TIGERMAG EP ™

INSTALLATION OPERATION & MAINTENANCE MANUAL

SPARLING

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TABLE OF CONTENTS

TABLE OF CONTENTS
cont'd.

1.0 General

1.1 Measuring System

The Sparling TigermagEP™ Model FM-626, FM627, FM-656 and FM-657 flowmeters are obstructionless devices for monitoring the volumetric flow of conductive liquids in full closed pipes.

The flowmeter consists of a sensor (wafer or flanged) with a nonmagnetic liner, sensing electrodes and a measuring transmitter.

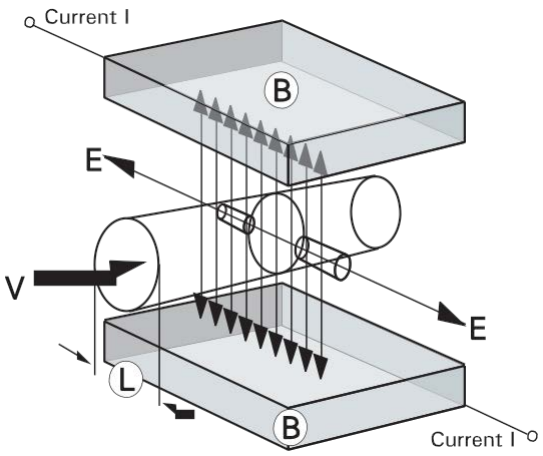
1.2 Operating Principle

Operation is based on Faraday s Law of Mag- netic Induction. An electrically conductive liquid flowing through a magnetic field induces a voltage which is perpendicular to this field and to the direction of the flow. This voltage is proportional to the average flow velocity. See Figure 1.1.

The mathematical formula describing Faraday s law reads:

$E = B \times L \times V$

E = Induced voltage
B = Magnetic field intensity (flux density) L = Distance between the electrodes
(pipe diameter)
V = Average flow velocity of liquid



Measuring Principle
Figure 1.1

1.3 Application to Magnetic Flow Measurement

In a magnetic flowmeter the liquid acts as a moving conductor as it flows through the pipe. The induced voltage (E) in the liquid is measured by two sensing electrodes mounted opposite each other in the meter sensing head.

The length of the conductor is equal to the distance between sensing electrodes and also the internal diameter (D) of the pipe. The flux density is proportional to the coil current (I), times a constant (k). The above formula can be restated as follows:
$E = I \times k \times D \times V$

$$V = \frac{Q}{A} = \frac{\text{flow}}{\text{cross sectional area}}$$

$$E = \frac{Q \times I \times 4 \times k}{D^2}$$

Note that if I is held constant, E is proportional to Q or the induced voltage is directly proportional to the average flow rate (V).

1.4 Interference

1.4.1 Electrochemical Interference

The signal voltage is measured by two electrodes. Galvanic elements form on the surface areas between the ion-conducting liquid and the metal electrodes. The polarization voltages which result are dependent on temperature, pressure, and the chemical composition of the electrodes and liquid. These are direct voltages which cannot be predicted and which can be different at each electrode. The signal voltage must be separated from the interference direct voltage. Proper grounding eliminates these unpredictable voltages from interfering with the signal voltage.

1.4.2 Induction Interference (Quadrature)

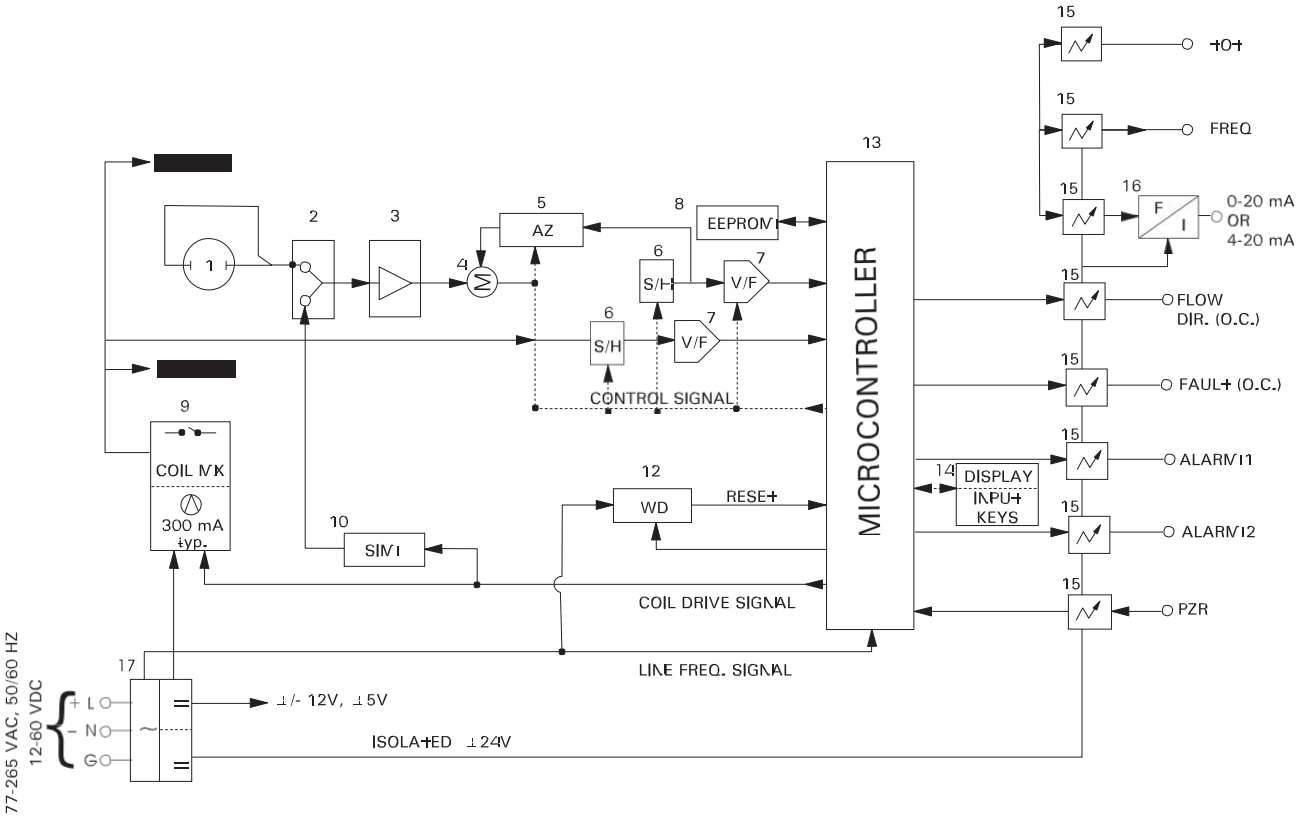
Electrode cables connect the electrodes with the meter electronics. Because these cables must run within the magnetic field, a voltage is induced which is proportional to the rate of change of the magnetic field strength. The meter design minimizes the length of conductor within the magnetic field in order to keep the value of this interference as low as possible.

1.4.3 Other Interference Voltages

Pipes and the liquids within them are often used as a conductor for electrical grounding. This creates a voltage potential between electrodes which can be high relative to the signal voltage. Proper grounding of the flowmeter to the liquid is necessary to achieve correct meter operation. Grounding rings should be installed if the flowing medium has a voltage potential, if piping is nonconductive (plastic or lined) or if conductivity is below 20 micromhos/cm. See Section 3.8 - Grounding.

1.5 System Operation

The Sparling TigermagEP™ uses the autozeroing, bipolar, pulsed-DC measuring technique. The circuitry (Fig. 1.2) energizes the coil with 300 mA typical current at a frequency of up to 100 Hz. The signal generated at the electrodes is measured near the end of each measuring cycle to eliminate the capacitive effects of coatings. The Hi-Z (10^{12} Ω) input impedance eliminates the resistive effects of electrode coatings. The field current alternates to a positive and negative state and the two measured signals are averaged to eliminate the effect of a zero offset-this is the auto-zeroing feature.



1. Measuring Sensor
2. Electrode Cable PCB
3. Input Amplifier
4. Summing Point
5. Autozero Circuit
6. Sample and Hold
7. Voltage to Frequency Converter
8. Nonvolatile E^2PROM
9. Coil Current Multiplexer
10. Built-in Simulator
11. Adjustable Empty Pipe Detection (in software)
12. Watchdog Timer
13. Microcontroller
14. LCD Display with Hall-Effect Switches
15. Optocouplers
16. Frequency to Current
17. Power Supply Section

Block Diagram
Figure 1.2

1.6 Construction

1.6.1 Sensor

The FM626 is a wafer style meter. It is available with either a ceramic or optional Tefzel® liner. The Tefzel® liner is rotamolded onto a stainless steel sensor tube. Both liners are press-fit into a carbon steel housing. The FM627 is a wafer style meter. The flow sensor housing is made of steel with a polyurethane liner. Sensor coils are completely encapsulated in polyurethane. The FM656 flow sensor is a welded fabrication of 304 stainless steel, fitted with two carbon steel flanges. The flow sensor contains a nonconductive liner of ceramic, polyurethane, Tefzel®, hard rubber, soft rubber, or neoprene. The FM657 flow sensor housing is made of steel with a polyurethane liner. Sensor coils are completely encapsulated in polyurethane. All TigermagEP™ meters are rugged, waterproof assemblies capable of handling a wide range of highly corrosive and abrasive liquids.

Fused platinum electrodes, standard on ceramic meters from 0.1" to 2", require no O-rings, eliminating the possibility of leaking. Platinum is suitable for nearly all conductive liquids. The electrodes in all other liners are self-sealing.

All internal cavities of the FM-626 sensor housing are filled with a high temperature silicone potting compound to prevent the possibility of moisture damage and to avoid the possibility of collection of explosive gases.

▼ **WHEN PROPERLY CONNECTED WITH LIQUID-TIGHT CONDUIT, THE FM626 AND FM627 REMOTE FLOW SENSOR WILL WITHSTAND ACCIDENTAL SUBMERGENCE. (SEE FIG. 3.16 ON PAGE 25).**

1.6.2 Integral Transmitter

The transmitter is mounted on the meter body and housed in a NEMA-4X and NEMA-7 enclosure that is approved by CSA and Factory Mutual. The power and signal electrical connections are made in a separate section of the housing which is isolated from the electronics.

1.6.3 Remote Transmitter

The transmitter is housed in a NEMA-4X enclosure some distance away from the meter body. Remote mounting is recommended where pipe vibration is excessive or when flooding is
possible.

Remote mounting tor the FM626 and FM656 is REQUIRED when high process tempera- tures exist at high ambient temperatures (above 212° F/100° C). The FM627 and FM657 should not be installed where process temperatures will exceed 180° F.

The optional remote mounting kit includes interconnecting cable between the sensor and transmitter enclosure. The standard interconnecting cable length is 15 feet. Shorter or longer cables should be specified when ordered from the factory. The cable may be shortened in the field.

CAUTION

DO NOT MAKE CONNECTIONS WHILE POWER IS APPLIED.

Disconnect Power Before Proceeding

1.7 Specifications

Power Requirements
See Nameplate

Fuses
Slo-Blo (12-60 Vdc) ..... 2.0 amp Slo-Blo (77-265 Vac) .....
1.0 amp Spare fuse provided on connector PCB.

Wire Size Max
Power ..... 16 AWG 14 AWG

Signal ..... 18 AWG

Ground Cable
Third wire ground of power cable

Accuracy (Frequency Output)
0.1" - 0.25"

1.0% of flow rate (3-33 fps)

0.5" - 54.0"

0.5% of flow rate (1-33 fps)

Reference Conditions
25° C, 6 fps full scale. Temperature effect, 0.025% Full Scale/°C. Accuracy statement based on digital outputs

Repeatability
Within ±0.1% full scale

Power Consumption
Less than 20 W

Output Signals
Simultaneous isolated analog and digital (all referenced to the same isolated ground) Analog:

0 to 20 or 4-20 mAdc into 800 ohms max. Digital:

Scaled pulse and frequency

a. Scaled, 24 Vdc pulse with 12.5/25/50/100 ms on-time, 0-60 Hz max into 150 ohm impedance min.
b. Scaled frequency. 15 Vdc square wave, 50/50 duty cycle, 0-1000 Hz max into 1000 ohms min.
c. Fault, with open collector
d. All open collectors are rated (100mA at 30 Vdc)
e. RS232 Communication and digital outputs to zero when an empty pipe condition can occur.

Minimum Conductivity
5 micromhos/cm

Input Signal
Positive zero return (PZR). Connect to remote dry contact to drive analog

Flow Direction
Open collector (rating: 100 mA at 30 Vdc). Active in reverse flow.

Fault Alarm
Open collector. Active on self test failure, empty pipe and during programming, low/no coil drive and failure of external totalizer to keep up with the flow (registration too small). Relay option available[1].

Two Flow Alarms
Open collector. Relay option available in remote mounting only.[1]

[1] Please note that Tigermag EP can only be configured with either two Flow Alarm Relays or the Fault Alarm Relay

1.7 Specifications Cont'd.

Full Scale Velocity Ranges 0-3 to 0-33 fps (0-1 to 0-10 mps)

Ambient Temp Limits -20° to 140°F (-30° to 60 °C) (Display may darken above 158 °F)

Process Temp

Integral Mount
Hard rubber, Soft rubber, Neoprene, Polyurethane ..... -40 - 180°F
Tefzel®, Ceramic: ..... -40 - 212° F

Remote Mount (opt)
Hard rubber, Soft rubber, Neoprene, Polyurethane ..... -40 - 180° F
Tefzel® (to 300 psi), Ceramic: ..... -40 - 266° F

High Temp Coils (opt)
Tefzel® (to 100 psi): ..... -40 - 300° F
Ceramic: ..... -40 - 420° F

Temperatures above 212°F (100° C) require mounting the electronics in a remote location (max. distance 15 feet at liquid conductivity of 5 micro-mhos and min. velocity of 1 fps).

Storage Temp Limits -20° to 140° F (-30° to 60° C)

Construction

Metering Tube ..... Model 626 – Steel, epoxy coated
Model 656 – 0.5"-4" Steel, epoxy coated
Model 656 - 6" - 72" 304 SS welded, epoxy coated
Model 627 - 1" - 8" Cast Ductile Iron, epoxy coated
Model 657 - 2" - 48" Fabricated Steel, epoxy coated

Flanges Carbon steel ANSI compatible

Lining ..... Model 626 – Aluminum Oxide 99.5% or Tefzel®
Model 656 – Polyurethane, Aluminum Oxide 99.5%
Tefzel®, Hard Rubber, Soft Rubber, Neoprene
Model 627 & 657 – Polyurethane

Electrodes ..... 316 SS. Others as required

Integral Housing (XMTR) ..... Cast Aluminum, Hi-build Epoxy Coated
Remote Housing (XMTR) ..... Fiberglass

Protection rating
Integral NEMA-4X, NEMA-7
Remote NEMA-4X

Electrical rating
Remote Mount General Purpose
Integral Mount Hazardous Locations
FM Approved* for Class I, Division 1, Groups B, C, D
Class II Groups E, F, G
CE Approved (pending)
CSA Approved* for Class 1, Division 2, Groups A, B, C, D

*FM and CSA applies to integrally mounted transmitters up to 150 psi only.

1.8 Interchangeability

The TigermagEP™ transmitter is designed to be used with any **FM626, FM627, FM656** or **FM657** sensor. Electronics are completely interchangeable. Meter identification (tube ID, Serial Number, K, Offset, etc.) is stored on an E^2PROM chip independent of transmitter electronics. This provides universal compatibility between all Tigermag EP electronics modules, eliminating the need for reprogramming when switching modules. **FM656** (0.5"- 4"), **FM627** (1"-4") and **FM657** (2"-4") sizes have the same face-to-face dimensions as FM626 wafer-style meters (0.5"- 4"). See Figure 1.3

1.9 Flow Rates, Dimensions & Weight

On meters smaller than 1" accuracy is ±1% of rate

Table 1 - Nominal Flow Rates (Full Scale GPM)

Nominal Meter Size		626 (Ceramic/Tefzel)**			626 (Sanitary)			627 (Poly)			626, 656, 657 (others)		
		±.5%	Min	Max	±.5%	Min	Max	±.5%	Min	Max	±.5%	Min	Max
Inches	mm	1 fps	3 fps	33 fps	1 fps	3 fps	33 fps	1 fps	3 fps	33 fps	1 fps	3 fps	33 fps
*0.1	2.5	0.04	0.1	1.3	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
*0.25	0	.22	0.6	7.2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
*0.5	12	0.50	1.5	16	N/A	N/A	N/A	N/A	N/A	N/A	0.	1.7	18
1.0	25	1.62	4	53	1.3	4	42	1.6	4.8	53	2	6	66
1.5	40	4	13	145	3.7	11	120	N/A	N/A	N/A	5	15	174
2.0	50	7	21	231	7.2	22	239	7	21	231	9	27	303
2.5	65	N/A	N/A	N/A	12	3	398	N/A	N/A	N/A	N/A	N/A	N/A
3.0	80	N/A	N/A	N/A	18	54	598	20	60	660	20	60	664
4.0	100	N/A	N/A	N/A	33	99	1088	35	105	1155	35	107	1182
6.0	150	N/A	N/A	N/A	N/A	N/A	N/A	88	264	2910	85	254	2800
8.0	200	N/A	N/A	N/A	N/A	N/A	N/A	147	441	4851	145	43	4800
10.0	250	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	23	709	7800
12.0	300	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	333	1000	11000
14.0	350	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	409	1227	13500
16.0	400	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	545	1636	18000
18.0	450	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	667	2000	22000
20.0	500	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	879	2636	29000
24.0	600	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1273	3818	42000
30.0	750	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1909	5727	63000
36.0	900	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2925	8775	96525
42.0	1050	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	4040	12120	133320
48.0	1200	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	5322	15966	175626
54.0	1350	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	7144	21433	235800
60.0	1500	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	8500	25500	280500
66.0	1650	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	10300	31000	341000
72.0	1800	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	12700	38100	419100

