MGL Avionics

Dual range fuel flow sender

GENERAL

This flow transducer has been designed for use with a range of different liquids including water and most fuels. The unit is capable of operating over two flow ranges. High flow (0.2 – 9.0 L/Min) is achieved by **NOT** inserting the supplied jet into the inlet pipe. For the lower flow rate (0.05 – 1.5 L/Min) the jet must be inserted into the inlet pipe as shown in the outline diagram. The unit will accept both 8mm and 12mm diameter hose fittings on inlet and outlet pipes.

NOTE:

1. Flow direction is indicated by the arrow moulded into the unit and is in **ONE DIRECTION ONLY.**
2. For low flow range the jet must be **FULLY** inserted in the inlet port, pushing it to the inner end with a flat ended rod and tapping it gently to ensure it is fully seated.

INSTALLATION

Before installation check the free running of the sensor by blowing through it. **DO NOT USE AN AIR LINE.**

The detector uses a Hall Effect system (magnetic) and should therefore not be mounted near strong magnetic fields. For example: motors, solenoids, relays etc. For the best overall performance the sensor should be positioned with the spindle vertical i.e. on either the face with the label or the face with the moulded arrow head. If a lot of gas bubbles are likely to be present in the fluid the most accurate results would be obtained with the flow vertically upwards through the meter. It may however be positioned in any attitude.

Pockets of vapour or bubbles of air will effect some of the volumetric flow and so alter the number of pulses recorded from the sensor. On the lower flow model these bubbles may take some time to clear because of the low fluid velocities inside the chamber. A large back pressure will reduce any tendency the liquid has to form vapour pockets.

PUMPS

All pumps cause pulsations in the fluid, centrifugal pumps have probably the lowest disturbance, and reciprocating pumps the largest. With a centrifugal pump the pulsations reduce after a fairly short pipe run so if the flow sensor is positioned as far from the pump as possible, the effects will be minimized. With reciprocating pumps more positive isolation is desirable and a pulse damper or accumulator is probably required. If pulsations cannot be removed the unit must be recalibrated over the desired flow range.

CONSIDERATIONS

All flow sensors should only be installed with the following in mind: bends, valves, flow regulators, tee junctions and other fittings which cause the flow to travel faster at one side of the pipe relative to the other. This asymmetry in the flow can seriously affect the calibration and the disturbance should be as far removed from the sensor as possible and if at all practical, put after the flow sensor. Recalibration on site will, of course, remove any doubt about the installation. In all cases an 80 mesh filter should be fitted upstream of the flow sensor.

VISCOSITY

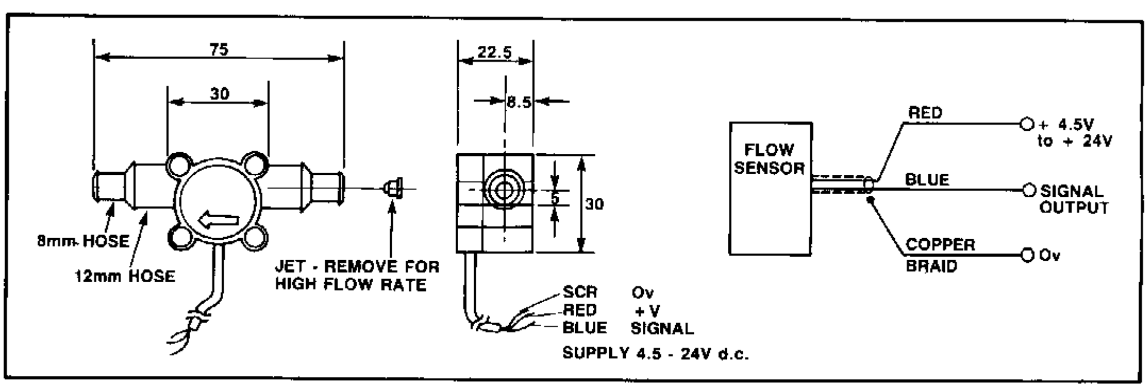
Viscosity effects: all turbine transducers are affected by viscosity and where possible the viscosity (temperature) of the liquid should be kept fairly constant. Viscous drag causes the turbine to be slowed down quicker at the lower flows, as viscosity increases so does the threshold to operation. If the fluid is lubricating and a higher pressure drop is acceptable, the turbine can be run at up to 50% over range with no detrimental effects.

