

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.

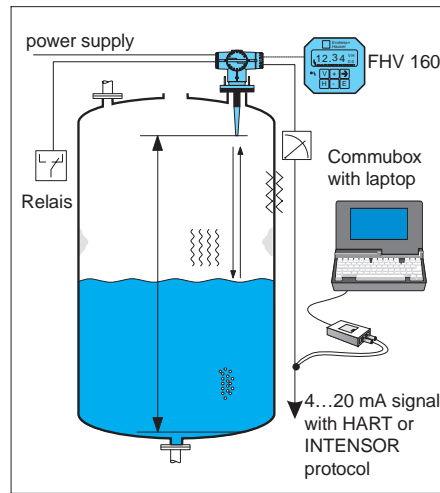
Endress + Hauser

Nothing beats know-how



Measuring System

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



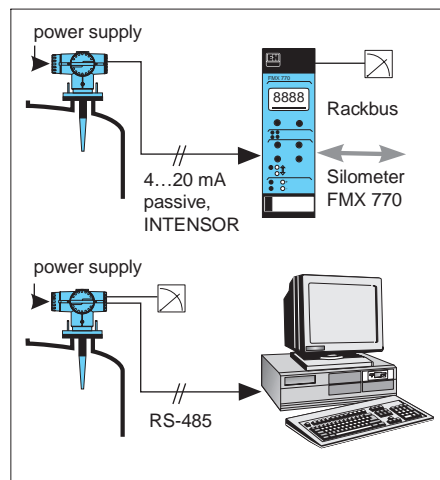
System Components

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

- FHV 160 operating and display module as well as INTENSOR or 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 Silometer FMX 770 (passive INTENSOR) or direct connection to PC via Rackbus RS-485



Silometer FMX 770 (Option)

A Silometer FMX 770 transmitter mounted in a Monorack housing or 19" rack connected to a Micropilot with *passive INTENSOR* output provides:

- a single measuring point *and/or*
- Rackbus connection to a ZA gateway and process control system

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:

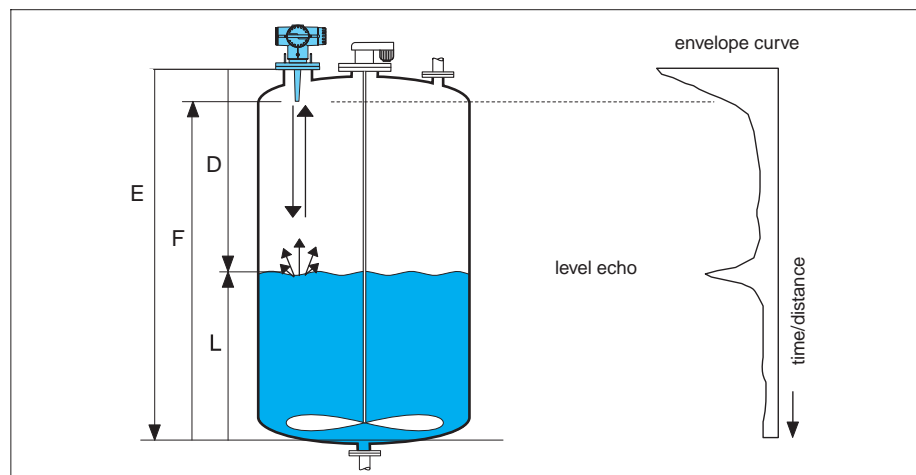
$$D = c \cdot t/2$$

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

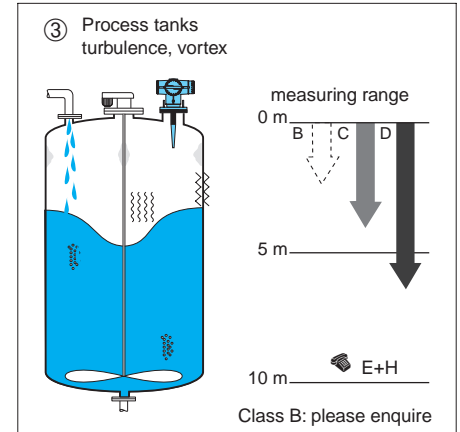
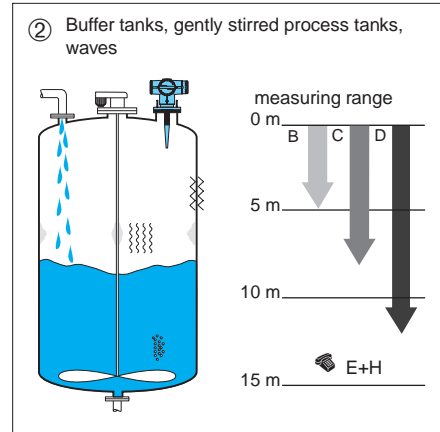
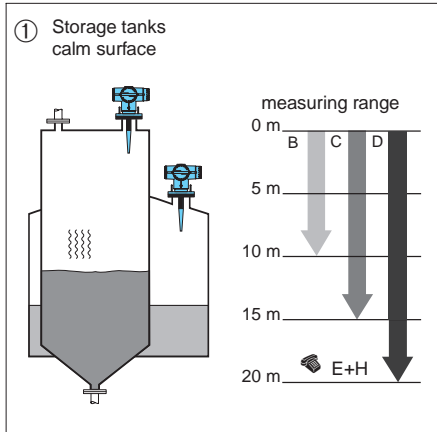
Measuring Range

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 ϵ_r approx. 1.9...4
C ↓	e.g. conc. acids, organic solvents, analine, esters, alcohols, acetone, oil/water mixtures, ϵ_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 German 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 ¹⁾²⁾	-1...16 bar
Hygienic	PFA	1.4571/cladding FDA-approved	None	DN80/DN100 ¹⁾²⁾³⁾	-1...16 bar
High pressure	PTFE	1.4571	Viton, Kalrez	DN80 / DN100 ¹⁾³⁾	-1...40 bar

¹⁾ Also as ANSI or JIS equivalents

²⁾ DN50 on request

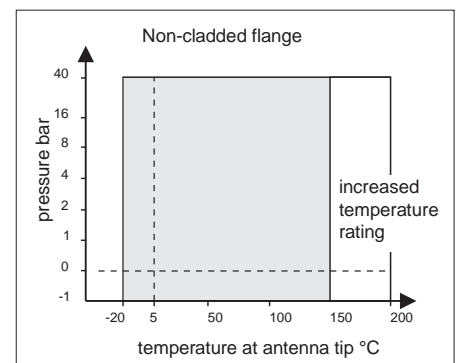
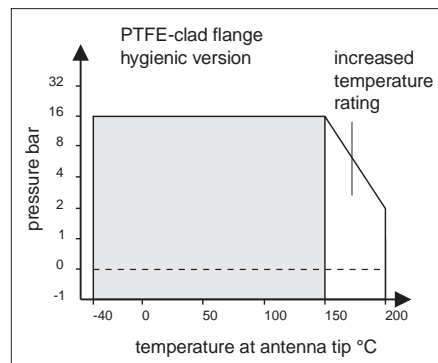
³⁾ Without "anti-static" coating

1.4571 \equiv 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

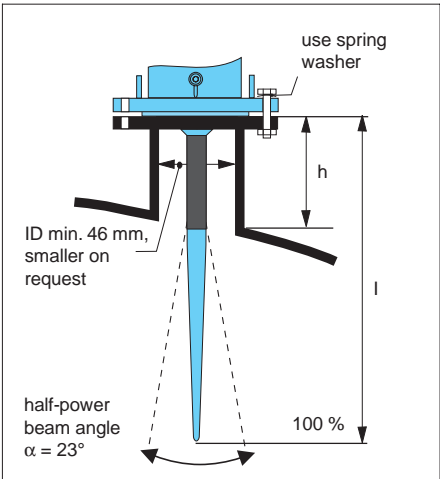
The ideal antenna installation is:

- 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:

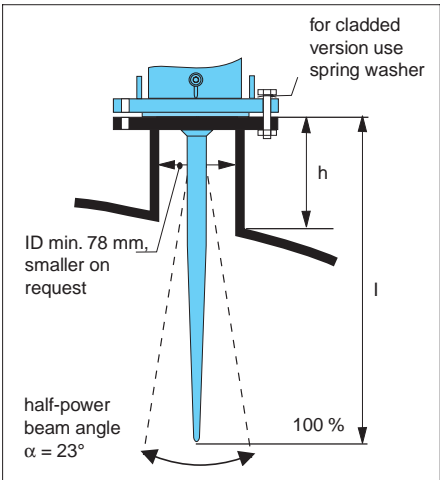
length l	max. nozzle height
100 mm, inactive length	h = 100 mm
250 mm, inactive length	h = 250 mm
445 mm, hygienic and high pressure	h = 200 mm

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)

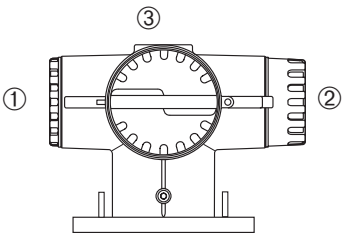


Hygienic/High pressure

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.



Terminal assignment

HART is a registered trademark of the HART Communication Foundation
INTENSOR is a registered trademark of Endress+Hauser

Smart (HART, INTENSOR) Standard	Smart (HART, INTENSOR) Ex-certificate	Rackbus RS-485 Standard/(Ex-certificate)																																																									
Compartment ①																																																											
<table><tr><td>1</td><td>L+/L1</td><td rowspan="3">power supply</td></tr><tr><td>2</td><td>L-/N</td></tr><tr><td>3</td><td>GND</td></tr><tr><td>4</td><td>r/nc</td><td rowspan="3">Relay</td></tr><tr><td>5</td><td>u/C</td></tr><tr><td>6</td><td>a/no</td></tr><tr><td>7</td><td>-</td><td rowspan="2">4...20 mA</td></tr><tr><td>8</td><td>+</td></tr></table>	1	L+/L1	power supply	2	L-/N	3	GND	4	r/nc	Relay	5	u/C	6	a/no	7	-	4...20 mA	8	+	<table><tr><td>1</td><td>L+/L1</td><td rowspan="3">power supply EEx e /Ex d</td></tr><tr><td>2</td><td>L-/N</td></tr><tr><td>3</td><td>GND</td></tr><tr><td>4</td><td>r/nc</td><td rowspan="3">Relay EEx e /Ex d</td></tr><tr><td>5</td><td>u/C</td></tr><tr><td>6</td><td>a/no</td></tr><tr><td>7</td><td>-</td><td rowspan="2">4...20 mA</td></tr><tr><td>8</td><td>+</td></tr></table>	1	L+/L1	power supply EEx e /Ex d	2	L-/N	3	GND	4	r/nc	Relay EEx e /Ex d	5	u/C	6	a/no	7	-	4...20 mA	8	+	<table><tr><td>1</td><td>L+/L1</td><td rowspan="3">power supply EEx e /Ex d</td></tr><tr><td>2</td><td>L-/N</td></tr><tr><td>3</td><td>GND</td></tr><tr><td>4</td><td>r/nc</td><td rowspan="3">Relay EEx e /Ex d</td></tr><tr><td>5</td><td>u/C</td></tr><tr><td>6</td><td>a/no</td></tr><tr><td>7</td><td>B</td><td rowspan="2">RS 485</td></tr><tr><td>8</td><td>A</td></tr></table>	1	L+/L1	power supply EEx e /Ex d	2	L-/N	3	GND	4	r/nc	Relay EEx e /Ex d	5	u/C	6	a/no	7	B	RS 485	8	A
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Note: for Ex-versions, the negative analogue output terminal is internally connected to ground

