Product Data Sheet
PDS-656

TigermagEP
Technical Specifications

FM656 Obstructionless Electromagnetic Flowmeter

DESCRIPTION

The Model 656 is a microprocessor based electromagnetic flowmeter designed to measure the flow of conductive liquids in full pipes. The sensor and the transmitter are integral and enclosed in a NEMA-7 explosion-proof housing. The sensor housing is made of steel.

A wide variety of liners and electrodes are available to tailor the meter to operate in many processes.

The Model 656's nonvolatile EEPROM memory and circuitry eliminates the need for a microprocessor backup battery. It is not necessary to reprogram if the electronic module is replaced or exchanged with electronics from another size flowmeter.

APPLICATIONS

The Model 656's high signal frequency makes it ideally suited to applications with high levels of inherent noise including: Process Chemicals, Heavy Slurries, Polymers, Acids, Alkalies, Sewage, Cooling Water. Nearly any conductive liquid can be measured.

CERTIFIED ACCURACY

Each **TigemagEP™** is wet-flow calibrated in Sparling's Primary Flow Lab traceable to the National Institute of Standards and Technology. A certificate of accuracy is furnished with each meter.

PRINCIPLE OF OPERATION

The Model 656 magnetic flowmeter is based on Faraday's Law which states that the voltage induced in a conductor moving through a magnetic field is proportional to the velocity of that conductor. The magnetic flowmeter will measure liquids with conductivities greater than 5 micromhos.

STANDARD FEATURES

- Sampling frequency up to 100 Hz for accurate measurement of fluids with high levels of inherent noise
- Forward, reverse and net totalization
- Programmable high and low flow alarms
- Nonvolatile EEPROM memory
- Universal electronics module compatibility
- 2-Line, 16 character backlit display
- Programming made easy with Mag-Command
- User-selectable damping & low flow cutoff
- NEMA-4X or NEMA-7 explosion proof enclosure
- Accidental Submergence (NEMA6/IP67), Permanent Submergence (NEMA6P/IP68) and Direct Burial Sensors available
- Approvals include: FM, CSA, NSF61
- Rotatable modular display
- Empty pipe detection
- PZR - Positive Zero Return
- Standard 0.5% accuracy
- Sizes available from 0.5" - 72"

SE-V3.0 Modbus Organization Conformance Tested

HART COMMUNICATION PROTOCOL

NSF Certified to NSF/ANSI 61

CSA

FM APPROVED

SPARLING INSTRUMENTS, LLC

EASY TO READ BACKLIT ROTATABLE DISPLAY

The 16 character, 2-line backlit transmitter display is rotatable 360° in 90° increments ensuring easy reading in any orientation.

INSTALLATION

The meter must be mounted at a point in the line in which the pipe is always full of the process liquid under flowing conditions.

The meter may be equipped with ANSI 150 or 300 lb., AWWA, DIN, PN10 or 16, JIS 10K or 20K, or British Standard flanges.

Only three diameters of straight pipe length are required from the center of the meter to normal obstructions to obtain specified accuracies. In the smaller sizes all of the necessary straight pipe is contained within the meter itself.

E²PROM NONVOLATILE MEMORY

A backup battery is not required and there is no need to reprogram if the electronics module is replaced or exchanged. Meter identification (tube ID, serial number, K, offset, etc.) is stored on an E²PROM chip independent of transmitter electronics. The E²PROM chip has lifetime data retention.

EMPTY PIPE DETECTION - Standard

The Sparling TigermagEP™ is designed to detect absence or inadequate volume of process fluid in the pipe and will hold the output signal to 4 mA or zero. This feature does not require any hard wiring as it is a software selection. One of the most important values of this feature is that it prevents false totalization possible with other meters under partially filled pipe conditions.

EASE OF COMMUNICATIONS

The TigermagEP™ is programmable with Mag-Command, Hart Protocol. 4-20 mA, RS-232 or RS-485 outputs give you flexibility w hen interfacing with your distributed control system.