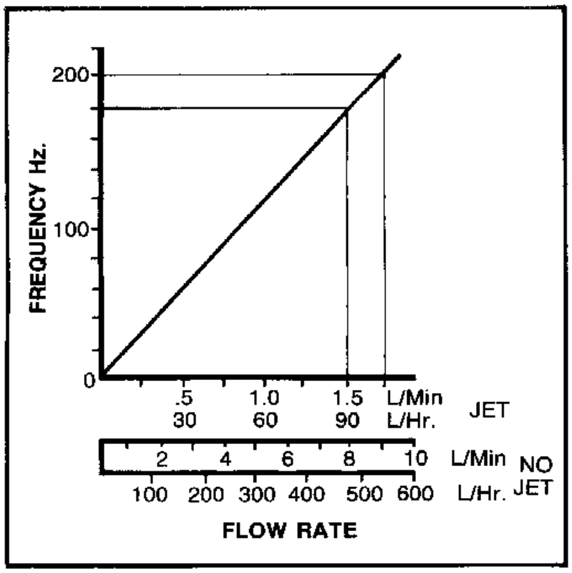
ELECTRONIC

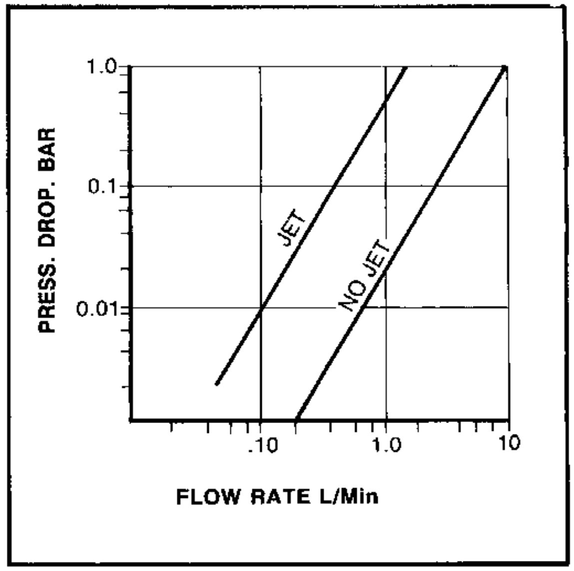
Inside the housing is a Hall Effect switch which is activated by three small magnets in the turbine. Each Hall Effect circuit includes a voltage regulator, quadratic Hall voltage generator, temperature stability circuit, signal amplifier, Schmitt trigger, and open-collector output with pull-up resistor. The on-board regulator permits operation with supply voltage of 4.5 to 24V. The switches' output can sink up to 20mA which includes the internal 10KΩ pull-up resistor. They can be used directly with bipolar or MOS logic circuits. The detector has an operating range of −40°C to +125°C.

Standard Materials of Construction

Body	–	PVDF
Cover	–	PVDF
Rotor	–	PVDF
Spindle	–	Sapphire
Bearings	–	Sapphire
"O" Ring	–	Viton
Cable	–	Oil Res. PVC







	Flow Range L/Hr	Linearity at FSD	Approx. FS Frequency	Approx. Pulses/L at FS
Jet	3 – 90	±1.0%	175 Hz	7000
No Jet	12 – 540	±1.0%	200 Hz	1330

ELECTRICAL CHARACTERISTICS at T_A = +25°C, V_{CC} = 4.5V to 24V (unless otherwise noted)

Characteristic	Symbol	Min	Typ.	Max.	Units
Supply Voltage	V_{CC}	4.5	—	24	V
O/P Saturation V.	$V_{CC(SAT)}$	—	150	400	mV
O/P Leakage Current	I_{OFF}	—	0.05	10	μA
Supply Current	I_{CC}	—	4.7	8	mA
O/P Rise Time	t_r	—	0.04	2	μS
O/P Fall Time	t_f	—	0.18	2	μS

