



TS Series
W & F Assy.
Stainless Steel,
Electronic

FPPMSW12, Rev. 2010-10

Installation, Operation & Parts Manual

Flow meter P/No.: _____

Flow meter S/No.: _____

SCL included (#13 in parts list):



MODEL

ACCESSORIES

Register/Signal Conditioner

- TS10C
- TS15C
- TS20C
- TS30C

- none
- Strainer Y-type
- Basket type ELNC
- ANSI flange EMR³
- Air Eliminator

- none
- PC58

other _____

Internals:

- Rotors: PPS/carbon LV HT HV
 PPS/Teflon LV HT HV
- Seals : Teflon



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Accessories: **Strainer**

Tuthill SS meters are available with Basket & Y-type Strainers from major strainer manufacturers. Replacement baskets & O-rings are available.

Air Eliminator

Tuthill models TS15C, TS20C & TS30C are available with Armstrong Air Eliminators. This device has no service parts.

Name of Distributor who supplied this flow meter : _____

Phone number for Distributor Service Department: _____

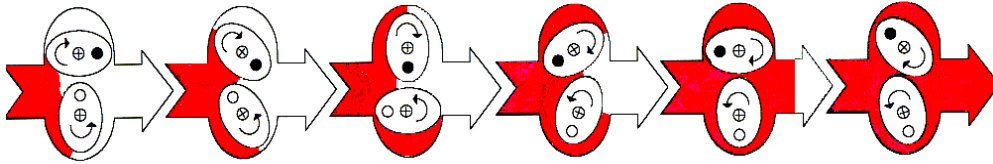
Serial No.

This flow meter is the subject of a continuing improvement program. To ensure correct supply of replacement parts, every parts inquiry must include the Serial No. from the original flow meter assembly.



Spec plate with flow meter S/No. is attached to flow meter **rear cover**.

TS Series, Principle of Operation



- Only 2 moving parts.
- Patented 'Waveform' oval gears = sustained accuracy with a minimum of maintenance.
- No metal-to-metal contact in measuring chamber or in bearings.
- The lowest differential pressure values amongst rotary PD meters.

=> **Lower Cost of Ownership!**

About FPP Meters

We thank you for purchasing an **FPP Meter** for liquid measurement service. **FPP Meters**, formerly Fluid Power Products, is now a trade name of Tuthill Transfer Systems. FPP was established in 1980. Since its inception, the company has been dedicated to manufacturing cost-effective, high performance flow metering devices for petroleum, industrial, commercial and municipal service.

Our facilities include computerized order entry and inventory control, so that you are assured of accurate and prompt deliveries. Furthermore, our production personnel ensure that each order, regardless of size, receives individual attention.

Constant attention to new product development and production design, our high standards of manufacture and final testing are the reasons why **FPP Meters** meet your most demanding requirements. With the 'Waveform' oval gear (2003 patent) meter accuracy is better than ever before.

Our meters are used in batching, blending, process control and to dispense fluids in liquid handling facilities throughout the World. Service includes gasohol blends, bio-diesel and special formulation racing fuels.

Principle of Operation

Positive Displacement meters have a measuring chamber, where inlet & outlet are separated by rotors, a rotating element or sliding vanes. As the liquid passes through the flow meter, it causes the rotors/element/vanes to turn, which forms the basis for volumetric measurement.

The **Oval Gear** metering principle is based on two elliptical (oval) gears, which turn on center on two horizontal shafts inside a measuring chamber formed by two overlapping cylinders. The oval gears have meshing teeth along their entire circumference, ensuring that the gears will maintain correct position in relation to each other at all times, without the use of timing gears.

The volume being transferred from the inlet to the outlet side (= volume measured), forms between the oval gear and the side of the measuring chamber, alternately in the upper and the lower half of the measuring chamber.



In a full 360° rotation of the gears, four such known volumes are released to the downstream side of the flow meter.

With precision machining and close internal tolerances, the slippage is minimal for superior linearity (accuracy) over a broad turn-down ratio. Oval gear meters are largely unaffected by changes in liquid viscosity.

The TS Series meter is designed to provide:

- V●● Assy: Drive to a mechanical register (covered in separate manual).
- F●● Assy: Electrical pulse signal to an electronic register installed on the flow meter.
- W●● Assy: Electrical pulse signal to a remote electronic register.

In the two electronic versions, the flow meter is 100% glandless with static O-ring seals only. An internal magnet turns in the vertical plane; a sensor mounted in flow meter end cover reads changes in the magnetic field, and generates 64 pulses per 360° rotation. Several different signal types are available, to ensure signal compatibility with all electronic registers.

Fluid Compatibility

FPP Meters flow meters are available in anodized aluminum and stainless steel, with a variety of rotor types and seals, to ensure compatibility with a broad range of liquids. If in doubt about compatibility with a specific fluid, please refer to the **FPP200 Technical Manual**. If that publication does not provide a clear answer, please consult with your authorized FPP Meter distributor, or Customer Care at the factory.

While most refined petroleum products can be handled with the same flow meter, some require different rotors and/or seals. **Do not change service liquid, without consulting with your authorized FPP Meter distributor.**



Flow Meter Specifications

Model Nominal Pressure Rating¹ at 100°F (38°C):

| | | | | |
|--------------------------------|---------|--------|----------|--|
| Flow Meter, | | | | |
| TS10C-TS20C² | 400 PSI | 28 BAR | 2750 kPa | |
| TS30C | 275 PSI | 19 BAR | 1900 kPa | |
| Strainer² | 400 PSI | 28 BAR | 2750 kPa | |
| Air Eliminator | 150 PSI | 10 BAR | 1035 kPa | |

- (1) Pressure rating is reduced at higher operating temperatures.
 (2) With optional 150# RF ANSI flanges (std. for TS30C) pressure rating is 275 PSI = 19 BAR = 1900 kPa.

Model Nominal Temperature Rating:

Design temperature: -40°F/+257°F -40°C/+125°C
 Pulsar ATEX listing: -40°F/+140°F -40°C/+60°C

If the operating temperature can exceed +120°F (+50°C), use high temperature (HT) rotors, code L (or M).

Model Nominal Capacity on low viscosity liquids (1 cP):

| | | | | |
|--------------|-------|---------|----------|----------------------|
| TS10C | | 40 GPM | 150 lpm | 9 m ³ /h |
| TS15C | | 60 GPM | 230 lpm | 14 m ³ /h |
| TS20C | | 150 GPM | 570 lpm | 34 m ³ /h |
| TS30C | W&M | 200 GPM | 760 lpm | 45 m ³ /h |
| | OK to | 265 GPM | 1000 lpm | 60 m ³ /h |

- Optimum performance (accuracy & service life) is between 50% and 85% of nominal capacity.
- On low viscosity, lubricating liquids, intermittent service to 125% of nominal capacity is acceptable.
- NTEP approvals are with 5:1 turn-down.
- OIML approvals are with 10:1 turn-down.
- Meters may be used at lower flow rates, but meter error increases below 10% of capacity on low viscosity liquids.
- On higher viscosity liquids, error at low flow rates diminishes progressively. Over 100 cP performance should be acceptable to 3-5% of capacity, over 1000 cP performance should be acceptable to 1-2% of capacity.

Liquid Viscosity³:

With standard LV rotors, meters may be used to full nominal capacity up to 300 cPs (1500 SSU). When viscosity can exceed 300 cPs (1500 SSU), high viscosity (HV) rotors must be used.

- With HV rotors, meters may be used to full nominal capacity up to 1000 cPs (5000 SSU).
- Over 1000 cPs (5000 SSU), HV rotors are mandatory.

In high viscosity service, flow meter capacity is reduced according to this table:

| Liquid Viscosity | | Flow Meter Coefficient | | | | | | Liquid Viscosity | |
|------------------|------|------------------------|------|------|--------------|------|-----------|------------------|--|
| | | Standard | | | Teflon brgs. | | | | |
| | | Rotor Code | | | Rotor Code | | | | |
| cP | B | C | D | E | P | H | SSU | | |
| 1 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 32 | | |
| 10 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 60 | | |
| 50 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 240 | | |
| 100 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 475 | | |
| 200 | 1.00 | 1.00 | 1.00 | 0.90 | 0.90 | 1.00 | 925 | | |
| 300 | 0.86 | 0.86 | 1.00 | 0.73 | 0.73 | 0.98 | 1,425 | | |
| 400 | 0.77 | 0.77 | 1.00 | 0.62 | 0.62 | 0.96 | 1,875 | | |
| 500 | 0.71 | 0.71 | 1.00 | 0.57 | 0.57 | 0.94 | 2,350 | | |
| 600 | 0.66 | 0.66 | 1.00 | 0.53 | 0.53 | 0.92 | 2,825 | | |
| 700 | 0.63 | 0.63 | 1.00 | 0.50 | 0.50 | 0.90 | 3,300 | | |
| 800 | 0.60 | 0.60 | 1.00 | 0.48 | 0.48 | 0.85 | 3,775 | | |
| 900 | | 0.56 | 1.00 | | 0.45 | 0.80 | 4,250 | | |
| 1,000 | | 0.54 | 1.00 | | 0.43 | 0.75 | 4,725 | | |
| 5,000 | | | 0.53 | | | 0.42 | 23,600 | | |
| 10,000 | | | 0.41 | | | 0.32 | 47,200 | | |
| 100,000 | | | 0.11 | | | 0.09 | 472,000 | | |
| 1,000,000 | | | 0.05 | | | 0.04 | 4,720,000 | | |

- (3) Teflon bearings are used primarily on shear sensitive liquids, resins & adhesives.

Stainless Steel:

316 Stainless Steel

| | |
|------------|------------|
| Carbon | 0.10% max. |
| Manganese | 2.0% max. |
| Silicon | 1.0% max. |
| Chromium | 16.0-18.0% |
| Nickel | 10.0-14.0% |
| Molybdenum | 2.0-3.0% |
| Iron | remainder |

CF8M Stainless Steel

| | |
|-------------|------------|
| Carbon | 0.08% |
| Manganese | 1.50% |
| Phosphorous | 0.04% |
| Sulfur | 0.04% |
| Silicon | 1.50% |
| Chromium | 18.0-21.0% |
| Nickel | 9.0-12.0% |
| Molybdenum | 2.0-3.0% |
| Iron | remainder |

Rotors : PPS (polyphenylene sulfide resin), carbon bearings standard; Teflon™ bearings optional, for use on shear sensitive liquids and where trace contamination from wear on carbon bearings might be an issue.

Rotor shafts : HC316SS

Internal fasteners: 300 Series SS

Seals : Teflon™ standard,

Flow Meter Assembly No. & Part No.

Model No. + Assy. No. + Variable Identifiers = Part No.

Model No. : 5 digits; referenced in certifications, etc.
 Assy. No. : 3 digits, define basic type & configuration
 Variables : Identified in remainder of the Part No.

The Part No., is found on flow meter Spec Plate, together with the Serial No. The P/No. can be as short as 8, or as long as 18 positions; where each position has some significance. The key identifier for the purpose of identifying spare parts is in all cases **Pos. 10** which identifies flow meter internals:

- B** = LV, PPS/carbon rotors, Teflon seals (standard)
- C** = HT, PPS/carbon rotors, Teflon seals
- D** = HV, PPS/carbon rotors, Teflon seals
- E** = LV, PPS/Teflon rotors, Teflon seals
- P** = HT, PPS/Teflon rotors, Teflon seals
- H** = HV, PPS/Teflon rotors, Teflon seals

If it is necessary to replace the board found in the pulser compartment in the front cover, the key identifiers are:

Fxx assemblies, Pos. 11:

| 5-12VDC | 24VDC | | |
|----------|------------|--------------|-----------------------|
| 1-9 or T | same : | EL0304 | Terminal Block Board |
| G | H : | EL0300-3-13_ | 100 PPG scaler |
| L | K : | EL0300-3-18_ | 10 PPL scaler |
| A | A : | EL0305 | TBB/Amplifier |
| F | J : | EL0306 | TBB/Quadrature Filter |

Wxx assemblies, Pos. 12:

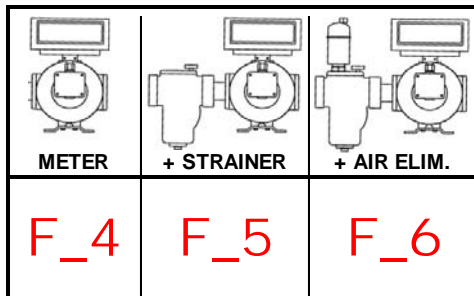
| 5-12VDC | 24VDC | | |
|----------|------------|--------------|-----------------------|
| T | T : | EL0304 | Terminal Block Board |
| G | H : | EL0300-3-13_ | 100 PPG scaler |
| L | K : | EL0300-3-18_ | 10 PPL scaler |
| A | A : | EL0305 | TBB/Amplifier |
| F | J : | EL0306 | TBB/Quadrature Filter |

Fxx = Flow Meter with Register Mounting flange:

- Position 1-5 : Model No. (capacity & materials)
- Position 6 : **F** = Electronic, with mounting flange
- Position 7 : Register included, if any
- Position 8 : Accessories included, if any
- Position 9 : Flange type
- Position 10 : Rotor type, Bearing Material & Seals
- Position 11 : Register & Printer included
- Position 12 : UL or ATEX listed components
- Position 13 : Register language
- Position 14 : Strainer identifier
- Position 15 : Strainer basket mesh identifier
- Pos. 16-17 : Solenoid valve type & voltage
- Position 18 : no significance at this time

Wxx = Flow Meter without Register Mounting flange:

- Position 1-5 : Model No. (capacity & materials)
- Position 6 : **W** = Electronic, without mounting flange
- Position 7 : Register included, if any
- Position 8 : Accessories included, if any
- Position 9 : Flange type
- Position 10 : Rotor type, Bearing Material & Seals
- Position 11 : Internal signal conditioner, if any
- Position 12 : UL or ATEX cable gland, if any
- Position 13 : Register enclosure, if any
- Position 14 : Strainer identifier
- Position 15 : Strainer basket mesh identifier
- Pos. 16-17 : Solenoid valve type & voltage
- Position 18 : no significance at this time



Assy No. (pos. 6-8 in P/No.)

