



TS06A, LPG

Anodized Aluminum,
Electronic Dispenser Meter

Installation, Operation & Parts Manual



TS06AS86
with thermo well

		<u>Non-Compensated</u>	<u>With Thermo Well</u>
Assembly No.,	Single	___ TS06AS83	___ TS06AS86
	Twin	___ TS06AS84	___ TS06AS88
	for register	___ TS06AE83	___ TS06AE86
	with EMR ³	___ TS06AE93	___ TS06AE96
	with ELNC	___ TS06AE71	
		___ TS06AE72	
		___ TS06AE73	

S/No.: _____

The flow meter shipped under this general manual, has specifically:

ACCESSORIES

- Backpressure Valve
- Strainer
- Vapor Eliminator
- Differential Valve

REGISTER

- None
- RAD register adaptor
- EMR³ Register
- ELNC Register



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SAFETY PROCEDURES

This manual provides warnings and procedures that are intended to inform the owner/operator of the hazards present when using the Tuthill Transfer Systems, TUTHILL meters and other products. The reading of these warnings and the avoidance of such hazards is strictly in the hands of the owner/operator of the equipment. Neglect of that responsibility is not within the control of the manufacturer of the flow meter.

Read this manual as well as the literature provided in your owner's manual. If you have any questions, consult with your full-service distributor or call the Service Department at Tuthill Transfer Systems, TUTHILL meters at 888-578-3258.

Please have the following information available when you make inquiries, order replacement parts, or schedule service. If a specific meter accessory is involved, please provide the model and serial number of the accessory in question.

Meter Serial Number: _____

Your Full Service Distributor:

Name: _____

Telephone: _____

The meters non-shock maximum operating pressure is indicated on the meter name plate. The meter should never be operated in excess of this pressure. Care should be taken to eliminate thermal and hydraulic shock conditions, so that they do not exceed the meters maximum working pressure.

IN THE EVENT OF A GAS LEAK

In the event of a large gas leak:

- Evacuate the area and notify the fire department or other appropriate authorities.

In the event of a small, contained gas leak:

- Isolate and stop the leak
- Prevent accidental ignition
- Prevent entrance of gas into other portions of the building. Be aware that LPG is heavier than air and will seek lower levels
- Evacuate all people from the danger zone
- See that the gas is dispersed before resuming the business and operations. If in doubt, notify your local authorities.

IN THE EVENT OF A GAS FIRE

In the event of large fires or fires that are spreading:

Evacuate the building and notify your local fire department. Stop the leakage only if you can safely reach the equipment.

In the event of small, contained fires that you can safely control:

Stop the leakage if you can safely reach the equipment. Then use the appropriate extinguisher: Class B fire extinguisher, water, fog, etc. depending on the equipment. If in doubt, call your local fire department.

Installation:

Before Start-up of the Meter, make certain:

- The meter is properly mounted, secured and piped
- All shipping plugs are removed and lines are clean of all debris.
- All connections are tight and there are no leaks
- All bleed and drain valves are closed
- Do NOT smoke near the meter, or use the meter near an open flame when metering flammable fluids. Fire or explosions could result.
- This meter is not intended for use with fluids for human consumption.

***** Install the Meter and Accessories in Compliance with all applicable local, state and federal construction, electrical and safety codes. Additionally, the LPG meter must be installed in accordance with the requirements of ANSI-NFPA 58**

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

Before shipment, protective thread caps were placed in the meter and accessories openings for protection. They should remain in place until your are ready to attach the piping.

The meter must always be securely bolted to a platform or supporting member, regardless of the mounting position. Never "hang" a meter on the connecting pipe.

Position the meter with service in mind. Provide ample work space. Removing covers can be difficult when work space is not available. Always supply a platform or support for the meter mounting.

Prior to meter installation, the entire piping system should be thoroughly flushed of all debris with a liquid that is compatible with the construction of the meter.

Keep all external surfaces of the meter clean.

Positive displacement meters are designed to operate full of liquid. The meter should be installed in a manner such that it remains full of liquid at all times.

Install the companion flanges. Tighten to a position that allows the meter to bolt to the companion flanges, free of pipe stress. The meter should always be supported by bolting to a platform. Never use the connecting pipe as the means of support.

In critical installation, block valves and by-pass lines are recommended. This allows the meter to be serviced without interruption of flow in a critical process application.

Thermal and or over pressure relief valves are recommended and should be installed whenever it is possible to block the meter between two valves. Thermal pressures many times the operating pressure are possible with only a small rise in temperature.

It is recommended that a strainer be installed upstream of each meter to prevent damage from foreign matter such as weld slag, pipe scale, etc.

A means to calibrate and prove the meter should be provided during installation. An easy means for diverting flow into a calibration vessel should be considered.

Hydraulic shock like thermal expansion can be harmful to the meter components. Consideration should be given to designing pumping and piping systems to eliminate hydraulic shock.

WIRING

- If the flow meter is part of a dispenser, please refer to dispenser manufacturer wiring diagram.
- If the flow meter is used as a 'stand-alone' dispensing meter, please refer to:
 - Page for TS06A with ELNC register
 - Page for TS06A with EMR register
 - Page for TS06A used with other registers

Operation Requirements:

Upstream lines must be maintained full to prevent air from entering the meter. If the upstream or inlet lines are constructed in a manner which allows reverse flow, foot or back check valves should be installed.

Underground tanks that are furnished with a submersible pump will eliminate many problems that occur with positive displacement pumps with suction pipes when the suction piping is incorrectly sized creating too large a lift.

Installation & Operation continued

Every meter should be calibrated under actual service and installation conditions. Follow your local Weights and Measures recommendations.

Provide a means of conveniently diverting liquid for calibration purposes.

Give careful attention to your system's pumping equipment and piping because of their influence on the liquid being measured as it enters the meter assembly. Systems should be made free of conditions that cause or introduce entrained air or vapor.

