

Technical Information

Radar sensor USR30

Free space radar



Sensor unit for distance measurement and level monitoring of liquids and bulk solids

Application

- Continuous distance measurement and level monitoring of liquids and bulk solids
- Maximum measuring range: 35 m (115 ft))
- Ambient temperature: -40 to +85 °C (-40 to +176 °F)

Your benefits

- Reliable 80 GHz radar sensor
- Precise distance measurement due to strong focus, even in rough environments
- Can be installed in small process connections
- Low power consumption - suitable for battery applications
- Radio compliant according to ETSI EN 302729 and radio approval on sensor base for North America (FCC, ISSED)

Table of contents

About this document	3	Accessories	14
Document function	3		
Symbols used	3	Explanations and supplementary documentation ..	14
Function and input parameters	4	Supplementary documentation	14
Measuring principle	4	Disposal	14
Process	4	Contact addresses	14
Measured variable	4		
Measuring range	4		
Operating frequency	5		
Blocking distance	5		
Sensitivity	5		
Output	6		
Output signal	6		
Protocol-specific data	6		
Performance characteristics	6		
Reference operating conditions	6		
Maximum measured error	6		
Influence of ambient temperature	7		
Environment	7		
Ambient temperature	7		
Storage temperature	7		
Relative humidity	7		
Degree of protection	7		
Mechanical construction	7		
Dimensions	7		
Weight	7		
Materials	7		
Power supply	8		
Supply voltage	8		
Power consumption	8		
Electrical connection and pin assignment	8		
Installation instructions	9		
Safety notes for installation	9		
Beam angle	9		
Positioning	9		
"Frequency mode" parameter	10		
Integration into an overall system	11		
Certificates and approvals	12		
RoHS	12		
Compliance Radio Directive ETSI EN 302 729	12		
FCC	13		
Industry Canada	13		
Approvals of closed measuring systems	14		

About this document

Document function This document contains all the technical data for the device and provides an overview of the device versions that can be ordered.

Symbols used **Safety symbols**

Symbol	Meaning
	NOTICE! This symbol contains information on procedures and other facts which do not result in personal injury.

Symbols for certain types of information

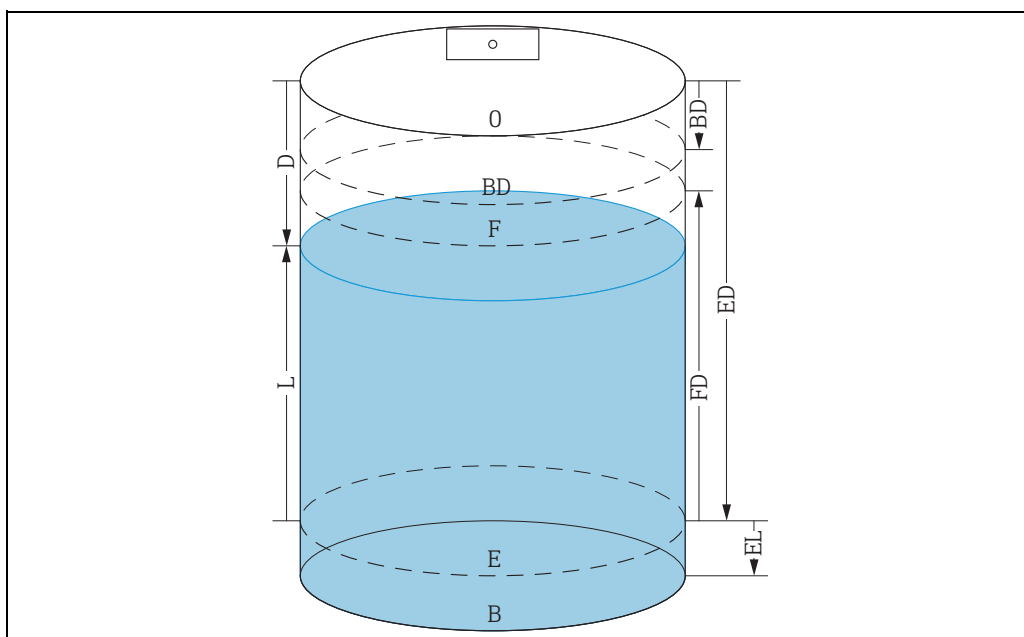
Symbol	Meaning
	Tip Indicates additional information.
	Permitted or recommended
	Forbidden or not recommended
1. , 2. , 3. ...	Series of steps
	Reference to page

