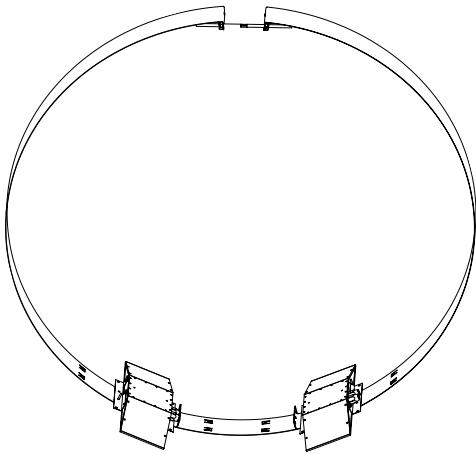


ChannelMag PM2 Magnetic Flowmeter for Full & Partially Full Pipes



The ChannelMag PM Series is a bi-directional magnetic flowmeter suitable for full and partially full pipes 20" - 120" (500 - 3000 mm) Ø. The PM Series is suitable for raw sewage, storm water, river water or similar. The electrodes may be permanently coated with sewage grease, algae, calcium carbonate or similar, without the need to clean and without affecting accuracy.

The ChannelMags are used singularly or in multiples to measure mean velocity, dependant on pipe size. They are retained by a magnetic enhancement band that is secured to the pipe inside diameter by an expansion mechanism. As such, they are ideal for use in concrete pipes since no holes or fixtures are required for installation.

A high-resolution hydrostatic level transducer is built into the ChannelMag PM sensors when used for partially filled pipe measurement. The hydrostatic level transducer has automatic compensation for change in barometric pressure. Alternatively, an ultrasonic level transducer may be used and mounted separately to the ChannelMag sensors.

A remote 4411e Pulsed AC bi-directional transmitter calculates volumetric flow from the mean velocity and level sensor inputs. It displays rate and totals, and is programmable to show net forward totals from storm water back up. Transmission signals include two 4 – 20 mA outputs from separate terminals, scaleable pulse frequency output, RS233 and HART protocol.

See separate data sheets for ChannelMag CM Series for rivers and open channels, or diameters < 20" (500 mm) and for the 4411e transmitter.

CHANNELMAG FEATURE	BENEFIT
Patented Coil Excitation 1 - 5 A @ 40 Hz	Produces a high accuracy linear signal, unaffected by permanent coatings such as sewage grease, calcium carbonate, algae.
No sensor cleaning necessary	High energy magnetic flux over the complete cross sectional area to generate a true weighted volumetric flow signal.
Suitable for existing pipes of any material	No restrictions, no gradients, no spool piece required.
USA NIST and international traceable calibrated accuracy	Suitable for custody transfer with high accuracy and wide ranges.
Solid state sensors, no moving parts	Virtually maintenance free.

EMCO Flow Systems

ChannelMag Method of Operation

The ChannelMag PM2 Series is suitable for full or partially full pipes from 20" to 120" (500 - 3000 mm). They meet or exceed the requirements of ISO 9213 and are calibrated in a long open tank, believed to be the largest NIST traceable facility available. ChannelMags are calibrated in accordance with ISO* approved methods. Each ChannelMag system is normally supplied with a NIST traceable Calibration Certificate.

Magnetic enhancement plates are fixed to and calibrated with the ChannelMag sensor(s). The enhancement plates are custom made to the required diameter of the channel. Their purpose is to determine the distribution pattern of magnetic flux on calibration in the EMCO test laboratory and to insure it is the same as the distribution on-site. In this way, the test calibration is the same as on-site. The other function of the enhancement plates is to retain the ChannelMag sensors in place in the pipe. They incorporate an expander mechanism which holds the sensor(s) firmly in place, without the need of further fixtures or to cut holes in the pipe.

ChannelMag sensors generate a uniquely powerful magnetic field over the whole cross sectional area of the pipe. They operate using Faraday's Law, where a conductor moving in a magnetic field induces a voltage, the amplitude of which is proportional to the velocity of the conductor. The conductor is the media being measured. Large conical electrodes on the PM2 sensor measure the voltage signal, which is the mean velocity "weighted" to account for the complete cross sectional velocity profile. The signal is unaffected by media viscosity or density.

Each ChannelMag PM2 sensor contains an exciter coil, powered by a remote 4411e transmitter. The 4411e is a microprocessor based patented Pulsed AC technology transmitter. The uniquely powerful and far-reaching magnetic field is created by energizing the coil with a magnetizing current up to 5 Amps at an exciter frequency of 40 Hz (for 60 Hz supply) or 33 Hz (for 50 Hz supply). This combination provides a signal to media noise ratio typically 50 times superior to traditional pulsed DC technology. As such, the electrodes may be permanently coated with sewage grease, calcium carbonate and similar without loss of accuracy. Cleaning the ChannelMag is not necessary. The sensors may be installed such that the electrodes remain above non-moving silt deposits on the bed of the channel.

