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User Manual EE600

Differential Pressure Sensor

Modbus

ASHRAE BACnet®

www.epluse.com

Content

1 General Information

This user manual serves for ensuring proper handling and optimal functioning of the device. The user manual shall be read before commissioning the equipment and it shall be provided to all staff involved in transport, installation, operation, maintenance and repair. E+E Elektronik Ges.m.b.H. does not accept warranty and liability claims neither upon this publication nor in case of improper treatment of the described products.

All information, technical data and diagrams included in this document are based on the information available at the time of writing. It may contain technical inaccuracies and typographical errors. The contents will be revised on a regular basis and changes will be implemented in subsequent versions. The described product(s) and the contents of this document may be changed or improved at any time without prior notice.

PLEASE NOTE

Find this document and further product information on our website at www.epluse.com/ee600.

1.1 Explanation of Warning Notices and Symbols

Safety precautions

Precautionary statements warn of hazards in handling the device and provide information on their prevention. The safety instruction labeling is classified by hazard severity and is divided into the following groups:

DANGER

Danger indicates hazards for persons. If the safety instruction marked in this way is not followed, the hazard will verly likely result in severe injury or death.

WARNING

Warning indicates hazards for persons. If the safety instruction marked in this way is not followed, there is a risk of injury or death.

CAUTION

Caution indicates hazards for persons. If the safety instruction marked in this way is not followed, minor or moderate injuries may occur.

NOTICE

Notice signals danger to objects or data. If the notice is not observed, damage to property or data may occur.

Informational notes

Informational notes provide important information which stands out due to its relevance.

INFO

The information symbol indicates tips on handling the device or provides additional information on it. The information is useful for reaching optimal performance of the device.

The title field can deviate from “INFO” depending on the context. For instance, it may also read “PLEASE NOTE”.

1.2 Safety Instructions

1.2.1. General Safety Instructions

NOTICE

Improper handling of the device may result in its damage.

- Avoid any unnecessary mechanical stress and inappropriate use.
- Use the EE600 only as intended and observe all technical specifications.
- Installation, electrical connection, maintenance and commissioning shall be performed by qualified personnel only.
- Do not blow into the pressure connections.
- The device may be permanently damaged if a pressure is connected to the EE600 which is outside the measuring range according to the product specification.
- Do not apply the supply voltage to the output terminals.

1.2.2. Intended Use

The EE600 is dedicated for the highly accurate measurement of differential pressure. The multi-range device is suitable for air as well as all non-flammable and non-aggressive gases. The sensor can be used between -20 °C and +60 °C (-4 °F and +140 °F) and max. 95 %RH (non-condensing).

Please observe the mounting and installation instructions in chapter 4 Mounting and Installation. Check the measuring range for the appropriate use and be aware of the maximum overload limit.

⚠ WARNING

Non-compliance with the product documentation may cause safety risks for people and the entire measurement installation.

The manufacturer cannot be held responsible for damages as a result of incorrect handling, installation and maintenance of the device.

- Do not use EE600 in explosive atmosphere or for measurement in aggressive gases.
- This device is not appropriate for safety, emergency stop or other critical applications where device malfunction or failure could cause injury to human beings.
- The device may not be manipulated with tools other than specifically described in this manual.

NOTICE

Failing to follow the instructions in this user manual may lead to measurement inaccuracy and device failures.

- The EE600 may only be operated under the conditions described in this user manual and within the specification included in chapter 7 Technical Data.
- Unauthorized product modification leads to loss of all warranty claims. Modification may be accomplished only with an explicit permission of E+E Elektronik Ges.m.b.H.!

1.2.3. Mounting, Start-up and Operation

The EE600 has been produced under state of the art manufacturing conditions, has been thoroughly tested and has left the factory after fulfilling all safety criteria. The manufacturer has taken all precautions to ensure safe operation of the device. The user must ensure that the device is set up and installed in a way that does not impair its safe use. The user is responsible for observing all applicable local and international safety guidelines for safe installation and operation of the device. This user manual contains information and warnings that must be observed by the user in order to ensure safe operation.

PLEASE NOTE

The manufacturer or his authorized agent can only be held liable in case of willful or gross negligence. In any case, the scope of liability is limited to the corresponding amount of the order issued to the manufacturer. The manufacturer assumes no liability for damages incurred due to failure to comply with the applicable regulations, operating instructions or the specified operating conditions. Consequential damage is excluded from liability.

WARNING

Non-compliance with the product documentation may cause accidents, personal injury or property damage.

- Mounting, installation, commissioning, start-up, operation and maintenance of the device may be performed by qualified staff only. Such staff must be authorized by the operator of the facility to carry out the mentioned activities.
- The qualified staff must have read and understood this user manual and must follow the instructions contained within. The manufacturer accepts no responsibility for non-compliance with instructions, recommendations and warnings.
- All process and electrical connections shall be thoroughly checked by authorized staff before putting the device into operation.
- Do not install or start-up a device supposed to be faulty. Make sure that such devices are not used accidentally by marking them clearly as faulty.
- A faulty device shall be removed from the process.
- Service operations other than described in this user manual may only be performed by the manufacturer.

1.3 Environmental Aspects

PLEASE NOTE

Products from E+E Elektronik Ges.m.b.H. are developed and manufactured in compliance with all relevant environmental protection requirements. Please observe local regulations for the disposal of the device.

For disposal, the individual components of the device must be separated according to local recycling regulations. The electronics shall be disposed of correctly as electronics waste.

2 Scope of Supply

- EE600 Differential Pressure Sensor according to the ordering guide
- Quick Guide
- Test report according to DIN EN 10204-2.2
- Pressure connection set, including 2 m (6.6 ft) PVC hose with two ABS pressure connection nipples
- Mounting material
- For the digital version (ordering code J3): M16x1.5 cable gland for daisy chain wiring

3 Product Description

3.1 General

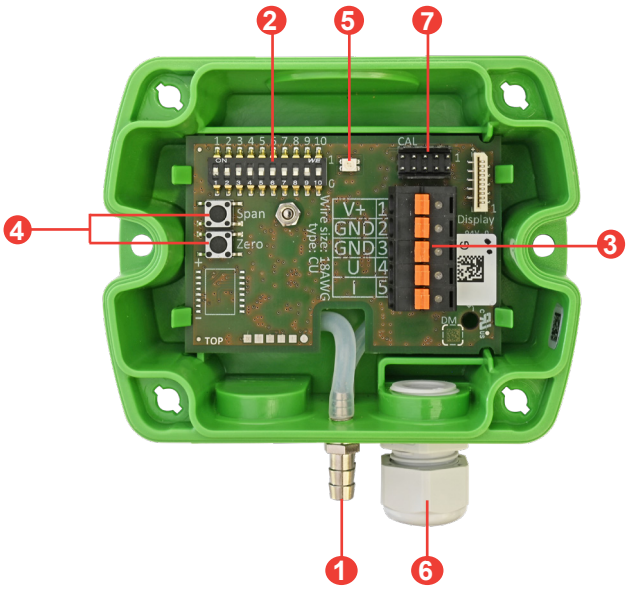
The measurement performance of the EE600 sensor covers the measuring ranges 1 000 Pa (4 inch WC) and 10 000 Pa (40 inch WC) and offers an accuracy of ±0.5 % of the measuring range. The pressure sensing element is piezoresistive and non-flow-through, and makes the sensor a long-term stable device.