Symbols in graphics

Symbol	Meaning
1, 2, 3, ...	Item numbers
A, B, C, ...	Views

Function and input parameters

Measuring principle	The Micropilot is a measuring system, operating based on the time-of-flight method (ToF). It measures the distance from the reference point to the product surface. The radar signals based on the "Frequency Modulated Continuous Wave" (FMCW) principle are emitted by an antenna, reflected off the product surface and received again by the radar system.
Process	■ The Measurement can be carried out directly through the tank → This is only possible for electrically non-conductive tank walls - No contact is made with the process medium.
Measured variable	Measured process variables: ■ Level / Distance: 0 to 35 m (0 to 115 ft)
Measuring range	Maximum measuring range: 0 to 30 m (0 to 98 ft) for solids and liquids with permittivity > 1.9 Increased measuring range: 30 to 35 m (98 to 115 ft) for solids and liquids with the following application conditions: ■ Only for media with a high permittivity value, such as water. ■ No turbulent surfaces ■ No increased inhomogeneous atmosphere (increased amount of dust particles, gas phases, high humidity or similar)



Radartransducer_Abgleichparameter

<i>Calibration parameter</i>	
<i>B</i>	<i>Bottom</i>
<i>D</i>	<i>Measured distance</i>
<i>E</i>	<i>Empty calibration (= zero)</i>
<i>F</i>	<i>Full calibration (= span)</i>
<i>L</i>	<i>Level in %</i>
<i>BD</i>	<i>Blocking distance</i>
<i>FD</i>	<i>Full distance</i>
<i>ED</i>	<i>Empty distance</i>
<i>EL</i>	<i>Extended length</i>

Medium

Media: solids and liquids

Usable measuring range for solid applications

The usable measuring range depends on the reflection properties of the medium, the installation position and possible interference reflections.

**Measurement of the following media with absorbing gas phase**

For example the following media

- Ammonia (pure - 100 %)
- Acetone
- Methylene chloride
- Methyl ethyl ketone
- Propylene oxide
- VCM (vinyl chloride monomer)

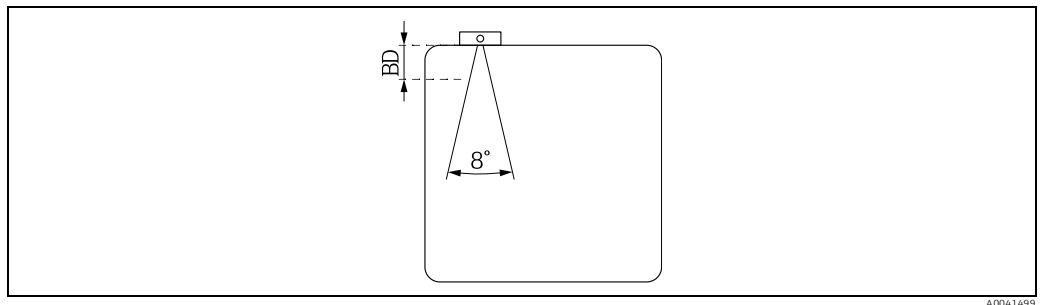
To measure absorbing gases, either use a guided radar, measuring devices with another measuring frequency or another measuring principle.

If measurements must be performed in one of these media, please contact Endress+Hauser.

Operating frequency

80 GHz

The operating frequency is for measurement purposes only.

Blocking distance

A0041499

- No signals are analyzed within the blocking distance (BD)
For this reason, the blocking distance can be used to suppress interference signals (e.g. from condensate) near the antenna.
- The blocking distance (BD) can be set. The factory setting is 0 mm.
A change is made via a blocking distance parameter.

Sensitivity

The sensitivity of the sensor can be configured using a "sensitivity parameter" (high, medium, low).

