PF4

Differential Pressurep and Temperature Transmitter

Instruction Manual

Contents

Scope:

This manual is valid for the PF4 transmitter series with firmware version V3.x. The low-order digit of the firmware version stands for minor changes, e.g. correction of errors that do not influence the main functionality of the device.

1 Overview

The PF4 is a high-precision differential pressure transmitter. The integrated measurement technology is able to detect very small differential pressures. The measurement results can be shown on the built-in display and exported via the analog outputs. Optional connection of a HygroClip2 probe, Pt100 sensor or analog input signal is possible. The isolated change-over switch of a relay can be controlled with configurable alarms.

Main features of the PF4 transmitter:

- High-precision measurement and long-term stability
- Fast response time and low hysteresis
- Freely configurable analog signals
- Isolated integral relay switch contact
- Large overload range
- Optional HygroClip2 connection for humidity, temperature or analog signals
- Selectable units
- High immunity to dust and humidity in the environment

New firmware updates will fix newly discovered issues and add new features. The user is encouraged to stay up to date with the newest firmware.

2 Dimensions

The PF4 comes as wall-mounted unit in a ROTRONIC housing. The following drawings show the relevant overall dimensions in mm.

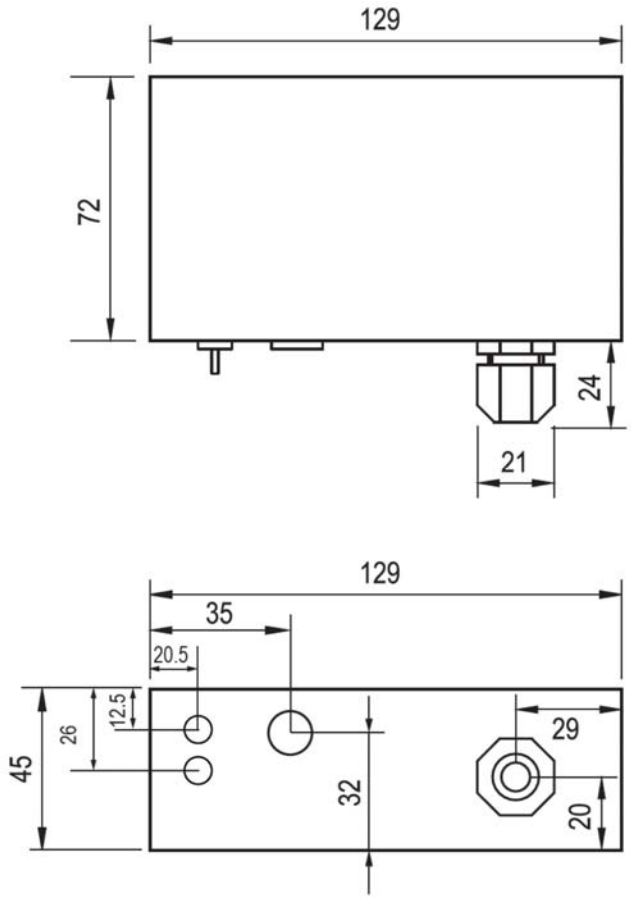


Figure 1: Important overall dimensions of the PF4

3 General Description

3.1 Power Supply

The PF4 is only available as three-wire version without galvanic isolation. For configuration purposes, the device can also be supplied with power via the service interface (Mini-USB port inside housing). During configuration with the service interface there is insufficient power to run the differential pressure sensor to its most accurate performance levels. The USB service connector should be used only for configuration purposes.

3.1.1 Power Supply / Current Consumption

Power supply specifications for the PF4:

Operating Voltage	Current Consumption
15…40 VDC	<70 mA / <150 mA (with Ethernet interface)
14…28 VAC – 50/60 Hz	<70 mA / <450 mA (with Ethernet interface)

3.2 Differential Pressure Measurement

The differential pressure measurement is based on the principle of thermal mass flow. A flow limiter in a tube generates a differential pressure. A very small quantity of gas diverted by a bypass before and after the limiter (max. 180 µl/min) is passed over a differential pressure sensor (Δp sensor) and then returned to the main flow. Figure 2 on the left shows the principle of this mass flow measurement.

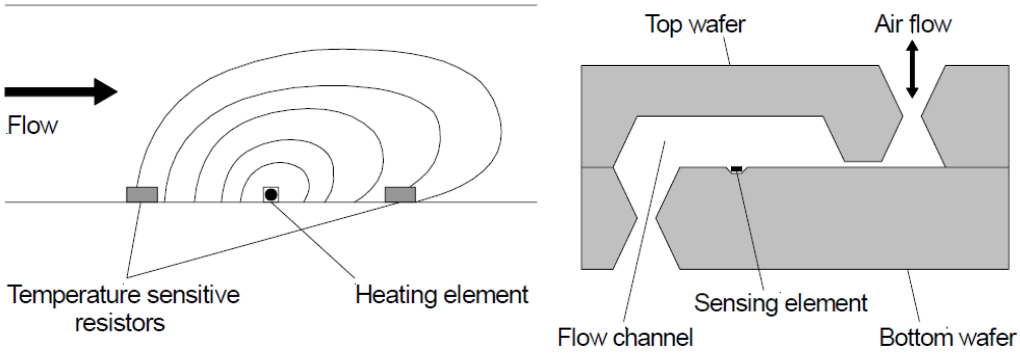


Figure 2:
Principle of the mass flow measurement (left) and cross-section of MEMS differential pressure sensor (right)

The Δp sensor contains a heating element and a temperature sensor each before and after the heating element. Due to the differential-pressure dependent flow velocity in the flow passage of the Δp sensor, the downstream temperature sensor heats up more or less than the upstream temperature sensor. In this way it is possible to obtain an output voltage from the Δp sensor as potential difference between the temperature sensor output signals that is, following careful linearization, strictly proportional to the volume flow.
The sensor used in the PF4 series is based on a 2x2 mm silicon chip (Figure 2, right). This enables production of an extremely small and exactly reproducible flow passage with a very high pneumatic resistance, resulting in extremely small sensor flow rates (max. 180 µl/min) and practically independent of the bypass tube lengths and dust and moisture loads in the gas stream.
Conclusion: The high measuring sensitivity, accuracy and long-term stability of the ROTRONIC PF4 series make it the ideal choice for monitoring volume flows and pressures in energy-efficient and economical ventilation and air conditioning systems.

Inside View:

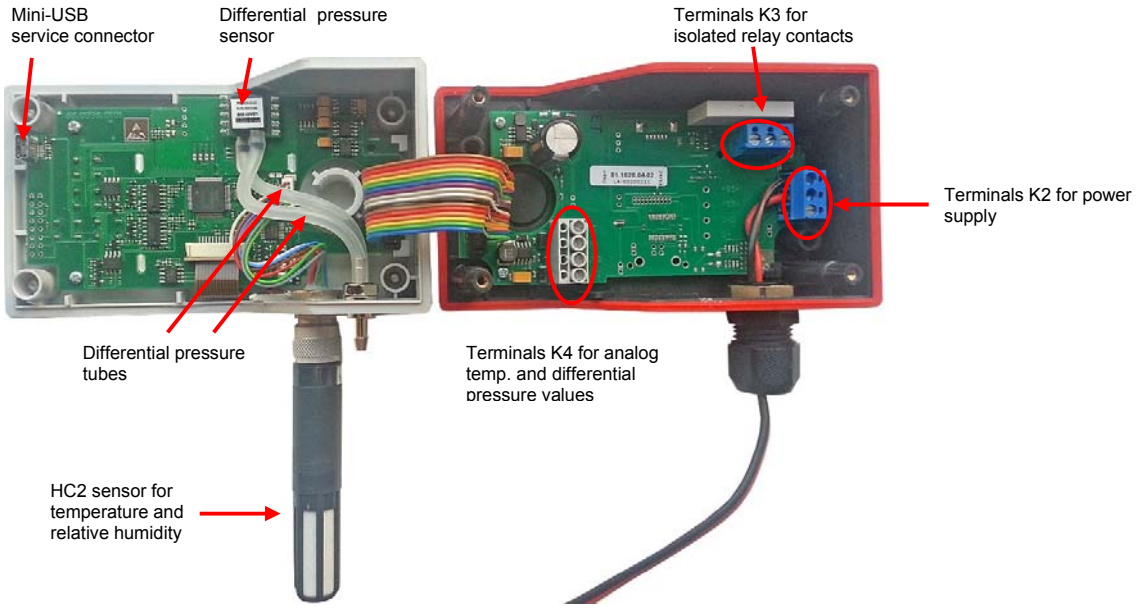


Figure 3: Inside view with description of the main components of the PF4

3.2.1 Differential Pressure Measurement Ranges

The following sensor measurement ranges are available:

- -25...+25 Pa
- -50…+50 Pa
- -100…+100 Pa
- -250…+250 Pa
- -500…+500 Pa

Differential pressures outside the specified ranges are shown, but the measurement results are not reliable.