The measured data is available on the analogue voltage and current output or on the RS485 interface with Modbus RTU or BACnet MS/TP protocol.

The setup can be performed with DIP switches on the electronics board (EE600 with analogue output) or with an optional adapter and the free PCS10 Product Configuration Software. The setup includes measuring range, output signal, response time, displayed units and backlight. The auto-zero interval can be set with the PCS10. The EE600 can be set up for volume flow or air velocity measurement, as well as for filter monitoring or level indication. A zero point and span adjustment can be performed with push buttons on the electronics board.

3.1.1. Analogue Version

Output (A7)

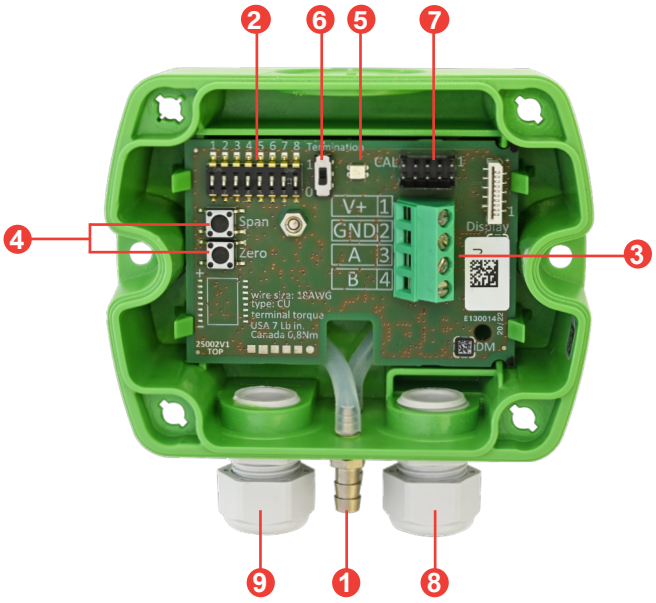


No.	Function
1	Pressure connection nipples
2	DIP switches for configuration (Measuring ranges, response time, ...)
3	Spring-loaded terminals
4	Push buttons for zero point and span point adjustment
5	Status LED
6	Cable gland for wiring
7	Service interface connector

Tab. 1 Design and components of the EE600 analogue sensor

3.1.2. Digital Version

Output (J3)

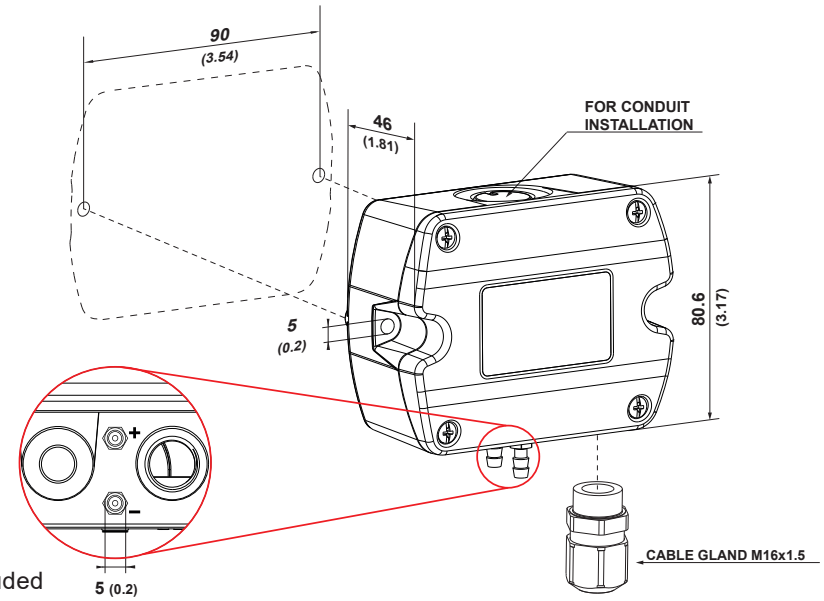


No.	Function
1	Pressure connection nipples
2	DIP switches for RS485 addressing
3	Screw terminals
4	Push buttons for zero point and span point adjustment
5	Status LED
6	Slide switch termination resistor
7	Service interface connector
8	Cable gland for wiring
9	Additional cable gland for daisy chain wiring

Tab. 2 Design and components of the EE600 digital sensor

3.2 Dimensions

Values in mm (inch)



Pressure fittings Ø5 (0.2)

\+ high pressure

\- low pressure

Pressure connection set is included in the scope of supply.

3.3 Electrical Connection

The EE600 features screw terminals for connecting the power supply and the outputs. The cables are fed into the enclosure through the M16 cable gland.

⚠ WARNING

Incorrect installation, wiring or power supply may cause overheating and therefore personal injuries or damage to property.

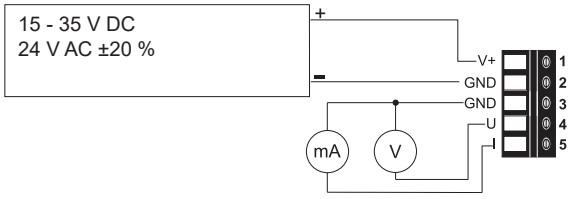
For correct cabling of the device, always observe the presented wiring diagram for the product version used.

The manufacturer cannot be held responsible for personal injuries or damage to property as a result of incorrect handling, installation, wiring, power supply and maintenance of the device.

NOTICE

It is important to make sure that the cable glands are closed tightly for the power supply and outputs cable. This is necessary for assuring the IP rating of the enclosure according to the EE600 specification, as well as for stress relief at the screw terminals on the EE600 board.

Analogue Version (A7)



Digital Version (J3)

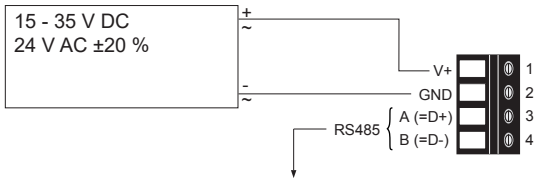


Fig. 1 Connection Diagram

3.4 User Interface

3.4.1. LED Indication

Green LED	Description
Flashing (1 s interval)	The EE600 operates normally, the measured data is within the selected measuring range
One flash (2 s)	Confirms adjustment or return to factory settings
Off	No power supply or electronics failure
Fast flashing (0.2 s interval)	Auto-zero is executed, first time 10 s after start / reset.

Red LED	Description
Flashing (1 s interval)	The measured data is out of the selected range (overload or reversed pressure connection)
One flash (2 s)	Indicates the failure of the attempt to adjust zero point or span point, or to return to factory adjustment

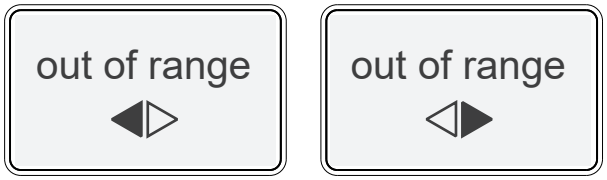
3.4.2. Display

The optional display shows the measured value(s) together with a linear gauge or in two lines and has a configurable backlight. It is also indicated when the measured value is out of range.

In the factory setting, the display shows the measured differential pressure in Pascal [Pa]. Refer to chapter 5.3 Display Settings and Output Signals for changing the display settings.

