

## Fuel Gauge and Sender Instruction

### The Principle:

The fuel monitor works by supplying a minute amount of precise power to the outer aluminum tube of the probe. The amount of this power which is induced into a second conductor inside the tube (and insulated from it) depends upon the dielectric values of the medium separating the two conductors. Electronics in the head of the probe measure the induced potential amplify it and send it to the gauge. As the amount of fuel in the probe decreases from burn off, the amount of air in the probe increases, thus continuously changing the amount of power being induced.

The electronics are sealed to isolate them from weather, fuel spills, etc. The system will work properly with nearly any hydrocarbon-based compound ranging from kerosene to diesel oil.

Because the electronics of the fuel sender are designed for hydrocarbons, the gauge will not read properly if it is used with other liquids. If the probe touches water, it will read "Full" providing a good way to determine if the fuel tank has been contaminated. The probe will also read "Full" if it touches metal. Therefore, when planning installation, care must be taken to isolate the probe from any possible contact with metal. For example, if metal foam will be used, the probe should be isolated by installing it into a non-metallic tube, e.g., PVC.

Turbulence-induced fuel "slosh" has little effect on the system because the fuel being measured is inside the probe and the fuel cannot move fast enough to affect the gauge reading.

### Probe Info:

Probes come in one-foot increments. One and two foot lengths are standard. Longer probes are available at extra cost. Note: 12" probe has a 3" bendable area, and can be cut as short as 6", measured from the "head" of the probe. A 24" probe has a 5" bendable area and can be cut back to 12".

The actual working length of a probe is determined by the depth of the tank and the owner's decision as to the amount of fuel to be kept in reserve. The gauge will read "Empty" when no fuel is touching the end of the probe. As the probes are supplied in increments of one foot, it is necessary to plan carefully for tank depth prior to installation.

The user trims back the probe with a tubing cutter to a predetermined depth, then recalibrates the probe, adjusting the "Empty" and "Full" trim pots on the probe head following the included instructions.

With the optional LOW FUEL warning indicator, the user then adjusts the low fuel warning trigger point.

Probes have three or four wires exiting the side. The probe supplies power to the gauge which reads the variable millivolt output.

### Accuracy:

The probe is highly accurate, reading linearly - meaning that when the fuel is half way up the probe, the gauge reads "1/2". However, most aircraft fuel tanks are not linear - the sides are not parallel with the probe. As a result, some gauges will be "off" at some point in the needle travel. A solution is to calibrate the gauge so it reads an accurate "1/4" when you have one-quarter fuel remaining. Depending upon the tank's shape, higher readings will be "off" to some degree - such variations can be "carded" or marked on the gauge.

The bendable portion also registers if the probe is shorted, it need to be recalibrated. Probes can only be bent between the mark and the neck of the sender.

### Gauges:

The standard gauge fits a 2 1/4" instrument hole and has a 60 degree needle sweep. This gauge is also available as a 2" round (inserts from the pilot side, held by a "U" clamp). Gauges are available for 12 or 24VDC systems. Digital gauges can be specified at additional cost.

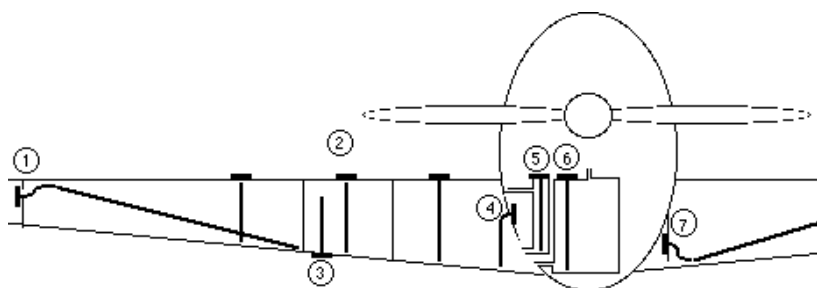
For multiple tank installations, dual gauges are available.

The kits include: probe(s) as specified, gauge as specified, multi-conductor wire, electrical connectors, AN bolts, mounting hardware (aluminum flange and gasket, for internal or external fixation), instrument mount screws and instructions.

### Options:

Probes are available with one or two additional adjustable output signals to activate a warning light or other device when the fuel reaches a predetermined level. A special 12V light emitting diode is supplied with these systems.

