

Tech Reference: Instruments

do
you
need
more
information?

The following section addresses technical questions often asked about instruments.

The information in this document was provided by one of Catalina's early instrument vendors. In the interest of clarity we have deleted irrelevant information such as outboard motor instruments, trim gauges and twin engine synchronization. Although today's instruments are approximate equivalents they may be not exactly the same. Troubleshooting information will still be helpful if not exact.

Specifications:

Operating Temperature Range:

-40°F to +185°F, with a $\pm 2\%$ of full scale reading change (max.) to 75°F indication for all Teleflex gauges.

Shock Withstand:

Teleflex instruments remain within initial accuracy specification up to 50 G's, half-sine 9-13 milliseconds duration, 25 shocks of equal magnitude in each of three axes.

Vibration Withstand:

Teleflex instruments stay within initial accuracy specification at .060" double amplitude vibration from 10-80-10 Hz for one minute periods over three hours in each of 3 axes (six hours total).

Humidity:

Teleflex instruments remain within initial accuracy specification in 95% humidity at 100°F (37.8°C) for 48 hours.

Overvoltage:

Teleflex 12-volt instruments withstand a maximum of 18 volts DC applied to the +14 terminal with no damage.

Reverse Polarity Protection:

Reverse polarity protection is designed into all Teleflex instruments.

Voltage Variance:

Accuracy remains within $\pm 2\%$ of initial reading at 14.5 volts DC when voltage is varied from 12 to 16 volts.

Salt Spray:

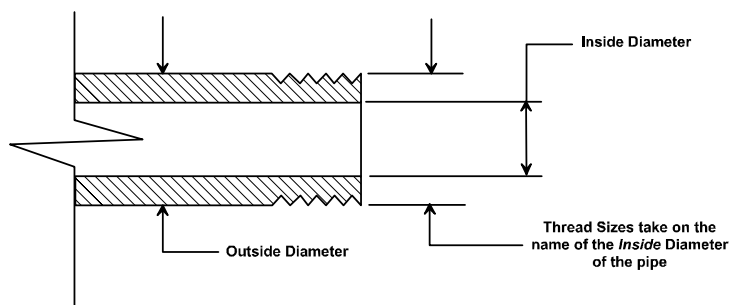
all Teleflex instruments conform to ASTM B 117 after 48 hours of salt spray exposure.

European Standards:

All current production Teleflex analog electrical instruments comply with the EMC requirements directive for sale in Europe.

Why NPT (National Pipe Thread) Threads Aren't What They Measure.

The industry designation for National Pipe Threads comes from the pipe's **inside diameter**. If you measure the outside diameter of a sender pipe thread, it will be considerably larger than the NPT size:



INDUSTRY DESIGNATION	PIPE INSIDE DIAMETER	ACTUAL PIPE OUTSIDE DIAMETER	
1/8-27 NPT	1/8"	.405"	13/32"
1/4-18 NPT	1/4"	.504"	35/64"
3/8-18 NPT	3/8"	.675"	43/67"
1/2-14 NPT	1/2"	.840"	27/32"

Teleflex Marine Instruments

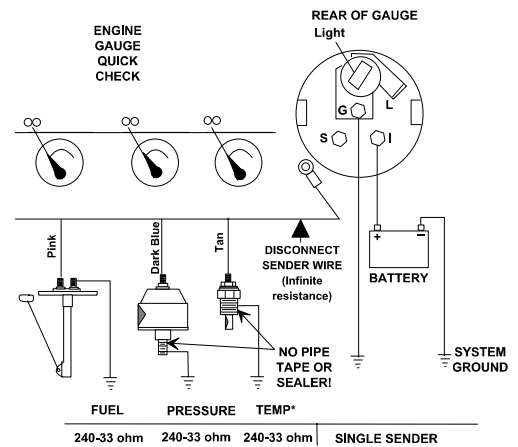
Does The Gauge Work?

To see if the gauge is operating correctly:

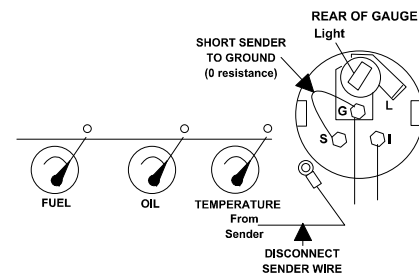
1. Remove the gauge's sender wire. Turn on the power. The pointer of whatever gauge you are checking should be at the position shown in the upper portion of the diagram at right.
2. Next, take a short wire and connect to sender terminal and ground terminal (shorting sender terminal to ground).

