



## OVAL GEAR

Medium Capacity positive displacement  
Pulse flowmeters

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### INSTRUCTION MANUAL

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*Model: 1/2" (D-40)*



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### 1.1 Overview

The Oval Gear meter is a precise positive displacement flowmeter incorporating a pair of oval geared rotors. These meters are capable of measuring the flow of a range of clean liquids such as fuels, fuel oils & lubricating liquids.

The flowmeter is available with a pulse output only for safe or hazardous areas. The meter also has a flow rate register option with either RT40 (*option E*) for safe areas or an intrinsically safe RT12 (*option I*) for hazardous areas. Both these totalisers have pulse output capabilities of interfacing to most monitoring and control instrumentation. The RT12 instrument also has monitoring and control output options 4-20mA, scaled pulse and flowrate alarms.

Both RT12 and RT40 options have multiple display units (kgs, Litres, lbs, Gal and m<sup>3</sup>) and can show instantaneous flow rate and total flow values

### 1.2 Operating Principle

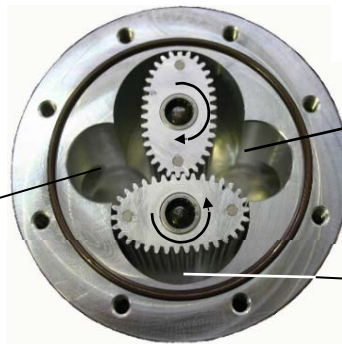
The Oval gear are positive displacement flowmeters where the passage of liquid causes two oval geared rotors to rotate within a precision measuring chamber and with each rotation a fixed volume of liquid is displaced passing through the meter. Magnets embedded within the rotors initiate a high resolution 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

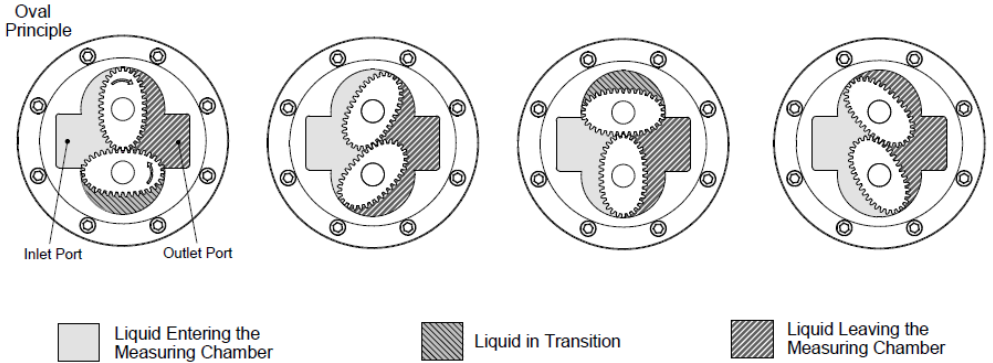
liquid entering measuring chamber



liquid exits the measuring chamber

flow

liquid in transit



1.3 Specifications

Model Prefix	D-40
Nominal size (Inches)	15mm (1/2")
*Flow range - (LPM) Litres/min	1 ~ 40
- (GPM) USGal/min	0.26 ~ 10.6
Accuracy @ 3cp	±0.5%
Repeatability	typically ±0.03% of reading
Temperature range	-20°C ~ +80°C (-4°F ~ +176°F)
Maximum pressure; Bar (PSI) (threaded meters)	40 (580)
Protection Class	IP66/67
Display	flowrate total (accumulative & resettable)
Recommended filter	150microns (100mesh)
<b>Electrical</b>	
Nominal output resolution	pulses per litre (pulses per gallon) - Nominal
Hall Effect (E register only)	168 (636)
Reed	84 (31.8)
Reed switch output	30vDC x 200mA max
Hall Effect output (NPN)	3 wire open collector, 5 ~24vDC, 20mA max
<p>* Maximum flow is to be reduced as viscosity increases, see flow de-rating guide</p> <p>* Maximum flow may be increased by 10% for intermittent refueling periods</p>	

**2.0 Mechanical Installation** *Prior to installing the meter check that :*

- The fluid is compatible with the meter materials of construction using appropriate information such as fluid compatibility charts and site experience.
- The application and process conditions are compatible with the meter specifications. Minimum and maximum 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).
- The process temperature and pressure does not exceed meter ratings.
- The meter is not exposed to process temperatures and pressures that will cause the liquid medium to gasify (flash) within the meter.