3.2.2 Unit Systems

The following unit systems are available:

Unit	Unit Symbol	Remarks
Pascal	Pa	1 Pa = 1 N/m²
Inch water column	inH_2O	1 inH_2O (4 °C) = 249.089 Pa
Milli-pound-force per square inch	mpsi	1 mpsi = 0.001 psi = 6.89476 Pa
Millibar	mbar	1 mbar = 0.001 bar = 100 Pa
mm mercury column	mmHg	1 mmHg (0 °C) = 133.322 Pa
mm water column	mmH_2O	1 mmH_2O (4 °C) = 9.80665 Pa
Torr	Torr	1 Torr = 133.322 Pa
Gram per square centimeter	g/cm^2	1 g/cm^2 = 98.0665 Pa

3.2.3 Filters

The curve of the differential pressure measured values can be smoothened with the help of a low-pass filter with selectable time constant. There are 13 smoothing filter stages available. Practice has shown stages 0...7 meet most application requirements.

Filter Stage	Time Constant τ63	Time Constant τ99	Description
0	0 s	0 s	No filtering
1	0.4 s	1.8 s	Weak filtering
2	0.9 s	4.3 s	…
3	1.9 s	9.3 s	…
4	3.9 s	19.3 s	…
5	7.8 s	39.2 s	…
6	15.8 s	78.9 s	…
7	32.0 s	2.7 min.	…
8	1.0 min.	5.3 min.	Strong filtering
9	2.1 min.	10.6 min.	…
10	4.2 min.	21.2 min.	…
11	8.5 min.	42.4 min.	…
12	17.0 min.	1.4 h	…
13	33.9 min.	2.8 h	Extremely strong filtering

3.2.4 Simulator Value

When the simulator value has been activated, a defined simulator value is used instead of the current measured value.

3.3 Pt100 Connection

A Pt100 temperature sensor can optionally be connected to the four-pin connector (Binder series 711). The possible measurement range depends on the Pt100 sensor and is max. -100...200 °C.

3.3.1 Unit Systems

The following unit systems are available for temperature measurement:

- °C
- °F

3.3.2 Simulator Value

When the simulator value has been activated, a defined simulator value is used instead of the current measured value.

3.4 HC2 Connection

The PF4 optionally comes with a HC2 connection socket. It can be used for all HC2 probes in the ROTRONIC portfolio. Alternatively, one pin of the socket can be used as analog current or voltage input. It must be established on ordering the device whether the pin can evaluate current or voltage signals; it cannot be reconfigured to do so later on (see chapter 6.4).

3.4.1 Unit Systems

The following unit systems are available for the HC2 connection:

- %RH
- °C / °F
- mV / mA

3.4.2 Simulator Value

When the simulation value has been activated, a defined simulator value is used instead of the current measured value.

3.5 Analog Outputs

The ROTRONIC HW4 software enables free configuration and scaling of the analog outputs. The measured values (differential pressure, humidity, temperature, calculation value) can be assigned at will to any analog output (Out1, Out2) and the required range can also be scaled freely.

The following output ranges are available:

Type	Range
Voltage	• 0…1 V • 0…5 V • 0…10 V
Current	• 0…20 mA • 4…20 mA

The different variants of the analog output each have a minimal offset:

Signal Type	Maximum Offset at Start of Range
0...1 V	3 mV
0...5 V	50 mV
0...10 V	90 mV
0...20 mA	4 µA
4...20 mA	No offset

3.5.1 Scale

The scale can be changed at will with the ROTRONIC HW4 software in a range from -9,999 to +99,999. The limits of the sensor must, however, be observed (see chapter 3.2 /3.3 / 3.4).

The devices have one of the following optional default settings on delivery:

Differential Pressure	Humidity	Temperature	Analog Input
• 0…+10 Pa • 0…+25 Pa • 0…+50 Pa • 0…+100 Pa • 0…+250 Pa • 0…+500 Pa • -25…+25 Pa • -50…+50 Pa • -100…+100 Pa • -250…+250 Pa • -500…+500 Pa	• 0…100 %RH	• 0…50 °C • 0…70 °C • +10…40 °C • 0…+100 °F • 0…+200 °F	• 0…3.2 V • 0…25 mA

3.6 Relay

The PF4 provides a freely configurable internal isolated relay contact.

- Normally closed (NC)
- Common (COM)
- Normally open (NO)

The relay can be controlled by freely configurable alarms. The following can also be set:

- **Time delay**
  The relay is only switched on when an alarm endures for a certain minimum time.

- **Switch off when alarm finished**
  The relay automatically disengages when the alarm is no longer active; otherwise the relay remains active until it is reset manually.

- **Maximum duty cycle**
  The relay stays on for at most the time set and is then switched off.

The relay can only be activated by a measured value. Assignment of more than one measured value is not possible.

3.7 Service Interface

Using the HW4 software, the service interface (UART) allows device settings, loading of language data and updating of the firmware. The service interface is located inside the housing. It is connected to the computer with the HW4 software with an AC3006 or AC3009 connection cable.

Important:
The PF4 can be supplied with power through the service cable. The service cable provides insufficient power for correct differential power measurement.
For sensor adjustment, the PF4 must be supplied with power from a suitable power source via the terminals provided (K2-1: -/~, K2-2: +/~).

3.8 Display and Keys

The optional LCD for the PF4 has a backlight.
The display unit is configurable. Depending on the version (differential pressure / differential pressure & Pt100 / differential pressure & HC2 connection), the different parameters can be assigned to the different display lines. In the full version with HC2 connection, there are three display lines available. They can be assigned the following parameters:

- differential pressure
- humidity
- temperature
- analog input (is only shown when analog input is active)
- calculation
- no value

The first line of the display shows the differential pressure, the second the relative humidity and the third the temperature or calculated value such as dew point / frost point. A trend indicator can also be configured for every line.

The optional LCD for the PF4 has a backlight. The first line of the display shows the differential pressure, the second the relative humidity and the third the temperature or calculated value such as dew point / frost point. The display can be configured to show a trend indicator in every line.

Figure 4: Display of the PF4 with connected HC2 probe

Keys:

menu:	Open menu / Next-higher menu level
+:	Increase value
-:	Decrease value
✓:	OK / Next-lower menu level

3.8.1 Alarms

Measured values with an alarm are shown with an exclamation mark **[!]**. Alarms are configured with the HW4 software.

3.8.2 Decimals

The PF4 adjusts the number of decimal places automatically on the basis of the current measured value. The display therefore always shows the measured value clearly with the corresponding number of significant decimals.

3.9 HW4 Software Compatibility

PF4 differential pressure transmitters are integrated completely in the HW4 software - devices with only differential pressure measurement or additional Pt100 connector from V3.2 and later, and with HC2 connection option from V3.4.

PF4 Version	**Supported in HW4 from Version:**
PF4 without additional connector PF4 with B4 connector	HW4 V3.2
PF4 with E2 connector	HW4 V3.4

4 Mechanical Installation

4.1 General

The PF4 can be mounted on a wall or on a DIN top-hat rail. The position of the device and thus of the differential pressure sensor has no influence on measurement, i.e. the device is not sensitive to position. However, for exact measurement, the device must not move and must not be exposed to vibrations.

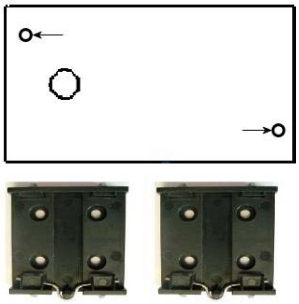
IMPORTANT:
After complete mechanical installation, the atmospheric pressure must be programmed in the device as described in chapter 6.1.1.

4.2 Housing

The housing can be opened by unscrewing four screws. The screw breakthroughs for wall mounting and electrical connections for the power supply, analog outputs, service interface and the relay are to be found inside the housing.

Figure 5: Front view PF4 housing

4.3 Mounting



Method 1: The PF4 comes with two screws, two wall plugs and two rubber washers. There are two screw depressions in the bottom part of the housing (closed on delivery). Use the template delivered with the PF4 to drill the holes in the wall and put in the wall plugs. Place a rubber washer under each screw head. Put a screw in each depression and push through the bottom of the depression.