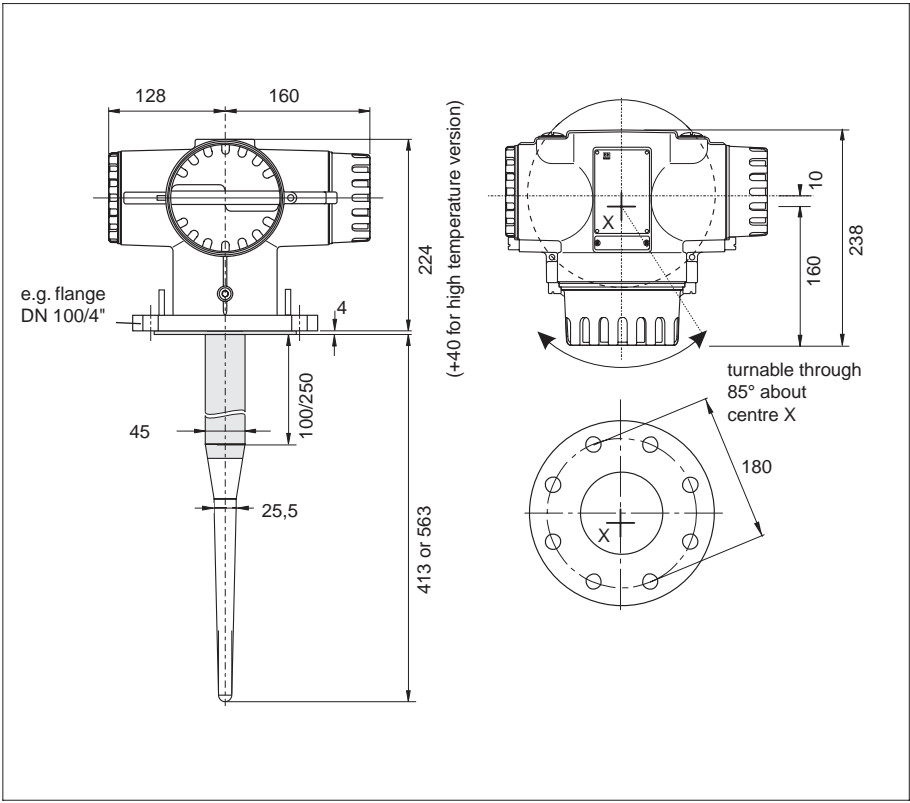
Product Structure

- ¹⁾ For antenna "3" and "4" only
²⁾ Not available with DN 150 flange or equivalent
³⁾ FDA-approved material