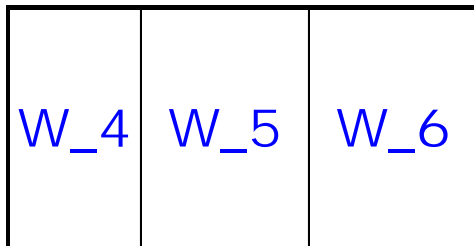
Pos. 7 identifier inserted from list below

F_X = with Register mounting flange

- 1 = Register Ready (no register from Tuthill)
- 5 = with EMR3 register, without Temp probe.
- 6 = with EMR3 register, with Temp probe
(select strainer with thermo well if ATC)
- 7 = with SCL & ELNC register

W_X = without register flange

- 0 = Flow Sensor (nothing attached)
- 1 = 1x PIA-300 amplifier (2 x single channel)
- 2 = 2x PIA-300 amplifier (1 x Quadrature)
- 3 = PC58
- 4 = PC58 + PIA-300
- 5 = PC58 + 4-20 mA signal
- 6 = PC58 + 4-20 mA signal + multipoint calibration
- 7 = PC58 + 4-20 mA + PIA-300



Installation, Start-Up & Operation

SAFETY INSTRUCTIONS

Make sure that all necessary safety precautions have been taken, including proper clothing, personal safety equipment and fire safety equipment if required.

Before Start-Up of the Flow Meter, **make certain** that:

1. The meter is properly mounted, secured and piped.
2. All connections are tight.
3. All bleed and drain valves are closed.
4. Do NOT smoke near meter, or use meter near an open flame, when metering flammable liquids. Fire or Explosion could result.
5. This meter is not intended for use on liquids, which require 3A Sanitary equipment for human consumption. It may be used on edible liquids, which do not spoil easily, such as vegetable oils, liquid sweeteners & similar.

Install the Flow Meter and Accessories in compliance with all applicable Local, State & Federal Construction, Electrical and Safety Codes.

OPERATING TEMPERATURE

TS Series assemblies are rated for:

- F●● assy See register temperature rating
- W●● assy -40°F/+225°F (-40°C/+107°C).

However:

- They are not suitable for cryogenic service.
- When operating temperature exceeds +120°F (+50°C), pressure rating is reduced. Please refer to FPP Technical Manual for details.

OPERATING PRESSURE

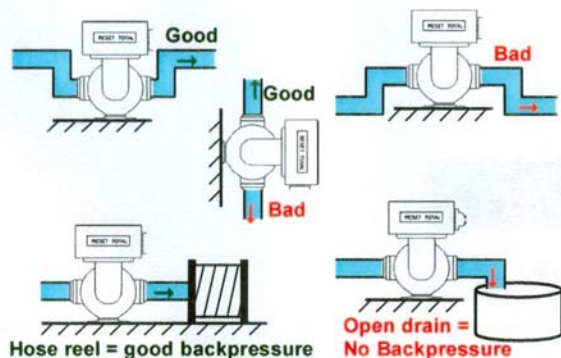
Maximum **non-shock** Operating Pressure is:

- Flow Meter/Strainer : 400 PSI (28 BAR) } at 100°F
- Air Eliminator/Valves: 150 PSI (10 BAR) } (= +38°C)

The flow meter should never be operated in excess of this pressure. Care should be taken to eliminate thermal and hydraulic shock conditions, so that system pressure never exceeds Maximum Working Pressure rating.

Installation

- Protective caps installed in flow meter flanges prior to shipment should remain in place until you are ready to install in the piping system.
- Positive Displacement meters are designed to operate full of liquid. The meter should be installed in a manner, so that it **remains full of liquid at all times**.
The flow meter is not designed to operate on air, but the design and materials of construction allow for operation on vapor *for short periods of time* without damage to the oval gears or flow meter internals.
- The **meter should always be supported** by bolting firmly to a solid platform or foundation. Never use the connecting pipe as the sole means of support.
- For most accurate measurement, the flow meter should operate with some backpressure (avoid delivering into an open vessel).
- The flow meter can operate with liquid going Left-to-Right, Right-to-Left (see page 1.8) or Vertical Up, but it must be installed with **rotor shafts in horizontal position** (= with vertical end covers). Failure to observe this will impact negatively on flow meter accuracy.



- **Hydraulic shock** can be harmful to flow meter and other system components. Consideration to eliminate hydraulic shock should be given in selection of pump and design of the piping system.
- Flow meters are designed to withstand a certain level of **vibrations**, such as might be experienced on retail delivery tank trucks. If the flow meter will be used in a system with higher levels of vibration, it must be protected with:
 - Vibration isolating pad under the mounting pedestal.
 - Vibration isolators (flexible hose) on both inlet & outlet.
- Apply pipe compound to male threads, to **install the two companion flanges**. Tighten to a position, that allows the meter to bolt to the companion flanges, free of pipe stress.
- It is recommended that a **Strainer** be installed upstream of each flow meter, to prevent damage from foreign matter, such as welding slag, pipe scale or parts breaking off other equipment.
 - If no fluid is specified, strainer basket comes standard with 40 mesh. We also offer:
 - 20 mesh (std. with HV rotors) for use on high viscosity liquids, such as heavy fuel oil, automotive lube oils, liquid sugars, molasses, etc.
 - 100 mesh for gasoline, alcohol & solvent service.
- Flush the system to remove all debris, scale and welding slag **prior to flow meter installation**. If this is not possible, temporarily remove rotors (oval gears), and reinstall after the system has been flushed.
- When installing the flow meter, consider future maintenance of both flow meter and accessories. The meter can be serviced in place, provided block (isolation) valves are included, and adequate space allowed.

Installation continued & Start-Up/Operation

- In critical installations a **by-pass line is recommended**, so flow can continue while flow meter is being serviced.
- When an **Air Eliminator** is included in the flow meter assembly, the strainer/air eliminator must be in horizontal position, since the air eliminator operates on a gravity principle. A few drops of liquid may be expelled when the air eliminator vents, so vent ports should be piped back to storage or to a collection tank (sloping towards the tank).
- **Thermal relief valves are recommended**, and should be installed whenever it is possible to block (isolate) the flow meter between two valves. The pressure rise in a closed system, from just a few degrees increase in temperature, can be many times normal working pressure.
- **Connections for calibration** should be provided during installation. An easy means for diverting flow into a calibration vessel (or master meter) should be considered. Refer a diagram for the suggested installation is shown below.

Start-Up & Operation

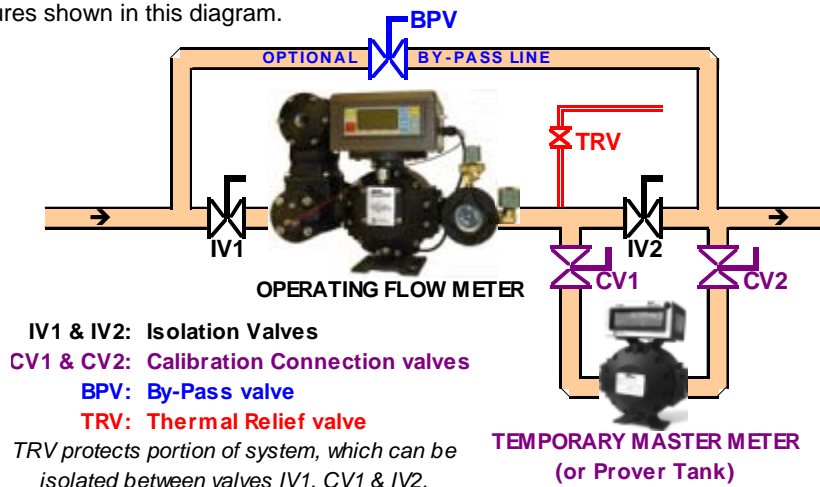
Very slowly fill the system with liquid, to avoid operating the flow meter on air or vapor. This can be accomplished in the following manner:

1. Throttle the meter inlet valve, and allow the system to fill slowly by gravity.
2. Crack open the outlet valve. Start the pump, and then slowly crack open the inlet valve, filling the meter slowly before fully opening the inlet and outlet valves.

In normal operations:

- Avoid sudden changes in temperature.
- Avoid sudden changes in flow rate.
- Gradually increase or decrease the flow rate.

The optimum flow meter installation should include the components and features shown in this diagram.



IV1 & IV2: Isolation Valves
CV1 & CV2: Calibration Connection valves
BPV: By-Pass valve
TRV: Thermal Relief valve
TRV protects portion of system, which can be isolated between valves IV1, CV1 & IV2.

Normal Operation : BPV, CV1 & CV2 closed
 Service/Maintenance : IV1 & IV2 closed (by-pass open)
 During Calibration : IV2 & BPV closed, other valves open

Flow Meter Communications & Direction of Flow

TS Series meters in F●● & W●● assembly have an internal pulser. The pulse signal generated by the flow meter, can be fed directly to most electronic registers. In such assemblies, flow meter calibration (or re-calibration) is through correction of the K Factor (number of pulses/unit volume) in the electronic register.

In some cases an SCL board (#13) is added to the flow meter assembly. This signal conditioner is added when:

1. Flow meter pulse frequency exceeds the electronic register capacity at maximum flow rate. This can occur at surprisingly low flow rates (see below).
2. The electronic register requires a scaled pulse value (1, 10, 100 or 1000 pulses/volume unit).
3. Local authorities demand a mechanical calibration device. The SCL includes two dials with setting from 00 to 99. Changing the setting by 1, represents approx. 0.03% correction to the pulse signal.

Register model: **ELNC** **EMR³** **LCR-II™**
 Frequency limit: **400 Hz** **1667 Hz** **625 Hz**

Please refer to FPP261 for other registers.

| FLOW METER MODEL | CAPACITY | | K Factor | | Frequency (Hz) & Pulse ON time at 100% of model cap. | |
|---------------------|----------|------|----------|-----|--|-----------------|
| | GPM | LPM | PPG | ppl | | |
| TS10C | 40 | 150 | 2176 | 575 | ➔ | 1451 Hz 0.35 ms |
| TS15C | 60 | 230 | 1152 | 304 | | 1152 Hz 0.43 ms |
| TS20C, NS | 150 | 570 | 395 | 104 | | 988 Hz 0.51 ms |
| TS30C, | 200 | 760 | 276 | 73 | | 920 Hz 0.54 ms |
| <i>Interm. duty</i> | 250 | 945 | | | | 1150 Hz 0.44 ms |
| <i>Interm. duty</i> | 300 | 1135 | | | | 1380 Hz 0.36 ms |

With EL0300-3-13 = 100 PPG scaler

| | | | | | | |
|---------------------|-----|-----|-----|----|---|----------------|
| TS10C | 40 | 150 | 100 | 26 | ➔ | 67 Hz 1.30 ms |
| TS15C | 60 | 230 | 100 | 26 | | 100 Hz 1.30 ms |
| TS20C, NS | 150 | 570 | 100 | 26 | | 250 Hz 1.30 ms |
| TS30C, | 200 | 760 | 100 | 26 | | 333 Hz 1.30 ms |
| <i>Interm. duty</i> | 231 | 875 | | | | 385 Hz 1.30 ms |

If higher flow rates occur, use EL0300-3-18 (see below)

With EL0300-3-18 = 10 PPL scaler

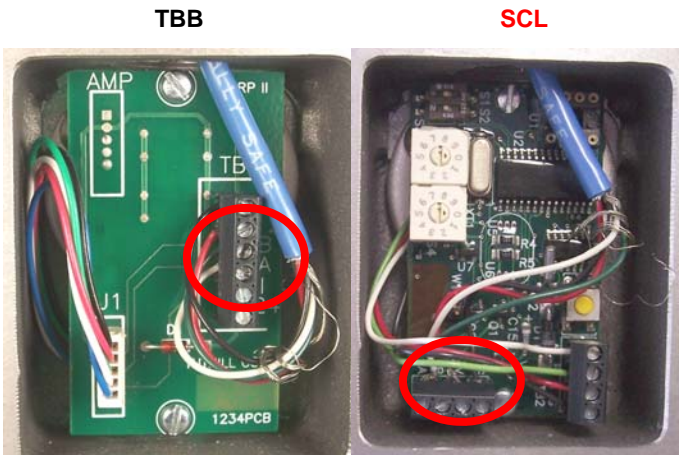
| | | | | | | |
|---------------------|-----|------|------|----|---|----------------|
| TS10C | 40 | 150 | 37.9 | 10 | ➔ | 25 Hz 2.50 ms |
| TS15C | 60 | 230 | 37.9 | 10 | | 38 Hz 2.50 ms |
| TS20C, NS | 150 | 570 | 37.9 | 10 | | 95 Hz 2.50 ms |
| TS30C, | 200 | 760 | 37.9 | 10 | | 126 Hz 2.50 ms |
| <i>Interm. duty</i> | 250 | 945 | | | | 158 Hz 2.50 ms |
| <i>Interm. duty</i> | 300 | 1135 | | | | 189 Hz 2.50 ms |

NOTE: K Factors shown here are nominal (average). Individual flow meters can vary slightly; and all flow meters will shift to some degree with viscosity fluctuations (see page 1.14)

Direction of Flow

TS Series flow meters can operate in either direction. Standard assembly, when facing the flow meter, has the flow going **Left-to-Right**, unless specified differently at time of the order. A label with the word **INLET** is placed on the inlet flange, as assembled at the factory. To change the direction of flow:

1. Reverse the position of any accessories attached to the flow meter.
2. If Quadrature pulse signal is used, reverse output leads for channels A & B on the TBB (or SCL):



| | | |
|--------|---------------|---------------|
| | L-to-R | R-to-L |
| WHITE: | On A | On B |
| GREEN: | On B | On A |

NOTE: *The ELNC register is not W&M certified in the EU.*

The SCL is not yet approved for use in the EU.

