

# Microimpulse Level Measurement *levelflex FMP 232 / 332*

**Continuous level measurement of medium and fine-grained bulk solids**



Levelflex FMP 232  
with threaded connection  
and standard wire  
cable (5/32") and weight



Levelflex FMP 332  
with threaded flange  
and heavy duty wire  
cable (5/16") and weight

## Application

The Levelflex FMP 232/332 is a top-mounted, compact level transmitter for process control or inventory/storage applications that operates with micro-impulse radar on the guided time-of-flight principle. It measures a wide variety of bulk solids, including:

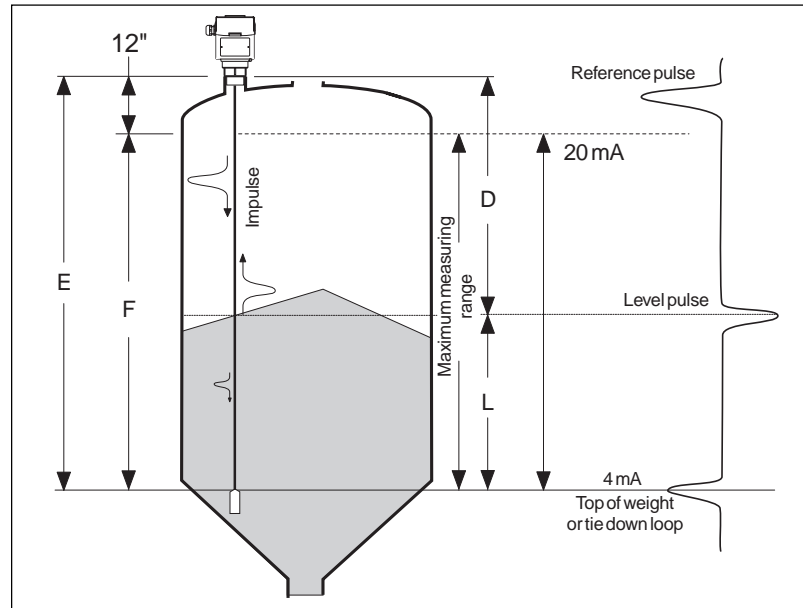
- minerals, plastics, agricultural products, foodstuffs, pharmaceuticals and solid fuels
- independent of their physical properties

## Features and Benefits

- Mount and measure:  
zero and span for the 4 to 20 mA signal are already aligned to the top of the weight and 12 inches from the flange
- Safe and reliable:  
measurement independent of material properties (moisture content, dielectric constant, change of contents), bin construction (materials, geometry), and operating conditions (dust, build up and angled material surfaces)
- Flexible:  
coated or stainless steel ropes for standard and heavy duty applications;  
on-site or remote operation via standardized interfaces

## Measurement Principle

Block diagram of the measurement principle and signal processing of the Levelflex



The Levelflex is a “downward-looking” time-of-flight system, which measures the distance from the probe mounting (top of bin) to the material level. An electrical pulse is launched and guided down the probe wire cable, which acts as a surface wave transmission line.

When the surface wave meets a discontinuity in the surrounding medium, i.e. a sudden change in dielectric constant, it is partially reflected. The reflected pulse travels back up the probe to the pulse sampler where it is detected and timed. Any unreflected portion travels on to the end of the probe to provide an “empty” signal.

### Input

Each point along the probe is sampled for its pulse reflection behavior. The information accumulated over the sampling cycle is captured and passed onto signal processing. The signal produced by the change in dielectric constant at the air/product interface is identified.

The distance  $D$  to the surface of the product is proportional to the time of flight of the pulse  $t$ :

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

where  $c$  is the speed of propagation.

Since the empty distance  $E$  is known to the system, it is a simple matter to calculate the level  $L$ :

$$L = E - D$$

### Output

The Levelflex is factory pre-calibrated. The probe tip is zero, the span is set at 90% of the total wire cable length. For versions with current output these points correspond to 4 mA and 20 mA respectively, for digital outputs and the display, 0% and 100% level. The range and units may be re-adjusted locally at the display or remotely via the communications interface.

### Accuracy

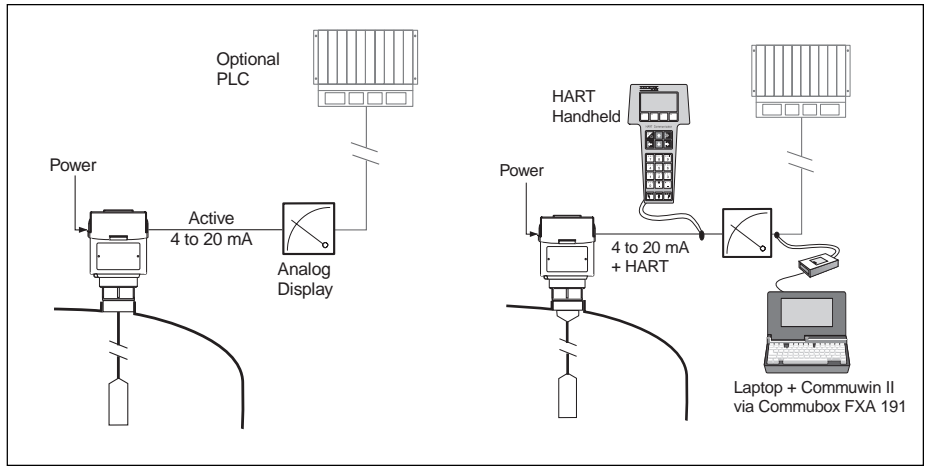
The Levelflex FMP 232/332 is capable of measuring at all points from the top of the weight to within 12" of the mounting point to a measured error of  $\pm 1\%$  (see Technical Data).

