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User Manual EE650

Air Velocity Sensor for HVAC Applications



Modbus

www.epluse.com

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1 General Information

This user manual is intended to ensure 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. accepts no liability for any warranty or liability claims arising from this publication or improper handling of the product(s) described.

All information, technical data and diagrams included in this document are based on the information available at the time of writing. The document 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 product(s) described and the contents of this document may be changed or improved at any time without prior notice.

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PLEASE NOTE

Find this document and further product information on our website at www.epluse.com/ee650.

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.

Informative notes

Informative notes provide important information that is characterised by its relevance.

INFO

The information symbol indicates tips on handling the device or provides additional information on it. This information is useful to achieve optimum performance of the device.

The title field may 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.

- The EE650 enclosure, the sensing probe and the sensing module shall not be exposed to unnecessary mechanical stress.
- Do not apply the supply voltage to the RS485 data lines.
- Use the EE650 only as intended and observe all technical specifications.

1.2.2. Intended Use

The EE650 air velocity sensor is dedicated for accurate and reliable measurement in building automation and ventilation applications.

⚠ 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 the EE650 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

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

- The EE650 may only be operated under the conditions described in this user manual and within the specification included in chapter 9 Technical Data.
- Any unauthorised product modification will invalidate all warranty claims. Modifications may only be carried out with the express authorisation of E+E Elektronik Ges.m.b.H.!

1.2.3. Mounting, Start-up and Operation

The EE650 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 device shall be set up and installed in a way that does not impair its safe use. All applicable local and international safety guidelines for safe installation and operation of the device have to be observed. This user manual contains information and warnings that must be observed in order to ensure safe operation.

ⓘ PLEASE NOTE

The manufacturer or his authorised 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 damage caused by non-compliance with the applicable regulations, operating instructions or the specified operating conditions. Any consequential damage is excluded from liability.

⚠ WARNING

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

- Mounting, installation, commissioning, start-up, operation and maintenance of the device may only be carried out by qualified staff. Such staff must be authorised 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 must be thoroughly checked by authorised staff before commissioning the device.
- Do not install or start-up a device suspected to be faulty. Mark it clearly as faulty and remove it from the process.
- Service operations other than described in this user manual may only be performed by the manufacturer. A faulty device may only be investigated and possibly repaired by qualified, trained and authorised staff. If the fault cannot be fixed, the device shall be removed from the process.

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

- EE650 Sensor
- Cable gland (two pieces for daisy chain wiring at the RS485 output)
- Mounting flange
- Mounting material
- Protection cap
- Quick guide
- Test report according to DIN EN 10204-2.2

3 Product Description

3.1 General

The EE650 air velocity sensor is dedicated for accurate and reliable measurement in building automation and ventilation applications.
The device employs an air velocity sensing element, which operates on the thermal anemometer principle. It features an innovative and very robust sensing element manufactured in thin-film technology and with state-of-the-art transfer molding. The construction of the sensing head results in a very low angle dependency, which facilitates installation. The mounting flange allows for easy adjustment of the immersion depth.

The measuring range and the response time of the EE650 can be selected via jumpers on the electronics board, please refer to chapter 6.1 Analogue Settings.

Product Variants

Two different EE650 types provide a broad range of options for measurement tasks:

Probe Type	Description
T2	Duct mount
T3	Remote probe

Tab. 1 Probe types

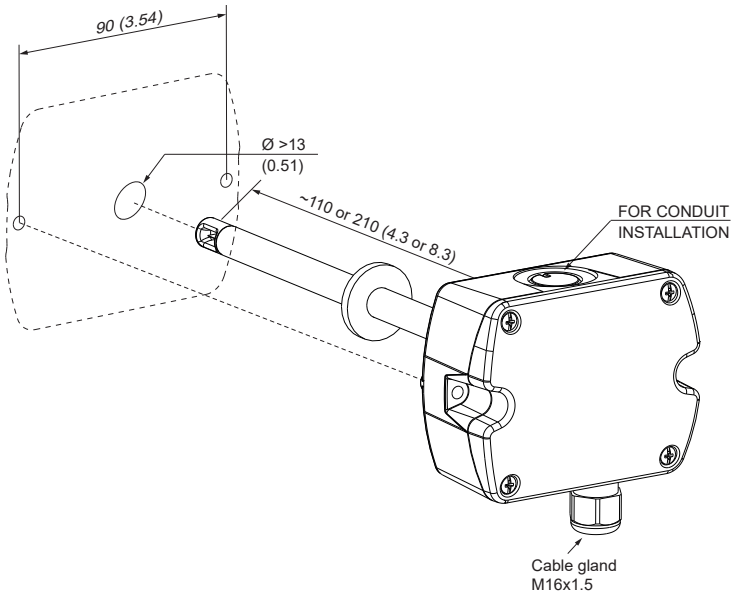
Supply

The EE650 is supplied with 24 V AC/DC ±20 % via cable gland and direct wiring to the internal terminals, depending on the electrical connection option ordered.

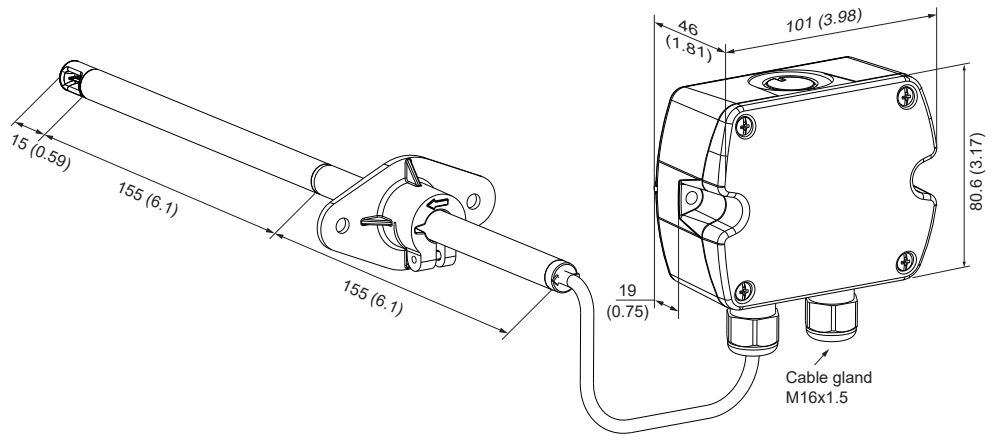
3.2 Dimensions

Values in mm (inch)

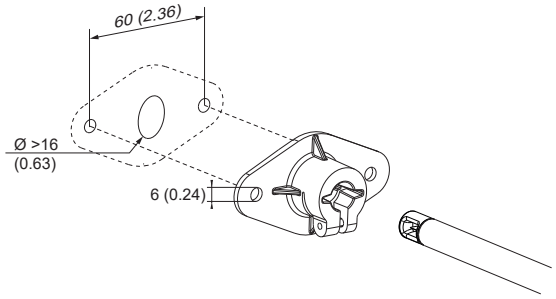
Duct mount



Remote Probe



Mounting flange



4 Mounting and Installation



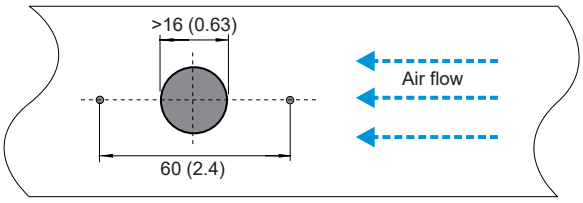
Fig. 1 Flow direction - from right to left

In the EE650 duct version, the flow direction is always from right to left, on the condition that the cable gland of the sensor is oriented downwards (see Fig. 1 above). This allows the flow direction to be checked even when the sensor is already installed in the duct.