Volumetric flow in partially filled pipes is computed in the 4411e by multiplying level x mean velocity. The level signal is linearized in the 4411e. Level is measured normally by a high resolution pressure transducer, which is used under the ramps of the ChannelMag velocity sensor. This has the advantage of being supplied with the PM2 sensor as a single unit, as well as being virtually insensitive to froth on the surface of the media. However, an ultrasonic level transducer is available, which must be mounted in a suitable manhole.

* Relevant ISO standards ISO 2537, ISO 3455, and ISO/TR 11974.

ChannelMag Equation

The basic equation performed by the 4411e transmitter is:

$$Q = K V H^n$$

where Q = volumetric flow
K = calibration constant
V = mean velocity
H = linearized level
n = exponent depending on size and shape of channel

ChannelMag PM Series Installation

The ideal location in the pipe is where there is maximum straight length. The table below provides recommendations of minimum straight lengths of pipe for various pipe configurations. Shorter lengths or other configurations affect published accuracy, dependant on pipe size and velocity range. Consult EMCO Flow Systems or a qualified representative.

Diametrically opposite sensors are either 1 pair or 2 pair.

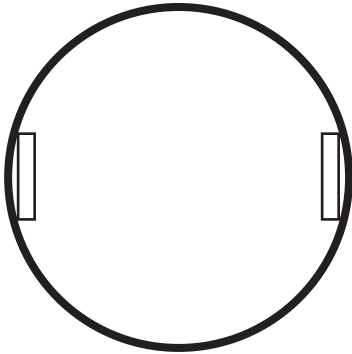
When an ultrasonic level transducer is used for partially filled pipe applications it must be located at least 8" (200 mm) before or after the ends of the ramps to avoid drops in level due to sub-critical flows, or rises in level due to super-critical flows. When the hydrostatic level transducer is employed its level sensing position is virtually at the start of the upstream ramp and avoids critical flow rises and falls.

PIPE CONFIGURATION	SINGLE SENSOR Number or Straight Pipe Diameters D		MULTIPLE SENSORS Number of Straight Pipe Diameters D	
	Upstream	Downstream	Upstream	Downstream
90° bend upstream and downstream	10 D	5 D	5 D	2 D
After a tee	15 D	5 D	8 D	2 D
Upstream partially closed valve	25 D	5 D	15 D	2 D
Downstream partially closed valve	--	8 D	--	5 D

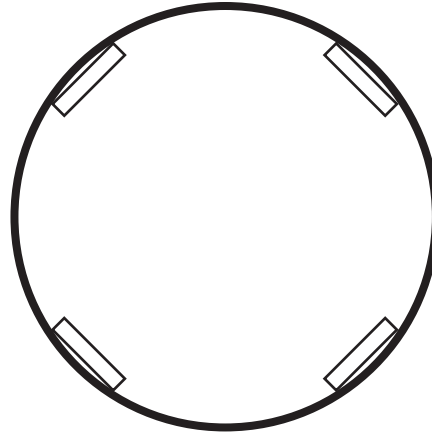
ChannelMags For Full Pipe Flow Measurement

ChannelMag PM Series sensors are used for full pipe flow measurement from 20" - 120" (500 - 3000 mm) diameter. For 20" - 47" (500 - 1195 mm) diameter a single sensor or double sensor is used, dependant on the number of straight lengths of pipe available. For 48" - 120" (1200 - 3000 mm) diameters either 2 sensors or 4 sensors are used, again dependant on available straight pipe lengths.

The sensor(s) are attached to a stainless steel retention band designed for a specific pipe internal diameter. The retention band is equipped with an expander mechanism, which opens out against the pipe internal diameter to secure the sensors. In this way the pipe wall does not require holes or fixtures and is ideal for concrete tunnels.



Full Pipes -- Single or Double Sensors
20" - 47" (500 - 1195 mm) Diameters

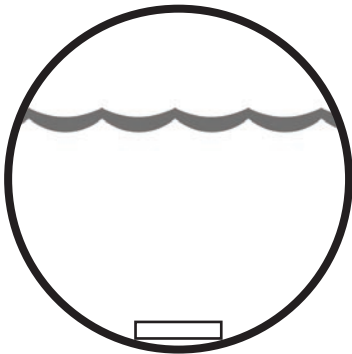


Full Pipes -- Double or Quadruple Sensors
48" - 120" (1200 - 3000 mm) Diameters

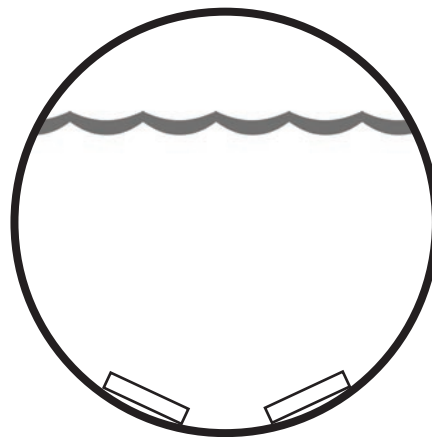
ChannelMags For Partially Filled Pipe Flow Measurement

The ChannelMag PM Series sensors are used in partially filled pipes from 20" - 120" (500 - 3000 mm) diameter. For pipes 20" - 36" (500 - 915 mm) a single ChannelMag sensor is installed in a retention band at the bottom of a horizontal pipe. For larger pipes two sensors are used at the bottom of the pipe, with their center lines equally dispersed at 15 degrees from the pipe center.