Method 2: The mounting kit **AC5002** (not included) is needed for mounting on a DIN top-hat rail (35 mm / 1 3/8"). The mounting kit consists of two clips, which are fastened to the back of the housing with the screws supplied.

Figure 6: Mounting kit AC5002 and drilling points for wall mounting

4.4 Differential Pressure Connection

Tubes with an internal diameter of 4 mm can be connected. The tubes must be fastened securely so that they do not move or vibrate during operation. This would falsify the measurement.

Configuration of differential pressure connections:

+: Positive pressure connection

-: Negative pressure connection

Figure 7: Differential pressure connections and E2 socket on the bottom side of the PF4

4.5 HC2 / Analog Connection

The PF4 can optionally be ordered with an E2 socket. This interface and its possible uses are described below.

4.5.1 Use of HC2 Probe

The PF4 can optionally be set up for a HC2 probe. After connection of a HC2 probe, it is possible to measure and display three parameters:

- Differential pressure
- Humidity
- Temperature / Calculation

Figure 8: E2 and differential pressure connection on the bottom side of the PF4

All HC2 probes currently available can be connected. The measured data of the HC2 probe is evaluated digitally and shown on the display. Two of the measured values can be assigned to the analog outputs (chapter 6.2) and processed further. The optional Ethernet interface (chapter 6.3) of the PF4 can output all measured values.

4.5.2 Use of Analog Input

The device menu is used to switch between use of a HC2 probe and an analog third-party probe. The display of the PF4 switches automatically to the units mA / mV of the analog input.
The input is reconfigured with the device menu:

MENU > *Probe Information* > *Sensor Type*

Select between the following options:

- HC2 Digital HC2 probes are read out
- Analog In Analog input is used

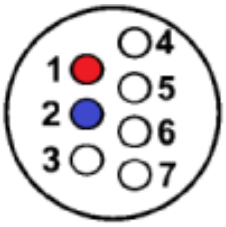
The PF4 then asks the user to confirm the sensor change and restarts with the corresponding display configuration.

Remark:

The PF4 does not contain a power supply for an analog third-party probe. If adequate, the power supply for the HC2 probe can be used via the pins V+ and GND (see Figure 9).

When using an analog probe, be sure to define both the voltage signal range and the measurement range of the probe. The HW4 software requires definition of the measurement range for an analog probe. The HW4 software can also be used to change the probe type for the input.

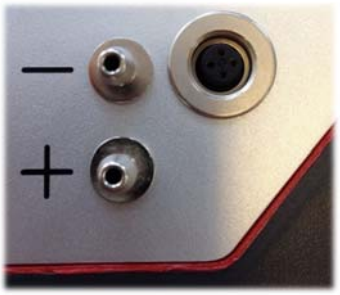
Pin Configuration E2 Connection



1) V+: Digital probe: 3.3 VDC, 10 mA
2) GND: Digital and supply ground
3) RXD: UART digital probe
4) TXD: UART digital probe
5) ANA IN: Analog input: 0…3.2 V / 0…25 mA
6) NU: Not used
7) AGND: (Analog GND)

Figure 9: Pin configuration of the E2 socket (view from front)

4.6 Pt100 Connection



The PF4 comes optionally with a Pt100 connection with four-pin connector (Binder series 711) for all Pt100 probes from ROTRONIC and all variants of third-party Pt100 probes.

Figure 10: Pt100 and differential pressure connection on the bottom side of the PF4

Wiring Diagram / Pin Configuration

Figure 11 shows the pin configuration and wiring diagram for the Pt100 probe.

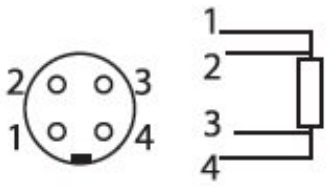


Figure 11: Four-wire wiring of the Pt100

5 Electrical Installation

This section describes the general safety precautions for electric wiring.

5.1.1 Cable Grip and Cable Specifications

The PF4 comes with a M16 cable grip with screw cable gland. The M16 cable grip offers effective sealing if cables with external diameters of 6 to 7 mm (0.236 to 0.275 inch) with connection wires per 18 AWG are used.

5.1.2 General Connection Information

Heavy machinery and measuring instruments should not share the same electric cables for power supply. If this cannot be avoided, noise filters and surge protectors should be used, as integrated in most UPS devices.

5.1.3 Signal Cable Information

The following guidelines are derived from the European standard EN 50170 for the transmission of signals by copper wires. Note on installation planning: when determining the position of machinery and equipment, the rules given in EN 50170 should be followed with due regard to local circumstances.

All ROTRONIC products are tested for electromagnetic compatibility according to EMC Directive 2004/108/EC and the following European standards:

- EN 61000-6-1: 2007, EN 61000-6-2: 2005
- EN 61000-6-3: 2007, EN 61000-6-4: 2007

Whenever the level of electromagnetic interference is expected to be high, both the devices and signal cables should be placed as far away as possible from the source of interference.

In general, signal cables should be installed in bundles or channels / conduits, separate from other cables as indicated in the table below:

• Bus signals such as RS-485 • Data signals for PCs, printers, etc. • Shielded analog inputs • Unshielded DC voltage (<= 60 V) • Shielded process signals (<= 25 V) • Unshielded AC voltage (<= 25 V) • Coaxial cables for CRT monitors	**in common bundles or channels / conduits**
• DC voltage from 60 V to 400 V (unshielded) • AC voltage from 25 V to 400 V (unshielded)	**in separated bundles or channels / conduits, without minimum distance**
• DC and AC voltage > 400 V (unshielded) • Telephone lines • Lines leading into EX-rated areas	**in separated bundles or channels / conduits, without minimum distance**

5.2 Wiring

This section describes the wiring of the device with connection possibilities.

5.2.1 Electrical Diagrams

The PF4 is wired with a four-pin connection cable for transmission of the electrical power and measured values. The maximum permissible cable length depends on the voltage drop caused by the flow of current to the devices connected to the PF4 outputs. The effective load of a PF4 output comprises the cable and load resistance and should amount to at least 1000 ohm. The cable resistance should not be more than 1/1000 of the load resistance.

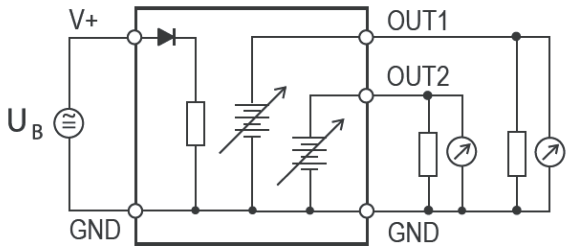


Figure 12: Voltage outputs

The maximum permissible length of the cable connecting the unit to other devices is determined by the total resistance resulting from addition of the cable resistance and resistance of the devices connected to the unit in series. This resistance should not exceed 500 ohm (load).

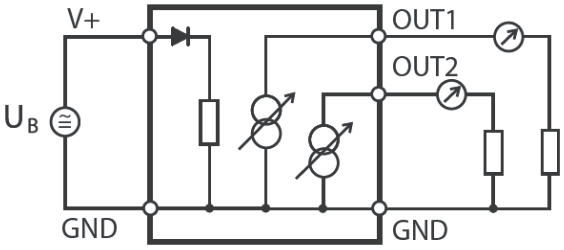


Figure 13: Current outputs

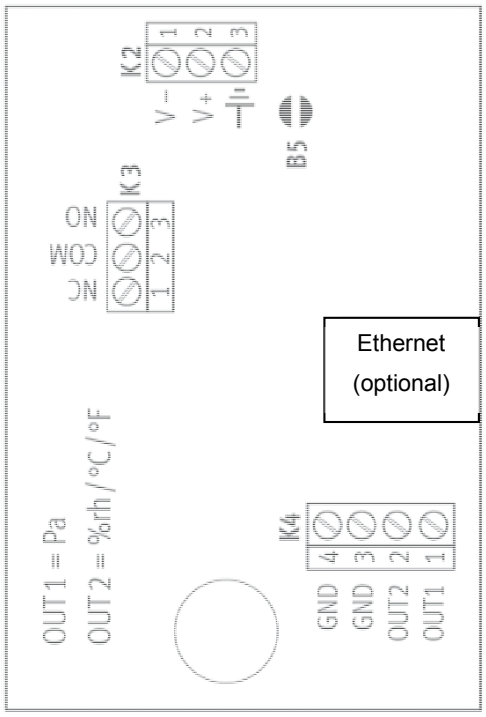


Figure 14: Connection terminals on the board

Terminals	Description
K2-1: V-	Power supply: 15…40 VDC (-) or 14…28 VAC
K2-2: V+	Power supply: 15…40 VDC (+) or 14…28 VAC
K2-3: ⏚	Protective ground

K3-1: NC	Normally closed – relay not energized
K3-2: COM	Common – common contact
K3-3: NO	Normally open – relay energized

K4-1: OUT1	Differential pressure analog output (+)
K4-2: OUT2	Temperature / Humidity analog output (+)
K4-3: GND	Ground (connected to other GND), see note below
K4-4: GND	Ground (connected to other GND)

Note:

Terminal K2-3 (protective ground) is connected with GND due to the closed solder jumper B5. To remove this connection, open solder jumper **B5**.

