SATAM

AIM BLOCK

ADDITIVE INJECTION MANIFOLD
Models: AIM004, AIM006, AIM008

I N S T R U C T I O N   M A N U A L

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Index / contents

1 General

1.1 Overview

AIM block is a compact all stainless steel manifold assembly with isolating, flow regulating & check valves, a fine mesh strainer, solenoid valve & a precision oval gear flow meter. Inlet & outlet elbows can be arranged in three orientations providing installation flexibility. All assemblies shown are modular to the manifold & may be quickly changed in-situ.

AIM block will work with any controller or TAS system, serving as a composite slave assembly for the accurate blending of fuel additives to fuels at loading facilities, stationary & mobile transfer units within the petroleum industry worldwide.

Central to the AIM block is a precision oval positive displacement flowmeter having both a solid state & reed switch style outputs with the options of an Exd explosion proof terminal housing, alternatively the reed switch output can be used in conjunction with an approved Intrinsically safe interface for hazardous area operation.

The second most crucial element is the solenoid valve, SATAM have chosen a fast direct acting valve with a ruby seat in order to avoid the use of expensive sealing elastomers, the ruby seat also allows for high velocity flows through a small 3mm orifice providing minute proportion control even at high injection pressures where seating elastomers can deform & extrude (cold flow).

AIM accurately injects small amounts of modifying additives to base product. Additives include lead replacements, Dyes & Markers, Denaturants, Detergents, Odorizing, Antifreeze, Anti-corrosion, Anti-detonating, Anti-static, Antiicing, Anti-foaming, Emulsifiers and performance enhancing agents.

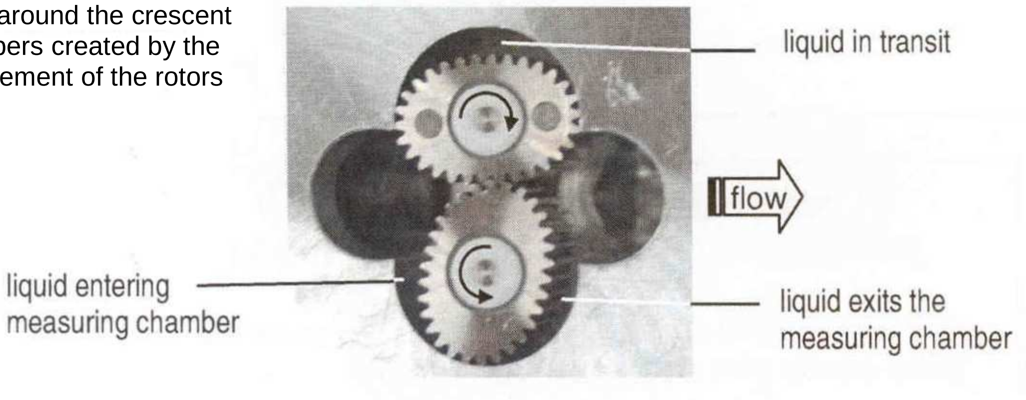
1.2 Flowmeter Operating Principle

The Oval Gear meters are positive displacement flowmeter where the passage of liquid causes two oval geared rotors to rotate within a precision measuring chamber and with each rotation a fixed volume of liquid is displaced passing through the meter. Magnets embedded within the rotors initiate a high resolution pulse train output. The pulse output can be wired directly to process control and monitoring equipment or can be used as an input to instruments supplied with or fitted directly to the meter.

The benefits of this technology allow precise flow measurement and dispensing of most clean liquids irrespective of their conductivity, with other liquid characteristics having nil or minimal effect on meter performance. This metering technology does not require flow profile conditioning as required with alternative flow technologies making the installation relatively compact and low cost.

OPERATION :

Liquid travels around the crescent shaped chambers created by the rotational movement of the rotors



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1.3 Model number information

AIM004	0.01 ~ 1.0 L/min	*(0.002 ~ 0.27 GPM)*
AIM006	0.03 ~ 1.66 L/min	*(0.008 ~ 0.44 GPM)*
AIM008	0.25 ~ 10 L/min	*(0.07 ~ 2.65 GPM)*

AIM materials

S	*meter, all valves & strainer 316SS, manifold block 303SS

* solenoid valve has a ruby seat to cover all applications

O-ring materials

1	Viton *(standard)*
2	Ethylene Propylene Rubber *(EPR)*
3	Teflon encapsulated viton
4	Buna-N *(Nitrile)*

Meter protection approval

0	No appoval
1	IEC / ATEX / Ex d
2	ATEX / EX ib

Cable entry for meter

1	M20 x 1.5mm
2	1/2" NPT

Solenoid valve voltage

-	0	12Vdc - max. 7 bar (100 psi)
-	1	24Vdc - max. 7 bar (100 psi)
-	2	110Vac - Max. 20 bar (300 psi)
-	3	220Vac - *Max. 20 bar (300 psi)*
-	9	Customer nominated

Solenoid valve approval

0	No approval
1	IEC / ATEX

Integral options

	0	No options
return to drum prime valve	1	**290kpa (43psig) relief valve
2 NPN open collector phased outputs	2	Quadrature pulse output
	3	Quadrature output + relief valve

Model No. Example

AIM006 | S | 1 | 1 | 3 | - | 2 | IO | 2

***used for re-priming system when additives are being pumped from 200L drums*

1.4 Specifications

Model prefix :	AIM004	AIM006	AIM008
Process connections	*3/8"NPT elbows, 3 x 90° orientation positions*		
Flow range - *litres / min*	0.01 ~ 1.0	0.03 ~ 1.66	0.25 ~ 10
Accuracy @ 3cp	±0.5% o.r.		
Repeatability	typically ±0.25%		
Temperature range			
non Ex d installations	-20ºC ~ +100ºC		
Ex d installations	-20ºC ~ +65ºC		
Maximum pressure			
Maximum Static Pressure	30 bar		
6~110Vdc solenoid coils	10 bar		
108~240Vac solenoid coils	20 bar		
Protection class			
Flowmeter	IP66/67 (NEMA4X), Exd IIB T6 or		
	IP66/67 Ex ib IIA T4		
Solenoid valve	IP66/67 (NEMA4X), EEx dm IIC T4		
Strainer element	75 micron (*200 mesh*) minimum		
Electrical			
Output pulse resolution	pulses / litre - nominal		
Reed switch	2890	2100	355
Hall effect	2890	2100	710
Ex d			
** Reed switch output	30Vdc x 200mA max.		
Hall effect output (NPN)	3 wire open collector, 5~24Vdc max., 20mA max.		
Ex ib			
Safety parameters	Ui = 5.88VDC, Pi ‹ 1.2W		
Optional			
Quadrature pulse output	dual Hall Effect phased outputs		

