

# Microwave Level Measurement *micropilot FMR 131*

**Smart transmitter for non-contact measurement  
in storage, buffer and process tanks  
Version for use in explosion hazardous areas**



Standard version with  
inactive length and  
DN 100 flange



Hygienic version with  
DN 100 flange

## Application

The Micropilot FMR 131 is designed for continuous, non-contact level measurement of liquids, pastes and slurries. It is particularly suitable for applications in which products often change, and temperature gradients, inert gas blankets or vapour are present.

The Micropilot uses the microwave pulsed time-of-flight measurement method and operates in a frequency band approved for industrial use. Its low beam power allows safe installation in metallic and non-metallic vessels, with no risk to humans or the environment.

## Features and Benefits

- Rod antenna with small process connections: can be installed on existing nozzles
- Standard version with inactive length: tall nozzles and heavy condensation present no problems
- All parts on process side made of PTFE: extremely good corrosion resistance, no need for special materials
- Gap-free version in FDA approved materials: accurate, non-contact measurement in hygienic applications
- Simple calibration: zero and span can be taken from tank drawings

## Functions

- Linearisation for volume measurement
- Suppression of interference echoes by fuzzy logic algorithms
- Self-monitoring.

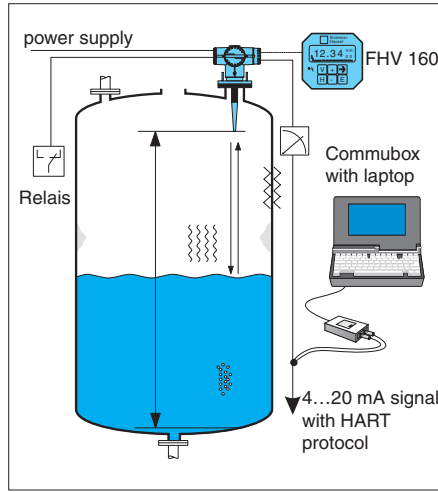
**Endress + Hauser**

The Power of Know How



# Measuring System

Micropilot FMR 131 measuring system: a handheld terminal or Commubox and laptop allows remote operation

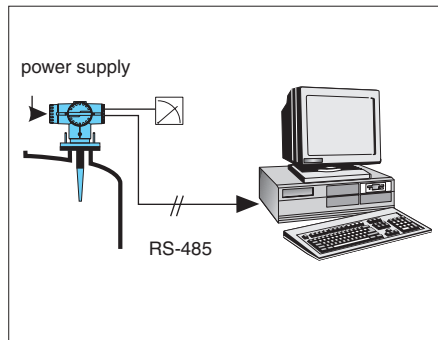


## System Components

Used as a compact transmitter the Micropilot FMR 131 is equipped with:

- FHV 160 operating and display module as well as HART protocol
- Remote operation is possible by handheld terminal or Commubox plus laptop.

The 4...20 mA output can be supplied *active* for powering follow-up devices or *passive* for connection to powered lines. A relay with potential-free changeover contact signals transmitter faults or level limits.



Single measuring point with direct connection to PC via Rackbus RS-485

## Rackbus RS-485 Interface (Option)

Using this option, several Micropilot transmitters can be connected together on a bus and operated directly from a personal computer. Alternatively, an FXA 675 card allows connection to a process control system via Rackbus.

# Measurement Principle

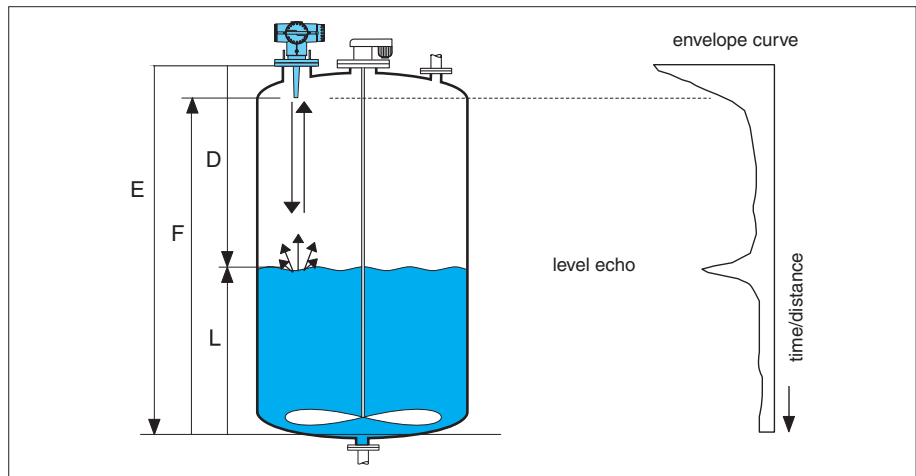
Short microwave pulses are beamed by the antenna towards the product, reflected by its surface and detected as a temporal record of the echoes – the envelope curve – by the same arrangement. The distance to the product surface is proportional to the time-of-flight of the microwave pulse:

$$D = c \cdot t/2$$

D= distance sensor - product surface,  
c= velocity of light,  
t= time-of-flight.

The Micropilot is calibrated by entering the empty distance E, the full distance F and an application parameter A, which automatically tunes the instrument to the measuring conditions. Two evaluation algorithms are used:

- The Floating Average Curve – this is particularly good for suppressing interference echoes due to tank filling and product agitation.
- The Time Dependent Threshold – this suppresses interference echoes from tank fittings.



Microwave measurement principle

# Planning Hints

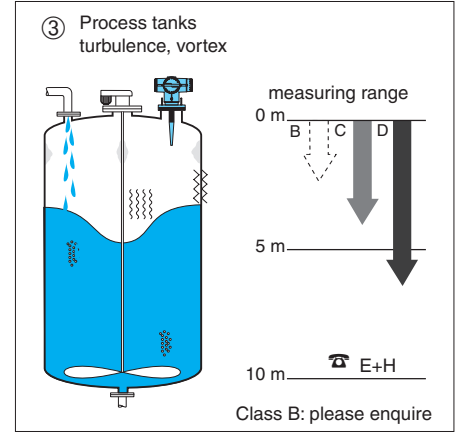
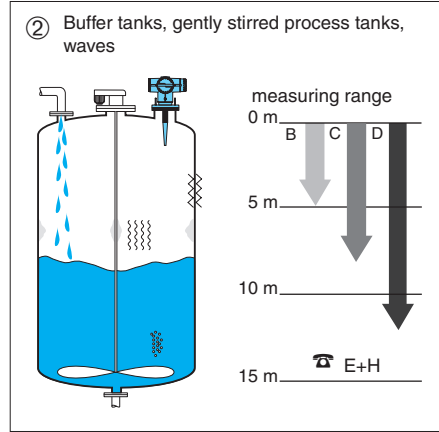
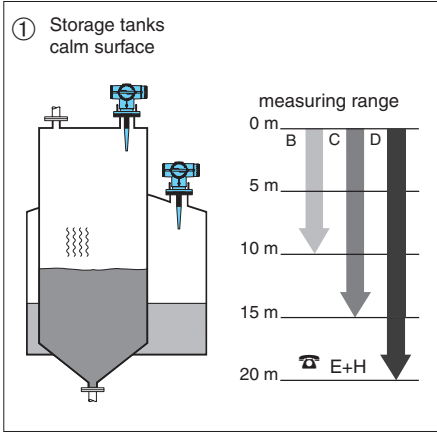
## Measuring Range

The measuring range depends upon:

- the conditions in the tank,
- the medium to be measured, see table and diagrams ①, ② and ③ below

If the liquid properties are unknown, take Class B. For liquid gases or longer ranges, use horn antenna, by-pass pipe or stilling well

Class	Examples
B ↓	non-conducting liquids, e.g. petrochemicals, benzine, oil, toluol, dielectric constant $\epsilon_r$ approx. 1.9...4
C ↓	e.g. conc. acids, organic solvents, analine, esters, alcohols, acetone, oil/water mixtures, $\epsilon_r$ approx. 4...10
D ↓	conducting liquids, e.g. aqueous solutions, dilute acids and alkalis, $\epsilon_r > 10$ or $\sigma > 10$ mS/cm



Typical measuring range as a function of tank conditions and medium properties for antenna installed as shown on page 4.  
Taller nozzles than recommended lead to a corresponding reduction in performance

## Antenna Selection

There are three antenna types, see below for performance specifications:

- Standard version, with inactive length, long or short, for use in applications with tall, narrow nozzles, condensation or conductive built-up. Also available with Zone 0 approval.

