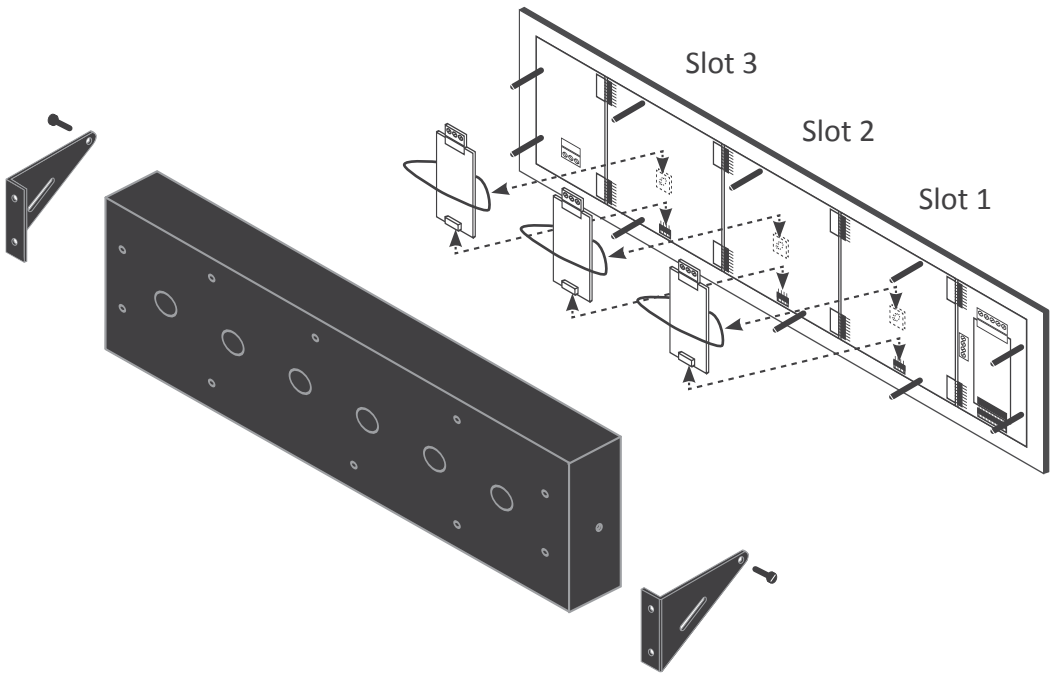
PCE Instruments

User's Manual



Output and control options

Series PCE-BPD

BIG PANEL DISPLAYS

Output and control options for big panel displays. Relay outputs, transistor outputs, SSR control outputs, analog outputs, Modbus RTU communications, RS-485 and RS-232 communications. Modular output and control options to integrate in any meter of the series.

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Index

1.1 Read this first

Series PCE-BPD has 4 formats, with different sizes and number of digits, and slots for output and control options.

Format	*Digits*	*Digit height*	*Options*
46	*4*	*60 mm*	*2*
41	*4*	*100 mm*	*2*
66	*6*	*60 mm*	*3*
61	*6*	*100 mm*	*3*

This document assumes the following :

- inside the programming menus, when a 6 digits value is shown, it is assumed that only 4 digits apply to formats 46 and 41
- when this document explains that a maximum of 3 output and control modules are installable, it is assumed that the maximum is 2 modules for formats 46 and 41

The output and control modules mentioned in this document, are covered by the warranty of the instrument where they are installed. Check the user's manual of the instrument for more information related to warranty.

The user's manual of the instrument where the module is installed, has important information related to installation that applies also to the output and control modules mentioned in this document. Check the user's manual of the instrument for more information related to installation precautions.

The output and control modules mentioned in this document are covered by the 'CE declaration of conformity' of the instrument where they are installed. Check the user's manual of the instrument for more information related to the CE declaration of conformity.

1.2 Installation and material

The Series PCE-BPD modular architecture allows the installation of output and control modules. Each module is supplied together with the following items:

1x cable tie (black)
1x square self adhesive tie base
1x white cable tie
1x female terminal
1x cable gland.

To install an optional output and control module :

1. remove the rear cover of the instrument *(see section 1.3)*
2. install the module at one of the free slots *(see section 1.4)*
3. place the squared 'tie base' at the slot selected. Location for the 'tie base' is clearly indicated on the PCB *(see section 1.4)*.
4. pass the 'cable tie' (black) through the 'tie base' *(see section 1.4)*
5. place the module at the slot 'connection jumpers' *(see section 1.4)*
6. use the 'cable tie' to firmly fix the module *(see section 1.4)*
7. if needed, configure the jumpers of the module
8. at the rear cover, replace the cable gland cover by the cable gland provided, and pass the connection wires through the cable gland
9. connect the wires to the module terminals
10. close the rear cover of the instrument *(see section 1.3)*
11. configure the parameters at the 'Configuration menu'.
    - modules PCE-BPD/R, PCE-BPD/T and PCE-BPD/SSR are configured from the alarms menu of the instrument
    - other modules are configured from from menu entries 'Opt.1', 'Opt.2' or 'Opt.3', depending on the slot where the module has been installed.

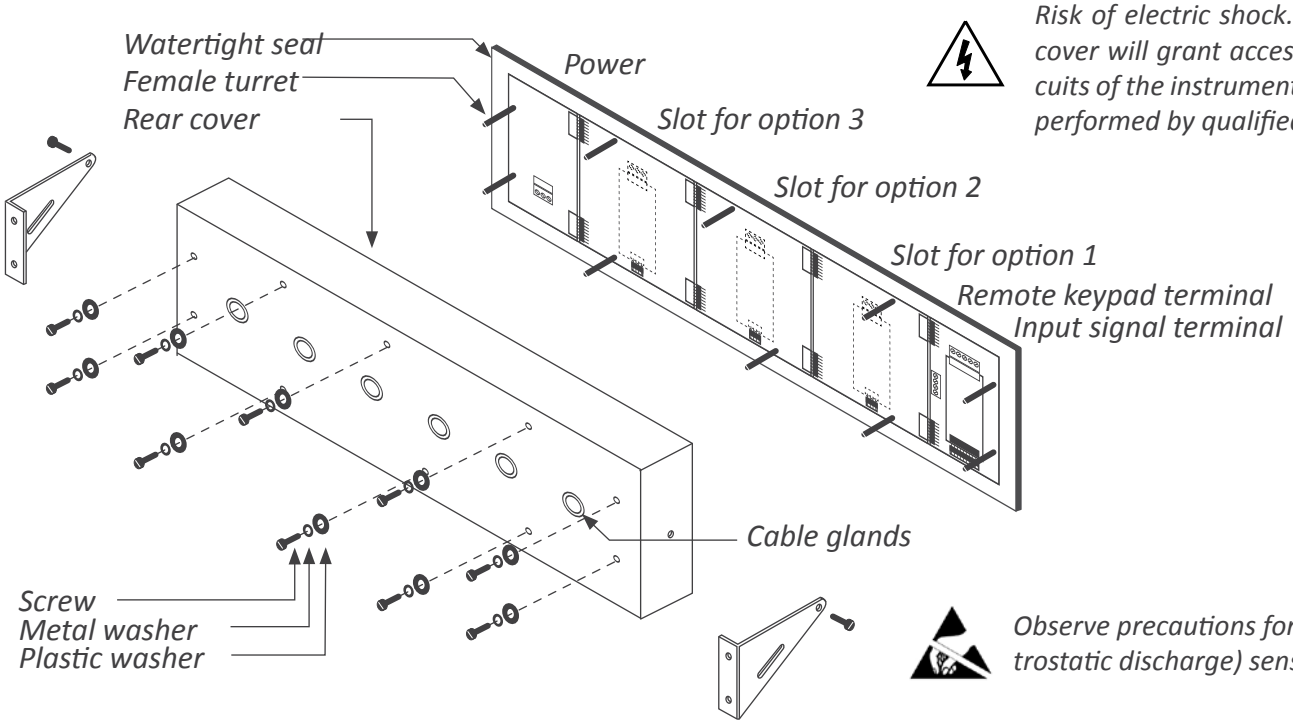
1.3 To access the instrument

To open the housing, remove the screws from the back cover. With each screw there is a metal washer and a plastic washer. Once the screws are out, remove the back cover.