TECHNICAL SPECIFICATION

	standard	*high flow*
Flow rate	3-90 L/hr	12-540 L/hr
F.S. frequency	175 Hz	200 Hz
Frequency @ 12 L/Hr	23Hz	4Hz
Viscosity range	0.8-20+ cSt.	0.8-50 cSt.
F.S. pressure drop	1 Bar at 1 cSt.	
Operating pressure (max.)	10 Bar	
Temperature range	−25 to 125°C	
Repeatability	±0.25%	
Linearity	1% FSD	
Sensor to sensor variation	±3%	
Supply voltage	4.5 to 24 Vd.c.	
Current consumption	10 mA typical	
Output	Open collector (10KΩ internal pull up)	
Output low	100 mV max.	
Rise and fall times	2μS max.	
Wetted materials	PVDF, Sapphire & Viton	

Fuel flow sender notes

The jet supplied with the fuel flow sender may have been installed for your convenience if we know that you need the low range fuel flow sender.
We recommend the low range for engines up to a fuel flow rate of 25 liters/hour during cruise.
Please note that a pressure drop may be caused by the sender at high fuel flow rates. Please consult the graphs in this document to ensure compatibility with your engine and fuel pump.

Please take note of the following:

Fuel filter

The fuel flow sender **MUST** be installed **AFTER** the fuel filter. Failure to install a fuel filter before the fuel flow sender is dangerous as debris sucked from the tank can block the jet of the fuel flow sender resulting in engine failure.
The diameter of the jet is larger than the diameter of the main jet in your carburetor. You would not consider operating the carburetors without a fuel filter installed. Please do not operate the fuel flow sender without a fuel filter installed in its supply line.
We recommend Diesel fuel filters available from Mercedes Benz. Do not use paper based filters.