Warning:

Before connecting the PF4 to an active Ethernet network, make sure it is configured correctly for IP communication. Otherwise conflicts could disturb communication in the network.

6 Operation

This chapter describes handling of the device in operation.

6.1 Differential Pressure

6.1.1 Ambient Pressure

The differential pressure sensor in the device is dependent on the local absolute ambient atmospheric pressure P_{abs}. This must be communicated to the PF4 per display or HW4 software in order to attain the measuring accuracy named in the data sheet. P_{abs} can be determined with a barometer.

Note:
The "atmospheric pressure at the place of use" QFE is to be used and not the "normalized atmospheric pressure" QFF, which is communicated in weather forecasts (see also http://de.wikipedia.org/wiki/QFE#QFE).

The ambient pressure enters the measurement as follows and the differential pressure is compensated automatically on the basis of the ambient pressure setting:

Formula	Legend
$\Delta P_{eff} = \Delta P_{Sensor}\left(\frac{1000hPa}{P_{abs}}\right)$	ΔP_{eff} Real differential pressure [Pa] ΔP_{Sensor} Measured differential pressure [Pa] P_{abs} Ambient pressure [hPa]

Relationship between altitude and pressure (on average):

Formula: $P_{abs} = P_0\left(1 - \frac{Höhe}{44330}\right)^{5.255}$ where $P_0 = 1013.25hPa$

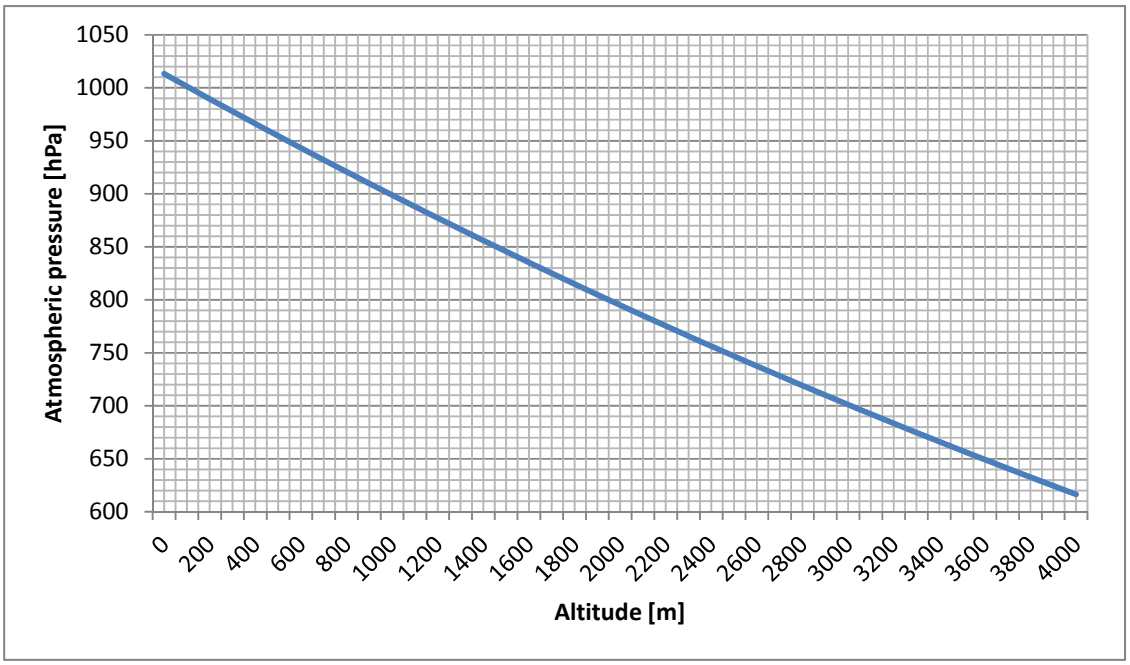


Figure 15: Graph showing the correlation between atmospheric pressure and altitude

6.1.2 Dust and Humidity

Since the flow of air through the differential pressure sensor is very low (max. 180 µl/min), dust particles already settle on the inside walls of the inlet tube and do not reach the sensor. The device is thus largely insensitive to dust in the air being measured. The same applies to condensing air in the tube. As a result very little humidity is transported to the sensor.

6.2 Analog Outputs

The analog outputs of the PF4 are configured at the factory according to the order specifications. If a change is required use HW4 software to modify the instrument configuration.

6.3 Ethernet Connection

The PF4 with digital option uses the standard RO-ASCII protocol. Users who wish to evaluate the measured data without ROTRONIC HW4 software are asked to consult ROTRONIC.

The Ethernet interface of the PF4 can be used best together with a PC with installed HW4 software (version 3.2 or later). Users may in principle access the measured data of the PF4 with any communication software. This is described in detail in the document **E-M-AC3000-CP**.

Before connecting the PF4 to an active Ethernet network, it is first necessary to configure the TCP/IP settings. You can find instructions for this in the HW4 manual **E-M-HW4v3-Main** (chapter 7.4) and the technical guidelines **E-M-TCPIP-Conf**. The manuals can be downloaded from the website www.rotronic.com.

***WARNING**:*
Before connecting the PF4 to an active Ethernet network, make sure it is configured correctly for IP communication. Otherwise conflicts could disturb communication in the network.

6.4 Analog Input

The measurement range for the input voltage lies between 0 and 3.2 V if a voltage input is configured and from 0...25 mA if a current input is configured. It must be stipulated in the order code whether the analog input is to be configured as current or voltage measurement (see also chapter 3.4).

6.4.1 Display for Analog Input

The measured values of the analog input are shown in the display in mV / mA by default. For the analog input, input signals smaller than 0 mV / mA are shown as vv.vv. Input signals greater than 3.2 V / 25 mA are shown in the display as ^^.^^. This display is also shown if a display calculated via Range and Scale is wanted and the effective input signal measured lies outside the permissible range.
The number of decimals shown in the display of the analog input is adjusted automatically in dependence on the input or scale value.

6.4.2 Unit Systems

The default analog input unit is mV / mA. A user-specific unit can be configured in the HW4 software (e.g. %, mbar, etc.). There are a maximum of four characters available for this.

6.4.3 Accuracy

The accuracy of the analog input is better than 0.5% of the displayed value and additionally ±1 digit of the last place of the display.

6.4.4 Scaling of the Analog Input

The analog input can be scaled within the range 0…3.2 V / 0…25 mA. If, for example, only 1...2.5 V are to be shown in the display due to the application or a connected third-party probe, the analog input must be scaled accordingly. Figure 16 illustrates scaling of the analog input.

Legend for Figure 16:

Input-Range:	0…3.2 V / 0…25 mA
RangeLo:	0 V / 0 mA (lowest input value)
RangeHi:	3.2 V / 25 mA (highest input value)
ScaleLo:	Bottom scale limit (min. value shown in display)
ScaleHi:	Top scale limit (max. value shown in display)

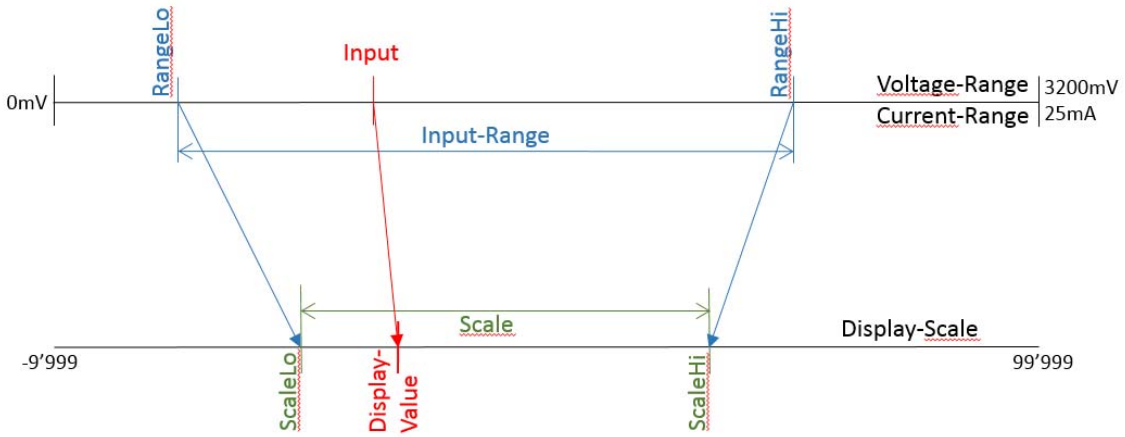


Figure 16: Graphic representation of scaling the analog input

Example:

An ambient pressure sensor with an analog output of 500…1000 mV (900…1100 hPa) is to be connected and its signal shown in hPa. The Input-Range with the limits RangeLo = 500 mV and RangeHi = 1000 mV and the display range Scale with ScaleLo = 900 and ScaleHi = 1100 mean that an input voltage of 500 mV shows the value 900 in the display and an input voltage of 1000 mV the value 1100. The unit is configured with the HW4 software as "hPa".