Wiring Diagram to High Frequency Quadrature Register/Controller

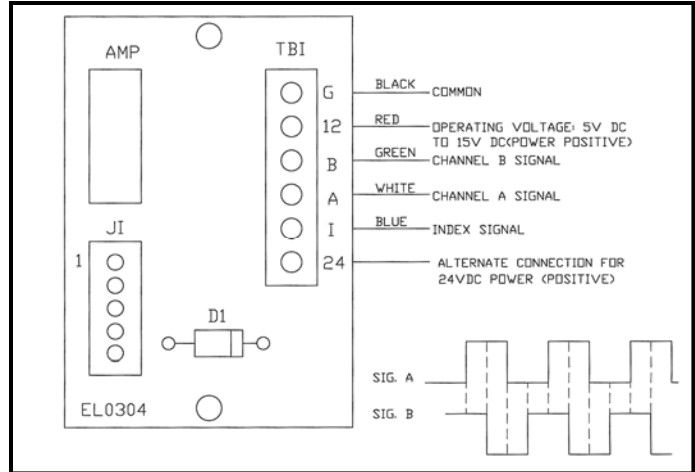
A. EL0304 Terminal Block Board (TBB)

EL0305 TBB/Amplifier

EL0305 is used for **remote** high frequency electronic registers accepting quadrature signal, when the cable distance is in 200-600' (60-180 m) range.

For greater distances external amplifier (2xPIA-300) is required.

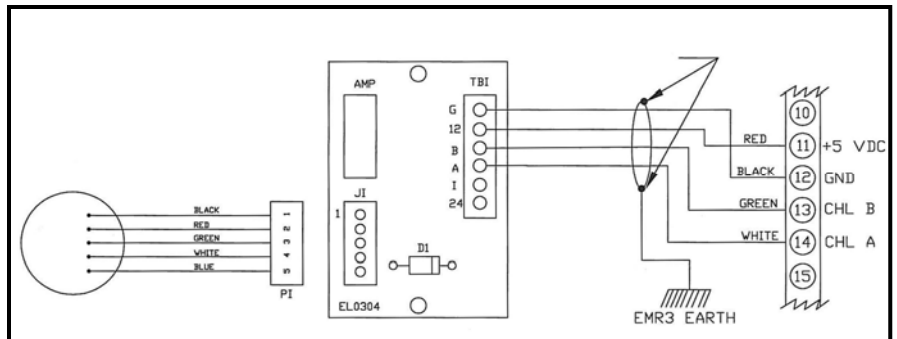
- Pulser cable plugs into:
 - **J1** on EL0304
 - **AMP** on EL0305
- Signal output cable is connected to **TB1**



B. EL0304 to EMR³ Register

EL0305 TBB/Amplifier to EMR³ Register

- Pulser cable plugs into:
 - **J1** on EL0304
 - **AMP** on EL0305
- Signal output cable is connected to **TB1**



Wiring to Low Frequency Quadrature Register/Controller

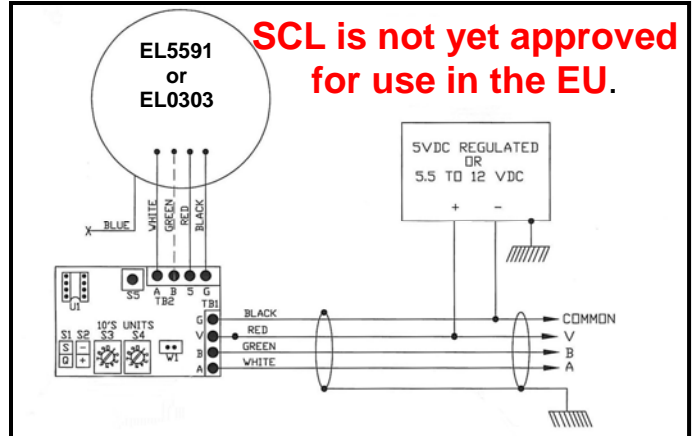
C. EL0300 Scaler/Calibrator/Linearizer (SCL)

While the SCL can have multiple functions, in many cases it is included strictly as a signal conditioner (= 'Jitter filter'). In those cases, only the calibrator function is active.

- Pulser plug is removed. Pulser leads are connected directly to **TB2** on the SCL.
- Signal output cable is connected to **TB1**.

This diagram applies to the ELNC register, when the flow meter/register are used **in non-hazardous zone**.

It also applies to LectroCount™ and other lower frequency registers with quadrature input.

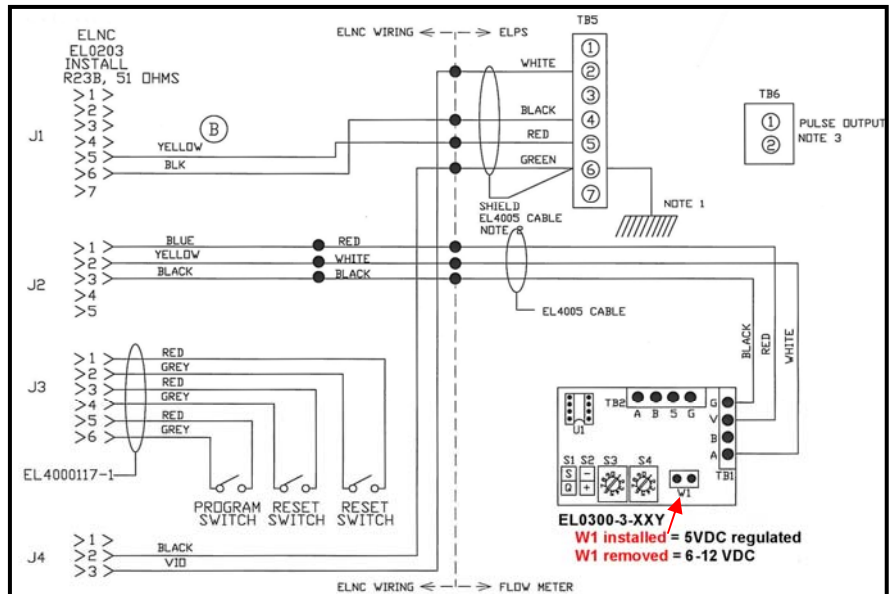


D. EL0300 (SCL), EL2057 Energy Limited Power Supply (ELPS) & ELNC Register

When flow meter/ELNC register is used in a hazardous zone, the EL2057 (AC/DC power supply & barrier, UL listed) must be used. EL2057 is in a NEMA 7 enclosure (ExpI-Proof, but not water proof), so it must be installed under roof or inside a water proof cabinet.

- Pulser plug is removed. Pulser leads are connected directly to **TB2** on the SCL.
- Signal output cable is connected to **TB1**.

SCL is not yet approved for use in the EU.



Note 1 : See CD1000 & CD1001 for installation of intrinsically safe apparatus.

Note 2 : Cable lengths are limited by entity parameters.

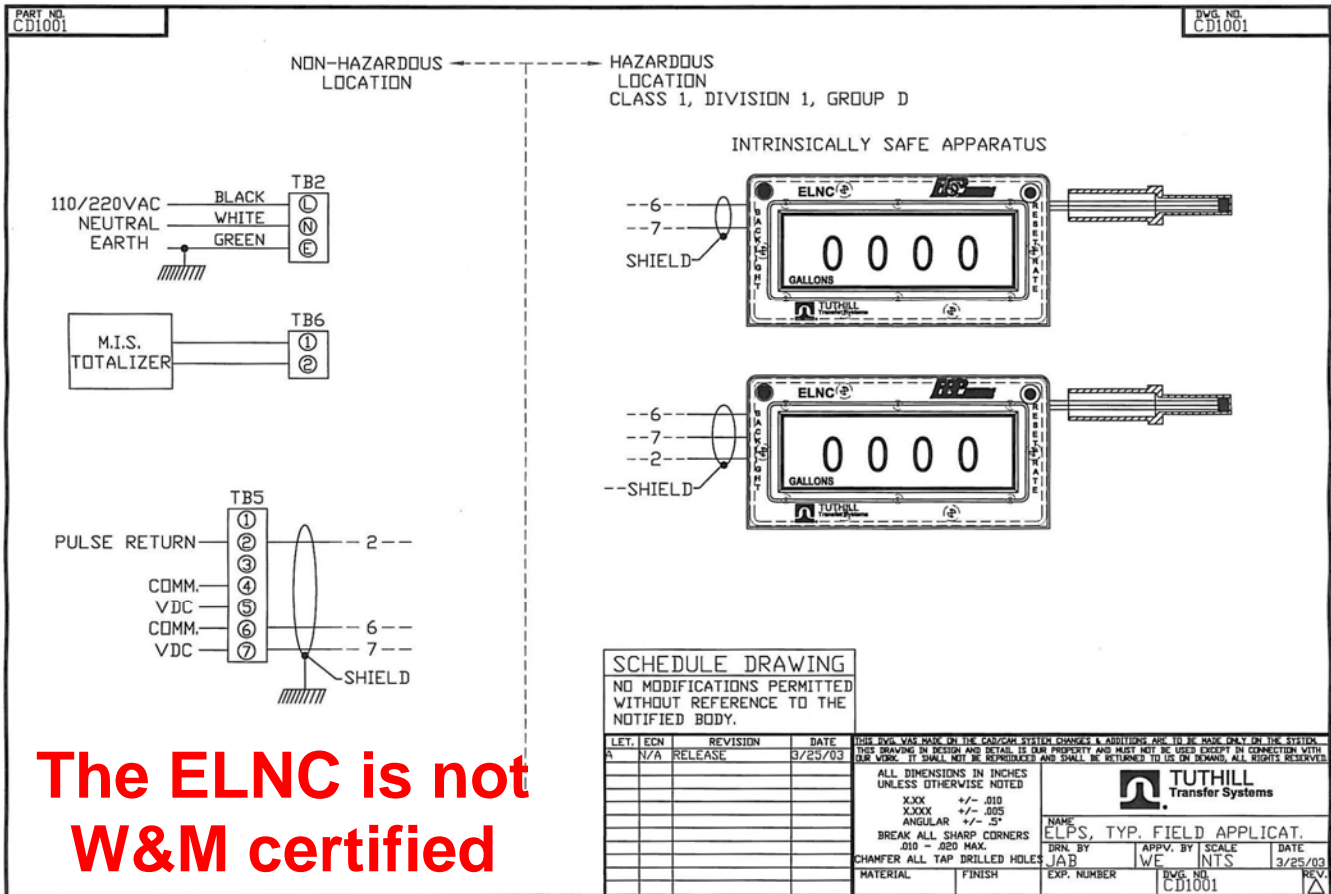
Note 3 : ELPS output option: Install U1, R3 & TB6.

E. EL0300 to non-Quadrature Register

Same as diagram **D**, but connect only signal channel A.

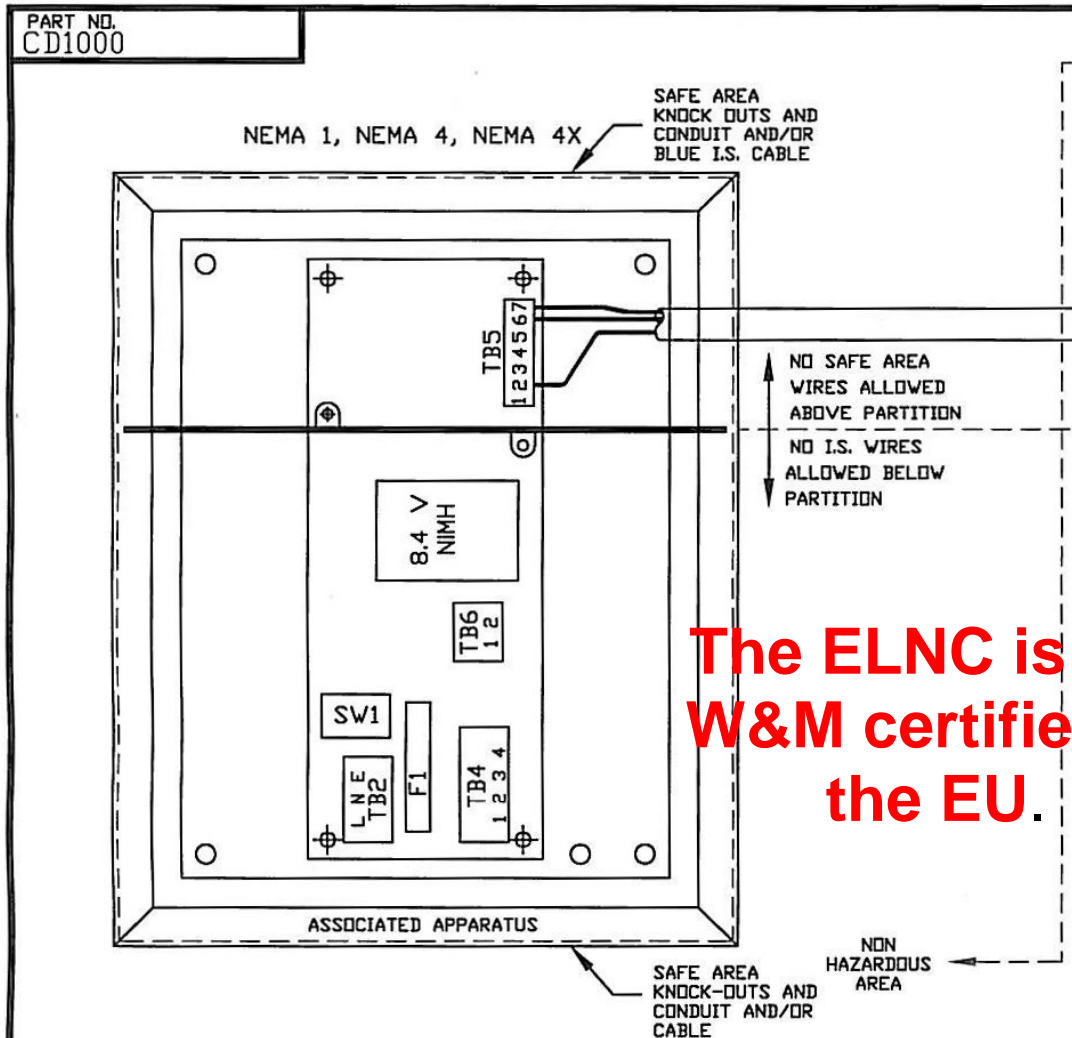
SCL is not yet approved for use in the EU.

Control Drawing CD1001



The ELNC is not W&M certified in the EU.