Follow the manufacturer's recommendation fully when installing pumps. Give particular attention to factors like: use of foot valves, pipe size to the inlet and conformance to net positive suction head (NPSH) conditions when suction pumping is required. Following the manufactures' recommendations will minimize air and vapor elimination problems.

Start-Up:

Fill the system slowly to avoid operation on air or vapor. This can be accomplished in the following manner:

- Throttle the meter inlet valve, and allow the meter and piping to fill slowly by gravity.
- Crack open the outlet valve and start the pump, then slowly open the inlet valve until the system is up to pressure. Open the outlet valve fully to establish full flow. Check the flow rate to assure the meter is operating within specified rates.

The meter is not designed to operate on air, but the design and materials of construction of the TUTHILL meter allows for operation on vapor for short periods of time without damage to the elliptical gears or other meter internals.

Note: Over- speed and hammer caused by the presence of vapor in the system can cause internal damage to the meter.

Torque Chart

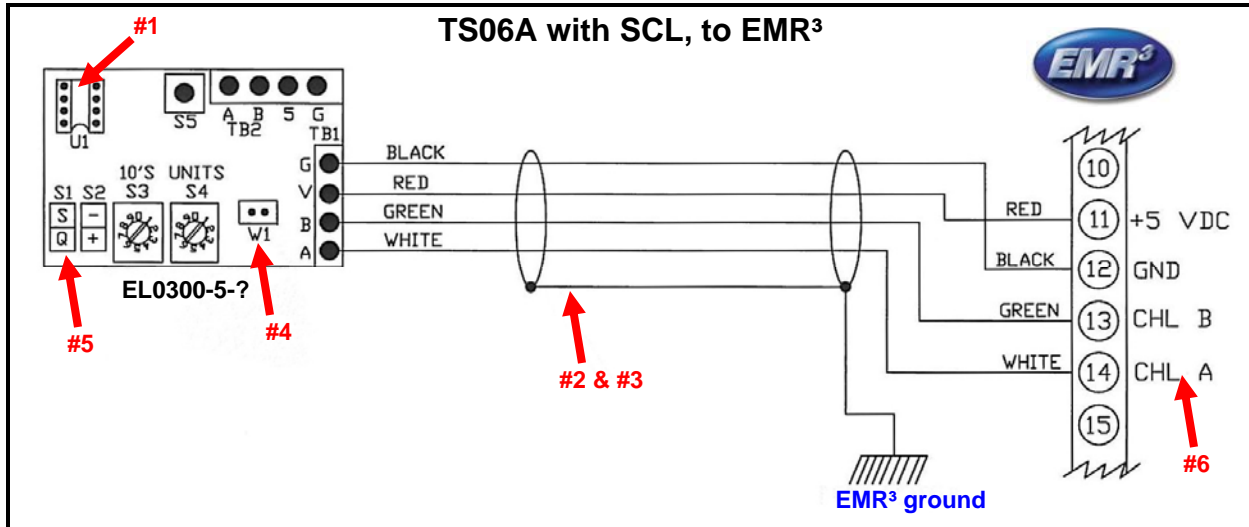
Part #	Discription	Torque	Wrench
FS2801	1/4"-20 x 1" Hex Bolt	12 ft-lbs	7/16" Box/Open End Wrench
FS2800	1/4"-20 x 1" SHCS	12 ft-lbs	3/16" Allen Wrench
FS2910	1/4"-20 x 5" Hex Bolt	12 ft-lbs	7/16" Box/Open End Wrench
FS2911	1/4"-20 x 2 1/2" SHCS	12 ft-lbs	3/16" Allen Wrench
FS2914	1/4"-20 x 1 1/2" SHCS	12 ft-lbs	3/16" Allen Wrench
FS2919	1/4"-20 x 1 1/2" SHCS		3/16" Allen Wrench
FS2959	1/2"-13 x 1 1/4" Hex Bolt	80 ft-lbs	3/4" Box/Open End Wrench

Installation & Operation continued

Where the TS06A is used in a commercial or retail LPG dispenser, the flow meter will be shown in dispenser manufacturer wiring diagram.

In wiring diagrams on these 2 pages, we show the flow meter used with registers available through Tuthill. It can of course also be used with many other registers.

When the TS06A-EDM is used as a free-standing dispenser meter, it can be used with many different electronic registers, which can be either installed on the flow meter, or remote.



1. The SCL is **model specific**, and in some cases also *application specific*. **Do NOT transfer to another flow meter without consulting with Tuthill.**
2. Use 4 conductor shielded cable.
3. Terminate shields at receiving instrument (register).
4. Move W1 shunt (jumper) to match operating voltage:
5. S1 must be in Q position.
6. Output signal has an internal pull-up resistor (1000 Ω) on each channel.
7. If the receiving instrument (register) is more than 200' (60 m) cable distance from the flow meter, an amplifier is required on the pulse signal. If this option was not ordered, please consult with Tuthill prior to start-up.