Remark on PF4 with HC2 and analog input:

The formula for calculation of the Display-Value is:

$$DisplayValue = \frac{(Input - RangeLo) * (ScaleHi - ScaleLo)}{RangeHi - RangeLo} + ScaleLo$$

Examples:

	RangeLo	500						
	RangeHi	1000						
	ScaleLo	900						
	ScaleHi	1100						
Input	Value	Input	Value	Input	Value	Input	Value	
0	700.00	1000	1100.00	2000	1500.00	3000	1900.00	
100	740.00	1100	1140.00	2100	1540.00	3100	1940.00	
200	780.00	1200	1180.00	2200	1580.00	3200	1980.00	
300	820.00	1300	1220.00	2300	1620.00			
400	860.00	1400	1260.00	2400	1660.00			
500	900.00	1500	1300.00	2500	1700.00			
600	940.00	1600	1340.00	2600	1740.00			
700	980.00	1700	1380.00	2700	1780.00			
800	1020.00	1800	1420.00	2800	1820.00			
900	1060.00	1900	1460.00	2900	1860.00			

	RangeLo	800						
	RangeHi	2200						
	ScaleLo	-50						
	ScaleHi	50						
Input	Value	Input	Value	Input	Value	Input	Value	
0	-107.14	1000	-35.71	2000	35.71	3000	107.14	
100	-100.00	1100	-28.57	2100	42.86	3100	114.29	
200	-92.86	1200	-21.43	2200	50.00	3200	121.43	
300	-85.71	1300	-14.29	2300	57.14			
400	-78.57	1400	-7.14	2400	64.29			
500	-71.43	1500	0.00	2500	71.43			
600	-64.29	1600	7.14	2600	78.57			
700	-57.14	1700	14.29	2700	85.71			
800	-50.00	1800	21.43	2800	92.86			
900	-42.86	1900	28.57	2900	100.00			

6.4.5 Output Scale

The display range (Scale = ScaleHi - ScaleLo) of the Display-Value can be selected freely within the complete display range (Display-Scale), but may not exceed the maximum display range of -9,999…99,999.

The output range (Output-Range = RangeHi - RangeLo) of the output signal (Output-Value) can be selected freely within the complete output range (Voltage- / Current-Range), but may not exceed the maximum output range, cf. chapter 3.5 (0…1 V / 0…5 V / 0…10 V / 0…24 mA / 4…24 mA). Fixed values (Fix-Value) are treated in the same way as Display-Values.

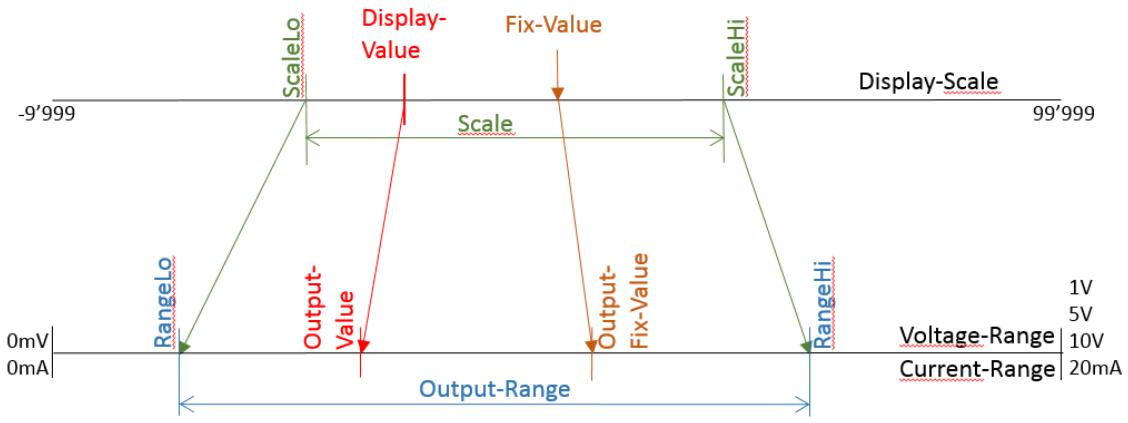


Figure 17: Graphic representation of scaling the analog output

Remark on PF4 with HC2 and analog input:

The formula for calculation of the Output-Value is:

$$OutputValue = \frac{(DisplayValue - ScaleLo) * (RangeHi - RangeLo)}{ScaleHi - ScaleLo} + RangeLo$$

Examples:

	ScaleLo	0					
	ScaleHi	100					
	RangeLo	0	V				
	RangeHi	10	V				
Display	Output	Display	Output	Display	Output	Display	Output
0.0	0.00	25.0	2.50	50.0	5.00	75.0	7.50
2.5	0.25	27.5	2.75	52.5	5.25	77.5	7.75
5.0	0.50	30.0	3.00	55.0	5.50	80.0	8.00
7.5	0.75	32.5	3.25	57.5	5.75	82.5	8.25
10.0	1.00	35.0	3.50	60.0	6.00	85.0	8.50
12.5	1.25	37.5	3.75	62.5	6.25	87.5	8.75
15.0	1.50	40.0	4.00	65.0	6.50	90.0	9.00
17.5	1.75	42.5	4.25	67.5	6.75	92.5	9.25
20.0	2.00	45.0	4.50	70.0	7.00	95.0	9.50
22.5	2.25	47.5	4.75	72.5	7.25	97.5	9.75
						100.0	10.00

	ScaleLo	-50					
	ScaleHi	50					
	RangeLo	2	V				
	RangeHi	9	V				
Display	Output	Display	Output	Display	Output	Display	Output
-50.0	2.00	-25.0	3.75	0.0	5.50	25.00	7.25
-47.5	2.18	-22.5	3.93	2.5	5.68	27.50	7.43
-45.0	2.35	-20.0	4.10	5.0	5.85	30.00	7.60
-42.5	2.53	-17.5	4.28	7.5	6.03	32.50	7.78
-40.0	2.70	-15.0	4.45	10.0	6.20	35.00	7.95
-37.5	2.88	-12.5	4.63	12.5	6.38	37.50	8.13
-35.0	3.05	-10.0	4.80	15.0	6.55	40.00	8.30
-32.5	3.23	-7.5	4.98	17.5	6.73	42.50	8.48
-30.0	3.40	-5.0	5.15	20.0	6.90	45.00	8.65
-27.5	3.58	-2.5	5.33	22.5	7.08	47.50	8.83
						50.00	9.00

6.5 Display and Keys

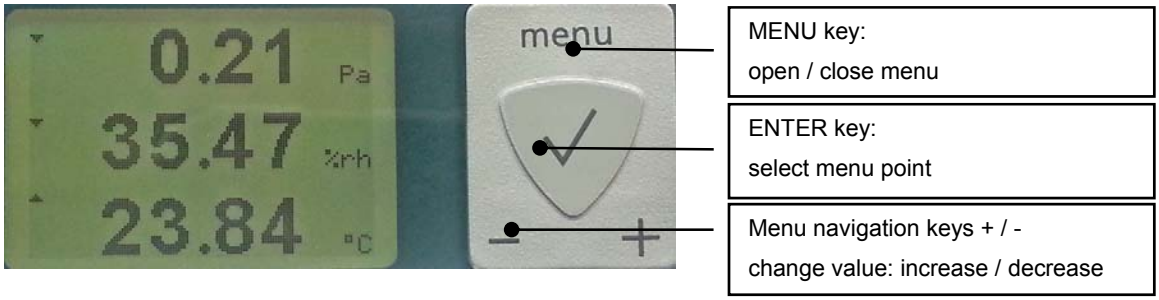
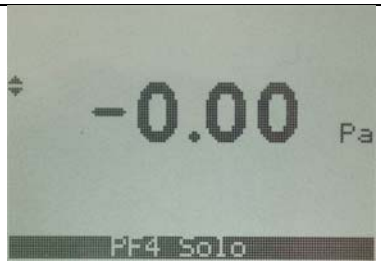


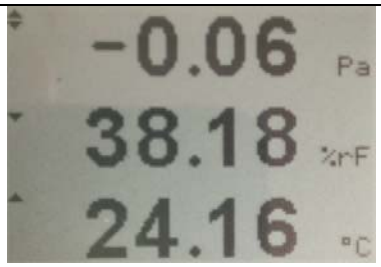
Figure 18: Display of the PF4 with connected HC2 probe

Note:
Unauthorized use of the menu can be prevented by locking the setting "Display Menu" (using the HW4 software > *Device Manager > Display).*

The display shows different measured values in dependence on the configuration of the device.