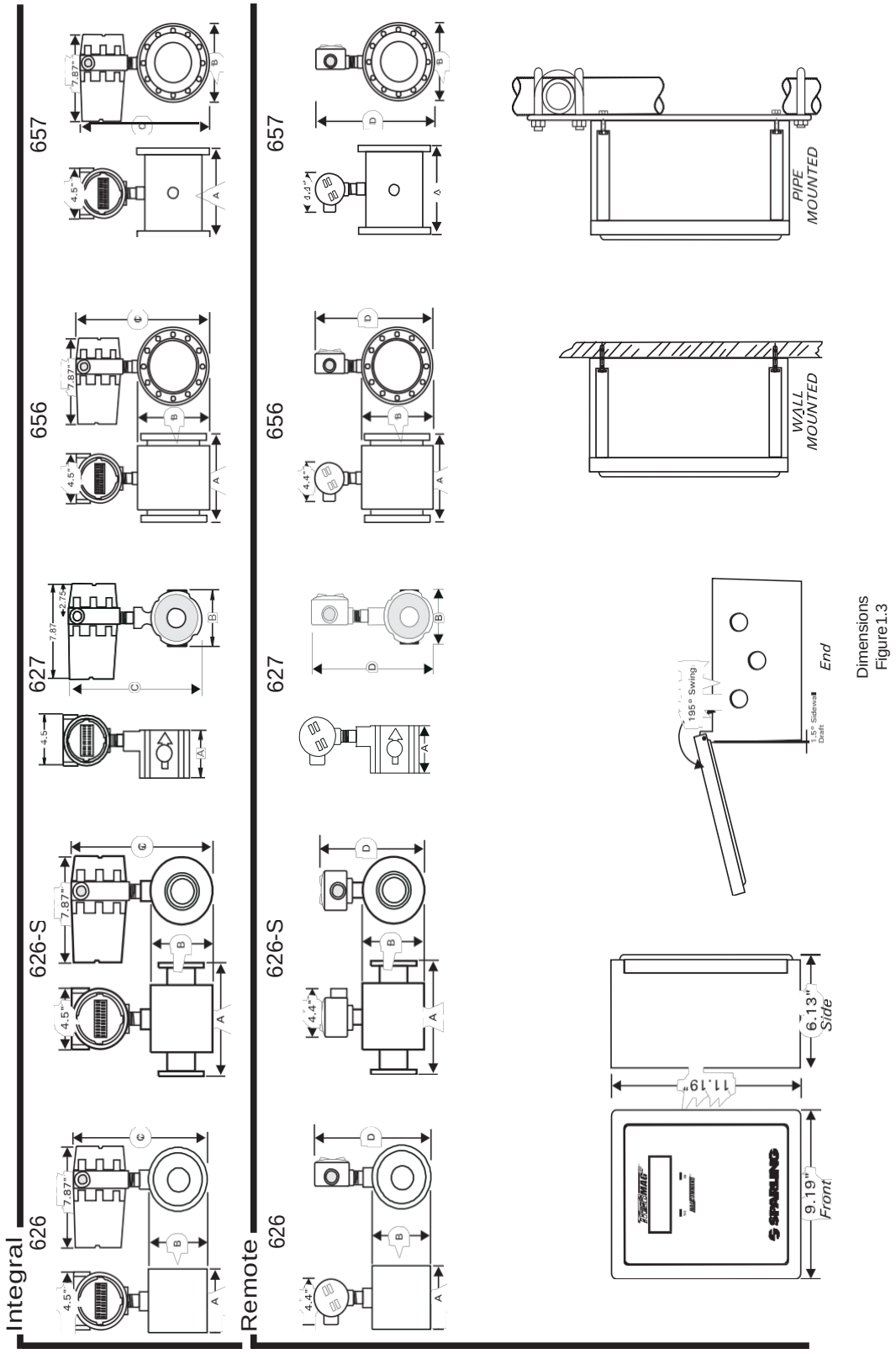
**Ceramic liners are slightly smaller than Tefzel. Flow rates for Tefzel lined meters from .5" to 2" ID's are slightly higher than shown in Table 1 (above). Refer to PDS-626 for actual numbers.

Table 2 - Weight

Nominal Meter Size		626		627		656		657	
inches	mm	lbs	kg	lbs	kg	lbs	kg	lbs	kg
0.1	2.5	15	7	N/A	N/A	N/A	N/A	N/A	N/A
0.25		5	7	N/A	N/A	N/A	N/A	N/A	N/A
0.5	12	15	7	N/A	N/A	18	8	N/A	N/A
1.0	25	15	7	15	7	20	9	N/A	N/A
1.5	40	20	9	N/A	N/A	26	12	N/A	N/A
2.0	50	20	9	20	9	30	14	30	14
2.5	65	20	9	N/A	N/A	N/A	N/A	N/A	N/A
3.0	80	30	14	30	14	48	22	48	22
4.0	100	35	1	35	1	55	25	55	25
6.0	150	N/A	N/A	46	21	75	34	75	34
8.0	200	N/A	N/A	49	22	105	77	105	77
10.0	250	N/A	N/A	N/A	N/A	155	8	155	86
12.0	300	N/A	N/A	N/A	N/A	235	117	235	117
14.0	350	N/A	N/A	N/A	N/A	365	140	365	140
16.0	400	N/A	N/A	N/A	N/A	460	182	460	182
18.0	450	N/A	N/A	N/A	N/A	555	209	555	209
20.0	500	N/A	N/A	N/A	N/A	625	250	625	250
24.0	600	N/A	N/A	N/A	N/A	860	336	860	336
30.0	750	N/A	N/A	N/A	N/A	1325	432	1325	432
36.0	900	N/A	N/A	N/A	N/A	1800	648	1800	648
42.0	1050	N/A	N/A	N/A	N/A	2280	818	2280	818
48.0	1200	N/A	N/A	N/A	N/A	3500	977	3500	977

1.9

Flow Rates, Dimensions & Weight
cont'd.



Dimensions
Figure 1.3

1.9 Flow Rates, Dimensions & Weight cont'd.

Table 3 - Dimensions

Nominal Meter Size		Dimensions (Inches)																	
		A			B					C					D				
Inches	mm	*All	626-S	627	626	626-S	627	656	657	626	626-S	627	656	657	626	626-S	627	656	657
0.1	2.5	4.00	N/A	N/A	2.31	N/A	N/A	N/A	N/A	8.75	N/A	N/A	N/A	N/A	8.50	N/A	N/A	N/A	N/A
0.25	4	.00	N/A	N/A	2.31	N/A	N/A	N/A	N/A	8.75	N/A	N/A	N/A	N/A	8.50	N/A	N/A	N/A	N/A
0.5	12	4.00	N/A	N/A	2.31	N/A	N/A	3.50	N/A	8.75	N/A	N/A	9.50	N/A	8.50	N/A	N/A	9.25	N/A
1.0	25	4.00	4.12	4.00	2.92	2.375	2.92	4.25	N/A	9.38	9.125	10.2	10.19	N/A	9.13	7.88	9.9	9.94	N/A
1.5	40	4.00	4.12	N/A	3.62	3.50	N/A	5.00	N/A	10.00	10.25	N/A	10.88	N/A	9.75	9.00	N/A	10.63	N/A
2.0	50	4.00	4.12	4.00	4.12	3.50	4.25	6.00	6.00	10.63	10.25	11.8	11.69	11.25	10.38	9.00	11.5	11.44	11.00
2.5	65	N/A	4.12	N/A	N/A	4.00	N/A	N/A	N/A	N/A	10.75	N/A	N/A	N/A	N/A	9.50	N/A	N/A	N/A
3.0	80	6.00	8.00	6.00	5.70	4.50	5.40	7.50	7.50	11.75	11.25	13.4	13.00	13.00	11.50	10.00	13.1	12.75	12.75
4.0	100	6.00	8.00	6.00	6.60	6.625	6.60	9.00	9.00	13.00	13.375	14.9	14.38	14.38	12.75	12.12	14.6	14.13	14.13
6.0	150	13.38	N/A	8.00	N/A	N/A	9.00	11.00	11.00	N/A	N/A	17.3	17.00	16.25	N/A	N/A	17.0	16.75	16.00
8.0	200	13.38	N/A	8.00	N/A	N/A	10.70	13.50	13.50	N/A	N/A	19.4	19.40	18.50	N/A	N/A	19.1	19.15	18.25
10.0	250	18.15	N/A	N/A	N/A	N/A	N/A	16.00	16.00	N/A	N/A	N/A	22.56	20.75	N/A	N/A	N/A	22.31	20.50
12.0	300	19.40	N/A	N/A	N/A	N/A	N/A	19.00	19.00	N/A	N/A	N/A	25.00	23.25	N/A	N/A	N/A	24.75	23.00
14.0	350	21.38	N/A	N/A	N/A	N/A	N/A	21.00	21.00	N/A	N/A	N/A	26.67	25.25	N/A	N/A	N/A	26.42	25.00
16.0	400	23.38	N/A	N/A	N/A	N/A	N/A	23.50	23.50	N/A	N/A	N/A	28.97	27.50	N/A	N/A	N/A	28.72	27.25
18.0	450	27.25	N/A	N/A	N/A	N/A	N/A	25.00	25.00	N/A	N/A	N/A	31.14	29.25	N/A	N/A	N/A	30.89	29.00
20.0	500	27.63	N/A	N/A	N/A	N/A	N/A	27.50	27.50	N/A	N/A	N/A	33.39	31.50	N/A	N/A	N/A	33.14	31.25
24.0	600	32.75	N/A	N/A	N/A	N/A	N/A	32.00	32.00	N/A	N/A	N/A	37.44	35.75	N/A	N/A	N/A	37.19	35.50
30.0	750	43.50	N/A	N/A	N/A	N/A	N/A	38.75	38.75	N/A	N/A	N/A	43.72	42.13	N/A	N/A	N/A	43.47	41.88
36.0	900	47.75	N/A	N/A	N/A	N/A	N/A	46.00	46.00	N/A	N/A	N/A	50.20	48.75	N/A	N/A	N/A	49.95	48.50
42.0	1050	51.75	N/A	N/A	N/A	N/A	N/A	53.00	53.00	N/A	N/A	N/A	56.90	55.25	N/A	N/A	N/A	56.65	55.00
48.0	1200	51.75	N/A	N/A	N/A	N/A	N/A	59.50	59.50	N/A	N/A	N/A	63.05	61.50	N/A	N/A	N/A	62.80	61.25
54.0	1350	53.50	N/A	N/A	N/A	N/A	N/A	66.25	N/A	N/A	N/A	N/A	69.88	N/A	N/A	N/A	N/A	69.63	N/A
60.0	1500	65.50	N/A	N/A	N/A	N/A	N/A	73.00	N/A	N/A	N/A	N/A	76.75	N/A	N/A	N/A	N/A	76.50	N/A
66.0	1650	65.50	N/A	N/A	N/A	N/A	N/A	80.00	N/A	N/A	N/A	N/A	83.75	N/A	N/A	N/A	N/A	83.50	N/A
72.0	1800	72.75	N/A	N/A	N/A	N/A	N/A	86.50	N/A	N/A	N/A	N/A	90.00	N/A	N/A	N/A	NA	89.75	N/A

Note 1: Dimensions and chart values for 150 lb. flanges (ANSI template).
Note 2: Allow 1/4" for 0.5 to 6" meters and 1/2" for 8" and larger meters for grounding rings and gaskets.
Note 3: "C" & "D" Dimensions ±0.125"

2.0 Pre-Installation

2.1 Receivingand Inspection

When the equipment is received, the outside of the package should be inspected for damage. If any damage or shortage is found, notation to that effect should be made on the carrier s delivery receipt.

Visually inspect the sensor and transmitter for damage from rough handling or faulty packaging. If concealed damage is discovered, notify the delivering carrier at once and request an inspection. Confirm telephone conversations in writing. If inspection is not made, prepare an affidavit stating that you notified the transportation company and that they failed to inspect. Save containers and packaging material.

It is essential that the carrier be notified within 15 days from the date of delivery in order to be in a position to present your claim. Make your claim promptly.

Unpacking and handling of TigermagEP™ Magnetic Flowmeters should be consistent with the procedures used to handle field instruments.

2.2 Storage

This equipment should be stored in a clean, dry environment. Do not store outside in an unprotected area. Observe the storage temperature requirements. Unpowered storage should not exceed two years.

2.3 Returnof Equipment

Obtain an **RGA (Returned Goods Authorization)** number from the factory prior to returning any materials. The RGA number should be marked on the outside of the package. Failure to obtain authorization will unnecessarily delay any work to be performed at the factory.

CAUTION

When the meter is returned to our factory, a statement MUST be attached indicating the liquid that was flowing through the meter, the concentration of the liquid, and that the meter has been decontaminated and flushed clean.

WE WILL NOT HANDLE THE RETURNED EQUIPMENT UNLESS THIS STATEMENT ACCOMPANIES THE METER.

This procedure is in accordance with the Toxic Control Act 7.

3.0 Installation

3.1 Application Considerations

The TigermagEP™ can be used to accurately measure the volumetric flow rate of liquids having a conductivity of at least 5 micromhos/cm.

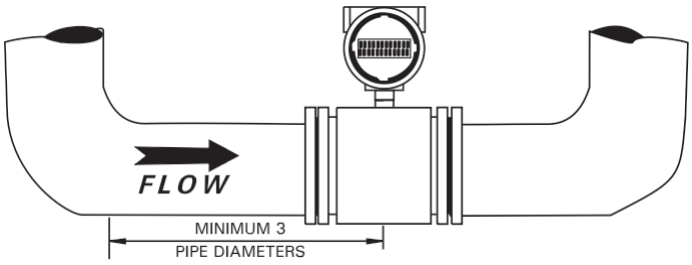
The presence of entrained air or gases in the process liquid will not prevent meter operation, but will produce a positive (+) error equal to the % by volume gas entrainment.

▼ **FULL SCALE FLOW RATES SHOULD BE SELECTED ABOVE 3 FEET PER SECOND (1 METER PER SECOND) FOR BEST ACCURACY.**

3.2 Site Selection

Select a pipe location which will always be full of liquid. The equipment should be located where the flowmeter will be accessible for adjustment. Provide a minimum of 18" clearance to the electronics enclosure.

The meter may be located in any position from vertical to horizontal. Flow may be in either direction through the meter. Vertical installation with the liquid flowing upwards, minimizes the possibility of slurry separation and assures a full pipe condition.



Full Pipe Required
Figure 3.1

Horizontal installation requires that the sensing electrodes be positioned in the horizontal plane. See Figure 3.7.

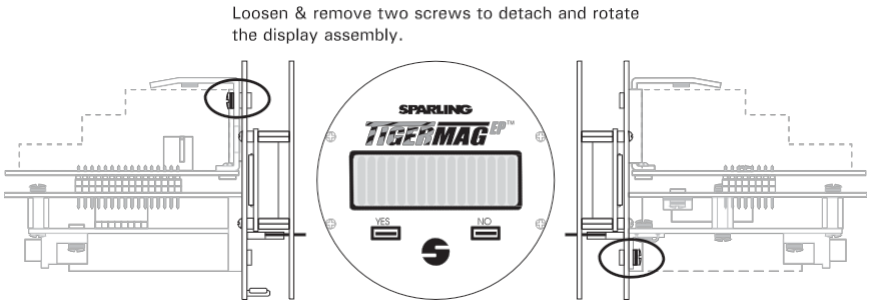
Provide at least three pipe diameters of straight piping approach between an upstream elbow and the midpoint of the meter. In small meters this can be achieved within the meter itself. More straight approach should be provided after valves or multiple elbows. Provide at least 10 diameters after expanders or laterals which are of smaller diameter than the line size.

3.3 Rotating the Transmitter Display

The Sparling TigermagEP's modular display is designed to allow you to rotate the display in four different orientations. The display assembly can be rotated, at 90° intervals, by removing the two screws circled in Figure 3.2 below, for ease of reading the display.

The display features long lasting LCD numerals. The display may darken if ambient temperatures exceed its temperature rating of -4° to +158° F. Darkening usually occurs when the electronics are installed in direct sunlight. To avoid this problem install a sun shield when the flowmeter is in direct sunlight.

The display assembly can be replaced in the field without replacing the entire electronics, by following the same procedures as utilized for rotating the display.



Removing the Rotatable Display
Figure 3.2

3.4 Removable Electrodes (optional)

The line must be depressurized and drained in order to check and replace the removable electrodes.

3.4.1 How the Design Works

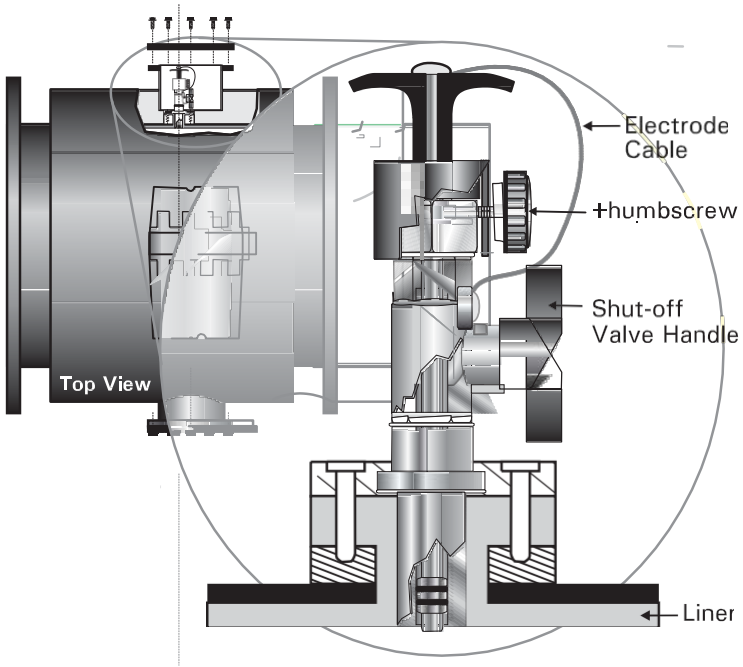
This design utilizes electrodes which are installed through accessible ports provided on the sensor body. Electrodes are sealed using two o-rings. One o-ring acts as a primary seal while the other is a backup seal. This redundant sealing approach provides positive sealing.

To withdraw the electrodes, process line has to be depressurized and drained. The outer cover must be removed by unscrewing cap bolts using an 11/32 nut driver to allow access to the electrode cavity. Remove cables from electrodes by removing nuts and lock washers. Using a 3/4" socket, unscrew and remove the electrode assembly.

3.4.2 The Need for Replacement

Sparling's flowmeter design utilizes High Impedance circuitry (Hi-Z) which is not affected by coating buildup on the electrodes. Replacement of the electrode only becomes necessary when physical damage due to erosion or corrosion has occurred.

3.5 Hot-Tap Removable Electrodes (optional)



Hot-Tap Removable Electrode
Figure 3.4

Sparling's optional hot-tap removable electrode design allows the inspection or replacement of electrodes without stopping the flow or depressurizing the line. The electrode assembly is sealed with multiple o-rings to maintain isolation from the pressurized medium. During removal of the electrode, a stainless steel ball valve is closed to keep the process fluid from leaking out while the electrodes are inspected or cleaned. The electrode housing, wired as a backup electrode, functions as a redundant electrode assembly providing the flow signal to the electronics. In other words, even when the electrode is withdrawn, the flowmeter keeps on providing important flow information.