The figure below shows the instrument internal structure for a B26 format. It shows the location of the 3 slots for optional output and control modules, the power terminal and the input signal terminal.

To close the instrument, place the back cover, the screws, the metal washer and the plastic washer. The plastic washer is in contact with the back cover. Confirm that the screws are correctly turning inside the internal female screws.

To ensure a correct IP65 protection tighten the back cover screws with a strength between 30 and 40 Ncm, with the help of a dynamometer screwdriver.

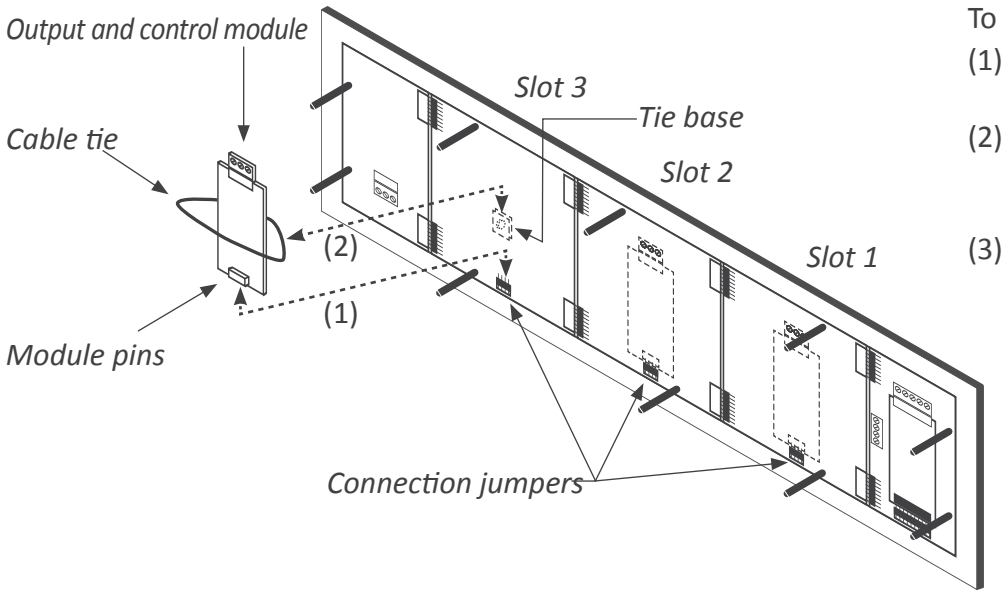


Risk of electric shock. Removing the back cover will grant access to the internal circuits of the instrument. Operation must be performed by qualified personnel only.

Observe precautions for handling ESD (electrostatic discharge) sensitive devices

1.4 Modular system

Large format meters from Series PCE-BPD are designed with an internal modular architecture. The output and control modules are independent and can be installed by accessing the internal circuits of the instrument, and connecting the module to the connection jumpers of the selected slot. Each module is provided with a cable tie to fix the module to the tie base. A cable gland to install at the back cover is also provided, in order to enable an output for the connection wires.

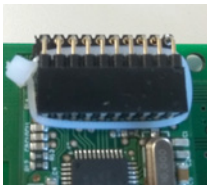


To install an output and control module

(1) insert the 'module pins' into the 'connection jumpers' in one of the free slots

(2) place the 'cable tie' into the 'tie base' and embrace the 'module' firmly, until it is fixed

(3) an additional white cable tie is provided to fix as indicated below. Only needed in case of vibrations or heavy transportation.



1. Options PCE-BPD/R, PCE-BPD/T and SSR

The PCE-BPD/R, PCE-BPD/T and PCE-BPD/SSR modules provide 1 digital 'on/off' output. The output is configured from the instrument alarms menu ('ALr.1', 'ALr.2' o 'ALr.3'). The menu allows to configure the setpoint, hysteresis, independent activation and deactivation delays, and a second setpoint to create windowed alarms.
The PCE-BPD/R, PCE-BPD/T and PCE-BPD/SSR output modules are isolated between them and between all other circuits of the instrument.

1.1 Module PCE-BPD/R

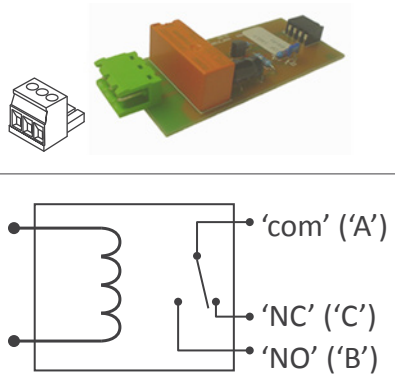
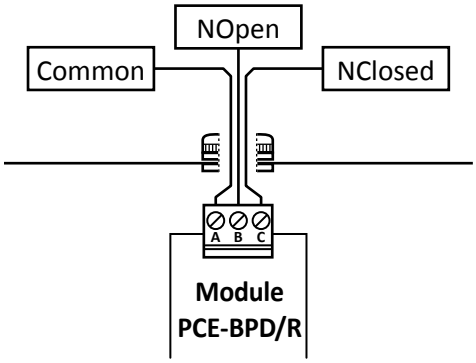


Figure 1 - Detail for the 'PCE-BPD/R' module and internal schematic

Option	PCE-BPD/R
Type of output	relay
Type of relay	3 contacts (Com, NO, NC)
Max. current	3 A (resistive load)
Voltage	250 Vac continuous
(max. 150 Vac if switching power network with Overvoltage category III)	
Isolation	3500 Veff
Type of terminal	plug-in screw clamp pitch 5.08 mm
Installation allowed at	slot 1, slot 2, slot 3



A	Common
B	NO (Normally Open)
C	NC (Normally Closed)

Figure 2 - Connections for the 'PCE-BPD/R' relay output module

1.2 Module PCE-BPD/T

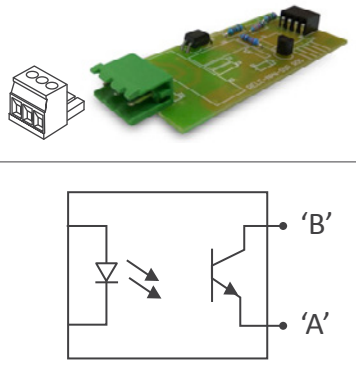
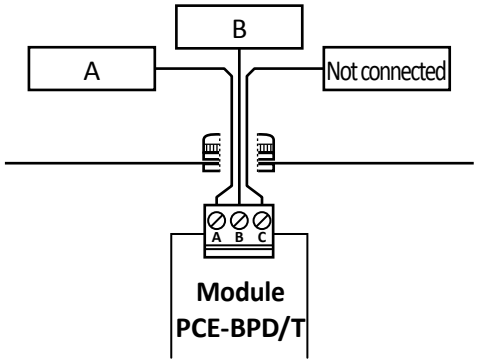