Fig. 2 Examples for display indications

In case of differential pressure out of the measuring range or negative pressure due to inverse pressure connection the display indicates:



Δp < scale value low, -5 % of span

Δp > scale value high, +5 % of span

Fig. 3 Out of range indications

4 Mounting and Installation

4.1 General

For mounting, the cable gland (in the scope of supply) onto the EE600 enclosure use a matching wrench.

When using the EE600 with conduit connection use a flat screwdriver to knock open the blind at the top of the enclosure, carefully. Take care to avoid damaging the electronics inside the enclosure. The conduit adapter is not included in the scope of supply. The M16x1.5 opening for the cable gland shall be tightly closed using the blind plug included in the scope of supply (refer to chapter 3.2 Dimensions).

For best measurement results, please note the following:

- Mount the EE600 onto a vertical, smooth surface.
- The pressure connection nipples must point downwards.
- Avoid installation close to heaters and sources of strong electromagnetic interference.
- Insert the cable for supply voltage and output signal through the cable gland and connect it to the spring-loaded or srew terminals according to the wiring diagram (Fig. 1 Connection Diagram).
- Make sure that the connecting cable or wires do not impact with the push buttons in order to prevent unintentional trigger of the span or zero point adjustment.
- Close tightly the cable gland. This is essential for the compliance with the IP65 / NEMA 4X protection rating of the EE600 enclosure.

4.2 Sensor Positioning and Pressure Connection

To ensure a valid measurement, the sensor and the hose position must be selected correctly.

1. Mount the sensor on the correct place. Pay attention to the alignment, (refer to Fig. 4 Mounting orientation).

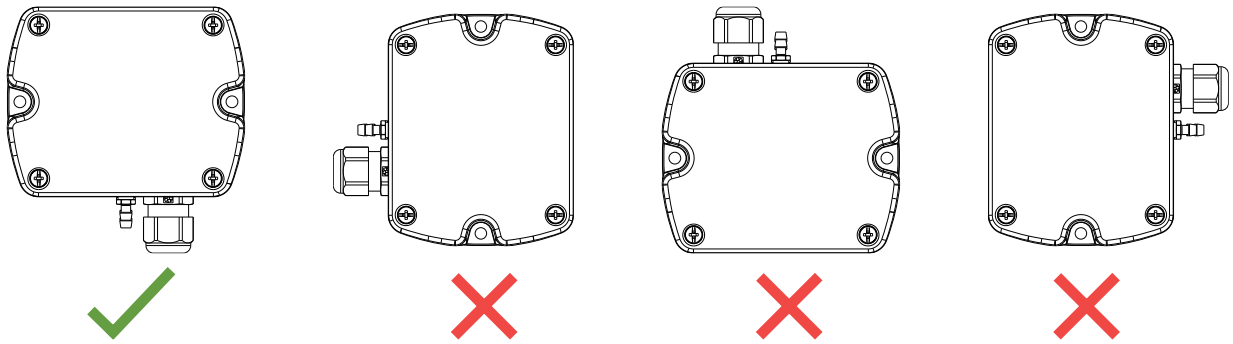


Fig. 4 Mounting orientation

2. To connect the hoses at a duct use the pressure connection nipples (included in the scope of supply). Use a Ø7.5 mm (0.30") drill for the holes regarding the dimensions in Fig. 5.

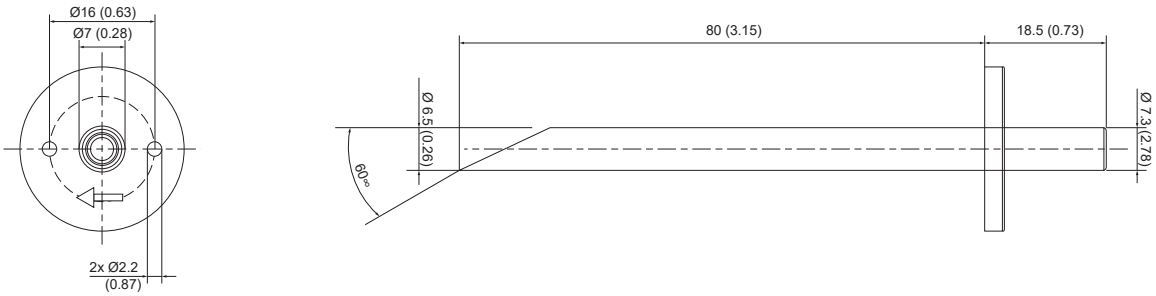


Fig. 5 Dimension of pressure connection nipples

3. Connect the pressure hose (included in the scope of supply) first to the EE600 and then to the duct. Route the pressure hose for avoiding sharp bends which might lead to the hose obstruction (Fig. 6 and Fig. 7).

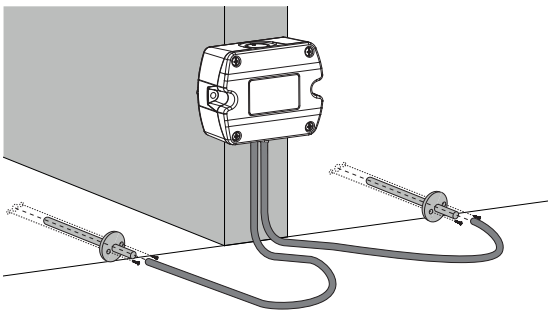


Fig. 6 Pressure connection

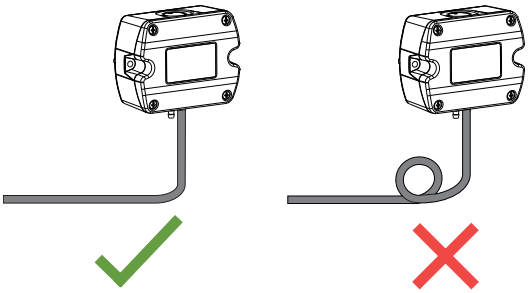


Fig. 7 Pressure hose route

Depending on the application, the following connections are possible:

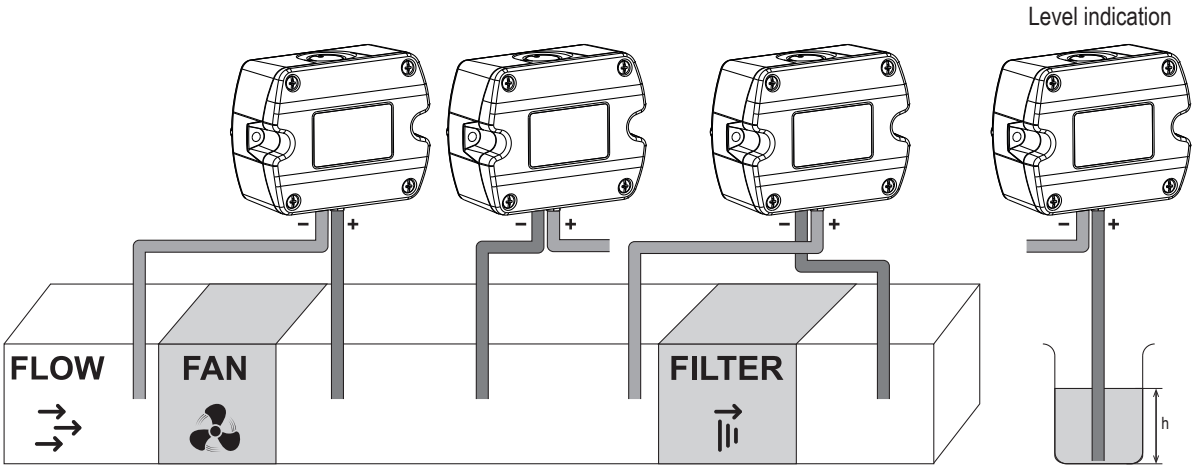


Fig. 8 Mounting examples

PLEASE NOTE

Make sure to connect the higher pressure at the “+” pressure connector and the lower pressure at the “-“ pressure connector. Inverted connection leads to “out of range” information on the optional display and at the analogue outputs, refer to chapter 5.1.7 Outputs and 3.4.2 Display.