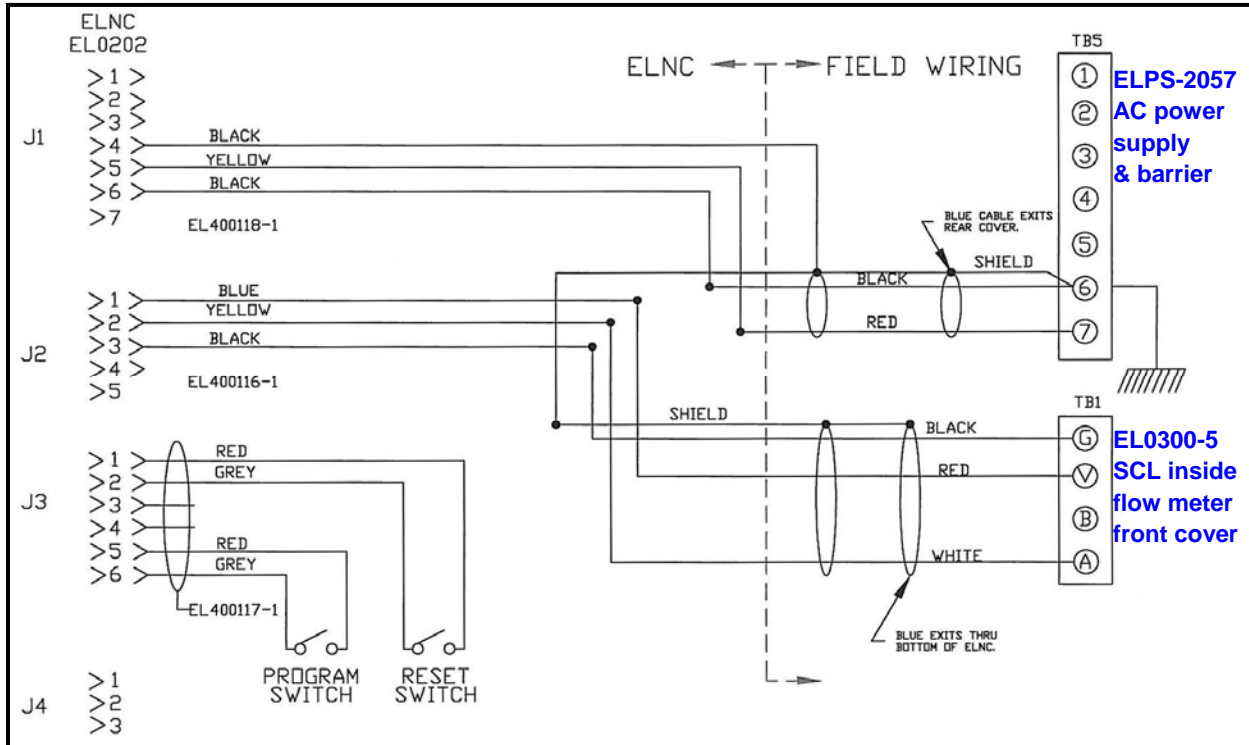


Both pins covered: 5VDC Regulated
= EL0300-5-1



1 pin exposed: 5.5 - 12 VDC
= EL0300-5-3

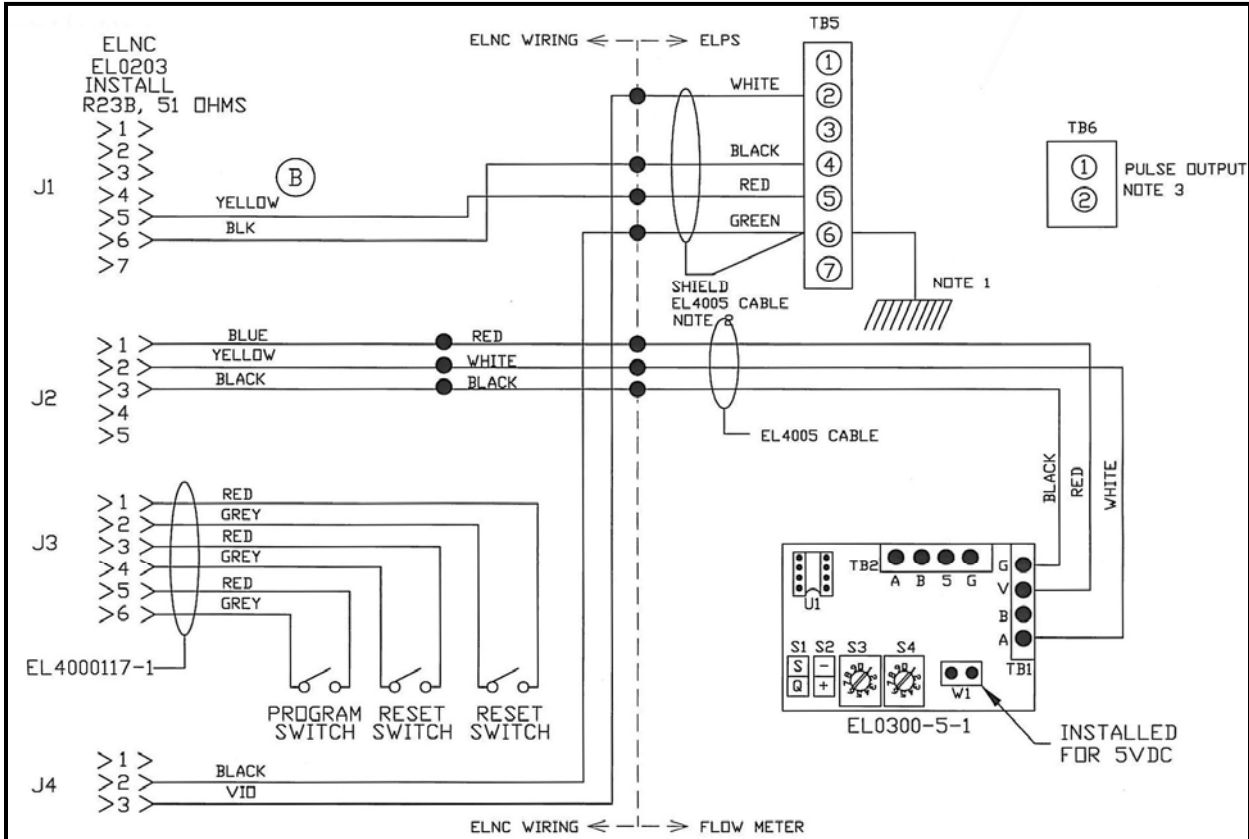
TS06A with SCL & ER9044 (ELNC-1141) register, AC powered through EL2057



1. This drawing does not guarantee compliance for intrinsically safe apparatus. Refer to CD1000, CD1001 and State & National electrical codes.
2. Terminate shields only at J1-4.
3. Cable lengths are limited by entity parameters.