Gauge pointer should be at the position shown in the lower portion of the diagram.

3. To test senders, the resistance values are shown at minimum and full gauge scales.



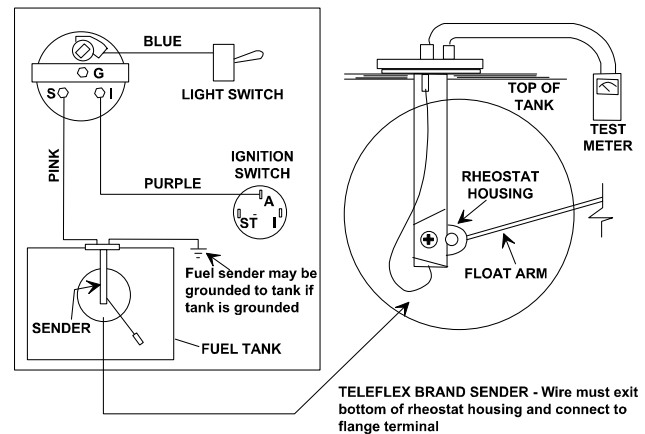
TEMP* Sender value @ 72°F is 800± ohm Single, 400± ohm Dual



Teleflex Marine Instruments

Fuel Systems (Marine)

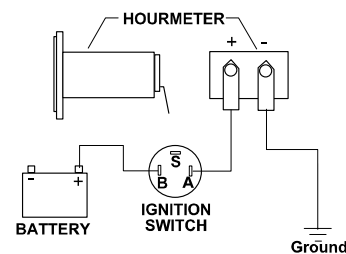
1. Voltage - "I" to "G" terminal - 10 to 16 volts.
2. Test gauge as follows: Connect "hot" wire to the "I" terminal and ground wire to "G" terminal. Remove sender (usually pink) wire from back of gauge. Gauge should read below "EMPTY." Next, add a short wire from the gauge's "S" (sender) terminal to ground. Gauge should read above "FULL." If the pointer sweeps back and forth, gauge is OK.
3. The sender can be tested by checking its resistance with a volt/ohm test meter (use analog meter) as follows:
 - a. Remove sender (usually pink) wire from sender.
 - b. Connect two test meter wires to two sender terminals (or center terminal & flange if sender has only one terminal).
 - c. Move float arm by hand. Approximate values:
Empty = 240 ohms, 1/2 = 103 ohms,
Full = 33 ohms.
(Teleflex sender: rheostat housing installed upside down will cause gauge to read backwards. See illustration.)
4. Sender resistance tolerances at full may cause the gauge to read 2-3 pointer widths either side of the full mark.
5. The sender will accurately operate only one standard gauge at a time. It is not designed for dual station use with standard gauges.
6. Gauge will not operate accurately from more than one sender at a time. Some installations use a switch to connect one gauge to various tanks, one at a time.



7. Sender will not operate in water tanks. Rheostat will become electrically "open".
8. Be certain sender dimensions are adjusted per the instruction sheet.
9. If sender is "open" (infinite resistance) gauge will read below empty. If sender is shorted (0 resistance) gauge will read above "FULL".
10. Some "bowing" of the flange may occur when the 5 mounting screws are tightened. The gasket under the flange will normally seal the flange properly, but do not overtighten the mounting screws.
11. Sender must be grounded, or gauge will always read "EMPTY."
12. If sender is installed in a tank not designed for a sender, care must be taken to seal screw threads. Sealant under screw head is also advisable. Sealant must withstand gas and diesel fuels.

Hourmeters

1. The hourmeter operates on voltages between 12 and 32 volts DC.
2. The hourmeter's "indicator" wheel (lone window to the right) should index every 3.6 seconds.
3. The hourmeter is not and cannot be lighted.
4. Time recorded cannot be erased or altered backwards.
5. Real time can be added to the hourmeter by connecting it to a power source (12-32 volts). Time added cannot be accelerated.
6. The hourmeter is easy to wire and can be connected to the ignition switch and ground or another gauge's "hot" terminal and ground. The hot side must be switched off when the boat engine is not in use. Be aware that this connection method allows the hourmeter to record time whenever the ignition is on, even when the engine is not running.