** Max flow is to be reduced as viscosity increases, max. press. drop 100Kpa. (15 psi)*

*** Maximum thermal shock 10ºC / min. applies to the reed switch*

2.0 Installation

2.1 Mechanical Installation *Prior to installing the block check :*
The fluid is compatible with the meter materials of construction using appropriate information such as fluid compatibility charts and site experience.

Application and process conditions are compatible with the block specifications. Minimum and max. flows are within the meter specified range including any in-situ cleaning processes. When metering viscous liquids the maximum allowable flow may need to be reduced to ensure the pressure drop across the meter does not exceed 100 kPa *(1 Barg, 15 PSIG).*

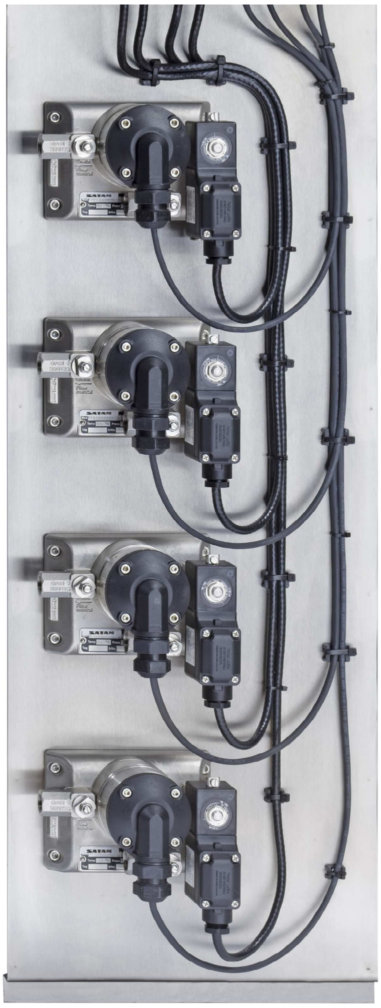
Process temperature and pressure does not exceed block ratings.

The block is not exposed to process temperatures and pressures that will cause the liquid medium to gasify (flash) within the assembly.

2.1.1 Orientation

The flowmeter MUST be mounted so that the rotor shafts are in a horizontal plane, this can be achieved by mounting the block on a vertical surface or a vertically orientated backing plate as pictured (4 blocks shown).

Note the terminal cover can be rotated in 90 degree increments to provide access to the electrical entry from 4 angles, the solenoid valve coil can also be orientated in various positions to suit the installation.



2.1.2 Flow Conditioning and Location

Flow conditioning : The flowmeter does not require any flow conditioning, therefore straight pipe runs before or after the block are not required. If required, the pipe size about the block can be altered to suit the installation.

Fluid state : Fluid entering the block must remain a liquid at all times so protect the meter to avoid solidification or gelling of the metered medium. If meters are to be trace heated or jacketed in any way the maximum temperature rating of the meter must not be exceeded. Size the meter to avoid gasification of volatiles *(flashing)* within the liquid due to the pressure drop experienced within the system or within the meter.

Locations : The block is to be fitted downstream of the additive pump, there is a discharge check valve within the block outlet which prevents reverse flow through the block and minimizes the risk of rainage and air entrapment which can result in erroneous readings or damage the meter on start up.

If exposed to weather ensure a suitable watertight gland or plug is used to seal any open electrical entries. In humid environments take precautions to avoid condensation build up within the electrical chambers. It is good wiring practice for conduits to be connected from the bottom of an entry port, in this way any condensation will gravitate away from any terminal housing.

2.2 Electrical Installation

2.2.1 Instrument Cable Twisted pair low capacitance shielded instrument cable 7 x 0.3mm *(0.5mm²)* should be used for electrical connection between the flowmeter and remote instrumentation, use Belden® number 9363 or similar. The cable drain or screen should be terminated on a DC COMMON or a specifically assigned shield termination at the readout instrument end only in order to protect the transmitted signal from mutual inductive interference. IMPORTANT, tape off & isolate the shield at the flowmeter end of the cable.

The cable should not be run in a common conduit or parallel with power and high inductive load carrying cables as power surges may induce erroneous noise transients onto the transmitted pulse signal or cause damage to the electronics. Run the cable in separate conduit or with other low energy instrument cables. The maximum transmission distance is typically 1000m *(3300 Ft).*

2.2.2 Hazardous area wiring Intrinsically safe wiring including using the reed switch pulse output as a simple apparatus, wiring to an Intrinsically Safe Instrument or wiring to the Exd explosion proof option(Exd IIB T4/T6) wiring techniques must be undertaken in accordance with the rules, regulations and requirements applying to the territory in which the meter is being installed. The meters should only be connected by qualified staff, the qualified staff must have knowledge of protection classes, regulations & provisions for the apparatus in hazardous areas.