REMOTE MOUNTED TRANSMITTER

Remote mounting of the transmitter is required when pipe vibration is excessive, when flooding is possible or where high temperature conditions exist (over 212°F / 100°C).

The TigermagEP™ remote transmitter is housed in a NEMA-4X enclosure and features a larger sized (8mm) 16 digit 2-line backlit display. All power, coil and electrode connections are made within the transmitter enclosure and junction box. The meter is programmed using Mag-Command. Hall-effect switches which are energized from outside the enclosure. The enclosure can be wall mounted. An optional bracket for pipe mounting is available.

HI-Z CIRCUITRY

The Sparling TigermagEP™ provides superior performance in liquids which tend to deposit nonconductive coatings. Hi-Z™ circuitry produces a high input impedance to the transmitter's preamplifier (10^{12} ohms). The impedance of the coating is negligible as compared to the impedance of the receiving instrument. The voltage drop across the electrode coating is also negligible eliminating the need for electrode cleaners.

TWO FLOW ALARMS

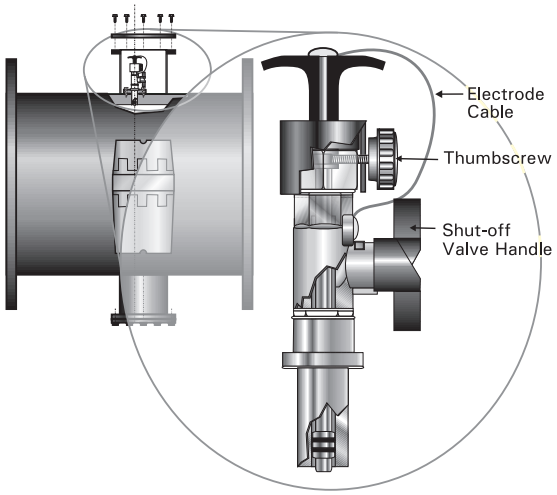
Fault alarms can be configured with alarm set points between 0-99% of flow for each alarm. Open collector output turns on above programmed set point.

PZR – Positive Zero Return

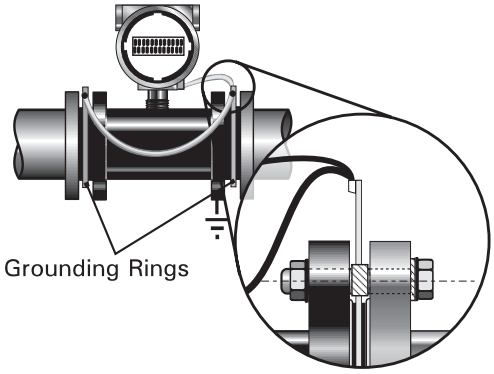
An electronic circuit is activated by an external contact closure when lines go empty or when a pump or valve is shut down, indicating to the meter that it should drive the output signal to 4 mA or zero.

REMOVABLE ELECTRODES *(option)*

Two configurations of removable electrodes are available in sizes 6" or greater for all FM656 meters. The first configuration allows removal of the electrode after the line has been depressurized and drained. Removal is performed with an 11/32" nut driver and a 3/4" socket wrench.



The second is the "hot-tap" electrode which allows electrode replacement while the system is still under pressure without disturbing the process flow. Removal can be easily performed with a phillips screwdriver and a crescent wrench. Special locking catches were designed to prevent high pressure accidents during electrode removal. The shut-off valve must be closed before the electrode may be removed.



GROUNDING

The use of grounding rings is recommended to ensure accuracy. Grounding rings are required if adjacent piping is lined or nonconductive. Pump noise or excessive RF should be minimized to achieve highest accuracy.