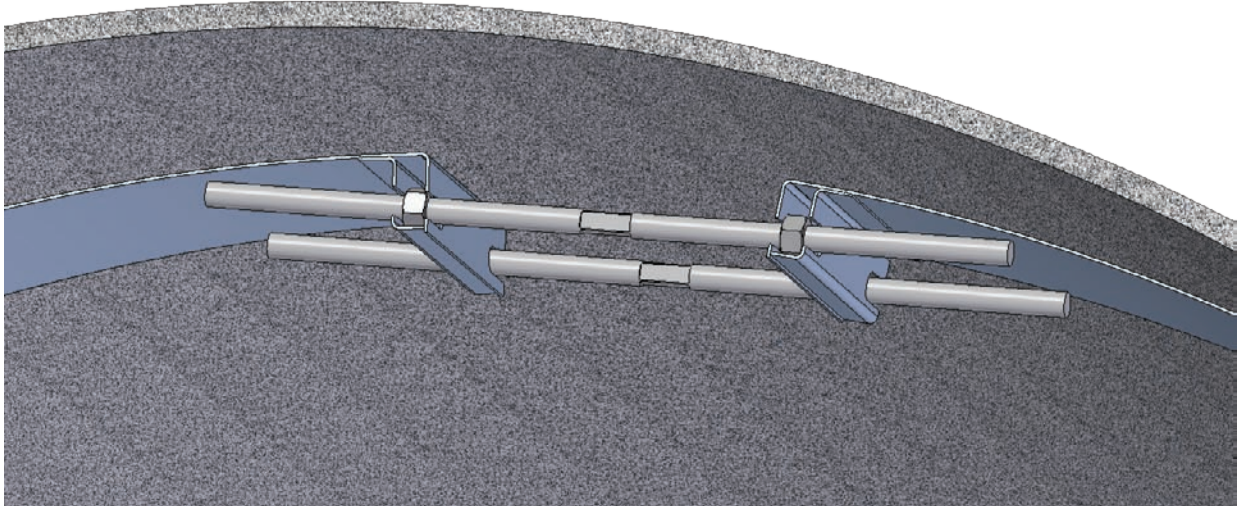
For partially filled pipes a hydrostatic level transducer is incorporated in a ramp on the upstream end of the sensor. The level transducer cable includes a "breather" tube, which is vented in the remote 4411e transmitter, or in a junction box when the cable is longer than 33 feet (10 m). The cables are run in plastic conduits to the pipe exterior.