Control Drawing CD1000, left side



The ELNC is not
W&M certified in
the EU.

| TERMINALS | Vt | It | Po | Ca | La |
|-----------|---------|--------|--------|------|-------|
| 2,6,7 | 10.5Vdc | 197 mA | 520 mW | 60mF | 10mH |
| 5 TO 4 | 14.201 | 1.495 | 5.3 W | 13mF | 0.1mH |

TERMINAL BLOCK TB2

- L: AC LINE (110/220). SELECT WITH SW1.
- N: AC NEUTRAL
- E: EARTH (TERMINAL 3 IS CONNECTED TO THE ENCLOSURE).

TERMINAL BLOCK TB5 (INTRINSICALLY SAFE CIRCUITS)

- 2. PULSE OUTPUT (SWITCH TO COMMON OUTPUT)
- 4. COMMON (DC COMMON AND EARTH)
- 5. 9.25 VDC 50MA UNREGULATED ENERGY LIMITED OUTPUT
- 6. COMMON (DC COMMON TO EARTH)
- 7. 9.25 VDC 50MA UNREGULATED ENERGY LIMITED OUTPUT FOR ELNC.

TERMINAL BLOCK TB6 (OPTIONAL FUNCTION)

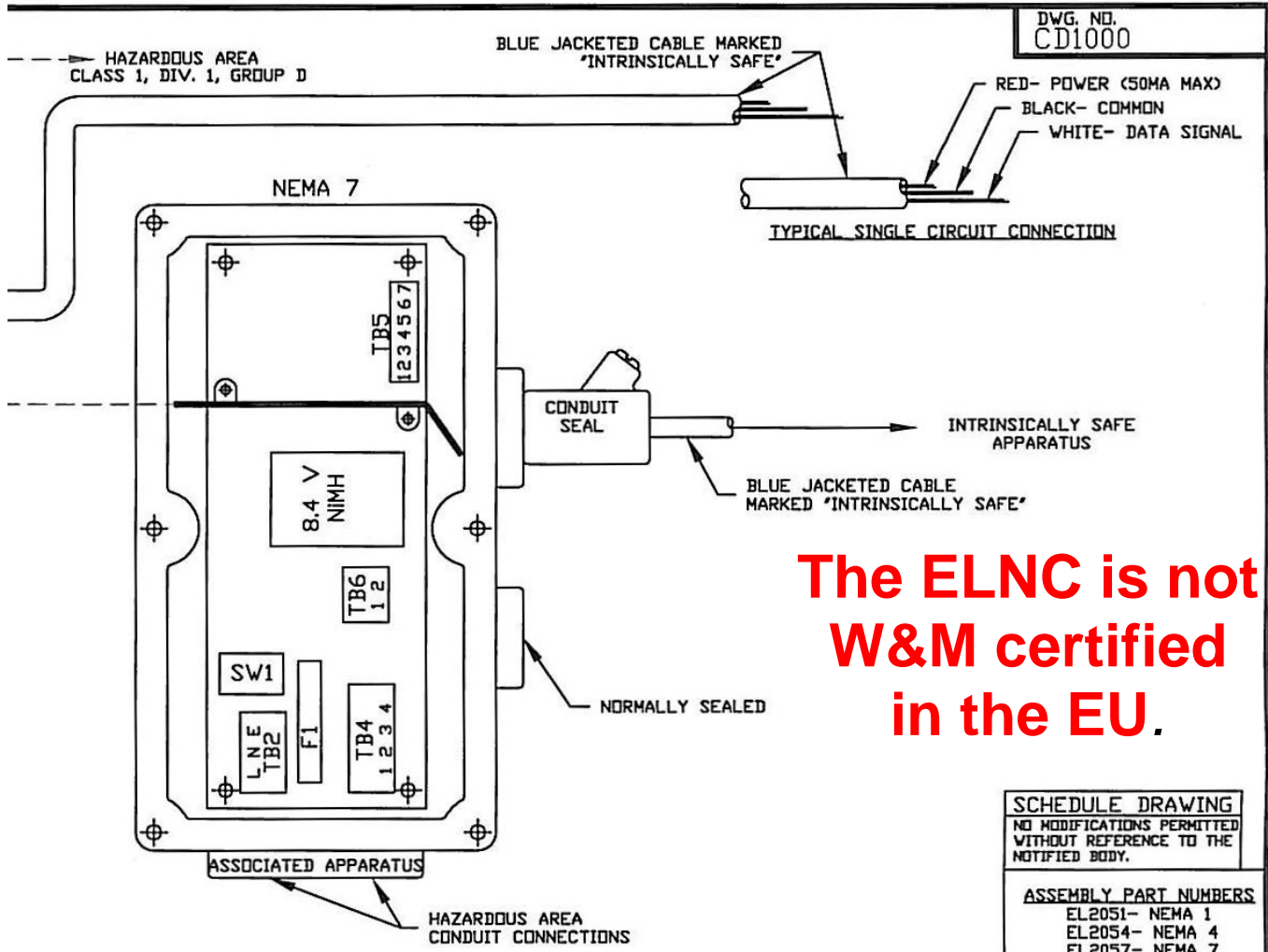
- 1. PULSE OUTPUT (AC/DC RELAY LOW LEVEL)
- 2. PULSE OUTPUT (AC/DC RELAY LOW LEVEL)

TB2-E MUST BE CONNECTED TO EARTH AND TB5-4 AND/OR TB5-6 MUST BE CONNECTED TO EARTH AT THE POWER SUPPLY ENCLOSURE.

PART OF TABLE 1

| I.S. EQUIPMENT | | BARRIER |
|----------------|---|---------|
| V max | ≥ | Vt |
| I max | ≥ | It |
| P max | ≥ | Po |
| Cl + Cc | ≤ | Ca |
| Ll + La | ≤ | La |

Control Drawing CD1000, right side



The ELNC is not W&M certified in the EU.

DWG. NO. CD1000

SCHEDULE DRAWING
NO MODIFICATIONS PERMITTED WITHOUT REFERENCE TO THE NOTIFIED BODY.

ASSEMBLY PART NUMBERS
EL2051- NEMA 1
EL2054- NEMA 4
EL2057- NEMA 7

1. ASSOCIATED APPARATUS MAY BE IN A DIVISION 1 OR DIVISION 2 LOCATION IF SO APPROVED.
2. CAPACITANCE AND INDUCTANCE OF THE FIELD WIRING FROM THE INTRINSICALLY SAFE EQUIPMENT TO THE BARRIER SHOULD BE CALCULATED AND SHOULD BE INCLUDED IN THE SYSTEM CALCULATIONS AS SHOWN IN TABLE 1. CABLE CAPACITANCE (C_c) PLUS INTRINSICALLY SAFE EQUIPMENT CAPACITANCE (C_i) MUST BE LESS THAN THE MARKED CAPACITANCE (C_a OR C_o) SHOWN ON ANY BARRIER USED. THE SAME APPLIES FOR INDUCTANCE (L_c, L_i AND L_a OR L_o , RESPECTIVELY). WHERE THE CABLE CAPACITANCE AND INDUCTANCE PER FOOT ARE NOT KNOWN, THE FOLLOWING VALUES SHALL BE USED: $C_c=60\text{pF/ft.}$, $L_c=0.2\text{uH/ft.}$
3. DEVICES MUST BE INSTALLED IN ACCORDANCE WITH THIS CONTROL DRAWING, CD1001 AND ARTICLE 504 OF THE NATIONAL ELECTRICAL CODE, ANSI/NFPA 70, FOR INSTALLATION IN THE UNITED STATES, OR SECTION 18 OF THE CANADIAN ELECTRICAL CODE FOR INSTALLATIONS IN CANADA.
4. THE ASSOCIATED APPARATUS MUST BE CONNECTED TO A SUITABLE GROUND ELECTRODE PER THE NATIONAL ELECTRICAL CODE, ANSI/NFPA 70, THE CANADIAN ELECTRICAL CODE, OR OTHER LOCAL INSTALLATION CODES, AS APPLICABLE. THE RESISTANCE OF THE GROUND PATH MUST BE LESS THAN 1 OHM.
5. ASSOCIATED APPARATUS MUST NOT USE OR GENERATE MORE THAN 250 V RMS OR DC WITH RESPECT TO EARTH.

| LET. | ECN | REVISION | DATE |
|------|-----|----------|---------|
| A | N/A | RELEASE | 3/25/03 |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
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| | | | |
| | | | |
| | | | |

THIS DWG. WAS MADE ON THE CAD/CAM SYSTEM CHANGES & ADDITIONS ARE TO BE MADE ONLY ON THE SYSTEM. THIS DRAWING IN DESIGN AND DETAIL IS OUR PROPERTY AND MUST NOT BE USED EXCEPT IN CONNECTION WITH OUR WORK. IT SHALL NOT BE REPRODUCED AND SHALL BE RETURNED TO US ON DEMAND, ALL RIGHTS RESERVED.

ALL DIMENSIONS IN INCHES UNLESS OTHERWISE NOTED

X.XX +/- .010
X.XXX +/- .005
ANGULAR +/- .5°

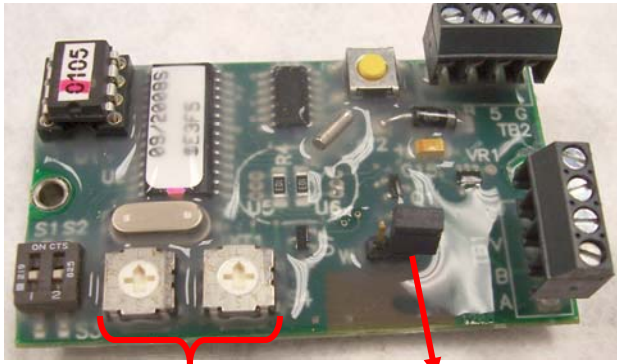
BREAK ALL SHARP CORNERS .010 - .020 MAX.
CHAMFER ALL TAP DRILLED HOLES

MATERIAL FINISH

NAME CONTROL DRAWING

| | | | |
|-------------|-----------------|-----------|--------------|
| DRN. BY JAB | APPV. BY WE | SCALE NTS | DATE 3/25/03 |
| EXP. NUMBER | DWG. NO. CD1000 | REV. | |

Flow Meter Calibration



Optional SCL scaler card (not yet approved in the EU)
Mechanical calibrator for pulse signal. **Jumper for Voltage selection (5 or 6-12 VDC)**

Flow Meter Calibration

All TS Series meters are accuracy tested prior to shipment. Data from accuracy testing is not supplied with flow meters, since results achieved on our test fluid do not apply to actual liquid of operation, unless the two liquids have identical viscosity characteristics. When calibrated on a liquid with 1 cP viscosity, we expect that flow meters used on:

| | |
|---------------|-------------------------------------|
| 0.5 cP liquid | will under-register by about 2% |
| 10 cP liquid | will over-register by 0.35% to 0.6% |
| 100 cP liquid | will over-register by 0.7% to 1.5% |

This shift in the accuracy curve illustrates the need for re-calibration of new flow meters on actual liquid of service, after installation in place of service. The accuracy curve will not shift significantly at higher viscosities, even if the actual operating liquid has viscosities up to 500,000 cP.

Individual flow meters may differ slightly from the norm. Such variations are corrected through the K Factor programmed into the register/controller.

Frequency of Calibration

If the flow meter is used in Custody Transfer service (subject to Weights&Measures regulations), it must obviously be re-calibrated in accordance with local W&M regulations. In most cases these regulations call for annual re-calibration, though different time periods apply in some territories.

If the user is ISO9000 certified, user ISO standards will indicate frequency of re-calibration for instrumentation. Those rules should be observed.

If neither W&M regulations, nor internal standards apply, our recommendations are:

- A. Calibrate immediately after installation.
- B. Re-calibrate after 15-30, 180 and 360 days.

After the run-in calibration and follow-up calibrations, it is possible to evaluate degree of change under normal operating conditions. Based on values found, and total volume being metered under normal operating conditions, decide whether a 6, 12 or possibly 24 month schedule should be adopted.

Procedures & Methods

Flow meters subject to Weights&Measures regulations, or used in systems where the flow rate can fluctuate, should be tested at minimum, intermediate & maximum flow rates. In non-W&M service, a flow meter always operating at a steady flow rate, can be tested at that flow rate only.

All calibration tests should be:

- Of at least 60 second duration, to minimize the effect of flow meter error during start-up and shut-down.
- Repeated 3 times to confirm flow meter repeatability.

Flow meters can be calibrated against a prover tank, a pipe prover or a master meter. Please consult with your distributor and/or local regulatory agencies to determine methods available (or required).

- After calibrating a known volume (X) into an accurate prover, or through a Master Meter (MM), compare with register reading (Y) and calculate correction:

$$\frac{X - Y}{X} \times 100 = \% \text{ correction}$$

If using a MM, always correct for MM error as shown on MM accuracy curve, for the flow rate used during the test.

- When re-calibration has established that a correction is required, the procedure varies with flow meter configuration and/or the specific electronic register used. Please refer to register manual for full details & procedures.

A. In some electronic registers, you can enter a revised K Factor in programming model (the ELNC & EMR³).

B. In some electronic registers, you can run a given volume, and then tell the register what that volume was. It will update the K Factor based on this (EMR³).