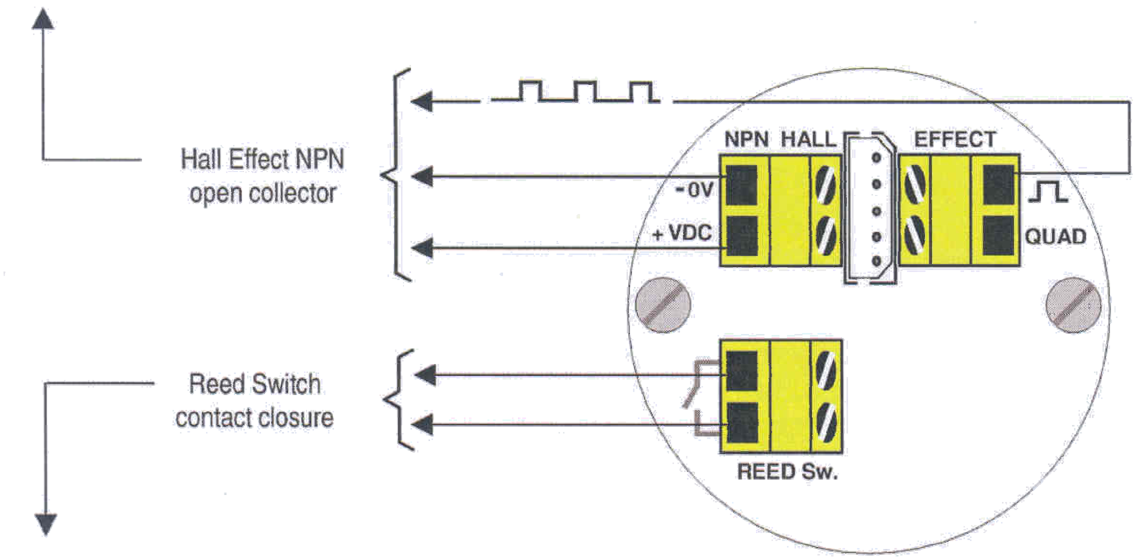
Earthing lugs are located within the terminal housing cover, use a separate earth within the cable making sure that the earth conductor does not come in contact with the cable shield / screen. Use only high temperature cable at the flowmeter when the process temperature exceeds 85ºC.

2.3 Pulse Output selection for pulse meters Two types of output are available on each meter, open collector from Hall Effect sensors or reed switch contact. Each output type is linearly proportional to volumetric flow and each pulse is representative of an equal volume of liquid.

2.3.1 Hall Effect Sensor Pulse Output The Hall Effect Sensor is a high resolution solid state 3 wire device providing an un-sourced, open collector, NPN transistor output. The term “un-sourced” means that no voltage is applied to the output from within the flowmeter, it must be pulled to a ‘high’ or ‘on’ state by between 5~24Vdc supplied from an external source, typically the receiving instrument.

The pulse output between signal and -0V is a voltage square wave with the high level being the dc voltage available at the open collector and the low level being -0V.

The receiving instrument must incorporate a pull up resistor *(typically greater than 10K ohms in most instruments)* which ties the open collector to the available dc voltage level when the Hall sensor is not energized. When energized the open collector output is pulled to ground through the emitter (-0V).

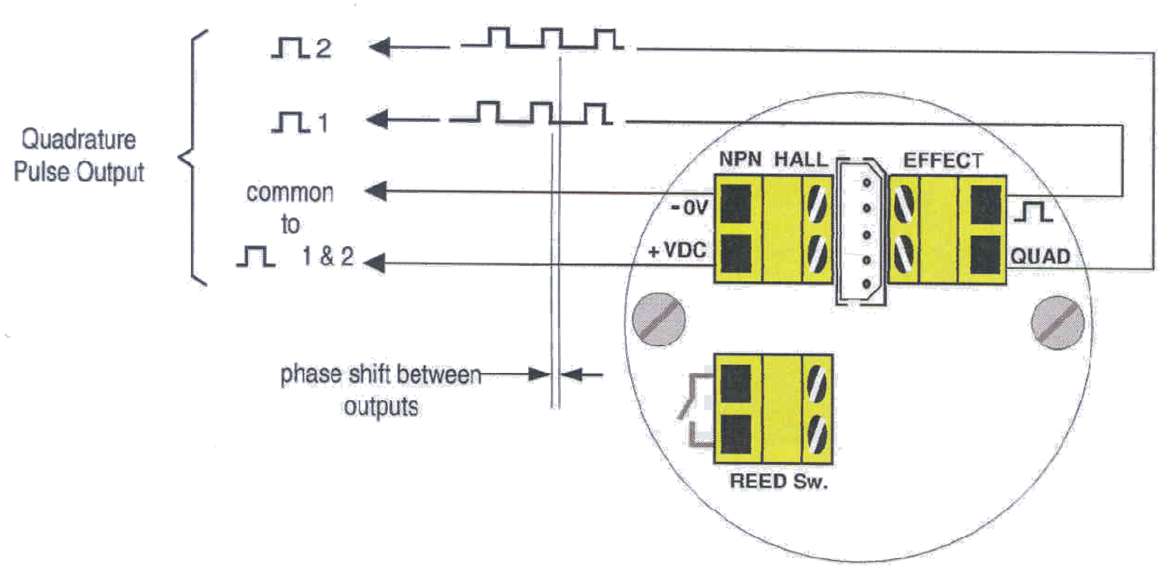


2.3.2 Reed Switch Pulse Output The reed switch output is a two wire normally open SPST voltage free contact ideal for installations without external power or for use in hazardous area locations when Intrinsically Safe (I.S.) philosophy is adopted. **Note:** when using the reed switch output the liquid temperature must not change at a rate greater than 10ºC per minute (50ºF per minute). In general the reed switch life will exceed 2 billion actuations when switching less than 5Vdc @10mA.

2.3.3 Quadrature (QUAD) Pulse Output The diagrams below apply when the meter is fitted with the Quadrature pulse output option *(two Hall Effect sensors arranged to give separate outputs out of phase withone another).*

The Quadrature output is typically suited to custody transfer applications where signal integrity verification is required, it is also used for metering bi-directional flow.

2.3.4 Signal integrity verification Many fiscal transactions require the primary measuring device *(flowmeter)* to have Quadrature outputs in order to detect any difference in the number of pulses from each input (*from* &) during delivery.



3.0 Commissioning

Once the block has been mechanically and electrically installed in accordance with this and any other relevant instrument manual(s) the meter is ready for commissioning.