4.1 Drilling in the Wall of the Duct for Installing the Mounting Flange

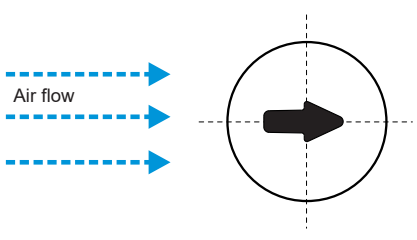
Drilling hole dimensions

in mm (inch)

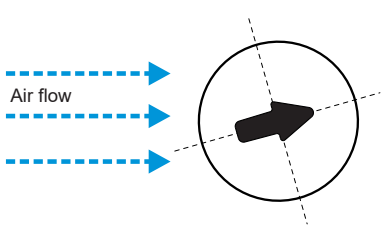


The arrow engraved on the sensing head of EE650 indicates the direction of the air stream during factory adjustment. When installing the EE650 probe, make sure that the arrow exactly matches the flow direction.

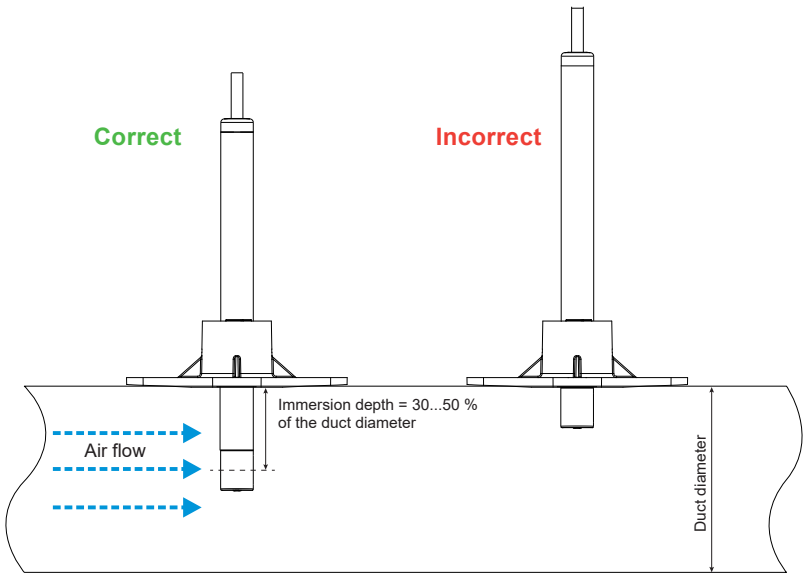
Correct



Incorrect



The mounting flange allows for precise setting of the EE650 immersion depth in a duct. The entire sensing head must be in the air flow to be measured.

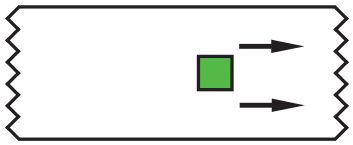
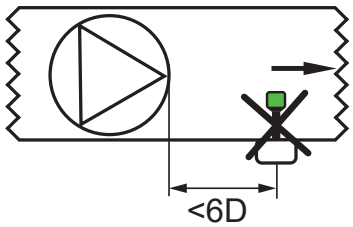
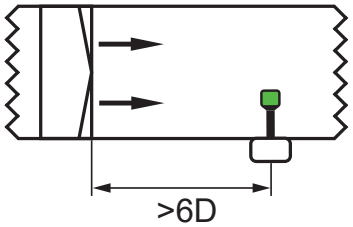


