Stratomaster Smart Single

FF-1

Fuel management system
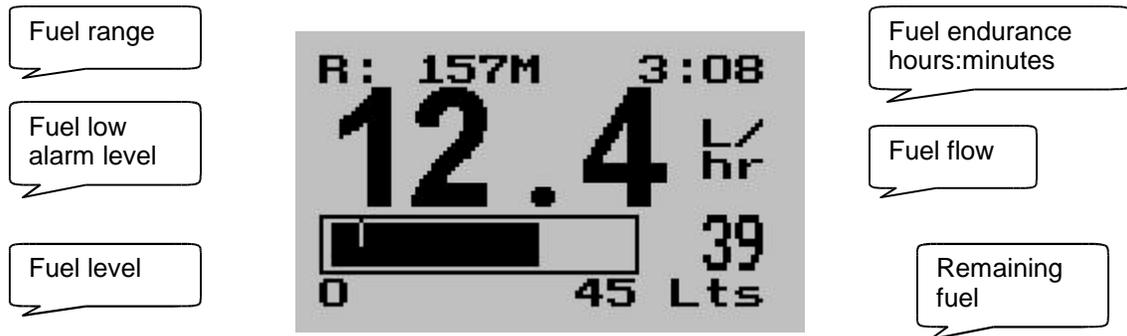**Fuel flow, fuel range, fuel endurance, fuel level**

The FF-1 fuel management computer is a 2.25" instrument intended for efficient monitoring of fuel related information onboard small aircraft.

The FF-1 unit can connect to a fuel flow sender, fuel level sender or both. Full functionality is available with both senders or only with a fuel flow sender using calculated fuel levels based on fuel usage.
Standard automotive fuel level senders can be used, even with odd shaped tanks thanks to a comprehensive, multi point calibration system.
Most fuel flow senders can be used and the K-factor of the sender can be entered into the system for simple calibration. MGL Avionics supplies a lightweight dual range fuel flow sender that is ideally suited for the FF-1 unit.

The main display

Fuel range

Fuel low alarm level

Fuel level

```
R: 157M      3:08
12.4  L/
              hr
┌──────────────┐   39
│▐            │
└──────────────┘
0          45 Lts
```

Fuel endurance hours:minutes

Fuel flow

Remaining fuel

Setting up the FF-1

Press the Menu key to enter the menu. You can move forward and backwards in the menu by using the + and – keys. To change or select a menu item, move the highlight to the desired item and then press the Menu key. To end an edit or function, press the Menu key again.

To exit the menu and continue normal operation, select the ***Done*** function and press the Menu key. Note, all changes you have initiated during your session will only be remembered by the instrument if you exit the menu using the ***Done*** function.

```
*** Done ***
Speed     50M
Fuel    39
LevelSend Yes
Calibration
FlowSend Yes
K-Factor 7000
Contrast 4
```

```
LevelSend Yes
Calibration
FlowSend Yes
K-Factor 7000
Contrast 4
BL: On
Alarm:      6L
Units: L/M
```

Speed

Enter your aircrafts cruising speed. This value will be used to calculate the fuel range, i.e. how far you can fly with remaining fuel at zero wind speed. For this calculation, your current remaining fuel, your current fuel flow and the speed entered here are taken into account.
You can easily change the speed during flight to reflect changes in ground speed or cruising speed.
Use this function with care and do not use it to extend your range. You must at all times have a secondary indication of available fuel. Note that flow senders and level senders may be subject to malfunction that may result in incorrect fuel levels being displayed or calculated.

Fuel

This function is used to manually enter your current fuel level after fueling or defueling your aircraft. This function is only available if you do not have a fuel level sender connected or you have disabled it using the relevant menu function.
If you only have a fuel flow sender this function is used to enter your available fuel. Fuel quantity used is then subtracted from this starting value to obtain a calculated fuel value.