Installation & Operation continued

TS06A with SCL & ER-9044-2 (ELNC-1141E) register, with Backlight Display & 10:1 Pulse, AC powered through EL2057



1. This drawing does not guarantee compliance for intrinsically safe apparatus. Refer to CD1000, CD1001 and State & National electrical codes.
2. Cable lengths are limited by entity parameters.
3. ELPS output option: Install U1, R3, TB6.

Theory of Operation:

The TUTHILL meters LPG metering system combines an oval gear positive displacement meter, differential valve, strainer and vapor eliminator in one assembly. The differential valve incorporates a piston type construction with the piston moving away from its seat when at least 15 PSI pressure (above product vapor pressure) is maintained at the meter outlet. The soft seat valve assures measurement accuracy by requiring pump operation for delivery, by requiring adequate back pressure to prevent product vaporization during measurement and by requiring blockage of flow when the vapor eliminator release valve is open. The strainer prevents foreign particulate from entering and damaging the meter. The meters close tolerance machine construction and no metal to metal contact provides accurate liquid measurement.

Installation, Flow Meter:

Install the meter assembly in a dispenser cabinet, or a truck deck to a secure base using the bolt holes on the "feet" of the strainer assembly base. Make inlet and outlet connections at the flanged surfaces on the strainer and differential valve, respectively. **Leave a minimum of 12 inches between the strainer flange and any obstacle for servicing the strainer.**

Installation, Vent Line:

The vent line from the meter's vapor vent to the vapor space on the supply tank should be a minimum of 1/4" inside diameter tube or pipe. A shutoff valve must be installed in the vapor vent line to allow removal of the strainer or service on the meter. The vapor release vent line must be returned to the vapor space of the supply tank and normally should not be made common with the other vapor return lines or pump by-

pass lines.

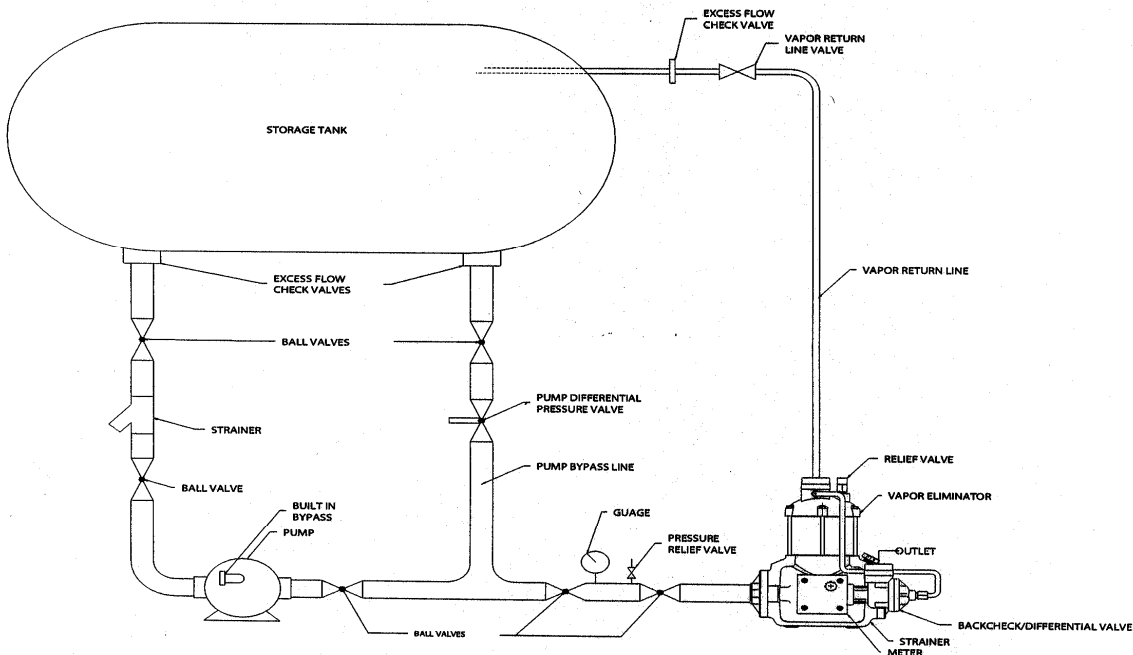
When properly installed, this line must permit free flow in either direction. If the vent line is closed the meter will not function, as the differential valve will not open. These instructions must be followed to maintain proper function of the differential valve.

Support:

Prevent pipe strain or stress from occurring when making connections to meter or accessories and during repairs. Pipe strain and stress occurs when the pipes are not supported or are not aligned correctly to the meter. The weight of the pipes must always be supported independent of the meter. This meter and accessories can easily be removed without affecting the pipes or the pipe alignment. Never leave any of the pipes hinging.

Storage:

If the meter is used for seasonal work, at the end of each season the meter should be removed from the system and thoroughly flushed with a compatible liquid. This includes removing the drain on the front and rear covers. Then flush the product from the front and rear covers. If flushing with water is preferred, extra care should be taken to drain the meter completely and to dry all internal parts. Immediate refilling with a compatible liquid (or oil misting) is essential to prevent corrosion as well as ice damage to parts from moisture that was overlooked after flushing and drying.



Danger!!

Danger!!

Danger!!

Relieve all internal pressure before servicing.

Line pressure must be 0.0 PSI

Serious injury or death from fire or explosion could result from maintenance of an improperly de-pressurized and evacuated system.