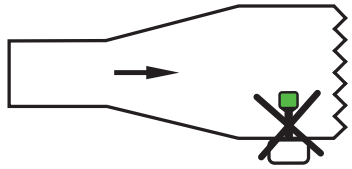
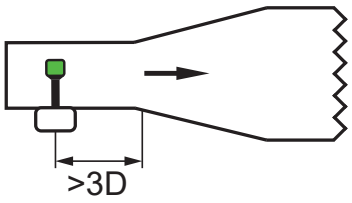
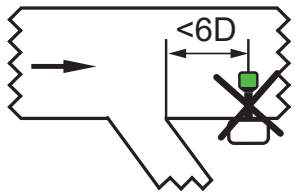
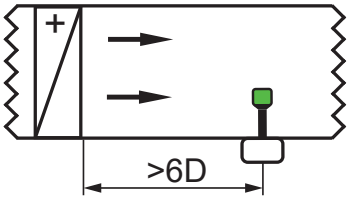
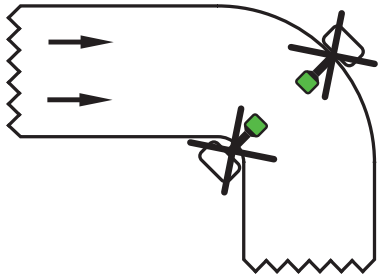
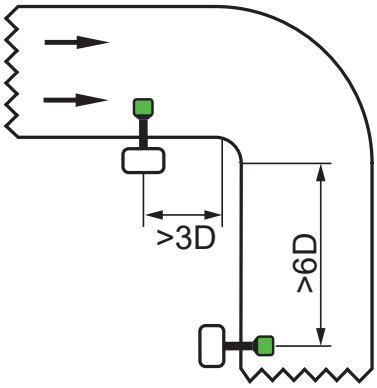
4.2 Positioning of Air Velocity Sensor in a Ventilation Duct

The reliable and accurate measurement of air velocity depends on the correct positioning of the sensor in the ventilation duct. Accurate measurements are only possible if the air velocity probe is positioned at a location with a laminar (not-turbulent) flow.

The required length of the calming section after a fault is a function of the tube diameter D. For a rectangular channel a x b applies:

$$D_{gl} = \frac{2 \cdot a \cdot b}{a + b}$$

Incorrect positioning	Correct positioning	Description
		Mounting the sensing probe in the centre of the duct.
		The optimal position is after the filter. Please ensusre sufficient distance.

Incorrect positioning	Correct positioning	Description
		Position the probe in front of the diffusor, at a place with high flow rate.
		Position the probe at a location with a laminar (to-turbulent) flow.
		Turbulent flows are caused by pipe bends, branches, behind flaps, flanges, air heaters, air coolers or cross-sectional changes.

Tab. 2 Positioning examples

5 Electrical Connection

⚠ WARNING

Incorrect installation, wiring or power supply may cause overheating and result in personal injury or property damage.

Cables must not be under voltage during electrical installation and connection or disconnection, especially at terminal connections on circuit boards. For correct cabling, always observe the presented wiring diagram for the product version used.

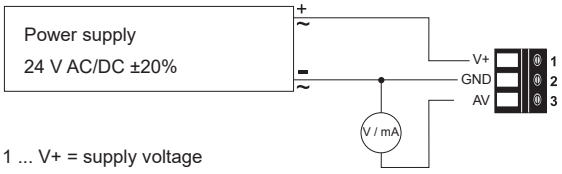
The manufacturer cannot be held responsible for personal injury or damage to property caused by incorrect handling, installation, wiring, power supply or maintenance of the device.

The EE650 features screw terminals for connecting the power supply and the outputs. The cables are fed into the enclosure through the M16 cable gland.

NOTICE

- Ensure that the cable glands are closed tightly for the power supply and outputs cable. This is necessary to assure the IP rating of the enclosure according to EE650 specification, as well as for stress relief at the screw terminals on the EE650 board.
- Accurate measurement results are conditioned by the correct positioning of the sensing probe in the air stream. The best accuracy is achieved with laminar flow.
- Observe the minimum inlet and outlet path length, refer to chapter 4.2 Positioning of Air Velocity Sensor in a Ventilation Duct.
- Avoid mechanical stress onto the probe and mainly onto the sensing head.
- Observe the humidity working range 5…95% RH, non-condensing.
- Avoid installation in corrosive environment, as this may lead to sensor destruction.