Output

Output signal

Digital: UART (8N1 inverted)
 Baud rate: 230.4 kBd
 data bits: 8
 Parity: none
 Stop bits: 1
 Polarity: inverted (idle low)

Protocol-specific data

The USR30 has the following read and write parameters:

Parameter	Unit	Read	Write
Measured distance	mm	X	
Measured level	%	X	
Configurable blocking distance	mm	X	X
Definition for state "Empty"	mm	X	X
Definition for level "Full"	mm	X	X
Medium type liquid / solid		X	X
Trigger measurement on / off		X	X
Reception strength of radar signal	strong, medium, weak, no signal	X	
Sensitivity of sensor	low, medium, high	X	X
Hardware version		X	
Software version		X	
Serial number		X	
Error status		X	
Z-Offset (correction value from the calibration)	mm	X	X

Performance characteristics

Reference operating conditions

- Temperature = +24 °C (+75 °F) ±5 °C (±9 °F)
- Pressure = 960 mbar abs. (14 psi) ±100 mbar (±1.45 psi)
- Humidity = 60 % ± 5 %
- Reflector: metal plate with a diameter ≥ 1 m (40 in)
- No major interference reflections inside the signal beam
- Frequency mode 1: default setting of 77 to 81 GHz

Maximum measured error

The accuracy is the sum of the non-linearity, non-repeatability and hysteresis.

For liquids:

- Measuring distance up to 0.25 m (0.82 ft): max. ±10 mm (±0.39 in)
- Measuring distance > 0.25 m (0.82 ft): ±2 mm (±0.08 in)

For solids:

- Measuring distance up to 0.8 m (2.6 ft): max. ±20 mm (±0.79 in)
- Measuring distance > 0.8 m (2.6 ft): ±4 mm (±0.16 in)

Non-repeatability is already included in the accuracy ≤ 1 mm (0.04 in).

Offset or zero point can be eliminated by entering a correction during commissioning.



The correction is described in the Operating Manual Radar.



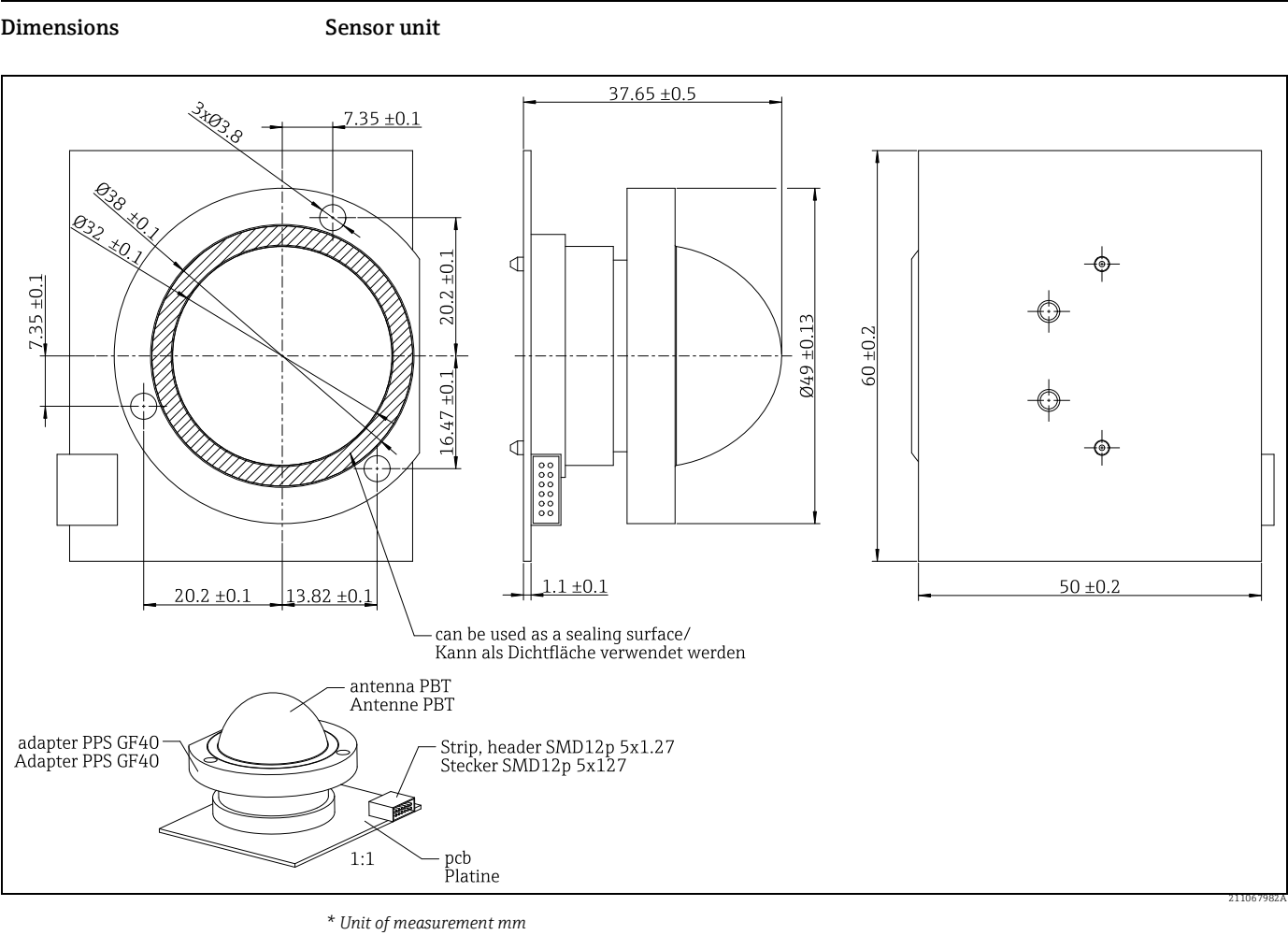
The reference condition for the accuracy refers to the setting **Medium type = Liquid**.
 With the setting **Medium type = Solid**, the devices are optimized for solid applications in the delivery state.