Depending on the application, it may be possible to measure to the end of the ballast weight or tie-down loop, but with decreased accuracy.

# Measuring System

Left:  
Single measuring point  
with 4 to 20 mA signal

Right:  
Single measuring point  
with HART output



## 4 to 20 mA Current Output

Version with active current output and local configuration only.

## 4 to 20 mA HART Output

Version with active current output and superimposed HART digital signal.

- can be configured locally, or remotely with a handheld terminal DXR 275
- alternatively a personal computer, Commuwin II and Commubox FXA191 can be used

## Rackbus RS-485

Version with digital output and Rackbus protocol for connection to a Rackbus RS-485 bus (in preparation).

- can be configured locally or remotely.
- the Commubox FXA 192 connects the bus directly to a PC with Commuwin II.
- the FXA 675 interface and ZA 67x gateway connect to a process control system.
- maximum 25 devices per segment are allowed

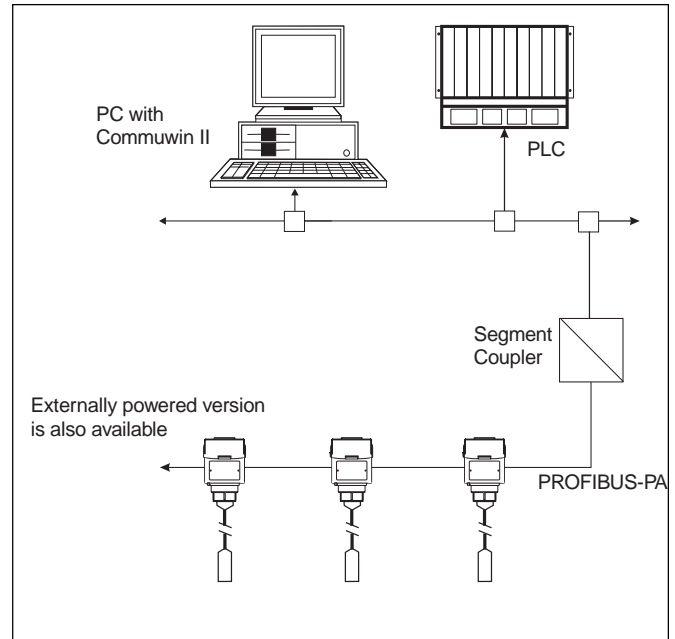
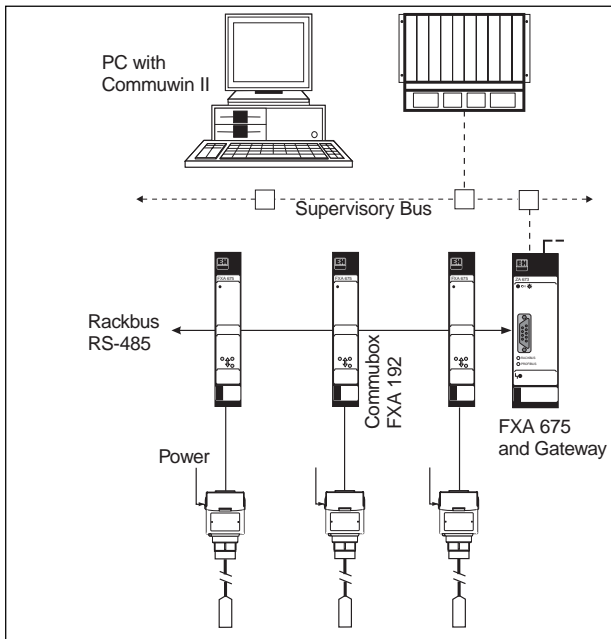
## PROFIBUS-PA

Version with digital output and PROFIBUS-PA protocol for connection to a PROFIBUS-PA field-bus segment (in preparation).

