



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	none	none
TS15C	Strainer Y-type	□ PC58
TS20C	☐ Basket type ELNC	
TS30C	ANSI flange EMR ³	
	Air Eliminator	other
Internals:	Rotors: PPS/carbon PPS/Teflon	LV HT HV LV HT HV
	□ Seals : □Teflon	



Tuthill Transfer Systems, 8825 Aviation Drive, www.tuthill.com

Fort Wayne, IN 46809, USA Tel: 260-747-9060 Fax: 800-866-4861 FPPWebInguiries@tuthill.com



INDEX

	Se	ction . Page					
FPP Meters and	d Principle of Operation	. 1.3					
Meter Specifications & Materials of Construction							
Model, Assemb	bly & Part No. (= identification of internals)	. 1.5					
Safety Instructi	ons	1 . 6-7					
Installation & O	peration Procedures	. 1.6-7					
Start-Up & Ope	ration	. 1.6-7					
Wiring diagram	a, directly to high frequency quadrature registers	1.9					
Wiring diagram	, via SCL to lower frequency quadrature registers	1 . 10					
Wiring diagram	n, to non-quadrature registers	. 1.10					
Control Dr	awing CD1000	1 . 11					
Control Dr	awing CD1001	1 . 12-13					
Reversing Dire	ction of Flow	. 1.8					
Flow Meter Re-	Calibration	1 . 14					
Warranty		. 1.22					
Flow Meter	WFT vs DRY pulser	1 15					
	Trouble Shooting the Flow Meter	. 1.16					
	Servicing the Flow Meter	. 1.17-19					
	Parts List: 1st generation (WET pulser)	. 1.20					
	2nd generation (DRY pulser)	. 1.22					
	Torque/Tool Table	. 1.24					
SCL:	optional Signal Conditioner	1 . 25-26					

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 A a a a a	

- 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-TS20C ²	400 PSI	28 BAR	2750 kPa
TS30C	275 PSI	19 BAR	1900 kPa
Strainer ²	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 Pulser 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 m³/h
TS15C		60 GPM	230 lpm	14 m³/h
TS20C		150 GPM	570 lpm	34 m³/h
TS30C	W&M	200 GPM	760 lpm	45 m³/h
	OK to	265 GPM	1000 lpm	60 m³/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.

Molybdenum

Iron

- 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.

2.0-3.0%

remainder

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:

	S	tandaı	rd	Teflon brgs.			
Liquid	Ro	tor Co	de	Ro	tor Co	de	Liquid
Viscosity	В	С	D	E	Ρ	Н	Viscosity
cP 1	1.00	1.00	1.00	1.00	1.00	1.00	32 SSU
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		Rotors :	PPS (polyphenylene sulfide resin),
Carbon	0.10% max.		carbon bearings standard;
Manganese	2.0% max.		Teflon [™] bearings optional,
Silicon	1.0% max.		for use on shear sensitive liquids and
Chromium	16.0-18.0%		where trace contamination from wear on
Nickel	10.0-14.0%		carbon bearings might be an issue.
Molybdenum	2.0-3.0%		3. 3
Iron	remainder	Rotor shafts	HC316SS
CF8M Stainless Stee			
Carbon	0.08%	Internal factoriare	200 Sorias SS
Manganese	1.50%	internal lasteners.	300 Selles 33
Phosphorous	0.04%		
Sulfur	0.04%	Seals :	Teflon™ standard,
Silicon	1.50%		
Chromium	18.0-21.0%		
Nickel	9.0-12.0%		



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 : EL0300-3-18_ 10 PPL scaler L κ Α : EL0305 **TBB/Amplifier** Α F : EL0306 J **TBB/Quadrature Filter** Wxx assemblies, Pos. 12: 5-12VDC 24VDC EL0304 Terminal Block Board т Т 1

G	н	:	EL0300-3-13_	100 PPG scaler
L	Κ	:	EL0300-3-18_	10 PPL scaler
Α	Α	:	EL0305	TBB/Amplifier
F	J	:	EL0306	TBB/Quadrature Filter



W_4	W_5	W_6	
-----	-----	------------	--

Fxx = Flow Meter with Register Mounting flange:

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

Wxx = Flow Meter without Register Mounting flange:

FUSILION 1-5	·	Model No. (capacity & materials)
Position 6 Position 7 Position 8	:	W = Electronic, without mounting flange Register included, if any Accessories included, if any
Position 9 Position 10 Position 11 Position 12 Position 13		Flange type Rotor type, Bearing Material & Seals Internal signal conditioner, if any UL or ATEX cable gland, if any 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

1.6

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.

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.



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.

- 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.





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:

- 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).
- 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:		EL	NC	EMR [°]	LCR-I	тм
Frequency	lim it:	400	Hz	1667 Hz	2 625 H	łz
		Please	e refer	to FPP2	61 for othe	r registers.
FLOW					Frequen	су (Hz) &
METER	CAPA	ACITY	K Fac	ctor	Pulse O	N time at
MODEL	GPM	LPM	PPG	ppl	100% of I	model cap.
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
Interm. duty	250	945			1150 Hz	0.44 ms
Interm. duty	300	1135			1380 Hz	0.36 ms

With EL0300-3-13 = 100 PPG scaler

TS10C	40	150	100	26 븆	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			
Interm. duty	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
Interm. duty	250	945			158 Hz	2.50 ms
Interm. duty	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):

SCL

TBB



	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. <u>EL0304 to EMR³ Register</u> <u>EL0305 TBB/Amplifier to EMR³ Register</u>

- 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 (Expl-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





Control Drawing CD1000, left side





Control Drawing CD1000, right side





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 recalibration 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 recalibrated 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.





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.
- <u>Meter must be isolated & drained</u> if pulser must be inspected.

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 <u>without draining the flow meter</u>.

Make sure to identify which type you are working on!



Identifies : Retainer thickness : Hole diameter : Part No. : WET 0.105" (2.67 mm) 7/8" (21 mm) ST9250 DRY 0.020" (0.51 mm) 19/32" (15 mm) ST9250-1 WET

DRY



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, Bottomto-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



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:

Foo 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 lightening.

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





A. Pulser O-ring (16), or Pulser (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.
- 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).
- 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.

- 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





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.

• 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

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



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

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

ke. perhaps some of these items should be kept on hand.

If flow meter is in a remote location,

(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.



Exploded View - DRY pulser





Torque/Tools Table

		TS10C	T\$150	TS20C	TS20C
TEM		13100	13150	13200	13300
9	Stand-off Tool	Box w rench	Box w rench	Box w rench	Box w rench
	Torque specification	Hand tight	Hand tight	Hand tight	Hand tight
11a	Retainer plate screw Tool	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 Tool	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 Tool	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 Tool	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 Tool	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 Tool	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 Tool	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 Tool	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 Tool	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 Tool	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 Tool	5/16" Allen	1/4" Allen	5/16" Allen	NI/A
	Torque specification	3/8 236in-lbs	5/16-18 132in-lbs	3/8 236in-lbs	11/7

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. Manufacturers 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.

SCL is not yet approved for use in the EU.

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:

🗖 Tuthill

- Input Voltage : 5Vdc and 6 to12 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 SLC 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 in 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%

Tuthill

SCL is not yet approved for use in the EU.

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 recalibrated.

When the change is significantly higher than that found in previous re-calibrations, it is time to rebuild 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 x 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.



This page is intentionally left blank



This page is intentionally left blank