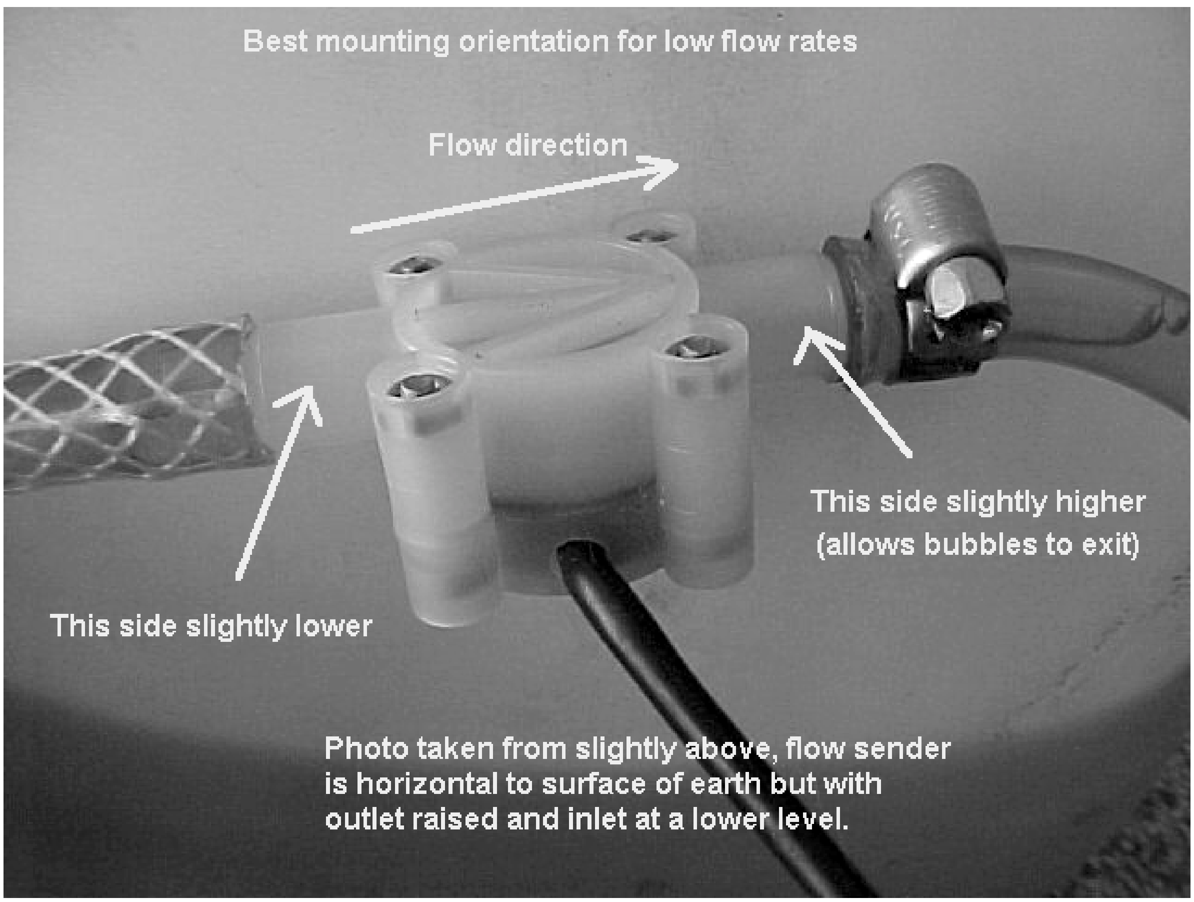
Flow direction

The fuel flow sender must be installed taking the flow direction into account. This is indicated with a large arrow on the side of the fuel flow sender.

Mounting of the sender

It is common to see the fuel flow sender installed incorrectly in many aircraft, rendering it near useless. Please take the following into account when installing the sender:
It must not be possible for the sender to trap fuel vapor which will prevent the turbine from turning properly with low fuel flow rates found on many of our engines.
The easiest way to ensure this is to mount the sender in a slightly upright way as shown in the following photo. Please note that we suggest that the fuel will flow from the lower part to the top part. This way no bubbles will be trapped in front of the jet.
A correctly installed fuel flow sender will assume its optimum operation after a few hours of operation to bed in the tiny sapphire bearings after which it is capable of showing accurate fuel flow down to less than 2 liters/hour.
The orientation shown in the photo results in best performance at low flow rates (less than 12 liters/hour) as the impeller rests on one bearing only. This reduces the friction greatly.

We also recommend the mounting orientation shown below if you operate the sender without the jet installed.



For installations were long fuel lines are unavoidable we recommend to fit the fuel flow sender AFTER the fuel pump. Install a second fuel filter before the sender to act as reservoir to prevent pressure pulses from the fuel pump to affect the fuel flow reading accuracy.