Oil Pressure System — Inboard

1. To test the gauge, voltage from “I” to “G” terminal must be 10-16 volts DC, with no wire on “S” terminal. Gauge pointer should rest below the “0 PSI” mark. Next, connect the “S” terminal to the “G” terminal (leave “I” and “G” terminals connected). The gauge pointer should rest above the maximum pressure mark.
2. Sender resistance can be measured to determine the sender’s correct operation. Remove wire to gauge. Connect an ohmmeter to terminal of sender and to engine block.

Approximate pressure sender resistance values are:

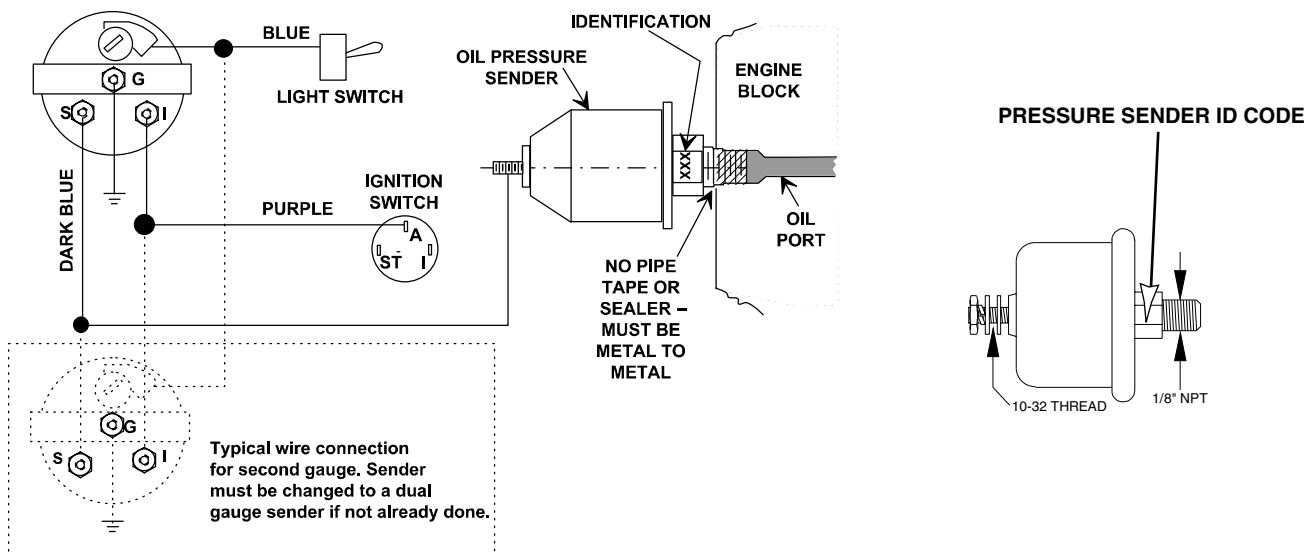
Zero pressure = 240 ohms

1/2 gauge reading = 103 ohms

full gauge pressure = 33 ohms.