- Hygienic version, active, gap-free with FDA/3A approval for use in food applications.
  - High pressure version, active, with unclad stainless steel flange.
- Active antennas are unsuitable for narrow nozzles or condensing liquids.*

Version	Rod material	Flange material	Process side O-ring seal	Flange	Pressure
Standard	PTFE	1.4571/PTFE clad	None	DN80/DN150 <sup>1)2)</sup>	-1...16 bar
Hygienic	PFA	1.4571/cladding FDA-approved	None	DN80/DN100 <sup>1)2)3)</sup>	-1...16 bar
High pressure	PTFE	1.4571	Viton, Kalrez	DN80 / DN100 <sup>1)3)</sup>	-1...40 bar

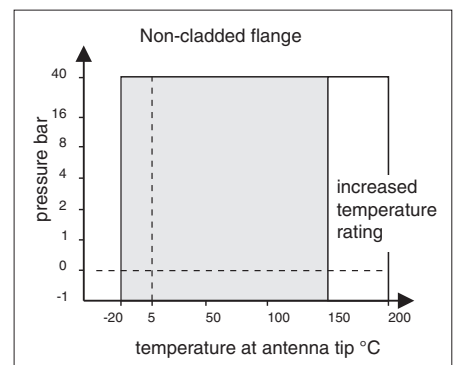
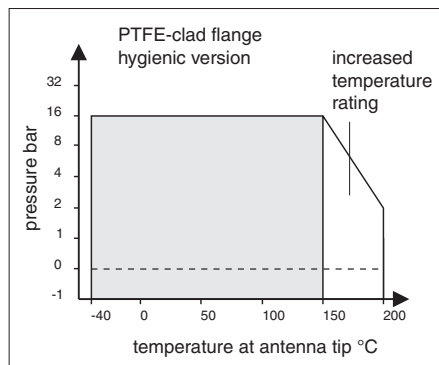
<sup>1)</sup> Also as ANSI or JIS equivalents  
<sup>2)</sup> DN50 on request  
<sup>3)</sup> Without "anti-static" coating

1.4751  $\approx$  SS 316 Ti

Derating curves for rod antenna

O-Ring:  
 Viton: -20...+150 °C  
 Kalrez: +5...+200 °C (D4079)  
 (Product Structure 20)

Please enquire about applications with superheated steam



# Installation Hints

## Mounting

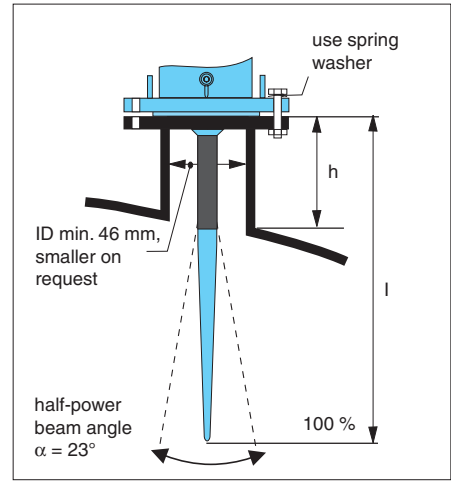
The ideal antenna installation is:

- with rod perpendicular
- more than 30 cm from tank wall
- where possible no fittings in beam — the beam angle is 23°
- where possible, clear of the filling inlet and e.g. centre of any vortex
- on nozzle of max. length h below:

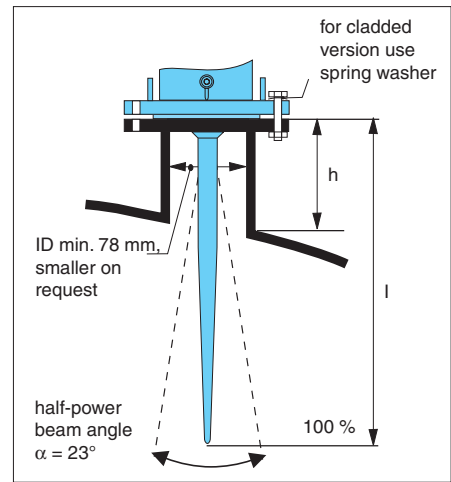
length l	max. nozzle height
413 mm (100 mm inactive length)	h = 100 mm
563 mm /250 mm (inactive length)	h = 250 mm
445 mm, hygienic and high pressure	h = 200 mm

1" = 2.54 mm

Avoid positions with heavy vibration, i.e. greater than 2 g, high-pressure cleaning and lateral loads. Above 150°C (high temperature version) the mechanical properties of PTFE must be considered. Please enquire about superheated steam.