5 Setup and Configuration

The EE600 is ready to use and does not require any configuration by the user. The factory setup of the EE600 corresponds to the product order code. Please refer to the datasheet at www.epluse.com/ee600. If needed, the user can change the factory setup with the on-board DIP switches (analogue versions) or the PCS10 Product Configuration Software and the USB configuration adapter (HA011066), please refer to the chapters below.

5.1 Analogue Version

Each EE600 sensor is delivered with the following factory settings (all switches on “0”):

Factory settings	
Measurement range	100 % of the full scale (1 000 Pa or 10 000 Pa)
Response time	50 ms
Displayed unit	Pa
Display backlight	On
Output signals	0 - 10 V and 4 - 20 mA
Source of settings	DIP switch settings (if available)

The analogue version is intended to be configured with the on-board DIP switches. All changes to the factory setup can also be done using the PCS10.

PLEASE NOTE

EE600 sensor versions with 8 DIP switches are not supported by the PCS10 Product Configuration Software.

Settings that can be changed via PCS10:

- Application settings (refer to chapter 5.4.1. Application Settings)
- Display visualisation (refer to chapter 5.3.2 Analogue Version with PCS10 Settings or Digital Version)
- Measurands and their measuring range
- Auto-zero on/off and interval (refer to chapter 6.3.4 Auto-zero (Optional))
- Response time

INFO

The EE600 is fully configurable. Before commissioning, set the individual configuration of the EE600 according to the application requirements using the DIP switches S1 to S9 as described below. The function of the DIP switches is also indicated inside the EE600 front cover.

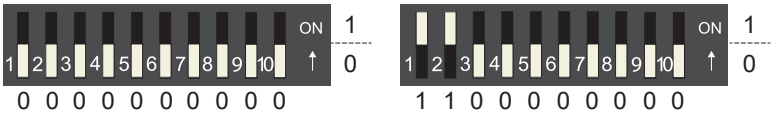


Fig. 9 DIP switch examples

PLEASE NOTE

If settings were changed via PCS10 and DIP switch settings shall apply again, be sure to restore the factory settings before applying the DIP switches.

- Outputs scale: 0...1 000/10 000 Pa
- Analogue bar limits: -10...1 000/10 000 Pa
- Number of lines: 1
- Unit: Pa

5.1.1. Select the Measuring Range with S1 and S2

EE600-HV52A7

S1	S2	Pa	mbar	inch WC	kPa
0	**0**	1 000	10	4	1
1	**0**	750	7.5	3	0.75
0	**1**	500	5	2	0.5
1	**1**	250	2.5	1	0.25

EE600-HV53A7

S1	S2	Pa	mbar	inch WC	kPa
0	**0**	10 000	100	40	10
1	**0**	7 500	75	30	7.5
0	**1**	5 000	50	20	5
1	**1**	2 500	25	10	2.5

Tab. 3 DIP switch settings - Measuring range

5.1.2. Select the Response Time with S3 and S4

S3	S4	Response Time
0	**0**	50 ms
1	**0**	500 ms
0	**1**	2 s
1	**1**	4 s

Tab. 4 DIP switch settings - Response time

5.1.3. Select the Displayed Unit with S5 and S6

S5	S6	Displayed unit
0	**0**	Pa
1	**0**	mbar
0	**1**	inch WC
1	**1**	kPa

Tab. 5 DIP switch settings - Displayed unit

5.1.4. Select the Display Backlight with S7

S7	Backlight
0	on
1	off

Tab. 6 DIP switch settings - Backlight

5.1.5. Select the Output Signal with S8

S8	Output signal
0	0 - 10 V and 4 - 20 mA
1	0 - 5 V and 0 - 20 mA

Tab. 7 DIP switch settings - Output signals

5.1.6. Select the Source of Settings with S9

(Versions with 10 DIP-Switches on the Electronics Board)

S9	Source of settings
0	DIP switches
1	PCS10

Tab. 8 Source for the settings

PLEASE NOTE

No functions are assigned to the DIP-switch S10.

5.1.7. Outputs

The measured data is available at the spring terminals as 0 - 10 V and 4 - 20 mA or as 0 - 5 V and 0 - 20 mA signals (refer to chapter 5.1.5. Select the Output Signal with S8). The EE600 provides simultaneously a voltage and a current output signal at the spring terminals.

Additionally, the analogue outputs indicate measurement out of range as follows.

Indication of $\Delta p < -5$ % of the measuring range and of the negative difference pressure due to inverted pressure connection.

Output signal	Indication of negative differential pressure
0 - 10 V	-0.5 V
0 - 5 V	-0.25 V
4 - 20 mA	3.2 mA
0 - 20 mA	-1 mA

Tab. 9 Indication of $\Delta p <$ scale value low, -5 % of span

Indication of $\Delta p >$ 105 % of the measuring range

Output signal	Indication of overload
0 - 10 V	10.5 V
0 - 5 V	5.25 V
4 - 20 mA	20.8 mA
0 - 20 mA	21 mA

Tab. 10 Indication of $\Delta p >$ scale value high, +5 % of span

PLEASE NOTE

An overload value can be set via the PCS10.

5.2 Digital Version

The RS485 digital interface version is intended to be configured with PCS10 Product Configuration Software and the USB configuration adapter (code HA011066). The device address can be overruled by setting the DIP switches. The factory setup of the EE600 corresponds to the specified order code.

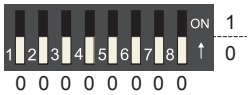
Settings that can be changed with the PCS10

- Digital communication parameters
- Application settings (refer to chapter 5.4.1. Application Settings)
- Display visualisation (refer to chapter 5.3.2 Analogue Version with PCS10 Settings or Digital Version)
- Auto-zero on/off and interval (refer to chapter 6.3.4. Auto-zero (Optional))
- Response time

Hardware Bus Termination

For bus termination the EE600 features an internal 120 Ω resistor which can be activated using the slide switch on the electronics board (refer to Tab. 2 Design and components of the EE600 digital sensor).

Address setting via PCS10 Product Configuration Software



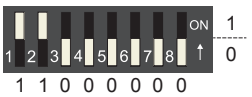
All DIP switches at position 0 → address has to be set via PCS10

Modbus (slave device): factory setting 43 (permitted values: 1…247).

BACnet (master device): factory setting 43 (permitted values: 0…127).

Example: Address is set via configuration software = factory setting.

Address setting via DIP switch



Modbus (slave device): Setting the DIP switches to any other address than 0, overrules the Modbus address set via PCS10 (permitted values: 1…247).

BACnet (master device): Setting the DIP switches to any other address than 0, overrules the BACnet address set via configuration software. BACnet Note: permitted values are 0…127. The 8th bit of the DIP switches is ignored (ID 127 = 0111 111). To set address 0 via DIP switches, the 8th bit shall be set to 1 (ID 0 = 1000 0000).