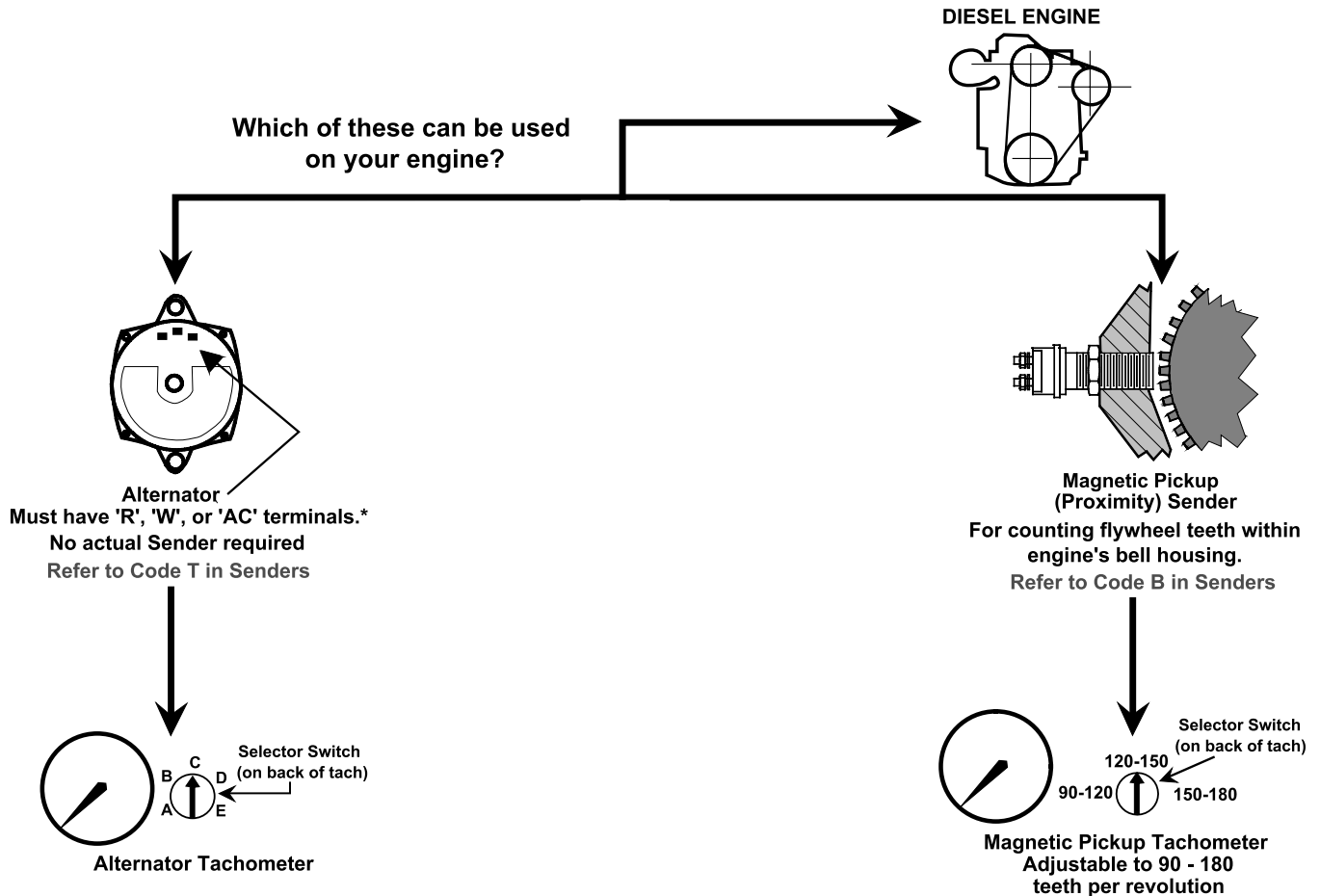
(You will get half these values on a dual gauge sender.)

3. If sender is shorted (0 ohms) gauge will read above full gauge pressure reading.
4. If sender has infinite resistance (open) gauge will read below 0 PSI.
5. If gauge reads lower than expected, was sealer used on the sender threads? (See illustration.)
6. The accuracy of the system (gauge & sender) can be ± 5 PSI at 40 or 50 PSI.
7. Use of pipe extenders to plumb both a sender and pressure switch (for horn or warning light) from one port is not recommended. Pressure readings will be accurate, but the weight added to the extended fitting of a vibrating engine may cause fatigue related breakage.
8. **Teleflex does not offer senders for metric threaded ports.**



Teleflex Marine Instruments

Tachometers (Diesel)



Tachometer Guide (Diesels)

Diesel tachs may require a sender, depending on the engine. These tachs are offered in “dedicated” (specific sender type) versions. Diesel Tach/Hourmeters are offered in a “programmable” versions (Heavy Duty) which accommodate several sender types or “dedicated” versions (Lido Pro).

1. Engine has No Provision for Tach Sender:

Use Diesel Alternator Tachometer (CODE “T”). Diesel Alternator tachs read the alternator signal. **Alternator must have an AC tap**, usually marked “AC”, “R” or “W”. If there’s no tap, a local alternator repair shop can usually add one at a small cost. You **need to know the number of magnetic poles** in your alternator. Consult the alternator maker or local alternator repair shop if in doubt. Also, **calculate the pulley ratio from crankshaft to alternator.** Determine **Switch Setting**, based on Number of Alternator Poles and Crankshaft-to-Alternator Pulley Ratio, calculated as follows:

$$\text{Crank Pulley Dia. / Alternator Pulley Dia.} = \text{Pulley Ratio}$$

(Match number of poles and pulley ratio to the appropriate switch position setting on the chart below.)