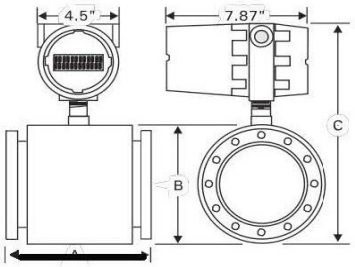
FLOW RATES & DIMENSIONS

Table 1 Flow & Dimensions

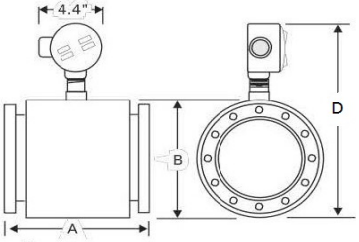
	Dimensions (inches)										
Size	A		B		C		D		Flowrates (GPM) Full Scale		
(inch)	150 lb	300 lb	150 lb	300 lb	150 lb	300 lb	150 lb	300 lb	1 fps	3 fps	33 fps
0.1	4.00	4.00	3.50	3.75	9.50	9.62	9.25	9.30	0.04	0.1	1.3
0.25	4.00	4.00	3.50	3.75	9.50	9.62	9.25	9.30	0.15	0.5	5.0
0.375	4.00	4.00	3.50	3.75	9.50	9.62	9.25	9.30	0.34	1.0	11
0.5	4.00	4.00	3.50	3.75	9.50	9.62	9.25	9.30	0.6	1.7	18
1	4.00	4.00	4.25	4.88	10.19	10.50	9.94	10.25	2	6	66
1.5	4.00	4.00	5.00	5.12	10.88	11.44	10.63	11.19	5	15	174
2	4.00	4.00	6.00	6.50	11.69	11.89	11.44	11.64	9	27	303
2.5	6.00	6.00	7.00	7.50	12.62	12.88	11.56	11.88	13	39	431
3	6.00	6.00	7.50	8.25	13.00	13.40	12.75	13.15	20	60	664
4	6.00	6.00	9.00	10.00	14.38	14.88	14.13	14.63	35	107	1,182
6	13.38	14.88	11.00	12.50	17.00	17.75	16.75	17.50	85	254	2,800
8	13.38	15.40	13.50	14.25	19.40	19.78	19.15	19.53	145	436	4,800
10	18.15	20.55	16.00	17.50	22.56	23.31	22.31	23.06	236	709	7,800
12	19.40	21.78	19.00	20.50	25.00	25.75	24.75	25.50	333	1,000	11,000
14	21.38	23.75	21.00	23.00	26.67	27.67	26.42	27.42	409	1,227	13,500
16	23.38	25.88	23.50	25.50	28.97	29.97	28.72	29.72	545	1,636	18,000
18	27.25	29.88	25.00	28.00	31.14	32.64	30.89	32.39	667	2,000	22,000
20	27.63	30.40	27.50	30.50	33.39	34.89	33.14	34.64	879	2,636	29,000
24	32.75	35.75	32.00	36.00	37.44	39.44	37.19	39.19	1,273	3,818	42,000
30	43.50	46.63	38.75	43.00	43.72	45.85	43.47	45.60	1,909	5,727	63,000
36	47.75	50.85	46.00	50.00	50.20	52.20	49.95	51.95	2,925	8,775	96,525
42	51.75	55.12	53.00	57.00	56.90	58.90	56.65	58.65	4,040	12,120	133,320
48	51.75	55.38	59.50	65.00	63.05	65.80	62.80	65.55	5,322	15,966	175,626
54	53.50	*	66.25	*	69.88	*	69.63	*	7,144	21,433	235,800
60	65.50	*	73.00	*	76.75	*	76.50	*	8,500	25,500	280,500
66	65.50	*	80.00	*	83.75	*	83.50	*	10,300	31,000	341,000
72	72.75	*	86.50	*	90.00	*	89.75	*	12,700	38,100	419,100

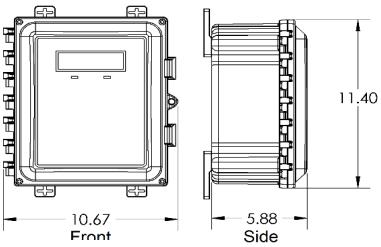
Dimensions for flanges. Allow 1/8" to 1/4" for lining thickness/ Dimensions C & D ± 0125"
Flow Rates: 0.25" - 4.0" flow rates are for FEP/PTFE, Poly and HR liners. Ceramic sensor flow rates differ slightly. Please see PDS-626 for ceramic sensor flow rates for 0.25" - 4.0".