Example: Address set to 11 (= 0000 1011 binary).

5.2.1. BACnet Protocol Settings

	Factory settings	User selectable values (via PCS10)
Baud rate	As ordered via order code	9 600, 19 200, 38 400, 57 600, 76 800, 115 200
Data bits	8	8
Parity	None	None
Stop bits	1	1
BACnet address	43	0…127

Tab. 11 BACnet protocol settings

PLEASE NOTE

The recommended settings for multiple devices in a BACnet MS/TP network are 38 400, 8, none, 1.

BACnet address and baud rate can be set via:

- PCS10 Product Configuration Software and the USB configuration adapter HA011066.
- BACnet protocol, refer to PICS.

The EE600 PICS (Product Implementation Conformance Statement) is available on the E+E website at www.epluse.com/ee600.

5.2.2. Modbus RTU Protocol Settings

	Factory settings	Selectable values (via PCS10)
Baud rate	As ordered via order code	9 600, 19 200, 38 400, 57 600, 76 800, 115 200
Data bits	8	8
Parity	Even	None, odd, even
Stop bits	1	1, 2
Modbus address	43	1...247

Tab. 12 Modbus RTU protocol settings

PLEASE NOTE

- The recommended settings for multiple devices in a Modbus RTU network are 9600, 8, even, 1.
- The EE600 represents 1/2 unit load on an RS485 network.

The Modbus address, baud rate, parity and stop bits can be set via:

- PCS10 Product Configuration Software and the USB configuration adapter HA011066.
  The PCS10 can be downloaded free of charge from www.epluse.com/pcs10.
- Modbus protocol in the register 1 (0x00) and 2 (0x01).
  Refer to Application Note Modbus AN0103 (available at www.epluse.com/ee600).

The measured values are saved as a 32 bit floating point value and as 16 bit signed integer, refer to chapter 5.2.3 Modbus Register Map.

The serial number as ASCII-code is located in read-only registers 1 - 8 (0x00 - 0x07).
The firmware version is located in read-only register 9 (0x08) (bit 15...8 = major release; bit 7...0 = minor release).
The sensor name as ASCII-code is located in read-only registers 10 - 17 (0x09 - 0x11).

NOTICE

When reading information that spans multiple registers, it is always necessary to read all registers, even if the desired information requires less.

NOTICE

For obtaining the correct floating point values, both registers have to be read within the same reading cycle. The measured value can change between two Modbus requests, exponent and mantissa may get inconsistent then.

INFO

The Modbus function codes mentioned throughout this document shall be used as described in the MODBUS APPLICATION PROTOCOL SPECIFICATION V1.1b3, chapter 6:
www.modbus.org/docs/Modbus_Application_Protocol_V1_1b3.pdf

Communication settings (INT16)

Parameter	Register number[1] [Dec]	Register address[2] [Hex]	Size[3]
Write register: function code 0x06			
Modbus address[4]	1	00	1
Modbus protocol settings[4]	2	01	1
Initiate manual zeroing	508	1FB	1

Device information (INT16)

Parameter	Register number[1] [Dec]	Register address[2] [Hex]	Size[3]
Read register: function code 0x03 / 0x04			
Serial number (as ASCII)	1	00	8
Firmware version	9	08	1
Sensor name (as ASCII)	10	09	8
Device status (bit decoded)[5]	602	259	1

1) Register number (decimal) starts from 1.
2) Register address (hexadecimal) starts from 0.
3) Number of registers
4) For Modbus address and protocol settings see Application Note Modbus AN0103 (available at www.epluse.com/ee600).
5) Refer to chapter 5.2.6. Device Status Indication.

Tab. 13 EE600 registers for device setup

5.2.3. Modbus Register Map

The measurement data is saved as 32 bit floating point values (data type FLOAT32) and as 16 bit signed integer values (data type INT16).

FLOAT32

Parameter	Unit[1)]	Register number[2)] [DEC]	Register address[3)] [HEX]
Read register: function code 0x03 / 0x04			
Differential pressure	mm H_2O	1211	4BA
Differential pressure	mbar	1213	4BC
Differential pressure	Pa	1215	4BE
Differential pressure	kPa	1217	4C0
Differential pressure	inch WC	1219	4C2
Air velocity	m/s	1041	410
Air velocity	ft/min	1043	412
Volume flow	m^3/h	1055	41E
Volume flow	l/s	1057	420
Volume flow	m^3/s	1059	422
Volume flow	ft^3/min	1181	49C
Filter monitoring	%	1075	432
Level indicator	cm	1077	434
Level indicator	inch	1079	436

INT16

Parameter	Unit[1)]	Scale[4)]	Register number[2)] [DEC]	Register address[3)] [HEX]
Read register: function code 0x03 / 0x04				
Differential pressure	mm H_2O	10	4106	1009
Differential pressure	mbar	100	4107	100A
Differential pressure	Pa	1	4108	100B
Differential pressure	kPa	1000	4109	100C
Differential pressure	inch WC	100	4110	100D
Air velocity	m/s	100	4021	FB4
Air velocity	ft/min	1	4022	FB5
Volume flow	m^3/h	1	4028	FBB
Volume flow	l/s	1	4029	FBC
Volume flow	m^3/s	1000	4030	FBD
Volume flow	ft^3/min	1	4091	FFA
Filter monitoring	%	10	4038	FC5
Level indicator	cm	10	4039	FC6
Level indicator	inch	10	4040	FC7

1) The choice of measurement units (metric or non-metric) must be done according to the ordering guide, refer to EE600 datasheet. Switching from metric to non-metric or vice versa by using the PCS10 is not possible.
2) Register number (decimal) starts from 1.
3) Register address (hexadecimal) starts from 0.
4) Examples: For scale 100, the reading of 2550 means a value of 25.5. For scale 50, the reading of 2550 means a value of 51.

Tab. 14 EE600 FLOAT32 and INT16 measured data registers

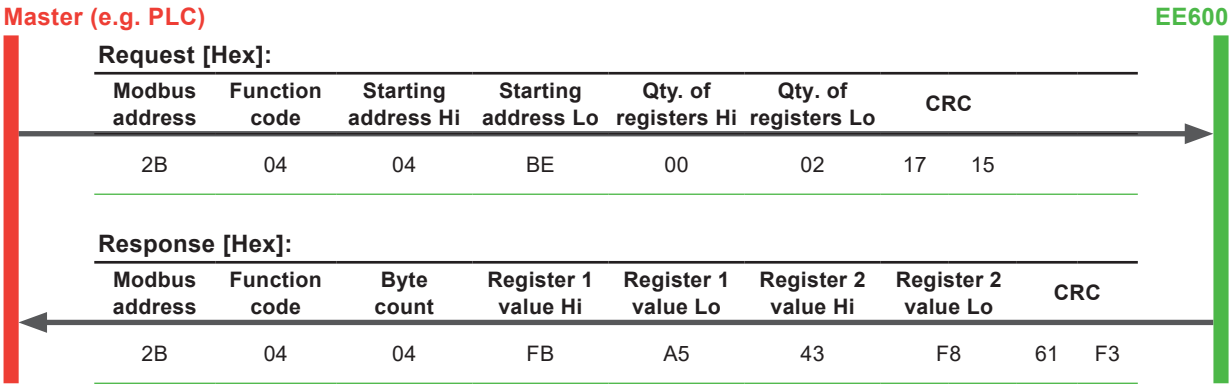
5.2.4. Modbus RTU Example

The EE600's Modbus address is 43 [0x2B].