Partially Filled Pipes -- Single Sensor
20" - 36" (500 - 915 mm) Diameters

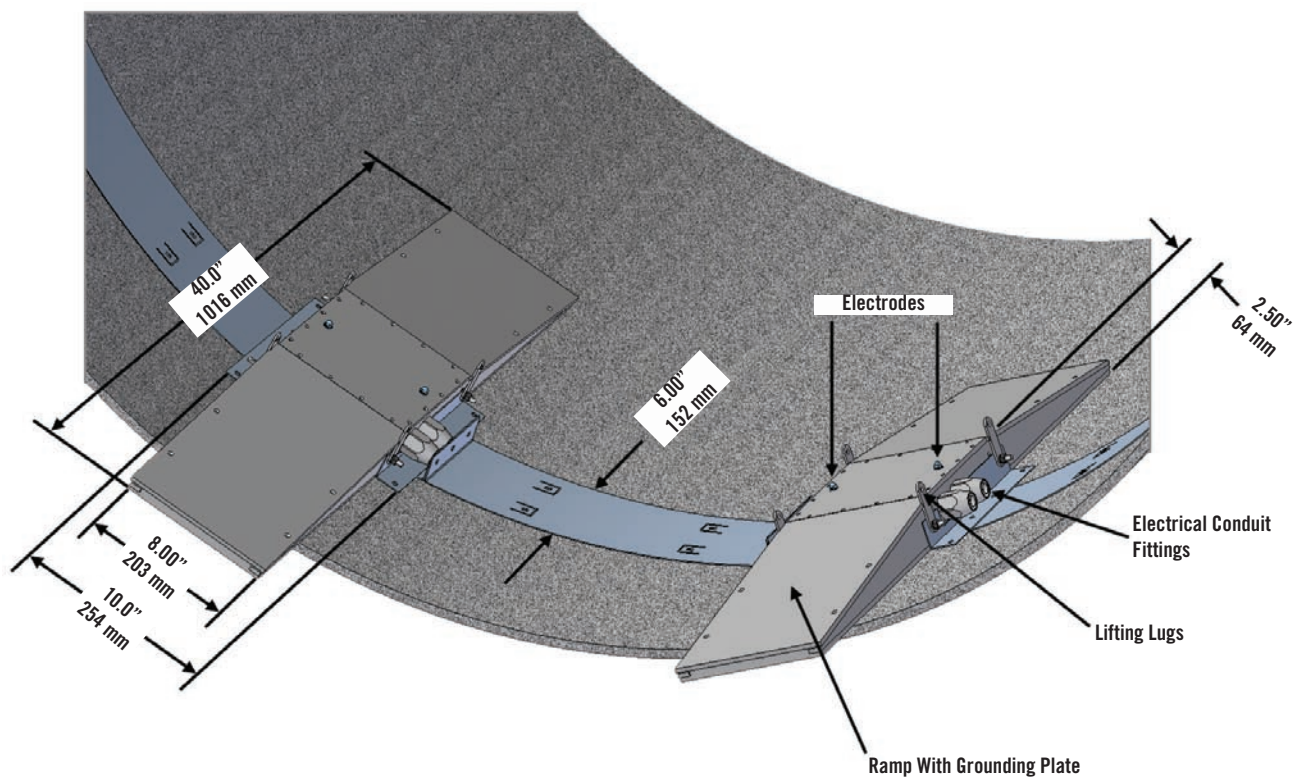


Partially Filled Pipes -- Double Sensors
38" - 120" (920 - 3000 mm) Diameters



The expander mechanism incorporates 2 left-hand and right-hand threaded rods, which when turned with a wrench (spanner), secure the enhancement plates and sensor assembly firmly in the pipe. Additional fixtures or holes in the pipe are unnecessary.

ChannelMag PM Series Weights and Dimensions



ChannelMag PM2 Sensor Specification

Non Full Pipe Calibrated Accuracy	± 2% of rate for mean velocities > 2 fps (0.6 m/s) ± 0.04 fps (0.012 m/s) for < 2 fps (0.6 m/s)
Full Pipe Calibrated Accuracy	± 1.0% of rate for mean velocities > 1.5 fps (0.45 m/s) ± 0.0015 fps (0.0045 m/s) for < 1.5 fps (0.45 m/s)

Note: For media such as ferric chloride, ferric sulphate (Odophos), high temperature paper mill liquors, lime mud or similar highly conductive media, flowmeter performance can be adversely affected. Please consult EMC0 for these types of applications, otherwise performance guarantee is null and void.

NOTE: ChannelMags are calibrated to meet or exceed the requirements of the UK Environmental Agency mCERTS, as well as ISO 2537, ISO 3455 and ISO/TR 11974. Overall accuracy depends on accuracy of measuring effective internal diameter of pipe into which ChannelMag is installed.

Minimum Level	5.0" (125mm) for pipes 36" (915mm) and less 12" (300mm) for pipes 38" (920mm) and larger
Adjustable Mean Velocity Range	0-2 fps (0-0.6 m/s) to 0-10 fps (0-3 m/s)
PM2 Sensor Body Material	HDPE with stainless steel fittings
Magnetic Enhancement Band Material	Ferritic steel with fusion bonded epoxy protection and stainless steel expander screw mechanism

NOTE: Fusion bonded epoxy conforms to USA National Sanitation Foundation NSF61 and AWWA Standard C213 for drinking water.

Electrode Material and Grounding	AISI 316 stainless steel (Hastelloy C electrodes optional)
Electrode Seals	Viton
PM2 Protection and Pressure	Permanently submersible to NEMA 6 and IP 68
Maximum Media Temperature and Pressure	140° F (60° C) @ 15 psig (1 bar g) 100° F (40° C) @ 30 psig (2 bar g)
PM2 Remote Junction Box	Supplied with all PM2 sensors
Cable Lengths From Junction Box	Standard 50 feet (15m) from junction box, but without conduits.
Cable Lengths to Junction Box	From PM2 sensor(s) to junction box a single cable 50 feet (15m) (special lengths to order)

Note: For total distances > 150 feet (50 m) from PM2 sensor(s) a pre-amp is installed in the junction box. Maximum distance 300 feet (100m). ½" NPT conduit connectors supplied in the junction box in plain holes.