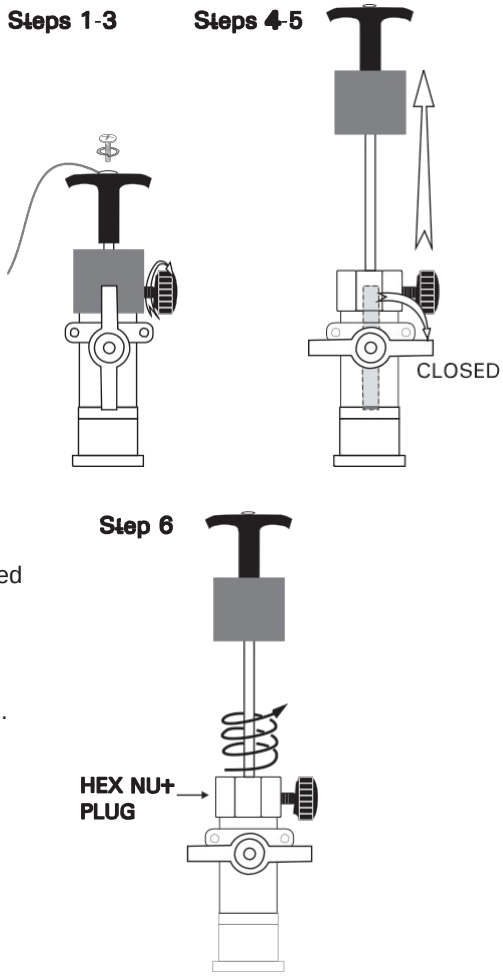
3.5 Hot-Tap Removable Electrodes (cont'd)

3.5.1 Electrode Removal

1. Use a cross recessed (phillips) screwdriver to remove the screw and lock washer from the handle.
2. Gently remove the electrode cable (orange wire) and place aside.
3. Secure cable then loosen the side knob.
4. Using the handle on the electrode head, pull electrode straight to the point that the valve can be closed.
5. Close the ball valve clockwise.
6. Unscrew the hex plug from the valve counterclockwise and remove the electrode assembly.

3.5.2 Electrode Installation

1. Install hex plug clockwise. Seal tight into closed valve assembly.
2. Open ball valve counterclockwise.
3. Push electrode assembly in, aligning the slot in the cover with the screw, until firmly seated.
4. Tighten the side knob.
5. Place electrode cables on handle.
6. Install the lock washer and screw, tighten.
7. Replace gasket, cover, cover screws and tighten securely.



Removing the Electrode
Figure 3.5

CAUTION

- **Avoid Scratching or damaging the withdrawn electrodes**
- **Ball valve must be closed before the hex-head electrode assembly is unscrewed and removed.**
- **Electrode hes-head assembly must be replaced and secured tightly before opening the ball valve and reinserting the electrode**

3.5.3 When to Replace

Sparling's flowmeter design utilizes High Impedance circuitry (Hi-Z) which is not affected by coating buildup on the electrodes. Replacement of the electrode only becomes necessary when physical damage due to erosion or corrosion has occurred.

3.6 Pipe Connections

MODELS FM626 & FM627 FLANGELESS (WAFER) SENSOR

The flangeless sensor is installed between two process pipe flanges. The sensor contains a nonconductive polyurethane, ceramic or Tefzel® liner. The integrity of this liner must be maintained for the flowmeter to function. **CARE SHOULD BE TAKEN DURING INSTALLATION TO INSURE THAT THIS LINER IS NOT DAMAGED**. Depending upon meter size, four (4) or eight (8) steel bolts are required for installation of the FM626 & FM627. These bolts are used to install the meter between existing flanges. See Table 4. Gaskets are required between the meter and the pipe flanges and between grounding rings and the mating surfaces.

Install the two bolts at the bottom of the meter. Place the meter temporarily between the flanges to confirm correct positioning. The meter should rest directly on the bolts. Remove the meter.

▼ **REINSTALL THE METER TAKING CARE TO KEEP THE GASKET CENTERED. INSTALL ALL BOLTS AND TURN FINGER TIGHT. COMPLETE INSTALLATION WITH TORQUE WRENCH. IT IS IMPORTANT THAT THE BOLTS BE TIGHTENED ALTERNATELY SO THAT EXCESSIVE FORCE IS NOT APPLIED TO A CONCENTRATED POINT. SEE FIGURE 3.6. DO NOT EXCEED THE TORQUE LIMITS IN TABLE 6.**

MODELS FM656 & FM657 FLANGED SENSORS

The flanged sensor is installed between two process pipe flanges. The sensing head tube interior is covered with an electrically nonconductive liner which overlaps the flange seal surfaces. The integrity of this liner must be maintained for the flowmeter to function **CARE SHOULD BE TAKEN DURING INSTALLATION TO INSURE THAT THIS LINER IS NOT DAMAGED. FLANGE GASKETS MUST BE USED.**

Gasket material should be selected which is compatible with the piping and process conditions. Table 4 contains typical satisfactory gasket materials. Do not use spiral wound metal gaskets as they may cause liner damage.

Table 4 - Gasket Material

LINER MATERIAL	GASKET MATERIAL
Ceramic	Teflon®
Tefzel®	Teflon® Coated Asbestos
Hard or Soft Rubber	Asbestos Neoprene Rubber
Neoprene	Asbestos Neoprene Rubber
Polyurethane	Asbestos Neoprene Rubber
FM627 Polyurethane	Armstrong Syntheseal

▼ **THE GASKETS, METER FLANGES, AND MATING PIPE FLANGES SHOULD BE DUSTED WITH GASKET TALC PRIOR TO INSTALLATION TO PREVENT DAMAGE TO THE LINER SHOULD IT BE NECESSARY TO REMOVE THE METER FROM THE LINE. DO NOT USE GRAPHITE TO DUST THE GASKET. A CONDUCTIVE FILM WILL COAT THE METER INTERIOR AND CAUSE A MALFUNCTION.**

DO NOT EXCEED THE TORQUE LIMITS IN TABLE 6.

3.7 Special Mounting Bolts & Gaskets

Sparling provides carbon steel mounting hardware with wafer meter sizes 0.1"to 4", On flanged meters, special mounting bolts are provided for meter sizes 0.5", 1.5" and 3" only. Gaskets are provided for ceramic sensors only.

Optional 304SS mounting bolts for these sizes are available at extra cost.

Table 5 - Meter I.D.

Nominal I.D.	Actual I.D.			
	Ceramic		Other	
in	in	mm	in	mm
0.10	0.125	3.17	N/A	N/A
0.25	0.302	7.67	N/A	N/A
0.50	0.452	11.48	0.48	12.24
1.0	0.812	20.62	0.91	23.09
1.5	1.34	34.04	1.47	37.34
2.0	1.69	42.93	1.94	49.20
2.5	N/A	N/A	2.24	56.90
3.0	N/A	N/A	2.87	72.85
4.0	N/A	N/A	3.83	97.18
6.0	N/A	N/A	6.00	152.40
8.0	N/A	N/A	7.75	196.85
10.0	N/A	N/A	10.00	254.00
12.0	N/A	N/A	12.00	304.80
14.0	N/A	N/A	13.00	330.20
16.0	N/A	N/A	15.00	381.00
18.0	N/A	N/A	17.00	431.80
20.0	N/A	N/A	19.00	482.60
24.0	N/A	N/A	22.90	581.66
30.0	N/A	N/A	29.00	736.60
36.0	N/A	N/A	34.60	878.84
42.0	N/A	N/A	40.60	1031.24
48.0	N/A	N/A	46.60	1183.64
54.0	N/A	N/A	52.50	1333.50
60.0	N/A	N/A	58.50	1485.90
66.0	N/A	N/A	64.50	1638.30
72.0	N/A	N/A	70.25	1790.70

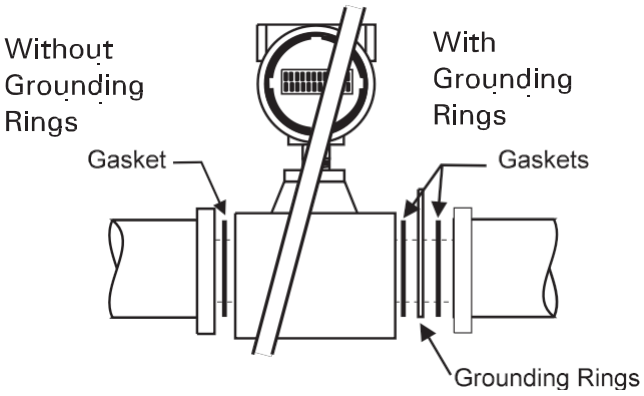
Table 6 - Torque, Flange & Bolt Specifications

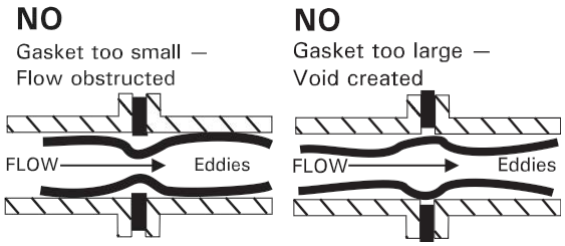
Nom. Meter Size(in)	Maximum Torque		ANSI / AWWA Flange & Bolt Specs						DIN Flange & Bolt Specs					
	ft-lbs	kg-m	Mating Flange	Pressure Rating	OD Inch	Bolt Circle	Hole Dia	Bolt Size	Mating Flange	Pressure Rating	OD mm	Bolt Circle	Hole Dia	Bolt Size
0.1	17	2.3	0.5	150	3-1/2	2-3/8	4 @ 5/8	7/16-14 x 6-3/4	15	10	95	65	4 @ 14	M10 X 170
	17	2.3	0.5	300	3-3/4	2-5/8	4 @ 5/8	1/2-13 x 6-3/4	15	25	95	65	4 @ 14	M12 X 170
	17		0.5	600	3-3/4	2-5/8	4 @ 5/8	1/2-13 x 6-3/4						
0.25	17	2.3	0.5	150	3-1/2	2-3/8	4 @ 5/8	7/16-14 x 6-3/4	15	10	95	65	4 @ 14	M10 X 170
	17	2.3	0.5	300	3-3/4	2-5/8	4 @ 5/8	1/2-13 x 6-3/4	15	25	95	65	4 @ 14	M12 X 170
	17		0.5	600	3-3/4	2-5/8	4 @ 5/8	1/2-13 x 6-3/4						
0.5	17	2.3	0.5	150	3-1/2	2-3/8	4 @ 5/8	7/16-14 x 6-3/4	15	10	95	65	4 @ 14	M10 X 170
	17	2.3	0.5	300	3-3/4	2-5/8	4 @ 5/8	1/2-13 x 6-3/4	15	25	95	65	4 @ 14	M12 X 170
	17		0.5	600	3-3/4	2-5/8	4 @ 5/8	1/2-13 x 6-3/4						
1.0	17	2.3	1	150	4-1/2	3-1/8	4 @ 5/8	7/16-14 x 6-3/4	25	10	115	85	4 @ 14	M12 X 170
	17	2.3	1	300	4-7/8	3-1/2	4 @ 3/4	5/8-11 x 7-1/2	25	25	115	85	4 @ 14	M12 X 170
	17		1	600	4-7/8	3-1/2	4 @ 3/4	5/8-11 x 7-1/2						
1.5	17	2.3	1.5	150	5	3-7/8	4 @ 5/8	1/2-13 x 6-3/4	40	10	150	110	4 @ 18	M16 X 190
	17	2.3	1.5	300	6-1/8	4-1/2	4 @ 7/8	3/4-10 x 7-1/2	40	25	150	110	4 @ 18	M16 X 190
	17		1.5	600	6-1/8	4-1/2	4 @ 7/8	3/4-10 x 7-1/2						
2.0	17	2.3	2	150	4	-3/4	4 @ 3/4	5/8-11 x 7-1/2	50	10	165	125	4 @ 18	M16 X 190
	17	2.3	2	300	6-1/2	5	8 @ 3/4	5/8-11 x 7-1/2	50	25	165	125	4 @ 18	M16 X 190
	17		2	600	6-1/2	5	8 @ 3/4	5/8-11 x 7-1/2						
3.0	24	3.3	3	150	7-1/2		@ 3/4	5/8-11 x 9-1/2	80	10	200	160	8 @ 18	M16 X 240
	24	3.3	3	300	8-1/4	6-5/8	8 @ 7/8	3/4-10 x 10-1/2	80	25	200	160	8 @ 18	M16 X 240
4.0	30	4	4	150	9	7-1/2	8 @ 3/4	5/8-11 x 9-1/2	100	10	220	180	8 @ 18	M12 X 240
	30	4	4	300	10	7-7/8	8 @ 7/8	3/4-10 x 10-1/2	100	25	235	190	8 @ 22	M20 X 260
6.0	92	12.7												
8.0	133	18.4												
10.0	70	9.7												
12.0	83	11.5												
14.0	100	13.8												
16.0	110	15.2												
18.0	110	15.2												
20.0	115	15.9												
24.0	135	18.7												
30.0	140	19.4												
36.0	140	19.4												
42.0	140	19.4												
48.0	140	19.4												
54.0 & 60.0	140	19.4												
66.0 & 72.0	140	19.4												

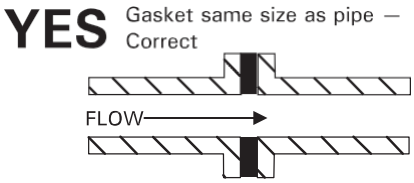
All specifications per customer requirements and
in compliance with recognized standards such as:
ANS/AWWA/DIN

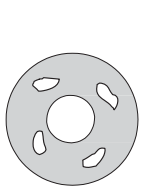
FM626/ FM627 (Wafer Style)

Gasket Installation

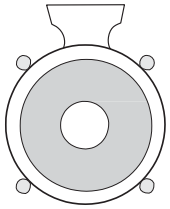




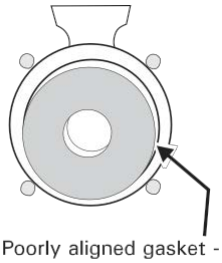




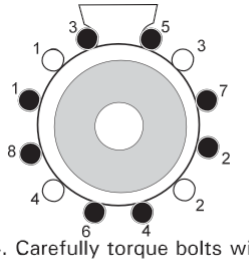
1. Apply silicone grease or other viscous fixative to gasket for temporary positioning



2. Fit gaskets, checking to ensure it is perfectly centered



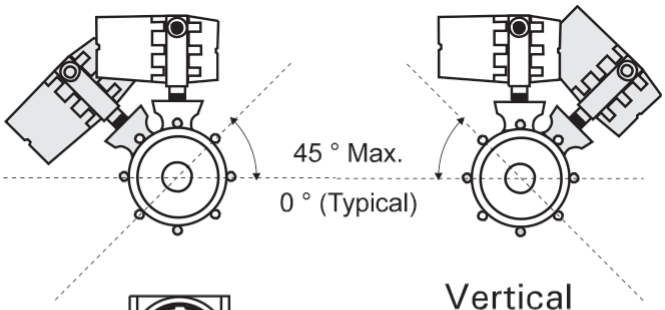
3. Poorly aligned gasket - can cause catastrophic leaks and flow errors



4. Carefully torque bolts with Bolt torque sequence above
   - ○ 4 Bolt Pattern
   - ● 8 Bolt Pattern See Table 4

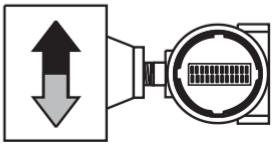
Gasket Installation
Figure 3.6

Sensor Position

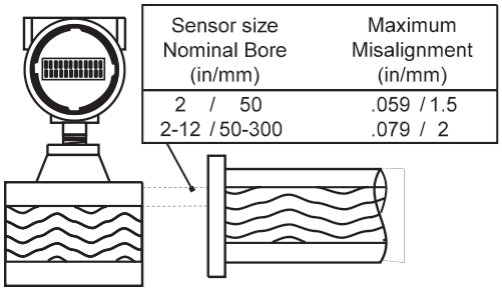


Horizontal

Vertical
(up-flow preferred to guarantee full-pipe condition)



Sensor Alignment

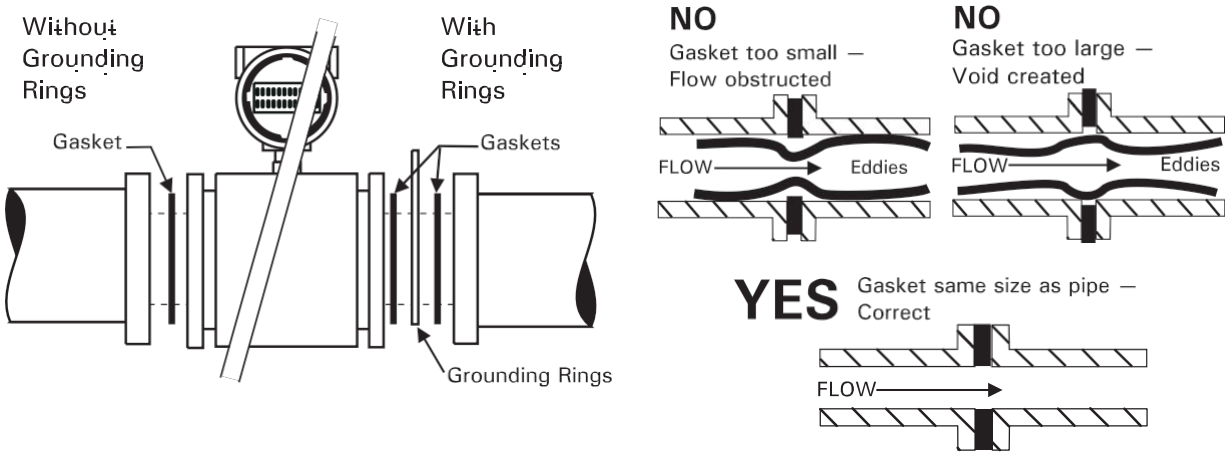


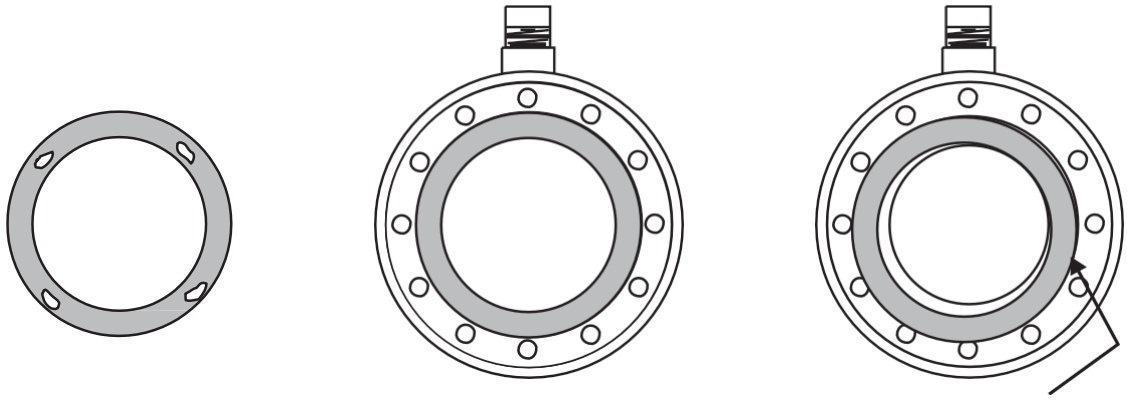
Sensor size Nominal Bore (in/mm)	Maximum Misalignment (in/mm)
2 / 50	.059 / 1.5
2-12 / 50-300	.079 / 2