Standard antenna (inactive)

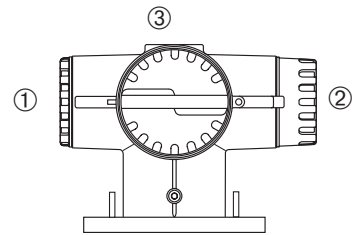


Hygienic/High pressure antenna

# Electrical Connection

The Micropilot FMR 131 housing has three separate compartments: ① and ② contain the terminals, ③ the electronics.

- The 4...20 mA connections can be made in compartment ① or ② (selected by jumper). The RS-485 option is connected in compartment ②
- The 4...20 mA output is passive or active to order (Product Structure 40)
- The transmitter housing can be turned through 85° for easy wiring.



Smart (HART) Standard	Smart (HART) Ex-certificate	Rackbus RS-485 Standard/(Ex-certificate)																																																									
<b>Compartment ①</b>																																																											
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Terminal assignment

HART is a registered trademark of the HART Communication Foundation

# Product Structure

Rod antenna FMR 131				
10	<b>Certificate</b>			
	<b>Type</b>	<b>Explosion Protection</b>	<b>Communication</b>	
	R Standard	none	BZT approval	
	G ATEX II 2 G	EEx de [ia] IIC T4/T6	BZT	
	A <sup>1)</sup> ATEX II 1/2 G	EEx de [ia] IIC T4/T6	BZT approval	
	5 Standard	none	FCC approval	
	O FM	Class I, Div. 1&2, Group A - D	FCC approval	
	P FM	Class I, Div. 1&2, Group A - D	BZT approval	
S CSA	Class I, Div. 1&2, Group A - D	Canadian approval		
Y	Special certificate			
20	<b>Antenna</b>		<b>For Process Connection</b>	
	4	Standard PTFE, long 250 mm inactive length	for PTFE clad 1.4571 flange,	
	3	Standard PTFE, short 100 mm inactive length	for PTFE clad 1.4571 flange,	
	U <sup>2)</sup>	High pressure PTFE	for 1.4571 flange	
	W <sup>2)</sup>	High pressure PTFE	for 1.4571 flange	
	2 <sup>2)</sup>	Hygienic PFA	for TFM-clad flange <sup>3)</sup>	
30	<b>Process Connection</b>			
		<b>Dia/Pressure</b>	<b>Standard</b>	
	CA3	DN80/PN16	DIN 2526, with raised face, Form C	
	CH3	DN100/PN16	DIN 2526, with raised face, Form C	
	CO3	DN150/PN16	DIN 2526, with raised face, Form C	
	AA3	3"/150psi	ANSI B16.5, with raised face, R.F	
	AH3	4"/150psi	ANSI B16.5, with raised face, R.F	
	AO3	6"/150psi	ANSI B16.5, with raised face, R.F	
	KA3	10 K 80	JIS B2210, with raised face, R.F	
	KH3	10 K 100	JIS B2210, with raised face, R.F	
	KO3	10 K 150	JIS B2210, with raised face, R.F	
	CE2	DN80/PN40	DIN 2526, with raised face, Form C	
	CL2	DN100/PN40	DIN 2526, with raised face, Form C	
	AE2	3"/300psi	ANSI B16.5, with raised face, R.F	
	AL2	4"/300psi	ANSI B16.5, with raised face, R.F	
	KE2	40 K 80	JIS B2210, with raised face, R.F	
	KL2	40 K 100	JIS B2210, with raised face, R.F	
	YY9	Special process connection		
	40	<b>4...20mA Analogue Output/Communication</b>		
			<b>Type</b>	<b>Digital Interface</b>
C		Active	HART protocol;	
D		Active	RS-485 interface;	
F		Active	HART protocol;	
G		Active	RS-485 interface;	
N		Passive	HART protocol;	
Q		Passive	RS-485 interface;	
P		Passive	HART protocol;	
R		Passive	RS-485 interface;	
50	<b>Cable Entry</b>			
	4	For M20 x 1.5		
	2	For NPT 1/2"		
	3	For NPT 3/4"		
	5	For G 1/2"		
9	Special version			
60	<b>Version</b>			
	A	Measuring range max. 20 m, any span		
Y	Special version			
70	<b>Power Supply</b>			
	1	230VAC 50/60 Hz		
	2	115VAC 50/60 Hz		
	3	48VAC 50/60 Hz		
	4	24VAC 50/60 Hz		
	5	24VDC		
9	Special version			
80	<b>Additional Equipment</b>			
	A	None (maximum flange temperature 150 °C)		
	B	With heating (ambient temperature -40 °C)		
	D	With increased temperature rating(antenna tip 200 °C)		
	E	With heating and increased temperature rating		
FMR131-			with rod antenna	
			product designation	