5.1 Analogue Output



1 ... V+ = supply voltage
2 ... GND = ground
3 ... AV_U = voltage output air velocity

Remote Sensor Probe



Notation	Colour
b	brown
g	green
y	yellow
w	white
s	black

Fig. 2 Connection diagram for analogue output

5.2 RS485 Interface

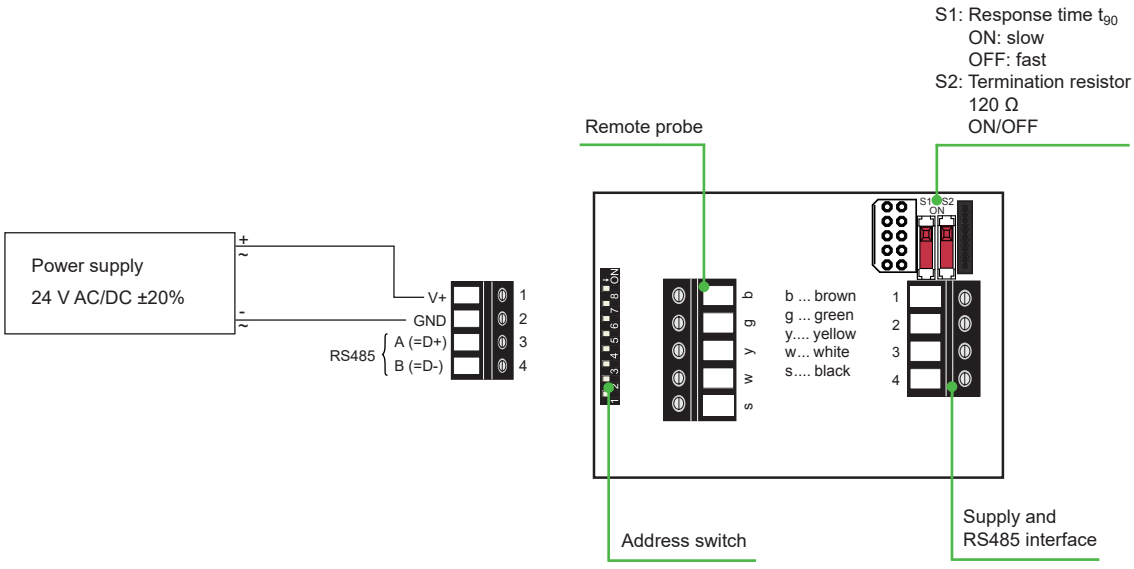


Fig. 3 Connection diagram for RS485 interface

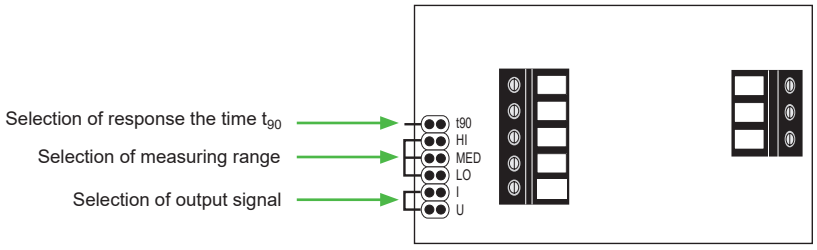
6 Setup and Configuration

The EE650 is ready to use and does not require any further configuration. The factory setup of the EE650 corresponds to the specified order code. Please refer to the datasheet at www.epluse.com/ee650.

If needed, the factory setup can be modified with the help of the free PCS10 Product Configuration Software (free download from www.epluse.com/pcs10) and the USB-C configuration stick (HA011070).

6.1 Analogue Settings

For performing the EE650 settings via the PCS10 Product Configuration Software, the jumper for the measuring range must be set to HI.



6.1.1. Selection of the Output Signal

	
Jumper I Current (factory setting)	Jumper U Voltage

6.1.2. Selection of Response Time t_{90}

	
Jumper t_{90} SLOW 4 s (factory setting)	no jumper FAST 1 s

6.1.3. Selection of Measuring Range

		
Jumper HI 0...20 m/s (0...4000 ft/min) (factory setting)	Jumper MED 0...15 m/s (0...3000 ft/min)	Jumper LO 0...10 m/s (0...2000 ft/min)

6.1.4. Customised ranges



Jumper HI + MED (factory setting)

*) Upon request, customised ranges are fixed, no further selection with jumpers is possible.

