SKY*Sports*®

Sky Sports® Fuel Monitor System Instructions

INTRO

SkySports ® Fuel Monitor System is a capacitance system. It has no float - or other moving parts - except the needle in the gauge. Military and commercial aircraft have used capacitance type fuel monitoring systems for many years, but SkySports® is the first supplier of such units to general and sport aviation.

Well over 6,000 units are in the air, all over the world. Many have been in service for more than eighteen years. SkySports® systems have been adapted over the years to nearly every type of aircraft - gyro planes, (Bensen and Air Command), helicopters (Bell and Rotorway), war birds including P-51, T34 and PBY, amphibians, such as the SeaBee, every type of ultralight, and most of the popular wood, metal and composite homebuilts. Every day, more applications are added.

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 (maximum of approx. 80mA). As the amount of fuel in the probe decreases from burnoff, 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. SkySports® can also supply systems to measure water, ethylene glycol and many other liquids.

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. Probes for depths of less than 5" are also available by special order.

Note: A non-bendable 12" probe can be cut as short as 5", measured from the "head" of the probe. A 24" probe can be cut back to 13".

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 or HIGH FUEL warning indicators, the user then adjusts the low and/or high fuel warning trigger point.

Probes have three, four or five wires exiting the side. The probe supplies power to the gauge which reads the variable milliamp output. For special applications probes which output 0-5 VDC, the standard feed to computer systems, can be ordered.

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.

Probe Types:

If a probe location requires the probe to be bent, a "bendable" probe can be supplied. The "short bendable" tube's maximum "Full" location is about 3" below the probe head (5" on "long bendable" probe). The bendable portion does not register, as a result of insulating the inner conductor in that area to preclude shorting the probe during bending. (Remember, if the probe is shorted, it will read "Full" at all times.) The bending area is indicated by a mark. Probes can only be bent between the mark and the neck of the sender. The unreadable bending zone should be taken into account if a location requiring a bendable unit is being considered, as some portion of fuel may be unmeasurable. For example, if a standard bendable probe is installed in the side of a tank and the distance from the top of the tank to the probe is 3", there is an unmeasurable depth of 6". If this "dead" zone represents one-quarter of the fuel, the probe can be calibrated to read "3/4" at this point instead of "Full". Obviously, there will be no indication of fuel usage until one-quarter of the fuel is burned off. But from that point, the gauge will be accurate -taking into consideration the shape of the tank as previously discussed. "Long

bendable" probes are available which will allow you to bend the probe up to the top of the tank, then down, enabling reading nearly all of the tank, even though the probe enters below the top.

The "Basic System" is a single probe reading to a single gauge. Multiple probe/gauge combinations are available. For aircraft having multiple tanks at different locations and heights, probes which "sum" or read together, can be supplied.

Gauges:

and what gauges will work with theSkySports® Capacitance System?
A number of gauge configurations are available, the choice depending upon the application. 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 9, 12, 24, or 28VDC systems. Digital, VDO or Westach gauges can be specified at additional cost. Probes can often be built to work with a gauge that you already own or that matches other gauges in your panel.

For multiple tank installations, dual and triple gauges are available. Multiple probes can be switched to read on a single gauge. SkySports® can also supply combination gauges, for example: fuel level and fuel pressure. For aircraft without electrical systems, a 9 VDC system is available operated from a momentary push switch. Battery life is hundreds of flying hours on an alkaline cell.

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, cable ties 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. However, a buzzer or other device drawing less than 200 milliamperes can be substituted. Some builders use the high point output to toggle a fuel transfer pump switch to "off" to prevent overfilling.

Special probes are also available to measure oil levels, water levels or exotic fuels, such as methanol.

Probes can be built to your specific length for an additional charge.

Bendable (insulated) sections can be ordered in any length for no additional charge.

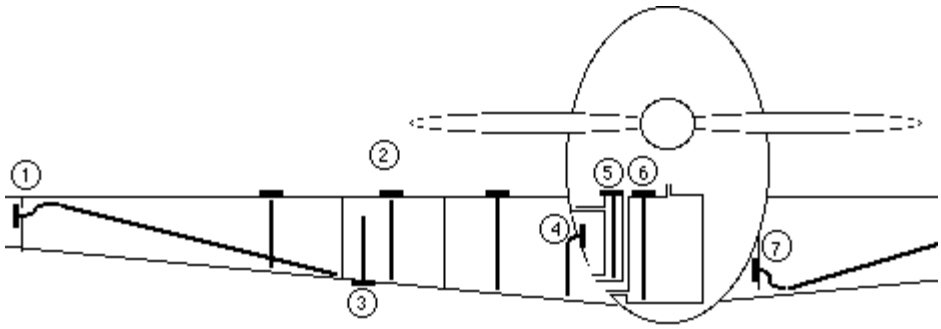
Probes may be ordered with a threaded fitting at the neck.