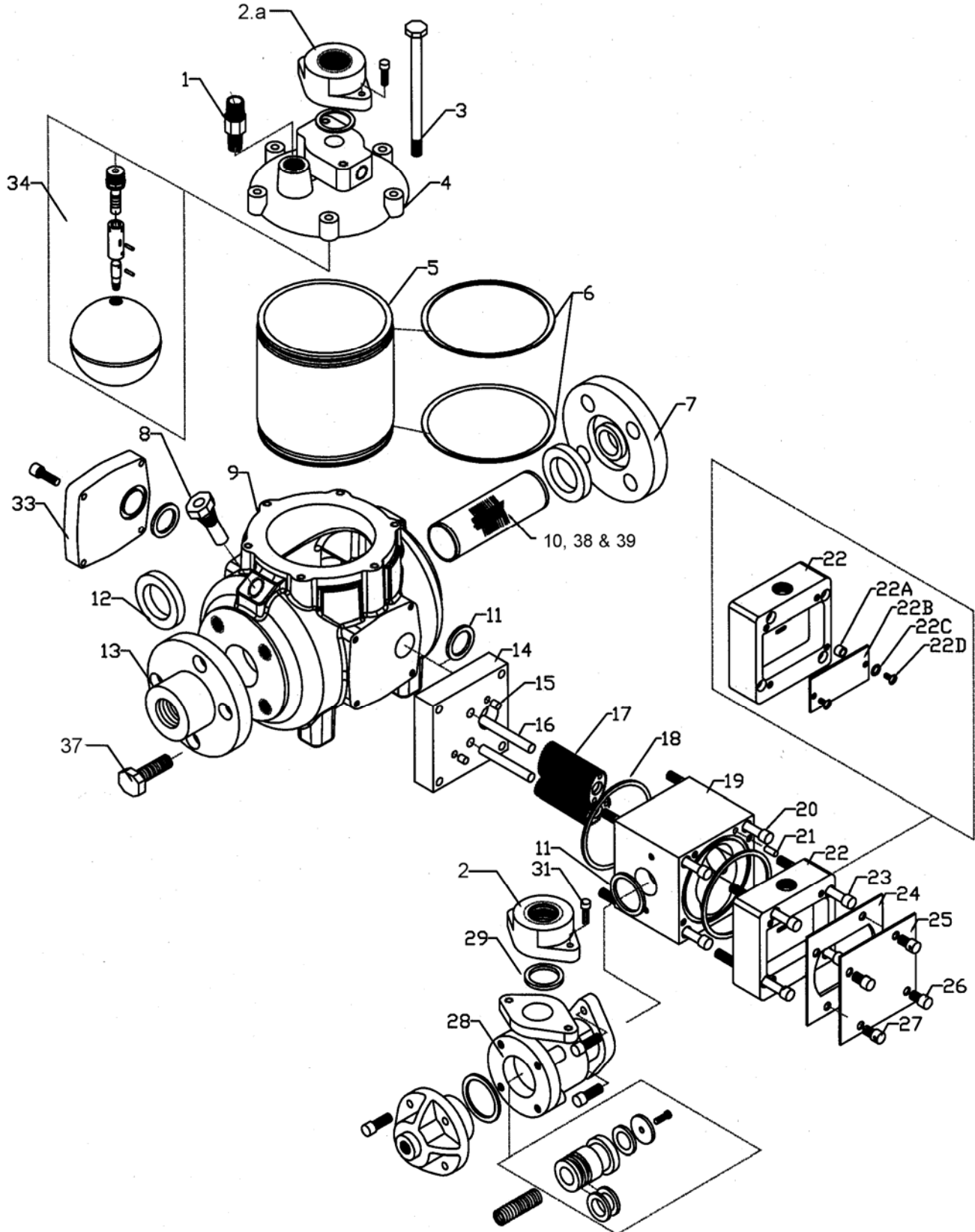
Preparing for Service:

- Close the belly valve of the supply tank.
- Close the valve on the vapor return line.
- Close the manual valve in the supply line on eh inlet side of the meter. If no manual valve exists on the inlet side, consult the dispenser manufacturer or installer for procedures to depressurize the system.
- Slowly open the valve/nozzle on the end of the supply line
- After product is bled off, close the valve/nozzle at the end of the supply line.
- Open the bleed valve provided by your installer to relieve the system pressure. Product will drain from the meter system.
- As product is bleeding from the bleed valve, slowly reopen and close the valve/nozzle on the discharge line. Repeat this step until the product stops draining from the bleed valve and discharge line valve/nozzle.
- Leave the discharge line valve/nozzle open while working on the system.
- Removing flange seals: When removing the flange assembly, always carefully remove the O-ring seal. Make sure that the flange surface is clean. Discard and replace the old O-ring seals if it is nicked or scratched in any way. If it is undamaged, it can be re-used.
- Examine all fasteners: make sure fasteners are not bent, rusted, or have pulled or burred threads. The threads should all appear evenly placed. If the bolts are bent, check the housing and cover for flatness. Use a straight edge to determine flatness. Use a stone to remove any burrs on the flat surfaces for the housing.
- Look for gaps: When disassembling a meter, use a feeler gauge to check for gaps between the post and gear plates and housing. If you do find gaps, check the plates for flatness with a straight edge. Gaps can be caused by shock problems that must be resolved. Contact your full service distributor, or the Service Department at TUTHILL meters for assistance if this occurs.
- Check the O-Rings: O-rings should be smooth. Cracked or worn O-rings should be replaced. However, a more serious problem of shock may have occurred if the O-rings are nibbled or extruded. Shock problems must be verified and resolved. Contact your full service distributor, or the Service Department at TUTHILL meters for assistance if this occurs.

General Service:

- Do not scratch or mar any of the precision machined surfaces by prying or sanding parts.
- Torque specifications. All fasteners such as screws and bolts should be torqued to proper specifications. See the "Torque Chart" in this manual.
- Stone the machined surfaces when reassembling the meter to assure the machined surfaces are free of burrs and scratches.
- Repair pulled threads with threaded insert fasteners. These can be used in many instances. Contact your full-service distributor for advice if this occurs.
- Coating threads: When removing and replacing bolts and screws in a meter, always coat the threads with anti-seize.
- Check the post and gear plates: Check the plates for flatness. Use a straight edge. Warped plates can be caused by hydraulic shock problems that must be resolved. Contact your full service distributor, or the Service Department at TUTHILL meters for assistance if this occurs.
- Weights & Measures: Check with the regulatory agency that governs Weights and Measures in your area. Removing a seal wire may require Weight & Measures recalibration.