Cable Types For All PM2 Sensors	3 cables run from the remote junction box to the 4411e. 1 for the electrodes, 1 for the reference coil(s) and 1 for the exciter coil(s). Each cable is 2 core, 18 SWG (0.75 mm ²) multi-strand shielded, Beldon #8760 or equivalent, or 2 x 0.75mm ² . From the PM2 sensor(s) to the junction box a single magmeter cable is used, UL listed to UL Standard 1424 and 13 and IEC approved, submersible and buryable.
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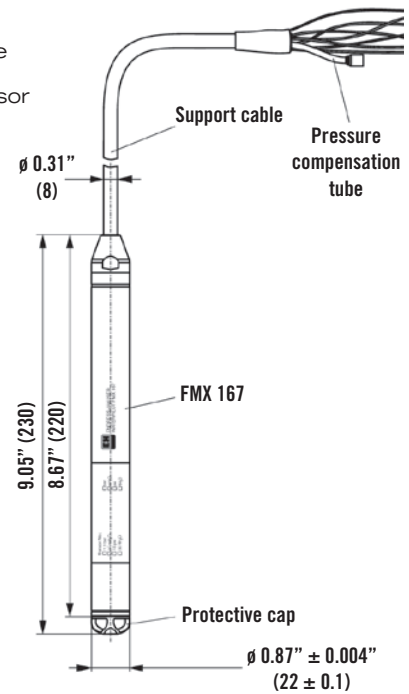
NOTE: The junction box is potted on site with re-enterable gel and is submersible to NEMA 6 and IP 68. It is made from fusion bonded polyethylene protected aluminum and is not intended for permanent submersion. The junction box is supplied with potting gel, ½" NPT cable connectors. For ATEX Zone 2 explosive area or UL, CSA Ordinary Locations, approved cable connectors are supplied, but without conduits. ATEX requirements are that each connector is used for one cable only.

Cable Length From Level Transducer	Same overall length as PM2 velocity sensor (Standard 66 feet / 20m)
Minimum Conductivity	1 µS/cm (water is typically 200-1000 µS/cm)
CE Electromagnetic Compatibility	Interference emission and immunity to EN 61326

FMX 167 Hydrostatic Level Transducer Specification

A hydrostatic pressure transducer is standard supply for measuring level in partially filled pipes. It is also normally used when the level sensor needs to be hidden from view, or if there is substantial froth on the surface of the media.
The hydrostatic level transducer is normally an integral part of the ChannelMag velocity sensor type PM2.

Basic Type	FMX167
Range	0 - 20" (0 - 500 mm) to 0 - 600 feet (0 - 180 m)
Accuracy	± 0.2% full scale or 0.072" (0.13 mm) eg. accuracy at 10" level = $0.072/20 \times 100 = 0.36\%$ accuracy at 36" level = $0.072/36 \times 100 = 0.2\%$ Cable contains "breather" tube for compensation
Barometric Pressure Change	Mounted integrally on PM2 ChannelMag sensors Mounted at side of channel for widths < 8" (200 mm)
Cable Length	See ordering code. Normally same length as PM2 cables. Max. length 1000 feet (300 m)
2-wire 4411e Signal	4 - 20mA, 2 wire system, 18 VDC.
Electromagnetic Compatibility Protection	Interference emission to EN 61326 for CE requirements NEMA 6 and IP68 indefinitely to 700 feet (200 m) w.c. Porous Gore-Tex Teflon filter protects internals
Ambient Temperature	14 to 158 degrees F (-10 to 70 degrees C)
Materials of Construction	Transducer housing: 316L stainless steel Sensor diaphragm: aluminum trioxide ceramic Internal seal: standard Viton, optional EPDM Protective cap: high density polyethylene Cable: polyethylene with Gore-Tex Teflon filter
Explosive Atmospheres	See ordering code
Weight	Probe: 0.63 lb (0.3 kg) Cable: Add 0.13 lb/foot (0.05 kg/m)



FMX 167 Ordering Code

FMX 167 -

1	2	3	4	5	6	7
□	□	□	□	□	□	□

- Certificate
 - A = Standard
 - B = ATEX II 2 G
 - C = ATEX II 3 G
 - D = FM approved
 - E = CSA approved
 - EEex Ia IIC T6
 - EEex nA IIC T6
 - IS, Class I, Div. 1, Grps A-D
 - IS, Class I, Div. 1, Grps
- Mechanical Connection (cable suspension)
 - 1 = None
 - 2 = Mounting clamp, 316L SS
 - 3 = Cable mounting screw G 1 1/2 A 304 SS
 - 4 = Cable mounting screw 1 1/2" NPT, 304 SS
 - 9 = Special version
- Measuring Cell Tube Material
 - A = 316L SS cell enclosure
 - Y = Special version
- Measuring Range

