in an error resulting in a restart of the program, the cause of the restart can be established from this display.

Parameter **up.EC** displays the number of processor errors having occured. Ideally this error indication should be 0.

Parameter **Pr-n** displays the name of the program.
This is also displayed for 1 sec every time the module is restarted.

Parameter **Pr-r** displays the version of the program.
This is also displayed for 1 sec every time the module is restarted.

5.6.2 Implementing a basic setting

It may prove necessary after programming to reset the parameters to the factory setting. This is done with the parameter **PRES**

PRES	Function
0	no reset
1	acknowledge error indication
2	set parameter to factory setting
3	set parameter to factory setting and delete tank calibration data

Note: Parameter is reset to 0 when a preset has been made.

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5.7 Parameters on page 7

5.7.1 Activating module calibration

Module calibration is activated via the **CAL** parameter. This is a service function. This is why its access is protected by a code word, so that the module is not accidentally wrongly calibrated.

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6 Error codes

6.1 Cyclic error codes in RUN mode and DISPLAY mode

The **pem-dd** module incorporates a cyclic display of error codes to inform the user when something has gone wrong. This display is made in the RUN mode and in the DISPLAY mode.
If an error exists the actual display alternates in time with the error code, the latter being highlighted by its special display form and by blinking, thus making it readily discernible in indicating that something has gone wrong.
Example:
Error code (blinking) **0.0.0.1** meaning: input 1 error

If several errors occur at the same time, this is indicated by an addition of error codes.
Example:
Error code (blinking) **0.1.5.1** meaning: errors **0.1.0.0** / **0.0.1.0**/**0.0.4.0** exist simultaneously.

List of error codes:

Error code	What it means	What to do
0.0.0.1	Error in **input current 1** current is <3.5mA or > 22mA	Remedy current or disable watchdog with **Err.E**
0.0.0.2	Error in **input current 2** current is <3.5mA or > 22mA	Remedy current or disable watchdog with **Err.E**
0.0.0.4	Error in AUTO probe correction. Deviation of sensed actual value is hreater than 10% of required actual value.	Sensor may be defective or as drifted away too far.
0.0.0.8	Operator error: output current span entered is < 1mA	Change **SA.AN** and **SA.EN** accordingly
0.0.1.0	. Calibration error in empty tank calibration (only in diff. mode) Delta of **input current 1** too low.	Difference between current at E1 when tank at zero pressure and when pressurized, empty must be > 1mA
0.0.2.0	Calibration error in empty tank calibration (only in diff. mode) Delta of **input current 2** too low or negative.	Difference between current at E2 when tank at zero pressure and when pressurized, empty must be > 1mA
0.0.4.0	Calibration error in full tank calibration Delta of **input current 1** too low or negative	(for 1 sensor): difference between current at E1 when tank empty and when tank full must be > 1mA (for 2 sensors): difference between current at E1 when tank at zero pressure and when pressurized, full must be > 1mA
0.0.8.0	Calibration error in full tank calibration (only in diff. mode) Delta of **input current 2** too low or negative.	difference between current at E2 when tank at zero pressure and when pressurized, full must be > 1mA
0.1.0.0	Tank calibration error (only in diff. mode) : Difference between currents 1 and 2 too low or negative.	Difference between currents E1-E2 when tank pressurized, full must be > 1mA
0.2.0.0	Input amplifier calibration error (check sum wrong)	Call in servicing: modules needs recalibrating
0.4.0.0	Tank calibration error (check sum wrong)	Reimplement tank calibration
0.8.0.0	Parameter set error (check sum wrong) :	Reenter parameters
1.0.0.0	Error in entering linearisation data	Check plausibility of dimensions or lin. curve

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8.0.0.0	EEPROM read error	Call in servicing: module defective