Note that it is good airmanship to take into account a "silent" fuel reserve. For example, if you have a 50 liter tank and you fill it, enter 40 or 45 liters as your available fuel. Also view the text on "fuel tank size" below.

LevelSend

Select yes or no to reflect if you have a fuel level sender installed. If you do not have a fuel level sender, you can use a fuel flow sender only to reflect fuel level.

Calibration

This function enters the fuel level sender calibration menu. The fuel level sender needs to be calibrated before it can be used with this system. The calibration allows the system to learn the size of your tank and its shape as well as any errors your fuel level sender or installation has.

Should you not have a fuel level sender you will still use this function to set the size of your tank.

The size of your fuel tank EXLUDING reserve fuel

The six calibration points from zero fuel level to full tank

```
Sender:     592
Tank :      45
    0L   -      0
    9L   -     96
   18L   -    208
   27L   -    420
   36L   -    528
   45L   -    672
```

The current level sender reading

Level sender readings at the calibration points

Performing the calibration procedure. Note: You start with an empty tank, you need a measuring jug or fueling device that has calibration marks and you need enough fuel to fully fill the tanl.

Regardless of your use of a fuel flow sender, you can install a fuel level sender into your fuel tank. These level senders are inexpensive and are available as after market replacement fittings from a car spares outlet. We recommend the senders available from VDO. **Be aware that some makes of cheap level senders can prove troublesome, as the lever arms tend to be sticky. This prevents the floats from floating on the surface of the fuel at all times. As a consequence, this will lead to incorrect fuel level indication.**

Once you have installed a fuel level sender into your tank, make sure the float can travel all the way from empty to full position without hindrance of any kind.

The calibration procedure should be carried out with your aircraft in flight attitude. This means you need to lift the tail if you have a tail-dragger or lift the nose wheel if you have a weightshift trike. You start the calibration procedure with an empty tank.

Your first determination should be how much reserve fuel you should carry. Reserve fuel would be fuel that is not taken into account by the fuel level sender. We recommend at least 10% of your fuel tank capacity as reserve fuel, preferably even more.

To illustrate the calibration procedure, let us assume we have a weightshift trike with a tank capacity of 50 liters without reserve.
We decide to use a five-liter reserve, leaving us with a usable fuel capacity of 45 liters.

Our first step is now to enter this capacity into the instrument. Use the "+" and "-" keys to move the highlight to the "Tank:" item. Then press the Menu key. Now a new screen is shown and you can use the "+" and "–" keys to set the entry to read 45 liters. Press the Menu key again when you are done.

Our next step would be to raise the nose gear of the trike to flight position. An upturned bucket or similar item is normally all that is required.

We now start with the empty tank. Add five liters of fuel (our reserve quantity) using a suitable measure. Make sure the measure is suitably accurate.
This is now the "level sender reading at 0 Lt" position. Move the highlight to this position and wait until the sender reading has stabilized (You will see the sender reading at the top line). This could take up to a minute so have patience.
ENSURE THAT THE FLOAT IS NOT SUBMERGED AND IS FLOATING ON TOP OF THE FUEL LEVEL.

Should this number not react to changes of your level sender position, then you have a problem. Please check your wiring according to the installation section of this manual.
You should expect the number to change in the region of at least 20 to 60 counts per calibration position. If the number does not change with fuel level or only changes a very small amount – check your installation. Something is not right !!!

If you see the number changing then everything is well. Once it has stabilized and the highlight is on the 0 Lt position, press the "Menu" key to transfer the reading from the sender to the calibration point.

Now you are ready for the next step. Add the required amount of fuel to get to the next level (In our case 9 Lt – this is 20% tank capacity). Once done, wait for the reading to stabilize and press "Menu" again after you have moved the highlight to the "9 Lt" position.

Proceed in a similar manner until you have reached the last calibration position at 100% tank capacity.

You are done !

If you press "+" past the last calibration point then the unit will display:

Done ?