Sensor Position
Figure 3.7

FM656 / FM657 (Flanged)

Gasket Installation

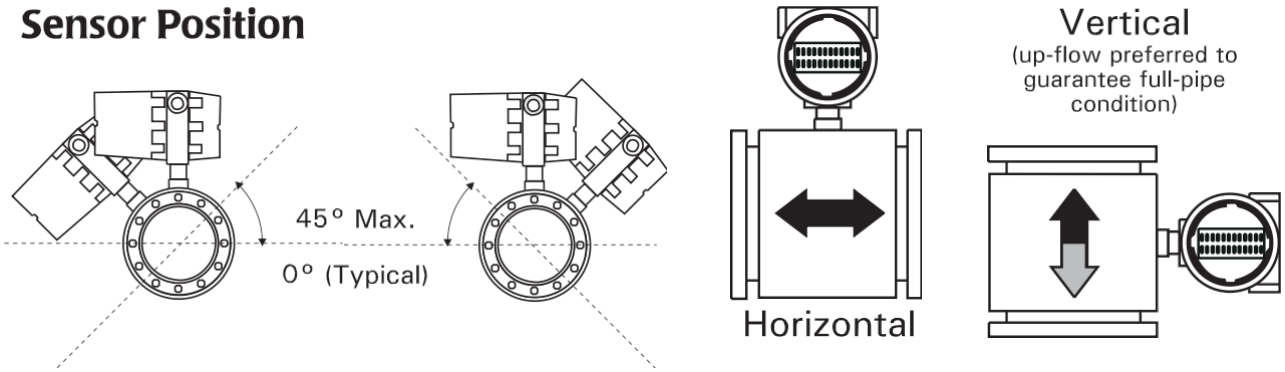




1. Apply silicone grease or other viscous fixative to gasket for temporary positioning
2. Fit gaskets, checking to ensure it is perfectly centered
3. Poorly aligned gasket - can cause catastrophic leaks and flow errors

Gasket Installation Figure 3.8

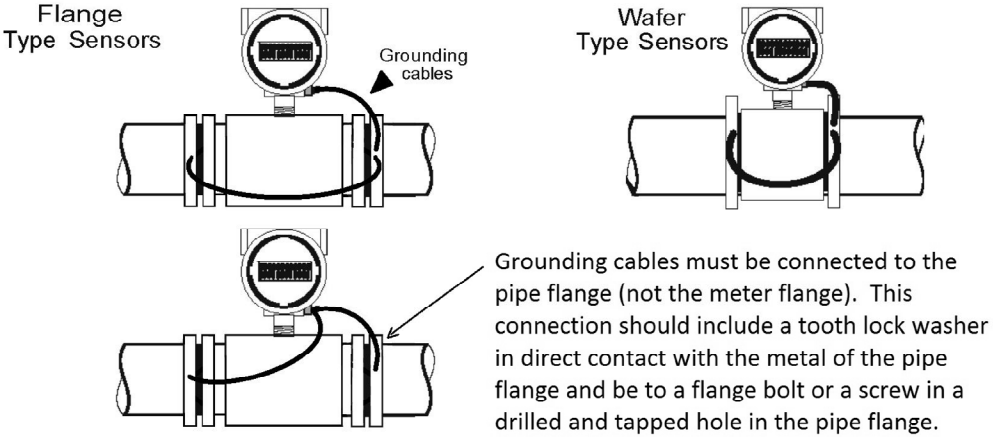
Sensor Position



Sensor Position Figure 3.9

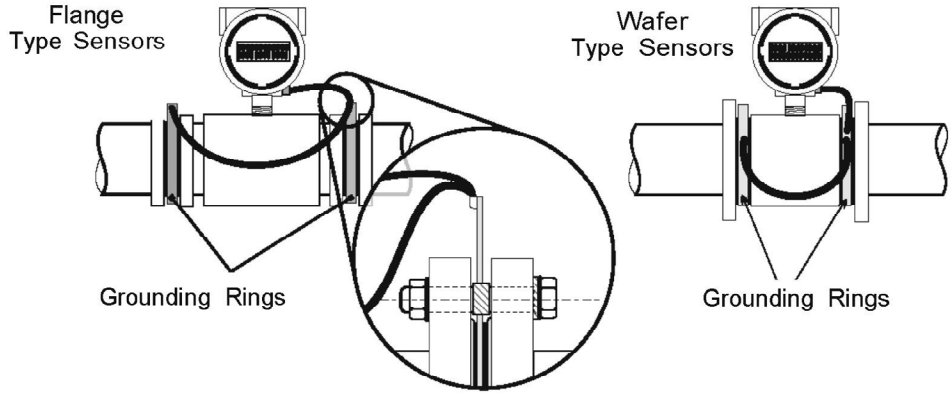
3.8 Grounding

Mounting in Unlined Metal Pipelines

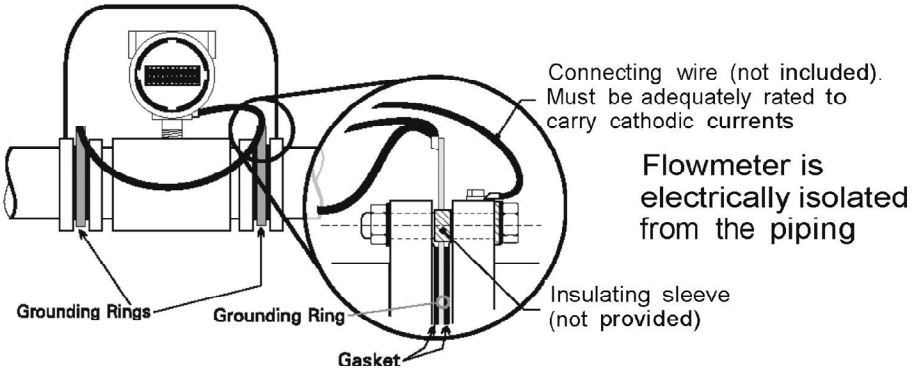


Grounding cables must be connected to the pipe flange (not the meter flange). This connection should include a tooth lock washer in direct contact with the metal of the pipe flange and be to a flange bolt or a screw in a drilled and tapped hole in the pipe flange.

Mounting in Plastic or Lined Pipeline, or where Conductivity <20 micromhos/cm



Mounting in Pipes with Cathodic Protection



Grounding
Figure 3.10

3.8 Grounding Cont'd.

DC and AC voltages can be transmitted through conductive fluids which can lead to magnetic flow meter instrument errors. Adequate grounding between the liquid and the instrument is essential to ensure correct flow measurement. Magnetic flow meters should always be grounded at four places: 1) Flowmeter tube, 2) Transmitter, 3) Receiving instrument, 4) the fluid.

▼ **EXTERNAL GROUNDING RINGS SHOULD BE INSTALLED ON ANY METER WHERE THERE IS LINED OR NONCONDUCTIVE PIPE OR CONDUCTIVITY IS LESS THAN 20 MICROMHOS/CM. SEE FIGURE 3.10.**

The grounding rings are in continuous contact with the process liquid providing a direct means for grounding electrical noise in the liquid. The electrical noise potential in the process liquid is at a similar level to the electrical ground plane to which the AC power supply ground is connected. This grounding method stabilizes the electrical field within the sensor measuring section permitting accurate flow detection. Grounding resistance must be less than 20 ohms.

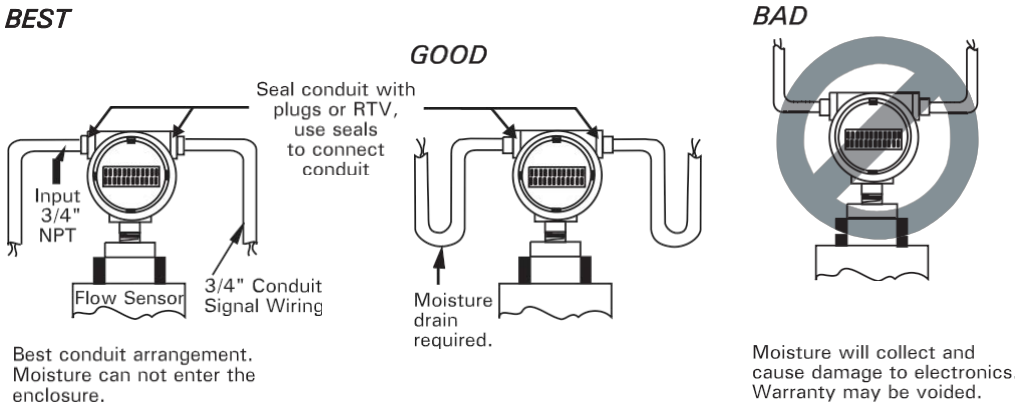
▼ **CONTACT OUR TECHNICAL SUPPORT GROUP IF PROCESS LIQUID NEEDS TO BE MAINTAINED AT A POTENTIAL ABOVE OR OTHER THAN GROUND.**

3.9 Electrical Connections

Unscrew the small blind cover of the electronics enclosure to gain access to the I/O PCB. Separate 3/4" NPT conduit entrances are provided for power and signal wiring. Conduit connections should follow good practice and should be routed from below the meter. If conduit cannot be routed from below, provide moisture traps and seals to prevent moisture from entering the meter enclosure. See Figure 3.11. Be sure to tighten conduit connections.

CAUTION

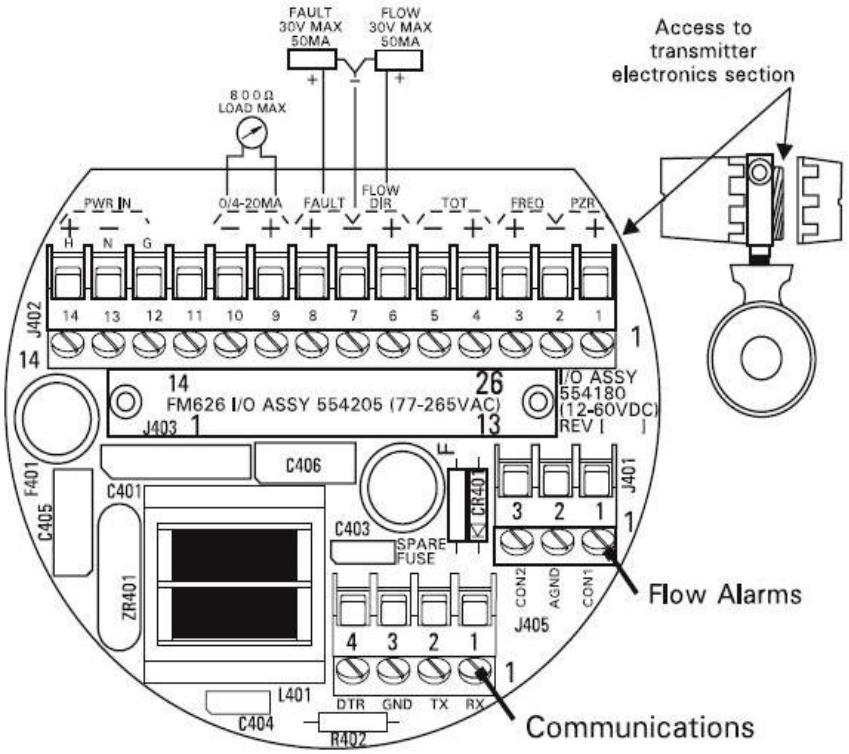
Watertight conduit, NEMA·6P fittings and seals are required to maintain the moisture·free integ· rity of all enclosures and electronics in the system. Entry of moisture may void Sparling's warranty. All fittings must conform to NEMA·6P Classifications.



Conduit Connections Figure 3.11

3.9 Electrical Connections

cont'd.



Electrical Connections
I/O
PCB Figure 3.12

CONNECTING POWER LEADS

A connection diagram is located in the cover of the connection section and in Figure 3.12.
If Fault Alarm Relay option (AC681) is chosen, Figure 3.12a is the correct connection diagram.

Connect power leads to terminal block J402, terminals 14 (H), 13 (N), and 12 (G). Be sure to connect a good ground to terminal 12.

The TigermagEP series is equipped with a switching power supply (standard) which accommodates power sources of 77-265 Vac 50/60 Hz. An optional 12-60 Vdc power supply is available. No adjustments or jumpers are required.

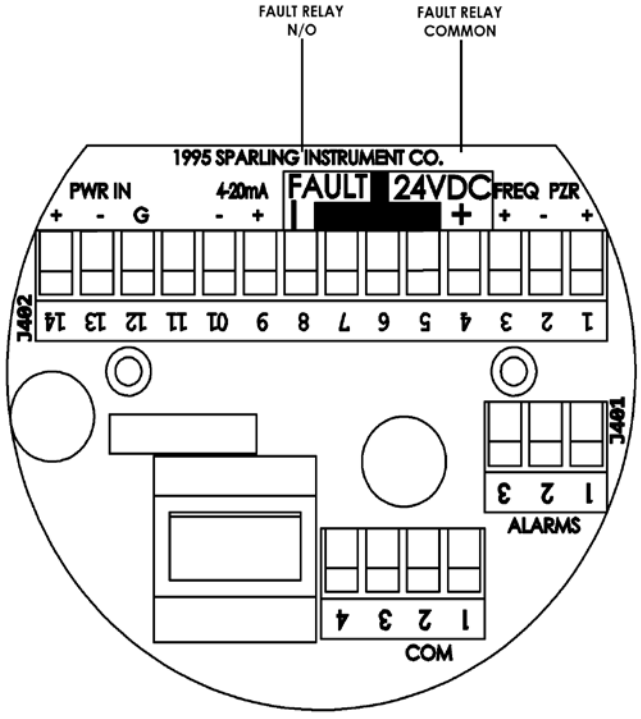


Figure 3.12a
Electrical Connection
I/O PCB with AC681
Fault Alarm Relay

See next page for output connections.

3.9 Electrical Connections Cont'd.

Disconnect power before proceeding. Do not make connections while power is applied.

CAUTION

The TigermagEP provides voltage to drive the 4·20mA output to your device. Only 4·20mA devices without external power supplies may be connected to the TigermagEP.

If devices with external power supplies are connected to the 4·20mA output terminals, it will blow the power supply and void your warranty.

CONNECTING OUTPUTS

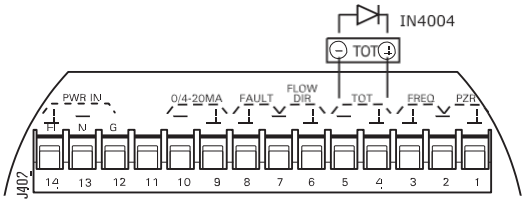
Determine which of the outputs (4-20 mA, fault, flow direction, pulse or frequency) are to be used. Connectors for available outputs are also located on terminal block J402.

After you have determined what outputs are required you need to verify that the external load on the outputs is within the limits specified. Calculate the external load by summing the input resistance, including all interconnecting cable. Signal cable of 18-22 gauge is normally adequate.

External load limits	Analog output	800 Ω max. impedance
	Pulse output	150 Ω min. impedance
	Frequency	1000 Ω min. impedance

Connect the required outputs as shown in Figure 3.12. When driving inductive loads, install 1N4004 diodes across the load as shown in Figure 3.13. If required, connect the Positive Zero Return (PZR) input. Note that meter outputs are forced to zero when terminals 1 and 2 (Terminal J402) are connected together through normally closed relay contacts.

All outputs are floating and use the same isolated ground. If more than one output is used simultaneously, only one of the common legs can be grounded. If both are grounded, a ground loop will occur causing erroneous signals. **Do not ground any part ot current loop it another output is already ready.**



Connecting Diode When Driving Inductive Loads
Figure 3.13

CAUTION

Only one load may have a leg strapped to ground unless the loads are isolated from each other.

3.10 Remote Mounted Transmitter

Figure 3.14
Tigermag EP NEMA-4X Enclosure
Remote Display

Remote mounting of the electronics is required when process temperatures exceed 212°F(100° C), when pipe vibration is excessive or when flooding is possible. Remote mounting should be used when high process temperatures exist at high ambient temperatures.

A bracket for wall or pipe mounting is furnished as part of the optional remote mounting kit. Interconnecting cable is supplied between the sensor and transmitter enclosure. Also supplied is a sensor mounted NEMA-7 rated junction box and a transmitter-mounted junction box in which coil and electrode connections are made.

The standard interconnecting cable length is 15 feet. Shorter or longer cables should be ordered from the factory. The cable may be shortened in the field. **DO** NOT **SPLICE CABLE IN THE FIELD.**

When installing provide moisture traps and seals to prevent moisture from entering the meter enclosure. See Figure 3.15. Be sure to tighten conduit connections

WATERTIGHT CONDUIT, NEMA-6P FITTINGS AND SEALS ARE REQUIRED TO MAINTAIN THE MOISTURE-FREE INTEGRITY OF ALL ENCLOSURES AND ELECTRONICS IN THE SYSTEM. ENTRY OF MOISTURE MAY VOID SPARLING S WARRANTY.

ALL FITTINGS MUST CONFORM TO NEMA-6P CLASSIFICATIONS.