6.2 Product Configuration

6.2.1. EE650 Configuration using HA011070

for digital types

NOTICE

The USB-C configuration stick HA011070 galvanically isolates the USB interface of the PC from the supply voltage of the EE650. When using the USB-C configuration stick, the EE650 needs external supply.

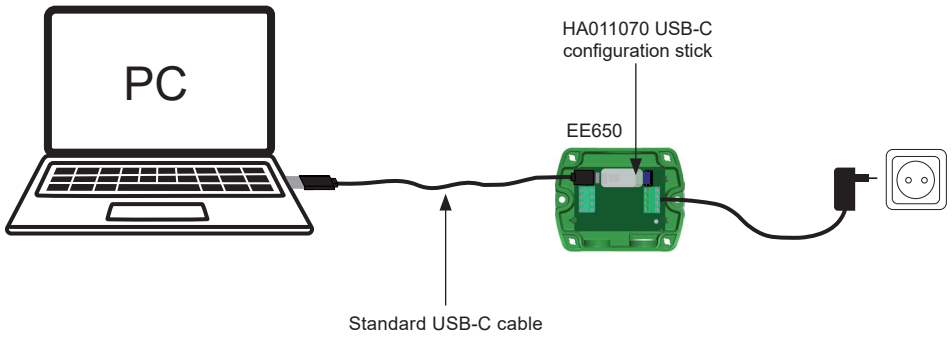


Fig. 4 EE650 configuration using the HA011070 USB-C configuration stick

6.2.2. EE650 Configuration using legacy USB configuration adapter HA011066

(not intended for new designs)

NOTICE

The EE650 must not be connected to any additional power supply when using the USB configuration adapter HA011066.

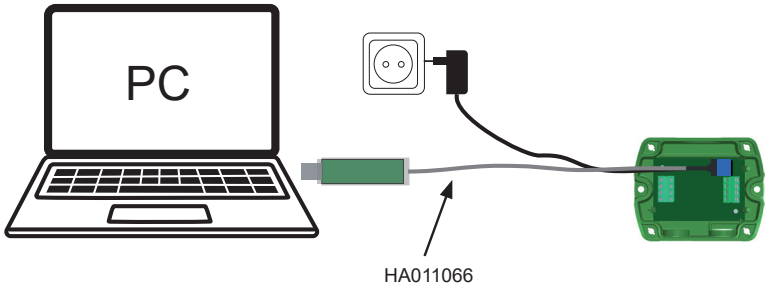


Fig. 5 EE650 connected to a PC running PCS10

6.2.3. PCS10 Product Configuration Software

Use the software to change the settings and proceed as follows:

1. Download the PCS10 Product Configuration Software from www.epluse.com/pcs10 and install it on the PC.
2. Connect the EE650 to the PC using the USB configuration adapter.
3. Start the PCS10 software.
4. Follow the instructions on the PCS10 opening page to scan the ports and to identify the connected device.
5. Click on the desired setup mode from the main PCS10 menu on the left. Follow the PCS10 online instructions that are displayed when clicking on the “Tutorial” button.
6. Upload changes to the sensor by pressing the “Sync” button.

6.3 RS485 Digital Interface

6.3.1. Hardware Bus Termination

For bus termination the EE650 features an internal 120 Ω resistor which can be activated using the slide switch S2 on the electronics board (refer to also chapter 5.2 RS485 Interface for details).

NOTICE

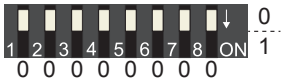
For proper function, the power supply must be strong enough to ensure supply voltage within the specified range (refer to chapter 9 Technical Data) at any time and at all devices in the bus. This is particularly relevant when using long and thin cables which can cause a high voltage drop.

PLEASE NOTE

A single EE650 requires peak current of 150 mA.

6.3.2. Device Address

Address Switch



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 65 (permitted values: 1…247).

BACnet (master device): factory setting 65 (permitted values: 0…127).