Flow Meter Maintenance



Danger!!

Danger!!

Danger!!

Relieve all internal pressure before servicing.

Line pressure must be 0.0 PSI

Serious injury or death from fire or explosion could result from maintenance of an

Meter Disassembly:

- If your meter is equipped with an electronic register, remove the register and register housing assembly.
 - Disconnect the outlet flange (30) and the vapor tube connecting the differential valve and the vapor return line.
 - Remove the four bolts (26) and (27) and the dust cover (25).
 - Disconnect the outlet wiring from the electronic pulser assembly (SCL) terminal TB1 (See SCL service manual)
 - Install a new oval gear set (17) if necessary. Gears should be perpendicular to each other. The gears will not rotate a complete revolution if not installed properly. Once installed, the gears should rotate freely with out binds or rubs. Check the clearance between the gears and the body. There should be a minimum of .003 inch between gears (17) and the meter cover (22). If there is any binds or rubs between the gears and the meter body, it is recommended that the meter be replaced.
 - Reinstall the meter cover (22).
 - Reinstall the differential valve.
 - It is recommended that all O-rings and seals be replaced during service, but a good inspection is critical if seals are reused.
 - Calibrate the meter and return to service.
- Note: If the SCL does not require service, and there is no damage to the meter cover (22), it is possible to replace the meter using the existing meter cover. In this case it is not necessary to disconnect the outlet wiring.**
- Remove the four bolts (23) and the SCL housing (22).
 - Inspect the internal parts for wear. Gear may be replaced at this point if all other components are good.
 - Remove the bolts () and remove the differential valve.
 - Remove the four bolts (20) and the meter assembly (body (19) and post plate (14).
 - Clean all surfaces using a brush or fine (200 grit) emery cloth.
 - Inspect and repair the inlet check valve if you have this option.
 - Inspect the meter body for damage. Use 200 grit paper to remove small scratches and blemishes, if the damage is more than superficial, replace the body.
 - Inspect the post and post plate. Replace if there is any wear.
 - Inspect the O-ring seals, and replace any damaged or brittle seals.
 - Reinstall the meter in reverse order.

Inlet Check Valve Service: (Optional component)

- Disconnect the outlet piping from the meter assembly at the differential valve outlet flange.
 - Remove the meter as detailed in the METER DISASSEMBLY section.
 - Remove the back check valve assembly (11).
 - Manually open and close the valve to assure proper operations.
 - Inspect for dirt or salt build-up and clean if necessary.
 - Inspect the seals for wear or damage. Replace worn or brittle seals.
 - Reassemble the valve and install in the strainer housing. This valve is optional and will not retrofit into strainer housing not originally supplied with the valve.
 - Reassemble the system making sure bolts are torqued to the proper specifications
- Inspect the slide valve. Remove and build-up of salts or dirt which may cause the valve to stick. The valve should slide freely without any signs of sticking. There should be no scratches or burrs on the valve assembly. Replace if there are signs of damage.
 - Inspect all seals, and replace if damaged or brittle.
 - Re-assemble the meter in the opposite direction making sure all bolts are torqued to the proper specifications.

Strainer Service: (See page 8)

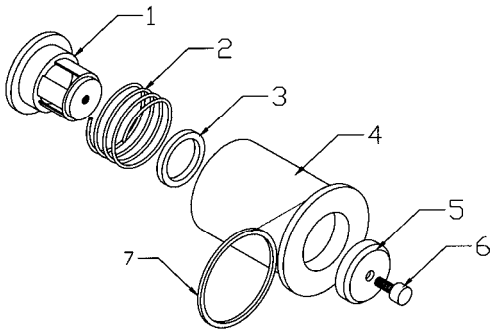
- Remove the four bolts (37) from the rear cover and remove the cover (7).
 - Inspect the seal (12) and replace if damaged or brittle
 - Remove the strainer (10). Clean the strainer with low pressure air, blowing out all loose sediment. Wash the strainer with solvent.
 - Inspect the strainer for holes or other damage and replace if necessary.
 - Re-assemble making sure the bolts are torqued to the proper specifications.
- Remove the outlet piping flange.
 - Remove the connecting tube between the differential valve and the vapor eliminator.
 - Remove the Screws (1) securing the cover (2) from the valve body (4).
 - Remove the differential valve piston assembly (8) and spring (7).
 - Inspect the valve body and cover for damage. Clean all surfaces of dirt or deposits using a fine (200 grit) emery cloth if necessary. If damage is more than superficial, replace the valve.
 - Inspect all seals and replace any brittle or damaged seals. It is recommended that all seals be replaced during service.
 - Replace the U-Cup seals (8a). Note proper position of the seals. Use a small amount of Teflon lubricant to help install the seals.
 - Replace the square cut seal (8b). Use thread sealer (Locktite Blue) when installing the fastener (7e).
 - Re-assemble the valve in the opposite manner.

Vapor Eliminator Service: (See pages 8 & 11)

- Disconnect the vapor return line flange and the differential valve tubing.
- Remove the five bolts (3) from the vapor eliminator housing.
- Remove the cover (4) from the vapor eliminator housing.
- Remove the float and valve assembly (34) from the cover for inspection.
- Inspect the float for damage or leakage. A crack will allow the float to fill with liquid and sink thus prevent the valve from closing. A collapsed float is an indication of over pressure or hammer and these operation conditions must be corrected before reusing the meter.