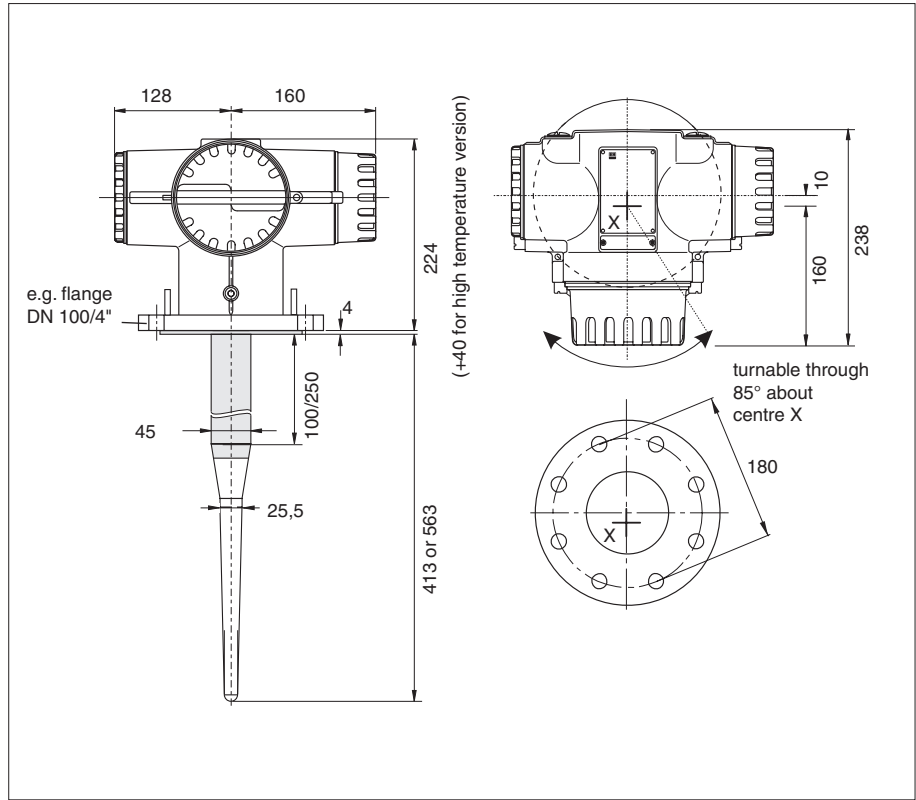
<sup>1)</sup> For antenna "3" and "4" only