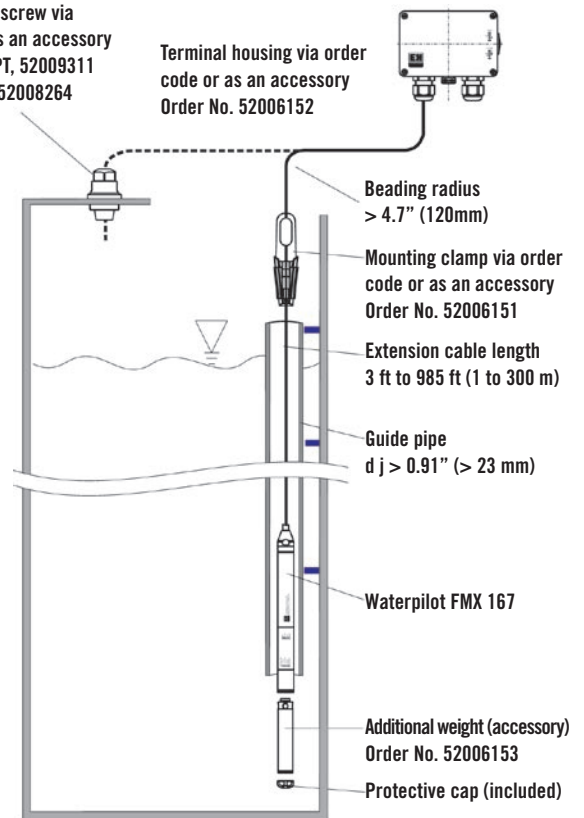
FA = 0 to 3 ftH ₂ O	MA = 0 to 1 mH ₂ O	73 psi
FB = 0 to 6 ftH ₂ O	MB = 0 to 2 mH ₂ O	73 psi
FC = 0 to 15 ftH ₂ O	MC = 0 to 4 mH ₂ O	101 psi
FD = 0 to 20 ftH ₂ O	MD = 0 to 6 mH ₂ O	145 psi
FE = 0 to 30 ftH ₂ O	ME = 0 to 10 mH ₂ O	145 psi
FF = 0 to 60 ftH ₂ O	MF = 0 to 20 mH ₂ O	261 psi
FG = 0 to 150 ftH ₂ O	MG = 0 to 40 mH ₂ O	352 psi
FH = 0 to 300 ftH ₂ O	MH = 10 to 100 mH ₂ O	580 psi
FK = 0 to 600 ftH ₂ O	MK = 0 to 200 mH ₂ O	580 psi

VV = Adjusted to customer specifications from 0
YY = Special version
- Measuring Cell Seal
 - 1 = Viton
 - 2 = EPDM
 - 9 = Special version
- Extension Cable
 - A = Length in _____ meters, PE cable
 - B = 10m PE cable, can be shortened
 - C = 20m PE cable, can be shortened
 - E = 30 ft cable, PE, can be shortened
 - F = 60 ft cable, PE, can be shortened
 - G = Length in _____ feet, PE cable
 - Y = Special version
- Additional Equipment
 - 1 = Probe with integrated Pt 100, 4-wire
 - 3 = Terminal housing with GORE-TEX® filter, NEMA 4X

Cable mounting screw via
order code or as an accessory
Order No. 1 1/2 NPT, 52009311
Order No. G 1 1/2 52008264

Junction Box used for cables > 33 feet (10 m)

Terminal housing via order
code or as an accessory
Order No. 52006152

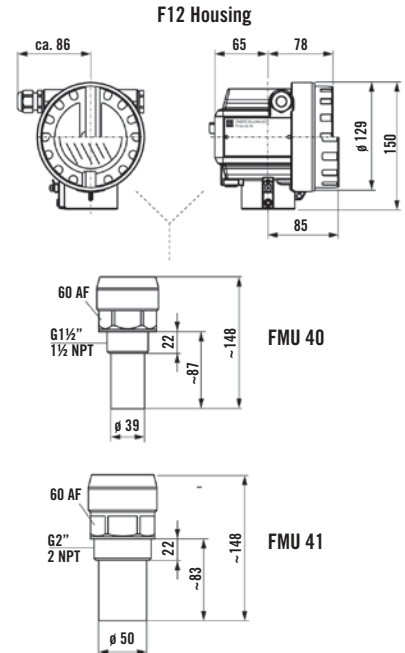


The FMX is normally installed inside the ramps of a PM2 sensor. Alternatively, it may be mounted in a stilling well, most conveniently a PVC tube of internal diameter > 0.9" (25 mm). The cable contains a breather tube and is normally terminated in the 4411e transmitter. This cable must not be kinked or blocked. An intermediate terminal housing is available, as well as a cable mounting screw or mounting clamp, as shown. Terminal housing supplied for level transducer cable greater than 50 feet (15 m). Breather tube ends in terminal housing. Extended cable from terminal housing not normally included. Extended cable may be same 2-core cable as PM2 cable.

FMU 40 & FMU 41 Ultrasonic Level Transducer Specification

As an alternative to the hydrostatic level transducer, an ultrasonic level transducer may be incorporated in a convenient man hole. This must be at least 1 diameter upstream or downstream of the end of the ramps of the PM2 ChannelMag sensor ramps. This avoids critical flow rise or fall errors.