The block must NOT be run until the pipework is flushed of foreign matter, more often than not foreign matter is present after pipework fabrication or modification, weld slag, grinding dust, sealing tape & compound &/or surface rust are most common offenders and can lead to server damage to precision components.

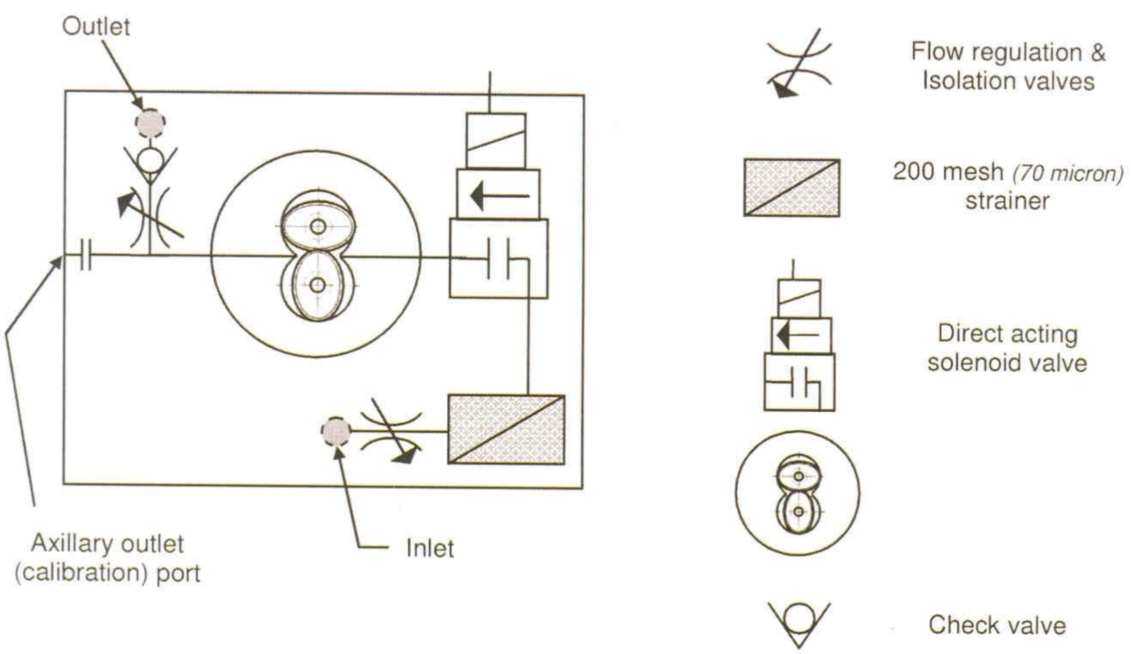
Flushing can be undertaken by utilizing a by-pass or removing the meter from the pipework.

After flushing or following long periods of shutdown the meter must be purged of air/vapour. This can be achieved by allowing the liquid to flow through the meter at a slow rate until all air/vapour is displaced. Never run the meter above its maximum flow or exceed 100kpa (1 bar, 15psi) pressure drop across the meter. Now the meter is ready for its operation to be confirmed by ensuring correct indication or operation at the receiving instrument(s). Refer if necessary to fault finding section of this manual.

3.1 Meter Calibration Factor *(K or scale Factor)* Each flowmeter is individually calibrated and supplied with a calibration certificate showing the number of pulses per unit volume *(eg pulses per litre or pulses per US gallon).* Initial calibration is done using Castrol diesel injector calibration fluid 4113, nominal calibration figures are shown in the specification section of this manual.

Due to operational variations such as additive batch cycle rates and batch cycle values it may be necessary to individually calibrate each block in situ using the actual additive of the process, this is commonly done as a matter of course at time of commissioning and periodically as required by any traceability standards within the industry (see in-situ calibration on following page).