If you press "Menu" at this point then the calibration function will exit and any changes you have done are written to permanent memory in the instrument. You can repeat this calibration many times so do not worry if you do not get it right the first time.

The instrument uses the 6 calibration points to work out a correction curve that takes into account the tolerances of your fuel level sender and the shape of your fuel tank. This results in an incredibly accurate and usable fuel level display that far exceeds that available from ordinary dial type gauges.

Note:

The calibration positions may be edited by using the + and – keys. This allows you, in theory, to copy calibration settings from one instrument to another. We however recommend that you do go though the calibration procedure even if the two aircraft are identical in all respects. Tolerances do exist and the calibration cancels these out.
Accurate fuel level displays are a vital safety factor for an aircraft and a very useful feature for peace of mind during cross county flights.

Notes on Slope error

Sender value is a value determined by the FF-1. It is used to calculate e.g. fuel level, fuel endurance estimate and current range estimate. The fuel tank setup sender value can either increase in value as fuel is added on decrease in value if fuel is added. This is dependant on the type of fuel level sender used. However should the second reading be larger than the first reading all readings will have to be larger than the previous reading. Likewise should the second reading be smaller than the first reading all readings will have to be smaller than the previous reading. If this is not the case the wording "Slope error" will be displayed. This could happen when fuel was removed instead of added between steps, no fuel was added between steps or when the fuel level sender was moved in the wrong direction e.g. moving the fuel level sender manually when it is not inserted in to the fuel tank.

Should you get a slope error message determine the cause of the error. If you do not know the cause of your error it is best to start from scratch. It should be remembered that accuracy is the fuel tank calibration is extremely important to enable your FF-1 to display the correct data.

Adjusting calibration points manually

You may want to set individual calibration points manually. For example you may find that your fuel level is over reading at a specific fuel level. Correcting the tank level reading for this area can be simply done by adjusting the calibration point. You can do this by moving the float level with your hands to the desired position and then performing the calibration as outlined above, or you can use the manual option.
To activate manual change of the calibration points use the "+" and "-" keys to highlight the "Sender: …." Entry (top line of screen). Now press the Menu key. You get:
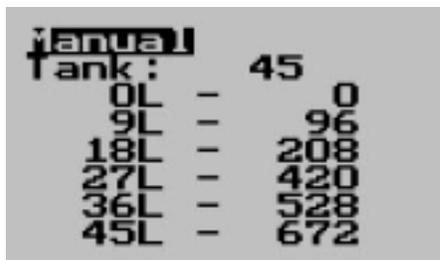
When you are in manual mode, use the "+" and "-" keys as before to select the point you want to calibrate. Then press the Menu key. This allows you to change the value at the calibration point using the "+" and '-' keys. When you are done, press the Menu key again. To end the calibration, move the highlight past the last calibration point as before.

Flowsend

This function allows you to enter if you have a fuel flow sender connected. Most installations would have the sender connected so you would choose "yes".

With the selection to "No", no fuel flow related functions are available.

K-Factor

The K-Factor is the number of pulses generated by the fuel flow sender for one liter of fuel. The dual range fuel flow sender supplied by MGL Avionics has a K-Factor of 7000 in the low flow mode (jet installed) and 1330 for the high flow mode (no jet installed).

You can use the K-Factor to calibrate your fuel flow sender.
The recommended procedure would be:

Fill your tank to an approximate known level (perhaps marked using a felt pen). Set the FF-1 to calculate fuel level from fuel flow (disable the fuel level sender using the menu function "LevelSend").
Set the fuel level to read 40 liters – the exact value is not important.
Now fly of a quantity of fuel, perhaps 25 liters as example (very roughly – it does not need to be exact). Note the reading of the fuel level after you switch off the engine. Assume we are reading 28 liters now (we used 22 liters according to the instrument).
Now fill the tank again, exactly to the previous level. Measure how much fuel you need to get to this previous level using a measuring jug.