### INSTALLATION PREPARATION:



### SUGGESTED PROBE LOCATIONS:

(1) Installation of a bendable probe from the wingtip end of a wet wing or wing tank. Probes may be very long, requiring extra installation steps. Probes over 5' will require additional support inside the tank. This is an example of a "long bendable" probe installed in a wet wing. The probe is first bent up to the top of the inside of the tank, then down to the bottom. This enables the owner to get a full tank reading though the probe is installed below the top of the tank.

(2) A "summed" three probe system in three tanks. Probes are different lengths, but read together on the gauge.

(3) A bottom mount system, required when the only opening or space available is at the bottom of the tank. Care must be taken to seal the opening and bolt holes.

(4) A "short bendable" probe bent 90 degrees installed in a wet wing. The probe will not read the total depth of the tank. It can, however, be calibrated to read accurately once the fuel level reaches the "readable" portion of the probe.

(5) "Standpipe" installation - a good solution to the mounting problems posed by wet wings. It requires the builder to create a "standpipe" in which to mount the probe. The standpipe can be made of any non-metallic material such as ABS, PVC or fiberglass. It should be longer than the height of the fuel and mounted in any convenient location. The top of the standpipe should be equivalent to the height of the fuel in a full tank and the bottom an inch or below the bottom of the tank. The diameter of the standpipe should be a minimum of 1/2" ID and be topped by a 3" diameter flange on which to mount the probe. Plumb the standpipe to the fuel line (a tee will work) and vent the top of the standpipe back to the tank, directly outside through a fuselage vent or to a fuselage fuel vent system.

If the top of a header tank is lower than the wing fuel level at full, a standpipe can be extended from the top of the tank in which to mount the probe.

(6) This is an example of a probe installed in a header tank which is as high as the fuel level in the wings at full.

(7) Typical wet wing installation.

#### MOUNTING PROBE

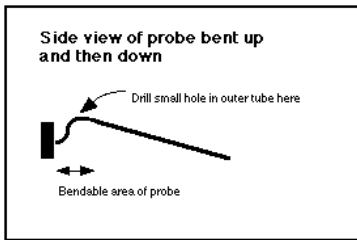
a. Locate an area on the top of the tank over the deepest portion of the tank. For internal flange mounted systems, a minimum area of 2 3/4" is required on the tank top. For external flange mounted systems, a flat area of at least 4" x 4" is necessary to accommodate the flange. However, the external flange may be trimmed to 2 3/4" diameter, if desired.

b. Drill a 1/2" hole in the tank in the area where the center of the probe will be located.

c. Important note: When performing this step, note that probes may not be excessively shortened. A 12" probe must not be shortened to less than 6". A 24" probe may not be shortened to less than 12". Measure the depth of the tank, and trial fit the probe for length.

Probes for flange mount systems will be spaced from the tank surface about 1/4" by the flange and gasket. Make a mock-up of the probe with a straightened wire coat hanger to check shape and dimension. See "Bending Notes"

#### BENDING NOTES:



1. The bendable portion of any probe is marked on the probe. You may bend anywhere between the probe head and this mark.

2. "Long bendable" probes are utilized for special side mount applications. A long bendable probe may be placed in the side of a fuel tank, and bent upwards to the top of the tank and then downwards beginning at the non-bendable section. This allows correct readings even in side mounted applications.

3. Before bending probes, make a mock-up of the finished probe bendable section using a straightened coat hanger. This will insure that the probe will be properly positioned and oriented in the tank.

4. Bend 1/4" probes no tighter than a 1" radius.

5. After bending, drill a small hole (about .060 inch, or 1mm) in the outer wall of the probe at the peak of the bent area. Use a drill stop to avoid hitting the inner conductor. This will allow the probe to vent and fill properly.

d. Using this trial fit as a guide, cut the probe as follows: Be sure of what you're doing. Once cut, probes cannot be exchanged or returned for credit! Plan to cut the probe 1/4" to 1" shorter than tank depth to leave a "reserve" when the tank is near empty. Using a tubing cutter carefully cut the outer probe tube to the desired length. Slide the separated section away from the center wire. This process will expose the center conductor, and one or more plastic spacers. Carefully slide the spacer closest to the cut end of the probe up into the probe end. This will insure that the center conductor is spaced and insulated from the outer tube. Using wire cutters, cut the center wire as nearly flush with the bottom of the tube as possible. The center wire is a small hollow tube which will crush slightly as it is cut. Don't try to reopen the center tube! This is unnecessary and may bend the center conductor. Fuel does not need to enter the bore of the center wire. It is made this way for rigidity only.