Please refer to

- MODBUS APPLICATION PROTOCOL SPECIFICATION V1.1b3, chapter 6: www.modbus.org/docs/Modbus_Application_Protocol_V1_1b3.pdf
- E+E Application Note Modbus AN0103 (available at www.epluse.com/ee600)

Read the differential pressure (FLOAT32) ∆p = 497,965972 Pa from the register address 0x4BE:



Tab. 15 Example of a differential pressure query

Decoding of floating point values:

Floating point values are stored according to IEEE754. The byte pairs 1, 2 and 3, 4 are transformed as follows (numbers taken from ∆p reading Modbus request/response example above):

Modbus response [Hex]			
Byte 3	Byte 4	Byte 1	Byte 2
FB	A5	43	F8
MMMMMMMM	MMMMMMMM	SEEEEEEE	EMMMMMMM

Tab. 16 Modbus response

IEEE754			
Byte 1	Byte 2	Byte 3	Byte 4
43	F8	FB	A5
0100 0011	1111 1000	1111 1011	1010 0101
SEEE EEEE	EMMM MMMM	MMMM MMMM	MMMM MMMM
Decimal value: 497.965972			

Tab. 17 Data representation according to IEEE754

5.2.5. Freely Configurable Custom Modbus Map

It is possible to map measured value/status registers arbitrarily in a block with up to 20 registers provided for this purpose. This means that registers of interest may be mapped in an area with consecutive registers, so that important values can be queried with a single command in one block.

The custom map can be configured via:

- PCS10 Product Configuration Software and the USB configuration cable HA011066.
  The PCS10 can be downloaded free of charge from www.epluse.com/pcs10.
- Modbus protocol commands, refer to the example in chapter 5.2.4 Modbus RTU Example.

The register block for the configuration of the customisable Modbus map consists of the registers 6001 (0x1770) to 6010 (0x1779). For the blockwise query of the measured values behind Modbus registers 3001 (0xBB8) to 3020 (0xBCB), the firmware accesses this configuration area and thus gets the information which measured value/status registers are to be output. A maximum of 10 user-defined registers can be mapped. The table below shows an example:

Registers ...		... with these assigned measurands ...			... map to registers ...		... mirrored from source registers	
Dec	**Hex**	**Meas.**	**Unit**	**Type**	**Dec**	**Hex**	**Dec**	**Hex**
Function code 0x10					*Function code 0x03/0x04*			
6001	1770	Δp	Pa	INT16	3001	BB8	4108	100B
6002	1771	V'	m^3/h	FLOAT32	3002	BB9	1055	41E
				FLOAT32	3003	BBA	1056	41F
6003	1772	v	m/s	FLOAT32	3004	BBB	1041	410
				FLOAT32	3005	BBC	1042	411

1) Register number starts from 1.
2) Protocol address starts from 0.

Tab. 18 Custom Modbus map example

5.2.6. Device Status Indication

If a critical error occurs, all Modbus values are set to NaN (according to IEEE754 for data type FLOAT32) or to 0x8000 (INT16). It is possible to read out all status and error information via Modbus register 609 (0x260). Errors are displayed in bit-coded form. If an event is present, the corresponding bit is set to 1.

Measured values outside the measuring range are limited with the corresponding limit value.

Error Bits	Description	Recommended action
Bit 0	Error: Sensor not adjusted	Carry out zero point adjustment
		Return to factory adjustment
		Return the unit to the E+E Customer Service
Bit 1	Error: Pressure measurement faulty	Check the installation and clean the device
		Carry out the zero point adjustment
		Return the unit to the E+E Customer Service
Bit 2	Error: Faulty display communication	Check the display connection
Bit 3	Error: Auto-zero did not work	Carry out zero point adjustment
		Return the unit to the E+E Customer Service

Tab. 19 Device status indication

5.3 Display Settings and Output Signals

5.3.1. Analogue Version with DIP Switch Settings

Refer to chapter 5.1 Analogue Version for the configuration options.

5.3.2. Analogue Version with PCS10 Settings or Digital Version

The factory setting of the display (if present) shows the measured differential pressure in Pascal [Pa]. All measurands can also be selected as output signal. With the PCS10 Product Configuration Software and the optional USB configuration adapter HA011066, the display layout, the visualised parameter according to the selected application and the output signal can be changed:

Measurands	Units	Possible display visualisations
Differential pressure measurement	Pa, kPa, mbar, mm H_2O, inch WC	▪ One line with linear gauge. ▪ One line without linear gauge.
Volume flow measurement	Pa, kPa, mbar, mm H_2O, inch WC m^3/h, m^3/s, ft^3/min, l/s	▪ One line with linear gauge. ▪ One line without linear gauge. ▪ Two lines without linear gauge.
Air velocity measurement	Pa, kPa, mbar, mm H_2O, inch WC m/s, ft/min	▪ One line with linear gauge. ▪ One line without linear gauge. ▪ Two lines without linear gauge.
Filter monitoring	Pa, kPa, mbar, mm H_2O, inch WC %	▪ One line with linear gauge. ▪ One line without linear gauge. ▪ Two lines without linear gauge.
Level indicator	Pa, kPa, mbar, mm H_2O, inch WC cm, inch	▪ One line with linear gauge. ▪ One line without linear gauge. ▪ Two lines without linear gauge.

Examples of Display Visualisation

Fig. 10 One line with linear gauge

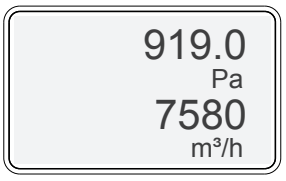


Fig. 11 Two lines without linear gauge.

PLEASE NOTE

If settings were changed via PCS10 and DIP switch settings shall apply again, be sure to restore the factory settings before applying the DIP switches.

- Outputs scale: 0...1 000/10 000 Pa
- Analogue linear gauge limits: -10...1 000/10 000 Pa
- Number of lines: 1
- Unit: Pa

5.4 PCS10 Product Configuration Software

PLEASE NOTE

EE600 versions with 10 DIP switches and digital versions of the EE600 are supported by the PCS10 Product Configuration Software.

To use the software for changes in settings, please proceed as follows:

1. Download the PCS10 Product Configuration Software from www.epluse.com/pcs10 and install it on the PC.
2. Connect the EE600 to the PC using the USB configuration adapter.
3. Start the PCS10 software.
4. Follow the instructions on the PCS10 opening page for scanning the ports and identifying the connected device
5. Click on the desired setup mode from the main PCS10 menu on the left. Follow the online instructions of the PCS10 which are displayed when clicking the “Tutorial” button.
6. Changes are uploaded to the sensor by pressing the “Sync” button.

NOTICE

The EE600 may not be connected to any additional power supply when using the USB configuration adapter HA011066.