- can be configured locally or remotely.
- segment coupler provides loop-power and a transparent interface to the process control system
- maximum 32 transmitters per segment are allowed in safe areas, maximum 10 in hazardous areas

Left:  
Rackbus RS-485 network  
- with configuration and display with Commuwin II  
- with gateway to process control system

Right:  
PROFIBUS-PA application

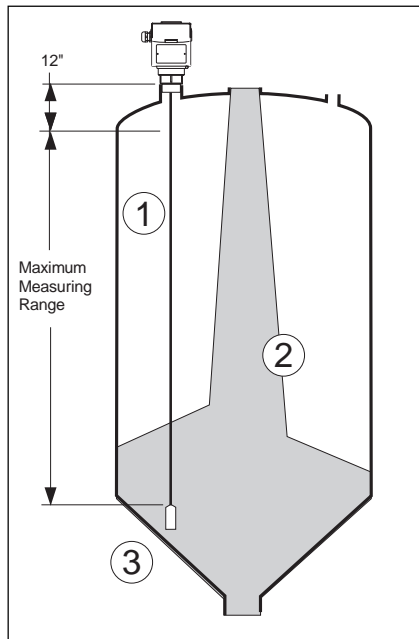


## Installation Hints

### Mounting Position

The Levelflex is mounted at the top of the vessel. The probe wire cable is hung, fully extended, across the entire distance where level measurement readings are desired.

- select the probe length according to the measurement range required - it can be shortened by the customer
- hang the probe at least 12" away from the vessel wall or any structural element
- do not hang the probe in the filling stream
- in the event that the probe can only be installed near to a wall or other obstruction (< 12"), then the tie-down option is recommended
- position the tie-down so that it is not subject to lateral forces
- the distance between the probe tip and vessel bottom has no minimum requirement



Selecting the best mounting position:

- 1 At least 12" away from the vessel wall or any structural element\
- 2 Not in the filling stream
- 3 If there is a danger of the probe hitting the wall, use the tie-down option

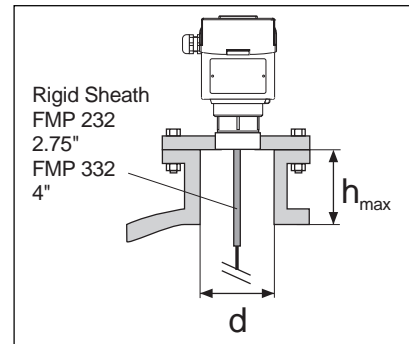
### Mounting Nozzles

To prevent deflection of the wire rope onto the side walls of nozzles or extended couplings, the rigid sheath at the top of the cable should project into the vessel.

The following nozzle dimensions allow immediate measurement after installation (refer to figure below).

d	2" (50mm)	3" (80mm)	4" (100mm)
h (max.)	2"	3"	4"

If circumstances do not permit that these requirements are met, then the user can program (probe map) the unit to ignore certain reflective surfaces that do indicate level measurement.



Minimum dimensions of mounting in a nozzle, see Table above

### Environment

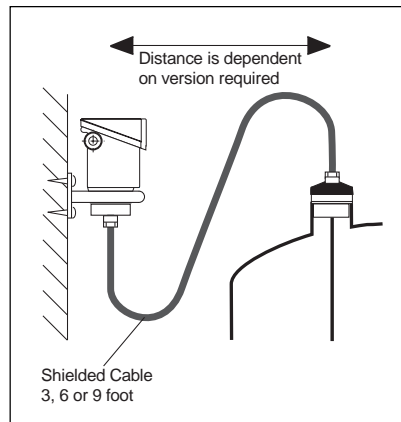
The normal operating temperature range is -40° to + 250°F.

- for higher ambient temperatures, the remote mount option allows the electronics to be located up to 9 feet away
- the remote option should also be used for process temperatures above 195°F
- for outdoor locations a protective hood is available

### Medium

The Levelflex measures reliably in granular materials such as cement, plastic pellets, plastic powders, limestone, flyash, aggregates and powdered materials. For other materials, the basic guideline is a relative dielectric constant of 1.8 or more.

- the temperature of the medium may not exceed +250°F
- a coated wire cable probe is available for abrasive or corrosive media
- the maximum grain size is 0.78" (20mm)



Remote mounting option for housing, for high temperatures, humid conditions or heavy vibration at the measuring point. For probes over 50 foot long, the remote distance should be kept at a minimum.

## Probe Selection

### Process Connection

The Levelflex is equipped with a standard threaded connection.

- pressure and temperature ratings are shown in the diagrams below
- standard adapter flanges with a threaded bore are available as accessories