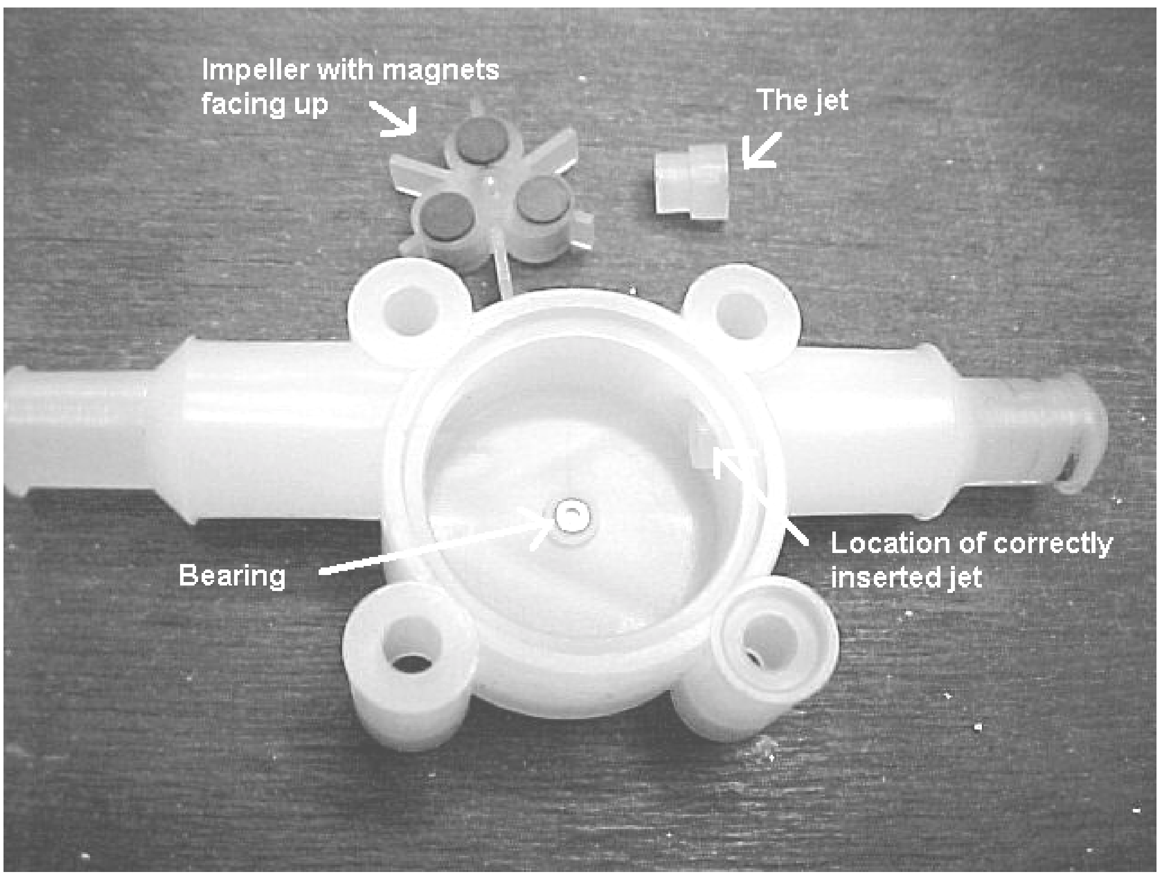
Recommended Installation test

Install a short, clear fuel line after the flow sender. Observe the fuel flowing in this line at various power settings. If bubbles are visible in this line this will affect the accuracy of the fuel flow reading very badly.
Bubbles can be caused by air leaks in the fuel line or by excessive low pressure which causes the fuel to vaporize.

Installation of the jet

If you install the jet yourself, do so by using the blunt side of a suitable diameter drill bit.
Please ensure that you push the jet ALL THE WAY to the stop. This can require a bit of force. If the jet is not installed correctly, the fuel flow sender will work very erratically.

Modifying the jet – some installations may require modification to the jet. Increasing the diameter of the jet using a suitable drill will create a new flow range and can lead to lower pressure drop across the sender if your installation requires this.
Perform the calibration procedure as outlined in the Stratomaster manuals if you do this.



Fuel type compatibility

It is responsibility of the operator of the aircraft to ensure compatibility of fuel used with his engine and fuel flow sender.
This flow sender has been tested over several years with a wide variety of automotive fuels containing methanol and alcohol based substances as well as common aircraft fuels such as 100LL.
As fuels are not under our control, MGL Avionics and the manufacturer of this flow sender cannot accept responsibility for incidents arising out of chemical incompatibilities between substances that might be added to your fuel and parts of the flow sender.
All wetted materials are specified in this document and if you are uncertain, please consult with the supplier of your fuel if any problem may occur.

Trouble shooting the flow sender

The flow sender has proven very reliable and accurate in many installations and it is very much a "fit and forget" item. The following lists experiences with the sender that may help you solve any problem you may encounter with the sender.

Using the sender with very low flow rates.