Influence of ambient temperature Temperature coefficient: ≤ 4 mm (0.16 in) per 10 K

Environment

Ambient temperature	-40 to +85 °C (-40 to 185 °F)
Storage temperature	-40 to +85 °C (-40 to +185 °F)
Relative humidity	0 to 95 %
Degree of protection	Open system: IP00

Mechanical construction

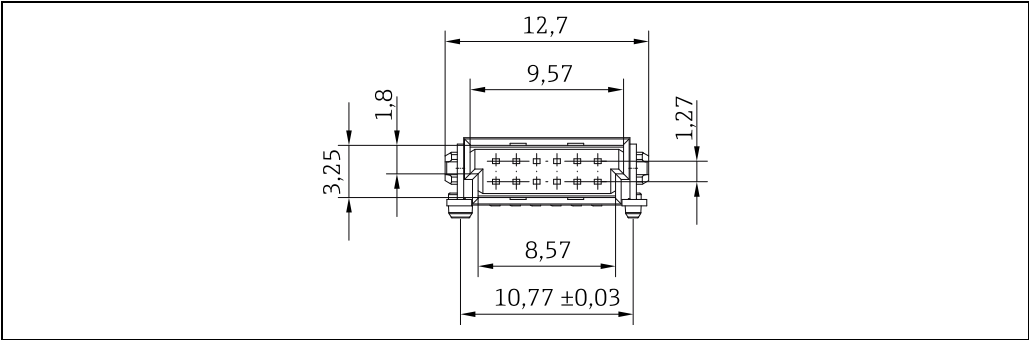


NOTICE
The fixing screws of the circuit board must not be removed!

Weight	Sensor unit with antenna: 68 g
Materials	■ Radar antenna: Plastic PBT ■ Coupling adapter: PPS GF40 (metallized)