Figure 3 - Detail for the 'PCE-BPD/T' module and internal schematic

Option	PCE-BPD/T
Type of output	transistor
Max voltage	35 Vdc
Max. current	50 mA
Isolation	3500 Veff, optoisolated
Type of terminal	plug-in screw clamp pitch 5.08 mm
Installation allowed at	slot 1, slot 2, slot 3



A	Emitter
B	Collector
C	Not connected

Figure 4 - Connections for the 'PCE-BPD/T' transistor output module

1.3 Module PCE-BPD/SSR

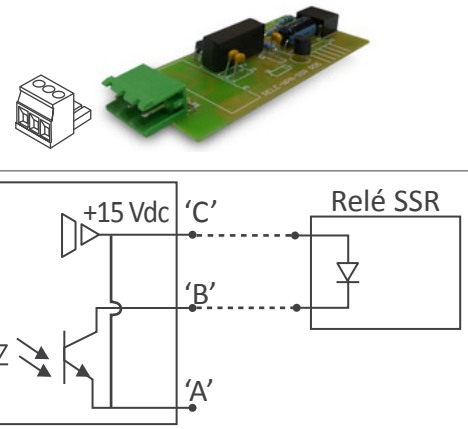
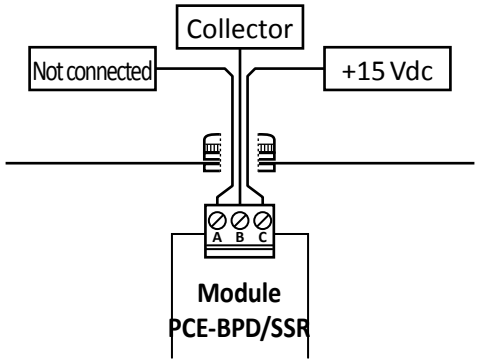


Figure 5 - Detail for the 'PCE-BPD/SSR' module and internal schematic

Option	**PCE-BPD/SSR**
Type of output	to control SSR relay
Output voltage	+15 Vdc
Max. current	45 mA
Isolation	1000 Vdc
Type of terminal	plug-in screw clamp pitch 5.08 mm

Installation allowed at slot 1, slot 2, slot 3



A	Not connected
B	Collector (-)
C	+15 Vdc (+)

Figure 6 - Connections for the PCE-BPD/SSR control output module

2. Option PCE-BPD/AV

The PCE-BPD/AV modules provide 1 analog output, configurable for 4/20 mA or 0/10 Vdc signal. The analog output is configured from the options menu entry ('Opt.1', 'Opt.2' or 'Opt.3') of the instrument.

Option	**PCE-BPD/AV**
Type of output	analog output
Signal output	4/20 mA active 4/20 mA passive 0/10 Vdc
Max. signal Min. signal	22 mA, 10.5 Vdc 0 mA, -50 mVdc
Scaling	proportional to the reading positive or negative slopes
Vexc (terminal A)	+13.8 Vdc ± 0.4 Vdc (max. 25 mA) protection against shortcircuit
Load impedances	≤350 Ohm (for 4/20 mA active) ≤800 Ohm (for 4/20 mA passive) *(for 24 Vdc external Vexc) (maximum voltage 27 Vdc between 'B' and 'C')* ≥10 KOhm (en 0/10 Vdc)
Accuracy (at 25 ºC)	<0.1 % FS
Thermal stability	60 ppm/ºC in mA 50 ppm/ºC in Vdc
Step response (0% to 99% of the signal)	<75 mSeconds + step response of the reading
Isolation	1000 Vdc
Warm up	15 minutes
Type of terminal	plug-in screw clamp pitch 5.08 mm
Factory configuration	'Mode mA' 'Scaling 0/9999 = 4/20 mA' 'On error 'to_h'
Installation allowed at	slot 1, slot 2, slot 3

The output signal is proportional to the reading, and it is scalable both in positive or negative slopes. The mA output can be configured for active loops (the instrument provides the power to the mA loop) or passive loops (the loop power is external to the instrument.

The PCE-BPD/AV analog output modules are isolated between them and between all other circuits of the instrument.

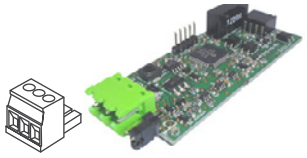
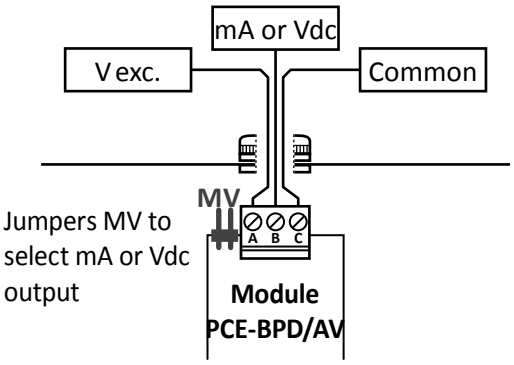


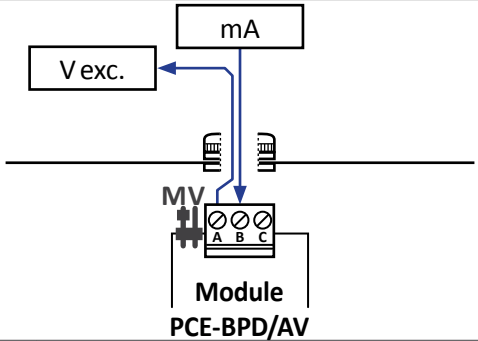
Figure 7 - Detail for the 'PCE-BPD/AV' module



A	Excitation voltage
B	Signal in mA or Vdc
C	Common
Jumper M	Jumper closed for mA output
Jumper V	Jumper closed for Vdc output

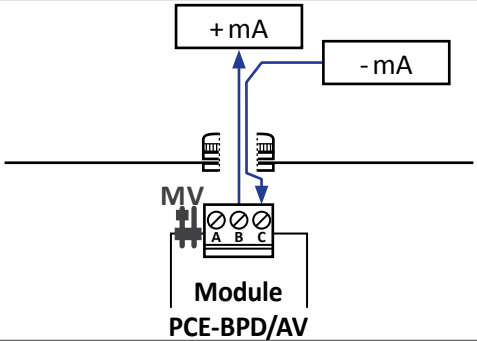
Figure 8 - Connections for 'PCE-BPD/AV' analog output module

2.1 Connection examples



Jumper M	Jumper closed
Jumper V	Jumper open

Figure 9 - Connections for active 4/20 mA. The current loop is internally powered from the 'PCE-BPD/AV' module



Jumper M	Jumper closed
Jumper V	Jumper open

Figure 10 - Connections for passive 4/20 mA. The current loop is externally powered.