DIESEL ALTERNATOR TACH SWITCH SETTING CHART						
(RATIO = Crank Pulley Diameter to Alternator Pulley Diameter)						
NUMBER OF ALTERNATOR POLES:	8	10	12	14	16	SWITCH SETTING
TACH WITH 5-POSITION SWITCH:						
RATIO	1.5:1	1.2:1	1:1	0.857:1	0.75:1	A
RATIO	2.25:1	1.8:1	1.5:1	1.28:1	1.125:1	B
RATIO	3:1	2.4:1	2:1	1.71:1	1.5:1	C
RATIO	3.75:1	3:1	2.5:1	2.14:1	1.875:1	D
RATIO	4.5:1	3.6:1	3:1	2.57:1	2.25:1	E

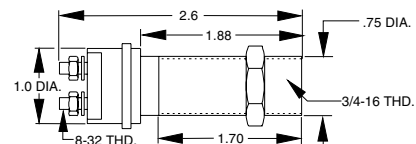
The switch is typically set to “B” for Universal Diesel engines, “C” for Yanmar engines if they have the original equipment alternator. Aftermarket alternators will likely require different settings.

NOTE: Tachometers are factory calibrated for several combinations of poles and pulley ratios, but in almost all cases you will need a Portable Master Shop Tachometer for initial calibration.

2. Engine has Magnetic Proximity Sender Mount:

Use Diesel Magnetic Pickup Tach with Magnetic Pickup Sender (CODE “B”). The sender mounts in a 3/4-16 threaded hole, usually in the bell housing. As each gear tooth passes the sender, a pulse signal is generated. Works with 90 to 180 teeth on gear.

CODE B
MAGNETIC
PROXIMITY
SENDER



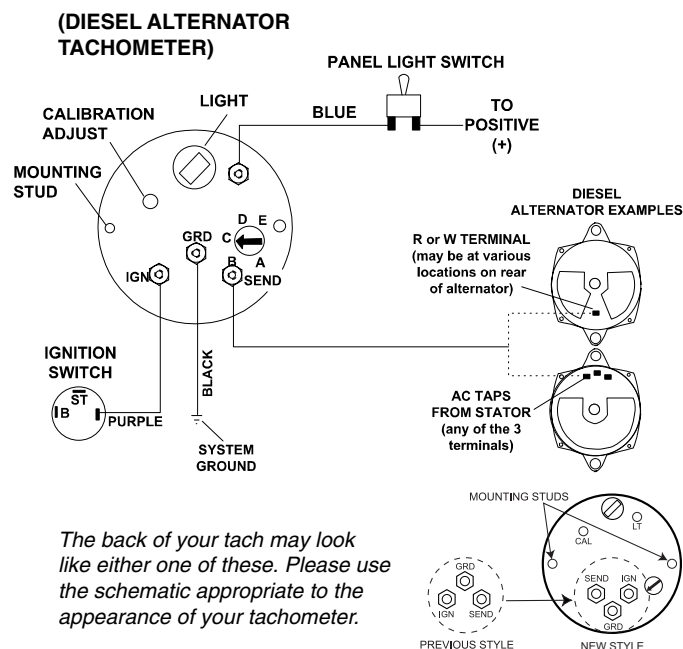
Teleflex Marine Instruments

Tach & Tach/Hourmeter (Diesel Alternator Type)

1. For this type of tachometer, the engine is usually a diesel, but can be a low-RPM gasoline stern drive or inboard.
2. Check all wire connections to see that they're tight and not corroded. **NOTE:** Some older style tachometers operate with only Ground and Sender connections. Teleflex tachs must have 12 VDC (from the ignition switch, "ON" when engine is running) to the "IGN" stud.
3. When tachometer is first turned on, pointer **must** go to zero ± 50 RPM. If not, check connections (if OK, tachometer is probably faulty).
4. **Voltages with engine running should be:**

IGN to GND terminal: 12 VDC minimum;
SEND to GND terminal: 5 VAC minimum.