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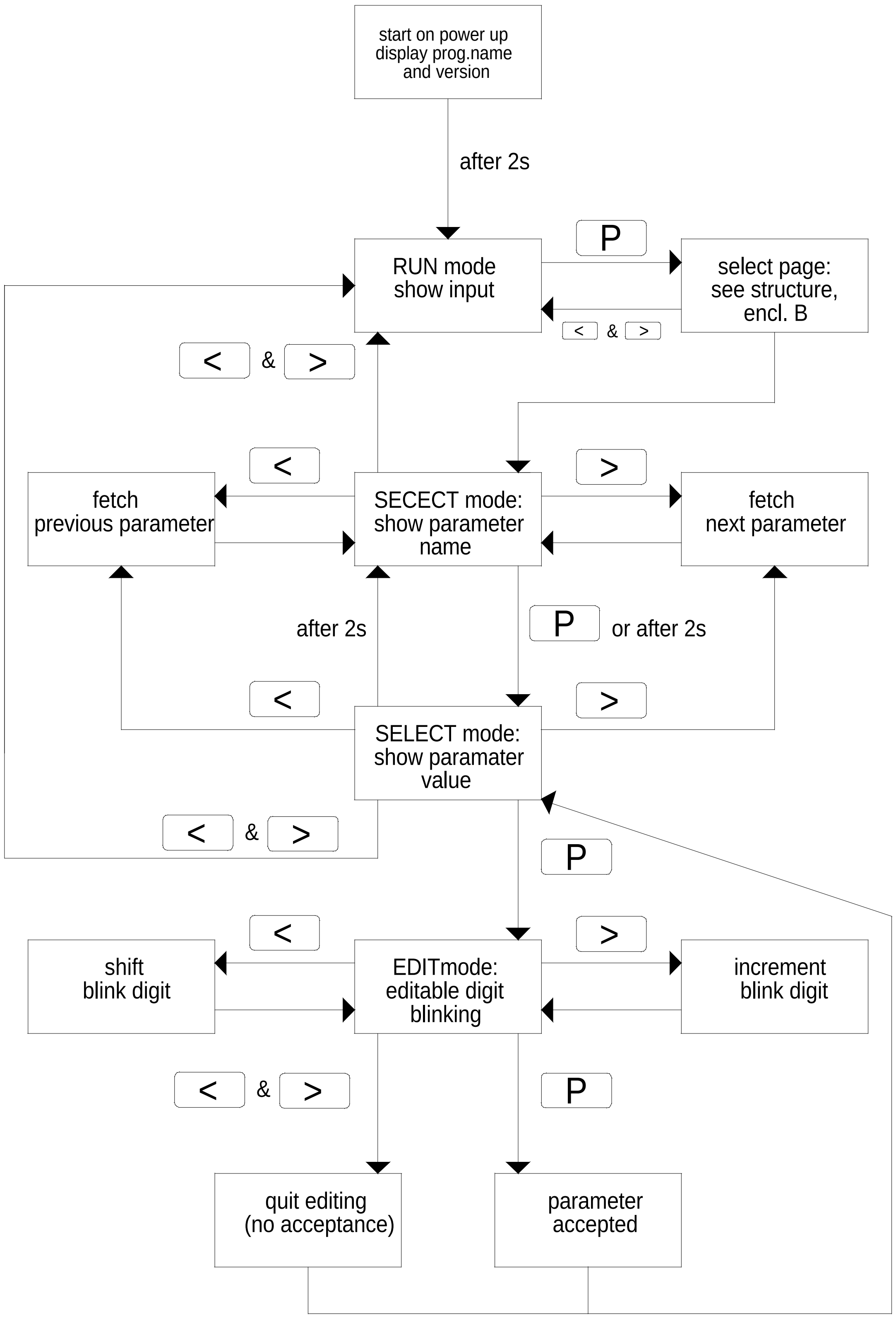
7 Enclosure A: General Control Structure