### Electrostatic Discharge

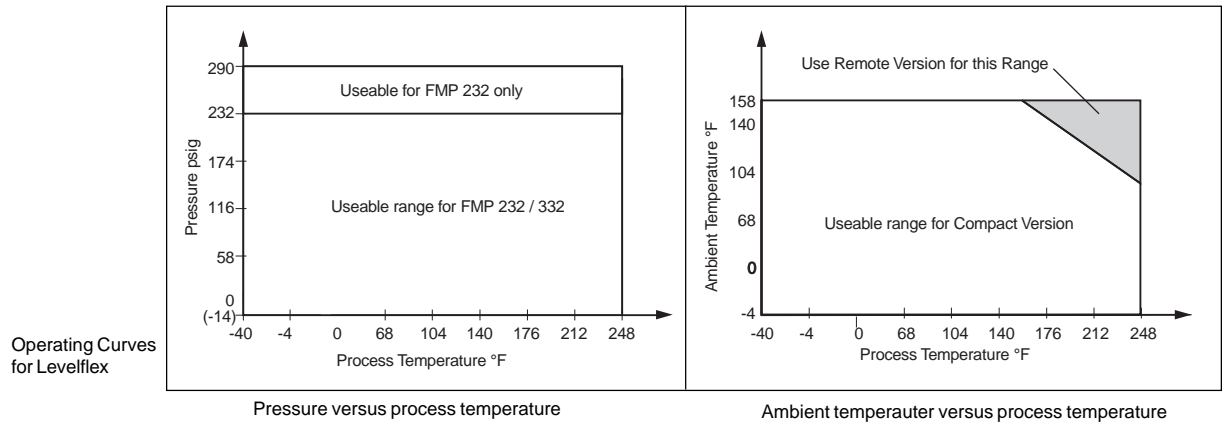
If the product tends to build up static electricity during handling, use an uncoated tie-down loop.

### Cable Material

Two types of cable are available:

- coated carbon steel cable for use with abrasives
- stainless steel cable, for food, pharmaceuticals and corrosive

The cable is available in two thicknesses and various lengths. When selecting the cable length, ensure the pull-down forces do not exceed the cable maximum load.



### Down-Pull Force on Probe Cable

The vessel top and probe cable must withstand the down-pull force of the material. Examples are shown in the table below.

- mounting near a sidewall may double forces
- the down-pull is dependent on the bulk density and coefficient of friction of the material, the size of the vessel, the position of the probe in the vessel, and the selected probe

### Forces on Cable with Ballast Weight

The table below summarizes the down-pull forces and permissible cable lengths for probes with ballast weights.

- for silos less than 33 feet in diameter, the full length (Lmax) applies to all cases shown
- the down-pull forces are shown to assist the user in considering safety factors

### Maximum Cable Load

Maximum cable load for the standard cable (FMP 232) and heavy duty cable (FMP 332) is shown in the table.

Type	Coated Cable	Stainless steel Cable
FMP 232	2855 lb	2360 lb
FMP 332	9780 lb	8990 lb

### Forces on Cable with Tie-down

Depending on the position in the vessel, the forces on wire ropes with tie-downs are from two to ten times greater than on cables with ballast weights.

- forces increase with buried length and vessel diameter, both parameters are of equal importance
- allow a good safety factor

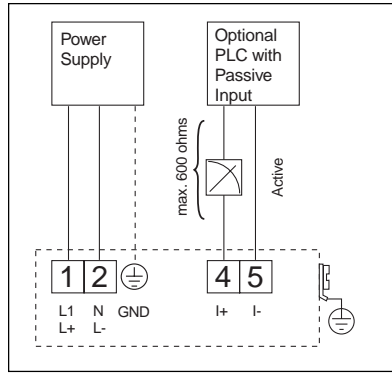
Worst case pull-down forces as a function of fully buried cable and material for a 40 foot diameter silo.  
Lmax = maximum probe length

Material	5/32" uncoated		1/4" coated		5/16" uncoated		7/16" coated	
	L max	pull (lb)	L max	pull (lb)	L max	pull (lb)	L max	pull (lb)
Wheat	33 ft	225	33 ft	315	65 ft	1170	65 ft	1620
Polypropylene pellets	33 ft	225	33 ft	160	65 ft	810	65 ft	810
Gravel	33 ft	1000	33 ft	1350	65 ft	5845	62 ft	9665
Cement	33 ft	1350	33 ft	1575	65 ft	8545	65 ft	8790

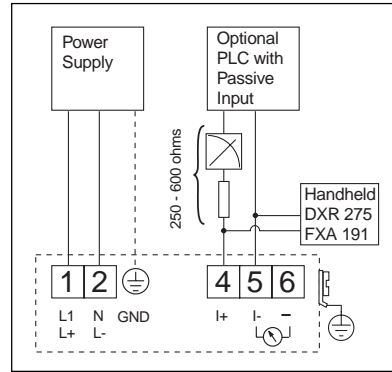


# Electrical Connection

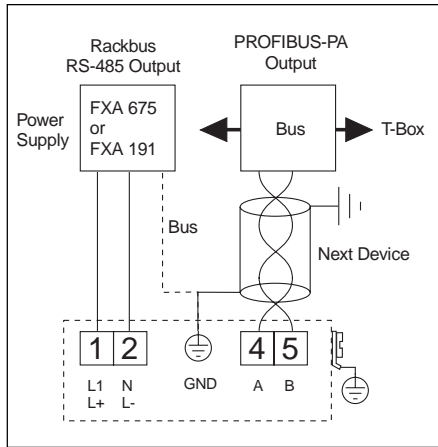
Wiring diagram for 4 to 20 mA current output



Wiring diagram for 4 to 20 mA with HART output



Wiring diagram for RS-485



## 4 to 20 mA Current Output

Four-wire transmitter with active current output.