Power supply

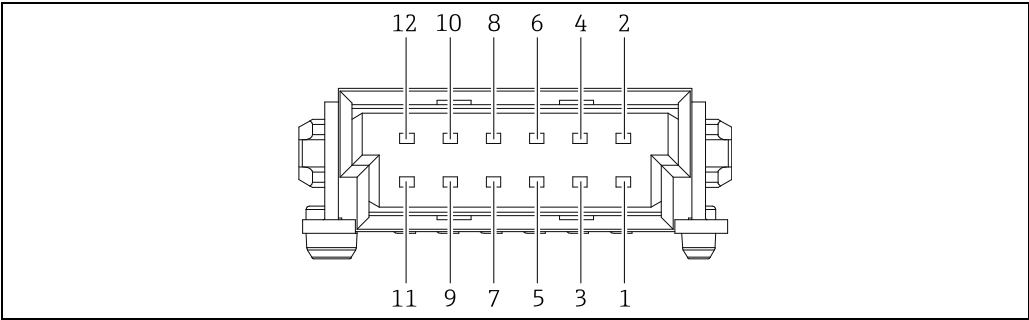
Supply voltage	The radar system requires 2 supply voltages: Sensor: 3.5 to 5.5 VDC Digital interface: 1.7 to 3.6 VDC (It is possible to cover both supply voltages with one voltage source).
Power consumption	~32 mW static ~1000 mW peak for < 10 ms during measurement
Electrical connection and pin assignment	The sensor is connected electrically via the attached plug.



Dimensions of the electrical connector plug

Connector plug	
Manufacturer	ERNI
Type	SMC Connector
Part no.	154763

Possible connection cables	Example 1	Example 2
Manufacturer	ERNI	HARTING
Type	SMC Cable	har-flex
Part no.	173799	33152430500102



PIN assignment of electrical connector plug

PIN	Type	Name	Description
1	Input	GND	Ground
2	Input	V _{DD_RADAR}	Power supply for HF part
3	Input	GND	Ground
4	Input	V _{DD_RADAR}	Power supply for HF part

PIN	Type	Name	Description
5	Input	GND	Ground
6	Input	V _{DD_IF}	Digital power supply
7	Input	RX	UART RX (data to USR30)
8	Output	TX	UART TX (data from USR30)
9	Input	RESET	Reset signal. If "HIGH", the USR30 is in reset.
10	Output	SIG1	Display of the standby status. If "HIGH" the USR30 is ready to start a new measurement.
11	Input	GND	Ground
12	Input	GND	Ground

Further details are described in the Operating Manual Radar (see Supplementary documentation →  14)

Installation instructions

Safety notes for installation

For work on and with the device:

NOTICE

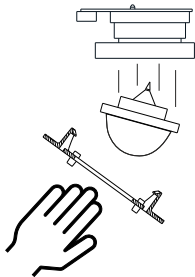
Danger of damaging the device
Static sensitive devices.

- ▶ Handle only at static safe work stations!



NOTICE

Danger of damaging the device
The radar antenna is secured against falling with a protective cap. If the protective cap is removed, the antenna may fall down and be damaged.