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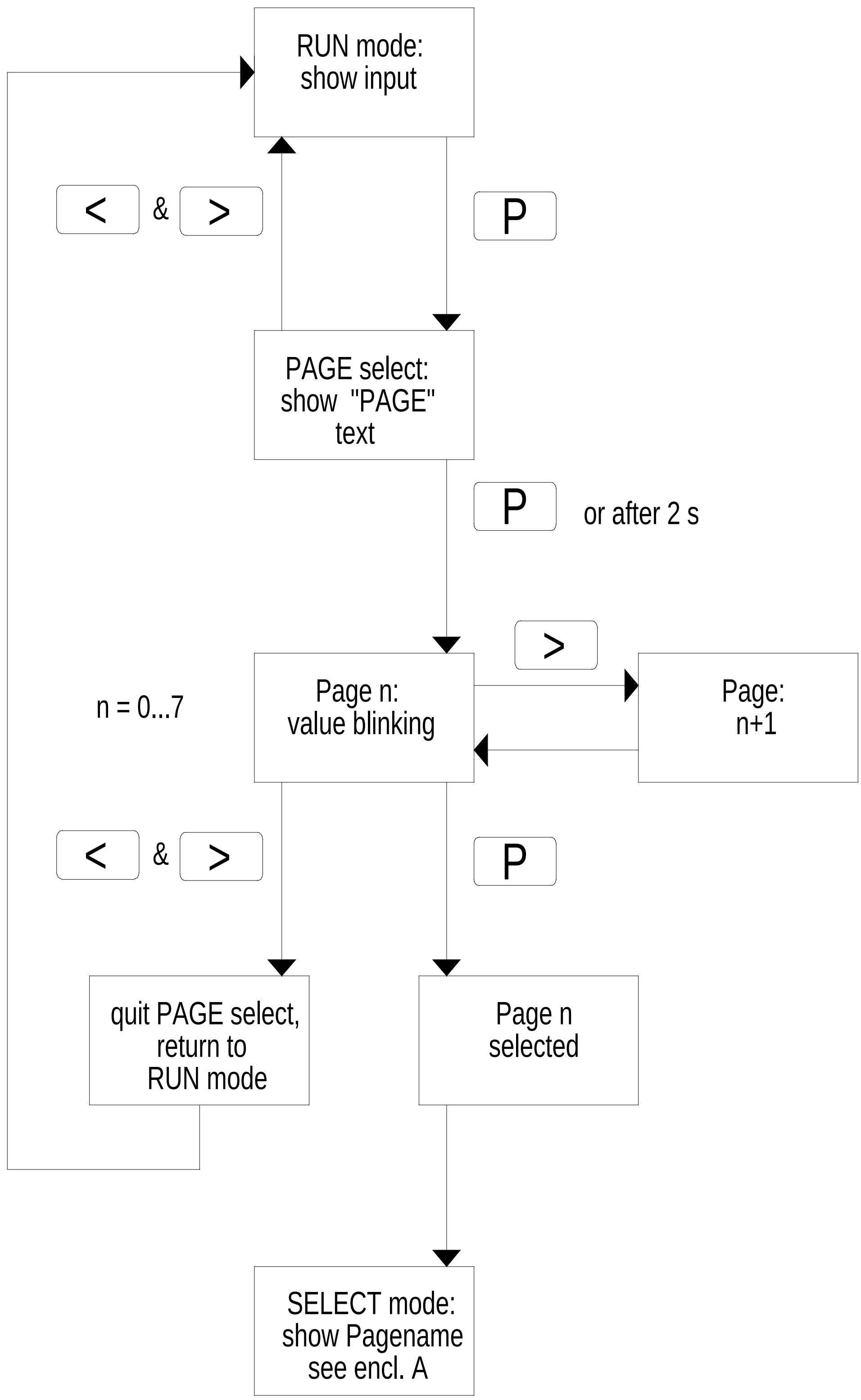
8 Enclosure B: PAGE Select Control Structure