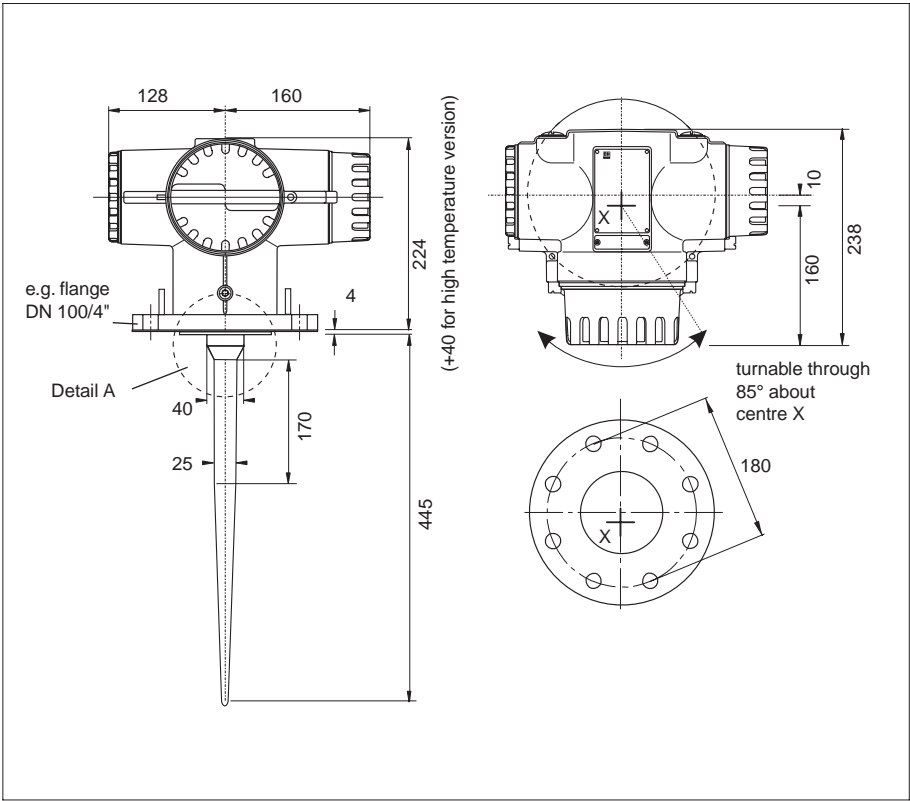
1.4751 ≡ SS 316 Ti

Rod antenna FMR 131									
10	Certificate		Explosion Protection				Communication		
	R	Standard	none				BZT approval		
	G	PTB	EEx de [ia] IIC T6; T4 with FHV 160				BZT approval		
	A ¹⁾	PTB	EEx de [ia] IIC T6; T4 with FHV 160 (Zone 0 Germany)				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	Antenna		For Process Connection				O-ring	
4		Standard PTFE, long 250 mm inactive length	for PTFE clad 1.4571 flange,				none		
3		Standard PTFE, short 100 mm inactive length	for PTFE clad 1.4571 flange,				none		
U ²⁾		High pressure PTFE	for 1.4571 flange				Viton O-Ring		
W ²⁾		High pressure PTFE	for 1.4571 flange				Kalrez O-Ring		
2 ²⁾		Hygienic PFA	for TFM-clad flange ³⁾				none		
30		Process Connection		Standard				Flange material	
	CA3	DN80/PN16	DIN 2526, with raised face, Form C				1.4571 clad		
	CH3	DN100/PN16	DIN 2526, with raised face, Form C				1.4571 clad		
	CO3	DN150/PN16	DIN 2526, with raised face, Form C				1.4571 clad		
	AA3	3"/150psi	ANSI B16.5, with raised face, R.F				1.4571 clad		
	AH3	4"/150psi	ANSI B16.5, with raised face, R.F				1.4571 clad		
	AO3	6"/150psi	ANSI B16.5, with raised face, R.F				1.4571 clad		
	KA3	10 K 80	JIS B2210, with raised face, R.F				1.4571 clad		
	KH3	10 K 100	JIS B2210, with raised face, R.F				1.4571 clad		
	KO3	10 K 150	JIS B2210, with raised face, R.F				1.4571 clad		
	CE2	DN80/PN40	DIN 2526, with raised face, Form C				1.4571		
	CL2	DN100/PN40	DIN 2526, with raised face, Form C				1.4571		
	AE2	3"/300psi	ANSI B16.5, with raised face, R.F				1.4571		
	AL2	4"/300psi	ANSI B16.5, with raised face, R.F				1.4571		
	KE2	40 K 80	JIS B2210, with raised face, R.F				1.4571		
	KL2	40 K 100	JIS B2210, with raised face, R.F				1.4571		
	YY9	Special process connection							
40	4...20mA Analogue Output/Communication		Digital Interface				Operation		
	B	Active	INTENSOR protocol;		FHV160 (supplied) or option "E"				
	C	Active	HART protocol;		FHV160 (supplied) or option "F"				
	D	Active	RS-485 interface;		FHV160 (supplied) or option "G"				
	E	Active	INTENSOR protocol;		VU260Z/FXA191 (accessory)				
	F	Active	HART protocol;		DXR275/FXA191 (accessory)				
	G	Active	RS-485 interface;		FXA675 /RS485 adapter (accessory)				
	M	Passive	INTENSOR protocol;		FHV160 (supplied) or option "O"				
	N	Passive	HART protocol;		FHV160 (supplied) or option "F"				
	Q	Passive	RS-485 interface;		FHV160 (supplied) or option "G"				
	O	Passive	INTENSOR protocol;		VU260Z/FMX770/FXA191 (accessory)				
	P	Passive	HART protocol;		DXR275/FXA191 (accessory)				
	R	Passive	RS-485 interface;		FXA675 /RS485 adapter (accessory)				
50	Cable Entry								
	1	With WADI Pg16							
	2	For NPT 1/2"							
	3	For NPT 3/4"							
	4	For M20 x 1.5							
	5	For G 1/2"							
60	Version								
	A	Measuring range max. 20 m, any span							
	Y	Special version							
70	Power Supply								
	1	230VAC 50/60 Hz							
	2	115VAC 50/60 Hz							
	3	48VAC 50/60 Hz							
	4	24VAC 50/60 Hz							
	5	24VDC							
80	Additional Equipment								
	A	None (maximum flange temperature 150 °C)							
	B	With heating (ambient temperature -40 °C)							
	D	With increased temeprature rating(antenna tip 200 °C)							
	E	With heating and increased temperature rating							
FMR131-									
with rod antenna									
product designation									