<sup>2)</sup> Not available with DN 150 flange or equivalent

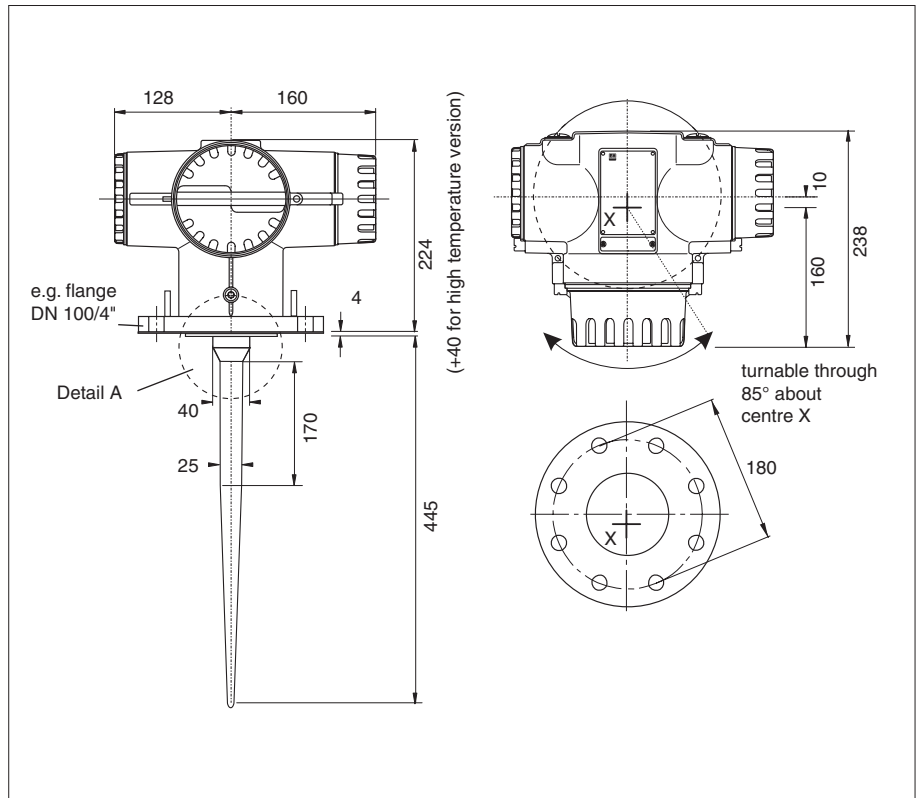
<sup>3)</sup> FDA-approved material

1.4751 ≙ SS 316 Ti

# Dimensions



Dimensions in mm of standard version with inactive length (DN 100 flange)



Detail A  
Uncladded flange  
(high pressure)

Detail A  
Hygienic version

Dimensions in mm of hygienic and high pressure versions (DN 100 flange)  
1" = 2.54 mm

# Technical Data

## General Specifications

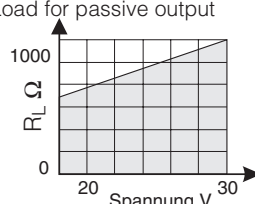
Manufacturer	Endress+Hauser GmbH+Co., D 79689 Maulburg, Germany
Designation	Micropilot FMR 131
Function	Smart transmitter for level measurement by the pulsed time-of-flight (PTOF) microwave method
Operating frequency	approx 6 GHz ultra wide band system
Beam angle	23°
Pulse power	1 μW ERP
Reference conditions	To IEC 770 (T <sub>U</sub> = 25°C) or as specified
Other	CE Mark

## Input

Signal	Time-of-flight of microwave pulse from antenna to medium and back again.
Evaluation	Sampled envelope curve, 44 curves/s, with interference echo suppression by floating average curve and/or fixed target suppression
Update time	≥ 0.3 s, depending upon software evaluation mode
Measuring range	20 m (67 ft), long antenna, see page 3
Accuracy	Medium Class B Class C Class D (see page 3) ±10 mm up to 5 m up to 10 m up to 15 m ±20 mm up to 10 m up to 15 m up to 20 m Digital resolution: 1 mm, see also analogue output Reproducibility: ± 3 mm Temperature coefficient: 0.02%/10°K of range end value Process pressure: 1 bar 16 bar 64 bar (physical) 20°C 0% -0.4% -1.7% of value 200°C % -0.2% -1.0% of value