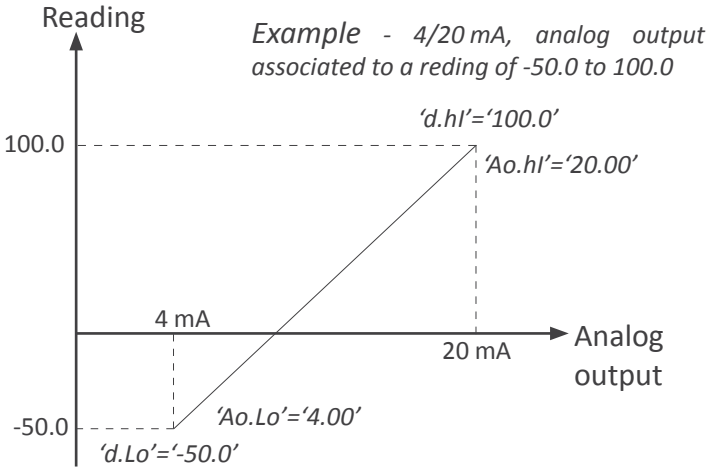
2.2 Configuration menu

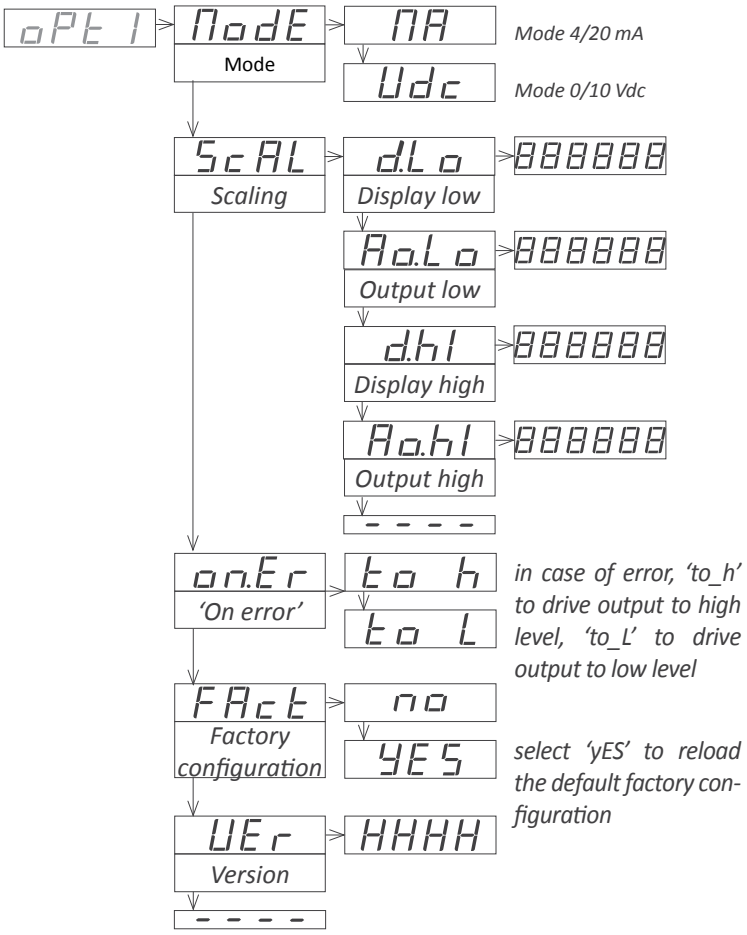
At the '**Mode**' ('**ModE**') menu configure the type of output '**4/20 mA**' ('**mA**') or '**0/10 Vdc**' ('**Vdc**'). Position for jumpers 'V' and 'M' must be according to the range selected.

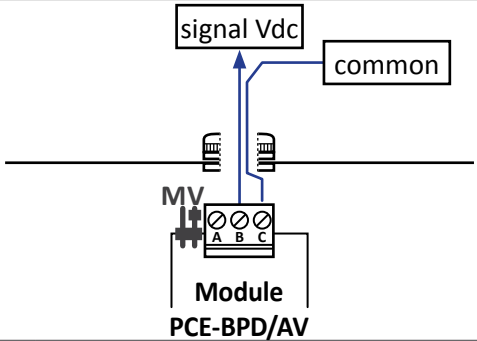
At the '**Scaling**' ('**ScAL**') menu enter the values that define the two points of the slope:

- the lower point, defined by the '**Low Display**' ('**d.Lo**') and '**Low Output**' ('**Ao.Lo**')
- the upper point, defined by the '**High Display**' ('**d.hI**') and '**High Output**' ('**Ao.hI**')

Analog output values are shown with 'XX.XX' format. acceptable values are '0.00' to '10.00' Vdc for voltage, and '0.00' to '20.00' mA for current.







Jumper M	Jumper open
Jumper V	Jumper closed

Figure 11 - Connections for 0/10 Vdc.

2.3 Error codes

'Er.34' output signal configured to value lower than 0 Vdc or 0 mA

'Er.35' output signal configured to a value higher than 10 Vdc or 20 mA

'Er.36' configured slope points are not acceptable, such as :

'd.Hi'='d.Lo'

'Ao.Hi'='Ao.Lo'

('Ao.Hi'-'Ao.Lo')>('d.Hi'-'d.Lo')

3. Option PCE-BPD/MB

The PCE-BPD/MB modules provide 1 port for communications in Modbus RTU protocol. Use function '4' ('*Read Input Registers*') of the Modbus RTU protocol, to access the instrument registers (reading value, alarm status, memory of maximum and minimum, setpoint values, ...).

The communication parameters are configured from the options menu entry ('Opt.1', 'Opt.2' or 'Opt.3') of the instrument.

The PCE-BPD/MB modules are isolated between them and between all other circuits of the instrument.

Option	**PCE-BPD/MB**
Type of output	Modbus RTU communication
Function implemented	4 (Read_Input_Registers)
Addresses	01 to 247
Exception codes	see section 3.3
Registers*	see section 3.1
**available registers can vary for different instruments*	
Bus	RS-485
Speed	57.6 Kbps to 600 bps
Data format	8e1 (standard), 8o1, 8n2
Bus terminator	not included
Isolation	1000 Vdc
Temperature	operation from 0 to 50 ºC storage from -20 to +70 ºC
Factory configuration	'Address 1' 'Speed 19.2 Kbps' 'Format 8e1' 'Decimal point Auto'
Installation allowed at	slot 1, slot 2, slot 3

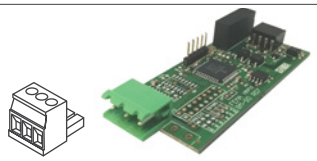
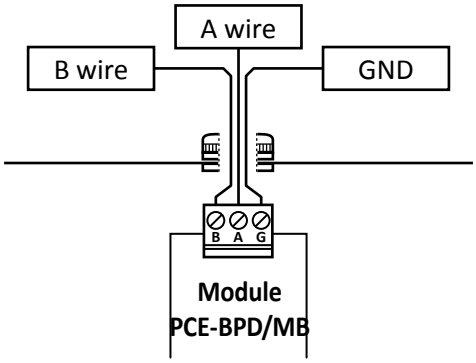