In some installations flow rates may be very close to the low end of the senders specifications. While the sender works very well at these rates one must keep in mind that the specifications are only valid for an even flow of liquid. In most aircraft engine installations this is not the case and the flow is rather erratic and controlled by a pulsating fuel pump in connection with carburetor float valves that open and close all the time.
We have found the best installation for this kind of environment (flow rates average < 10 liters/hour) is to install the sender so it lies on its side with the outlet slightly upwards. This causes the weight of the impeller to only impact on one bearing, reducing friction. The slight upwards orientation of the outlet ensures that vapor bubbles can escape.

Sender problem cause on new installations.

Be careful with new installations where molded plastic or fiberglass tanks are used. These tanks often have release wax residue in them. Fuel dissolves this wax but it can collect at the impeller bearings and this can stop the impeller from turning properly. Please see below on how to clean the bearings.

Sender installations where no fuel is in sender body when engine is switched off.

If fuel runs back to the tank and leaves the inside of the sender body dry, it is possible that residue from fuel (fuel additives) may collect and harden at the impeller bearings. See below on how to clean this.

Jet not properly inserted.

Most of our service calls are related to the jet not properly installed. Please ensure that you push the jet all the way. It must be located right in front of the impeller. It seeds a bit of force to push it that far.

Jet installed with larger engines

Please do not install the jet if you have a larger engine with increased fuel demand. The pressure drop at the jet can lead to instant carburetion of the fuel and the fuel vapor bubbles formed will interfere with the correct operation of the impeller. Please consult the relevant pressure drop chart in this document.
While it has to be decided on a case by case bases whether to install the jet or not, we would as general guideline recommend that you do not install the jet if your engine consumes more than about 20 to 25 liters of fuel per hour at cruising power setting.
Please note that the K-factor of the sender is 1330 without the jet installed. Be sure to set this factor in your instrument.

Unusual K-factors

Sometimes we get the comment that the sender works fine but that the K-factor has to be set to an unusual value, very different from that specified in this document.
Please be aware that if this is the case with your installation, **you have a problem**. Small variances of the K-factor can be tolerated (less than 5%), anything large means that the sender is not seeing a proper liquid flow. A favorite cause is an installation too close to a pulsating fuel pump and fuel pumps that are faulty and have backlash – in this case flow is in BOTH directions. The impeller is unable to distinguish direction of flow and as a result the instrument is unable to measure correct flow.

Cleaning the fuel flow sender

First, check to see if the sender requires cleaning. Very lightly blow through the sender (observe direction of flow). You should be able to spin the impeller with a lightest of blows. After a reasonably hard blow the impeller should continue to spin for a few seconds. You should not be able to hear any bearing noise which sounds like a loud screech (impeller is tumbling).
If the above test fails, you need to clean the bearings. You need a mild solvent such as methylated spirits, pure alcohol or clean fuel (do not use soap). A suitable cleaning tool is a ear-bud or very small brush.
Open the flow sender (four alan-key bolts) and split the body. The impeller can now be removed. You can see the small hall-effect sensor in the housing with the cable connected to. The three magnets in the impeller must face this sensor when you re-assemble the sender.
You can see the two small sapphire bearings, one in each side of the housing. Using the solvent, clean these bearings thoroughly. Also clean the sapphire shaft of the impeller.
Make sure there are no small derbies or foreign objects inside the sender body when you reassemble the sender.
To reassemble, place the turbine in its bearing in the side of the housing that does not have the cable. Place this housing on a flat surface and then close it with the other side of the housing making sure the o-ring seal is in place. Note that you can’t install the two sides wrong if you observe the cutouts for the inlet and outlet.
Once you have joined the two halves, give the impeller a blow and check to see if it is now turning freely.
Note that you can hear the impeller when you shake the housing. The impeller is very loose in the bearings. This is normal and intended.
Now you need to torque the four bolts. First tighten them so they are secure (about a 2nm force is quite enough)
Give the sender a good blow to spin the impeller. While the impeller is spinning tilt the sender in any orientation. If you can cause the impeller to tumble (loud screech) then tighten all four bolts a little more. Repeat this until the impeller runs smoothly regardless of orientation.
Before you install the sender into the fuel system, check to see if it works by connecting the instrument. Blow lightly into the sender for about four seconds and verify that you can get a flow reading on the instrument.