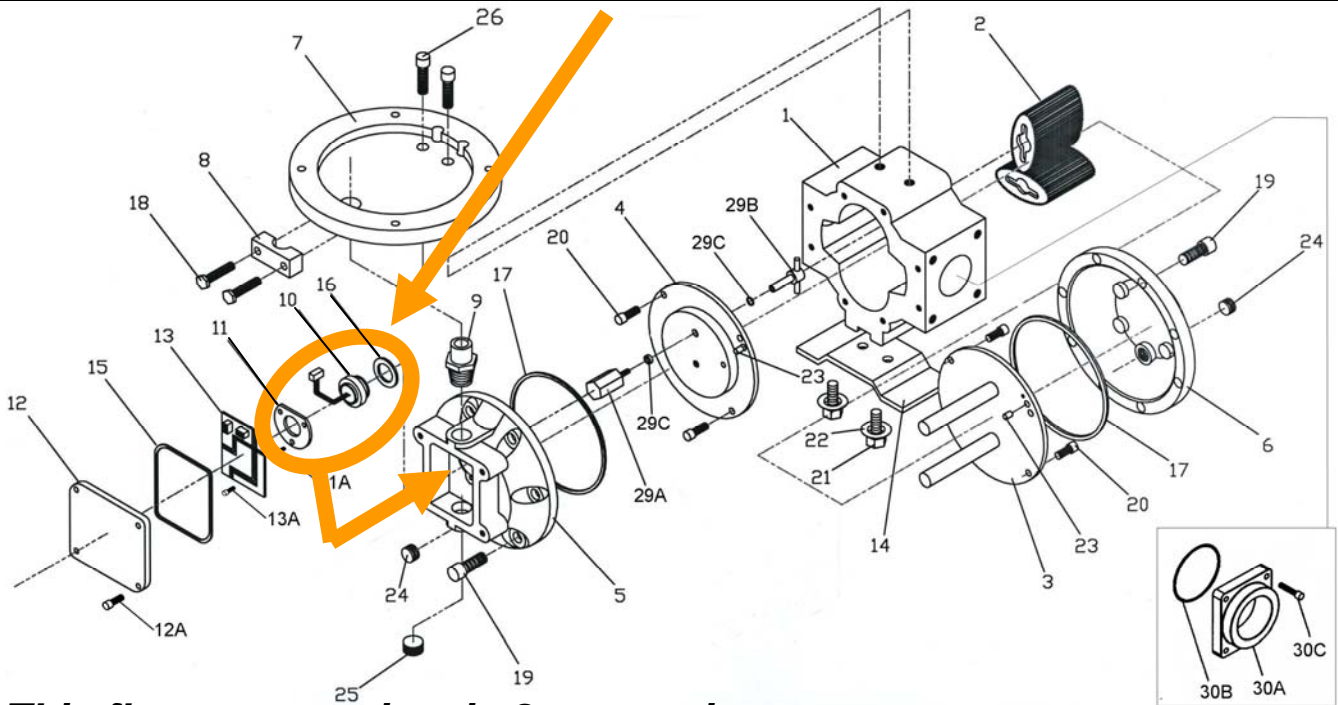
C. If the flow meter includes the SCL (see pages 24 & 25 for more detail), you can use a small screwdriver to change the mechanical calibrator setting. Each setting change (such as from 37 to 38), equals approximately a 0.03% change:

- When prover/master meter reading is **less than flow meter register reading**, add percentage calculated to original calibrator setting.
- When prover/master meter reading is **more than flow meter register reading**, subtract percentage calculated from original calibrator.

Circulate product through the flow meter for a few minutes. Then perform at least 3 more tests, to confirm flow meter accuracy & repeatability.

- Finally, enter % correction on the permanent flow meter record.

WET vs DRY Pulser



This flow meter exists in 2 generations:

1st generation, manufactured from 2007 through 2009

- ***Has pulser (#10) in SS housing, exposed to the operating fluid.***
- ***Pulser is sealed with an O-ring (#16), held in place by a heavy retainer (#11) with a LARGE center hole.***
- ***Meter must be isolated & drained if pulser must be inspected.***

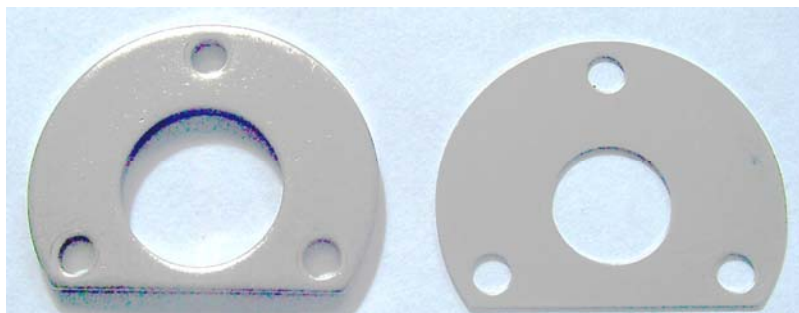
WET

2nd generation, introduced gradually; only type as of Jan 1st, 2010

- ***Pulser (#10) without housing, sensing magnet position through the wall.***
- ***No O-ring, held in place by a thin retainer (#11) with SMALL center hole.***
- ***Pulser can be inspected without draining the flow meter.***

DRY

Make sure to identify which type you are working on!



| | |
|----------------------|-------------------------|
| Identifies : | WET |
| Retainer thickness : | 0.105" (2.67 mm) |
| Hole diameter : | 7/8" (21 mm) |
| Part No. : | ST9250 |

| | |
|----------------------|-------------------------|
| Identifies : | DRY |
| Retainer thickness : | 0.020" (0.51 mm) |
| Hole diameter : | 19/32" (15 mm) |
| Part No. : | ST9250-1 |

Trouble Shooting the Flow Meter

Installation, Maintenance & Service must be performed by personnel:

A. Qualified to work on this type of equipment.

B. Familiar with all applicable local codes and ordinances covering the type of service, where the flow meter is used (gasoline, LPG, etc.).

Purpose

This high accuracy electronic positive displacement flow meter is designed to provide reliable liquid measurement with a minimum of service requirements.

Functionality

The liquid moves the rotors, which in turn drive a single magnet rotating in the vertical plane. Each 360° turn of the magnet generates 64 pulses, Quadrature or single channel.

If there are frequency limitations in the electronic register, it might be necessary to include an optional scaler board to reduce the pulse resolution. When required, this component fits inside the pulser enclosure in meter front cover.

Assembly

The flow meter can be assembled for Left-to-Right, Bottom-to-Top or Right-to-Left flow. The flow meter performs equally well in all directions, but when Quadrature pulse signal is used, it is necessary to reverse signal leads if used for a different flow direction from that originally intended.

Installation: See page 1.6

Maintenance

Electronic TS Series flow meters have no parts, which require replacement in the short term. The flow meter should be re-calibrated periodically, and when meter wear factor increases beyond the norm, the rotors should be replaced.

Trouble Shooting & Service

Prior to opening or disassembly of any flow meter, all internal pressure must be relieved and all liquid must be drained. This must be done in accordance with applicable company and local codes & ordinances.

Make sure that all necessary safety precautions have been taken, including proper clothing, personal safety equipment and fire safety equipment if required.

No Flow

- Blocked strainer basket. Clean the basket.
- Faulty or non-functioning pump. Repair pump.
- Valve stuck in closed position. Check and repair valves.
- Flow meter 'frozen' due to build-up of chemical salts (or frozen water) inside the measuring chamber. Clean the flow meter (see page), and inspect for damage.
- Meter jammed on a particle that has passed through a damaged strainer basket. Remove particle and replace rotors if necessary, replace strainer basket.

Reduced Flow Rate

- Strainer basket partially blocked. Clean the basket.
- Pump not functioning correctly. Repair pump.
- Valve stuck in partially closed position. Check valves and repair.
- Meter rotors (oval gears) partially 'salted' with chemical deposits, slowing the movement. Clean the meter (see page).

Product Flows, but the register does not record

- Check power supply to the register.
- Check the connections between the pulser and the electronic register.
- Check pulser output. Replace pulser (or SCL) if needed.
- If product is flowing, and the flow meter is generating a pulse signal, the problem is in the electronic register. Please refer to the manual for the electronic register.

Product Flows, register does not record correctly

If the **error factor is constant**, the flow meter is fine. The likely cause is either:

- Incorrect K Factor in the electronic register. Re-calibrate the meter and correct the K Factor.
- A constant problem with air getting into the system. Review system design and control valves.

If the **error is random**, the likely cause is either:

- Poor cable connections (insulation not trimmed, or stray strands getting close to incorrect contacts). This can be either on the scaler board or where pulse signal is connected to the register. Inspect and correct connections as necessary.
- Valve leaking, allowing a portion of the system to drain. Check & repair valves.
- An intermittent problem with air in the system, combined with inadequate air elimination. Review system design and control valves.
- Interference from other electrical equipment nearby., possibly combined with sub-standard cables.

Breaking Teeth on Rotors (Oval Gears)

This is a sign of hydraulic shock conditions in the system. Common sources:

- Starting or stopping flow too rapidly. Replace damaged components and **correct operational practices**.
- Pump by-pass not adjusted properly. Re-adjust as necessary.

Leakage from End Covers

The seals (and possibly end covers) have been damaged due to excessive pressure. There are two possible sources:

- Starting or stopping flow too rapidly. Replace damaged components and **correct operational practices**.
- The flow meter is in a system, where it can be isolated between two valves. Add a Thermal Relief Valve to bleed off excess pressure when the temperature rises.

Flow Meter - Disassembly



OR



Standard Terminal Block Board
Signal cable removed from TB1 for clarity



Optional SCL signal conditioner
Not yet approved for use in the EU.

This flow meter comes standard with a terminal block board for easy connections.

When the receiving instrument has special requirements (to K Factor, pulse frequency, signal width or similar), it might be necessary to add the optional SCL signal conditioner. The SCL then replaces the terminal block board.

In field retrofit, remove plug from pulser cable & strip leads, so cable can be attached to TB2. Pulse output signal cable is connected to TB1.

This electronic flow meter, with only 2 moving parts, is available in two versions:

F●● Assembly with register installed

In this version the electronic register is attached to the register mounting pad (#7), which is installed directly on top of flow meter case (#1). This permits service of the flow meter without removing the electronic register, eliminating the risk of unintentional swapping of registers between flow meters.

W●● Assembly for use with remote register

When the flow meter is used with a remote electronic register, whether for practical or temperature reasons, items 7, 8, 9, 18 & 26 in the parts list are deleted.

It does not get any simpler than this!

Installation, Maintenance & Service must be performed by personnel:

- A. Qualified to work on this type of equipment.***
- B. Familiar with all applicable local codes and ordinances covering the type of service, where the flow meter is used (gasoline, LPG, etc.).***

**Relieve All Internal Pressure Prior to Opening
Drain Liquid prior to Working on Flow Meter**

***Rinse with Neutral Liquid
prior to Seasonal Storage***

**Triple Rinse with Neutral Liquid
prior to Shipment for any reason.**

Servicing the Electronic Flow Meter

There are only 4 parts or components, which will require inspection and/or replacement at some point. In the order they are likely to occur, these are:

Regular Maintenance (1-3 years)

- A. Pulser O-ring (16) **1st generation/WET pulser only**
Not applicable to 2nd generation, see page 1.15.***

Very Long Term Wearing Components (3-10 years)

- B. Bearing Plate assembly (4)***
- C. Oval Gears (2)***

Longest Term Wearing Components (5-20 years)

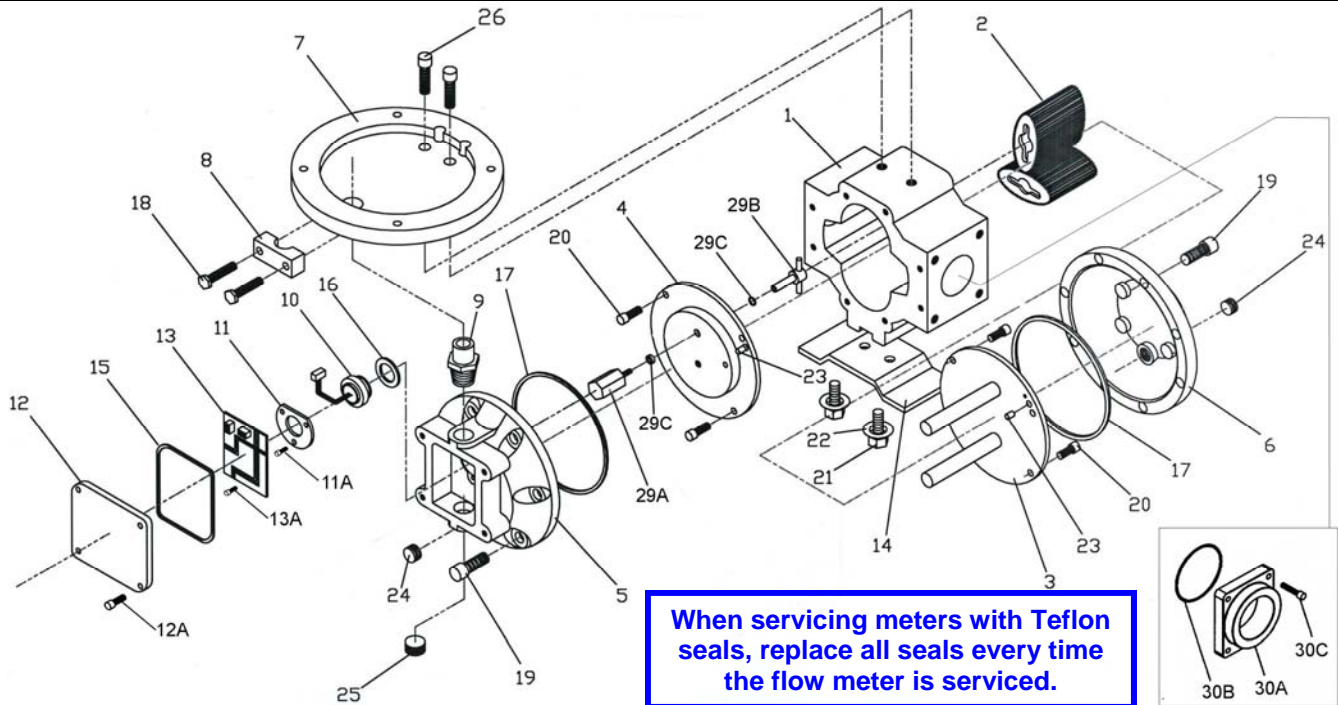
- D. Post Plate assembly (3)***

Electronic Components

The electronic components have an indefinite life expectancy, but can fail if the system is wired incorrectly, poorly grounded, cables used are not to minimum standard required or the system is hit by lightning.

While we do not expect that these components will need replacement, instructions are provided in case it should become necessary.

Flow Meter - Disassembly



When servicing meters with Teflon seals, replace all seals every time the flow meter is serviced.

A. Pulsar O-ring (16), or Pulsar (10)

First relieve system pressure and drain the flow meter.