For example, assume we need 26 liters to get back to the previously marked fuel level. This means the the fuel level should have been at 24 liters as we started with a value of 40 liters. This example would mean that our fuel flow sender is under reading by four liters as it has not measured the correct quantity of fuel.
Now start adjusting the K-Factor so your tank level changes from 28 liters to 24 liters. You would adjust the K-factor down in this case (fewer pulses per liter of fuel).

Using this calibration method you can get to very accurate fuel flow readings. The initial accuracy of fuel flow readings is dependant on the viscosity or type of fuel you use, added oils, installation and finally the temperature of the fuel.
A good installation can achieve about a +/- 3% accuracy with as little as 1% error after calibration.

Contrast …

This function allows you to change the display contrast to your liking. You can select values from about 20 to 45. (can vary depending on display type).

BL …

This function allows you to switch the display backlight on or off.

Alarm …

Enter your desired minimum fuel value that you would like to trigger the fuel low alarm. The fuel low alarm will result in flashing of the fuel level display and remaining fuel readout. You can also connect a warning lamp to the external alarm output (see installation diagram).
Note that the fuel low level will be displayed as a vertical line on your fuel level display. This level is over and above your "silent" fuel reserve.

Units …

Select your required units for distance and fuel quantity. The following options are available:

L/M: Liters and statute miles

G/M: U.S. Gallons and statute miles
L/Nm: Liters and nautical miles
G/Nm: U.S. Gallons and nautical miles
L/Km: Liters and kilometers
G/Km: U.S. Gallons and kilometers

Technical specifications:

Display temperature range (operational): -20 to +80 degrees C
Supply voltage: +8 to +18V. +24/28V with optional pre regulator.
Supply current: 35mA/70mA (backlight off/on)
Fuel level input: Maximum voltage: 5V, 5mA maximum current.
Fuel level senders supported: Any resistive type with common ground and capacitate probes with active voltage outputs up to 5V level (push pull or pullup).
Fuel flow senders: Supply 5V, 20mA maximum current. TTL level input with noise filter and schmidt trigger hysteresis. Required input voltage swing: less than 1.5V to more than 3.5V. Maximum input voltage range -5V to +18V.

Weight: 90 grams.

Warranty:
MGL avionics warrants their products for a period of one year from date of purchase against faulty workmanship. Warranty is limited to the replacement of faulty components and includes the cost of labor. Shipping costs are for the account of the purchaser.

Note for operation on supplies with inductive loads:

Any operation of electronic instrumentation on power supplies that are subject to high voltages caused by operation of inductive loads (starter motors, solenoids, relays) are required to be fitted with suitable protection.
All Smart Singles are guaranteed to withstand temporary over voltage up to 40V without additional protection. We recommend that measures are taken to prevent voltage transients in excess of this limit.
MGL Avionics recommends the fitment of a fuse in line with a 33V transorb (available from MGL Avionics at low cost) to protect electronic instruments, radios and intercom systems. Only one such arrangement is required for a cluster of instruments.
Please note that product warranty excludes damages caused by unprotected, unsuitable or incorrectly wired electrical supplies.

This instrument is not certified by the FAA. Fitting of this instrument to certified aircraft is subject to the rules and conditions pertaining to such in your country. Please check with your local aviation authorities if in doubt.
This instrument is intended for ultralight, microlight, homebuilt and experimental aircraft.

Operation of this instrument is the sole responsibility of the pilot in command (PIC) of the aircraft. This person must be proficient and carry a valid and relevant pilots license. This person has to make him/herself familiar with the operation of this instrument and the effect of any possible failure or malfunction. Under no circumstances does the manufacturer condone usage of this instrument for IFR flights.