Warranty:

All SkySports® products carry a one year limited warranty. Any product failing during that period will be replaced or repaired without cost to the original purchaser.

SPECIFICATIONS

PROBE LENGTHS: 3" TO 132"
PROBE DIAMETER: 1/4" TO 1/2" (depending on length)
BEND RADIUS: 1" (1/4" dia. probes), 3" (1/2" dia. probes)
PROBE HEAD SIZE: 2.60" diameter .750" high
MOUNTING HOLES: Standard SAE 5-hole pattern
CURRENT DRAW: 100 ma maximum
OPERATING VOLTAGE: 5,9,12,24 or 28 volts DC
ALARM OUTPUT CURRENT(optional): 200 ma maximum
SYSTEM WEIGHT: less than 1 lb. for single probe systems
PROBE WEIGHT: less than 5 oz. for 12" probe
FUELS: Gasoline, gas/oil mix, diesel, water



INSTALLATION

PREPARATION:

These instructions cover installation of all SkySports® fuel monitor systems. Accordingly, it is important that you locate and follow the instructions which pertain to your particular version of the probe and gauge. It is strongly recommended that you read the instructions completely before beginning installation.

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 (11' is the record so far), requiring extra installation steps. Probes over 24" are 1/2" OD for strength, 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 avail able 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.

WARNING: DO NOT ATTEMPT TO BEND PROBES UNLESS BENDABLE PROBES HAVE BEEN SUPPLIED. ON BENDABLE PROBES, THE BENDABLE SECTION IS BETWEEN THE PLASTIC PROBE HEAD AND THE INK MARK ON THE PROBE. DENTING OR BENDING A NON-BENDABLE PROBE WILL RUIN IT PERMANENTLY!

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 5". A 24 probe may not be shortened to less than 13". Bendable probes must have a length remaining of at least twice the length of the bendable section. (A probe with a 5" bendable section cannot be cut shorter than 10", a 3" bendable probe must be at least 6".) 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. If you are installing a bendable probe, make a mock-up of the probe with a straightened wire coat hanger to check shape and dimension. See "Bending Notes"

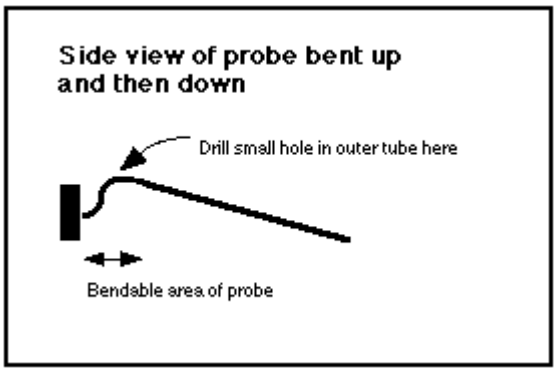
BENDING NOTES:

NOTE! Special bendable probes are available for special applications. Don't try to bend non-bendable probes!

1. The bendable portion of any probe is marked on the probe. You may bend anywhere between the probe head and this mark. The probe's bendable section is insulated, and will not measure changes in fuel levels.

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. Bend 1/2" probes no tighter than a 3" 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, or gauges. If installing a self-powered or single gauge, dual probe system, remember to leave room near the gauge for the momentary push "on" switch or tank selector toggle switch. 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, or 3 1/8" for triple or quad indicator gauge.

2. Mount the gauge and any related switches using supplied hardware. For optional low or high fuel light, select a mounting location and drill appropriate size hole within 2" of gauge. Push light assembly into hole.

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. Use Figure 1 for 9 volt systems, Figure 2 for 12 or 24 volt systems, and figure 3 for dual 12 or 24 volt systems. On Westach single gauges pin 2 is signal (S), pin 4 is + voltage, and pin 5 is ground.

2. Connect gauge to power as shown in figure 1, 2, or 3, again depending upon voltage. Nine volt systems come with a snap-on battery connector. Use only alkaline batteries for 9 volt systems. For 12 and 24-28 volt systems, a 1 amp fuse or circuit breaker must be wired in the circuit as shown.