1. Remove 4 screws (12a) from the dust cover (12), and detach the dust cover.
 2. Release signal cable from TB1 on the board (13).
 3. Release pulser (10) leads from **J1** on terminal block board/SCL (13).
 4. Remove 2 terminal block board/SCL screws (13a), and take the board (13) out. Place on a clean & dry surface.
 5. Remove 3 retainer screws (11a), and detach the retainer (11). The pulser (10) can now be removed, so the O-ring (16) can be replaced.
- Reassemble in reverse order, checking all O-ring seals for damage. *Teflon O-rings must be replaced whenever the flow meter has been opened.*

B. Bearing Plate (4)

C. Oval Gears (2)

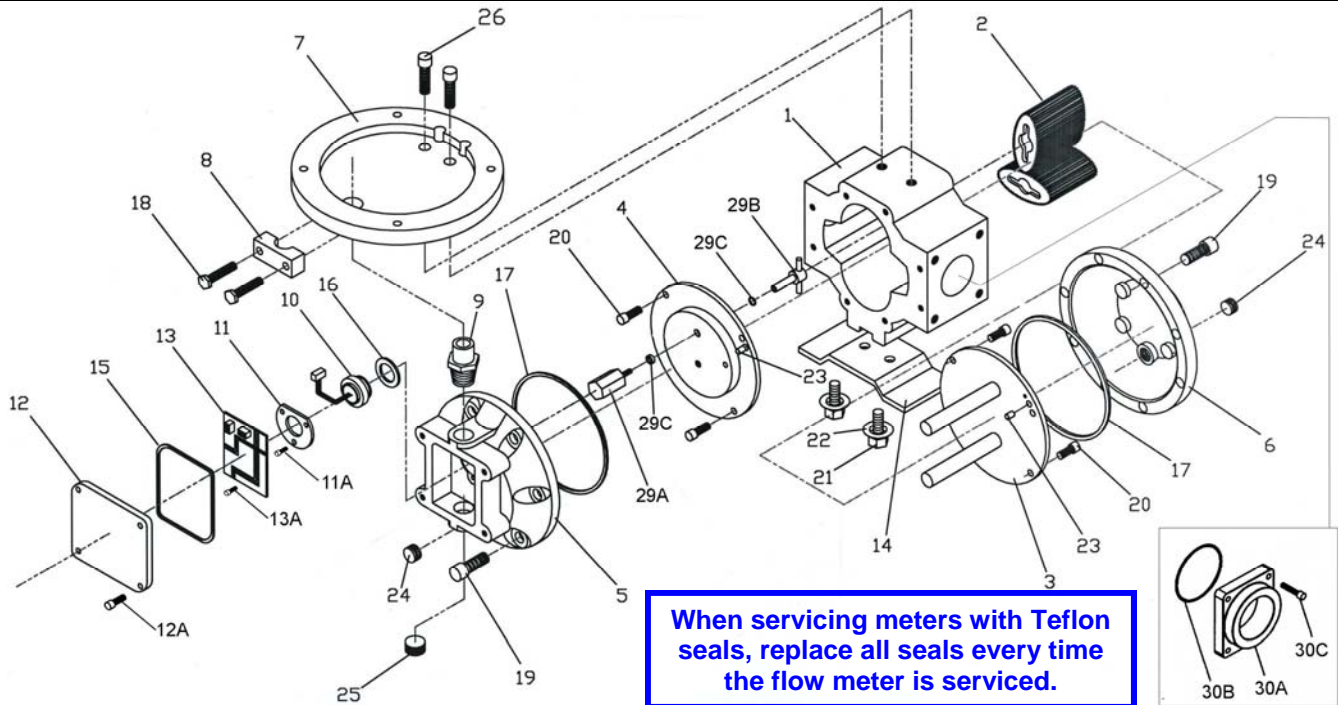
First relieve system pressure and drain the flow meter.

In a **W●●** flow sensor with remote register, items 7, 8, 9, 18 & 26 are not included. Here the front cover can be removed directly for access to flow meter internals after signal cable has been disconnected. In an **F●●** flow meter with register, remove the two screws (18) from the clamp (8) and take the clamp off - leaving the register in place on the flow meter.

1. Remove 4 screws (12a) from the dust cover (12), and detach the dust cover.
2. Release signal cable from TB1 on the board (13).
3. Remove cover screws (19) from the front cover, and slide the cover off the flow meter (downwards), leaving the register in place on the flow meter. Be careful that the plug on the output cable slips up through the stand-off (9); if the plug catches on the edge, it might pull off.

4. Remove 4 screws (20) from bearing plate assembly (4), and pull the bearing plate off the meter body. If the bearing plate is stuck to meter body, gently tap with a rubber mallet, or use a 5/16-8 x 1" jack bolt to push it free.
 5. Inspect inside of bearing plate (4) for scoring (minor markings is acceptable). If the bearing plate is scored, it should be replaced.
 6. Verify that the drive shaft (29A) for the magnet assembly is turning smoothly.
 - 6.1 If it wobbles, replace bearings (2 x 29B).
 - 6.2 If the drive shaft is worn, replace magnet drive assembly (29A, B & C).
 7. Before removing oval gears, mark across both gears (2) with a soft pencil for alignment during re-assembly.
 - 7.1 Extract the gears, and inspect for wear or damage. Replace if necessary.
 - 7.2 Inspect the interior of the measuring chamber and the post plate assembly for wear or damage. Remove any deposits using a fine emery cloth, or fine wire brush; be careful not to score or damage any of the internal parts.
 - 7.3 If posts, or post plate, are worn, the complete assembly must be replaced. To replace, see D.
- Reassemble in reverse order:
 - Align oval gears on mark made prior to disassembly.
 - Installing new gears, the lower gear must be at 90° to the upper gear, when the upper gear is horizontal. Make sure that the gears turn freely on the shafts, and do not rub or bind against the housing (1). Nor should there be excessive clearance. *Leave the top gear with the slot for the coupling (29A) in horizontal position.*
 - Re-attach the bearing plate (4) with coupling/magnet (29) in the up position. Align with dowel pins, and

TS Series - Exploded View, Electronic



make sure that coupling is horizontal to match up to the gear. Gently push into place.

- Turn the magnet (**29C**) with two fingers, to ensure that gears are turning freely in the measuring chamber.
- Re-install the front cover (**5**) and O-ring (**17**). Make sure that the drain plug (**24**) is located at the bottom of the flow meter.
- Check all O-ring seals for damage. *Teflon O-rings must be replaced whenever the flow meter has been opened.*
- Pull signal cable back down through the stand-off (**9**) and re-attach to the terminal block board/SCL (**13**).
- Replace dust cover and re-seal the flow meter.

D. Post Plate assembly (3)

First relieve system pressure and drain the flow meter.

1. Remove cover screws (**19**) from flow meter rear cover (**6**), and take the rear cover off.
 2. Remove 4 screws (**20**) from the post plate assembly (**3**), and pull the post plate assembly straight back. If the post plate assembly is stuck to meter body, gently tap with a rubber mallet, or use a 5/16-8 x 1" jack bolt to push it free. **Do not use a hammer on the posts!**
 3. Inspect the inside of the post plate assembly (**3**) for scoring (minor markings are acceptable). If the post plate assembly is scored, or posts are worn, it must be replaced.
- Re-assemble in reverse order:
 - Attach the post plate assembly to meter housing (**1**); it must attach to the side marked with a dimple on the flat side. Align on dowel pins and fasten.

When servicing meters with Teflon seals, replace all seals every time the flow meter is serviced.

- Next re-install the rear cover (**6**) and O-ring (**17**). Make sure that the drain plug (**24**) is located at the bottom of the flow meter.
- Check all O-ring seals for damage. *Teflon O-rings must be replaced whenever the flow meter has been opened.*

To check Pulser (10), or Terminal Block Board/SCL (13):

Same process as in A.

Terminal Block Board

Visual inspection of cables & terminals.

Pulser

The most practical field test is to install a new pulser. If the problem persists, the original pulser is good. The problem has now been isolated to the electronic register (either programming, or register failure).

SCL

When this optional component is included, please refer to the SCL section in this manual (pages 1.25 & 1.26).



Parts List, TS10C, TS15C, TS20C & TS30C - WET pulser

| ITEM | Assy No. | | DESCRIPTION | Mdl TS10C | Mdl TS15C | Mdl TS20C | Mdl TS30C | |
|------|----------|-----|--|---------------|---------------|---------------|---------------|------------|
| | Fxx | Wxx | | QTY & P/No. | QTY & P/No. | QTY & P/No. | QTY & P/No. | |
| 1 | + | + | Flow Meter body | 1 RK1CPP1 | 1 MB8580 | 1 MB9200 | 1 MB9350 | |
| 2 | Std. | + | Gear Set, PPS/carbon, LV | 1 GS560RC | 1 GS580RC | 1 GSTS2HRC | 1 GS5201RC | ** |
| opt. | | | HT | GS560RC-MV | GS580RC-MV | GSTS2HRC-MV | GS5201RC-MV | |
| | | | HV | GS560RC-HV | GS580RC-HV | GSTS2HRC-HV | GS5201RC-HV | |
| | | | PPS/Teflon, LV | GS560RT | GS580RT | GSTS2HRT | GS5201RT | |
| | | | HT | GS560RT-MV | GS580RT-MV | GSTS2HRT-MV | GS5201RT-MV | |
| | | | HV | GS560RT-HV | GS580RT-HV | GSTS2HRT-HV | GS5201RT-HV | |
| 3 | + | + | Post Plate Assy | See #1 | 1 RK5CPP1 | 1 RK2CPP2 | 1 RK3CPP1 | *** |
| 4 | + | + | Bearing Plate Assy/magnet | 1 RK1CWF1 (4) | 1 RK1CWF1 (4) | 1 RK2CWF1 (4) | 1 RK2CWF1 (4) | *** |
| 5 | + | + | Front Cover | incl. in #4 | incl. in #4 | incl. in #4 | incl. in #4 | |
| 6 | + | + | Rear Cover | n/a | 1 CP9561 | 1 CP9401 | 1 CP9401 | |
| 7 | + | | Register mounting pad | 1 MP1405 | 1 MP1405 | 1 MP1405 | 1 MP1405 | |
| 7a | + | | Screws for ELNC & EMR3 | 4 FS0856 | 4 FS0856 | 4 FS0856 | 4 FS0856 | |
| 8 | + | | Retainer for Stand-Off | 1 MP1811 | 1 MP1811 | 1 MP1811 | 1 MP1811 | |
| 9 | + | | Stand-Off | 1 MS4033 | 1 MS4033 | 1 MS4034 | 1 MS4034 | |
| | Std. | + | Cord grip, plastic | 1 EL1807 | 1 EL1807 | 1 EL1807 | 1 EL1807 | |
| opt. | | + | X-Prf cable gland (ATEX) | MS3141 | MS3141 | MS3141 | MS3141 | |
| 10 | + | + | Pulser, Quadrature, WET | 1 EL5519 | 1 EL5519 | 1 EL5519 | 1 EL5519 | (1) |
| 11 | + | + | Retaining plate, pulser | 1 ST9250 | 1 ST9250 | 1 ST9250 | 1 ST9250 | |
| 11a | + | + | Screw, retaining plate | 3 FS9515 | 3 FS9515 | 3 FS9515 | 1 FS9515 | |
| 12 | + | + | Dust cover, pulser compartm | 1 MP1310 | 1 MP1310 | 1 MP1310 | 1 MP1310 | |
| 12a | + | + | Screw, dust cover | 4 FS2799 | 4 FS2799 | 4 FS2799 | 4 FS2799 | |
| 13 | Std. | + | Terminal Block Board (TBB) | 1 EL0304 | 1 EL0304 | 1 EL0304 | 1 EL0304 | |
| opt. | | | Filter for non-quadr. Service SCL, signal conditioner | EL0306 (2) | EL0306 (2) | EL0306 (2) | EL0306 (2) | (1) (1) |
| 13a | + | + | Screw, TBB/SCL | 2 FS2222 | 2 FS2222 | 2 FS2222 | 2 FS2222 | |
| 13b | + | + | Signal output cable (3) | 3 EL4005 | 3 EL4005 | 3 EL4005 | 3 EL4005 | |
| 14 | + | + | Mounting pedestal | n/a | 1 MP9110 | 1 MP9116 | 1 MP9113 | |
| 15 | + | + | O-ring, dust cover, Buna N | 1 SL3043 | 1 SL3043 | 1 SL3043 | 1 SL3043 | * |
| 16 | + | + | O-ring, pulser, Teflon™ | 1 SL2212 | 1 SL2212 | 1 SL2212 | 1 SL2212 | * |
| 17 | + | + | O-ring, cover, Teflon™ | 1 SL2157 | 2 SL2157 | 2 SL2167 | 2 SL2167 | * |
| 18 | + | + | Bolt, stand-off retainer | 2 FS0856 | 2 FS0856 | 2 FS0856 | 2 FS0856 | |
| 19 | + | + | Screw, cover | 8 FS9901 | 16 FS9901 | 24 FS2928 | 24 FS2928 | |
| 20 | + | + | Screw, post/bearing plates | 4 FS9654 | 8 FS9654 | 8 FS9654 | 8 FS9654 | |
| 21 | + | + | Screw, pedestal to body | n/a | 2 FS9928 | 4 FS9928 | 4 FS9928 | |
| 22 | + | + | Split lock washer | n/a | 2 FS5008 | n/a | n/a | |
| 23 | + | + | Dowel pin | 2 MS9021 | 4 MS9021 | 4 MS9021 | 4 MS9021 | |
| 24 | + | + | Drain plug | 1 MS4019 | 2 MS4019 | 2 MS4019 | 2 MS4019 | |
| 25 | + | + | Plug, cable port | n/a | n/a | n/a | n/a | |
| 26 | + | + | Screw, mounting pad | 2 FS2926 | 2 FS2926 | 2 FS2926 | 2 FS2926 | |
| 29a | + | + | Magnet assy. | Incl. in #4 | Incl. in #4 | Incl. in #4 | Incl. in #4 | |
| 29b | + | + | Drive shaft/roll pin assy. | Incl. in #4 | Incl. in #4 | Incl. in #4 | Incl. in #4 | |
| 29c | + | + | Bearing insert | Incl. in #4 | Incl. in #4 | Incl. in #4 | Incl. in #4 | |
| 30 | Std. | + | Flange kit, NPT | 2 FK9100-1 | 2 FK9150-1 | 2 FK9200-1 | n/a | |
| opt. | | | Flange kit, BSP | FK9101-1 | FK9151-1 | FK9201-1 | n/a | |
| | | | Flange kit, welding | FK0100-1 | FK0150-1 | FK0200-1 | n/a | |
| | | | Flange kit, ANSI adaptor | FK9104-1 | FK9154-1 | FK9204-1 | n/a | |
| 30b | + | + | O-ring, flange, Teflon™ | 1 SL2122 | 1 SL2228 | 1 SL2233 | n/a | * |
| 30c | + | + | Screw, for comp. Flange | 2 FS2928 | 4 FS9901 | 4 FS2928 | n/a | |

Teflon O-rings have 'no memory', replace every time the flow meter has been opened for inspection or service.