Connecting the senders
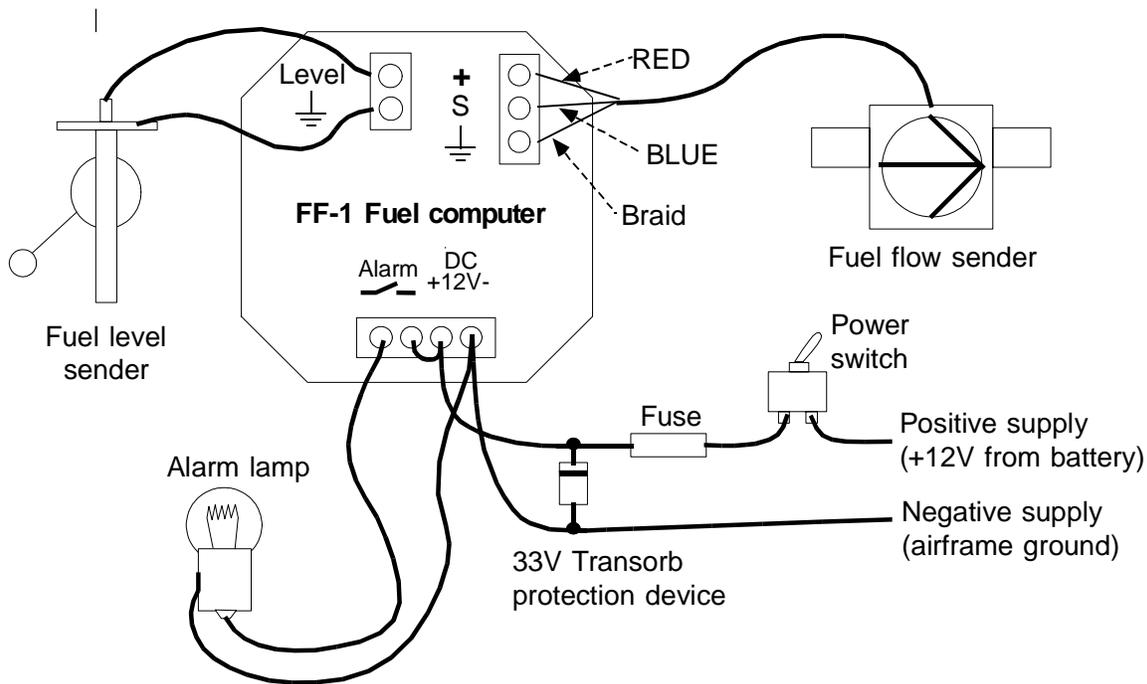
If required the FF-1 can interface to a standard automotive fuel level sender as indicated. Most of these senders are resistive types.

Capacitive types can be used provided they have a voltage output not exceeding 5V. The level terminal has an internal 1K resistor pull-up to 5V.

Please note that capacitive senders may exhibit large errors as they are very sensitive to the composition of the fuel used. We do not recommend using capacitive senders with automotive fuels for this reason.

Please ensure that the float of the level sender moves freely at all times and that the float is large enough not to remain submerged in case the mechanism becomes sticky. This will result in an incorrect indication of fuel level.

Note that you need to perform the calibration routine as outlined in the respective section of this manual.

Please observe the installation notes supplied with the fuel flow sender. Should you install a different fuel flow sender to that supplied by MGL Avionics, ensure that you enter the K-factor relevant for your sender.

Some senders require a pull-up resistor to the 12V supply line. We find most installations of these senders require a 4K7 pull-up resistor.

In all cases ensure that fuel flow through the sender is continues and smooth. Nearly all flow sender related problems are due to choosing a bad position in the fuel supply line. Any fuel flow sender will be negatively effected by having to measure pulsed fuel supply such as is created by most mechanical or pneumatic fuel pumps or by carburetor float valves that open and close continuously. Nearly every installation would require a suitable fuel reservoir to help create a smooth fuel flow for the sender. This can be easily created by installing a fuel filter before **AND** after the flow sender.