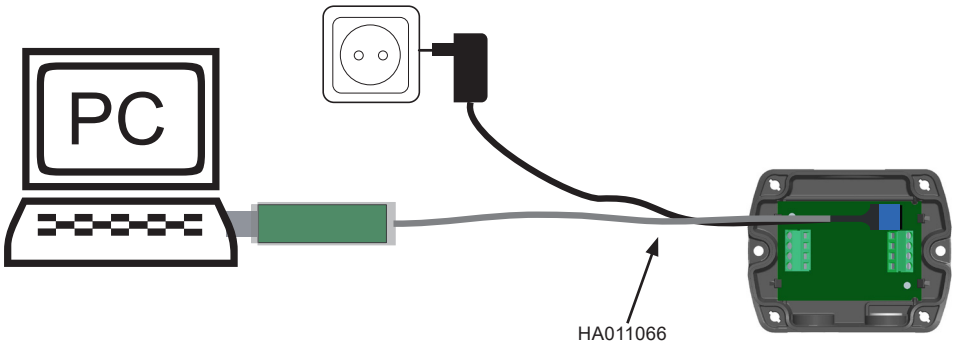


Fig. 12 EE600 connected to a PC running PCS10

5.4.1. Application Settings

This chapter provides some details on the possible applications and their inputs.

In addition to differential pressure measurement (Pa, kPa, mbar, mm H_2O, inch WC), the EE600 can be set up for the following applications:

- Volume flow rate measurement (k-factor input)
- Air velocity measurement (k-factor input)
- Filter monitoring
- Level indication

Volume flow measurement

By entering a k-factor in the application settings, the EE600 is able to calculate the volume flow (q) according to the following formula:

$q = k * \sqrt{\Delta p}$

Formula sign	Description	Unit
q	Volume flow	m^3/h
k	k-factor	
Δp	Differential pressure	Pa

The k-factor is a characteristic theoretical parameter for each fan model, specified by the manufacturer in the datasheet of the fan.

PLEASE NOTE

If the fan manufacturer's datasheet specifies a different method or unit for calculating the volume flow, the k-factor must be converted accordingly so that it fits into the above formula.

The calculated volume flow (q) is available in four different units: m^3/h, m^3/s, ft^3/min, l/s.

The default air density (ρ20) value at standard conditions is defined as follows:

Air density (ρ20) = 1.204 kg/m^3 @ T = 20 °C (68 °F) and p = 1 013 mbar (14.7 psi)

If the air density deviates from standard conditions, a compensation for the calculated volume flow is necessary.

By entering the specific air density (ρ') [kg/m^3] at the operating point, the EE600 applies a compensation to the calculated volume flow (q') according to the formula:

$$q' = k * \sqrt{\Delta p} * \sqrt{\frac{\rho 20}{\rho'}}$$

Formula sign	Description	Unit
q'	Volume flow	m^3/h
k	k-factor	
Δp	Differential pressure	Pa
ρ20	Air density at 20 °C (68 °F)	kg/m^3
ρ'	Specific air density	kg/m^3

Air velocity measurement

By entering a k-factor and the dimensions of the duct (round or square), the EE600 is able to calculate the air velocity (v) out of the volume flow (q) and the area of the duct.

$$v = \frac{q / 3600}{A}$$

Formula sign	Description	Unit
v	Air velocity	m/s
q	Volume flow	m^3/h
A	Area (cross section)	m^2

Details for k-factor refer to application settings for volume flow measurement.

The calculated air velocity (v) is available in two different units: m/s and ft/min.

Details for setting air density (when deviating from default air density at standard conditions) refer to application settings for volume flow measurement.

Filter monitoring

By entering filter limit values for the differential pressure, the EE600 is able to calculate a level of contamination for the monitored filter in order to plan maintenance activities.

$$\text{Contamination level [\%]} = \frac{\text{measured } \Delta p - \Delta p \text{ new filter}}{\Delta p \text{ change filter} - \Delta p \text{ new filter}}$$

For example:
With the application settings of Δp change filter = 800 Pa and Δp new filter = 100 Pa, a measured differential pressure at the filter of Δp = 450 Pa would mean a level of contamination of 50 %

Level indicator

By entering the density of a fluid the EE600 can act as a level indicator. The differential pressure level measurement uses the pressure values and the specific weight of the fluid to represent the level in a tank (refer to Fig. 8 Mounting examples).

$$h = \frac{\Delta p}{\rho * g} * 100$$

Formula sign	Description	Unit
h	level	cm
Δp	Differential pressure	Pa
ρ	Density of fluid	kg/m^3
g	Gravitation acceleration, 9.81	m/s^2

By applying the positive pressure connection into the tank, the user can measure the height of the fluid column. The level measurement is available in two different units: cm and inch. The maximum measurable level is limited by the highest differential pressure range 0…10 000 Pa. For water with a density of 998 kg/m^3 , for example, the maximum height at 10 000 Pa is 102 cm (40 inch).

6 Maintenance and Service

The EE600 does not require any special maintenance, nevertheless it is recommended to perform a zero point adjustment every 12 month. If needed, the enclosure may be cleaned and the device may be re-adjusted as described below.

6.1 Cleaning

Use a damp soft cloth to remove deposits of dust or dirt from the exterior of the device and from the display. Do not attempt to clean the interior of the device. Do not use any solvents, alcohol or abrasive cleaning agents.

6.2 Repairs

Repairs may be carried out by the manufacturer only. The attempt of unauthorized repair excludes any warranty claims.

6.3 Re-adjustment of the EE600

A periodical re-adjustment of EE600 might be required by the regulations of certain industries or by the need of best long-term measurement accuracy. The zero point and the span point can be adjusted with push buttons on the EE600 electronics board.

For adjustment the device must be powered and the enclosure cover removed. Consequently, the adjustment may be performed by authorised staff only, observing the handling of electrical sensitive devices (ESD).

6.3.1. Zero Point Adjustment

The zero point adjustment is used to correct an eventual zero point deviation.

1. Remove the tubes from both pressure connections of the EE600. This ensures that the pressure is the same at both connections. If the sensor has an auto-zero setting, the tubes do not need to be removed.
2. Press the “zero point” button 1-2 seconds (refer to chapter 3 Product Description).
3. Successful zero point adjustment is confirmed by the green LED lighting up for 2 seconds.
4. If the red LED lights up for 2 seconds, this indicates that the zero point adjustment was not successful. In this case, please repeat step 2.

PLEASE NOTE

The zero point adjustment (step 2) may not be successful because the deviation is more than 5 % of the original full scale value of the device. This is 50 Pa for the 0...1 000 Pa range and 500 Pa from the 0...10 000 Pa range. If the zero point adjustment is not successful even after pressing the button for at least 10 seconds, the deviation is too high for zeroing. Please check the sensor, the tubes and the environment and make sure that the pressure connection nipples are free.

6.3.2. Span Point Adjustment

The span point adjustment is used to correct an eventual deviation of the span value.

PLEASE NOTE

Make sure that you carry out a zero point adjustment as described above before setting the measuring range point.

1. Connect the differential pressure reference device / calibrator to the EE600 and set it according to the EE600 span value to be adjusted.
2. Note: The span value has to be set according to the selected measurement range.

Example:

Analogue version: (refer to chapter 5.1.1. Select the Measuring Range with S1 and S2, Tab. 3)
EE600-HV53A7, S1 = 0, S2 = 1, span value = 5 000 Pa

Digital version: EE600-HV52J3, span value = 1 000 Pa
EE600-HV53J3, span value = 10 000 Pa

PLEASE NOTE

Observe the User Manual of the reference device.

3. Press the span point adjustment button (refer to chapter 3 Product Description).
4. Successful span point adjustment is confirmed by the green LED lighting up for 2 seconds.
5. If the red LED lights up for 2 seconds, this indicates that the span point adjustment was not successful. In this case, please repeat step 2.
6. Successful span point adjustment is confirmed by the green LED lighting up for 2 seconds.