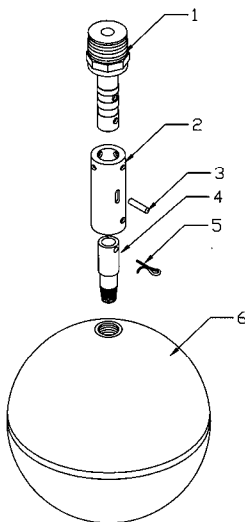
Flow Meter Maintenance

3/4" Back Check Valve Assembly (Optional)



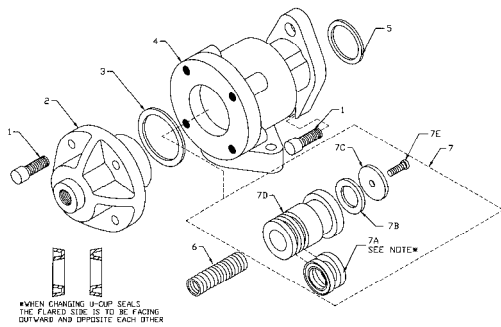
Item #	Qty	Description	Part #
	1	Complete Backcheck Valve Assy.	VP3075
1	1	Piston, 3/4" Backcheck Valve	MP4001
2	1	Spring	MS8031
3	1	"O" Ring	SL3114-UL
4	1	Body, 3/4" Backcheck Valve	MP3075-1
5	1	Poppet, 3/4" Backcheck Valve	MP3076
6	1	10-32 x .375 SHCS	FS9651
7	1	"O" Ring	SL218

Air Eliminator Assembly



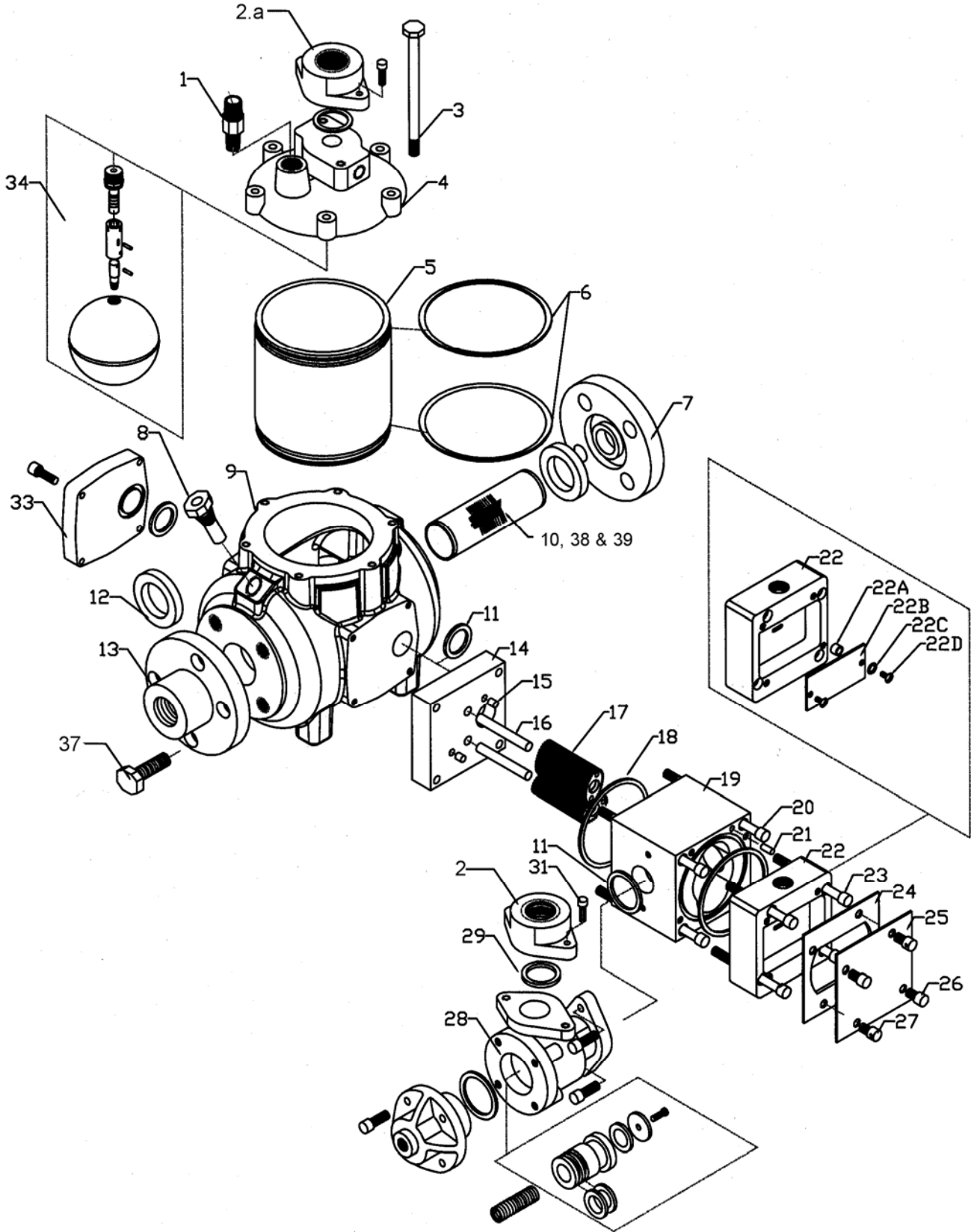
Item #	Qty	Description	Part #
	1	A/E Assembly	AE8201
1	1	Outlet Port, 3/4" A/E Assembly	MP4060
2	1	Valve Sleeve, 3/4" A/E Assembly	MP5200
3	1	3/32 Roll Pin	MS9260
4	1	Float Connector	MP1582
5	1	1/16 Cotter Pin	FS9213
6	1	Float	MS9100