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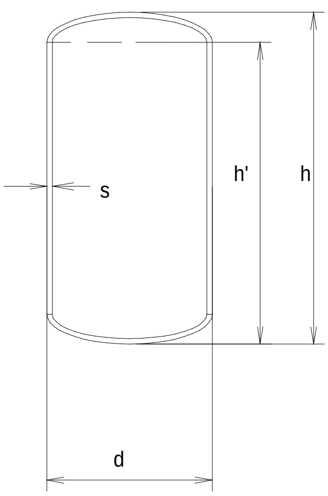
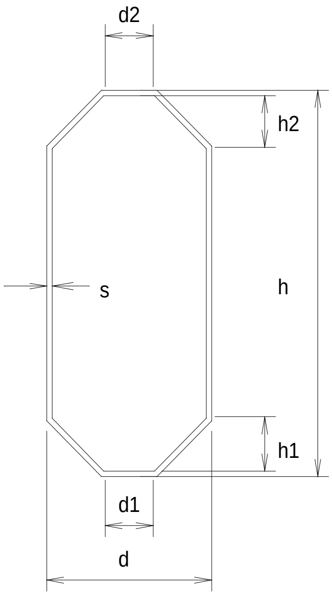
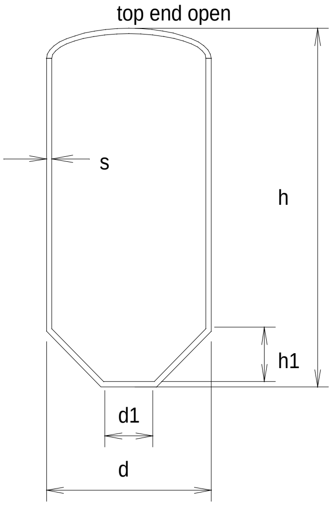
9 Enclosure C: Tank Shapes

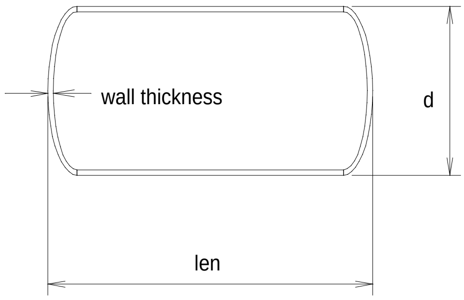




Lin = 2 cyl, upright with
dished ends top and bottom
Lin = 3 cyl, upright with
dished end bottom and
top end open

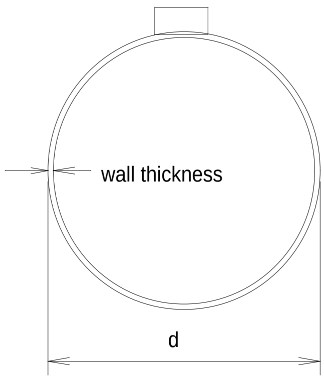
Lin = 4 cyl, upright with
conical top and bottom