Device Variant	Displays	Units

Differential pressure		Differential pressure in Pascal [Pa]
Differential pressure & Pt100 connection		Differential pressure in Pascal [Pa] Temperature in degrees Celsius [°C]

Differential pressure & HC2 connection		Differential pressure [Pa] Relative humidity [%RH] Temperature [°C]
		Differential pressure [Pa] Relative humidity [%RH] Calculation [°C]
		Differential pressure [Pa] Voltage [mV]
		Differential pressure [Pa] Current [mA]

Remark:

It is possible to switch between display of the temperature and the calculations by pressing the **Enter** key [✓]. It is likewise possible to change between use of the HC2 probe and analog input in the device menu, as described in chapter 4.5.2.

Pressing the **–** and **+** keys switches between the different calculations:

Ew [hPa], E [hPa], Ds [g/m³], R (g/kg), Q [g/kg], Dv [g/m³], H [kJkg], Tw [°C], Fp [°C], Dp [°C].

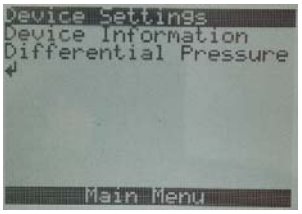
6.5.1 PF4 Menu

The menu structure depends on the hardware configuration of the device. The following three variants are possible:

- Only differential pressure
- Differential pressure & Pt100 connection
- Differential pressure & HC2 connection

Variant 1: Only differential pressure

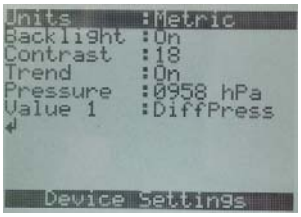
Main Menu



Menu Navigation (valid for all menus)

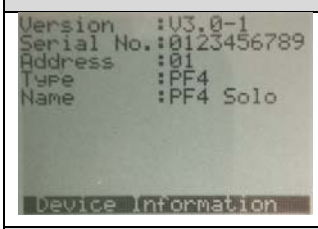
Select	Options
✓(Enter key)	Selection of the menu point
↵ or menu	Return; menu one level up
+	Line up; option right
-	Line down; option left

Device Settings



Select	Options
Units	Unit for the ambient pressure (Pressure): **Metric**, English
Backlight	**On**, Off, Key Press
Contrast	0…99 (suitable setting 15…40)
Trend	**On**, Off
Pressure	Ambient pressure (suitable setting: 950 - 1050 hPa): 0…9,999 hPa (Units: Metric) 0…9,999 inHg (Units: English)
Value 1	Main display: None, **DiffPress**

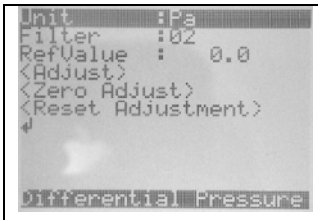
Device Information



The device information cannot be changed (except for "Name" and "Address").
"Name" and "Address" can be set with the HW4 software.

Settings for Differential Pressure

Select	Options
Unit	Unit for the differential pressure: **Pa**, inH_20, mpsi, mbar, mmHg, mmH_2O, Torr, g/cm2



Filters	Filter value (0 = fast, 13 = very slow): 0…13 (suitable setting 0…7)
RefValue	Current differential pressure can be changed
<Adjust>	Applies change to RefValue
<Zero Adjust>	Performs a zero adjustment
<Reset Adjustment>	Cancels the last change (<Adjust>, <Zero Adjust>)

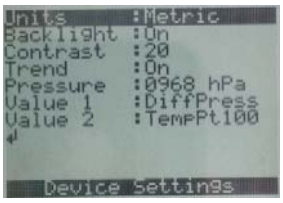
Variant 2: Differential pressure & Pt100 connection

Main Menu

Menu Navigation (valid for all menus)

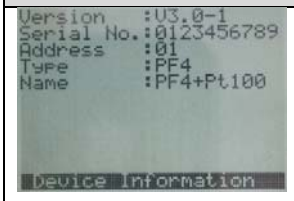
Select	Options
✓(Enter key)	Selection of the menu point
↵ or menu	Return; menu one level up
+	Line up; option right
-	Line down; option left

Device Settings



Select	Options
Units	Unit for the ambient pressure (Pressure): **Metric**, English
Backlight	**On**, Off, Key Press
Contrast	0…99 (suitable setting 15…40)
Trend	**On**, Off
Pressure	Ambient pressure (suitable setting: 950 - 1050 hPa): 0…9,999 hPa (Units: Metric) 0…9,999 inHg (Units: English)
Value 1	Main display: None, **DiffPress**, TempPt100
Value 2	Main display: None, DiffPress, **TempPt100**

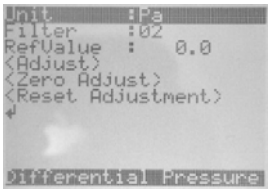
Device Information



The device information cannot be changed (except for "Name" and "Address").

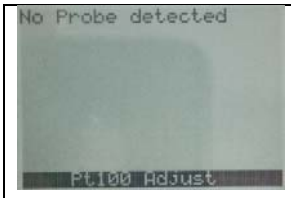
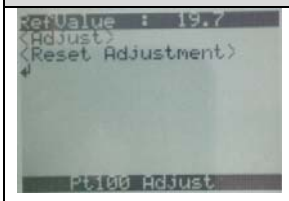
"Name" and "Address" can be set with the HW4 software.

Settings for Differential Pressure



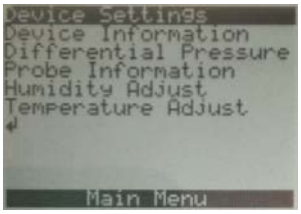
Select	Options
Unit	Unit for the differential pressure: **Pa**, inH_20, mpsi, mbar, mmHg, mmH_2O, Torr, g/cm2
Filters	Filter value (0 = fast, 13 = very slow): 0…13 (suitable setting 0…7)
RefValue	Current differential pressure can be changed
<Adjust>	Applies change to RefValue
<Zero Adjust>	Performs a zero adjustment
<Reset Adjustment>	Cancels the last change (<Adjust>, <Zero Adjust>)

Pt100 Adjust (1)

	Display when a Pt100 sensor **is not** connected
Pt100 Adjust (2)	
	Display when a Pt100 sensor **is** connected

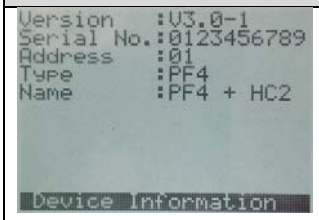
Select	**Options**
RefValue	The current temperature shown can be changed
<Adjust>	Applies change to RefValue
<Reset Adjustment>	Cancels the last change made with <Adjust>

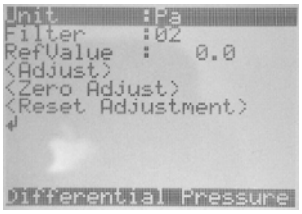
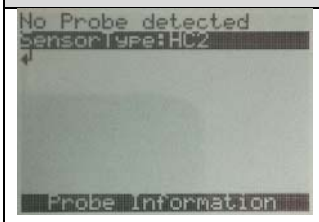
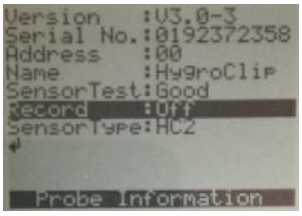
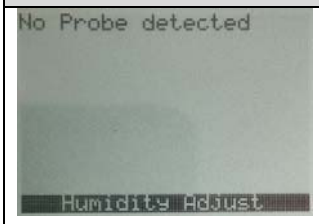
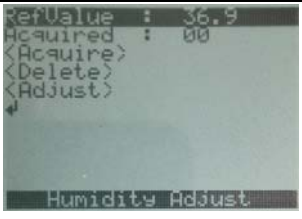
Variant 3: Differential pressure & HC2 connection