- maximum output load 600 Ohms (for hazardous versions, 500 Ohms)
- power 18 to 36 VDC, 90 to 127 VAC or 180 to 253 VAC

Use separate standard installation cable for input power and output wiring.

## 4 to 20 mA HART Output

Four-wire transmitter with active current output and superimposed HART digital signal.

- minimum output load 250 Ohms
- maximum output load 600 Ohms (for hazardous versions, 500 Ohms)
- power 18 to 36 VDC, 90 to 127 VAC or 180 to 253 VAC

Use standard installation wiring cable for input power, and shielded twisted pairs for the output wiring.

## Rackbus RS-485 Output

Four-wire transmitter with digital output and Rackbus protocol (in preparation, not available at this printing, please consult factory).

- power 90 to 127 VAC or 180 to 253 VAC
- maximum bus distance, 3900 feet

Use standard installation cable for the input power, and shielded, twisted pairs for the bus wiring.

## PROFIBUS-PA Output

Two-wire transmitter with digital output and PROFIBUS-PA protocol (in preparation, not available at this printing, please consult factory).

- loop-powered 9 to 32 VDC
- four-wire 90 to 127 VAC, 180 to 253 VAC

Use twisted pair shielded cable for the bus (e.g., Belden 8761, Belden 9841 or similar type).

## Technical Data

### System Function

Measurement Principle	Guided time-of-flight via micro-impulse time domain reflectometry (MiTDR)
Modularity	Compact four-wire instrument consisting of transmitter and integral wire rope probe. Optional remote electronics version with pipe or wall mounting kit. Optional display
Signal Transmission	4 to 20 mA and/or digital communication

### Input

Measured Variable	Level, determined by the time-of-flight of a guided radar pulse from transmitter to product surface and back.
Measuring Range	FMP 232, 36" to 360", adjustable to within 12" of the process connection. FMP 332, 72" to 720", adjustable to within 12" of the process connection.

### Output

Versions	Analog 4 to 20 mA output Analog 4 to 20 mA output with superimposed HART digital signal Digital with Rackbus RS-485 signal Digital with PROFIBUS-PA signal
Output Signal	Analog, useable output current range 3.8 mA to 20.5 mA Digital, -9999 to +9999
Output Resolution	10 bit (equivalent to 0.1% FS or microamps)
Load	Analog, maximum 600 Ohms HART, 250 to 600 Ohms Hazardous versions, maximum 500 Ohms Digital, none (terminating resistance is 150 Ohms at last device on bus)
Signal on Alarm	Adjustable; MIN, MAX or HOLD. Analog; MIN = 2.4 mA, MAX = 22.0 mA Digital; MIN = -9999, MAX = +9999
Output Damping	0 to 60 seconds, adjustable

### Accuracy

Reference Conditions	Reflection from flat surface of 0.12" grains; temperature 68°F; output scaled to 90% of probe length
Measured Error	± 1% full scale
Resolution	0.3% of probe length
Repeatability	0.2% full scale
Hysteresis	Better than 0.5% full scale
Settling Time	ε 2 seconds
Warm-up Time	30 seconds
Ambient Temperature Effect	± 0.02% FS/K
Process Temperature Effect	± 0.01% FS/K
Linearity	± 1% full scale (independent linearity)

### Operating Conditions

Orientation Installation	Vertical; top-mounted, minimum 4" from wall or structural elements.
Vessel Geometry Effects	No influence on measurement by vessel shape materials of construction or sensor movement under above conditions.
Operating Temperature Range	-5°F to + 160°F (meets all stated specifications)
Limiting Temperature Range	-40°F to + 175°F (operates at reduced specifications)
Storage Temperature Range	-40°F to + 175°F



## Technical Data

### Operating Conditions (con't)

Ingress Protection	Housing, NEMA 4X, 6 (open housing, NEMA 1) Probe, NEMA 4X, 6
Climate Class	IEC 68 part 2-30 Db, 4K2 per EN60721-3-4 (1995)
Thermal Shock Rating	IEC 68 part 2-14 NB (1K/min across temp. range)
Vibrational Resistance	IEC 68 part 2.6 (2g)
Electromagnetic Compatibility	Interference emission to EN 50 081-1 Interference immunity to EN 50 082-2 and NAMUR industrial standard, 10 V/m
Process Temperature Range	-40°F to + 250°F
Pressure Range	FMP 232, maximum 290 psig FMP 332, maximum 232 psig
Properties and Effects of Medium	Medium must have a minimum relative dielectric constant of 1.8. No influence on measurement by density, particle size (max. 0.78"), surface angle, or moisture content.