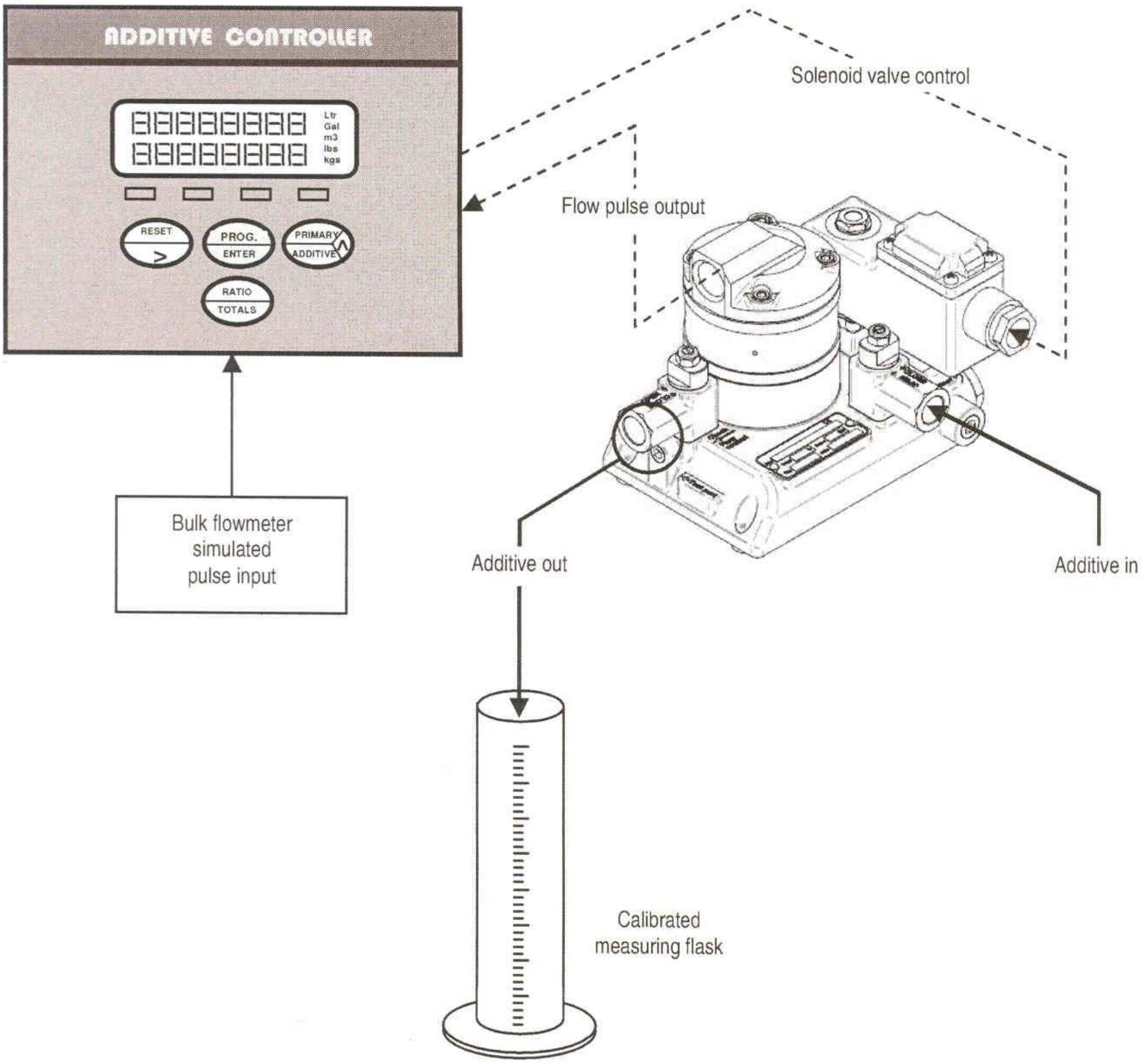
3.2 AIM block hydraulics



3.3 In-situ calibration

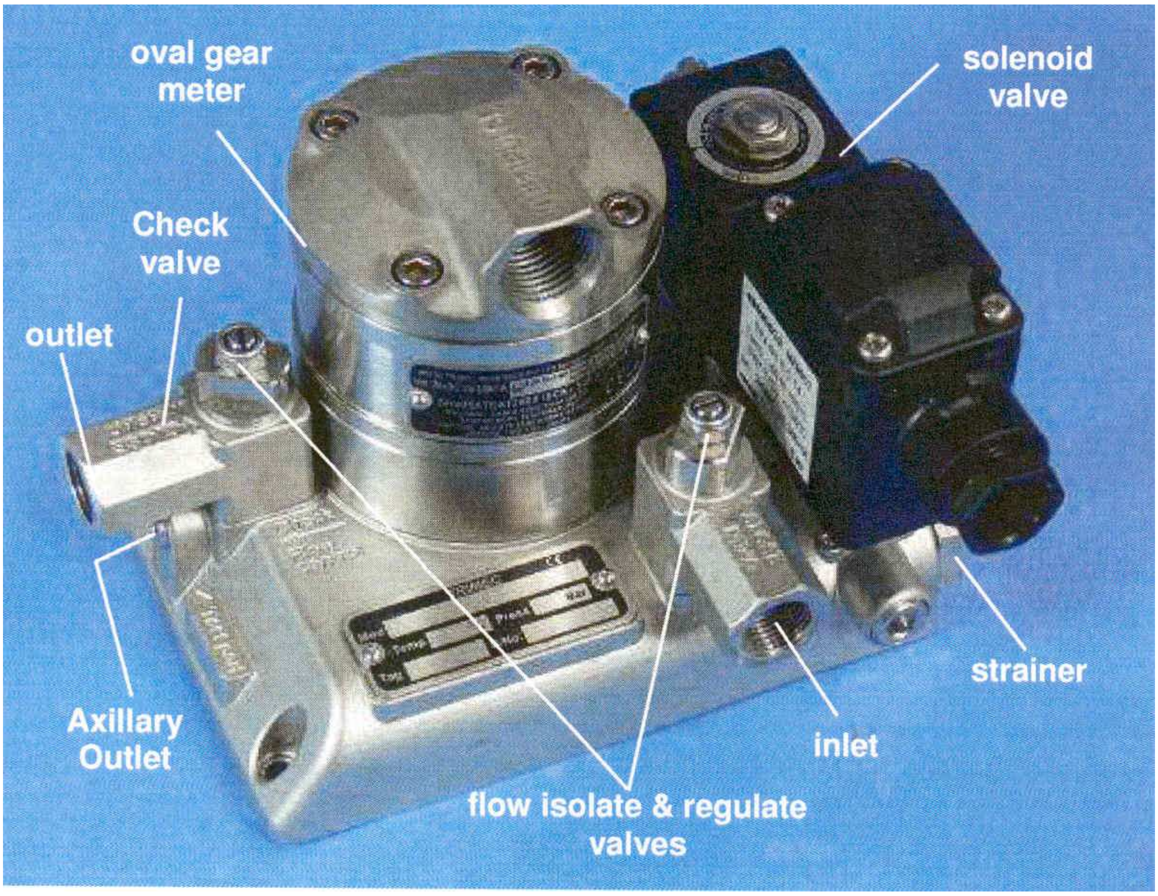
In-situ calibration can be taken from either the 3/8” outlet port via an appropriate “T” off connection or the ¼” auxiliary port in the AIM manifold. A precision calibrated flask or beaker is used to receive the calibration sample, this is then compared with the readings displayed on the additive controller.

Calibration is generally initiated by a simulated pulse being directed to the input to the additive controller, this simulated signal represent a flow input from the bulk fuel flowmeter, accordingly the controller will cause the AIM block to delivery a proportionate volume of additive to the measuring flask for comparison.