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

Address Switch



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).

6.3.3. BACnet Protocol Settings

	Factory settings	User selectable values (via PCS10)
Baud rate	As specified in the 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	65	0…127

Tab. 3 BACnet protocol settings

PLEASE NOTE

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

The EE650 PICS (Product Implementation Conformance Statement) is available on the E+E website at www.epluse.com/ee650.

BACnet address and baud rate can be set via:
- PCS10 Product Configuration Software and the USB-C configuration stick HA011070.
- BACnet protocol, refer to the PICS.

6.3.4. Modbus RTU Protocol Settings

	Factory settings	Selectable values (via PCS10)
Baud rate	As specified in the 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	65	1...247

Tab. 4 Modbus RTU protocol settings

PLEASE NOTE

- The recommended settings for multiple devices in a Modbus RTU network are 9600, 8, even, 1.
- The EE650 represents 1 unit load on an RS485 network.

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

- PCS10 Product Configuration Software and the USB-C configuration stick HA011070.
  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/ee650).

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 - 0x10).

NOTICE

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

NOTICE

To obtain the correct floating point values, both registers have to be read within the same reading cycle. The measured value may change between two Modbus requests. This can cause inconsistencies in the exponent and mantissa.

INFO

The Modbus function codes mentioned throughout this document shall be used as described in chapter 6 of the MODBUS APPLICATION PROTOCOL SPECIFICATION V1.1b3, available at the Modbus Organisation's Technical Resources site https://www.modbus.org/modbus-specifications.

Communication settings (INT16)

Parameter	Register number[1] [Dec]	Register address[2] [Hex]	Size[3]
Write register: function code 0x06			
Modbus address[4][5]	1	00	1
Modbus protocol settings[4]	2	01	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

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 refer to Application Note Modbus AN0103 (available at www.epluse.com/ee650).
5) If the ID is set via DIP-Switch the response will be NAK.

Tab. 5 EE650 registers for device setup

6.4 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			
Temperature	°C	1003	3EA
Temperature	°F	1005	3EC
Air velocity	m/s	1041	410
Air velocity	ft/min	1043	412

INT16

Parameter	Unit[1]	Scale[4]	Register number[2] [DEC]	Register address[3] [HEX]
Read register: function code 0x03 / 0x04				
Temperature	°C	100	4002	FA1
Temperature	°F	50	4003	FA2
Air velocity	m/s	100	4021	FB4
Air velocity	ft/min	1	4022	FB5

1) The choice of measurement units (metric or non-metric) must be done according to the ordering guide, refer to EE650 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. 6 EE650 FLOAT32 and INT16 measured data registers

6.5 Modbus RTU Example

The EE650's Modbus address is 65 [0x41].

Please refer to

- MODBUS APPLICATION PROTOCOL SPECIFICATION V1.1b3, chapter 6, available at the Modbus Organisation's Technical Resources site https://www.modbus.org/modbus-specifications.
- E+E Application Note Modbus AN0103 (available at www.epluse.com/ee650)

Read the temperature (FLOAT32) T = 26.652524 °C from the register 0x03EA:

Master (e.g. PLC) **EE650**

Request [Hex]:

Modbus address	Function code	Starting address Hi	Starting address Lo	Qty. of registers Hi	Qty. of registers Lo	CRC	
41	03	03	EA	00	02	EB	7B

Response [Hex]:

Modbus address	Function code	Byte count	Register 1 value Hi	Register 1 value Lo	Register 2 value Hi	Register 2 value Lo	CRC	
41	03	04	38	5F	41	D5	77	4A

Tab. 7 Example temperature 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 T reading Modbus request/response example above):

Modbus response [Hex]			
Byte 3	Byte 4	Byte 1	Byte 2
38	5F	41	D5
MMMMMMMM	MMMMMMMM	SEEEEEEE	EMMMMMMM