### Mechanical Construction

Housing Material	PC/ABS flame retardant
Conduit Entry	1/2" NPT
Seal	Housing gaskets and O-rings, EPDM
Process Connection and Material	1-1/2" NPT, 316 SS or carbon steel, compatible with standard 1-1/2" threaded flanges and PPS (FMP 232) or PTFE (FMP 332)
Process Seals	O-rings, EPDM
Cable / Weight	Carbon steel or 304 SS, PA (nylon) coated option
Cable Diameter	FMP 232; 5/32" uncoated, 1/4" coated FMP 332; 5/16" uncoated, 7/16" coated
Permissible Cable Load	FMP 232; maximum 2400 lb wt (uncoated) 2800 lb wt (coated) FMP 332; maximum 9000 lb wt (uncoated) 9800 lb wt (coated)
Housing and Probe Weight	FMP 232; 10.6 lb. + 0.05 lb/ft of probe FMP 332; 12.3 lb + 0.2 lb/ft of probe

### User Interface

Keypad	4 rubberized keys for matrix operation, data entry and system lock
External Indication	Green and red LED's indicate system status
Optional Display (internal)	4-digit LCD (measured values) with alphanumeric matrix location indication
Digital Communication	None, HART, RS-485 or PROFIBUS-PA

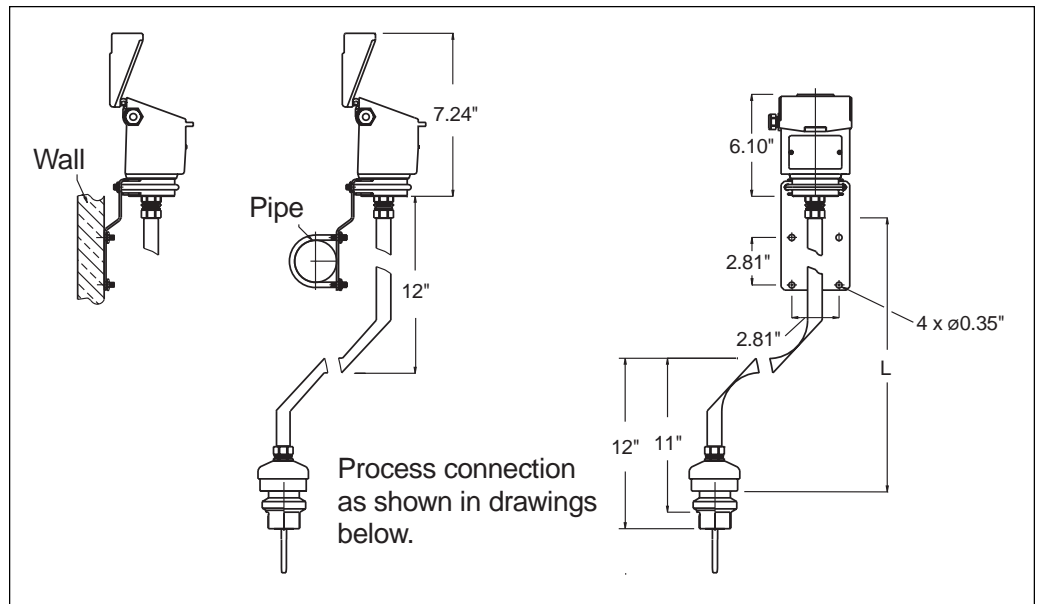
### Power

Input Power	90 to 127 VAC or 180 to 250 VAC, 50/60 Hz 1.2 VA power consumption. 18 to 36 VDC, 1.2 W power consumption. HART; ripple 47 to 125 Hz, $V_{pp} = 200$ mV (measured at 500 Ohms). Maximum noise 500 Hz to 10 kHz, $V_{rms} = 2.2$ mV (measured at 500 Ohms).
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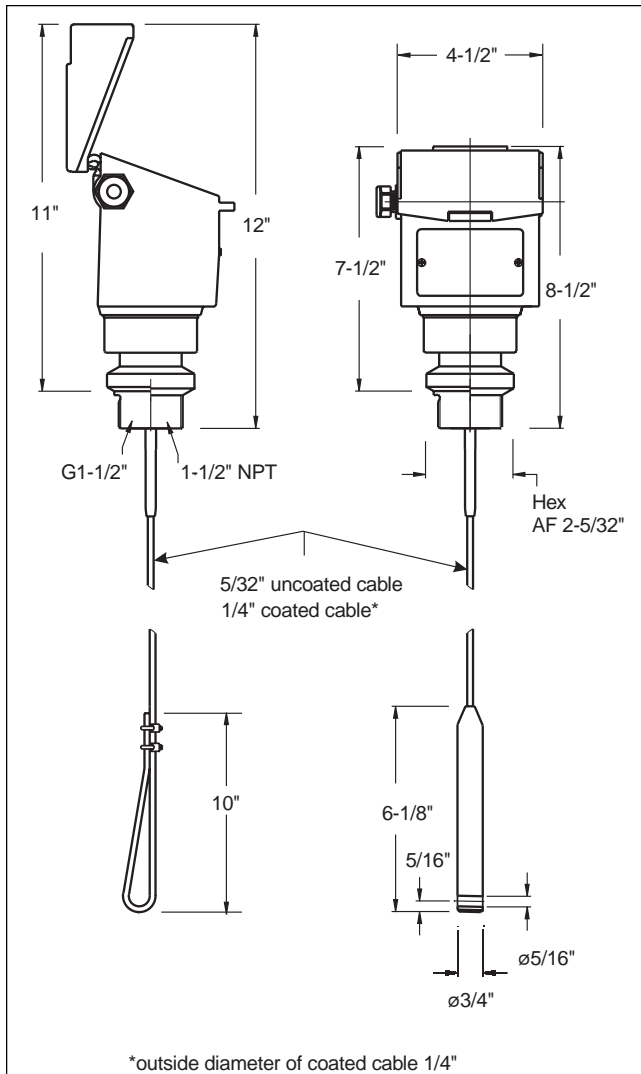
### Approvals