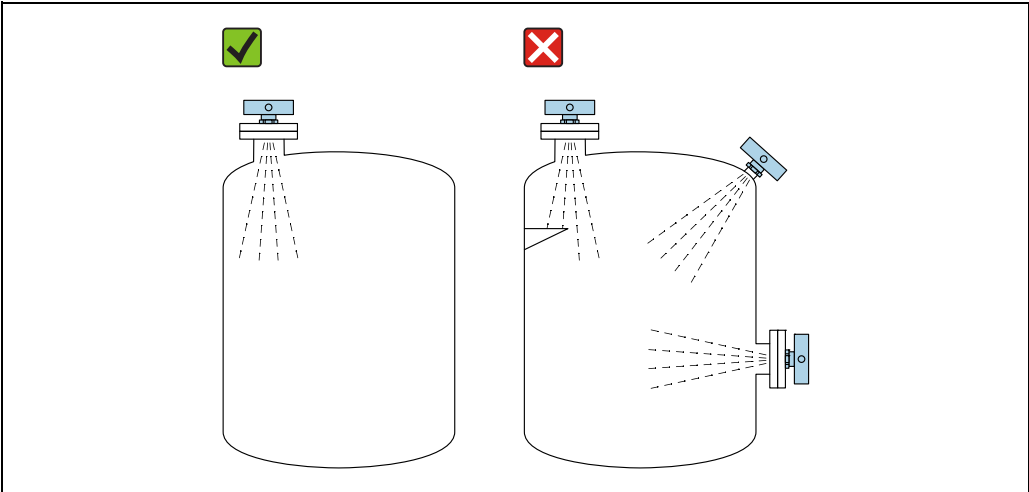


Beam angle

8°

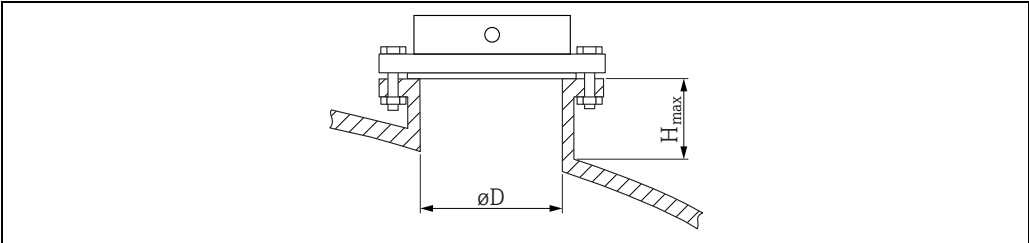
Positioning

- Mount the measuring device in a horizontal position so that it is parallel to the tank ceiling. Otherwise, undesired reflections from the surroundings can cause interference signals.
- The radar antenna should never be covered by metal objects.
- Do not mount any objects which may cause interference, such as tank internal fittings, grids or agitators, below or in the direct vicinity of the radar (see the graphic below).



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Maximum nozzle height and distance to wall



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Diameter D [mm]	H _{max} [mm]	Measuring distance [mm]	Radiation width ¹⁾ [mm]
40	230	500	70
50	300	1000	140
80	520	2000	280
100	660	5000	699
150	1020	10000	1399

1) The beam angle is 8°

"Frequency mode" parameter

The frequency mode parameter is used to define country or region-specific settings for the radar signals.

 Changing the frequency mode parameter is described in the Operating Manual Radar.

Operating frequency 80 GHz:

- Mode 1 (Default): Continent Europe, USA, Australia, New Zealand, Canada, Brazil, Japan, South Korea, Taiwan, Thailand (77 to 81 GHz)
- Mode 2: Kazakhstan (78 to 82 GHz)
- Mode 3: India (76 to 77 GHz)

 The performance characteristics of the device may vary on the mode set. The specified properties refer to device as supplied from factory (Mode 1).

Integration into an overall system

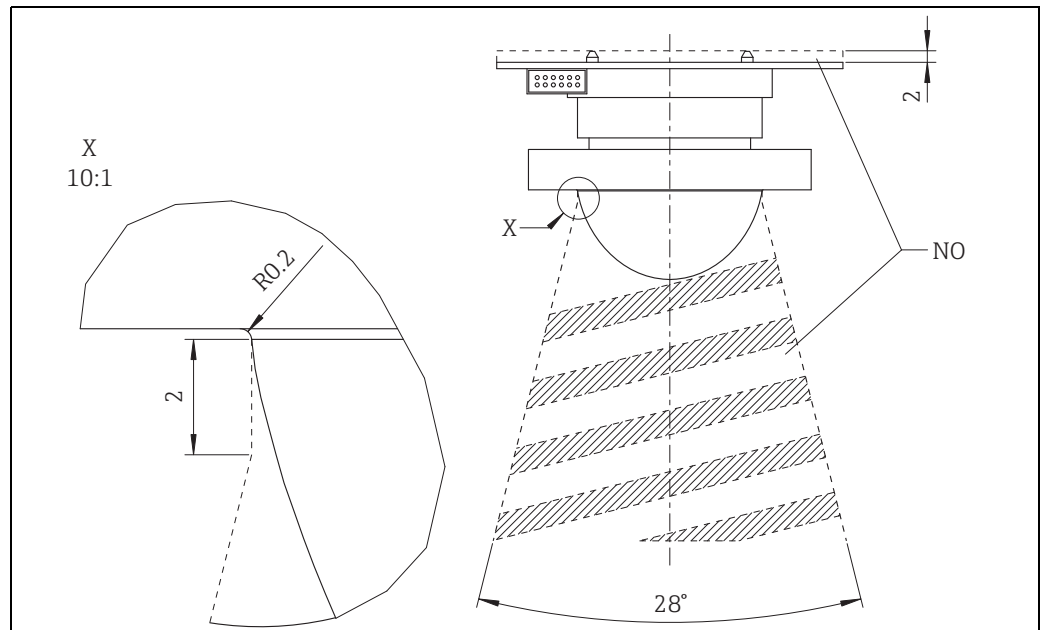
It is not allowed to modify the sensor module in any way or form. The sensor must be used with the antenna provided.