Figure 12 - Detail for the 'PCE-BPD/MB' module



A	Bus signal A
B	Bus signal B
G	GND

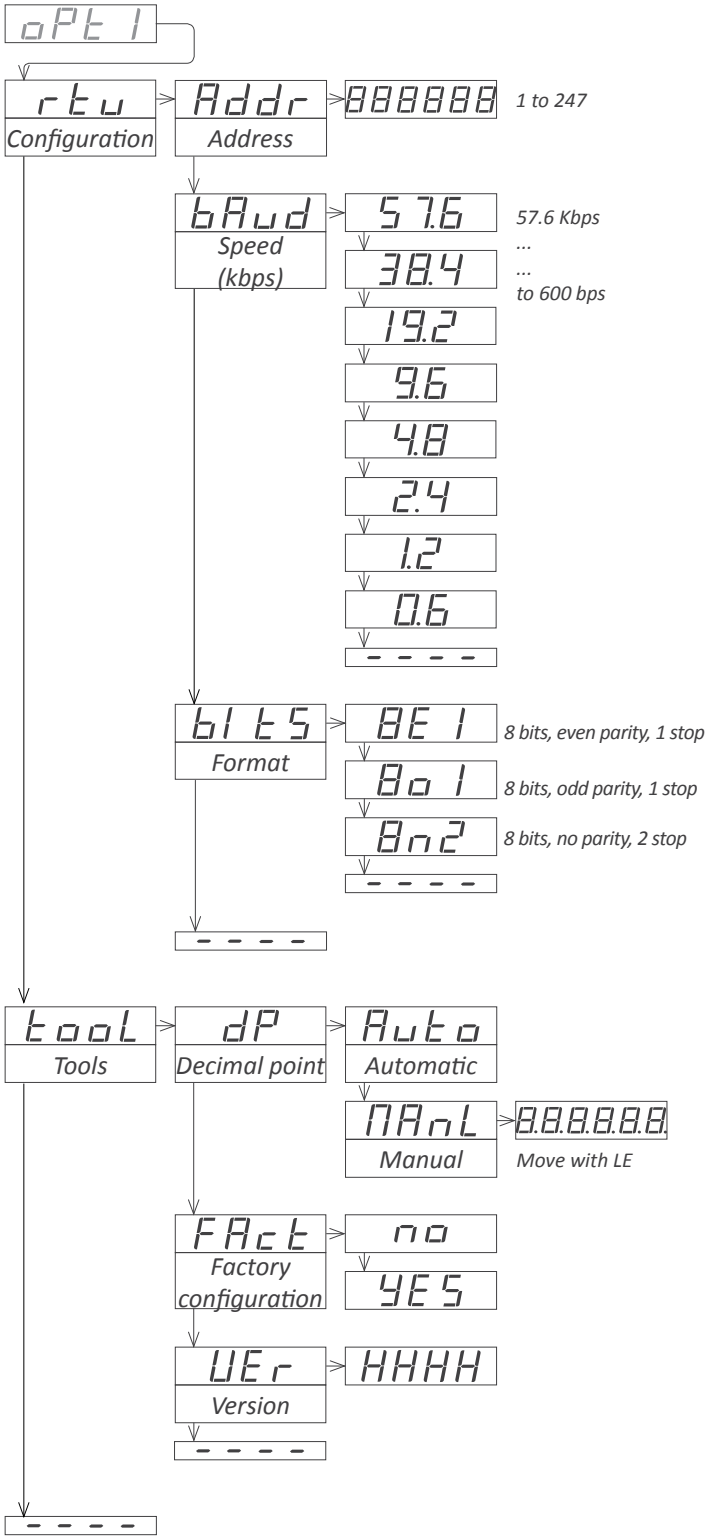
Figure 13 - Connections for 'PCE-BPD/MB' Modbus RTU module

3.1 Registers accessible through Modbus RTU

Register	*Name*	*Description*	*Size*	*Refresh*	*Valor (66 y 61)*	*Valor (46 y 41)*
0	*DISPLAY1_L*	*Display value*	*16 bits*	*same as display*	*999999 to -199999*	*9999 to -1999*
1	*DISPLAY1_H*		*16 bits*			
2	*DECIMALES1*	*Decimals on display*	*16 bits*		*0 to 6*	*0 to 4*
3	*MAXMEM_L*	*Memory of maximum*	*16 bits*	*every 30 seconds*	*999999 to -199999*	*9999 to -1999*
4	*MAXMEM_H*		*16 bits*			
5	*MINMEM_L*	*Memory of minimum*	*16 bits*		*999999 to -199999*	*9999 to -1999*
6	*MINMEM_H*		*16 bits*			
7	*SETPOINT1_L*	*Setpoint 1 value*	*16 bits*	*every 2 seconds*	*999999 to -199999*	*9999 to -1999*
8	*SETPOINT1_H*		*16 bits*			
9	*SETPOINT2_L*	*Setpoint 2 value*	*16 bits*		*999999 to -199999*	*9999 to -1999*
10	*SETPOINT2_H*		*16 bits*			
11	*SETPOINT3_L*	*Setpoint 3 value*	*16 bits*		*999999 to -199999*	*9999 to -1999**
12	*SETPOINT3_H*		*16 bits*			
13	*STATUS*	*Alarm status* *Instrument status*	*16 bits*	*same as display*	*bit 0...7 alarm status* *bit 8...16 instrument status*	
14 a 16	*Reserved*	*Reserved*	*16 x 3 bits*		*Not accessible*	*Not accessible*

Table 1 - Registers accessible through MODBUS-RTU. Registers codified as binary numbers. Negative values codified in two's complement. Available registers can vary for different instruments. Register 11 is not accessible for instruments with formats 46 and 41 (slot 3 is not available).

3.2 Configuration menu



At the '**Configuration**' ('**rtu**') menu, configure the '**Address**' ('**Addr**') parameter with the address value between '1' and '247', at the '**Speed**' ('**bAud**') parameter select the bus speed (in Kbps) and at the '**Format**' ('**bItS**') parameters select the data format.

Inside the '**Tools**' ('**TooL**') menu, special tools and functions are grouped.

- the '**Decimal point**' ('**dP**') menu is provided for compatibility with ancient hardware that does not support decimal point retransmission. By default, select '**Automatic**' ('**Auto**'). If your instrument does nos transmit the decimal point position, select '**Manual**' ('**MAnL**') and fix the position of the decimal point manually.
- at the '**Factory reset**' ('**FAct**') menu, select '**yes**' to load the default factory configuration for the instrument.

the '**Version**' ('**VEr**') menu informs of the current firmware version installed in the module.

3.3 Exception codes

The Modbus RTU protocol defines the following scenarios when a 'Master' is sending a frame to a 'Slave':

- the 'Slave' device receives the frame correctly and replies with the requested data
- the 'Slave' devices detects a CRC error, parity error, or other. and discards the frame without generating a reply frame. The 'Master' will detect a 'TIMEOUT' condition due to the absence of reply.
- the 'Slave' device receives the frame correctly, but replies with an 'EXCEPTION_CODE' as it can not process the function or register requested.