Electrical Classification (in preparation, consult factory)	FM approved Class II, Division 1, Groups E-G with intrinsically safe probe. Non-incendive Class I, Division 2, Groups A-D CSA, Associated equipment [Exi] Class II, Division 1, Group G and coal dust Non-incendive Class I, Division 2, Groups A-D CSA General purpose
Telecommunications	Meets FCC requirements for non-intentional radiators

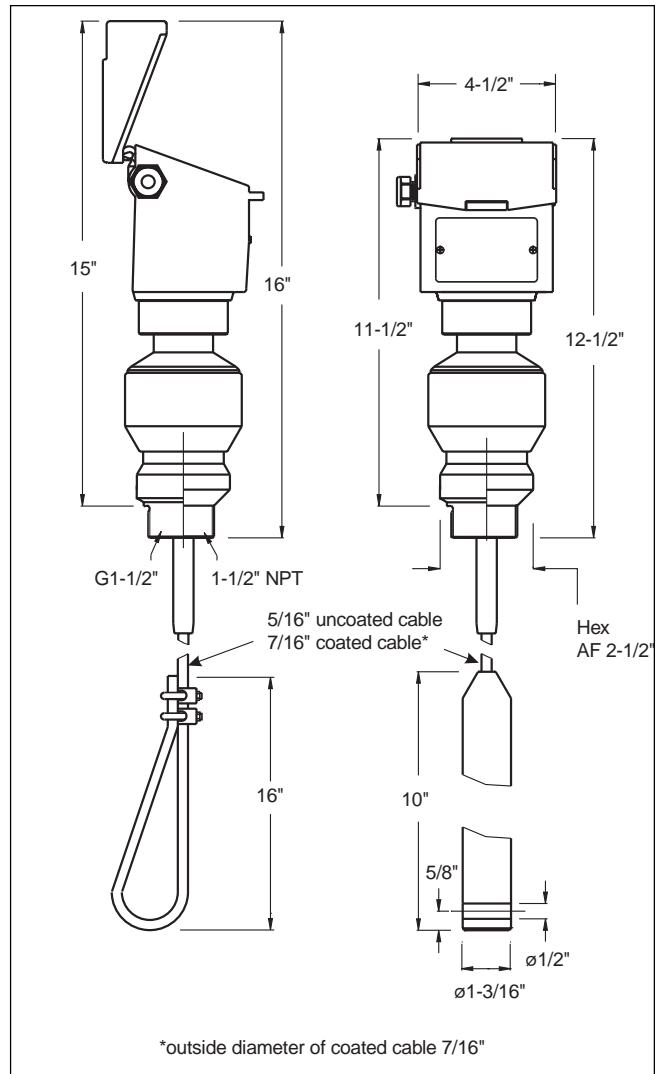
# Dimensions



Dimensions of remote electronics

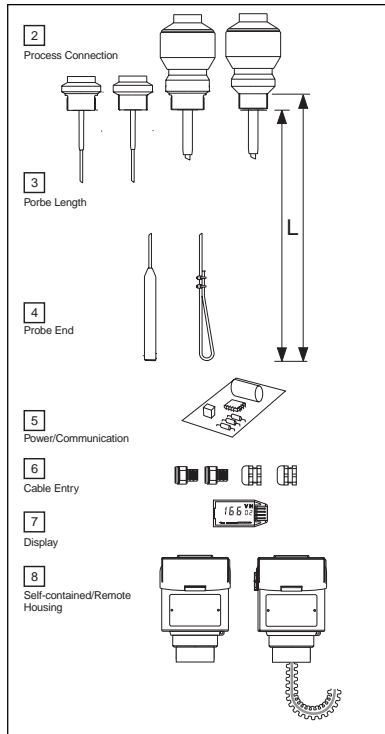


Dimensions of FMP 232



Dimensions of FMP 332

# Ordering Information



FMP 232 A 1 2 3 4 5 6 7 8

- 1 Certificate
  - A Non-hazardous area
  - M FM S Class II, Div. 1, Grp E-G \*
  - N CSA general purpose
  - S CSA Class II, Div. 1, Grp E-G \*
  - Y Other
- 2 Process Connection / Material
  - GN1 1-1/2" NPT / carbon steel
  - GNJ 1-1/2" NPT / 316 SS
  - Y Other
- 3 Probe Length and Material (minimum 4 foot)
  - A Steel cable, 5/32", polyamid coated, x ft.
  - B 304 SS cable, 5/32", polyamid coated, x ft.
  - C Steel cable, 20 foot, 5/32", polyamid coated
  - D 304 SS cable, 20 foot, 5/32"
  - E Steel cable, 30 foot, 5/32", polyamid coated
  - F 304 SS cable, 30 foot, 5/32"
- 4 Probe End
  - 1 Tie-down loop with 2 cable clamps
  - 2 Tensioning weight
  - 9 Other
- 5 Electronic Insert
  - D 18 to 36 VDC, 4 to 20 mA
  - E 18 to 36 VDC, 4 to 20 mA, HART
  - F 180 to 253 VAC, 4 to 20 mA
  - G 180 to 253 VAC, 4 to 20 mA, HART
  - J 90 to 127 VAC, 4 to 20 mA
  - K 90 to 127 VAC, 24 to 20 mA, HART
- 6 Housing, Cable Entry
  - 2 Housing, PC/ABS NEMA 6, 1/2" NPT
  - 9 Special version
- 7 Display
  - 1 No display selected
  - 2 4-character LCD display
- 8 Remote Kit / Mounting Plate
  - 1 Compact unit
  - 2 Remote housing, 3 foot cable
  - 3 Remote housing, 6 foot cable
  - 4 Remote housing, 9 foot cable

\* Consult factory for FM / CSA approval units.

FMP 332 A 1 2 3 4 5 6 7 8

- 1 Certificate
  - A Non-hazardous area
  - M FM S Class II, Div. 1, Grp E-G \*
  - N CSA general purpose
  - S CSA Class II, Div. 1, Grp E-G \*
  - Y Other
- 2 Process Connection / Material
  - GN1 1-1/2" NPT / carbon steel
  - GNJ 1-1/2" NPT / 316 SS
  - Y Other