DO NOT PERMANENTLY INSTALL PROBES AT THIS TIME!! Place probes in position, or set aside and continue.

#### INSTALLING GAUGE

1. Select the mounting location for your gauge. Depending on the system configuration which you have selected, cut a panel hole the appropriate size for the gauge, 2" for round auto style, 2 1/4" for standard aircraft style.

2. Mount the gauge and any related switches using supplied hardware.

#### CABLE ROUTING:

1. Select appropriate cable routing, remembering to leave slack to allow good radius bends and access to points to secure the cable to the airframe. You must avoid putting tension on gauge or probe terminals.

2. Using tie-wraps, loosely secure the cable in position.

#### WIRING CONNECTIONS:

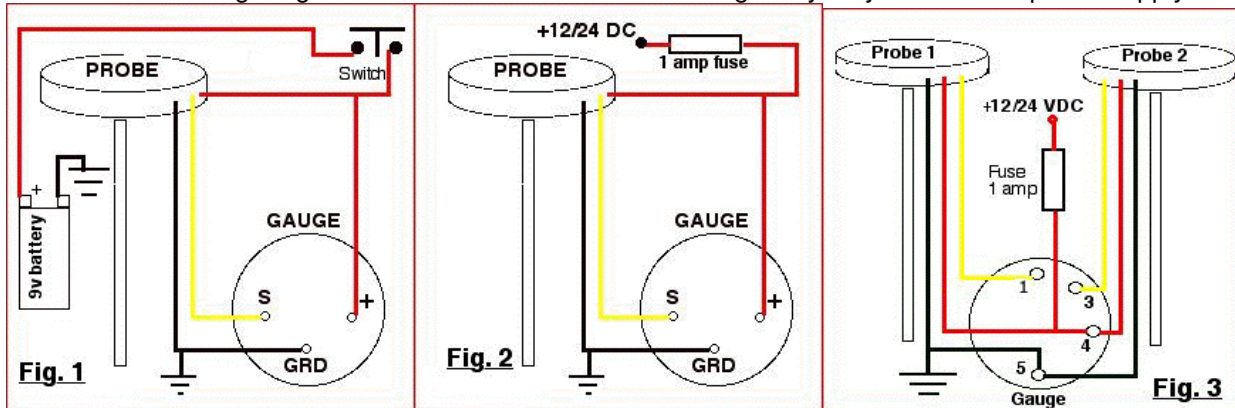
1. Connect probe to gauge as shown in the diagrams.

2. Connect gauge to power as shown in figure.

3. Carefully check and tighten all connections. For crimped connections, use the appropriate crimping tool and wrap the connection with insulating tape. As with all aircraft wiring, follow sound safety principles. Always include the fuse in 12 and 24-28 volt systems!

4. For multiple indicator gauges, see figure 3. If you have two probes on a single gauge, wire as shown in figure 5.

5. For multiple probes driving a single gauge simultaneously (a "summed" arrangement, so-called because the gauge reads the summed capacitance of the multiple probes), connect the signal and power wires of the probes together at the signal and power inputs of the gauge. Check aircraft voltage regulation! Electronic instrument readings may vary with aircraft power supply voltage!



## Calibrating the Fuel Monitor System

### CALIBRATION

1. If possible, do the calibration in the aircraft tank. If this is not possible (for example, inverted installation, extremely long probes, difficult access), use a portable fuel can or other container to carry out calibration. Long probes can be calibrated in a capped PVC tube. Kerosene is a suitable medium.