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!

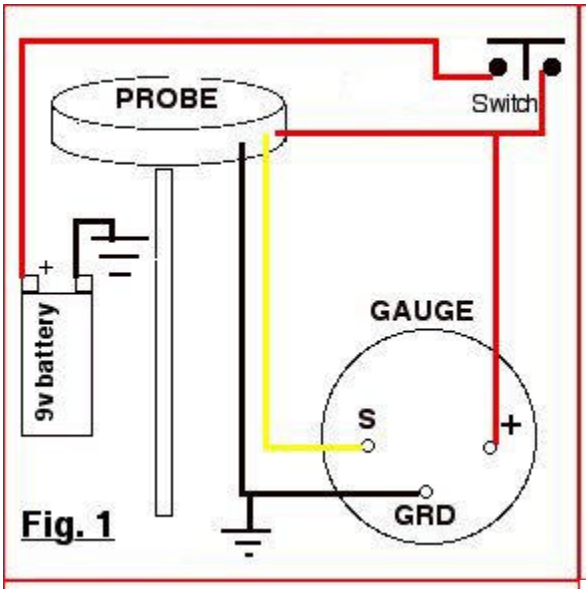


Fig. 1

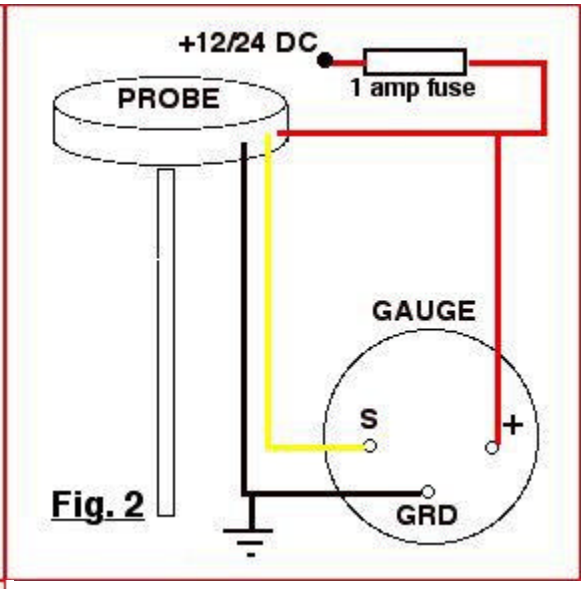


Fig. 2

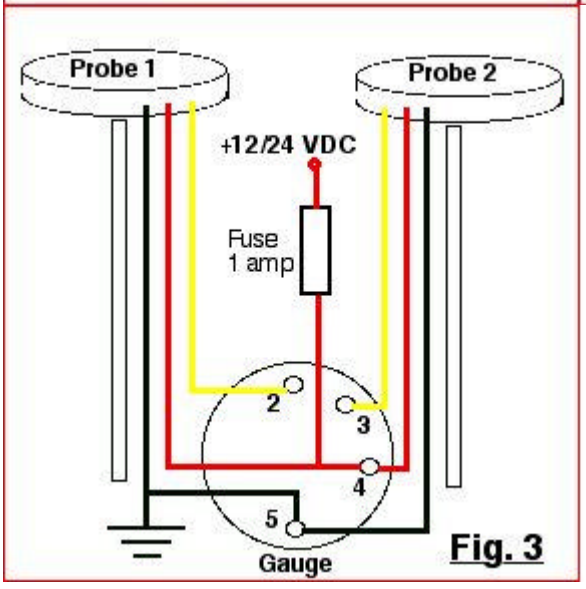


Fig. 3

Calibrating the SkySports® 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, three or four 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. For 9 VDC systems, depress and hold the pushbutton switch. 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 or HIGH 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 in-line connector. Using the supplied crimp-on round terminal, connect the other wire (red) of the warning light to the "+" terminal on the gauge.

HIGH: Connect the white signal wire from the gauge to the black wire of the "high" warning light. Using the supplied connectors, connect the red wire from 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.

4. HIGH WARNING(optional)- Add fuel to the level at which the "High" warning is desired. Turn the "HIGH" adjusting screw until the high warning light comes on, then turn in the opposite direction until the light just goes out. Add a bit more fuel to check operation.