- 3 Probe Length and Material (minimum 7 foot)
  - A Steel cable, 5/16", polyamid coated, x ft.
  - B 304 SS cable, 5/16", polyamid coated, x ft.
  - C Steel cable, 20 foot, 5/16", polyamid coated
  - D 304 SS cable, 20 foot, 5/16"
  - G Steel cable, 40 foot, 5/16", polyamid coated
  - H 304 SS cable, 40 foot, 5/16"
  - L Steel cable, 60 foot, 5/16", polyamid coated
  - M 304 SS cable, 60 foot, 5/16"
- 4 Probe End
  - 1 Tie-down loop with 2 cable clamps
  - 2 Tensioning weight
  - 9 Other
- 5 Electronic Insert
  - D 18 to 36 VDC, 4 to 20 mA
  - E 18 to 36 VDC, 4 to 20 mA, HART
  - F 180 to 253 VAC, 4 to 20 mA
  - G 180 to 253 VAC, 4 to 20 mA, HART
  - J 90 to 127 VAC, 4 to 20 mA
  - K 90 to 127 VAC, 24 to 20 mA, HART
- 6 Housing, Cable Entry
  - 2 Housing, PC/ABS NEMA 6, 1/2" NPT
  - 9 Special version
- 7 Display
  - 1 No display selected
  - 2 4-character LCD display
- 8 Remote Kit / Mounting Plate
  - 1 Compact unit
  - 2 Remote housing, 3 foot cable
  - 3 Remote housing, 6 foot cable
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\* Consult factory for FM / CSA approval units.

## Accessories

### Adapter Flange with Threaded Connection

316L Stainless Steel

FAU 70 1 2 3

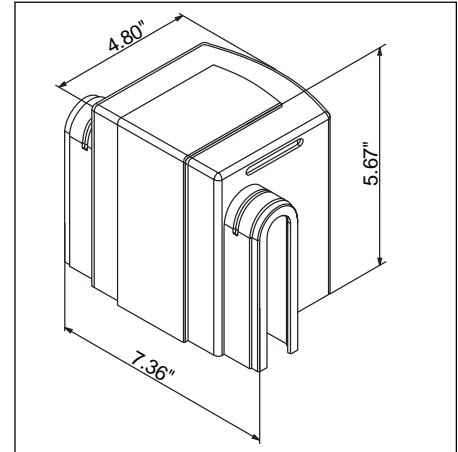
- 1 Process Connection  
A-22 2" ANSI, 150 lb flange  
A-23 3" ANSI, 150 lb flange  
A-24 4" ANSI, 150 lb flange
- 2 Probe Connection  
5 1/2" NPT
- 3 Flange Material  
2 316L SS

### Protective Hood

Plastic hood slips over the electronics housing as a sun shield for outdoor mounting locations. Helps to minimize condensation build-up inside the electronics housing.

PN 942665-0000

**NOTE:** Hood does not protect sensor from harsh environments nor extreme temperature fluctuations. The ambient temperature range of the electronics must be maintained.



#### United States

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FAX: (317) 535-8498

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Endress+Hauser  
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FAX: (281) 999-1891

Fogarty Engineering  
Sales Company  
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FAX: (504) 366-3816

Sterling IPC  
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