### WARNING: FUEL IS FLAMMABLE AND TOXIC. EXERCISE EXTREME CAUTION WHEN WORKING WITH GASOLINE!

2. Make sure the calibration tank is empty and the probe is completely dry, inside and out.
3. Examine the top of the probe. You will see two adjusting screws. These are marked on the label as "Full" and "Empty". The extra screws, if present, are for low and high warning signals, which will be adjusted later. Turn all adjusting screws fully clockwise. Be gentle! Excess force on the screws can damage the probe. Full travel on the screws is about three-quarters of a turn.
4. Place the probe in the empty tank. Note: do not touch the metal probe during calibration. Hold the probe only by its plastic cap.
5. Apply power to the system. Turn the "empty" screw slowly counter-clockwise until the needle points just below "empty" on the gauge. Slowly turn the screw clockwise until the needle reaches the "empty" mark. Stop! This is the empty calibration point.
6. Fill the tank with fuel to the normally full level. Turn the "full" screw counterclockwise until the gauge reads "full". This is the full calibration point.
7. Carefully remove the probe from the tank, shaking it gently to drain fuel from the probe (or, drain the tank). The gauge should read "empty". If not, you may "fine tune" the probe by repeating the above steps.

### LOW FUEL WARNING OPTION:

1. **LOW:** Connect the green signal wire from the wiring harness to the black wire of the warning light using the crimp-on inline connector. Using the supplied crimp-on round terminal, connect the other wire (red) of the warning light to the "+" terminal on the gauge.
2. **LOW WARNING (optional)** - Reinsert the probe in the tank. Add fuel until the tank fuel quantity equals the level at which you want the warning light to come on.
3. Turn the "LOW" adjusting screw until the warning light turns on. Turn in the opposite direction until light just turns off, then move the screw very slightly in the opposite direction until light comes on again. Drain a small amount of fuel from tank to test operation.

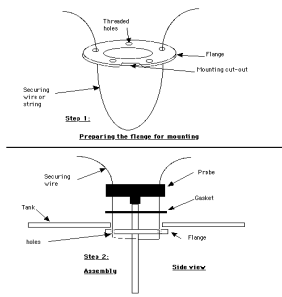
### ADJUSTING FOR TANK IRREGULARITIES:

Although the probe is linear in its output, irregular tank shapes will distort gauge readings. To accurately calibrate the gauge to the tank, do the following:

Place the aircraft in flight attitude for level flight. Accurately measure the volume of the tank using a known standard container. After calibrating the gauge as set out above, slowly add fuel to the tank to 1/4 of its capacity. Make a mark on the face of the gauge using a grease pencil. Continue the procedure by adding 1/4 tank volumes and noting each reading by a mark on the instrument face. If the readings on the gauge vary significantly from actual volumes, prepare a calibration card to be attached to the panel near the gauge to guide you in reading the gauge. Or, permanently mark face of gauge.

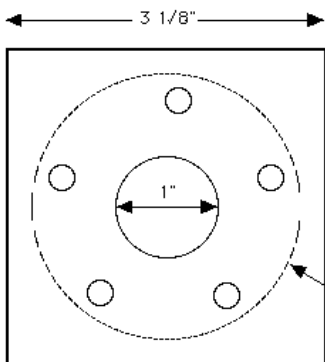
### PERMANENT INSTALLATION:

After calibration, permanently mount each probe. Choose the type of mount suitable for your tank material. The internal flange or universal mount is suitable for all types of tanks and is required on flexible or plastic tanks. Metal and fiberglass tanks can use the external flange mount.



## INTERNAL FLANGE MOUNT

1. Locate internal flange. Note notch in outer edge. Thread a thin wire (like safety wire) or string at least 24" long through two non-adjacent holes in the flange. See drawing on page 4. Set the flange aside for now.
2. Using the 1/2" hole drilled in the tank as the center, cut or drill a 2 3/8" hole in the tank. Debur the edge of the hole. Clean any debris from the tank.
3. Hold ends of string or wire threaded into flange. Tilt flange into hole in tank. Notch allows flange to fit into tank. Pull on both ends of wire to hold flange against inside of tank, just to see how the flange fits inside the hole. Now, thread the ends of the string or wire through gasket holes which correspond to the holes in the flange.



Note: That the hole pattern is not symmetrical in either the flange, gasket or probe. The space between two of the holes is a little larger than the space between the other holes!

4. Place probe in the tank, while threading the wire or string ends through the correct holes in the probe.

5. Holding tension on both ends of wire or string, thread one bolt through another hole in the probe and gasket, into the flange. Once it is finger tight, insert and finger tighten a second screw. You can now remove the wire, insert the remaining three screws, and tighten all five screws. This will secure the internal flange against the inside of the tank as the probe and gasket fit against the outside of the tank.