ADJUSTING FOR TANK IRREGULARITIES:

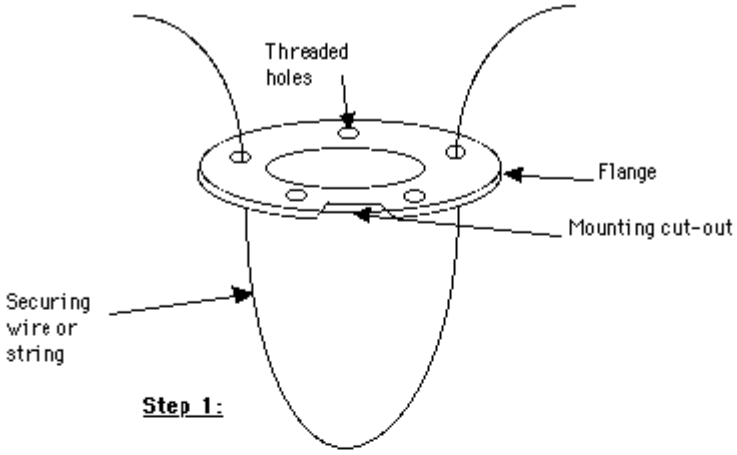
Although the probe is linear in its output, irregular tank shapes will distort gauge readings. To accurately calibrate the gauge to the tank, do the following:

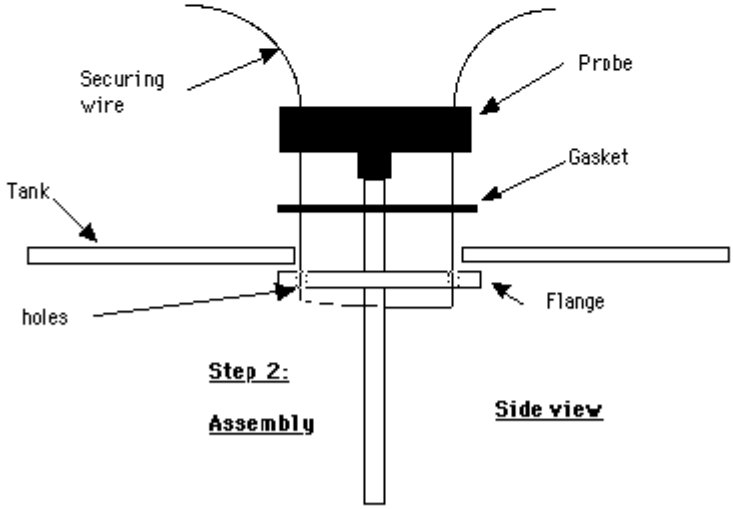
Place the aircraft in flight attitude for level flight. Accurately measure the volume of the tank using a known standard container. After calibrating the gauge as set out above, slowly add fuel to the tank to 1/4 of its capacity. Make a mark on the face of the gauge using a grease pencil. Continue the 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

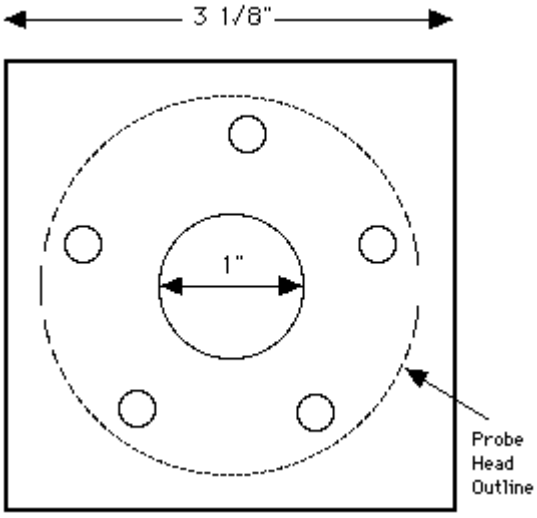




1. Locate internal flange. Note notch in outer edge. Thread a thin wire (like safety wire) or string at least 24" long through two non-adjacent holes in the flange. See drawing on page 4. Set the flange aside for now.

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 PREVIOUSLY 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 the SkySports® gauge is powered up, it will temporarily read "Full", then settle on the correct reading. Each time a Westach gauge is powered up, it will peg "empty", then rise toward the empty mark slightly.

2. For battery-powered 9 volt systems, a less than full reading at power up is a signal of a weak battery

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.

Visit our on-line catalog or contact us by mail, phone, fax, or email.

Mail:
Hangar 1
Linden Airport
LINDEN MI 48451 USA

1-800 AIRSTUFF
(800) 247-7883 (US and Canada)
810-735-9433
Fax 810-735-1078
E-mail mgm@airstuff.com