**2.0.1 Flow Conditioning and Locations**

Strainer : It is recommended to INSTALL a 100mesh (150 micron) strainer immediately upstream of (prior to) the meter. Strainers are available from the factory.

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

Locations : The flowmeter is preferred to be fitted upstream of any flow control and/or shut off valve, this prevents free discharge from the meter and minimizes the risk of drainage and air entrapment which can result in erroneous readings or damage the meter on start up.

Process or safety critical meters should be installed in a by-pass section of pipe with isolation valves to enable the meter to be isolated and serviced as required. A by-pass installation also allows purging of the system during commissioning (see *Commissioning*). The meter must be appropriately rated and is typically located downstream (on the discharge side) of the pump.

If mounted outdoors 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 and/or instrument enclosure. It is good wiring practice for conduits to be connected from the bottom of an entry port, in this way condensation will gravitate away from any terminal housing.

Fluid state : Fluid entering the meter 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.

Hydraulic shock : If pressure surges or hydraulic shock of any kind is possible, the system upstream of the meter must be fitted with a surge suppressor or pressure relief valve to protect the meter from damage. High frequency flow pulsations can damage the meter. Such pulsations can be caused by the injection profile in diesel engines. Most pulsations are removed with the installation of a suitable pulsation dampener.

## 2.1 Meter & totaliser orientation

The flowmeter MUST be mounted so that the rotor shafts are in a horizontal plane. This is achieved by mounting the meter so that the digital display is facing the user in a horizontal direction, it should never point towards the sky or towards the ground. If installed incorrectly the weight of the rotors will bear down on the base of the measuring chamber, leading to inaccuracy and meter damage and failure.

### Correct Orientation



### Incorrect Orientation

Liquid can flow into the meter from either a horizontal or vertical direction. For vertical flow installations the recommended orientation is for the liquid to rise through the meter (*i.e. travel from bottom to top*) to assist in air or entrained gas elimination. The meter operation is independent of the liquid flow direction thus there is no markings for inlet or outlet.

## 2.2 Electrical Installation

As a default the meter and totalizer is wired at the factory with the reed output pre-wired and DIP switches set for an integral rate/totaliser allowing self-powered operation of the instrument displays.

The output(s) and function(s) available from a meter fitted with an integral instrument depend on the model of the instrument fitted and may include meter pulse repeater, pre-scaled pulse output, 4-20mA flow output or flowrate alarms.

Refer to the option in the meter model number and relevant instrument manual. The instrument program will contain factory default parameters and be programmed with the relevant calibration factor (*K factor or scale factor*) for the reed switch meter.

Factory default settings can be found in the instrument instruction manual and it should be noted all output(s) are turned OFF and if required need to be turned ON then programmed to suit the application requirements.

**2.2.1 Instrument Cable** Twisted pair low capacitance shielded instrument cable 7 x 0.3mm ( $0.5\text{mm}^2$ ) 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 simple apparatus, wiring to an Intrinsically Safe Instrument 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.

If the flowmeter is fitted with an intrinsically safe instrument refer to the appropriate manual & I.S. supplement for wiring of the instrument inputs and outputs.

**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, unless it is intrinsically safe in which case only the reed switch pulse is available. 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. Used only for the E Register (RT40)