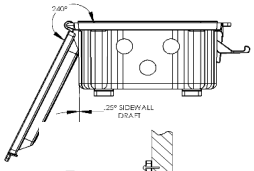
Integral Mount Transmitter

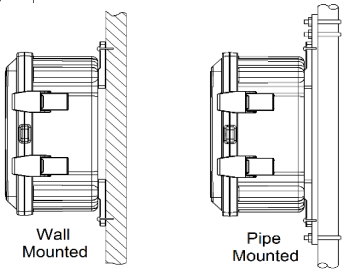


Remote Mount Transmitter









How to Order a TigermagEP FM656

Base Model Number - FM656

Table 2: Size

AA = 0.10"	OA = 0.25"	OB = 0.375"	OD = 0.5"	OF = 1"	OG = 1.5"
02 = 2"	OH = 2.5"	03 = 3"	04 = 4"	06 = 6"	08 = 8" etc.

Table 3: Liner

1 - Hard Rubber	(1" - 72")	6 - Ceramic [1]	(0.1" - 4")
5 - Polyurethane	(2" - 72")	8 - FEP / PTFE	(0.25" - 48")
A - Polyurethane - for potable water			(2" - 72")

Table 4: Electrode *BN = Bullet Nosed*

1 - 316SS	6 - Fused Pt - only ceramic liners	B - HastC BN
2 - HastelloyC	7 - Platinum: other liners	D - Titanium BN
3 - 316 SS BN	8 - Zirconium	E - Tantalum BN
4 - Titanium	9 - Monel	G - Platinum BN
5 - Tantalum	0 - Tungsten Carbide	H - Zirconium BN
		I - Monel BN

Table 5: Flange Rating *(JIS and DIN available upon request)*

1 - AWWA Cl D (150#)	A - ANSI B16.5 C	C - ANSI B16.5 Cl 400
3 - AWWA Cl F (300#)	B - ANSI B16.5 C	D - ANSI B16.5 Cl 600
	S - Tri-Clamp (Sanitary)	

Table 6: Transmitter and Sensor Protection Rating

F	Integral NEMA4X
G	Integral NEMA 4X Battery Operated
0	Integral NEMA-7[2] encl
1	Remote NEMA-7[2] encl., 15' cable
2	Remote NEMA-7[2] encl., 15' cable, perm. Sub
3	Remote NEMA-7[2] encl., 15' cable, Acc. Sub
4	Remote NEMA-7[2] encl., 15' cable, direct burial
5	Remote NEMA-4X encl., 15' cable
6	Remote NEMA-4X encl., 15' cable, Acc. Sub
7	Remote NEMA-4X encl., 15' cable, direct burial
8	Remote NEMA-4X encl., 15' cable,perm sub proof

[2] Transmitters 0, 1, 2, 3, 4 are both NEMA-7 and NEMA-4X rated. Default enclosure is FM certified. CSA mark available on request.

Table 7: Power[3]

0 - 77 - 265 VAC	1 - 12 - 60 VDC

Options

Comm: HART, Modbus, RS485, RS232
High Temperature Coils - over 266F
Removable/Hot Tap Removable electrodes
Add Cable Lengths (over 15 ft - max 300 ft)
Relay for Fault and Flow Alarms

Model	-	Size	Liner	-	Electrode	Flange	Transmitter	-	Power	
FM656	-	24	8		7	A	5	-	1	is 24", PTFE liner, Pt elect, B16.5 Cl 150 flanges, NEMA4X Trans, VDC

[1] Ceramic Liner not available in the following sizes: OB - 0.375" or OH - 2 1/2"

[3] FM approval is up to 120 volts

Note: Remote enclosure shown for meters shipped after July '16
Please call factory for dimensions for July'16 and before.