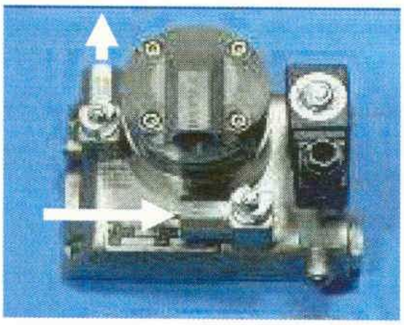
4 Maintainenance

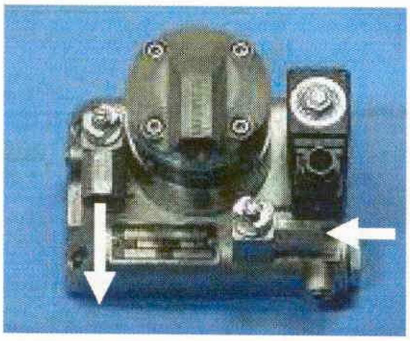
4.0 AIM block description

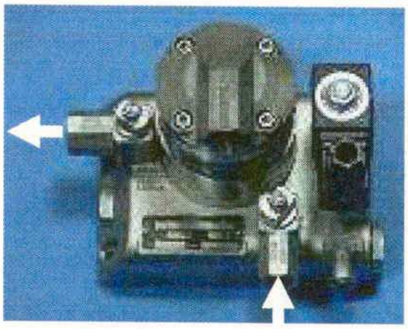


4.1 AIM block components

<u>*Isolation & flow regulation*</u> *:* The block incorporates two slotted stem isolation valves to enable the strainer, solenoid valve & meter to be isolated and serviced as required. The valves also serve as flow regulation valve as & when needed, typically under operation the upstream (inlet) valve would be opened fully then backed off by ½ a turn and the downstream (outlet) valve only would be used as a flow regulating valve. Once positioned both valve stems are to be secured using the Nyloc nuts included.





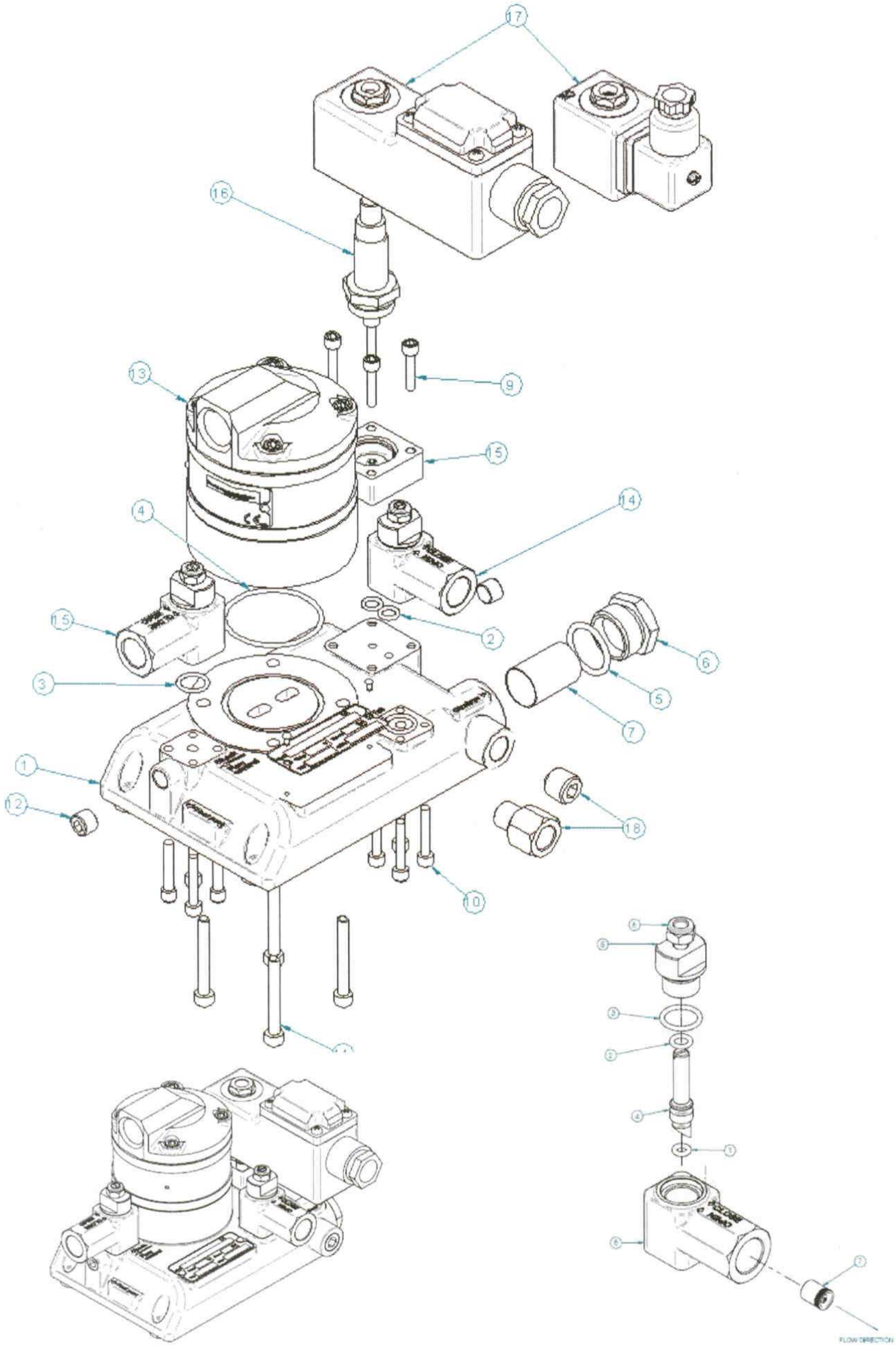


Shown above, each of the inlet & outlet valve assemblies may be repositioned in one of three 90 degree incremental positions by accessing the socket head screws on the underside of the manifold.

<u>*Strainer*</u> *:* The block has a 200mesh *(75 micron)* strainer immediately upstream of (prior to) the solenoid valve & flowmeter, this should be inspected regularly for cleanliness particularly if the flow rate slows and the block fails to keep pace with the mainline flow (master or wild stream).

<u>*In-situ calibration*</u> *:* A local calibration shunt can be taken off either the 3/8" NPT outlet port or the auxiliary ¼" NPT "fixed" outlet port located adjacent the 3/8" NPT outlet port.