Differential Valve Assembly



Item #	Qty	Description	Part #
	1	Complete valve assembly	DV6100
1	6	Bolt, 1/4"-20 x 1" ALSTPL SHCS	FS2801
2	1	Cover, 2/4" Differential Valve	CP6101
3	1	"O" Ring, UL Buna	SL3224
4	1	Valve Body, 3/4" Differential Valve	MP6100
5	1	"O" Ring, UL Buna	SL3132
6	1	Spring, 3/4" Differential Valve	MS8035
7	1	Repair Kit, Piston, 3/4" Differential Valve	RK4000
7a	2	U-Cup Seal, UL Viton	SL1212-U
7b	1	"O" Ring, Sq. Cut, UL Buna	SL3212-SQ
7c	1	Seal Retainer	ST6102
7d	1	Piston, Brass, 3/4" Differential Valve	MP4000

Exploded View



Parts List

Item #	Description	QTY	SINGLE	QTY	TWIN	
1	Relief Valve	1	MS8400	1	MS8400	R
2.a	Flange 1" FNPT (ALUM)	1	MP2568	1	MP2568	
	Flange 1" FBSP (ALUM)	1	MP2569	1	MP2569	
3	1/4-20 x 5" Hex Bolt	6	FS2910	6	FS2910	
4	Cover, Vapor Eliminator	1	MP2561	1	MP2561	
5	Housing, Vapor Eliminator	1	MP2565	1	MP2565	
6	O-Ring, Buna	2	SL3156	1	SL3156	R
7	Strainer Flange, Blind	1	MP2562	0	MP2562	
8	Thermowell					
	in S83, S84, E83, E93, E71-73	0		0		
	in S86, S88, E86 & E96	1	MP2564-1	1	MP2564-1	
9	Strainer Housing	1	MP2560	1	MP2560	
10	Strainer Basket	1	SA8010-200	1	SA8010-200	
11	O-Ring, Buna	2	SL3123	1	SL3123	R
12	O-Ring, Buna, Square Cut	2	SL3324-SQ	1	SL3324-SQ	R
2 & 13	Included in flange kits:					
	3/4" NPT	1	FK2075UA	1	FK2075-1UA	
	3/4" BSP	or	FK2075UB	or	FK2075-1UB	
	1" NPT	or	FK2100UA	or	FK2100-1UA	
	1" BSP	or	FK2100UB	or	FK2100-1UB	
14	Post Plate Assembly	1	CP25952	2	CP25952	R
15	Dowel Pins	2	MS2119-8	4	MS2119-8	
16	included in #14		nss		nss	
17	Gear Set	1	GS550CC	2	GS550CC	R
18	O- Ring, Buna	2	SL3151	4	SL3151	R
19	Meter Body	1	MB2551	2	MB2551	
20	1/4" - 20 x 3.25 SHCS	4	FS2911	4	FS2911	
21	Dowel Pins	2	MS2001	4	MS2001	
22	Cover, Chamber	1	MP2574	2	MP2574	
22b	SCL Assembly, 5V regulated ***	1	EL0300-5-1-3	2	EL0300-5-1-3	R
	SCL Assembly, 6-12 V ***	or	EL0300-5-3-3	or	EL0300-5-3-3	
23	1/4" - 20 x 1.25 SHCS	4	FS1803	8	FS1803	
24	Gasket, Dust Cover	1	SL7000	2	SL7000	
25	Dust Cover	1	ST1301	2	ST1301	
26	1/4" - 20 x 0.5 SHCS	2	FS9812	4	FS9812	
27	1/4" - 20 x 0.375 SHCS w/hole	2	FS9810	4	FS9810	
28	Differential Valve	1	DV6100	2	DV6100	R
	Differential Valve Hose Assy.	1	MS5075	2	MS5075	
29	O- Ring, Buna	2	SL3127	4	SL3127	R
31	1/4" - 20 x 1"- Hex Bolt	4	FS2801	8	FS2801	
33	Cover Blind	1	MP2573		MP2573	
34	Vapor Eliminator Float Assy	1	AE8201		AE8201	R
35	1/4" Lock Washers	10	FS9302		FS9302	
37	1/2" - 13 x 1.25" Hex Bolt	9				
38	Strainer Basket Magnet	1	MP5008		MP5008	
39	Magnet Holder	1	MS7017		MS7017	

*** Not all SCL software is the same. Output type and frequency may vary.

Please have meter model and S/N available for your specific product.

R = Recommended Spare Parts

Trouble Shooting

<u>Problem</u>	<u>Probable Cause and Solution</u>
Leakage from seal cover.	<ul style="list-style-type: none">• Seal has been damaged due to shock• Cover bolts have not been tightened sufficiently• Replace seal and /or re-torque bolts
Product flows through meter but the register does not operate	<ul style="list-style-type: none">• Pulser is not functioning properly• Meter gears are jammed and not turning• Replace the pulser, inspect internal meter parts
Breaking teeth on gears.	<ul style="list-style-type: none">• Starting or stopping flow too rapidly.• Normal wear after long service• Replace gears• Correct system operation• Check pump by-pass setting.
No flow or low flow through the meter	<ul style="list-style-type: none">• Faulty non-functioning pump• Differential valve not open or not functioning. Replace valve• Meter “frozen” due to build up of salts or frozen material. Clean meter internals and inspect for damage• Vapor vent line valve shut or obstruction in vapor vent line. Open valve or remove obstruction• Strainer dirty and plugged. Clean Strainer• U-Cups on differential valve leaking. Replace U-Cups
Meter operates too slowly:	<ul style="list-style-type: none">• Differential valve internal mechanism faulty. Valve does not open fully.• Meter gears or rotors partially “salted”, enough to slow the rotating gears. To correct, clean gears.• Strainer partially plugged. Clean strainer basket.• Pump not functioning properly. Repair pump
Product flows through the meter but register does not record properly:	<ul style="list-style-type: none">• Pulse output board faulty, or not calibrated for electronic register.• Vapor release valve sticking.• Differential valve leaking.• Repair or replace as necessary.

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%

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 (can), 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 20 gallon (75.7 liter) can, the can reads 113.5 ml high. The meter error is $(113.5/75700) = 0.0015$ or .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 113.5 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.