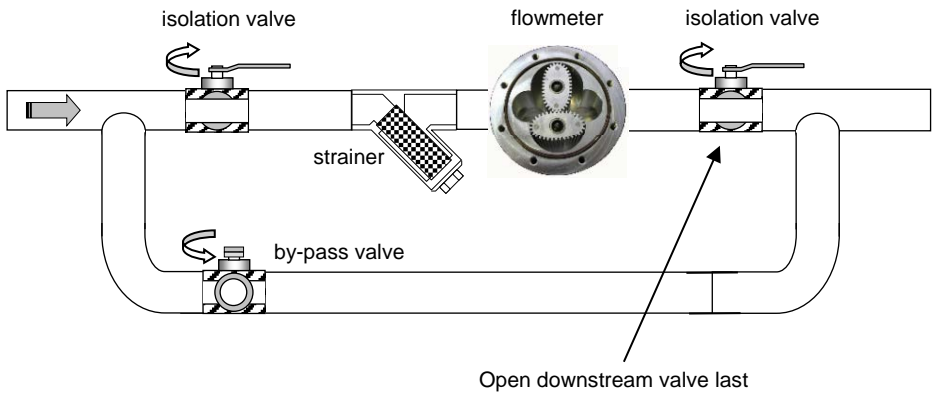
**2.3.2 Reed Switch Pulse Output** -The reed switch output is a two wire normally open SPST voltage free contact ideal for installations without power or for use in hazardous area locations when Intrinsically Safe (I.S.) philosophy is adopted. **Note:** when using the reed switch output the liquid temperature must not change at a rate greater than 10°C per minute (50°F per minute). In general the reed switch life will exceed 2 billion actuations when switching less than 5Vdc @10mA as is the case when combined with the I Register (RT12) and E register (RT40) instruments.

**2.4 Meter Calibration Factor (K or scale Factor)** Each flowmeter is individually calibrated and has the number of pulses per unit volume (eg pulses per litre or pulses per US gallon) entered into the program of the instrument. Please refer to relevant instrument manual for programming details. Nominal figures are shown in the specification section of this manual. For more accurate metering we recommend using the calibrated K factor. **Calibration certification is available upon request from your distributor.**

**3.0 Commissioning** Once the meter has been mechanically installed the meter is ready for commissioning.

The meter 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.

Flushing can be undertaken by utilizing a by-pass or removing the meter from the pipework. If neither is practical then the meter rotors must be removed prior to flushing (*refer to Maintenance section of this manual for disassembly*).



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 on the mechanical display. Refer if necessary to fault finding section of this manual.



**4.0 Maintenance** Adhering to the installation instructions in this manual should ensure your meter provides the required operational performance. The mechanical operation of these meters requires a periodic maintenance and inspection regime to maximize the operational availability of the meter.

The frequency of maintenance depends on the application factors including liquid lubricity, abrasiveness and operational factors such as flowrate and temperature.

**BEFORE undertaking meter maintenance ensure the following :**

*Associated alarm(s) or control output(s) are isolated so not to affect the process.*

*The meter is isolated from any source of supply of liquid upstream or downstream.*

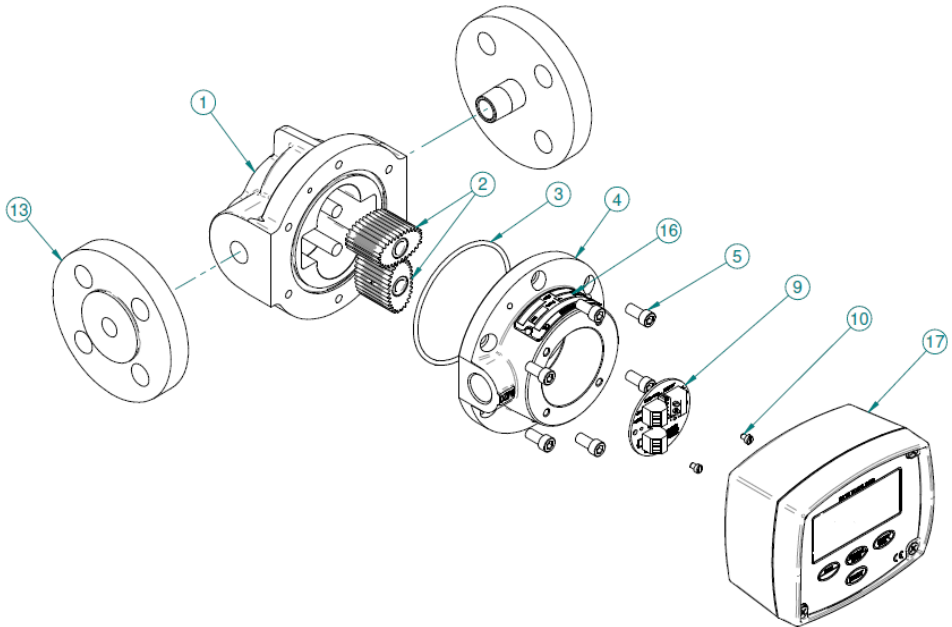
*The meter is depressurized and liquid drained from the meter.*