4.2 Block exploded view



4.3 BLOCK SPARE PARTS *(refer to exploded views)*

AIM BLOCK

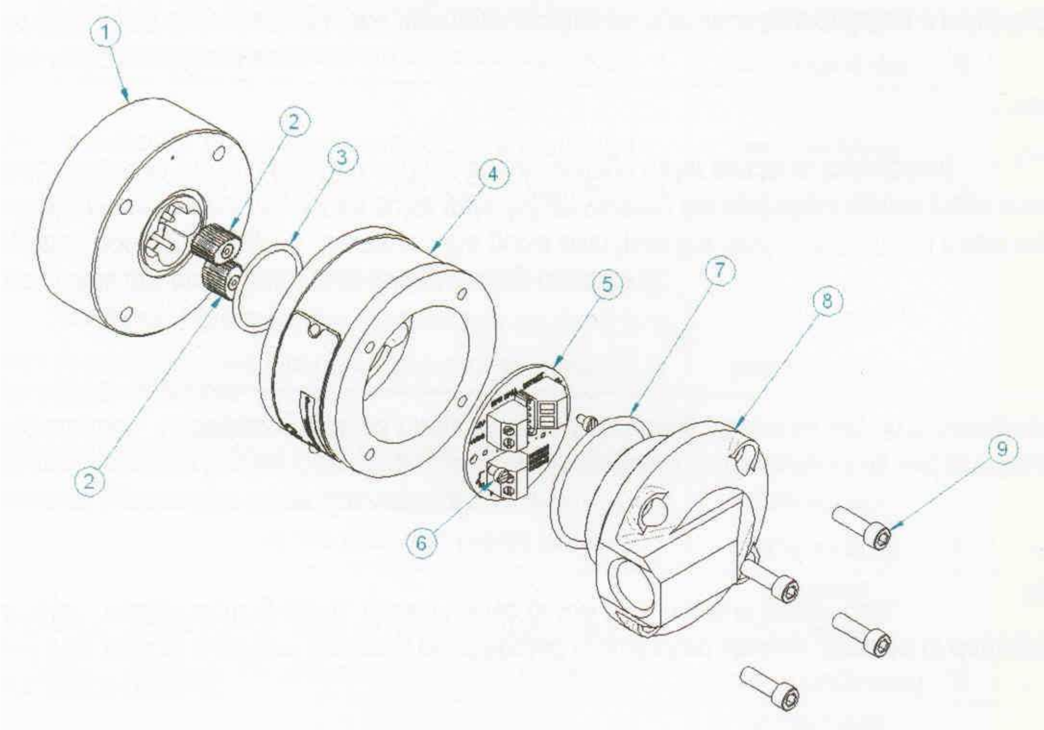
Item	Description	Part No.
1	Manifold	
	aluminum manifold	
	stainless steel manifold	1301126
2	Solenoid base O-ring	
	viton - std. *(BS010)*	13030101
	teflon *(BS010)*	13030103
3	Process port O-rings	
	viton - std. *(BS013)*	13030131
	teflon *(BS013)*	13030133
4	Meter base O-ring	
	viton - std. *(BS030)*	13030301
	teflon *(BS030)*	13030303
5	Strainer cap O-ring	
	viton - std. *(BS117)*	13031171
	teflon *(BS117)*	13031173
6	Strainer cap	
	stainless steel	1307011
7	Strainer element	
	stainless steel, 75 micron *(200 #)*	1307012
8	Solenoid base	
	stainless steel	1322151
9	Solenoid base screw	
	M4 x 20	130804106
10	Process port screws	
	M4 x 25	130804112
11	Meter base screw	
	M5 x 40	130805124
	M4 x 50	130804112
12	Hex plug	
	stainless steel, *1/8" NPT*	130810200
13	Meter assy. *(see meter spares page 12)*	
14	Inlet flow valve assy.	
	With flow isolation valve	1407006
15	Outlet flow control valve assy.	
	Flow regulation, isolation & check	1407007
16	Solenoid armature assy.	
	viton - standard *(BS030)*	
17	Solenoid coil	
	Explosionproof (state voltage)	refer
	Non Exd (state voltage)	factory
18	Hex plug	
	stainless steel, *1/4" NPT*	130810200

AIM CONNECTION ELBOWS

Item	Description	Part No.
1	Isolate O-ring	
	viton - standard *(BS007)*	13030071
	option *(BS007)*	
2	Regulate O-ring	
	viton - standard *(BS 009)*	13030091
	option *(BS 009)*	
3	Static O-ring	
	viton - standard *(BS014)*	13030141
	option *(BS014)*	
4	Regulation valve screw	
	stainless steel	1307015
5	Flow control housing	
	stainless steel	1307016
6	Process port housing	
	stainless steel - 3/8"NPT	1307018
7	Check valve	
	3mm oriface x 14kpa	1307019
8	Lock nut	
	M6	130806115

4.4 Disassembly of the meter *(Refer Exploded View)* First isolate any live electrical source and or liquid source to the block. To gain access to the meter terminals and pulse output board, undo the 4 cap screws (10), remove the cover (9) carefully to avoid putting strain on the terminal connections. The pulse output board (6) can now be accessed and removed if necessary (screws 7).

If required to gain access to the oval geared rotors undo the 4 body screws (11), carefully pry the meter body apart avoiding misplacing or damaging the O-ring (3) and rotors (2). Note items 1 & 4 are marked with a dimple and both dimples must align when reassembling, in addition *(model MG006 only)* the rotor shaft located closest to the dimple must take the driving rotor which is the rotor fitted with magnet(s).



4.5 Inspection Remove, inspect and clean the rotors, also check that the magnets have not been chemically attacked. Check the measuring chamber for damage or scoring & redress if necessary, the rotor shafts should NOT be loose or able to be rotated.

4.6 Re-assembly of meter When replacing the rotors be very sure to have the rounded tooth ends at the bottom of the measuring chamber otherwise the rotors will be severely damaged as the meter cap (4) is fastened into place.