The 'EXCEPTION_CODES' configured in the PCE-BPD/MB mod-

Exception code	*Name*	*Description*
0	ILLEGAL_FUNCTION	*Requested function is not supported*
1	ILLEGAL_DATA_ADDRESS	*Requested register is not supported*

Table 2 - Exception codes

3.4 Compatible versions

Formats 66, 61	*Firmware version*	*Formats 46, 41*	*Firmware version*
---	---	*46-U, 41-U*	*41.57*
66-U, 61-U	*50.00*	---	---
66-P, 61-P	*27.08*	*46-P, 41-P*	*47.07*
66-C, 61-C	*28.02*	*46-C, 41-C*	*48.05*

Table 3 - Firmware versions compatible with the indicated registers

3.5 Description and example of registers

Registers R0 and R1 (DISPLAY1_L y DISPLAY1_H)

Contains the display value of the instrument, codified in two registers of 16 bits each. Possible values are from 999999 to -199999. Decimal point position is codified at register R2.

Example R0=FBF1 (hex) and R1=0009 (hex)

Register value = 0009 FBF1 (hex)

Reading value = 654321

Register R2 (DECIMALS1)

Contains the number of decimals of the display, codified in a single register of 16 bits. Possible values are from 0 to 6.

Example R2=0002 (hex)

Number of decimals = 2 = 6543.21

Register R3 and R4 (MAXMEM_L and MAXMEM_H)

Contains the memory of maximum reading of the instrument, codified in two registers of 16 bits each. Possible values are from 999999 to -199999. Decimal point position is codified on register R2.

Example - same example as in R0 and R1 but accessing to R3 and R4.

Registers R5 and R6 (MINMEM_L and MINMEM_H)

Contains the memory of minimum reading of the instrument, codified in two registers of 16 bits each. Possible values are from 999999 to -199999. Decimal point position is codified on register R2.

Example - same example as in R0 and R1 but accessing to R5 and R6.

Registers R7 and R8 (SETPOINT1_L and SETPOINT1_H)

Contains the setpoint value of alarm 1, codified in two registers of 16 bits each. Possible values are from 999999 to -199999. Decimal point position is codified on register R2.

Example - same example as in R0 and R1 but accessing to R7 and R8.

Registers R9 and R10 (SETPOINT2_L and SETPOINT2_H)

Contains the setpoint value of alarm 2, codified in two registers of 16 bits each. Possible values are from 999999 to -199999. Decimal point position is codified on register R2.

Example - same example as in R0 and R1 but accessing to R9 and R10.

Registers R11 and R12 (SETPOINT3_L and SETPOINT3_H)

Contains the setpoint value of alarm 3, codified in two registers of 16 bits each. Possible values are from 999999 to -199999. Decimal point position is codified on register R2.

Example - same example as in R0 and R1 but accessing to R11 and R12.

Register R13 (STATUS)

Information bit-by-bit, for the alarm status (on / off) and instrument status. See below for a description.

Bit 0 Alarm 1 status (0 = inactive, 1 = active)
Bit 1 Alarm 2 status (0 = inactive, 1 = active)
Bit 2 Alarm 3 status (0 = inactive, 1 = active)
Bit 3 to 7 Reserved
Bit 8 Display overrange
Bit 9 Display underrange
Bit 10 Lost communication with the main processor
Bit 11 to 15 Reserved

Registers R14, R15 and R16

Reserved

4. Option PCE-BPD/485

The PCE-BPD/485 modules provide 1 port for communications RS-485 ASCII protocol. Protocol with 'master' - 'slave' architecture, addressable up to 31 modules. Frames codified in representable ASCII characters (codes 32 to 255), which are visible using 'hyper-terminal' or similar programs. Instrument registers are accessible through the RS-485 ASCII port (reading value, alarm status, memory of maximum and minimum, setpoint values, ...). The communication parameters are configured from the options menu entry ('Opt.1', 'Opt.2' or 'Opt.3') of the instrument. The PCE-BPD/485 modules are isolated between them and between all other circuits of the instrument.

Option	**PCE-BPD/485**	
Type of output	RS-485 ASCII communication	
Bus	RS-485	
Speed	57.6 Kbps to 600 bps	
Data format	8n1 (standard), 8o1, 8n2, 8e1	
Bus terminator	not included	
Protocol	ASCII	
Architecture	'master - slave'	
Addresses	01 to 31	
'Broadcast' address	128	
Registers*	see section *4.1*	
**available registers can vary for different instruments*		
Isolation	1000 Vdc	
Temperature	operation from 0 to 50 ºC	
	storage from -20 to +70 ºC	
Factory configuration	'Mode	Slave'
	'Address	1'
	'Speed	19.2 Kbps'
	'Format	8n1'
	'Decimal point	Auto'
Configuration 'Master'	'Destination address	31'
	'Frequency	0.5 sec.'
Tools	'Decimal point	Auto'
	'Legacy	Off'
	'Answer delay	0 mSec.'
Installation allowed at	'Opt.1', 'Opt.2', 'Opt.3'	

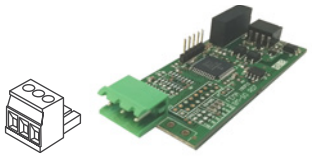
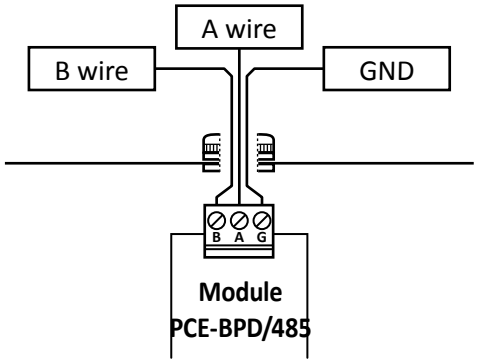


Figure 14 - Detail for the 'PCE-BPD/485' module



A	Bus signal A
B	Bus signal B
G	GND

Figure 15 - Connections for 'PCE-BPD/485' module

4.1 Accessible registers

Display values (DISPLAY1, MAXMEM, MINMEM, AL1, AL2, AL3) are codified with a minimum of 6 digits (left zeros are added if necessary), polarity and decimal point.

Register	*Name*	*Description*
0	*DISPLAY1*	*Display1 value*
1	*MAXMEM*	*Memory of maximum*
2	*MINMEM*	*Memory of minimum*
3	*AL1*	*Setpoint 1 value*
4	*AL2*	*Setpoint 2 value*
5	*AL3*	*Setpoint 3 value*
6	*STATUS*	*Alarm status*

Table 4 - Accessible registers for ASCII protocol.

Register 0 - DISPLAY1
Contains the display value of the instrument, in ASCII code, including polarity (positive / negative) and decimal point.
Example 1 - R0='+' '0' '6' '5' '4' '3' '.' '2' Display value = 6543.2
Example 2 - R0='-' '0' '0' '0' '4' '.' '5' '2' Display value = -4.52

Register 1 - MAXMEM
Contains the value for memory of maximum, in ASCII code, including polarity (positive / negative) and decimal point.

Register 2 - MINMEM
Contains the value for memory of minimum, in ASCII code, including polarity (positive / negative) and decimal point.

Register 3 - AL1
Contains the value for alarm 1 setpoint, in ASCII code, including polarity (positive / negative) and decimal point.