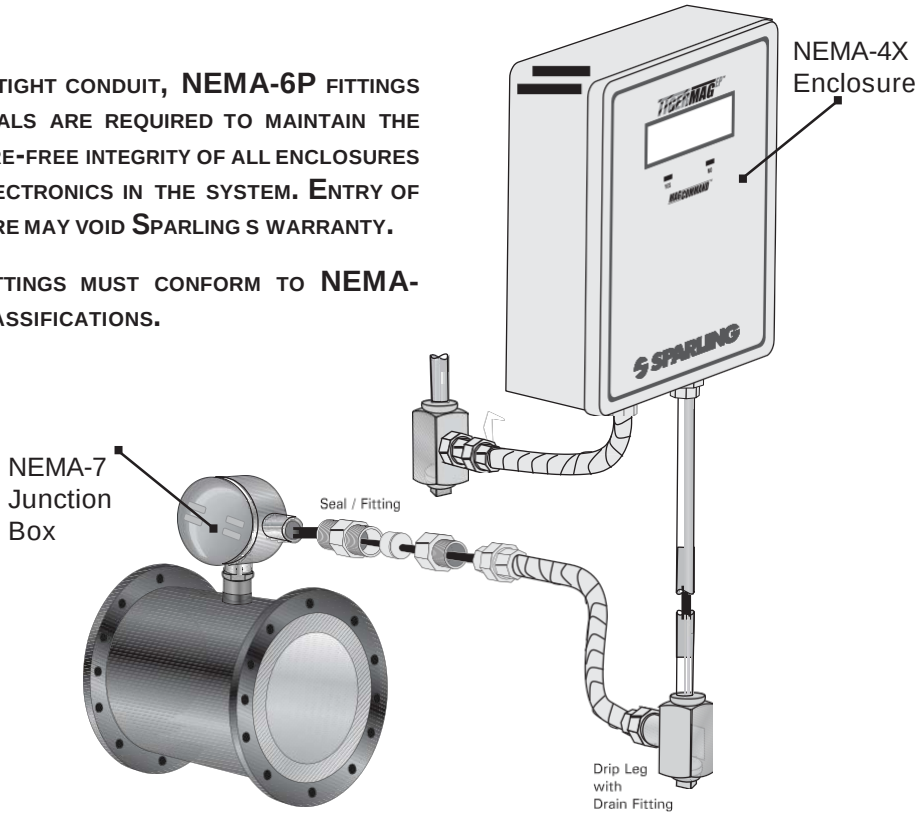


Figure 3.15
Tigermag EP Remote Conduit Connections

3.10

Remote Mounted Transmitter

cont'd.

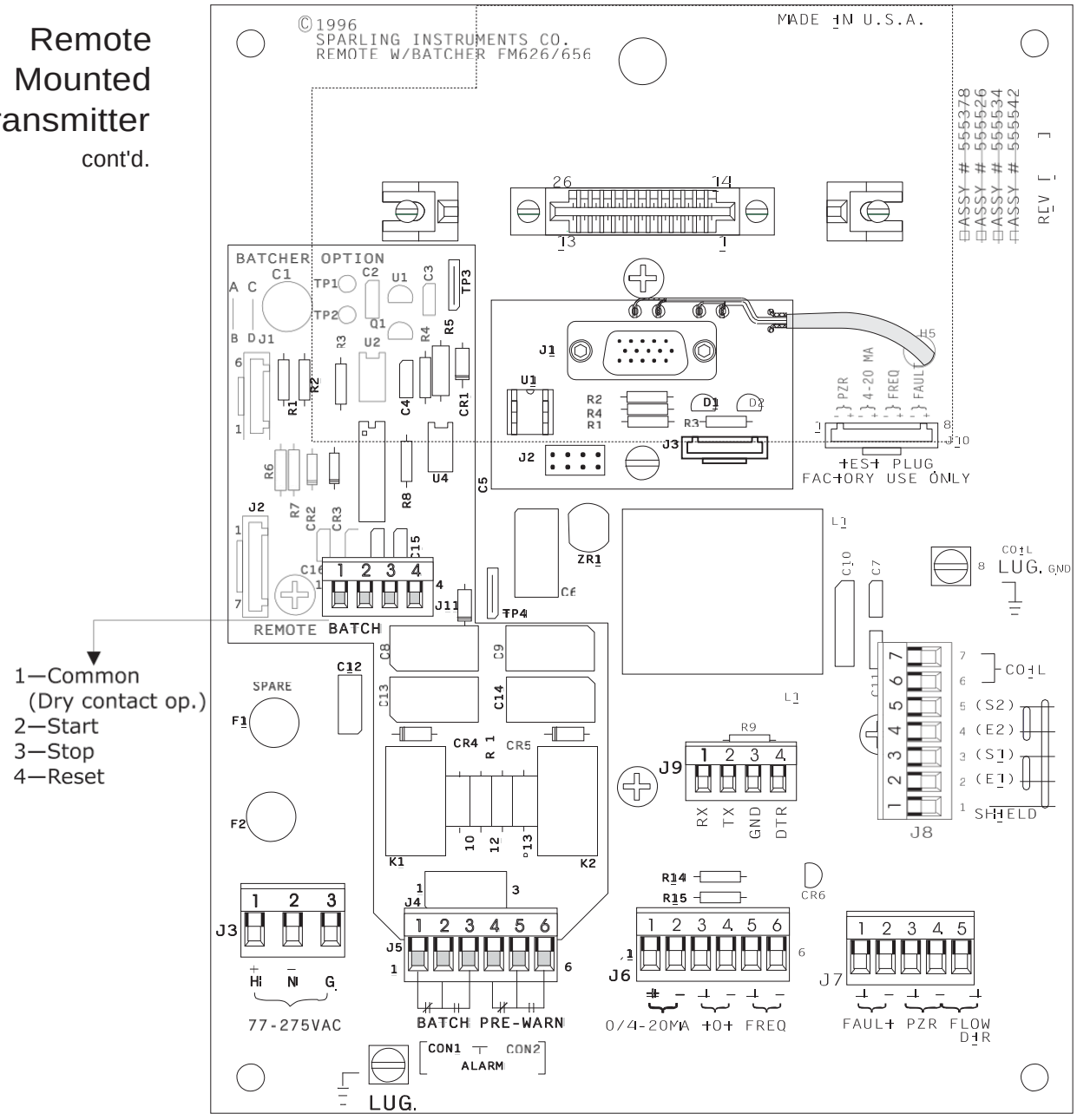


Figure 3.16
Tigermag EP Standard Motherboard

CAUTION

Disconnect power before proceeding. Do not make connections while power is applied.

3.10 Remote Mounted Transmitter cont'd.

If Fault Alarm Relay option (AC 682) is chosen, connectors J5 and J6 are wired as shown in figure 3.16a

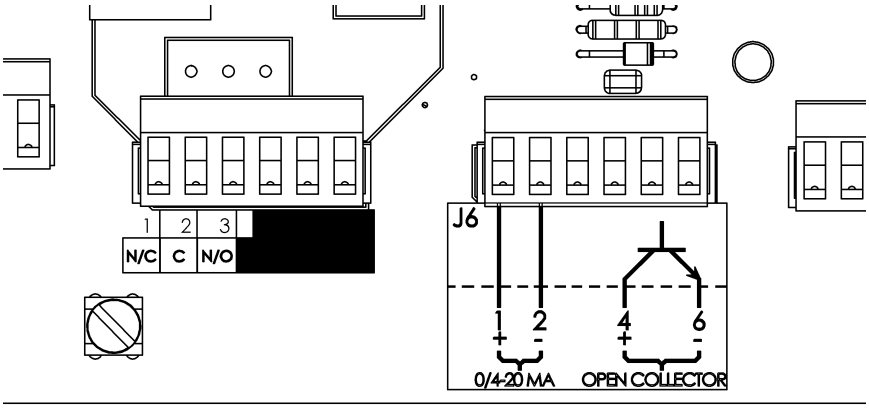


Figure 3.16a Tigermag EP Standard Motherboard with AC682 Fault Alarm Relay

Open the NEMA-4X enclosure to gain access to the motherboard. Separate 3/4" NPT conduit entrances are provided for power and signal wiring at the bottom of the enclosure. Connect the required outputs as shown in Figure 3.17.

CONNECTING POWER LEADS

Connect power leads to Connector J1, terminals 1 (H) and 2 (N). Be sure to connect a good ground to terminal 3 (G).

The TigermagEP series is equipped with a switching power supply (standard) which accommodates power sources of 77-265 Vac 50/60 Hz. An optional 12-60 Vdc power supply is available. No adjustments or jumpers are required.

CAUTION

Disconnect power before proceeding. Do not make connections while power is applied.

CONNECTING OUTPUTS

Connectors for available outputs are on connectors J6 & J7 See Figure 3.16. After you have determined what outputs are required you need to verify that the external load on the outputs are within the limits specified. Calculate the external load by summing the input resistance, including all interconnecting cable. Signal cable of 18-22 gauge is normally adequate.

External load limits	Analog output	800 Ω max. impedance
	Pulse output	150 Ω min. impedance
	Frequency	1000 Ω min. impedance

All outputs are floating and use the same isolated ground. If more than one output is used simultaneously, only one of the common legs can be grounded. If both are grounded, a ground loop will occur causing erroneous signals. Do not ground any part ot current loop it another output is already ready.

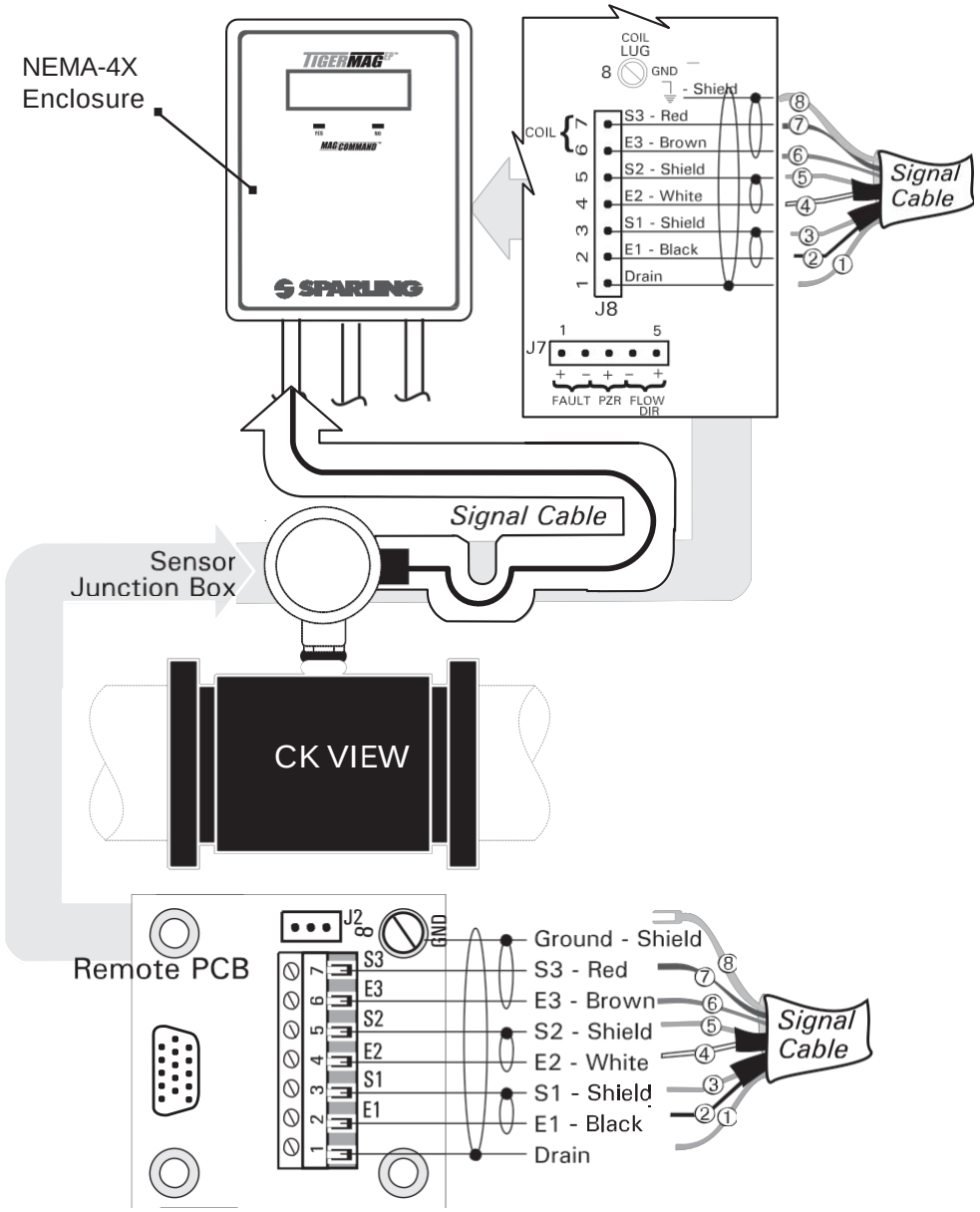
CAUTION

Only one load may have a leg strapped to ground unless the loads are isolated from each other.

3.10

Remote Mounted Transmitter

Cont'd.



Remote Mounted Transmitter
Figure 3.17

SIGNAL CONNECTIONS

Signal connections are made on the motherboard at connector J8, terminals 1 through 7 and ground (8) to lug. Similar connections are made in the remote junction box on the Remote PCB. Connect terminals 1 through 7 and ground (8) as shown using the special cable provided.

CAUTION

Disconnect power before proceeding. Do not make connections while power is applied.

3.11 Lightening & Transient Protection

Sparling's magnetic flowmeters utilize micro-processor based circuitry and are protected from noisy AC power, however power line transients generated by inductive motors, power line regulators and power load switching, commonly known as brown-outs, can cause memory loss, erroneous readout, blown semi-conductors and integrated circuits. These problems can be eliminated by using proper AC power transient suppressors.

It is also recommended that whenever the equipment is subjected to lightening, or high voltage transients, lightning supressors be used to protect the flowmeters.

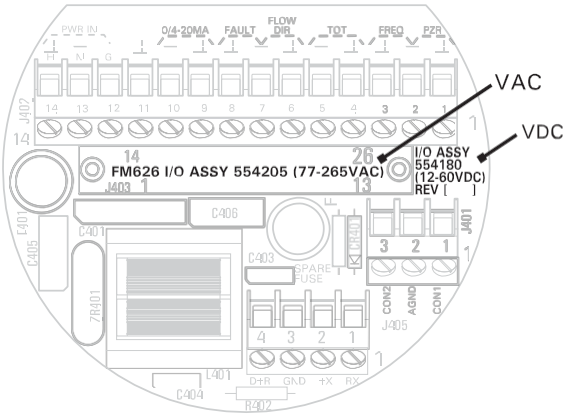
If you require assistance in proper selection of transient or lightening supressors, please contact Sparling.

4.0 Start-Up

4.1 Start-Up Procedure

Prior to applying power, the following checks should be made:

a) Check the flowmeter nameplate to insure that the power supply voltage is correct.
b) Verify that all electrical connections are correct. See Figures 3.12 and 3.17. The power supply voltage rating will be marked on the I/O PCB See Figure 4.1.
c) Check the polarity of external loads connected to the outputs.
d) Check to see that the two hall effect switches on the front of the transmitter are in place with the **dark side** of the switch **facing up** towards the LCD display. Do not remove these switches unless authorized by fac- tory personnel. If you suspect that one of the hall effect switches is de- fective, contact the factory.



Power Supply Voltage Ratings
Figure 4.1

5.0 Calibration

5.1 Calibration

All flowmeters are calibrated before leaving the factory. No field recalibration is required. The 4 and 20 mA current level may be checked if desired by following the procedure in **Appendix I DIAGNOSTICS**. The meter can be used as a current calibrator to check connected equipment. See Appendix 1, para. 2.3.3.

6.0 Maintenance

No routine maintenance is required.

7.0 Troubleshooting

The following sections describe field tests and bench tests that can be performed on Sparling s magnetic flow meters.

7.1 General

Each flowmeter is rigorously tested during production. The final test stage is a wet flow calibration in a Sparling precision primary flow laboratory traceable to the National Institute of Standards and Technology (NIST).

Before troubleshooting, carefully verify the operating conditions of the meter:

1. Verify the interconnecting wiring by using a local milliammeter connected to the current output with no other load connected.
2. Verify that the sensor is completely filled with liquid. An empty or partially full sensor will continue to send an erratic flow signal even with no flow.
3. Verify that any flow test comparison is valid before assuming that the meter is in error.
4. If in doubt, verify the conductivity of the liquid to see that it exceeds 5 micromhos/cm.

7.2 Trouble-shooting Chart

The following trouble shooting chart should assist in correcting meter malfunction. For additional assistance, contact Technical Support (800)800-FLOW, (626)444-0571 in California.

WARNING

a) "WARNING - EXPLOSION HAZARD - SUBSTITUTION OF COMPONENTS MAY IMPAIR SUITABILITY FOR CLASS 1, DIVISION 2";

"AVERTISSEMENT - RISQUE D'EXPLOSION- LA SUBSTI- TUTION DE COMPOSANTS PEUT RENDRE CE MATERIEL INACCEPTABLE POUR LES EMPLACEMENTS DE CLASSE 1, DIVISION 2".

b) "THIS EQUIPMENT IS SUITABLE FOR USE IN CLASS 1, DIVISION 2, GROUPS (AS APPLICABLE) OR NONHAZARD- OUS LOCATIONS ONLY".

Troubleshooting Chart

SYMPTOM	POSSIBLE CAUSE AND CURE
1. Erratic Reading (Output Wandering)	1. A. Installation a. Is sensor properly grounded? A good liquid ground is required. b. Empty pipe? Pipe must be full of liquid. c. Air in pipe? De-aerate d. Chemical being injected upstream of flowmeter? Change the chemical dosage downstream of the flowmeter. B. Electrical a. Variable Frequency Drive? Need additional filtering and improved grounding. b. Marginal Connection (particularly for remote units)? Rewire to insure good contacts. C. Moisture intrusion? Use leak tight fittings and keep the covers tight.
2. Inaccurate Reading	2. A. Run simulator test (47000/K) - Appendix 1, Section 2.3.6. B. Coil drive blown? Electronic module has to be returned to factory for repair C. Conductive coating? Clean sensor.
3. Output Incorrect (Pulse & Analog)	3. A. Disconnect wires and check circuit output with DVM. Reprogram current output. If program is OK, there is a sensor failure, return to factory. B. For pulse output need oscilloscope. If there is flow no pulse output, there is a sensor failure, return to factory.
4. Analog Output Zero	4. A. No external power required, unit is not loop powered. If external voltage was connected, electronics are damaged and should be returned to factory fo repair.
5. Display Readings Locked	5. A. Program errors? Cycle the power off and on, then reprogram if necessary.
6. Meter Reads Zero	6. Did it ever work? A. Blown coil drive? Return for repair B. Not properly wired (remote units)? Rewire correctly C. Conductive coating? Clean sensor.
7. Blank Display	7. A. Blown fuse? Replace Fuse B. Power supply damage? Return for repair.
a. Display is turning black around edges	8. Temperature is too high inside the enclosure. Relocate the meter or shield against the heat source. Continuing to power the meter in this condition will permanently damage the display.
9. Display is difficult to read	9. Improve the lighting conditions if ambient light is dim. Remove large cover and adjus the pot directly above the display for best contrast while viewing from the intended viewing angle.