Tab. 8 Modbus response

IEEE754			
Byte 1	Byte 2	Byte 3	Byte 4
41	D5	38	5F
0100 0001	1101 0101	0011 1000	0101 1111
SEEE EEEE	EMMM MMMM	MMMM MMMM	MMMM MMMM
Decimal value: 26.652524			

Tab. 9 Data representation according to IEEE754

7 Maintenance and Service

Due to the absence of moving parts, the E+E air velocity sensor is not a subject to wear. The design (shape, dimensions and materials) of the hot-film air velocity sensor is inherently very insensitive to dust and dirt. No maintenance is required under normal ambient conditions. For operation in dirty environments, it is advisable to clean the sensor head regularly in isopropyl alcohol, preferably in an ultrasonic cleaner. Alternatively shake it gently for a few minutes in a pot with isopropyl alcohol and allow it to dry freely.

NOTICE

Do not touch or rub the sensor and do not use any mechanical tools for cleaning.

7.1 Repairs

PLEASE NOTE

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

8 Accessories

For further information please refer to the Accessories datasheet.

Accessories	Code
USB-C configuration stick	**HA011070**
PCS10 Product Configuration Software (free download: www.epluse.com/pcs10)	**PCS10**
Power supply adapter 24 V DC	**V03**

9 Technical Data

Measurands

Air Velocity (v)	
Measuring range	0...10 m/s (0...2000 ft/min) 0...15 m/s (0...3000 ft/min) 0...20 m/s (0...4000 ft/min) (factory setting)
Accuracy[1] from 0.2 m/s, @ 20 °C (68 °F), 45 %RH and 1 013 hPa (14.7 psi)	±(0.2 m/s (40 ft/min) + 3 % of m. v.) mv = measured value
Response time t_{90}, typ. @constant temperature, selectable via jumpers, only for analogue output	4 s (factory setting) down to 1 s

1) The accuracy statement includes the uncertainty of the factory calibration with a coverage factor k=2 (2-times standard deviation). The accuracy was calculated in accordance with EA-4/02 and with regard to GUM (Guide to the Expression of Uncertainty in Measurement).

Outputs

Analogue

Air velocity (v) measuring range selectable via jumpers, only for analogue output	0 - 10 V 4 - 20 mA (3-wire, factory setting)	0 < I_L < 1 mA R_L ≤ 500 Ω	I_L = load current R_L = load resistance

Digital

Digital interface	RS485 (EE650 = 1 unit load)
Protocol **Factory settings** **Supported Baud rates** **Measured data types**	Modbus RTU 9 600 Baud, parity even, 1 stop bit, Modbus address 65 9 600, 19 200 and 38 400 FLOAT32 and INT16
Protocol **Factory settings** **Supported Baud rates**	BACnet MS/TP BACnet address 65 9 600, 19 200, 38 400, 57 600 and 76 800

General

Power supply class III ⧫ USA & Canada: Class 2 supply necessary		24 V AC/DC ±20 %	
Current consumption, max.		**AC supply**	**DC supply**
	Analogue output	170 mA	70 mA
	RS485	120 mA	50 mA
Electrical connection		Screw terminals max. 1.5 mm^2 (AWG 16)	
Cable gland		M16x1.5	
Humidity working range		5…95 %RH, non-condensing	
Temperature working range	**Probe** **Electronics** **Storage**	-25...+50 °C (-13...+122 °F) -10...+50 °C (+14...+122 °F) -30...+60 °C (-22...+140 °F)	
Enclosure material		PC (Polycarbonate), UL94V-0 approved	
Protection rating	**Enclosure** **Remote probe**	IP65 / NEMA 4X IP20	
Electromagnetic compatibility		EN 61326-1 FCC Part15 Class B	EN 61326-2-3 ICES-003 Class B Industrial environment
Conformity		CE UKCA	

10 Conformity

10.1 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/ee650 for the Declarations of Conformity.

10.2 Electromagnetic Compatibility

EMC for industrial environment.
The sensor is a group 1 device and corresponds to class B.

10.3 FCC Part 15 Compliance Statement

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the installation manual, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

10.4 ICES-003 Compliance Statement

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

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

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