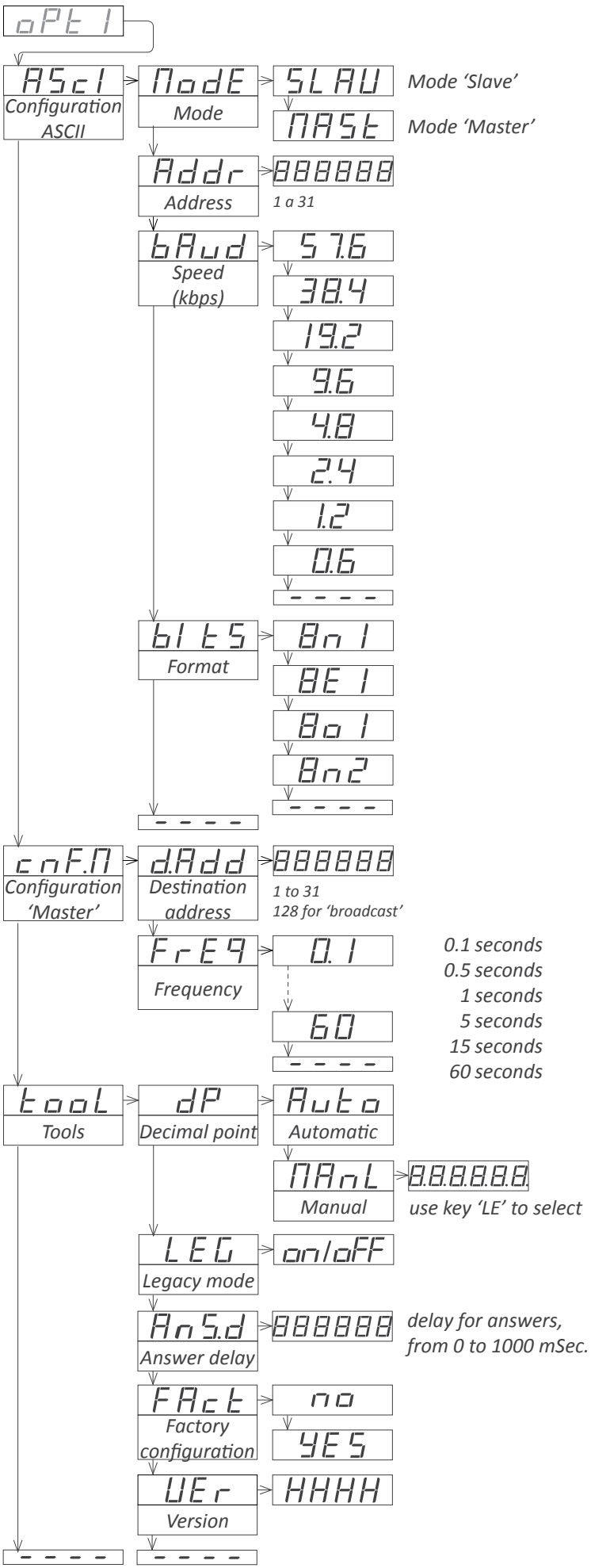
Register 4 - AL2
Contains the value for alarm 2 setpoint, in ASCII code, including polarity (positive / negative) and decimal point.

Register 5 - AL3
Contains the value for alarm 3 setpoint, in ASCII code, including polarity (positive / negative) and decimal point.

Register 6 - STATUS
Contains the alarm status (on/off).

Bit 0	Alarm 1 status (0 = inactive, 1 = active)
Bit 1	Alarm 2 status (0 = inactive, 1 = active)
Bit 2	Alarm 3 status (0 = inactive, 1 = active)
Bit 3 to 15	Reserved

4.2 Configuration menu



At the '**Configuration ASCII**' ('**AScI**') menu, configure the '**Mode**' ('**ModE**') parameter to select the 'slave' or the 'master' mode, at the '**Address**' ('**Addr**') parameter configure the local port address between '1' and '31', at the '**Speed**' ('**bAud**') parameter select the bus speed (in Kbps) and at the '**Format**' ('**bItS**') parameter select the data format.

When working as 'master', the instrument continuously transmits the display value data frame. The local module address is '0'. Configure at menu '**Configuration Master**' ('**cnF.M**') the '**Destination address**' ('**d.Add**') parameter from '1' to '31' or use value '128' for a broadcast message. At parameter '**Frequency**' ('**FrEq**') select the how often the frame with the reading value will be transmitted.

Special tools are grouped inside the '**Tools**' ('**TooL**') menu.

- the '**Decimal point**' ('**dP**') menu is provided for compatibility with ancient hardware that does not support decimal point retransmission. By default, select '**Automatic**' ('**Auto**'). If your instrument does nos transmit the decimal point position, select '**Manual**' ('**MAnL**') and fix the position of the decimal point manually.
- the '**Legacy mode**' ('**LEG**') parameter is provided to maintain compatibility with instruments with older communication protocols. Select '**on**' to activate this mode.
- the '**Answer delay**' ('**AnS.d**') parameter applies only to 'Slave' mode. The local module delays the answer frame. Configure for applications where the 'Master' needs additional time to switch between 'transmit' and 'receive' modes. Enter a numeric value between '0' and '1000' mSeconds.
- at the '**Factory reset**' ('**FAct**') menu, select '**yes**' to load the default factory configuration for the instrument.

the '**Version**' ('**VEr**') menu informs of the current firmware version installed in the module.

4.3 Compatible versions

Formats 66, 61	*Version firmware*	*Formats 46, 41*	*Version firmware*
Instruments with access to registers 0, 1, 2, 6			
		46-P, 41-U	*41.57*
66-P, 61-U	*50.00*	---	---
66-P, 61-P	*27.08*	*46-P, 41-P*	*47.07*
66-C, 61-C	*28.02*	*46-C, 41-C*	*48.05*

Table 5 - Firmware versions compatible with the indicated registers

4.4 Frame types

The ASCII protocol defines the following frames:

• Frame 'read' ('**RD**'). Id code 36. Request data frame. The requested register is indicated into the 'REG' byte ('Header' section).

• Frame 'answer' ('**ANS**'). Id code 37. Response frame to a request data frame. The requested register is indicated into the 'REG' byte' ('Header' section). Data of the requested register is indicated into data bytes 'D0' to 'Dn' ('Data' section).

• Frame 'error' ('**ERR**'). Id code 38. Response frame to a request data frame. Indicates that an error has occurred. Error code is codified into the 'REG' byte ('Header' section).

• Frame 'ping' ('**PING**'). Id code 32. Used to confirm the existence of the remote instrument.

• Frame 'pong' ('**PONG**'). Id code 33. Response to a 'ping' frame. It confirms the existence of the remote instrument.

4.5 Frame structure

Header								Data				Trail	
STX	ID	RSV	FROM	TO	REG	RSV	LONG	D0	D1	...	Dn	CRC	ETX
2	x	32	x	x	x	32	n+1	[data]				x	3
0	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*...*	*n+7*	*n+8*	*n+9*

Protocol frames have a structure made of 'Header', 'Data' and 'Trail'.

Section 'Header'

Contains the start byte ('STX'), the frame identifier ('ID'), the origin address ('FROM') and the destination address ('TO'), the register id ('REG') and the length ('LONG') of the 'Data' section.

Section 'Data'

Contains data for the requested register ('REG').

Section 'Trail'

Contains the 'CRC' code and the end of frame byte ('ETX').