Standard Specifications

Accuracy:	0.1" - 0.25": 1% of flow (1- 33 fps)
(Freq Out)	0.5" - 72": 0.5% of flow (1-33 fps) Optional 0.25% of flow (1 - 33 fps)
Temp Effect:	±0.025% FS/°C
Full Scale Ranges:	From 0-3 ftto0-33ft/sec
Repeatability:	±0.1% of full scale
Electrodes:	316 stainless steel standard (others available)
Liner:	Ceramic (AlOx 99.5%)Hard Rubber, Neoprene, Polyurethane Food Grade Polyurethane, TEF (FEP/PTFE)
Outputs:	1) Isolated analog 4-20mA DC into 800 ohms (std) 2) scaled pulse 24 V DC with selectable 12.5/25/50/100 ms on time, max.freq. 60 Hz 3) 0-1000 Hz freq., for 0-100% of flow rate, 15 V DC 4) Two flow alarms 5) Fault, with open collector 6) RS232 communication 7) flow direction with open collector 8) Positive Zero Return (PZR) for external relay contacts. Outputs 2 & 3 can be open collector if required.
Mag-Command™:	Selection and change of meter parameters by magnetic probe without opening the enclosure.
Display:	2-Line, 16 Digit alphanumeric backlit display (rate and total). Modular, rotatable 360° in 90° increments
Conductivity:	Minimum 5 micromhos/cm
Min Velocity:	0.3 fps (0.1 mps)
Power Requirements:	77-265 Vac 50/60 Hz (12-60 Vdc optional)
Power Consumption:	Less than 20 Watts
Enclosures:	Transmitter: Cast aluminum epoxy coated. Integral (NEMA-7) or remote mounted (NEMA-4X)
Sensor Housing:	Fabricated steel, epoxy coated.
Preamp Impedance:	10^{12} ohms minimum
Amb. Temp:	-20° to 140°F (-30° to 60°C) Display darkens over 158°F (70°C)
End Connections:	150 lb or 300 lb
Sensor Tube:	304 Stainless Steel
Process Temp:	**Integral Mount:** Hard Rubber, Neoprene, Polyurethane, Food Grade Polyurethane ..... -40- 180°F TEF, Ceramic.....-40 - 212°F **Remote Mount (opt):** TEF, Ceramic.....-40 - 266°F **High Temp Coils (opt)** TEF.....-40 - 300°F Ceramic.....-40 – 420°F
Selectable Damping:	0-99 seconds
Low Flow Cutoff:	Selectable 0-9% of FS
Options:	• Remote Mounted NEMA-4X or NEMA-7 Enclosure • Sensor rating of NEMA6/IP67, NEMA6P/IP68 and Direct Burial • Electrode Materials: Titanium, Hastelloy C, Monel, Zirconium, Tantalum, Platinum, Fused Platinum (ceramic only) • Process Temperature to 420°F (216°C) (Ceramic Only) • 12-60 Vdc operation • HART, Modbus • RS-485 Communication • Alarm with 10A relays (NEMA-4X remote only) • Process Pressure to 1750 psi