## Output

### Analogue output (Product Structure 40)

Output	4...20 mA (3.8...21.6 mA), active or passive
On alarm	-10% (2.4 mA), +110% (22 mA) or hold last value, switchable
Isolation	Electrically isolated from rest of circuitry For Ex-versions: the negative analogue output terminal is internally connected to ground
Characteristics	Resolution: better than 0.1% (13 μA) Temperature drift: ± 0.1%/10 K of range end value (20 mA) Linearity: ≤ 0.1% of range end value (20 mA) Load dependency: ± 0.3%/100 Ω of range end value (20 mA)
Load for passive output	 <p>HART RS-485          active 250*...600 Ω 0...600 Ω          active, EEx [ia] 250*...400 Ω 0...400 Ω          passive R<sub>K</sub>*... (R<sub>L</sub> - R<sub>K</sub>*)          passive, EEx ia R<sub>K</sub>*... (R<sub>L</sub> - R<sub>K</sub>* - R<sub>ISB</sub>)          R<sub>K</sub> = HART = 250 Ω; RS-485 = 0 Ω          R<sub>L</sub> = load, see diagram,          R<sub>ISB</sub> = impedance of any safety barrier          *If smart communication not used = 0 Ω</p>

### Communication interfaces (Product structure 40)

Local operation	HV 160 operating and display module Six keys. LC display, 4 1/2 digit with VH position and bar graph Polycarbonate housing, IP 44, EEx ia IIC T4
Remote operation (options)	HART: with DXR 275 handheld terminal, or Commubox/laptop RS-485 interface: with adapter/PC card or interface FXA 675

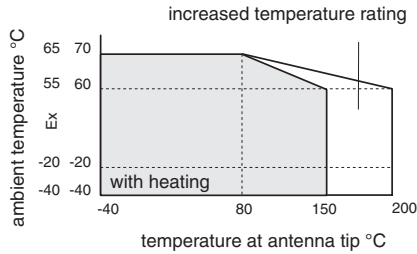
### Relay

Type	1 relay with potential-free changeover contact
Function	Selectable, alarm relay or limit relay For limit relay, maximum or minimum fail-safe mode selectable through switch-on and switch-off points
On alarm	Alarm relay de-energises
Switching capacity	AC: 2.5 A, 250 V, 600 VA at cos φ = 1; 300 VA at cos φ ≥ 0.7 DC: 2.5 A, 100V, 100 W

## Power supply

Versions (Product Structure 70)	230 V (184...250 V), 50/60 Hz; 115 V (90...138 V), 50/60 Hz; 48 V (38...58 V), 50/60 Hz; 24 V (19...29 V), 50/60 Hz 24 VDC (18...30 V), residual ripple 1 Vpp within tolerances
Power consumption	AC: ca. 10 VA, ca. 20 VA with heating DC: ca. 6 W, ca. 16 W with heating

## Environmental conditions



Temperature ratings (Product structure 10, 80)	Nominal range: -20...+70°C; with heating: -40...+70°C with certificate: -20...+65°C; with heating: -40...+65°C limit: -25 (-40)...+80°C; storage: -40...+85°C Max. temperature at antenna/counterflange: see diagram
Electromagnetic compatibility	Interference Emission to EN 61326, Electrical Equipment Class B Interference Immunity to EN 61326, Annex A (Industrial) and NAMUR Recommendation NE 21 (EMC) A standard installation cable is sufficient if only the analogue signal is used. Use a screened cable when working with a superimposed communications signal (HART).
Postal approval (Product structure 10)	R&TTE, FCC No. LCG FMR 13x
Explosion protection (Product structure 10)	EEx de [ia] IIC T2...T6/T2...T4 with FHV 160 FM/CSA: Class I, Div 1+2, Groups A-D
Climatic class	Housing: Class C, DIN 400 40; IEC 68
Ingress protection	Housing and antenna: IP 68, DIN 400 50 and NEMA 4X Housing: Salt spray test: 504h as per DIN 50 021
Vibration resistance	IEC 68 2-6/6.1990

## Mechanical construction

Antenna	Dimensions: see diagram, page 6 Material: solid PTFE or FDA-approved materials
Housing	Dimensions: see diagram, page 6 Material: Al, sea-water resistant, chromated, powder coated Weight: ca. 6 kg + flange

## Supplementary Documentation

- Micropilot  
System Information SI 019F/00/en
- Micropilot FMR 130  
Technical Information TI 253F/00/en
- Micropilot FMR 130  
for By-Pass and Stilling Wells  
Technical Information TI 258F/00/en
- Commubox FXA 191  
Technical Information TI 237/00/en
- Rackbus  
System Information SI 014F/00/en
- Silometer FMX 770  
Technical Information TI 222F/00/en
- RS-485 Interface FXA 675  
Technical Information TI 221F/00/en

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