PLEASE NOTE

The span point adjustment (step 2) may not be successful because the deviation is more than 5 % of the original full scale value of the device.
This is 50 Pa for the 0...1 000 Pa range and 500 Pa from the 0...10 000 Pa range. In this case, the set point adjustment can be forced by pressing and holding the span point button for 10 seconds. If the zero point adjustment is not successful even after pressing the key for at least 10 seconds, then the deviation is too high for zeroing. Please check the sensor, the tubes and the environment and make sure that the pressure connection nipples are free.

6.3.3. Return to Factory Adjustment

1. Press and hold simultaneously both “zero” and “span” buttons for 5 seconds.
2. The successful return to the factory setting is confirmed by the green LED lighting up for 2 seconds.
3. If the red LED lights up for 2 seconds, this indicates that the factory reset was not successful. In this case, repeat step 2.

PLEASE NOTE

Return to factory adjustment affects both zero and span.

6.3.4. Auto-zero (Optional)

With auto-zero, no maintenance of the sensor is necessary. Auto-zero is carried out every 24 hours (factory setting). The interval can be set from 10 minutes up to 7 days and can be changed by using PCS 10 and the USB configuration adapter (refer to chapter 5.4 PCS10 Product Configuration Software). For this purpose DIP switch 9 (refer to chapter 5.1.6 Select the Source of Settings with S9) has to be in position 1 (ON). During the auto-zero procedure (takes approx. 4 s), the green LED flashes quickly (see chapter 3.4.1 LED Indication) and the output signal value is frozen.

PLEASE NOTE

If the auto-zero interval was changed via PCS10 and DIP switch settings are applied again, the auto-zero interval value will be adopted.

6.4 Error Messages

Following error messages can be read on the display.

Code	Description	Recommended action
13	Sensor not adjusted	Carry out zero point adjustment
		Return to factory adjustment
		Return the unit to the E+E Customer Service
14	Pressure measurement faulty	Check the installation and clean the device
		Carry out the zero point adjustment
		Return the unit to the E+E Customer Service
18	Auto-zero did not work	Carry out zero point adjustment
		Return the unit to the E+E Customer Service
21	Faulty display communication	Check the display connection

Tab. 20 Displayed errors

7 Technical Data

Measurands

Differential Pressure (Δp)

Measurement principle		Piezoresistive, no flow-through
Measuring range **Analogue output selectable with DIP switches[1)]** **With PCS10**		0...250 / 500 / 750 / 1 000 Pa 0...2 500 / 5 000 / 7 500 / 10 000 Pa Configurable within max. measuring range
Accuracy @ 20 °C (68 °F), incl. hysteresis, non-linearity and repeatability		±0.5 % FS FS = full scale (1 000 Pa or 10 000 Pa)
Temperature dependency, typ.		<0.03 % from FS/K
Response time t_{90}	**Analogue output[1)]**	50 ms / 500 ms / 2 s / 4 s selectable with DIP switches Configurable in the range from 0.05 to 30 s with PCS10
	Digital interface[2)]	Configurable in the range from 0.5 to 30 s with PCS10
Auto-zero interval		24 h (factory setting) Configurable between 10 min and 7 days with PCS10. Can be deactivated.
Long-term stability		<0.5 % FS/year
Overload limits	**1 000 Pa FS**	±10 000 Pa
	10 000 Pa FS	±80 000 Pa

1) Factory setup analogue output: measurement range 0...100 % FS; response time t_{90}: 50 ms; displayed unit: Pa; display backlight: on; analogue outputs: 0 - 10 V and 4 - 20 mA. Other ranges upon request.
2) Factory setup RS485: response time t_{90}: 500 ms; displayed unit: Pa; display backlight: on.

Calculated measurands

		unit
Level indicator	LI	cm
		inch
Volume flow	V'	m^3/h
		l/s
		m^3/s
		ft^3/min
Air velocity	v	m/s
		ft/min
Filter contamination level		%

Outputs

Analogue

Analogue output[1)]	0 - 5 V or 0 - 10 V and 0 - 20 mA or 4 - 20 mA (3-wire)	-1 mA < I_L < 1 mA R_L ≤ 500 Ω	I_L = load current R_L = load resistor

1) Voltage and current output signals available simultaneously at the spring loaded terminals. Settings selectable with DIP switches. Factory setup analogue outputs: measurement range 0...100 % FS; response time t_{90}: 50 ms; displayed unit: Pa; display backlight: on; analogue outputs: 0 - 10 V and 4 - 20 mA. Other ranges upon request.

Digital

Digital interface	RS485 (EE600 = 1/2 unit load)
Protocol **Factory settings** **Supported Baud rates** **Data types for measured values**	Modbus RTU Baud rate according to ordering guide, parity even, 1 stop bit, Modbus address 43 9 600, 19 200 and 38 400 FLOAT32 and INT16
Protocol **Factory settings** **Supported Baud rates**	BACnet MS/TP Baud rate according to ordering guide, BACnet address 43 9 600, 19 200, 38 400, 57 600, and 76 800

General

Power supply class III ⧈ USA & Canada: Class 2 supply necessary, max. voltage 30 V DC	15 - 35 V DC or 24 V AC ±20 %		
Current consumption, typ. @ 0 Pa (0 psi) / 24 V DC		**Analogue output**	**Digital interface**
	Without display	23 mA	8 mA
	Display with backlight	49 mA	29 mA
Electrical connection **Analogue output** **Digital interface**	Spring-loaded terminals, max. 1.5 mm^2 (AWG16) Screw terminals, max. 2.5 mm^2 (AWG14)		
Cable gland	M16x1.5		
Display	Graphic, with backlight		
Selectable units on display with **Analogue output via DIP switch** **Analogue output and digital interface via PCS10**	Pa, kPa, mbar, mm H_2O Pa, kPa, mbar, mm H_2O, inch WC, m^3/h, m^3/s, ft^3/min, l/s m/s, ft/min, %		
Humidity range	0...95 %RH, non-condensing		
Temperature range **Operation** **Storage**	-20...+60 °C (-4...+140 °F) -40...+70 °C (-40...+158 °F)		
Enclosure **Material** **Protection rating**	Polycarbonate, UL94 V-0 (with display UL94 HB) approved IP65 / NEMA 4X		
Electromagnetic compatibility	EN 61326-1 FCC Part15 Class A	EN 61326-2-3 ICES-003 Class A	Industrial environment
Shock and vibration	Tested according to EN 60068-2-64 and EN 60068-2-27		
Conformity	CE UKCA		

Configurability

Device	DIP switches	PCS10
Analogue output without auto-zero	✓	✓
Analogue output with auto-zero	✓	✓
Digital interface without auto-zero	✓	✓
Digital interface with auto-zero	✓	✓

Configuration options see above or manual at www.epluse.com/ee600.

8 Conformity

8.1 Declarations of Conformity

E+E Elektronik Ges.m.b.H. hereby declares that the product complies with the respective regulations listed below:

CE European directives and standards.

and

UKCA UK statutory instruments and designated standards.

Please refer to the product page at www.epluse.com/ee600 for the Declarations of Conformity.

8.2 FCC Part 15 Compliance Statement

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

8.3 ICES-003 Compliance Statement

This Class A digital apparatus complies with Canadian ICES-003.

Cet appareil numérique de la classe A est conforme à la norme NMB-003 du Canada.

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