Lin = 6 cyl, horizontal with dished ends on both sides

Lin = 5 cyl, upriht with conical bottom
and dished end top



Lin = 7
ball tank

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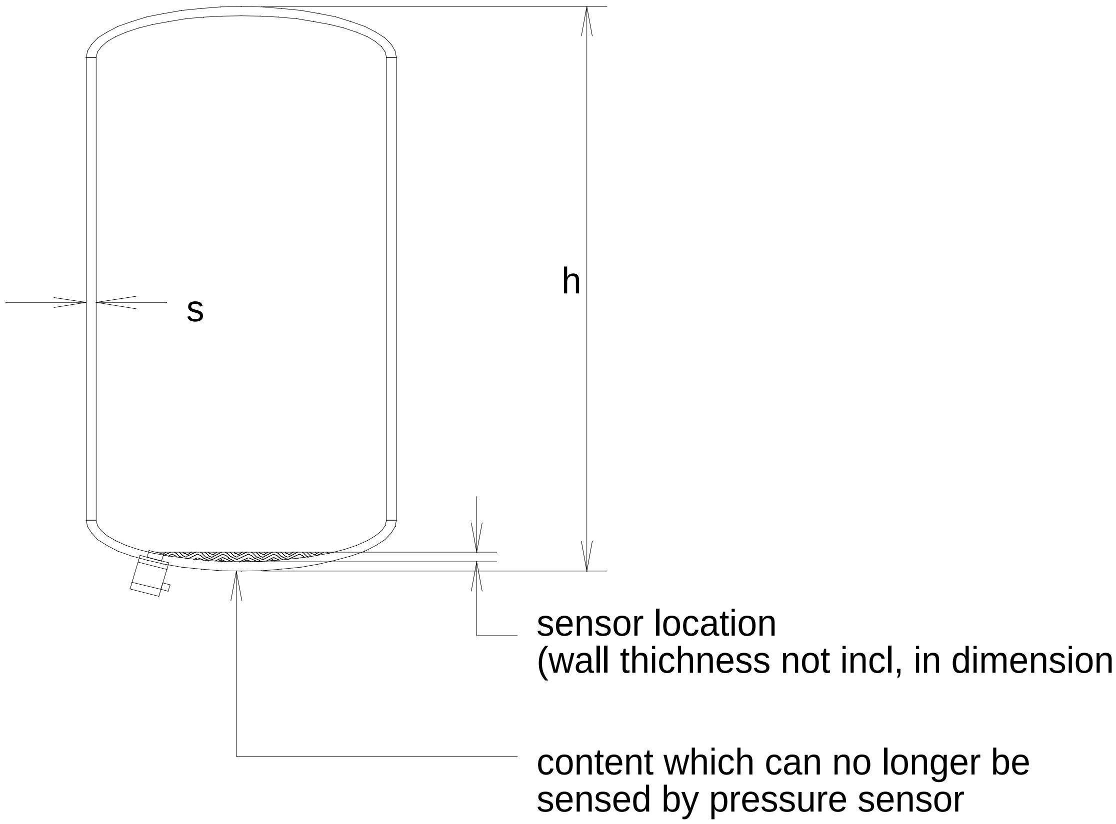
10 Enclosure D: Example of offset sensor location



Example for offset location of pressure sensor

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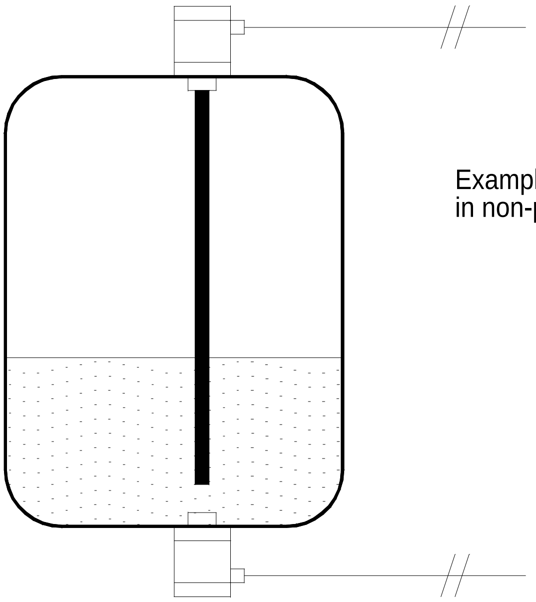
11 Enclosure E: Sensor Location Examples