**4.1 Disassembly of Pulse meter (Refer Exploded View)**

The meter is fitted with an integral instrument the instrument display assembly must be removed if required to gain access to the instrument terminal connections, instrument battery or pulse output board. This is achieved by:

1. Undo the bezel screws and separate the display assembly from its base. Do not stress or damage the wires that connect the display assembly to the meter output. Take care not to misplace or damage O-ring(s).The pulse output board can now be accessed.
2. To remove the pulse output board, first undo the screws that fix the instrument base to the flowmeter (Refer Exploded View).

If required to gain access to the oval geared rotors undo the 6 body screws (5), carefully pry the meter body apart avoiding misplacing or damaging the O-ring (3) and rotors (2).



**4.2 Inspection** (*refer Exploded View*) Inspect O-rings (3) for damage, chemical attack, deformity or any form. Remove, inspect & clean the rotors (2), check that the primary rotor gear pinion for any damage. Check the measuring chamber (1) for damage or scoring & redress if necessary, the rotor shafts should NOT be loose or able to be rotated.

**4.3 Re-assembly of meter** (*refer Exploded View*) When re-installing the rotors (2) all four magnets MUST be visible when both rotors are in place. 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 (3) into the groove and assemble the two parts of the meter, the body (1) & cap (4) align with a location pin.

Fit the body cap screws (5) and tighten in a star sequence then carryout a final tighten in the same sequence to 10 Nm (7.5 ft/lb).. This sequence and procedure ensures the meter bodies are assembled correctly and evenly. Fit the pulse output board and instrument as appropriate.

This sequence and procedure ensures the meter bodies are assembled correctly and evenly. Once completed, re-fit the totaliser assembly.

4.4 Spare Parts

		D-40
		Part No.
Item	Description	
1	<b>Body / shaft assembly</b>	
	Body / shaft assembly (E and I Registers)	1401098 (BSP) 1401128 (NPT)
2#	<b>Rotor assembly set</b>	
	Electronic rotor set	1524049
3#	<b>Body O-ring</b>	
	Body O-ring	BS150V
4	<b>Meter cap</b>	
	Electronic (E and I Registers) with M20 conduit entry	1302129
	M20 to 1/2"NPT conduit thread adaptor	1322131
5	<b>Body screws (Qty per meter)</b>	6 per meter
	Stainless steel socket head	M6X16 SHCS 304 SS
9#	<b>Pulse output board (E and I Registers)</b>	
	Intrinsically safe pulse board (I Registers)	1412193
	Standard pulse board (E Registers)	1412172
10	<b>Output board screw (E and I Registers)</b>	
	Stainless steel (2 per meter)	M3X4CHHD SCREW304SS
11	<b>Flange portion O-ring (O-ring size)</b>	
	Flange portion O-ring	
12	<b>Flange portion screws (8 per meter)</b>	
	Threaded portions	
	Flanged portions	
13	<b>Flange portion kit</b>	
	BSP Flange Kit	
	NPT Flange Kit	
	ANSI-150 Flange Kit	1522058
	DIN PN16 Flange Kit	1522059
14	<b>Optional (only when fitted with Air Eliminator Strainer)</b>	
	Back pressure wafer check valve	

**5.0 Fault Finding** Pulse meters have two distinct sections: the mechanical wetted section housing the rotors and the electrical section housing the pulse output board.

Meters fitted with integral instruments have these two sections plus the instrument.

The aim of fault finding is to trace the source of the fault to one of these sections.

If a fault is traced to an instrument section, refer to the relevant instruction manual.

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

**Step 1 - Check application, installation and setup.**

Refer to Mechanical Installation section for installation and application factors that may affect 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

<b>Symptom</b>	<b>Possible cause</b>	<b>Solution</b>
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

Notes:

**Each meter has been calibrated on mineral oil  
and will contain a small amount of oil residue.**

**The oil used is Castrol Diesel Calibration  
Fluid 4113 (product code 055830).**

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