Characteristics

- Simple mechanical/electrical integration into an end device
- Configuration and control via widely used digital interface (UART) with defined command set (see Customer Manual)
- Startup time: <250 ms until first measurement can be performed
- Measurement cycle time: <100 ms

Integration

- The sensor must be installed inside a closed housing.
- A minimum distance of >2 mm to any mechanical part has to be left around and above the PCB as to not interfere with any signals of the sensor.
- The signal cone must not be obstructed by any elements of the housing or add-ons.
- The electrical connection must be done through the provided connector (see chapter "Power supply" for pin assignment) and it is necessary to use a fitting counterpart connector with a locking mechanism.
- After mounting in a housing, a functional check and zero offset calibration has to be performed. The zero plane can be defined by the customer.



* Unit of measurement mm

NO no objects zone

Check list

- Is the sensor undamaged (visual inspection)?
- Is the sensor properly mounted and fixed in position?
- Is the antenna and housing properly sealed?
- Is the sensor signal cone unobstructed?
- Is the electrical connector properly fitted and locked?
- Is the sensor responsive and returns a correct measurement value without any communication errors or active error bits?

Certificates and approvals

RoHS

The Directive on the Restriction of the Use of Certain Hazardous Substances 2011/65/EU (RoHS 2) and the Delegated Directive (EU) 2015/863 (RoHS 3).

Compliance Radio Directive ETSI EN 302 729

The module complies with the requirements of ETSI EN 302 729 V2.1.1 (2016) for a level probing radar. If the module is integrated into an end product in accordance with the integration documentation, this standard can be used to assess the conformity of the end device in accordance with the Radio Equipment Directive 2014/53/EU.

That is exclusively valid for the listed products in delivery status.

Please note the following for operation of the devices outside of closed vessels:

1. The device must be mounted in accordance with the instructions in the "Installation instructions" section.
2. Installation must be carried out by properly trained, expert staff.
3. The device antenna must be installed in a fixed location pointing vertically downwards.
4. The installation site must be located at a distance of 4 km from the astronomy stations listed below or otherwise approval must be provided by the relevant authority. If the device is installed at a distance of 4 to 40 km from one of the listed stations, it must not be installed at a height of more than 15 m (49 ft) above the ground.

Astronomy stations

Country	Name of the station	Latitude	Longitude
Germany	Effelsberg	50°31'32" North	06°53'00" East
Finland	Metsähovi	60°13'04" North	24°23'37" East
	Tuorla	60°24'56" North	24°26'31" East
France	Plateau de Bure	44°38'01" North	05°54'26" East
	Floirac	44°50'10" North	00°31'37" West
Great Britain	Cambridge	52°09'59" North	00°02'20" East
	Damhall	53°09'22" North	02°32'03" West
	Jodrell Bank	53°14'10" North	02°18'26" West
	Knockin	52°47'24" North	02°59'45" West
	Pickmere	53°17'18" North	02°26'38" West
Italy	Medicina	44°31'14" North	11°38'49" East
	Noto	36°52'34" North	14°59'21" East
	Sardinia	39°29'50" North	09°14'40" East
Poland	Krakow Fort Skala	50°03'18" North	19°49'36" East
Russia	Dmitrov	56°26'00" North	37°27'00" East
	Kalyazin	57°13'22" North	37°54'01" East
	Pushchino	54°49'00" North	37°40'00" East
	Zelenchukskaya	43°49'53" North	41°35'32" East
Sweden	Onsala	57°23'45" North	11°55'35" East
Switzerland	Bleien	47°20'26" North	08°06'44" East
Spain	Yebes	40°31'27" North	03°05'22" West
	Robledo	40°25'38" North	04°14'57" West
Hungary	Penc	47°47'22" North	19°16'53" East



As a general rule, the requirements outlined in ETSI EN 302 729 V2.1.1 must be observed.