capacitive Sensor senses level

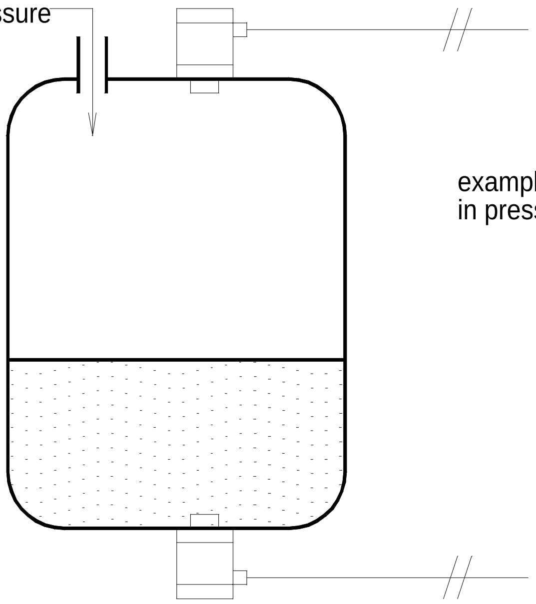


Example for level sensing
in non-pressurized tank

or pressure sensitiv sensor
senses hydrostatic pressure

sensor 2 senses overpressure

overpressure



example for level sensing
in pressuized tank

sensor 1,
senses hydrostatic pressure
plus overpressure

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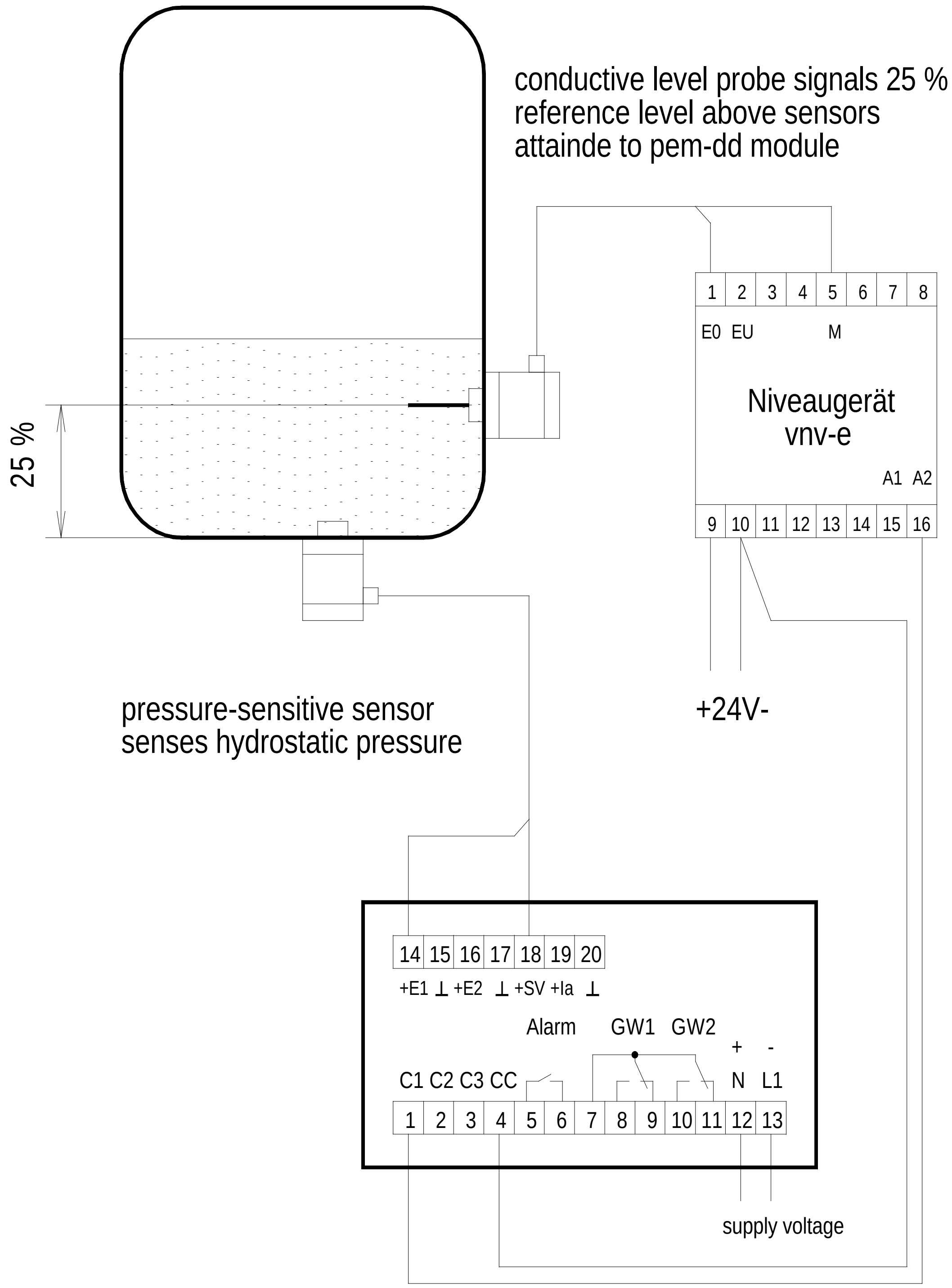
12 Enclosure F: Location and Connection Example for Probe Correction