6. Tie-wrap cable to gauge securely into position.

## EXTERNAL FLANGE MOUNTING:

1. For external flange mounting, the included aluminum flange must be secured, in a fuel proof fashion, to the probe mounting location. The flange may be welded or bolted to metal tanks, or bolted or glassed into fiberglass or composite tanks. The attachment must be fuel proof!

**Prior to welding, read all notes and warnings in this manual. When working with your fuel system, do so in a well-ventilated area. Prior to welding tanks which have preciously been filled with gasoline, it is advisable to flush the tank at least three times with water. Thereafter, many professional welders recommend filling the tank with inert gas (such as argon) prior to welding. Consult a qualified professional for welding aluminum.**

2. Keeping the above in mind secure the flange to the tank centered over the previously drilled 1/2" hole. If you wish, this hole may be enlarged as needed to facilitate flange installation, while still providing sufficient support for the flange.

3. Place the supplied probe gasket between the flange and the bottom of the probe head, and insert the probe into the hole. Align the holes in the probe head, the holes in the gasket, and the holes in the flange. Note: the 5 hole pattern is NOT symmetrical. There is only one correct alignment of the probe, gasket and flange. If you will be bending the probe, mark the "top" of the head of the probe to enable you to place the bends in the correct locations.

4. Attach the probe to the flange using the supplied AN3 bolts. Tighten securely, then safety wire the bolt heads to secure in position. For side and bottom mounted probes, use a fuel proof sealant on gasket and bolts!

## OPERATION:

1. Each time a full gauge is powered up; it will peg "empty", then rise toward the empty mark slightly.

## TROUBLESHOOTING

If apparently incorrect readings are obtained, try recalibrating the probe. Remember to calibrate with the aircraft in a level flight attitude, and that tank shape may affect the linearity of the gauge reading.

If the gauge stays at full or empty at all times, check:

- Is the probe contaminated with water?
- Is the probe bent? -- (non-bendable probes only)
- Is the probe touching the side or bottom of a metal tank?
- Are probe wires incorrectly connected?
- Is the wire harness shorted?
- Is the center wire touching the outer probe tube?
- Is the power turned on?
- Are voltage and polarities correct?

Is sealant blocking the probe vent? If so, fuel will not be able to rise in the probe.

If fuel reading varies when operating a transmitter, shield probe head and wires, relocate radio antenna and/or coax.

## Falcon Gauge 5V Output Fuel Quantity System Installation Instruction

### Sender

1. *Specification*

Power Supply:  $12 \pm 2V$  DC or  $24 \pm 4V$  DC (cut the jump wire when using 24V power)

Output: 0-5V DC

Weight: Approx. 115g

Wire Connection:            RED — Power supply positive  
                                       YELLOW — Sending signal, output 0-5V  
                                       BLACK — Ground

2. *Application*

Falcon Gauge fuel sender is applicable for fuel (not water, if the fuel sender is in contact with water or metal tank, it would read full.).

3. *Sender Preparation and Calibration*

The fuel sender was set up at the factory as follows: Empty  $\leq 100$  mV; Full = 5V (Located at 1" above the black bendable marking for 12" sender; at 2.5" above the black bendable marking for 24" sender. Please follow these instructions to recalibrate (*Note: You do not have to recalibrate if the sender is not shortened. It has to be recalibrated if it has been shortened.*)

- 1) Make sure there is no contact between the inner and outer tubes.
- 2) Turn the "full" adjustment screw all the way to the right
- 3) Calibrate at empty first, make sure sender is dry.

Connects the sender to the power supply and a Multi-Meter

RED — Positive; BLACK — Ground

YELLOW — Multi-Meter's positive (Multi-meter's negative connects to the power supply's negative.)

Turn "Empty" adjustment screw gently to left or right and find smallest value  $< 100mV$ .

4) Calibrate at "Full"

Place sender into full tank fuel. Turn "Full" adjustment screw left / right to read 5V

5) Turn off power supply

4. Connect sender with gauge as the diagram shown

Note: In case of needle move counter clockwise as voltage increases, check #4 and #5 for connection error.