If the above steps fail to correct the problem, try different flow rates and disconnecting loads temporarily and see if the problem persists. Perform simulator check and call the factory. **Please have the following information available when you call:**

- Meter serial number; G, I, Z values from "SHOW METER DATA?".
- Description of the problem. (Display, current output, totalizer/frequency, all of the above.)
- When does the symptom occur or repeat?
- What are the flow rates, the orientation of the meter in the pipeline, environmental conditions, output loads on the meter, pipe material and grounding technique?
- How did you verify the discrepancy?

Contact Technical Support 800/800-FLOW (in Califonia 626/444-0571) tor additional assistance.

7.3 Electronics Self Test

Using the **MAG-COMMAND™** magnetized screwdriver, enter programming mode by holding the magnet to the "NO" switch for five seconds. See **Appendix 1** for detailed instructions. Answer **"NO"** to all prompts until the DIAGNOSTICS menu appears. Answer YES to the DIAGNOSTICS menu. Follow the menu instructions. See Appendix 1, Section 2.3.

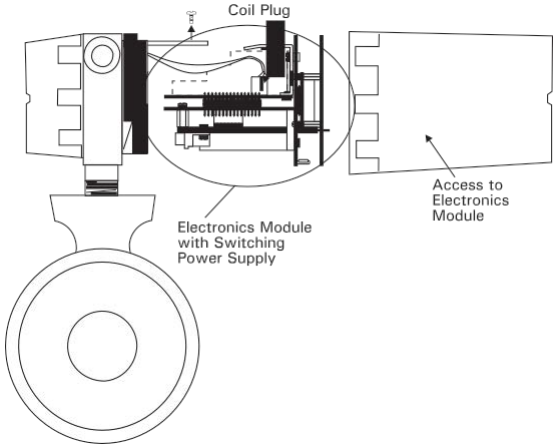
7.4 Electronics Module Replacement

To remove the electronics module, first unscrew the larger enclosure cover and remove the screw fastening the module bracket. Now unplug the coil cable converter. See Figures 7.1 and 7.2.

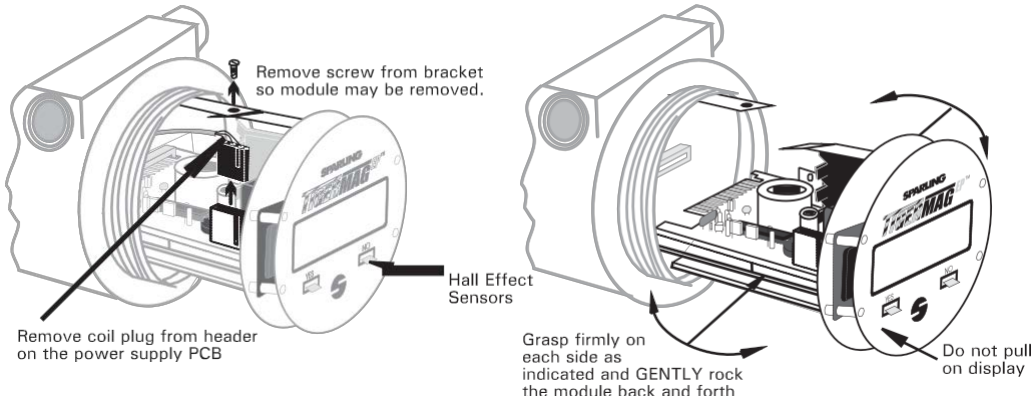
Grasp the module at each side and pull firmly while rocking the boards gently from side to side. Do not pull the module out by the display See Figure 7.2.

WARNING

Do not remove Electronics Module while power is applied. Disconnect Power before proceeding.



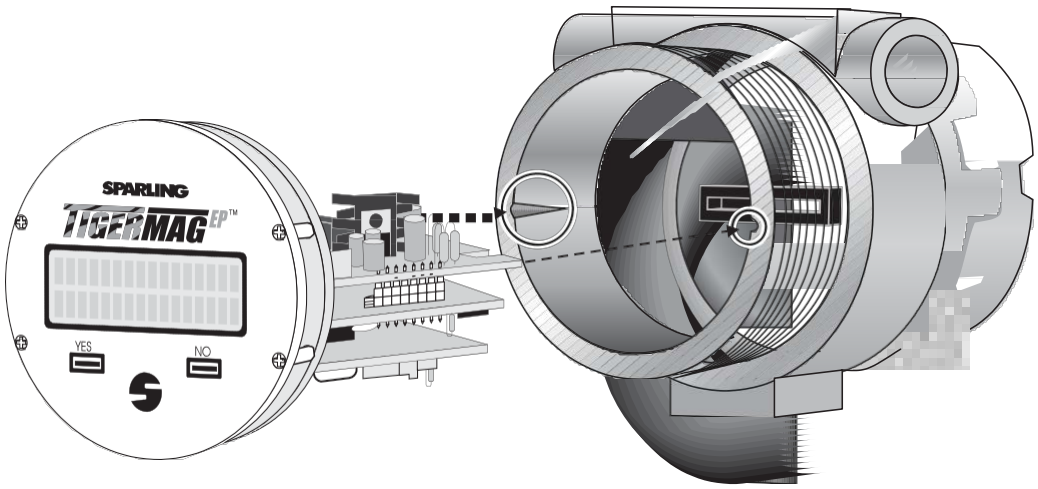
Access to Electronics
Figure 7.1



Removing the Electronics Module
Figure 7.2

▼ **METER ELECTRONICS ARE CONTAINED IN A PLUG IN MODULE. THIS MODULE CONTAINS NO USER SERVICEABLE PARTS.**

7.4 Electronics Module Replacement Cont'd.

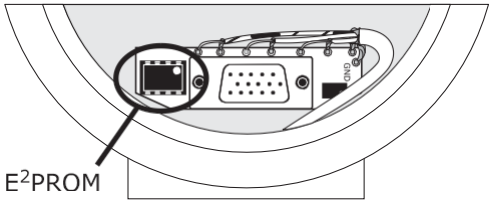


Aligning Electronics Module with Card Guides
Figure 7.3

When reinstalling the electronics module, observe the connector located in the base of the electronics enclosure. Line up the electronics module with housing card guides and the connector. See Figure 7.3. Plug in the replacement module. Plug in coil connector. **Be certain the plug wires are routed properly and will not interfere with the housing cover. Don t forget to replace the screw that fastens the module to the bracket. See Figure 7.2**

Apply power and observe display. Now, reprogram any values which were modified from factory preset levels. To obtain factory settings, look at calibration record shipped with meter. If sensor E^2PROM chip is damaged or has lost its data, call factory with the meter serial number and request another copy of the E^2PROM chip programmed with factory constants.

To replace the E^2PROM chip, you must remove the coil plug and the module. (See Figures 7.1 and 7.2). The E^2PROM is on the Coil PCB in the rear of the electronics enclosure. **Note the directional dot on the chip.** The new chip must be placed in this orientation. Gently remove the old chip and place the new factory-programmed chip in its' place.



Replacing the E^2PROM Chip
Figure 7.4

7.5 Sensor Testing

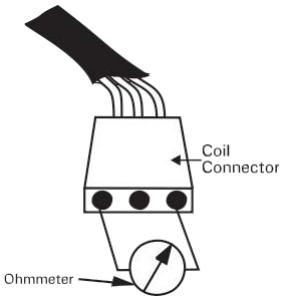
The sensor consists of a measuring section with electrodes and coils in a steel enclosure. The following paragraphs describe field tests that can be performed by the instrument technician. Defective sensors should be returned to the factory for repair. OBTAIN A RETURNED GOODS AUTHORIZATION (RGA) PRIOR TO RETURNING MATERIALS TO PREVENT DELAYS.

7.6 Coil Continuity Testing

WARNING

Disconnect power before proceeding. Do not make or break coil connection while power is applied.

Unplug coil cable plug. Using a short 22 gauge (or appropriate) test lead, connect ohmmeter between coil wires and measure resistance. See Figure 7.5.



Coil Resistance Testing
Figure 7.5

▼ **COIL RESISTANCE SHOULD MEASURE 110 OHMS ±10% AT ROOM TEMPERATURE. HOT COILS MAY READ AS HIGH AS 150 OHMS.**

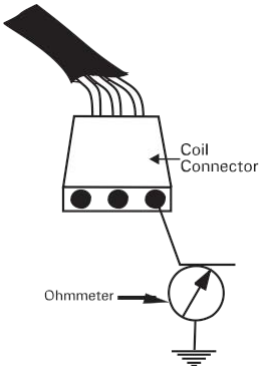
If the coil resistance is too high or low (including open and short circuits) the sensor must be returned to the factory for inspection and/or repair.

7.7 Coil Insulation Test

Required test equipment: Insulation tester 10^{12} ohm.

Disconnect power and signal cables. Disconnect coil connector, Figure 7.6. Connect insulation tester between coil wire and housing ground. Test the insulation at 500 Vdc. A reading below 10,000 meg ohms indicates moisture in the sensor. The sensor must be returned to the factory for inspection and/or repair.

Connect insulation tester between coil wire and housing ground. Test the insulation at 500 Vdc. A reading below 10,000 meg ohms indicates moisture in the sensor. The sensor must be returned to the factory for inspection and/or repair.



Coil Insulation Test
Figure 7.6

7.8 Electrode Circuit Insulation Test

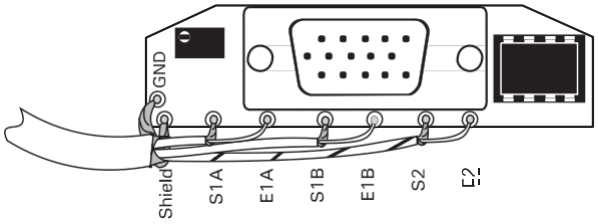
▼ **SENSOR MUST BE EMPTY AND DRY.**

Unplug coil and remove module from electronic enclosure.

Connect insulation tester three ways (see Figure 7.7.):

1. Between top post labeled E1A and S1A (shield)
2. Between center post labeled E1B and S1B (shield).
3. Between bottom post labeled E2 and S2 (shield).

Any leakage or fault indication indicates that the sensor should be returned to the factory for inspection and repair.



Electrode Circuit Insulation Test
Figure 7.7

8.0 Replacement Parts List

Description ***Part Number***

1. Electronics Modules
   - Integral Mount
     - 77 - 265 Vac 555584
     - 12 - 60 Vdc 555930
   - Remote NEMA 4X Mount
     - 77-265 Vac 555865
     - 12 - 60 Vdc 556409
   - Remote NEMA 4X Mount with Batcher
     - 77-265 Vac 555857
     - 12 - 60 Vdc 556417

2. I/O PCB
   - 12-60 Vdc 554180
   - 77-265 Vac 554205

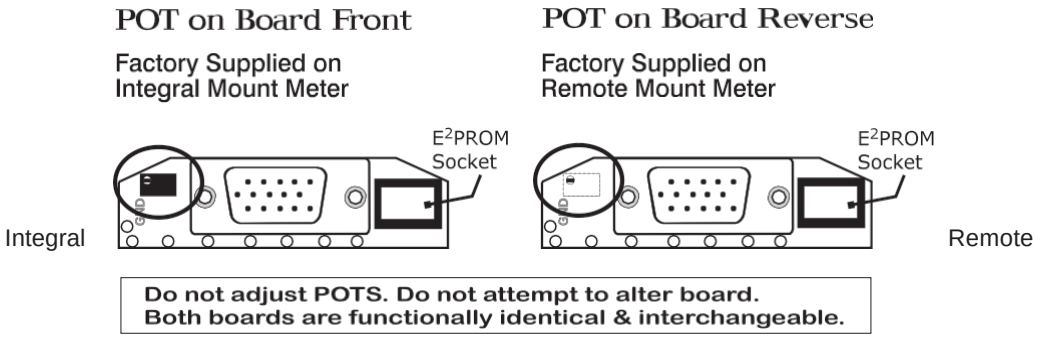
3. Fuses
   - Slo-Blo, (12-60 Vdc) 2.0 amp 148743
   - Slo-Blo (77-265 Vac) 1.0 amp 148446

4. Kit, remote mount for NEMA 7 Integral Transmitter 902579-019
   Assembly includes:
   a) Mounting bracket with U-bolt
   b) Cable grip
   c) Sensor junction box (two with Remote PCB)
   d) 15 ft. cable assembly
   e) Tee mounting stand-off

5. Kit, remote mount for NEMA 4X Fiberglass Enclosure with larger display 555724
   Includes:
   a) Hardware Kit
   b) Display board
   c) Remote PCB (Motherboard)
   d) Fiberglass enclosure
   e) Lexan label

   Mounting bracket with U-bolt (optional) 555732

6. Cable PCB (Integral or Remote) 554239



6. Replacement remote mount cable 150721
7. Grounding rings ..... Contact Factory

Your TigermagEP™ can be fitted with an optional digital communication capability utilizing HART® protocol. In order to operate this feature, you must have a Sparling model KP602 transmitter interface. Consult factory for more details. HART® is a registered trademark of Rosemount Inc.

Teflon® is a registered trademark of duPont

A.1 Appendix 1— Programming Firmware Ver. 1.0

1.1 General

The 16 character 2 line alphanumeric display is located directly above two magnetically operated Hall effect switches. The left switch is labeled "YES" and the right switch is labeled **"NO". THESE SWITCHES ARE THE ONLY CONTROLS REQUIRED TO SELECT AND CHANGE PARAM- ETERS ON THE TigermagEP. DO NOT ADJUST POTS.**

The TigermagEP is configured to the user's installation (programmed) using the MAG-COMMAND magnetic probe furnished with each meter. It can also be programmed with any high strength magnet. See Figure A1.1. Either switch is activated through the glass window in the housing by momentarily holding the **MAG-COMMAND** probe close to the switch.

IT IS NOT NECESSARY TO OPEN THE ELECTRONICS COMPARTMENT IN ORDER TO CHANGE PROGRAM SETTINGS.

Refer to Figure A 1.2 to determine how to get to each section of the program.
Alphanumeric data is required for the password and to enter or change constants.

1.2 Entering Data

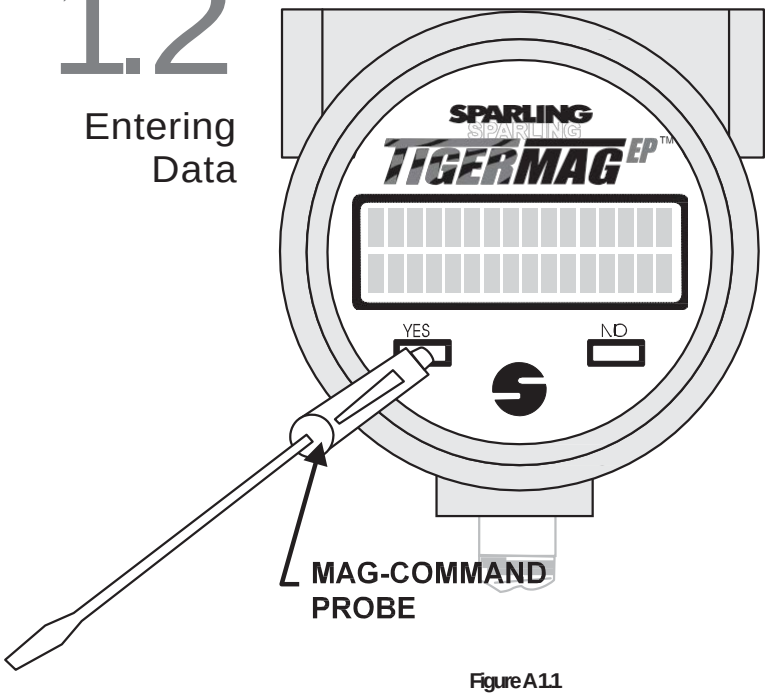


Figure A1.1
Tigermag EP Display

When data is required, the cursor will be positioned under the first character. A **"NO"** answer will cause the next valid character to be displayed in turn. A **"YES"** answer accepts the displayed character or digit and moves the cursor to the next position. After answering **"YES"** to the last character, you will be prompted with the entire data just entered. Answer **"NO"** if you wish to change. Answer **"YES"** when it is correct.

1.3 Batching Modes

If your TigermagEP is equipped with the optional batching function, answer **"YES"** while the meter is in normal operation mode to display batching information. For detail, see Appendix 2, Batch Programming.

1.4 Show Meter Data

Hold the **MAG-COMMAND** probe next to the **"NO"** switch for approximately 5 seconds. The meter will respond:

SHOW METER DATA?

a) Answer **"YES"** and the meter will display the model number, firmware version, serial number, tag number, K factor (pulses/gallon) liner and electrode material. The last three values, G, I, & Z, are useful when calling factory technical assistance when troubleshooting the meter. As each data line is displayed a **"YES"** answer will display the next item. A 'NO' answer at any item (or lack of response for 12 seconds) will return the meter to the operating display.

b) A failure to answer this prompt within a few seconds will automatically bring the PASSWORD menu. See Section 1.5.

c) Answer **"NO"** and the PASSWORD prompt appears. A failure to enter a correct password will return the meter to operation.

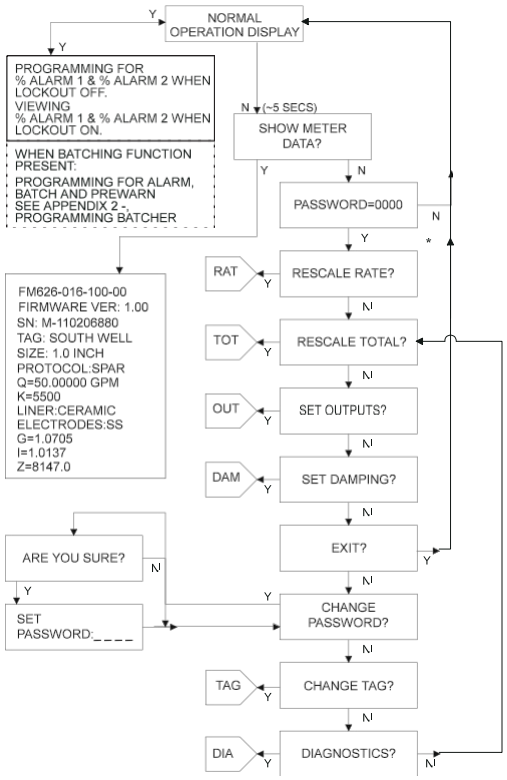


Figure A 1.2
Main Program

1.5 Password Entry

PASSWORD=0000

To go beyond this point, a valid password is required. **Every meter is shipped with the default password "0001".** Any user with a valid password can change the password.