level sensing in non-pressurized tank with probe correction



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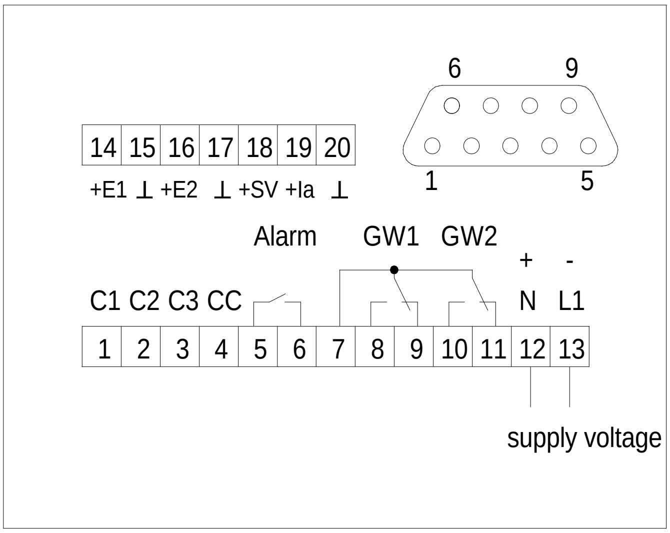
13 Enclosure G: pem-dd Pin Allocation



Terminal pin allocations:

Terminal	Name	Function
1	C1	control input 1 (probe correction)
2	C2	control input 2 (spare)
3	C3	control input 3 (spare)
4	CC	control input common (GND)
5 .. 11		relay contacts
12	N	supply voltage (plus on DC)
13	L1	supply voltage (minus on DC)
14	E1 +	current input 1 plus.
15	E1 -	current input 1 minus (GND).
16	E2 +	current input 2 plus.
17	E2 -	current input 2 minus (GND).
18	+SV	sensor supply +24V DC/50mA
19	+Ia	current output 0/4..20mA plus
20	- Ia	current output 0/4..20mA minus

Interface pin allocations (optional)

Terminal	using RS232	using RS485
1	GNDe	GND
2	TxD: ser. data output	
3	RxD: ser. data input	RxD-B/TxD-B: ser. data
4		
5	GND	GND
6		
7		
8		RxD-A/TxD-A: ser. data
9		