Basic Type	FMU 40
Range	0 - 200" (0 - 5000 mm)
Basic Type	FMU 41
Range	0 - 315" (0 - 8000 mm)
Accuracy	± 0.2% full scale
Minimum Dead Band	10" (250 mm)
Air Density Changes	Automatic temperature compensation
Connection	1½" NPT male for FMU 40 2" NPT male for FMU 41
2-Wire 4411e Signal	4 - 20mA, 2 wire system, 18VDC
HART Communication	Included
Protection	NEMA 6 and IP68 for 24 hours @ 6 feet w.c
Electromagnetic Compatibility	Interference emission to EN 61326
Indication	4 digit LCD
Ambient Temperature	-5 to +40 degrees F (-20 to +60 degrees C)
<i>Note: Outside these temperatures the LCD function is restricted. A protective cover is recommended if operating in strong sunlight.</i>	
Cable Entry	½" NPT
Materials of Construction	PVDF sensor with EPDM seal Aluminum enclosure, chromed and powder coated, sea water resistant.
Housing	F12 housing is standard
Explosive Atmospheres	FM and CSA Class 1 Div. 1 or 2 optional
Weight	FMU 40 approx. 5.5 lb (2.5 kg) FMU 41 approx. 6 lb (2.6 kg)



FMU 40 & FMU 41 Ordering Code

FMU 40 --

1	2	3	4	5	6
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1. Certificate

- A = Non-hazardous version
- S = FM IS Cl. I, II, III; Div. 1, Grps A - G
FM NI Cl. I, Div. 2
- T = FM XP Cl. I, II, III; Div. 1, Grps A - G
- U = CSA IS Cl. I, II, III; Div. 1, Grps A - G
CSA NI Cl. I, Div. 2
- V = CSA XP Cl. I, II, III; Div. 1, Grps A - G
- N = CSA General Purpose

2. Process Connection

- R = G 1½, ISO 228
- N = 1½" NPT

3. Power Supply / Communication

- B = 2-wire, 4 to 20 mA loop-powered / HART
- H = 4-wire, 10.5 to 32 VDC / 4 to 20 mA HART
- G = 4-wire, 90 to 253 VAC / 4 to 20 mA HART
- D = 2-wire PROFIBUS-PA
- F = 2-wire Foundation Fieldbus

4. Display / Operation

- 1 = Without LCD
- 2 = With LCD VU 331 / on-site operation

5. Housing

- A = F12 aluminum housing, coated, NEMA 6P
- C = T12 aluminum housing with separate terminal compartment, coated, NEMA 6P

6. Cable Entry

- 2 = M 20 x 1.5
- 3 = G ½
- 4 = ½" NPT
- 5 = M 12 PROFIBUS-PA plug-in connector
- 6 = 7/8" Foundation Fieldbus plug-in connector

FMU 41 --

1	2	3	4	5	6
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1. Certificate

- A = Non-hazardous version
- S = FM IS Cl. I, II, III; Div. 1, Grps A - G
FM NI Cl. I, Div. 2
- T = FM XP Cl. I, II, III; Div. 1, Grps A - G
- U = CSA IS Cl. I, II, III; Div. 1, Grps A - G
CSA NI Cl. I, Div. 2
- V = CSA XP Cl. I, II, III; Div. 1, Grps A - G
- N = CSA General Purpose

2. Process Connection

- R = G 2, ISO 228
- N = 2" NPT

3. Power Supply / Communication

- B = 2-wire, 4 to 20 mA loop-powered / HART
- H = 4-wire, 10.5 to 32 VDC / 4 to 20 mA HART
- G = 4-wire, 90 to 253 VAC / 4 to 20 mA HART
- D = 2-wire PROFIBUS-PA
- F = 2-wire Foundation Fieldbus