▼ Defaut Password "0001"

The meter password is entered by responding to each digit of the password with a **"YES"** or **"NO".** A **"YES"** moves the cursor under the next digit to the right. A **"NO"** scrolls to the next higher value for the underlined digit and then back to 0 again. A 12 second time limit applies to each digit selection, i.e., a lack of response advances the cursor to the next position. Upon entry of a valid password, the meter enters a program mode and activates the fault output to signal remotely that programming is taking place.

1.6 Rescale Rate

RESCALE RATE?

A **"YES"** answer enters the Rescale Rate loop. A **"NO"** answer continues to the next menu item.

A menu is presented to select the engineering units in which rate is displayed and scaled. By answer- ing **"NO"** each menu selection is presented in turn. A **"YES"** selection chooses the unit displayed and

moves on to the next item.

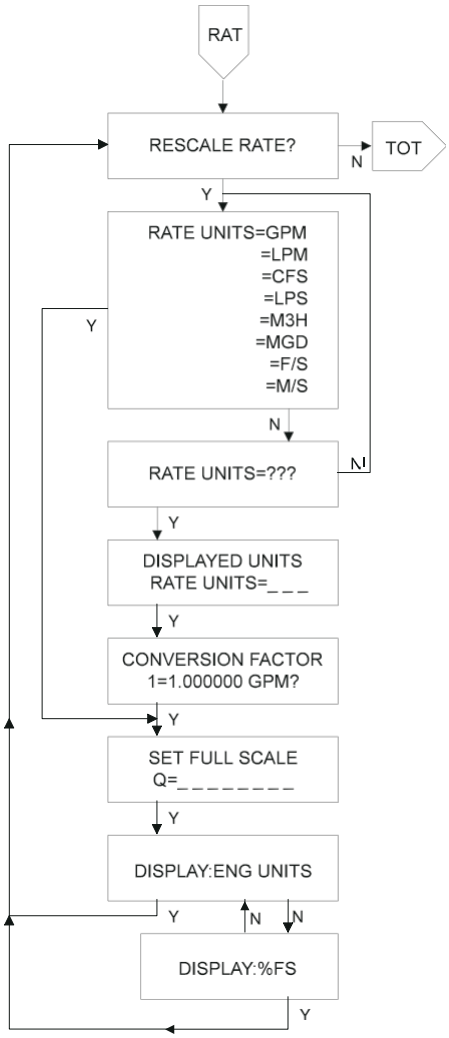


Figure A1.3
Rescale Rate Flowchart

1.6.1 Select Rate Units

RATE UNITS=GPM

An answer of **"YES"** will display the rate in "GPM". Otherwise answer **"NO".** A **"NO"** answer will dis- play the other predefined choices in turn, i.e., liters/ min., cu. ft./sec., liters/sec., cubic meters/hour, million gallons/day, ft./sec, meters/sec. and ???. Answer **"YES"** to the predefined rate units or to "???". A **"NO"** to each item brings you back to the beginning of the loop. A **"YES"** answer is required to one of the selections to leave the loop.

Select one of the presented units of measure by answering **"YES"** and skip to Sec. 1.6.2. If no appropriate choice is displayed, select "???" and define your own units in 1.6.1a.

1.6.1a User Defined Rate Units

RATE UNITS=AAA

Note the cursor under the first A. Select the three alphabetic or numeric characters which you want displayed for your selected rate units by answer- ing **"NO"** until the correct character is displayed in the current cursor position. A **"YES"** answer then accepts that character and moves the cursor one position to the right. A **"YES"** to the last character brings the conversion factor menu.

1.6.1b Conversion Factor

1=1.200000 GPM?

The conversion factor is defined as U.S. GPM/user unit. Enter the number of GPM which is equal to 1 of your selected units.

Example: To set the conversion factor for gallons per hour, enter the number of gallons per minute which is equal to 1 gallon per hour. One gallon per minute is equal to 0.016666 gallons per hour (1-;- 60). In this case, enter 0.0166666.

1.6 Rescale Rate Cont'd.

1.6.2 Set Full Scale

The full scale flow rate defines only the flow rate at which the current output is set to 20 mA and at which the frequency output is set to 1000 Hz. **It does not affect the display or the accuracy of the frequency or pulse output.**

0=5.000000 GPH?

In the case above, entering 5.0 GPH here will set the current output to 20 milliamps and the frequency to 1000 Hz when the fluid flow reaches 5.0 GPH. Full scale flow is selected in the units defined in 1.6.1 above. Thus, if "GPH" were defined, full scale would be defined in GPH not GPM. By answering **"YES"** or **"NO"** to each digit, it is possible to enter the full scale flow rate. A full scale below 3 FPS or above 35 FPS will receive a warning of "OUT OF RANGE LOW" or "OUT OF RANGE HIGH". Unit is still functional, but is operating out of recommended range.

1.6.3 Select Rate as Percent of Full Scale

DISPLAY:RATE UNITS

A **"YES"** answer will display flow in engineering units as defined in 1.6.2 **"NO"** displays rate as a percentage of full scale. Either choice will affect only the format of the display and nothing else.

1.7 Rescale Total

If your TigermagEP is equipped with the optional remote batcher, refer to Appendix 2.

RESCALE TOTAL?

A **"YES"** answer enters the Rescale Total loop. A **"NO"** answer continues to the next menu item.

1.7.0 Lockout

LOCKOUT: ON
LOCKOUT: OFF

LOCKOUT: OFF allows you to reprogram the high and low flow alarms when the **"YES"** key is activated while in normal operat- ing mode. No password is required.

LOCKOUT: ON will only allow the viewing of high and low flow alarms while in normal operating mode. To reprogram these values you will need to enter the MagCommand Rescale Total menu which requires a password.

After choice is made select **"YES"** to continue.

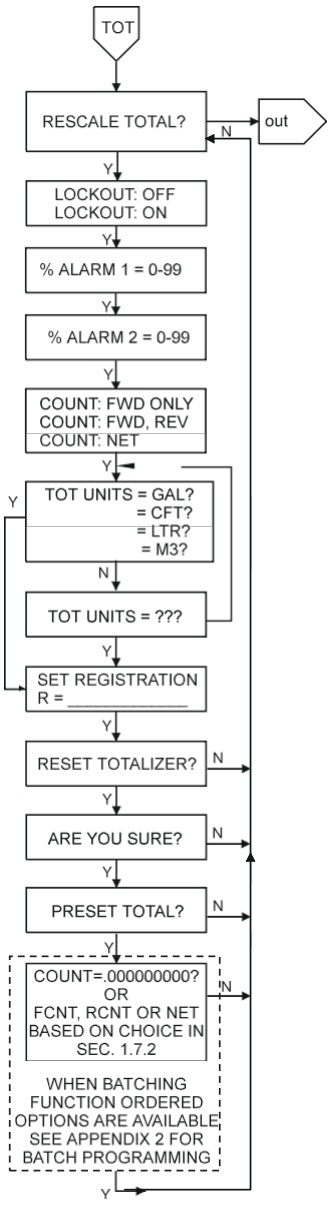


Figure A1.4
Rescale Total Flow

1.7 Rescale Total Cont'd.

1.7.1 Alarms

% ALARM 1 = 0-99

% ALARM 2 = 0-99

Using MagCommand, you can set these alarm contacts to activate when flow rate exceeds the set value in percent of full scale desired, from 0 through 99%. These contacts enable you to activate alarms, small relays, equipment, etc. at a preset percentage of full scale. Most commonly used as high and low flow alarms (through complementary contacts of externally supplied relays), these can be set to warn you of conditions outside your process parameters.

1.7.2 Count Direction

The internal totalizer can be programmed to totalize in the forward direction, to totalize separately for forward and reverse or provide you with net flow.

COUNT:FWD ONLY

Answer **"YES"** to count in the forward direction only (shown in the "operate" mode as "COUNT=")

COUNT:FWD,REV

Answer **"YES"** to have separate internal counters for forward and reverse flow (displayed as "F CNT=" and "R CNT=" respectively).

COUNT:NET

Answer **"YES"** to count net flow only

1.7.3 Select Total Units

A menu is presented to select the engineering units in which totalization or frequency is displayed and scaled. By answering "NO" each menu selection is presented in turn. A "YES" selects the unit displayed and moves on to the next item.

TOT UNITS=GAL

Answer **"NO"** to view the available predefined totalization units. Select "YES" to the preferred engineering units for totalization. One of the options will be ???. This permits the definition of any desired units. A **"YES"** must be selected to one of the options to exit this loop.

1.7.3a User Defined Totalizer Units

TOT UNITS = AAA

Select the desired three (3) character abbreviation as in 1.6.1a on the previous page.

1.7.3b Conversion Factor

1=1.2500000 GAL?

Enter the number of U.S. gallons which is equivalent to 1 of your selected units.

For example, the conversion factor from U.S. Gallons to Imperial Gallons is 1.25 because there are 1.25 U.S. Gallons to each 1 Imperial Gallon.

1.7 Rescale Total Cont'd.

1.7.4 Set Registration

R=100.000 GAL?

Enter the number of your engineering units of totalization which is equivalent to one count of the internal totalizer and external "TOT" output. This is normally an even number such as 0.1, 1, 10, 100, etc. In the above case 100 gallons will produce one totalizer pulse.

1.7.5 Reset Totalizer

Allows you to zero or reset the starting number on the totalizer.

RESET TOTALIZER?

Answer **"YES"** to advance, "NO" to return to RESCALE TOTAL?

ARE YOU SURE?

Answer **"YES"** to perform the reset of totalizer(s), "NO" to return to RESCALE TOTAL? (This is your last chance to abort before you lose your present value of totalizer(s).)

PRESET TOTAL?

Answer **"YES"** to be able to initialize the new nonzero beginning total, **"NO"** to return to RESCALE TOTAL? with totalizer(s) already reset to zero in the last step.

COUNT=.000000000?

Enter new beginning total. If counting FWD, REV or NET were selected earlier (1.7.2) then FCNT and RCNT can be preset to their starting values.

1.8 Set Outputs

SET OUTPUTS?

A "**YES"** answer enters the Set Outputs loop. A **"NO"** answer continues to the next menu item.

OUTPUT:4-20 MA

This permits the selection of 4-20 or 0-20 mA dc outputs. Answer **"YES**" to the output desired. Most North American installations will use 4-20.

1.8.1 Select Pulse Width

ONTIME:12.5

This selects the totalizer output of 0-60 Hz 12.5/25/50/100 ms, 24 Vdc. The choice is based on the external device requirement as well as your values of O (Sect. 1.6.2) and R so that pulses don't run together at the maximum flow. The frequency output of 0-1000 Hz, 50/50 duty cycle is always available (Section 1.6.2). See Figure 3.12, Electrical Connections.

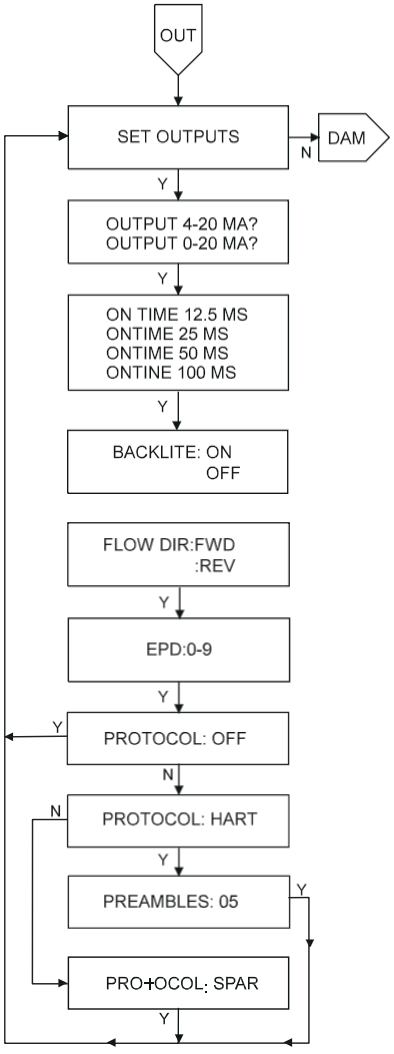


Figure A1.5
Set Outputs Flow Chart

1.8 Set Outputs Cont'd.

1.8.2 Backlight

BACKLITE:ON

BACKLITE:OFF

This allows you to turn the display backlight on or off. "NO" toggles between the choices. "YES" selects and advances.

1.8.3 Set Flow Direction

FLOW DIR: FWD

FLOW DIR: REV

This allows the user to reverse the normal flow direction. The default flow direction is from left to right as you face the display. If flow is in the opposite direction a minus sign ( ) will appear in the display the flow direction output will e active and the internal totalizer will e inhi ited in the count forward direction. Apart from that, the meter will operate properly in either direction. Both pulse and analog outputs will operate in both directions. Answer "NO" to reverse the normal flow direction.

1.8.4 Empty Pipe Detection

It allows the user to set the EPD control between 0 (=off) and 9 as part of "SET OUTPUTS?" menu. Numerically, this represents the approximate delay in seconds before the activation of EPD state (outputs driven to zero, totalizer on hold, message "OUTPUT INHIBITED" on display). Note EPD setting functions like a "volume" control, with "0" serving as an "EPD-off" click and "1" thru "9" enabling various levels of detection. Typical setting may be between 3 and 6, the lower the number, the higher the possibility of "false" detection of a single air bubble. Factory setting is "0" (off).

1.8.5 Protocol

Selects between "SPAR"-Sparling MagCommand and "OFF"-no programming interface. "HART" will also appear if meter has been equipped with the optional HART interface and will allow you to set the number of HART's preambles in a message.

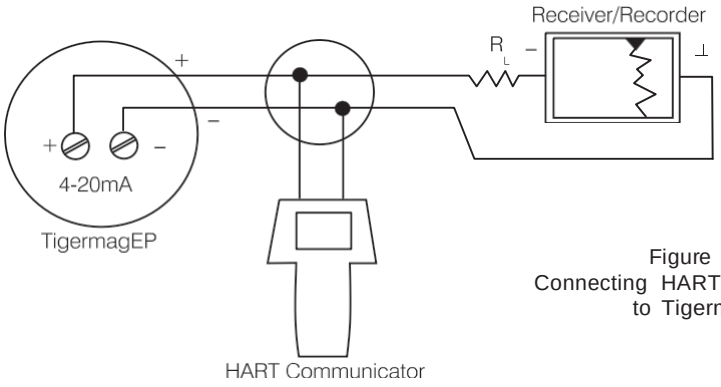


Figure A 1.6
Connecting HART Communicator to TigermagEP

NOTE: For the HART Communicator to function properly, a minimum of 250 ohms resistance RL must be present in the loop. The HART Communicator does not measure loop current directly.

WARNING

Explosions can result in death or serious injury. Before connecting the HART Communicator in an explosive atmosphere, make sure the instruments in the loop are installed in accordance with intrinsically safe or non-incendive field wiring practices.

1.9 Damping Adjustments

SET DAMPING?

Display and current output are damped independently. Answer **"YES"** to enter this loop.

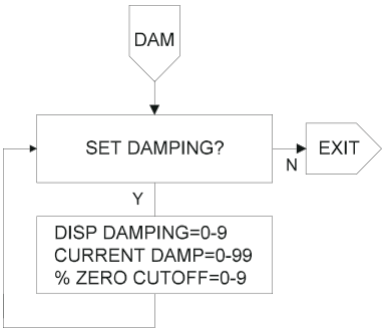


Figure A 1.7
Set Damping Flow Chart

1.9.1 Display Damping

DISP DAMPING - 5

A "NO" answer scrolls from 0 (no damping) through 9 (maximum damping). Answer **"YES"** to the desired degree of display damping. Some experimentation may be necessary to obtain optimum results.

1.9.2 Current Damping

CURRENT DAMP=15

Current damping may be selected from 0-99 seconds. This corresponds approximately to the number of seconds to respond 90% of the way to a step change in input.

1.9.3 Low Flow Cutoff

% ZERO CUTOFF=2

This is the minimum flow rate below which meter outputs are forced to zero. The number entered corresponds to the selected percentage of full scale as set for "0" in Section 1.6.2. Choices range from 0 (low flow cutoff disabled) through 9%.

2.0 Exit Programming

EXIT?

A **"YES"** answer stores the changes which have been made and returns the meter to operation. A **"NO"** goes to the next menu item.

2.1 Change Password

CHANGE PASSWORD?

ARE YOU SURE?

Answer **"NO"** to return to CHANGE PASSWORD. Answer **"NO"** again to continue to the next item.

A **"YES"** answer permits changing the password by scrolling through the four available digits. Be sure to record the new password.

▼ **FAILURE TO REENTER THE NEW PASSWORD WILL RESULT IN NOT BEING ABLE TO REPROGRAM AT A LATER DATE.**

2.2 Change Tag

CHANGE TAG?

Answer **"YES"** to change the tag. Default is "SPAR".

TAG=

A **"NO"** answer scrolls through your character choices. Answer **"YES"** to skip to next letter. When you have finished the tag name, **"YES"** will bring you back to the "CHANGE TAG" menu. **"NO"** will advance to "DIAGNOSTICS", **"YES"** will enter the TAG loop again.

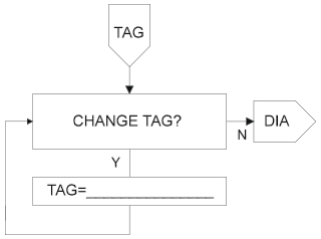


Figure A 1.8
Change Tag

2.3 Diagnostics

DIAGNOSTICS?

Answer **"YES"** to enter the diagnostics loop. A **"NO"** answer returns to the RESCALE RATE menu.

WARNING

It is NOT recommended that diagnostics be performed unless malfunction is suspected. Refer to the troubleshooting section for coil and electrode tests which can be performed.

Warning: The meter totalizers and flow rate will cease to be updated while you are in this loop. Outputs will be affected by some tests as well as totalizer count. Use caution.

2.3.1A Check HART Transmission

This option is only available if your meter is equipped with HART® communications. Toggle between MARK and SPACE by selecting **"NO".** Enter next box by selecting **"YES".**

2.3.1B Check Coil Current

STOP COIL DRIVE?