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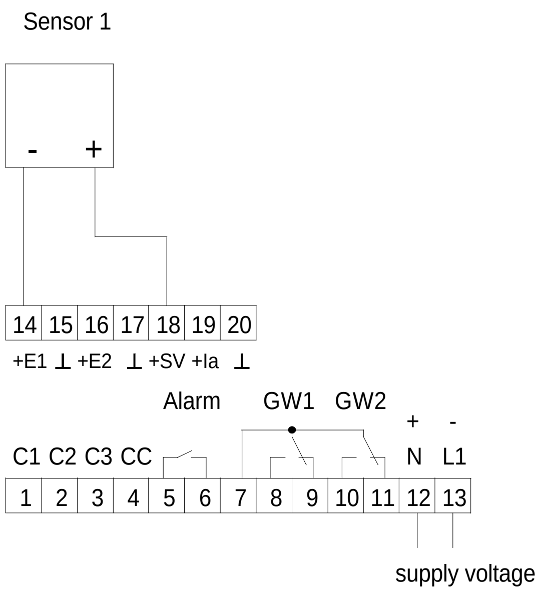
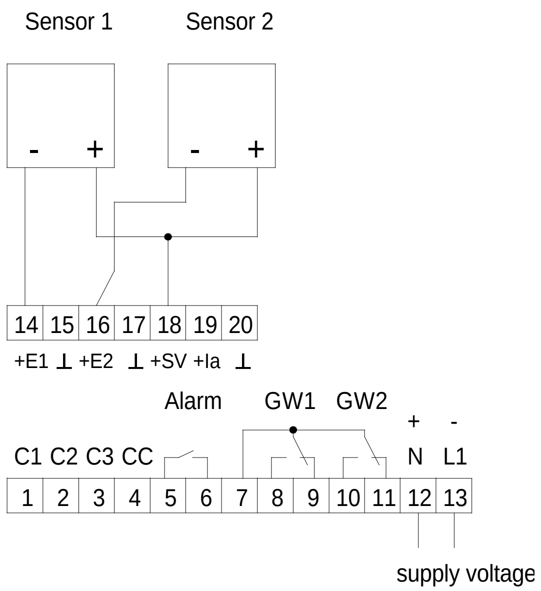
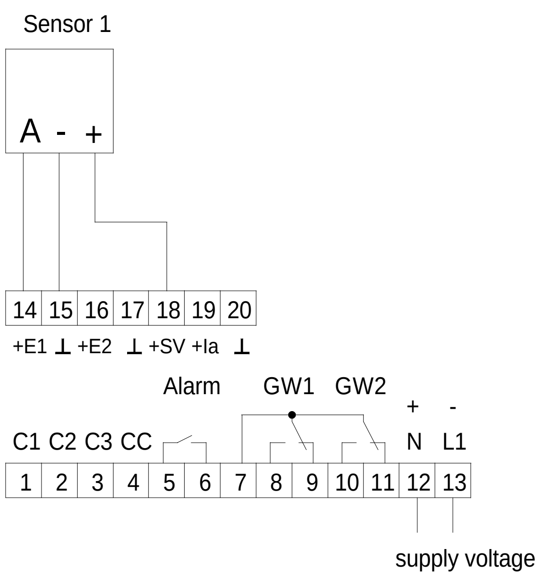
14 Enclosure H: pem-dd Terminal Pin Allocation and Connection Examples

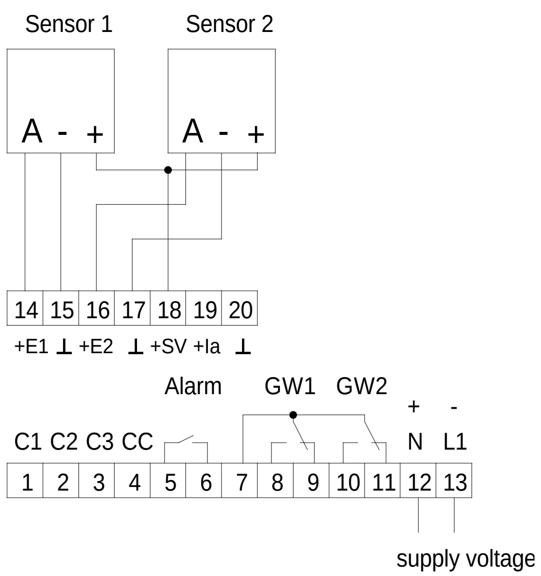
4...20 mA two-wire sensor connection





0/4...20 mA three-wire sensor connection





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15 Enclosure I: Linearisation Table

Tank No./Ident: ____

Total capacity: ____

Ref.No Nr.	Level: [______]	Level %	Vol [______]	Vol %
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				
22				
23				
24				
25				

Date ____________________ Name ________________________________