* = Recommended Spare Parts (regular maintenance items required every 1-2 years).

** = Suggested Spare Parts, with expected life in 3-10 year range

*** = Very long life items, with expected life in 5-20 year range.

(1) = Indefinite life expectancy. Can fail if wired incorrectly or exposed to voltage spike.

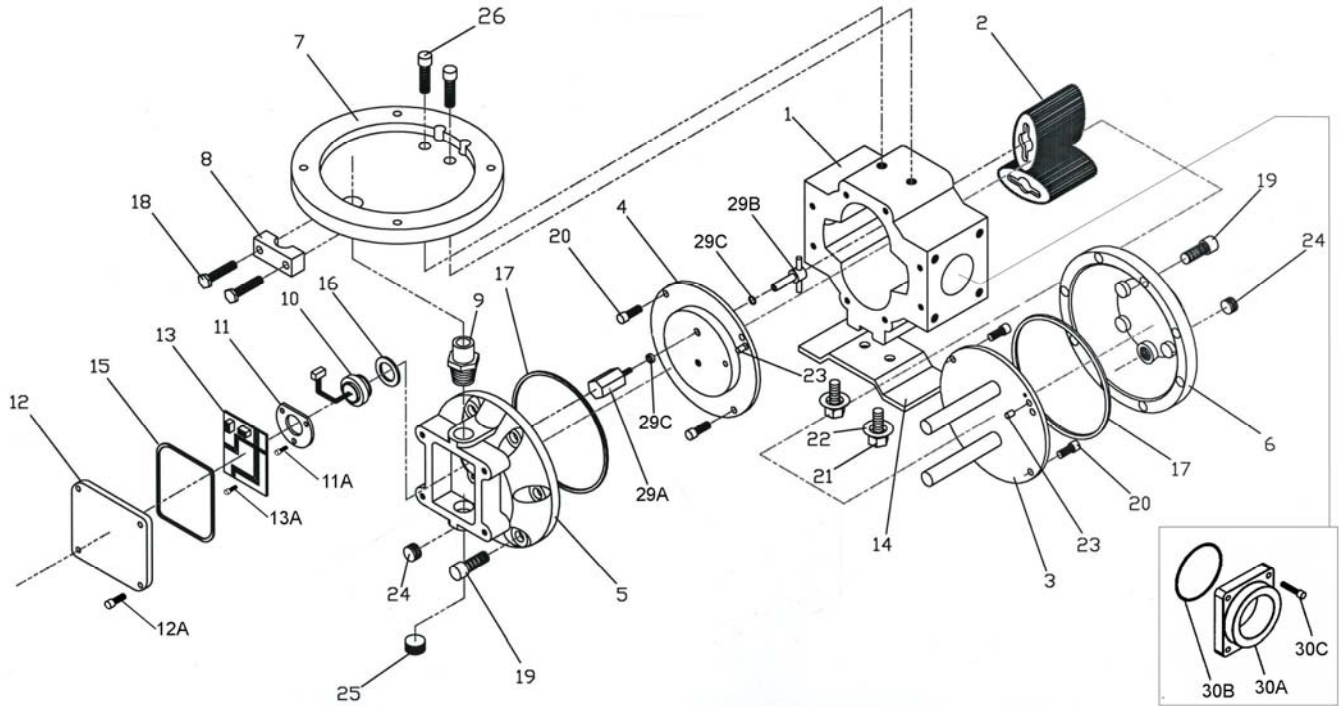
(2) = Several versions. If ordering replacement, please include meter Model & Serial No. + inscriptions from the original device.

(3) = Cable is supplied in increments of 1 foot (30 cm). **3 x EL4005 = 1 length, 3 feet (90 cm) long.**

(4) = This Repair Kit includes all parts for upgrade to DRY pulser. After installation, refer to page 1.22.

} If flow meter is in a remote location,
perhaps some of these items should
be kept on hand.

Exploded View - WET Pulsar





Parts List, TS10C, TS15C, TS20C & TS30C - DRY pulser

| ITEM | Assy No. | | DESCRIPTION | Mdl TS10C | Mdl TS15C | Mdl TS20C | Mdl TS30C | |
|------|----------|-----|--|---------------|---------------|---------------|---------------|------------|
| | Fxx | Wxx | | QTY & P/No. | QTY & P/No. | QTY & P/No. | QTY & P/No. | |
| 1 | + | + | Flow Meter body | 1 RK1CPP1 | 1 MB8580 | 1 MB9200 | 1 MB9350 | |
| 2 | Std. | + | Gear Set, PPS/carbon, LV HT HV PPS/Teflon, LV HT HV | 1 GS560RC | 1 GS580RC | 1 GSTS2HRC | 1 GS5201RC | ** |
| opt. | + | | | GS560RC-MV | GS580RC-MV | GSTS2HRC-MV | GS5201RC-MV | |
| | | | | GS560RC-HV | GS580RC-HV | GSTS2HRC-HV | GS5201RC-HV | |
| | | | | GS560RT | GS580RT | GSTS2HRT | GS5201RT | |
| | | | | GS560RT-MV | GS580RT-MV | GSTS2HRT-MV | GS5201RT-MV | |
| | | | | GS560RT-HV | GS580RT-HV | GSTS2HRT-HV | GS5201RT-HV | |
| 3 | + | + | Post Plate Assy | See #1 | 1 RK5CPP1 | 1 RK2CPP2 | 1 RK3CPP1 | *** |
| 4 | + | + | Bearing Plate Assy/magnet | 1 RK1CWF2 | 1 RK1CWF2 | 1 RK2CWF2 | 1 RK2CWF2 | *** |
| 5 | + | + | Front Cover | 1 CP9562-1 | 1 CP9562-1 | 1 CP9201-3 | 1 CP9201-3 | |
| 6 | + | + | Rear Cover | n/a | 1 CP9561 | 1 CP9401 | 1 CP9401 | |
| 7 | + | | Register mounting pad | 1 MP1405 | 1 MP1405 | 1 MP1405 | 1 MP1405 | |
| 7a | + | | Screws for ELNC & EMR3 | 4 FS0856 | 4 FS0856 | 4 FS0856 | 4 FS0856 | |
| 8 | + | | Retainer for Stand-Off | 1 MP1811 | 1 MP1811 | 1 MP1811 | 1 MP1811 | |
| 9 | + | | Stand-Off | 1 MS4033 | 1 MS4033 | 1 MS4034 | 1 MS4034 | |
| | Std. | + | Cord grip, plastic | 1 EL1807 | 1 EL1807 | 1 EL1807 | 1 EL1807 | |
| opt. | + | | X-Prf cable gland (ATEX) | MS3141 | MS3141 | MS3141 | MS3141 | |
| 10 | + | + | Pulser, Quadrature, DRY | 1 EL0303 | 1 EL0303 | 1 EL0303 | 1 EL0303 | (1) |
| 11 | + | + | Retaining plate, pulser | 1 ST9250-1 | 1 ST9250-1 | 1 ST9250-1 | 1 ST9250-1 | |
| 11a | + | + | Screw, retaining plate | 3 FS9515 | 3 FS9515 | 3 FS9515 | 1 FS9515 | |
| 12 | + | + | Dust cover, pulser comparm | 1 MP1310 | 1 MP1310 | 1 MP1310 | 1 MP1310 | |
| 12a | + | + | Screw, dust cover | 4 FS2799 | 4 FS2799 | 4 FS2799 | 4 FS2799 | |
| 13 | Std. | + | Terminal Block Board (TBB) | 1 EL0304 | 1 EL0304 | 1 EL0304 | 1 EL0304 | |
| opt. | + | | Filter for non-quadr. Service SCL, signal conditioner | EL0306 (2) | EL0306 (2) | EL0306 (2) | EL0306 (2) | (1) (1) |
| 13a | + | + | Screw, TBB/SCL | 2 FS2222 | 2 FS2222 | 2 FS2222 | 2 FS2222 | |
| 13b | + | + | Signal output cable (3) | 3 EL4005 | 3 EL4005 | 3 EL4005 | 3 EL4005 | |
| 14 | + | + | Mounting pedestal | n/a | 1 MP9110 | 1 MP9116 | 1 MP9113 | |
| 15 | + | + | O-ring, dust cover, Buna N | 1 SL3043 | 1 SL3043 | 1 SL3043 | 1 SL3043 | * |
| 17 | + | + | O-ring, cover, Teflon™ | 1 SL2157 | 2 SL2157 | 2 SL2167 | 2 SL2167 | * |
| 18 | + | + | Bolt, stand-off retainer | 2 FS0856 | 2 FS0856 | 2 FS0856 | 2 FS0856 | |
| 19 | + | + | Screw, cover | 8 FS9901 | 16 FS9901 | 24 FS2928 | 24 FS2928 | |
| 20 | + | + | Screw, post/bearing plates | 4 FS9654 | 8 FS9654 | 8 FS9654 | 8 FS9654 | |
| 21 | + | + | Screw, pedestal to body | n/a | 2 FS9928 | 4 FS9928 | 4 FS9928 | |
| 22 | + | + | Split lock washer | n/a | 2 FS5008 | n/a | n/a | |
| 23 | + | + | Dowel pin | 2 MS9021 | 4 MS9021 | 4 MS9021 | 4 MS9021 | |
| 24 | + | + | Drain plug | 1 MS4019 | 2 MS4019 | 2 MS4019 | 2 MS4019 | |
| 25 | + | + | Plug, cable port | n/a | n/a | 2 MS3145 | 2 MS3145 | |
| 26 | + | + | Screw, mounting pad | 2 FS2926 | 2 FS2926 | 2 FS2926 | 2 FS2926 | |
| 29a | + | + | Magnet assy. | Incl. in #4 | Incl. in #4 | Incl. in #4 | Incl. in #4 | |
| 29b | + | + | Drive shaft/roll pin assy. | Incl. in #4 | Incl. in #4 | Incl. in #4 | Incl. in #4 | |
| 29c | + | + | Bearing insert | Incl. in #4 | Incl. in #4 | Incl. in #4 | Incl. in #4 | |
| 30 | Std. | + | Flange kit, NPT | 2 FK9100-1 | 2 FK9150-1 | 2 FK9200-1 | n/a | |
| opt. | | | Flange kit, BSP | FK9101-1 | FK9151-1 | FK9201-1 | n/a | |
| | | | Flange kit, welding | FK0100-1 | FK0150-1 | FK0200-1 | n/a | |
| | | | Flange kit, ANSI adaptor | FK9104-1 | FK9154-1 | FK9204-1 | n/a | |
| 30b | + | + | O-ring, flange, Teflon™ | 1 SL2122 | 1 SL2228 | 1 SL2233 | n/a | * |
| 30c | + | + | Screw, for comp. Flange | 2 FS2928 | 4 FS9901 | 4 FS2928 | n/a | |

Teflon O-rings have 'no memory', replace every time the flow meter has been opened for inspection or service.

* = Recommended Spare Parts (regular maintenance items required every 1-2 years).

** = Suggested Spare Parts, with expected life in 3-10 year range

*** = Very long life items, with expected life in 5-20 year range.

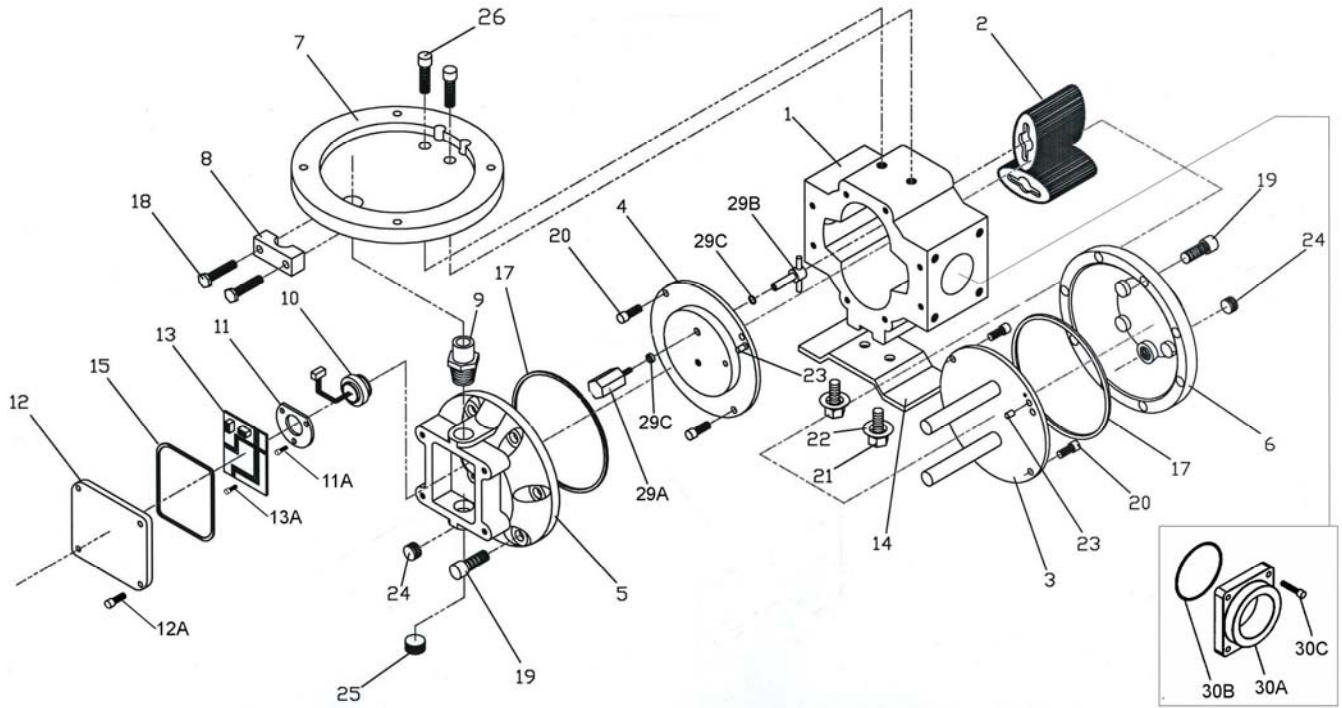
(1) = Indefinite life expectancy. Can fail if wired incorrectly or exposed to voltage spike.