Answer **"YES"**

COIL=HIGH

Note the value on the second line of the display. To test low coil, enter **"NO"**

COIL=LOW

Again, note its value. Both values should match closely. The typical coil current should range around 1/4 to 1/3 amp. Coil currents are affected by temperature. Unit is operating correctly unless currents don't match and are widely out of this range. To test high coil again, enter **"NO".** To end this test, enter **"YES".**

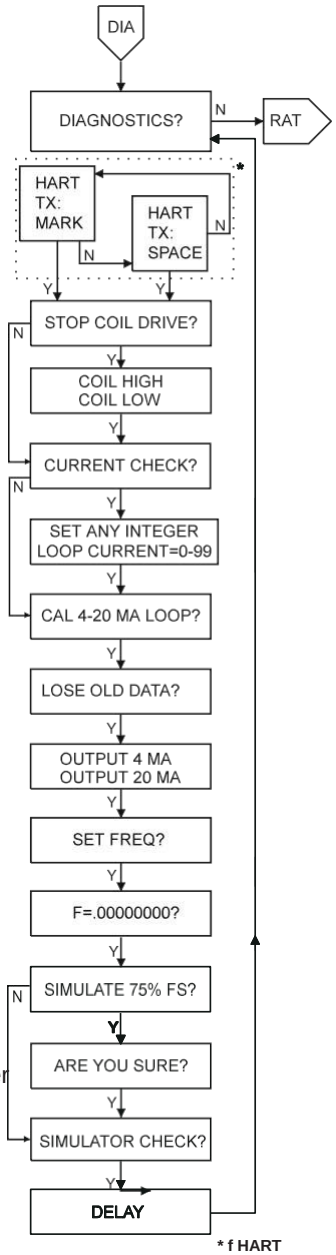


Figure A 1.9
Diagnostics Flow

2.3 Diagnostics Cont'd.

2.3.2 Check Current Loop

```
LOOP CURRENT=04
```

By answering **"NO"** the loop current can be scrolled by 1 mA increments, from 4 mA up to 20 mA and then back to 4. Answer **"NO"** to step to the next desired value. Answering **"YES"** at any time will exit the loop. Check the 4 mA and 20 mA positions with a digital milliammeter. Each should be accurate within ±0.02 mA (no damping is used).

The current output can also be used to test other equipment in the current loop such as recorders and controllers.

2.3.3 Calibrate 4-20 mA Loop

```
CAL 4-20mA LOOP?
```

Answer **"YES"** to enter the calibrate mode. You must leave your recently calibrated milliammeter connected in series with the 4-20 loop at this time.

```
LOSE OLD DATA?
```

Answer **"YES"** to continue, **"NO"** will exit leaving calibration unchanged. This is your last chance to abort if your setup is not ready.

```
OUTPUT: 4mA?
```

Answer **"YES"** if your meter reads 4.00 mA. "NO" will allow you to calibrate current for zero flow.

```
I= 4.0000000?
```

Enter in the actual reading value from your digital milliammeter to calibrate zero flow. Answer "**YES"** to continue.

```
OUTPUT: 20mA?
```

Answer **"YES"** if your meter reads 20.00 mA. "NO" will allow you to calibrate current for full scale.

```
I= 20.000000?
```

Enter in the actual reading value from your digital milliammeter to calibrate full scale. Answer **"YES"** to continue.

2.3.4 Set Frequency

Set frequency can be used to verify or set the frequency received by other devices to insure compatibility.

```
SET FRE0?
```

Select **"YES"** to enter the set frequency mode, select **"NO"** to continue.

```
F = .000000000
```

Enter desired frequency in the 1-1250 Hz range to appear as the frequency output or select **"YES"** to zero value and end this test.

2.3.5 Simulate 75% FS

This step will drive all outputs to 75% of full scale rate including the display.

CAUTION

This test will alter the totalizer counts. On exit from this test, reset or preset totalizers to their proper value.

Enter **"YES"** to get last chance to abort "ARE YOU SURE?" Enter "**YES"** only if you wish to continue at which point the meter will begin simulated 75% of its full scale (as signified by the letter "S" in the third from the last position on the top line of display (just before "12" for alarms - See figure A 2.0). To end, reenter diagnostics and reply **"NO"** to either "SIMULATE 75% FS?" or "ARE YOU SURE?" that follows.

2.3.6 Simulator Check

Simulator Check is used to verify that electronics are working satisfactorily by comparing actual values to the factory preset values. Testing is done internally.

SIMULATOR CHECK?

Select **"YES"** to enter the simulator check mode, select **"NO"** to continue.

PLEASE WAIT

"PLEASE WAIT" is displayed while electronics self-check.

SELF TEST PASSED

The electronics are working satisfactorily.

SELF TEST FAILED

The electronics are not working satisfactorily. Replace electronics module. The second line of the display will show a 47000/K value as GPM. Obtain K from meter record and calculate 47,000/K to check for match.

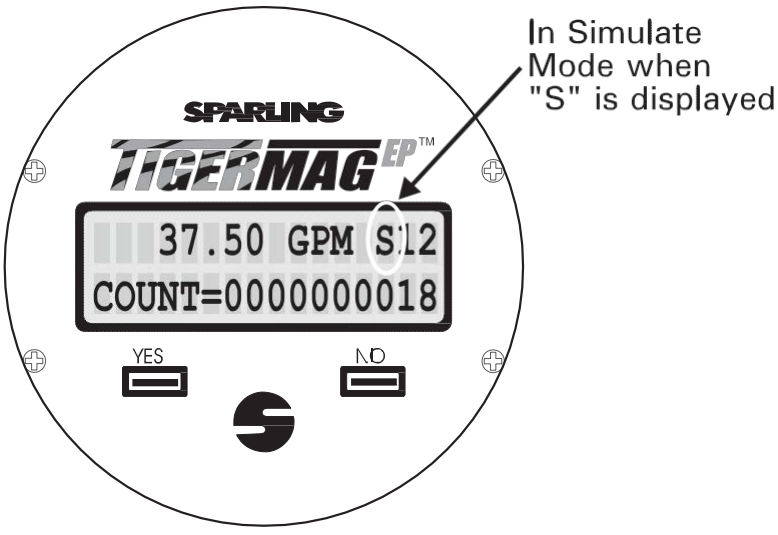


Figure A2.0
Simulate Mode

A.2 Appendix 2

Batch Programming & Operation - Firmware Ver. 1.0

This section of the manual covers only the batching function. For programming of other loops not associated with the batching function, see Appendix 1.

1.1 General

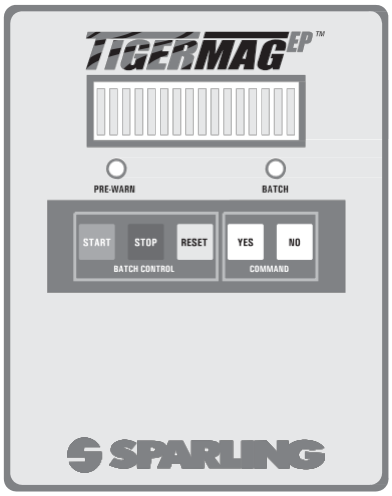


Figure A 2.1
Enclosure for TigermagEP with Batching

The TigermagEP Batcher utilizes a touch pad for programming both meter and batch operations. The "YES" and "NO" buttons are the only controls required to select and change parameters on the TigermagEP. Nothing else is required for programming the meter with MagCommand.

IT IS NOT NECESSARY TO OPEN THE ELECTRONICS COMPARTMENT IN ORDER TO CHANGE PROGRAM SETTINGS.

1.2 Programming

The batching mode is activated in the Rescale Total menu. Refer to Figure A1.2 to determine how to reach this section.

RESCALE TOTAL?

"YES" to enter the Rescale Total menu.

1.2.0 Lockout

LOCKOUT: ON

LOCKOUT: OFF

LOCKOUT: OFF allows you to reprogram batch size and prewarn levels while in normal operating mode. No password is required.

LOCKOUT: ON will only allow you to view batch size and prewarn levels while in normal operating mode. To reprogram these values you will need to enter the **MAG-COMMAND** Rescale Total menu which requires a password.

After choice is made select **"YES"** to continue.

1.3 Rescale Total

1.3.1 Batch On/Off

BATCH: ON

BATCH: OFF

"NO" toggles between 'Batch On' and 'Batch Off'.

BATCH: ON

1) gives you access to TigermagEP's batching functions while in normal operation mode
2) disables Alarms 1 and 2.
3) batch size and prewarn levels become accessible for viewing or reprogramming while in normal operation mode.

BATCH: OFF

1) turns off the TigermagEP's batching functions.
2) allows access to TigermagEP's Alarm 1 and Alarm 2
3) % Alarm 1 and % Alarm 2 become accessible for viewing or reprogramming while in normal operation mode.

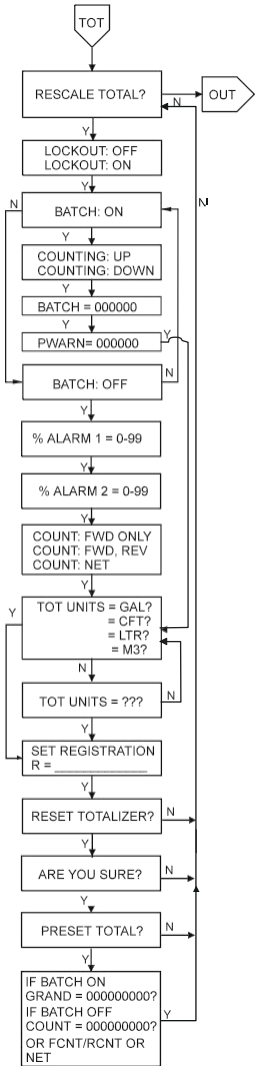


Figure A 2.2
Rescale Rate - Batcher

1.3.2 Alarms

% ALARM 1 = 0-99

% ALARM 2 = 0-99

Using MagCommand, you can set these alarm contacts to activate at any percent of full scale desired, from 0 through 99%. These contacts enable you to activate alarms, equipment, etc. at a preset percentage of full scale. Most commonly used as high and low flow alarms, these can be set to alert you that process parameters may be out of range.

Alarms 1 & 2 are only available when batch mode is turned off (BATCH: OFF). Alarm 1 and Alarm 2 can be set to activate at the percentage of full scale specified here. After setting, **"YES"** accepts selection of Alarm 1 and advances to Alarm 2. When lockout status is on (LOCKOUT: ON) you will be able to view % Alarm 1 and % Alarm 2 values from normal operation mode. When lockout status is off (LOCKOUT: OFF) you will be able to change the values of % Alarm 1 and % Alarm 2.

1.3.3 Count Direction

The internal totalizer can be programmed to totalize in the forward direction, to totalize separately for forward and reverse or provide you with net flow.

COUNT:FWD ONLY

Answer **"YES"** to count in the forward direction ***only*** (shown in the "operate" mode as "COUNT=")

COUNT:FWD,REV

Answer **"YES"** to have separate internal counters for forward and reverse flow (displayed as "F CNT=" and "R CNT=" respectively).

COUNT:NET

Answer **"YES"** to count net flow ***only***

1.3 Rescale Total Cont'd.

1.3.4 Select Total Units

A menu is presented to select the engineering units in which totalization or frequency is displayed and scaled. By answering **"NO"** each menu selection is presented in turn. A **"YES"** selects the unit displayed and moves on to the next item.

TOT UNITS=GAL

Answer **"NO"** to view the available predefined totalization units. Select **"YES**" to the preferred engineering units for totalization. One of the options will be ???. This permits the definition of any

desired units. A **"YES"** must be selected to one of the options to exit this loop.

1.3.5a User Defined Totalizer Units

TOT UNITS = AAA

Select the desired 3 character abbreviation as in 1.6.1a on the previous page.

1.3.5b Conversion Factor

1=1.2500000 GAL?

Enter the number of U.S. gallons which is equivalent to 1 of your selected units.

For example, the conversion factor from U.S. Gallons to Imperial Gallons is 1.25 because there are 1.25 U.S. Gallons to each 1 Imperial Gallon.

RESCALE TOTAL

A **"YES"** answer enters the Rescale Total loop. A **"NO"** answer continues to the next menu item. See Section 1.7.5 for details.

RESET TOTALIZER?

A **"NO"** answer ends this loop.

If batch is on (BATCH: ON) display will read:

GRAND = 000000000?

Enter

If batch is off (BATCH: OFF) display will read:

COUNT = 000000000?

1.4 Description of Operation

1.4.1 Description of Operation

This option, if available, can be either enabled (BATCH: ON) or disabled (BATCH: OFF) in users menu of "RESCALE TOTAL?" When enabled, the batch menu offers the choice of display direction of counting (up or down) and the limits of the prewarn (relay #2) and the batch (relay #1). The status of the relays will be displayed on line 1 (last two places) as digits 1 and/or 2 whenever the corresponding relay coil gets energized. Line 2 will show GRAND total, batch size, and the status of the batch.

Once the programming is in place, the cycle starts when RESET is pushed. The display line 2 will stop toggling between GRAND and BATCH and show 'BATCH=xxxxxx PZR' indicating that PZR input has reset the 626 for the next batch. Pushing START activates both relays (shown in line 1 and changes 'PZR' to 'RUN' as the batch starts counting off. Reaching PREWARN level drops out relay #2 and 'PRE' replaces 'RUN' in line 2. At the end of the batch, relay #2 drops out and line 2 reverts to toggling between Grand and 'BATCH=XXXXXX HLD' as the batching is on hold until RESET starts it again. To abort batch in progress, push STOP. This overrides relays ON command dropping them out (note line 1 will report them as ON). The flow and the count off will stop, at which point one can resume this batch by pushing START or abort it via RESET for another batch (note however that GRAND will include any flow that went into the batch prior to pushing STOP).

A.3 Appendix 3 – Communications

1.1 RS232 Sparling Protocol

Wiring (3-wire cable less than 50 ft.)

Connect as follows:

PC "COM" Port 25 pin		626 J405 on I/O PCB (Integral) 626 J9 (Remote - Motherbd)
2-TX	to	1-RX
3-RX	to	2-TX
7-GND	to	3-GND
4-RTS to 5-CTS	to	4 - No Connection

PC "COM" Port 9 pin		626 J405 on I/O PCB 626 J9 (Remote - Motherbd)
2-RX	to	2-TX
3-TX	to	1-RX
5-GND	to	3-GND
7-RTS to 8-CTS	to	4 - No Connection

Set up the PC communications software (DOS, Windows 3.x, Windows 95)) as follows:

Example: Hyper Terminal
1200 baud
8 data bits
1 stop bit
Odd Parity
(Flow control = none)

Conversation:

Control-0 (11 hex) starts it (626 will reply PZR/PGM on the PC screen),
Control-U (15 hex) ends it (626 - no reply, its display - back to run mode).
Menu follows MagCommand.
Keyboard exceptions (for compatibility with existing programmers):
(Space Bar) steps over existing characters
(Backspace) clears characters
(Enter) or "Y" key serves as "yes", anything else as "no".

Burst mode

Control-S (13 hex) starts it.
The 626 will continuously copy its 2-line display to RS232 line.
Press and hold Control-U to end it.

Problems checklist:

- Check wiring
- Check PC setup
- Verify that 626 in its "SHOW METER DATA?" menu (or user's "SET OUTPUTS?) has PROTOCOL: SPAR and not PROTOCOL: OFF nor PROTOCOL: HART.

1.2 RS-485

RS-485 (one-on-one only, no multidrop, less than 4000 ft.)
On digital PCB, U105 should be removed and U108 installed.

Wire and use as RS232

Line 4a5		626 (J405 on I/O PCB)
(+) or A	to	2-TX (also line load)
(1) or B	to	1-RX (also line load)
Shield	to	3-GND

Problems checklist:

- See Section 1.1, RS232
- Line must terminate in its characteristic impedance at BOTH ends, e.g. for 24 AWG twisted pair install terminating 120 ohm resister between 1 & 2 of J405 as well as across the other end. See Figure 3.12.

1.3 Modbus RTU

Modbus RTU Communications via RS-485 two-wire multidrop.

Wire as RS485

Terminal		RS-485 Bus
1 RX	to	A+
2 TX	to	B-
3 GND	to	GND
4 DTR	N/A	Not used

Communications must be performed via Modbus compatible communicator. Default settings are as follows:

Baud rate: 19200
Data bits: 8
Stop bits: 1
Parity: Even
Slave ID: 1

Baud rate, parity, and ID may be changed within the holding registers as shown below. The unit must be power cycled before any changes will be enacted. Settings must be unlocked before changes will be saved.

Modbus Reference Numbers

Output Coils

Reference	Offset	Data Type	Description
00001	0	bit	Assert PZR Control

Discrete Inputs

Reference	Offset	Data Type	Description
10001	0	bit	Alarm 1 Asserted
10002	1	bit	Alarm 2 Asserted
10003	2	bit	Reverse Flow
10004	3	bit	PZR Input Asserted
10005	4	bit	Empty Pipe Detected
10006	5	bit	Fault Asserted
10007	6	bit	Simulator in Effect
10008	7	bit	Holdoff in Effect
10009	8	bit	Reserved
10010	9	bit	Reserved
10011	10	bit	Reserved
10012	11	bit	Reserved

1.3 Modbus RTU Con't.

Input Registers

Reference	Offset	Size	Data Type	Description
30001	0	2	float	Flow rate
30003	2	2	integer	Total volume
30005	4	2	integer	Reverse Total volume
30007	6	2	ASCII	Flow Units
30009	8	2	ASCII	Total Units
30011	10	2	float	Total Registration
30013	12	2	integer	Time since last meter reading
30015	14	2	integer	Current time, 10 ms ticks
31000	999	1	integer	Reserved
31001	1000	1	integer	Version number * 1000
31002	1001	1	integer	Patch level and special builds
31003	1002	2	integer	32 bit serial number
31005	1004	4	n/a	reserved
31009	1008	1	integer	FLASH size in KB
31010	1009	1	integer	count of foreground loops
31011	1010	1	integer	count of valid reads
31012	1011	4	n/a	reserved
31016	1015	1	integer	Status of last pflash read
31017	1016	1	integer	Status of last pflash write
31018	1017	2	integer	Current meter face FSM state

Holding Registers

Reference	Offset	Size	Data Type	Description
40101	100	1	integer	Unlock with 0x7e11 (32273)
40102	101	1	integer	Modbus ID
40103	102	1	integer	Modbus baud rate
40104	103	1	integer	Modbus parity
40105	104	1	integer	Modbus serial mode
40106	105	1	integer	Activity Timeout in sec
40107	106	1	integer	Modbus Timeout in sec
40108	107	1	n/a	Reserved
40109	108	2	n/a	User defined

Sparling Mode

A module configured for Modbus RTU communications may still communicate in Sparling protocol via RS-485 or RS-232 via Hyper Terminal or equivalent as shown in Section 1.1 or 1.2.

Sparling Mode may be used to view Modbus configuration settings or to return the Modbus configuration settings to default. To enter the Modbus control menu, enter Control-M. Follow the prompts to either view or reset Modbus configuration. To return to Modbus mode, enter Control-Z.

Problems checklist:

- Check wiring
- Verify that 626/656 display is in "normal mode" and not in any menu and more than thirty seconds have passed since the meter returned to normal mode

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