'Real value' and 'Frame value'

To use representable ASCII values, the real values are codified before being sent into the frame. The following definitions apply :

- 'real value' is the value of the field without codification
- 'frame value' is the value of the field, codified

Field	*Description*	*Size*	*Position*	*Real value*	*Frame value*
STX	*Start of frame*	*1 byte*	*0*	*does not apply*	*2*
ID	*Frame type*	*1 byte*	*1*	*(see section 4.4)*	*real_value*
RSV	*Reserved*	*1 byte*	*2*	*0*	*32*
FROM	*Origin address*	*1 byte*	*3*	*0 ('Master') / 1 to 31 ('Slave')*	*32 + real_value*
TO	*Destination address*	*1 byte*	*4*	*0 ('Master') / 1 to 31 ('Slave')* *128 ('broadcast')*	*32 + real_value*
REG	*Register identification*	*1 byte*	*5*	*(see section 4.1)*	*32 + real_value*
RSV	*Reserved*	*1 byte*	*6*	*0*	*32*
LONG	*Length of 'Data' section*	*1 byte*	*7*	*n (between 0 and 32)*	*32 + real_value*
D0 ... Dn	*Data*	*n bytes*	*8 to n+7*	*number 0 to 9* *decimal point* *polarity (+/-)*	*ASCII code of the number (48 to 57)* *ASCII code of decimal point (46)* *ASCII code of '+' (43)* *ASCII code of '-' (45)*
CRC	*CRC calculation*	*1 byte*	*n+8*	*does not apply*	*(see section 4.7)*
ETX	*End of frame*	*1 byte*	*n+9*	*does not apply*	*3*

Table 6 - Description of the bytes for the ASCII frame

4.6 Error codes

Frames 'ERR' contain within the 'REG' field, the error code. Available error codes are :

error 1	unknown register
error 2	display overrange
error 3	display underrange
error 4	CRC error
error 5	internal error

4.8 Frame examples

4.8.1 Frames ‘RD’ (36) and ‘ANS’ (37)

Example - ‘Master’ (address ‘0’) requests the value of register ‘0’ (display value) to the ‘Slave’ at address ‘28’ (‘RD’ frame) and the ‘Slave’ replies to the ‘Master’ with a reply frame (‘ANS’ frame) containing the requested data (765.43).

**Instruments with 4 digits also send reading values formatted with 6 digits : value -321.5 is transmitted as -00321.5*

Header								Trail	
STX	ID	RSV	FROM	TO	REG	RSV	LONG	CRC	ETX
2	36	32	32	60	32	32	32	58	3
Start	RD	---	0	28	0	---	0	CRC	Stop

Header								Data								Trail	
STX	ID	RSV	FROM	TO	REG	RSV	LONG	D0	D1	D2	D3	D4	D5	D6	D7	CRC	ETX
2	37	32	60	32	32	32	40	43	48	55	54	53	46	52	51	15	3
Start	ANS	---	28	0	0	---	8	+0765.43								CRC	Stop

4.8.2 Frames ‘ERR’ (38)

Example - ‘Slave’ at address ‘11’ replies to the ‘Master’ (address ‘0’) with an error frame (‘ERR’ frame) indicating that the requested register number is unknown (‘UNKNOWN_REGISTER’, error code ‘1’). The error code is codified into the ‘REG’ byte. For a list of error code see section 4.6.

Header								Trail	
STX	ID	RSV	FROM	TO	REG	RSV	LONG	CRC	ETX
2	38	32	43	32	33	32	32	46	3
Start	ERR	---	11	0	1	---	0	CRC	Stop

4.7.1 Frames ‘PING’ (32) and ‘PONG’ (33)

Example - ‘Master’ (address ‘0’) requests confirmation of existence to the ‘Slave’ at addrress ‘22’ (‘PING’ frame) and the ‘Slave’ replies to the ‘Master’ with a ‘PONG’ frame.

Header								Trail	
STX	ID	RSV	FROM	TO	REG	RSV	LONG	CRC	ETX
2	32	32	32	54	32	32	32	52	3
Start	Ping	---	0	22	0	---	0	CRC	Stop

Header								Trail	
STX	ID	RSV	FROM	TO	REG	RSV	LONG	CRC	ETX
2	33	32	54	32	32	32	32	53	3
Start	Pong	---	22	0	0	---	0	CRC	Stop

4.7 CRC calculation

The ‘frame value’ for the CRC byte is calculated applying a XOR function to the ‘frame value’ *(see section 4.5)* of all bytes in sections ‘Header’ and ‘Data’, from byte ‘0’ (‘STX’) to the last data byte (‘Dn’).

- if the calculated CRC value is lower than ‘32’, it is normalized by applying the ‘one’s complement’ function .

CRC0=STX ^ ID ^ RSV ^ FROM ^ TO ^ REG ^ RSV ^ LONG ^ D0 ^...^ Dn

- if (CRC0<32) -> CRC=!CRC0 (one’s complement function)
- if (CRC0>31) -> CRC=CRC0

```
//example of CRC calculation in C language
int8 Calculate_CRC(int8 CRC_Position)
{
 int8 i,CRC=0;
  for(i=0;c<CRC_Position;c++)
  {
     crc=crc ^ frame[i];
  }
 if(crc<32) CRC=~CRC;
 return(CRC);
}
```

5. Option PCE-BPD/232

The PCE-BPD/232 modules provide 1 port for communications RS-232 ASCII protocol. The PCE-BPD/232 modules use the same protocol as the PCE-BPD/485 modules *(see section 4)*, the only difference is the physical layer of the bus, that is RS-232 for the PCE-BPD/232.

PCE-BPD/232 modules allow for point-to-point communication over RS-232 and also allow for multinode communication over RS-232 using a 'Daisy-Chain' type of connection.

Terminals RX1 and TX1 are for the main communication with the RS-232 bus. Terminals RX2 and TX2 are for the multinode connection, so all frames received at RX1 with destination address different from the local address, will be retransmitted through TX2. On the same way, frames received at RX2 with destination address different from the local address, will be retransmitted through TX1.

Option	**PCE-BPD/232**
Type of output	RS-232 ASCII communication
Bus	RS-232
Speed	57.6 Kbps a 600 bps
Data format	8n1 (standard), 8o1, 8n2, 8e1
Protocol	ASCII
Architecture	'master - slave'
Address	01 to 31
'Broadcast' address	128
Registers*	see section for PCE-BPD/485 module
**available registers can vary for different instruments*	
Isolation	1000 Vdc
Temperature	operation from 0 to 50 ºC storage from -20 to +70 ºC
Installation allowed at	'Opt.1', 'Opt.2', 'Opt.3'

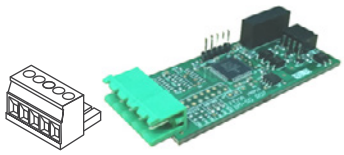
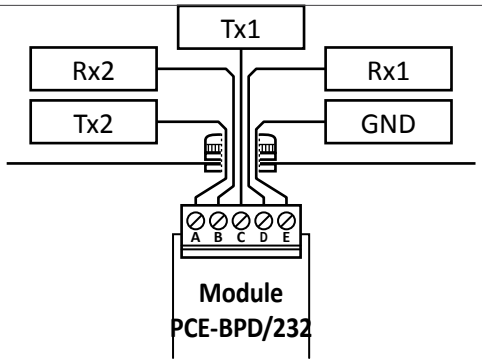


Figure 16 - Detail for the 'PCE-BPD/232' module



A	GND
B	Rx data reception
C	Tx data transmission
D	'Daisy chain' Rx data reception
E	'Daisy chain' Tx data transmission

Figure 17 - Connections for 'PCE-BPD/232' module

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