Model FM-656 Specifications

1.0	The magnetic flowmeter shall be microprocessor-based and flanged. It shall indicate, totalize, and transmit flow in full pipes.
1.1	The magnetic flowmeter shall utilize DC bipolar pulsed coil excitation,operating at frequencies up to 100 Hz and automatically re-zeroing after every cycle.
1.2	The accuracy shall be at least 0.5% of flow rate over a 33:1 turn-down at all flow rates above 1 fps. Accuracy shall be verified by calibration in a flow laboratory traceable to the U.S. National Institute of Standards and Technology.
1.3	The flow sensor liner shall be Ceramic, Hard Rubber, Neoprene, Polyurethane, Food Grade Poly, or TEF. The housing shall be steel.
1.4	NSF 61 certified for potable water.*
1.5	The integrally-mounted flow sensor and transmitter shall be FM approved for Class I, Division 1 & 2, Groups B, C, D and Class II, Division 1, Groups E, F, G environments without use of air purge. CSA Approved for Class 1, Division 2.
1.6	The electronics shall be integrally or remote mounted.
1.7	When remote mounted, the flowmeter transmitter shall be furnished in a NEMA-4X enclosure box, with a larger 3/8" character, 2-line 16 digit backlit display and 15 feet of cable (standard). NEMA-7 remote option available. The remote mounted flow sensor shall be accidental submergence proof, 33 ft/48 hours
1.8	The flowmeter shall be suitable for operation at temperatures from -40°F to 266°F and at pressures from full vacuum to 740 psi. (Optional: higher temperature & pressure)
1.9	The flowmeter electrodes on ceramic liners shall be fused platinum.
1.10	The meter shall incorporate Hi-Z circuitry. The preamplifier input impedance shall not be less than $10^{?}$ ohms. External ultrasonic electrode cleaners shall not be acceptable.
2.0	Available outputs 1) Isolated analog 4-20mAdc into 800 ohms (std); 2) scaled pulse 24 Vdc with selectable 12.5/25/50/100 ms on time, max. freq.60 Hz; 3) 0-1000 Hz freq., for 0-100% of flow rate, 15 Vdc; 4) two flow alarms; 5) fault, with open collector; 6) RS232 communication; 7) flow direction with open collector; 8) Positive Zero Return (PZR) for external relay contacts. Outputs 2 & 3 can be open collector if required.
2.1	Low flow cutoff shall be selectable from 0-9% of FS and there shall be two flow alarms settable from 0-99% of span.
2.2	A 2-line, 16 character backlit alphanumeric display shall include user-defined flow units and total flow. All menu advice and commands shall be visible on this display. The display shall be modular and rotatable 360°, in 90° increments. Characters shall be at least 0.125" high for ease of readability.
2.3	The flowmeter shall incorporate the MAG-COMMAND™ feature allowing menu selection and changes to be made from outside the housing via Hall-effect sensors. It shall not be necessary to remove covers, panels or fasteners to accomplish calibration or program changes.
2.4	The TigermagEPs unique diagnostic functions eliminate the need for a technician to carry test equipment or open the housing. Current ramp, complete coil check and true front-end input simulator may be activated in MAG-COMMAND™ without opening the enclosure.
2.5	The meter software shall incorporate a password feature preventing changes.
2.6	The meter shall feature nonvolatile E^2PROM memory and universal electronics module compatibility between all TigermagEP™ meters.
2.7	The flowmeter shall have a switching power supply having an operating range from 77-265 Vac, 50/60 Hz (12-60 Vdc). Power consumption shall not exceed 20 Watts.
2.8	All printed circuit boards shall be contained in a plug-in module and be interchangeable for any size without requiring test equipment.
2.9	The flowmeter manufacturer shall have meters of the DC pulse type in similar flowing media for a minimum of five years.
3.0	The flowmeter shall be warranted against defective workmanship or materials for a period of two years from date of shipment.
4.0	Totalized flow and programmed configuration shall be maintained in memory for the meters lifetime.
5.0	The flowmeter shall be FM 656 TigermagEP™ manufactured by Sparling Instruments, LLC

* Only certain models or options are NSF61 certified

SPARLING INSTRUMENTS, LLC

www.sparlinginstruments.com
4097 N. Temple City Blvd.
El Monte, CA 91731
(800) 800-FLOW
sales@sparlinginstrument.com
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