(2) = Several versions. If ordering replacement, please include meter Model & Serial No. + inscriptions from the original device.

(3) = Cable is supplied in increments of 1 foot (30 cm). **3 x EL4005** = 1 length, 3 feet (90 cm) long.

} If flow meter is in a remote location, perhaps some of these items should be kept on hand.

Exploded View - DRY pulser





Torque/Tools Table

| ITEM | DESCRIPTION | TS10C | TS15C | TS20C | TS30C |
|------|-----------------------------|---------------------|---------------------|---------------------|---------------------|
| 9 | Stand-off | Box w rench | Box w rench | Box w rench | Box w rench |
| | Tool | Hand tight | Hand tight | Hand tight | Hand tight |
| 11a | Retainer plate screw | Impact Battery Tool | Impact Battery Tool | Impact Battery Tool | Impact Battery Tool |
| | Torque specification | 8/32 19.8in-lbs | 8/32 19.8in-lbs | 8/32 19.8in-lbs | 8/32 19.8in-lbs |
| 12a | Dust cover screw | Impact Battery Tool | Impact Battery Tool | Impact Battery Tool | Impact Battery Tool |
| | Torque specification | 10MM 75.2in-lbs | 10MM 75.2in-lbs | 10MM 75.2in-lbs | 10MM 75.2in-lbs |
| 13a | TBB/SCL screw | Screw driver | Screw driver | Screw driver | Screw driver |
| | Torque specification | 8/32 Hand tight | 8/32 Hand tight | 8/32 Hand tight | 8/32 Hand tight |
| 18 | Retainer clamp screw | Impact Battery Tool | Impact Battery Tool | Impact Battery Tool | Impact Battery Tool |
| | Torque specification | 1/4-28 94in-lbs | 1/4-28 94in-lbs | 1/4-28 94in-lbs | 1/4-28 94in-lbs |
| 19 | Cover screw | 1/4" Allen | 1/4" Allen | 5/16" Allen | 5/16" Allen |
| | Torque specification | 5/16-18 132in-lbs | 5/16-18 132in-lbs | 3/8-16 236in-lbs | 3/8-16 236in-lbs |
| 20 | Post/Bearing plate screw | 5/32" Allen | 5/32" Allen | 5/32" Allen | 5/32" Allen |
| | Torque specification | 10/32 31.7in-lbs | 10/32 31.7in-lbs | 10/32 31.7in-lbs | 10/32 31.7in-lbs |
| 21 | Pedestal screw | Build-in pedestal | Impact Battery Tool | Impact Battery Tool | Impact Battery Tool |
| | Torque specification | N/A | 1/4-20 75.2in-lbs | 3/8-16 236in-lbs | 3/8-16 236in-lbs |
| 24 | Cover drain plug | 1/4" Allen | 1/4" Allen | 1/4" Allen | 1/4" Allen |
| | Torque specification | Hand tight | Hand tight | Hand tight | Hand tight |
| 25 | Cable port plug | Box w rench | Box w rench | Box w rench | Box w rench |
| | Torque specification | Hand tight | Hand tight | Hand tight | Hand tight |
| 26 | Reg mounting flange screw | Impact Battery Tool | Impact Battery Tool | Impact Battery Tool | Impact Battery Tool |
| | Torque specification | 1/4-28 94in-lbs | 1/4-28 94in-lbs | 1/4-28 94in-lbs | 1/4-28 94in-lbs |
| 30 | Companion flange screw | 5/16" Allen | 1/4" Allen | 5/16" Allen | N/A |
| | Torque specification | 3/8 236in-lbs | 5/16-18 132in-lbs | 3/8 236in-lbs | |

WARRANTY

Tuthill Transfer Systems ("Manufacturer") warrants to each buyer of its FPP Meters products (the "Buyer") for a period of 12 months from date of invoice or sales receipt, but in no event more than 18 months from date of manufacture, that goods of its manufacture ("Goods") will be free from defects of material and workmanship. Manufacturer's sole obligation under the foregoing warranties will be limited to either, at Manufacturer's option, replacing or repairing defective Goods (subject to limitations hereinafter provided) or refunding the purchase price for such Goods theretofore paid by the Buyer, and Buyer's exclusive remedy for breach of any such warranties will be enforcement of such obligations of Manufacturer. If Manufacturer so requests the return of the Goods, the Goods will be redelivered to Manufacturer in accordance with Manufacturer's instructions F.O.B. Factory. The remedies contained herein shall constitute the sole recourse of the Buyer against Manufacturer for breach of warranty. IN NO EVENT SHALL MANUFACTURER'S LIABILITY ON ANY CLAIM FOR DAMAGES ARISING OUT OF THE MANUFACTURE SALE, DELIVERY OR USE OF THE

GOODS EXCEED THE PURCHASE PRICE OF THE GOODS. The foregoing warranties will not extend to Goods subjected to misuse, neglect, accident or improper installation or maintenance, or which have been altered or repaired by anyone other than Manufacturer or its authorized representative. THE FOREGOING WARRANTIES ARE EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES OF MERCHANTABILITY, FITNESS FOR PURPOSE OF ANY OTHER TYPE, WHETHER EXPRESS OR IMPLIED. No person may vary the foregoing warranties and remedies except in writing signed by a duly authorized officer of Manufacturer. Warranties or remedies that differ from the foregoing shall not otherwise be binding on Manufacturer. The Buyer's acceptance of delivery of the Goods constitutes acceptance of the foregoing warranties and remedies, and all conditions and limitations thereof.

Tuthill Transfer Systems (TTS) warranty does not extend to damage due to corrosion, salt deposits or separation of chemicals - whether occurring during periods of operation or storage.

Non-TTS items, such as electronic registers, are covered by the original manufacturer warranty, but will be handled through TTS if the register was supplied by TTS.

Components added after shipment from TTS, such as hose, nozzles & similar, are the responsibility of the distributor or contractor selling the installation.

Optional SCL in place of TBB

SCL (Scaler/Calibrator/Linearizer)

Description: Tuthill SCL is a small electronic device designed to provide the function of a pulse **Scaler**, an electronic **Calibrator** and **Linearizer**. This electronics package replaces a mechanical gear plate and mechanical calibrator while at the same time providing the ability to improve the accuracy of a metering device during low flow operation, thus improving the overall meter accuracy, and extending the flow range of the metering device. The SCL may be used in conjunction with other Tuthill electronics to solve many of your electronic interface requirements.

Specifications:

- Input Voltage : 5Vdc and 6 to 12 Vdc
- Input Current : 25ma @ 5Vdc
- Operating Temperature : -40 °C to +85°C
(U/L T4 upper limit is +40C)
- Input signal : Hall Effect sensors, single or dual, or single ended input from 5Vdc logic
- Input Frequency : 2000 Hz (max)

Output:

- Quadrature Pulse
- Output Voltage : Proportional to power supply voltage
- Duty Cycle : Symmetrical Quadrature with 50/50 D.C.
- Output Frequency : (Input Frequency) X (ECF)
Scaled to application
- Linearizer : 32 points maximum
- Calibrator Range : +/- 3.0%
- Output pulse on-time : Fixed by firmware

OPERATION:

The SCL may be used to perform a number of functions depending upon the users application. The following is a brief description of several of the SCL functions.

SCALER MODE:

When operating in the Scaler mode only, the SCL applies a single error correction factor (ECF) to the incoming pulse signal. If a single correction factor is applied to the entire range of meter frequency inputs then the output frequency is proportional to the input frequency times the ECF (SCL Pulses out = SCL Pulses in times ECF). If the ECF is 1.0 (no scaling factor) the output frequency is equal to the input frequency.

As an example, use this feature when the customer's electronics requires a precise frequency or pulse resolution input. If the customer's electronics required 100 pulses per liter, then 100 PPL becomes the **base pulse resolution** based on which all input pulses are scaled. If, as an example, the meter is providing 108 pulses per liter, then an ECF of 0.925 (100/108) would be programmed into the SCL, and the output pulse frequency would be equivalent to the selected base resolution of 100 PPL.

LINEARIZER MODE:

If a metering device is not producing an output within the limits of accuracy required for an application, the SCL may be used as a linearizer. A linearizer is a device, which recognizes the output frequency of the metering device, and applies a correction factor (ECF), chosen for that frequency to improve the accuracy of the metering device.

The number of ECF points chosen for a specific application depends upon the accuracy of the metering device. In weights and measure applications, there is an ECF applied at each flow rate point where the meter accuracy varies by 0.25% from the previous flow rate point.

The ECF data is stored electronically in the SCL at the factory. The electronic chip storing this data is permanently attached to the printed circuit board. The ECF chip is marked with a code, that is used to reference the exact set of ECF data, that is supplied in your SCL device.

CALIBRATOR MODE:

The SCL is equipped with two rotary switches S3 and S4, and a two position switch S2. The three switches allow the SCL to adjust the pulse output up or down by 3%.

This allows the operator, or W&M authorities to calibrate the meter without having to alter scale factors in customer electronics. This feature is designed to replace mechanical calibrators used in the field for years to adjust the meter output to accurately match the volume in a proving vessel.

The calibrator feature may be used if the SCL is being used as a scaler only, or as a scaler/linearizer.

SWITCHES:

S1 : Allows the choice of either a single channel input, or a two channel quadrature input.

S2 : Is used in conjunction with S3 and S4.

If in the minus (-) position, an increase in the S3 and S4 switch settings will decrease the pulse output. A decrease in pulse output will increase the volume in a prover vessel. If in the plus (+) position, an increase in the S3 and S4 will increase the pulse output. An increase in pulse output will decrease the volume in the prover vessel.

S3/S4 Adjust the SCL pulse output up or down +/-3.0%.

S3 and S4 will allow for 00-99 settings. Each increment changed in this setting, changes the SCL pulse output by approximately 0.03%

SCL, continued

METER CALIBRATION:

- * **Flow meter re-calibration should be on a volume equal to 1 minute of flow at maximum flow rate.**
- * **All tests should be performed 3 times under identical conditions to confirm repeatability.**
- * **Maintain a permanent file for each flow meter, and record % change each time the meter is re-calibrated.**

When the change is significantly higher than that found in previous re-calibrations, it is time to re-build the flow meter (replace the two oval gears).

METER CALIBRATION: The calibrator allows you to adjust the output of the SCL up or down, like a mechanical calibrator, +/- 3% in increments of 0.03%.

- After calibrating a known volume (X) into an accurate prover (or through a master meter with adequate resolution), compare with register reading (Y) and calculate correction:

$$\frac{X - Y}{X} \times 100 = \% \text{ correction}$$

To reduce the volume in a prover vessel, place switch S2 in the plus(+) position.

- Adjust the S3 and S4 to the position required for the necessary volume reduction in the prover can. Switch S3 and S4 represent readings of 00 to 99, and each increment will adjust the output approximately 0.03%.

Example:

Using a 50 gallon (189.27 liter) prover (can), the can reads 17.3 cubic inches (284 ml) high. The meter error is $(284/189,270) = 0.0015$ or 0.15%. To adjust the meter output, place S2 in the positive position, and set S3 and S4 to read 05. This is approximately a 0.15% adjustment.

Activate the Reset push button switch to enter the new program settings. Retest the flow meter.

- To increase the volume in the prover vessel. Place switch S2 in the negative (-) position, and set switches S3 and S4 to the proper settings to adjust the output. Activate the Reset push button switch to enter the new data.

NOTE: If S2 is in the plus (+) position, and S3 and S4 are at 15 as an example, then moving the position of S3 and S4 to 00 will provide a $(0.03 \times 15) = .45\%$ increase in the prover volume. To obtain a greater increase in the prover volume, S2 must be placed in the minus (-) position and S3 and S4 rotated to the proper position to obtain the desired change in pulse resolution. The opposite is true if S2 is already in the minus (-) position at the beginning of calibration.

- Finally:
 - Re-seal the flow meter.
 - Enter date and % correction on the permanent flow meter record.

As long as degree of change is moderate, the flow meter is in good condition.

If there is a sudden significant jump in correction required, the rotors are likely about worn out. Rotor replacement should be considered now, rather than letting further wear cause rotors to start rubbing on flow meter housing.

METER CALBRATION: INCREASED PRECISION.

The standard method for calculating the single point adjustment is to obtain the error as a percentage of the desired test volume. In the previous examples, an excess volume in the prover vessel of 284 ml became 0.15% and the adjustment was 05 on S3 and S4.

However, the 0.15% correctly needs to be applied to the nominal ECF for the particular meter profile in order to more precisely calculate the adjustment for S3 and S4. The nominal ECF is the particular profile base divided by the natural meter pulse resolution.

As an example, a meter type which is scaled to 100 ppl and has 410 ppg pulse resolution, has a nominal ECF of $378.5/410 = 0.9232$. 0.15% of 9232 is 13.84. When divided by 3, the switch setting is 04.6. In this example, 4.6 is rounded up to 05. This is the same result as before because the ECF is close to unity (1.0000). If the ECF was 0.4200, then the switch setting would be 02.

There are applications where the nominal ECF is not near unity. In those cases, the nominal ECF needs to be known and used for the calculation. If the standard calculation is used, the adjustment would be excessive and the meter technician would have to estimate the reduction in his settings and perform an additional test run.



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