4. Display / Operation

- 1 = Without LCD
- 2 = With LCD VU 331 / on-site operation

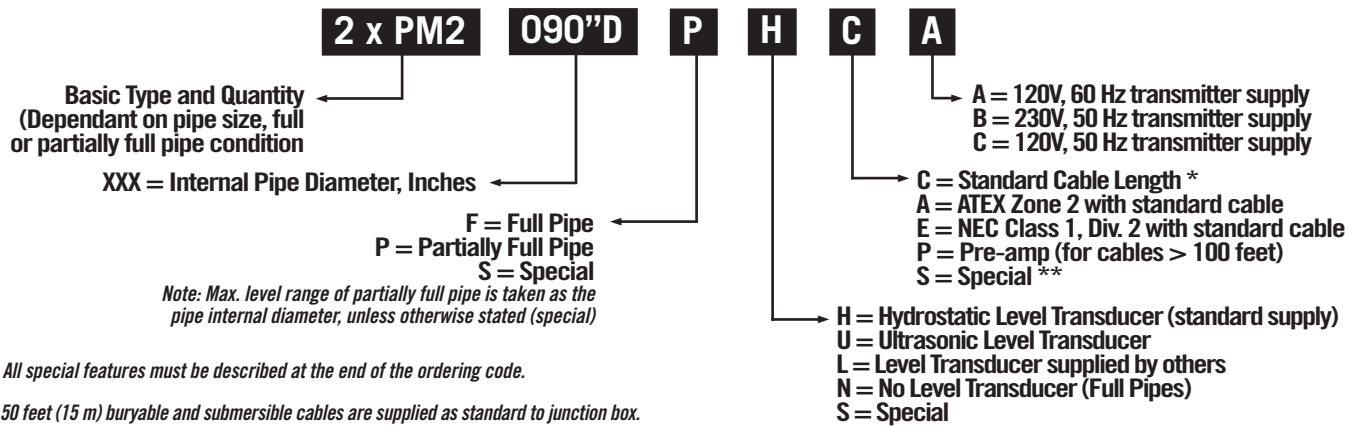
5. Housing

- A = F12 aluminum housing, coated, NEMA 6P
- C = T12 aluminum housing with separate terminal compartment, coated, NEMA 6P

6. Cable Entry

- 2 = M 20 x 1.5
- 3 = G ½
- 4 = ½" NPT
- 5 = M 12 PROFIBUS-PA plug-in connector
- 6 = 7/8" Foundation Fieldbus plug-in connector

PM2 ChannelMag Sensor Ordering Code



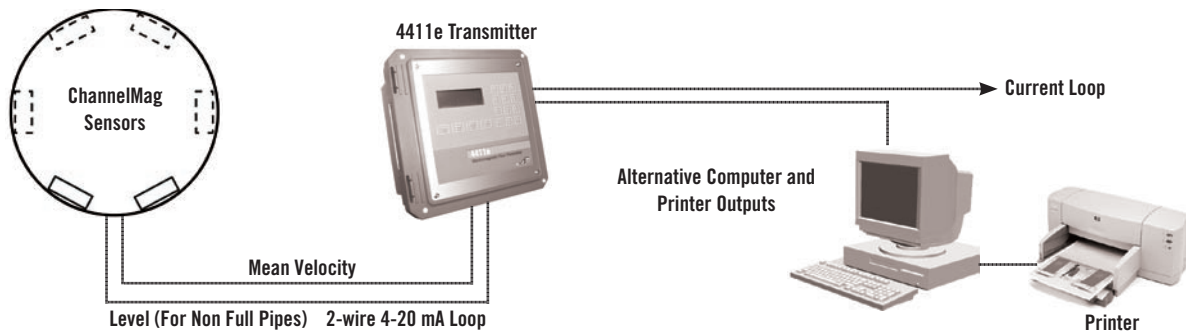
NOTE: All special features must be described at the end of the ordering code.

* **C** = 50 feet (15 m) buryable and submersible cables are supplied as standard to junction box. Junction box is potted on site with re-enterable potting gel. Junction box and gel supplied. Further cables from junction box to transmitter are as standard 50 feet (15 m) and are not conduited.

** **S** = Special details, including combinations. For cable lengths > 100 feet (30 m) from the ChannelMag junction box, a pre-amp is provided. Hydrostatic level transducer cable also requires junction box when cable is > 33 feet (10 m). The breather tube terminates in the junction box.

ChannelMag System Connection Diagram

The diagram shows how a typical ChannelMag system is connected. The supply of a system is limited to items specifically quoted.



Questionnaire

To obtain a quotation, please answer as many questions as possible and fax to 863-686-5321 or Email csr@advancedflow.com.

ON-SITE DETAILS

- Pipe internal diameter (mm/inches) _____
- Material (e.g. concrete, plastic, steel) _____
- Existing upstream straight length (m/feet) _____
Existing downstream straight length (m/feet) _____
- Media type _____
Possible significantly large solids _____
Possible corrosive characteristics _____
- Media temperature (degrees F, degrees C) _____
- Media max. pressure _____
- Location details: ☐ ATEX Zone 2 ☐ Class 1, Div. 2
☐ Ordinary Location

FLOW DETAILS

- Reverse flow required (back-up flow)? ☐ Yes ☐ No
- Flow rate (forward). State units. Min. _____ Max. _____

- Reverse flow. State units. Min. _____ Max. _____
- Minimum Level (mm/inches) _____

FLOWMETER DETAILS

- Power supply: ☐ 120 VAC, 60 Hz ☐ 230 VAC, 50 Hz
☐ 120 VAC, 50 Hz ☐ 24 VDC
- Length of cable from Sensors to 4411e transmitter
Standard 30 feet (10m), maximum 300 feet (100m)
- ☐ HART ☐ RS485 output ☐ RS232 output

CUSTOMER OR REPRESENTATIVE

Name: _____
Company: _____
Department: _____
Address: _____
City, State, Zip _____
Country: _____
Phone: _____ Fax: _____
Email: _____



Астана +7(77172)727-132 Волгоград (844)278-03-48 Воронеж (473)204-51-73 Екатеринбург (343)384-55-89
Казань (843)206-01-48 Краснодар (861)203-40-90 Красноярск (391)204-63-61 Москва (495)268-04-70
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