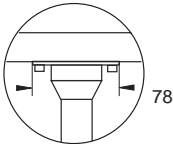
Dimensions



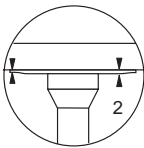
Dimenisons in mm of standard version with inactive length (DN 100 flange)



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

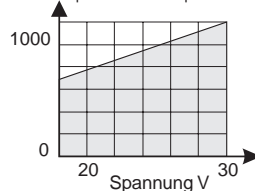
Manufacturer	Endress+Hauser GmbH+Co., D 79689 Maulburg, Germany
Designation	Micropilot FMR 131
Function	Smart transmitter for level measurement by the pulsed time-of-flight (PTOF) microwave method
Operating frequency	Standard 5.8 GHz (ISM band); 6.3 GHz with FCC approval
Beam angle	23°
Pulse power	1 µW ERP
Reference conditions	To IEC 770 (T _U = 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	<p>Medium Class B Class C Class D (see page 3)</p> <p>±10 mm up to 5 m up to 10 m up to 15 m</p> <p>±20 mm up to 10 m up to 15 m up to 20 m</p> <p>Digital resolution: 1 mm, see also analogue output</p> <p>Reproducibility: ± 3 mm</p> <p>Temperature coefficient: 0.02%/10°K of range end value</p> <p>Process pressure: 1 bar 16 bar 64 bar</p> <p>(physical) 20°C 0% -0.4% -1.7% of value</p> <p>200°C % -0.2% -1.0% of value</p>

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	<p>Resolution: better than 0.1% (13 µA)</p> <p>Temperature drift: ± 0.1%/10 K of range end value (20 mA)</p> <p>Linearity: ≤ 0.1% of range end value (20 mA)</p> <p>Load dependency: ± 0.3%/100 Ω of range end value (20 mA)</p>
Load for passive output	 <p>active INTENSOR/HART RS-485</p> <p>active, EEx [ia] 250*...600 Ω 0...600 Ω</p> <p>passive R_K*... (R_L - R_K*) 0...400 Ω</p> <p>passive, EEx ia R_K*... (R_L - R_K* - R_{ISB})</p> <p>R_K = INTENSOR/HART = 250 Ω; RS-485 = 0 Ω</p> <p>R_L = load, see diagram,</p> <p>R_{ISB} = impedance of any safety barrier</p> <p>*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)	INTENSOR: with Commulog VU 260 Z handheld terminal, Silometer FMX 770 transmitter, or Commubox/laptop HART: with DXR 275 handheld terminal, or Commubox/laptop RS-485 interface: with adapter/PC card or interface FXA 675

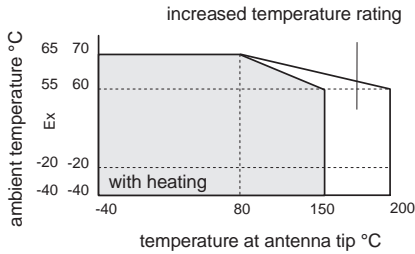
Relay

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	Emission to EN 50 081-1, immunity to EN 50 082-2 and NAMUR industrial standard
Postal approval (Product structure 10)	BZT No. G 750 476 (5.8 GHz, ISM band) FCC No. LCG FMR 13x (6.3 GHz)
Explosion protection (Product structure 10)	PTB: 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 011F/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/e
- ☐ RS-485 Interface FXA 675
Technical Information TI 221F/00/e

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