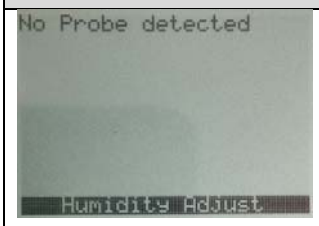
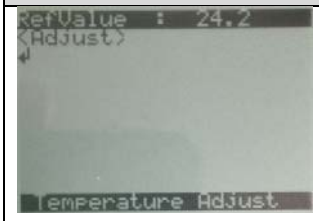
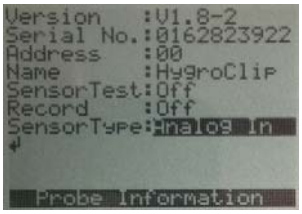
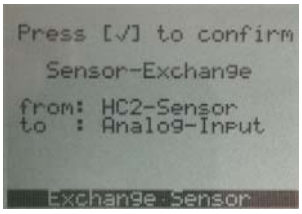
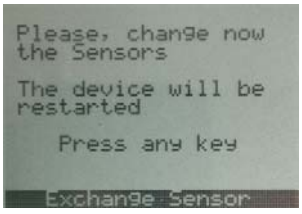
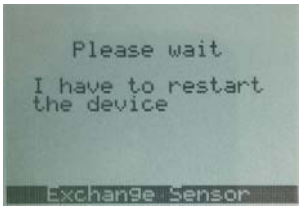
Main Menu	
	**Menu Navigation** (valid for all menus)

Select	**Options**
✓(Enter key)	Selection of the menu point
↵ or menu	Return; menu one level up
+	Line up; option right
-	Line down; option left

Device Settings		
	**Select**	**Options**
	Units	Unit for the ambient pressure (Pressure): **Metric**, English
	Backlight	**On**, Off, Key Press
	Contrast	0…99 (suitable setting 15…40)
	Trend	**On**, Off
	Pressure	Ambient pressure (suitable setting: 950 - 1050 hPa): 0…9,999 hPa (Units: Metric) 0…9,999 inHg (Units: English)
	Value 1	None, **DiffPress**, Humi HC2, Temp HC2, Calc
	Value 2	None, DiffPress, **Humi HC2**, Temp HC2, Calc
	Value 3	None, DiffPress, Humi HC2, **Temp HC2, Calc**

Device Information	
	The device information cannot be changed (except for "Name" and "Address").
	"Name" and "Address" can be set with the HW4 software.

Settings for Differential Pressure		
	**Select**	**Options**
	Unit	Unit for the differential pressure: **Pa**, inH_20, mpsi, mbar, mmHg, mmH_2O, Torr, g/cm2
	Filters	Filter value (0 = fast, 13 = very slow): 0…13 (suitable setting 0…7)
	RefValue	Current differential pressure can be changed
	<Adjust>	Applies change to RefValue
	<Zero Adjust>	Performs a zero adjustment
	<Reset Adjustment>	Cancels the last change (<Adjust>, <Zero Adjust>)
Probe Information (1)		
	Display when a HC2 sensor **is not** connected	
	Select	**Options**
	Sensor Type	Select sensor: **HC2**, Analog In
Probe Information (2)		
	Display when a HC2 sensor **is** connected	
	Select	**Options**
	Version	HC2 sensor: current firmware version
	Serial No.	HC2 sensor: serial number
	Address	HC2 sensor: sensor address
	Name	HC2 sensor: sensor name
	SensorTest	HC2 sensor: quality of sensor
	Record	HC2 sensor: **Off**, On
	SensorType	Select sensor: **HC2**, Analog In
Humidity Adjust (1)		
	Display when a HC2 sensor **is not** connected	
Humidity Adjust (2)		
	Display when a HC2 sensor **is** connected	
	Select	**Options**
	RefValue	Current relative humidity can be changed
	Acquired	
	<Acquire>	
	<Delete>	

	<Adjust>	Applies change to RefValue
Temperature Adjust (1)		
	Display when a HC2 sensor **is not** connected	
Temperature Adjust (2)		
	Display when a HC2 sensor **is** connected	
	Select	**Options**
	RefValue	The current temperature can be changed
	<Adjust>	Applies change to RefValue
Exchange Sensor		
	**Exchange Sensor** is started after selecting **Analog In** in menu **Probe Information**	
	The **HC2 sensor** can be substituted by an **analog input** (depending on order code, for current or voltage measurement). • The action is only started after confirmation by pressing the **Enter** key [✓]. • If the **Enter** key [✓] is not pressed within about 10 seconds, the device returns to the menu **Probe Information.**	
	Exchange **HC2 sensor** for the **analog input** and press any key • If a key is not pressed within about 20 seconds, the device starts automatically with the new settings.	
	The device is started with the new settings. **Summary of procedure:** MENU > *Probe Information > Enter > Sensor Type HC2 > Sensor Type Analog In > Enter > Change Sensors > Any Key*	

6.6 Relay

The relay can be used in operation as an alarm switch contact. The functions have already been described in section 3.6 . The relay is configured with the HW4 software, as described in the manual **E-M-HW4v3-P-001**.

6.6.1 Connections

The relay switch contacts are located at terminal block K3 (see Figure 14).

Connection	Designation	Description
COM	Common	Center tap of the change-over switch
NO	Normally open	Open when relay is not energized, closed when relay is energized
NC	Normally closed	Closed when relay is not energized, open when relay is energized

7 Maintenance

Warning:

If only the service cable AC3009 is used to supply power to the PF4, the differential pressure shown will not be correct because the voltage supply to the electronics is insufficient. For calibration or adjustment with the HW4 software, therefore, the power must be supplied via terminal block K2 in the bottom part of the housing.

7.1 Service Cable

Suitable service cables

- AC3006: requires additional power supply to the device
- AC3009: supplies the device directly with 5 VDC, differential pressure measurement will, however, not be correct without external power supply

7.2 Service Port

The Mini-USB service port is located inside the device. The device must be opened by unscrewing the four screws on the front of the housing in order to gain access to the Mini-USB service port.

Remark: AC3006 / AC3009 may be used as service cable.

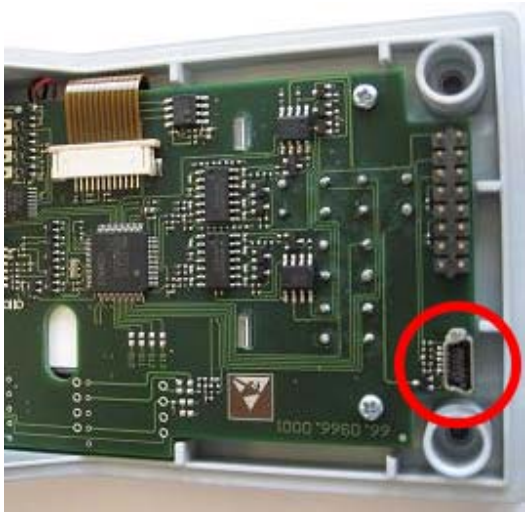


Figure 19: Location of the service port on the top side of the circuit board

7.3 Device Calibration and Adjustment Procedure

Both the differential pressure sensor and the corresponding electronics are very stable and require no maintenance. They do not normally need to be changed or recalibrated after factory calibration. For maximum accuracy, however, we recommend regular calibration of the device and adjustment when necessary.

Important:
When carrying out calibration or adjustment work on the open device, make sure you do not touch either the sensor or the compressed air tubes.

7.3.1 Adjust Differential Pressure

The differential pressure can be adjusted at two points.

- Zero
- Any reference point in the sensor measurement range

Zero Adjustment

1. Connect the pressure connections with a short tube
2. Select *"<Zero Adjust>"* in MENU > *Differential Pressure*

After successful zero adjustment, "OK" is shown in the display.

Reference Value Adjustment

1. Apply a defined differential pressure or determine the current differential pressure with a reference instrument connected in parallel.
2. Enter the reference value determined in MENU > *Differential Pressure* > *RefValue*.
3. Select *"<Adjust>"* in MENU > *Differential Pressure*.

After successful adjustment, "OK" is shown in the display.

Reset Adjustment

The following procedure is used to reset adjustment to the factory setting.

1. Select *"<Reset Adjustment>"* in MENU > *Differential Pressure*

After successful resetting of the adjustment, "OK" is shown in the display.

7.3.2 Adjust Pt100

Reference Value Adjustment

1. Enter a defined reference value with a Pt100 simulator or record the current nominal temperature with a reference instrument.
2. Enter the reference value determined in MENU > *Pt100* > *RefValue*.
3. Select *"<Adjust>"* in MENU > *Pt100*.