Re-install rotors by locating the dimple mark on the meter section which contains the rotor shafts. The shaft located closest to the dimple mark must be fitted with the driving rotor which is a rotor fitted with magnets *(this applies to model MG006 only).* The magnets MUST be visible when the rotor is installed. If the second rotor also contains magnets *(model MG008 only)* make sure all magnets are visible when installed. Both rotors will only engage correctly if fitted precisely at an orientation of 90 degrees to each other. Rotate the rotors slowly by hand to ensure they are correctly fitted at the same time check the rotor shafts & rotor bearings for wear.

Fit the O-ring into the groove and assemble the two parts of the meter ensuring the dimples on each section (1 & 4) are aligned. Fit the body cap screws (11) and tighten using a 1,3,2,4 sequence then torque in the same sequence to 3.5 Nm. This sequence and procedure ensures the meter bodies are assembled correctly and evenly. Fit the pulse output board, terminal cover or instrument as appropriate.

4.7 METER SPARE PARTS *(refer to exploded view)*

Item	Description	AIM004	AIM006	AIM008
		Part No.		
1	**Body / shaft assembly**			
	stainless steel - BSP	1402101	1402102	1402103
2	**Rotor assembly set**			
	stainless rotors, ceramic bearings	1524010	1524006	1524007
3	**Body O-ring**	*(size BS022)*	*(size BS024)*	*(size BS030)*
	viton (standard)	13030221	13030241	13030301
	EPR	13030222	13030242	13030302
	teflon	13030223	13030243	13030303
	buna-N	13030224	13030244	13030304
4	**Meter cap**			
	stainless steel	1302139	1302098	1302098
5	**Pulse output board**			
	standard pulse board	1412056	1412031	1412031
	quadrature pulse board	1412064	1412036	1412036
6	**Output board screw**			
	stainless steel	130803101	130803101	130803101
7	**Terminal cover O-ring**			
	GRN covers *(BS032)*	13030321	13030321	13030321
	metal covers *(BS132)*	13031321	13031321	13031321
8	**Terminal cover**			
	GRN glass re-inforced *(M20)*	1306012	1306012	1306012
	GRN glass re-inforced *(1/2" NPT)*	1306018	1306018	1306018
	stainless steel *(M20)*	1306001	1306001	1306001
	stainless steel *(1/2" NPT)*	1306008	1306008	1306008
9	**Terminal cover screw**			
	M5 x 12mm socket head	130805105	130805105	130805105

Recommended spare parts :

Item 2 rotor / bearing set
Item 3 body O-ring
Item 5 pulse output board

5 Fault finding

5.0 Meter Fault Finding The flowmeter has two distinct sections: the mechanical wetted section housing the rotors and the electrical section housing the pulse output board.
The aim of fault finding is to trace the source of the fault to one of these sections.

Below are basic fault finding steps. Also refer to Trouble Shooting Guide on following page.

Step 1 - *Check application, installation and set up.*
Refer to Mechanical Installation section for installation and application factors that may effect the meter operation including pulsation and air entrainment or incorrect meter selection including incorrect flow rate, temperature and pressure or materials compatibility. Refer to Electrical Installation for correct wiring.

Step 2 - *Check for blockages.*
The most common cause of fault/unsatisfactory meter operation, particularly for new or altered installations, is due to blockage within the system or meter caused by foreign particles such as weld slag, sealing tape or compound, rust, etc.

Step 3 - *Ensure flow is present.*
No flow or lower than normal minimum flow may be attributed to a blocked strainer, jammed or damaged rotors within the flowmeter, malfunctioning pump, closed valves or low liquid level in feeder tank.

Step 4 - *Ensure oval gears within meter are rotating.*
Rotation of the oval gears can be heard by holding a screw driver blade to the meter body and pressing the handle hard against the ear lobe. If necessary test the meter with the flow turned off and turned on to familiarize yourself with the audible rotation signature.

Step 5 - *Ensure pulses are being generated during flowing conditions.*
A multimeter is often not fast enough to distinguish the pulse train from the reed switch or Hall Effect sensor. An oscilloscope will allow you to view the output pulse train. When viewing the Hall effect sensor pulse ensure a pull up resistor is installed between the pulse output and the supply voltage (refer electrical installation).

Step 6 - *Confirm Instrument Operation.*
If an associated instrument is connected to the flowmeter confirm its operation by simulating a pulse input onto the flow input terminals. In most instances a contact closure on the flow input terminals is an adequate simulation.

5.1 TROUBLE SHOOTING

Symptom	Possible cause	Solution
Meter readings are high	1. Output signal interference	1. Ground shield of signal cable 2. Re-route cable from high electrical energy sources
	2. Entrained air or gas	1. Remove source of air or gas entrapment 2. Install an upstream air eliminator
	3. Pulsating flow from reciprocating style pump	1. Increase back pressure on pump 2. Install a fast response one way check valve 3. Install a surge arrestor between pump & meter 4. Re-calibrate meter in situ to compensate for pulsations 5. Change pump style to smooth delivery type pump
Meter readings are low	1. Damaged or worn rotors	1. Inspect, repair, clean or replace rotors
	2. Damaged or worn measuring chamber	1. Inspect measuring chamber for damage - repair 2. Check concentricity of rotor shafts within chamber
	3. Output signal interference	1. Ground shield of signal cable 2. Re-route cable from high electrical energy sources 3. Check all electrical terminations & wires for continuity.
No output from meter	1. Rotors fouled	1. Check that rounded teeth are towards base of chamber 2. Check for obstruction due to foreign particles 3. Clean, repair or replace rotors
	2. Meter incorrectly reassembled	1. See instructions for reassembly of meter with particular emphasis on positioning of rotors & magnets
	3. No output from output board	1. Check terminal connections & solder joints 2. Ensure dc voltage is available at Vdc & 0V and receiving instrument is fitted with a pull up resistor 3. Replace output board
Not reading on readout instrument	1. Faulty receiving instrument	1. Check DIP switch settings & program data 2. Check terminal connections & electrical continuity 3. Repair / replace receiving instrument