FCC

Compliance with Part 15 of the FCC rules. Operation is subject to the following two conditions:

- (1) This device may not cause harmful interference, and
- (2) this device must accept any interference received, including interference that may cause undesired operation

[Any] changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

The devices are compliant with the FCC Code of Federal Regulations, CFR 47, Part 15, Sections 15.205, 15.207, 15.209

The limited module approval is only valid with the provided Antenna.

In addition, the module is compliant with Section 15.256.

When the module is integrated into a device the text "Contains FCC ID: LCGUXR3XYEL" must be added to the type plate of the device. Further it has to be verified that the device meets all spurious emission FCC requirements and the fundamental-frequency has to be tested for compliance with the FCC. The device must comply to all applicable requirements of Part 15 Subpart B. Any integration of the module has to be approved by Endress+Hauser and a FCC Change in ID has to be requested.

If the module is used in combination with other active radio components the coexistence of the modules must be tested.

For these LPR (Level Probe Radar) applications the device must be professionally installed in a downward operating position. In addition, the devices are not allowed to be mounted in a zone of 4 km around RAS stations and within a radius of 40 km around RAS stations the maximum operation height of devices is 15 m (49 ft) above ground.

Industry Canada**Canada CNR-Gen Section 7.1.3**

Compliance with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions: (1) This device may not interfere, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

[Any] changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

- The installation of the LPR/TLPR module shall be done by trained installers, in strict compliance with the manufacturer's instructions
- The use of this device is on a "no-interference, no-protection" basis. That is, the user shall accept operations of high-powered radar in the same frequency band which may interfere with or damage this device. However, devices found to interfere with primary licensing operations will be required to be removed at the user's expense
- For any integration of the module into a device an ISED multiple listing has to be requested
- The installer/user of this device shall ensure that it is at least 10 km from the Dominion Astrophysical Radio Observatory (DRAO) near Penticton, British Columbia. The coordinates of the DRAO are latitude 49°19'15" N and longitude 119°37'12" W. For devices not meeting this 10 km separation (e.g., those in the Okanagan Valley, British Columbia,) the installer/user must coordinate with, and obtain the written concurrence of, the Director of the DRAO before the equipment can be installed or operated. The Director of the DRAO may be contacted at 250-497-2300 (tel.) or 250-497-2355 (fax). (Alternatively, the Manager, Regulatory Standards Industry Canada, may be contacted.)



The customers measurement systems with USR30 can fulfill the requirements for use as LPR (Level Probe Radar).

Approvals of closed measuring systems

NOTICE

The USR30 radar sensor is a sensor unit that is installed as a component in the customer's end system. It is therefore the customer's responsibility to obtain the relevant approvals for his end device / measuring system.

Endress+Hauser's closed measuring systems that include this sensor unit comply with the following guidelines:

EN 61010-1

Endress+Hauser **closed measuring systems with this sensor unit** meet the requirements of EN 61010-1 (Safety requirements for electrical equipment for measurement, control and laboratory use).

CE mark

The **closed measuring systems** from Endress+Hauser **with this sensor unit** meet the legal requirements of the applicable EU directives. These are listed in the corresponding EU Declaration of Conformity together with the standards applied.

Accessories

Designation	Type	Notes	Ambient temperature range
Cable	Adapter cable for electrical connector plug. Mating connector for ERNI 12 pin SMC plug.	Length: 40 mm (1.57 in)	-40 to 85 °C (-40 to 176 °F)

Explanations and supplementary documentation

Supplementary documentation



For an overview of the scope of the associated Technical Documentation, refer to the following:

- Operating Manual Radar

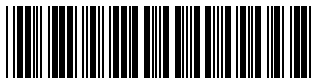
Disposal



As required by the Directive 2012/19/EU on waste electrical and electronic equipment (WEEE), our products are marked with the depicted symbol in order to minimize the disposal of WEEE as unsorted municipal waste. Such products may not be disposed of as unsorted municipal waste and can be returned to Endress+Hauser for disposal under the conditions stipulated in the General Terms and Conditions or as individually agreed.

Contact addresses

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