After successful adjustment, "OK" is shown in the display.

Reset Adjustment

The following procedure is used to reset adjustment to the factory setting.

1. Select *"<Reset Adjustment>"* in MENU > *Pt100*

After successful resetting of the adjustment, "OK" is shown in the display.

7.3.3 Adjust HC2 Probe

Both the Pt100-RTD temperature sensor used in the probe and the corresponding electronics are very stable and do not normally need to be calibrated after initial factory calibration.

The long-term stability of the HYGROMER humidity sensor from ROTRONIC is normally better than 1 %RH per year. For maximum accuracy, it is advisable to check the calibration of the probe every six to 12 months. Applications in which the probe is exposed to considerable contamination could require more frequent checks.

Temperature Adjustment

The optional keypad of the PF4 enables one-point adjustment of the temperature or humidity in relation to a reference. A one-point adjustment results in the same offset being added to all measured values.

- When the temperature is stable, press the MENU key to open the internal menu in the display.
- Select *Temperature Adjust* with the (-) key and press ENTER.
- Make sure that the text line beginning with *RefValue* is selected and press ENTER.
- Change the reference value to the temperature reference value with the (+) or (-) key.
- Move to the text line *Adjust* with the (-) key and press ENTER.
- The PF4 confirms adjustment with the message "Adjust OK".
- Press the MENU key two times to leave the menu and return the PF4 to normal operation.

Note:

- The following principle applies: perform temperature adjustment before humidity adjustment.
- The calibration point is deleted automatically from the probe memory after adjustment.
- Since the PF4 does not have a real-time clock, the date of the adjustment is not written in the probe. If it is important to record the adjustment date, use the HW4 software to adjust the probe.

Humidity Adjustment

The keypad of the PF4 enables multi-point adjustment of the humidity. The effect of a humidity adjustment differs in dependence on the number of calibration points entered into the probe memory before adjustment:

- One calibration point adds an offset to all measured values.
- Two calibration points influence the offset and gain of the measurement curve.
- Three or more calibration points influence the offset, gain and linearity of the measurement curve.

For maximum accuracy, three to four calibration points distributed over the measurement range in question should be used. The calibration points (maximum 100) can be entered in any order, but we recommend working from low humidity values to high humidity values.

- When the humidity is stable, press the MENU key to open the internal menu in the display.
- Select *Humidity Adjust* with the (-) key and press ENTER.
- Make sure that the text line beginning with *RefValue* is selected and press ENTER.
- Change the reference value to the reference humidity with the (+) or (-) key.
- Move to the text line *Acquire* with the (-) key and press ENTER.
- Note that the counter "Acquired" will be increased by 1 (number of calibration points in probe memory).
- When all calibration points have been acquired, move to the text line *Adjust* with the (-) key and press ENTER. **Only adjust the probe when all calibration points have been acquired.**
- The PF4 confirms adjustment with the message "Adjust OK".
- Press the MENU key two times to leave the menu and return the PF4 to normal operation.

Note:

- All calibration points are deleted automatically from the probe memory after adjustment.
- The text line *Delete* can be used to delete all calibration points before probe adjustment.
- Since the PF4 does not have a real-time clock, the date of the adjustment is not written in the probe. If it is important to record the adjustment date, use the HW4 software to adjust the probe.

7.4 Validation of Analog Output Signals

Using the HW4 software, it is possible to set fixed values with which the analog output signals can be validated.

8 Firmware Update

The firmware can be updated with the HW4 software. Firmware updates are available for downloading on the ROTRONIC website. To update the firmware, the PF4 must be connected to the HW4 with service cable AC3006. The PF4 must remain connected to the computer throughout the update process and there must be a stable power supply for the complete duration of the process.

Flashing of the display backlight indicates a firmware update is in progress.

9 Technical Data

General	
Device type	Differential pressure transmitter with analog output signals and optional Ethernet interface
Circuit type	3-wire circuit
Mounting types	W (Wall)

Power Supply and Connections	
Supply voltage (VDD)	15...40 VDC / 14...28 VAC
Rated current consumption DC supply	<70 mA (only analog outputs) <150 mA (with Ethernet interface)
Rated current consumption AC supply	<70 mA (only analog outputs) <450 mA (with Ethernet interface)
Electrical connections	Terminal block and M16 cable grip, optional RJ-45 Ethernet connector
Polarity protection	Protective diode on V+

Humidity and Temperature Measurement	
With HC2	See document **E-M-HC2 Probes** > Specifications.
With Pt100	Accuracy: ±0.2 °C Meas. range: -100…200 °C (depending on probe type)

Differential Pressure Measurement	
Measurement ranges	-25…+25 Pa / -50…+50 Pa / -100…+100 Pa / -250…+250 Pa / -500…+500 Pa
Accuracy	±1.0 %Full Scale Span
Response time sensor τ63	<10 ms (only sensor element)
Ambient pressure dependence	0.1 %/hPa
Air flow	120 – 180 µl/min
Pressure resistance	2 bar (2,000 hPa)
Long-term stability	<0.3 %/year
Adjustment points	Zero, reference point

Analog Input	
Measurement range	Voltage: 0…3.2 V Current: 0…25 mA
Accuracy	0.5% of current measured value
Temperature dependence	Voltage: ±30 mV Current: ±60 µA

Calculated Parameters	
Psychrometric parameters	Dew point (Dp) above and below freezing point Frost point (Fp) below freezing point and dew point above freezing point Wet bulb temperature (Tw) Enthalpy (H) Vapor concentration (Dv) Specific humidity (Q) Mixing ratio by weight (R) Vapor concentration at saturation (Dvs) Vapor partial pressure (E) Vapor saturation pressure (Ew)

Startup Time and Measurement Interval	
Startup time	<5 s (typical)
Measurement interval	1 s (typical)

Configurable Analog Outputs		
Output 1		Can be assigned to every parameter
	Default parameter	Differential pressure
	Default range	Per order code
Output 2		Can be assigned to every parameter
	Default parameter	Relative humidity / Temperature
	Default range	Per order code
Output 1 and output 2		
	Signal type	0…20 mA 4…20 mA 0…1 V 0…5 V 0…10 V (user-configurable)
	Accuracy analog output	±10 mV (voltage output) ±20 µA (current output)
	User-configurable range limits	-9,999...+99,999 units
	Refresh interval	1 s
	Short circuit tolerant	Yes
	Max. load	500 Ω (current output)
	Min. load resistance	1000 Ω (voltage output)

Digital Interface	
Interface type	Ethernet, wired

Service Connector	
Interface type	UART (TTL Level)
Max. length of service cable	5 m (16.4 ft)

General Specifications	
Relay switching capacity	<50 VAC / <75 VDC / <1 A
Optional display	LC, resolution 1 or 2 decimals, backlight, trend and alarm indicators
Housing material	ABS
Housing protection grade	IP65 (without Ethernet interface) IP40 (with Ethernet interface)
Dimensions	129 x 72 x 45 mm
Weight	240 g

Conformity with Standards	
CE / EMC immunity	EMC Directive 2004/108/EC: EN 61000-6-1: 2007, EN 61000-6-2: 2005 EN 61000-6-3: 2007, EN 61000-6-4: 2007
Solder type	Lead free (RoHS directive)
Fire protection class	Corresponds to UL94-HB
FDA / GAMP directives	CFR21 Part 11 and GAMP5

Environmental Limits	
Storage and transit	0...70 °C / 0...90 %RH, non-condensing
Operation	0...70 °C / 0...90 %RH, non-condensing

10 Accessories

10.1 Service Cable

Order Code	Description	
AC3006	Service cable, USB to UART	
AC3009	Service cable, USB to UART with integrated power supply	

10.2 Pressure Tubes

- AC6001 Connection tube with 4 mm diameter

10.1 Mounting Elements

Order Code	Description	
AC5002	Mounting kit for DIN top-hat rail (consisting of two clips, which are fastened to the back of the housing with the screws supplied). DIN top-hat rail (35 mm / 1 3/8") not included.	

11 Additional Documents

Document Name	Contents
E-M-HC2 Probes	HC2 manual
E-M-HW4v3-Main	HW4 software main manual
E-M-TCPIP-Conf	Manual for Ethernet configuration of ROTRONIC instruments
E-M-AC3000-CP	Communication protocol for all AirChip3000 instruments
E-M-HW4v3-P-001	HW4 software manual for PF4

12 Document Versions

Doc. Release	Date	Remark
E-M-PF4-V1_00	March 2014	Release document