5. Arrow on rotary selector switch must be pointed directly at setting or the tachometer will go to full scale.
6. Some alternators do not have output terminal for tachometer signal. A local alternator repair shop can install a tap from the internal rectifier to facilitate a tachometer signal from the alternator.
7. If the number of alternator poles is not known, measure actual RPM with a Master Tachometer. Rotate tach selector switch to the letter that puts the tach closest to actual RPM. Final calibration adjustment requires a Remote Master Tachometer. Connect the master tach and start the engine. At about 1,500-2,000 RPM, use a jeweller's screwdriver to carefully adjust the potentiometer in the "CAL" hole (about 10 o'clock on the rear of the tach), bringing the tachometer into agreement with the Master Tach. Only a minimal amount of turning is required. **Overtorquing of adjustment will damage gauge mechanism.** Turning clockwise increases tach reading, counterclockwise reduces reading. If the tach cannot be brought into calibration, the black Range Selector Switch is probably on the wrong setting.
8. Alternator belt slippage will cause some error on the tachometer.
9. Dual stations: the sender will drive two tachometers. Simply connect "IGN" to "IGN", "GND" to "GND", etc. **NOTE:** mixing brands/types (such as 2-wire/3-wire, see paragraph 2 above) may cause problems.



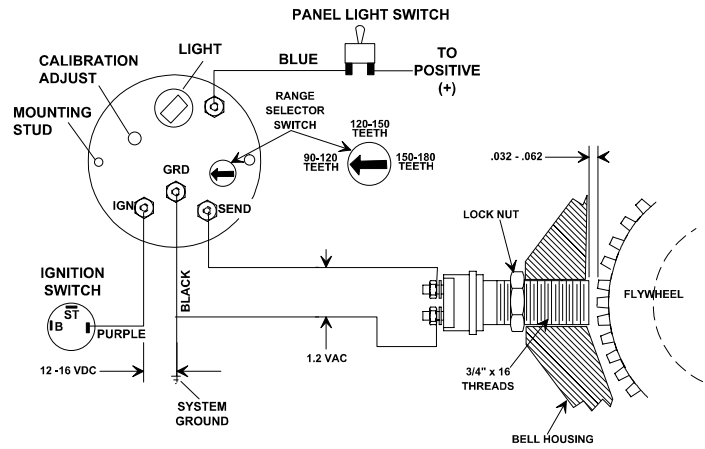
Tachometer (Magnetic Pickup) (Code B)

(For Diesel or Gas Engines with a Sender Mounting Point in Bell Housing or Adjacent to a Rotating Gear:)

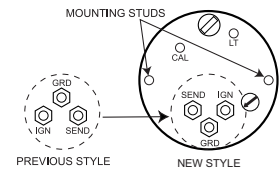
1. This tachometer is for a diesel or gasoline engine having a sender mounting point (3/4-16 thread) in the bell housing (or adjacent to some other rotating gear), and 12-16 VDC (24 Volt systems can be accommodated with a Voltage Reducer).
2. Check all wire connections to see that they're tight and not corroded. **NOTE:** Some older style tachometers operate with only Ground and Sender connections. Teleflex tachs must have 12 VDC (from the ignition switch, "ON" when engine is running) to the "IGN" stud.
3. When tachometer is first turned on, pointer **must** go to zero ± 50 RPM. If not, check connections (if OK, tachometer is probably faulty).
4. **Voltages with engine running should be:**
IGN to GND terminal: 12-16 VDC.
SEND to GND terminal: 0.3 VAC minimum at idle; (voltage will increase with engine speed).
5. Set rotary switch on tachometer back to the range that includes the number of gear teeth that pass by the Magnetic Pickup in **one** crankshaft revolution. This information can be obtained from the Engine Distributor or Dealer. Arrow on slot must point to setting; if it is between settings, the tach will go full scale when engine is started.

Tech Reference: information and troubleshooting

6. Final calibration requires a Remote Master Tachometer. Connect Master Tach and start engine. At about 1,500-2,000 RPM, use a jeweller's screwdriver to carefully adjust the potentiometer in the "CAL" hole (about 10 o'clock on the rear of the tach), bringing the tachometer into agreement with the Master Tach. Only a minimal turning is required. **Overtorquing of adjustment will damage gauge mechanism.** Turning clockwise increases tach reading, counterclockwise reduces reading. If the tachometer cannot be brought into calibration, the black Range Selector Switch is probably on the wrong setting.
7. The end of the sender must be within 1/32" - 1/16" of the gear teeth, **but not touching the teeth.** To adjust, **stop engine**, loosen the lock nut, and gently turn the sender clockwise until it touches the flywheel. Back off (counterclockwise) one turn, and secure with the locknut.
8. Rust buildup between the teeth can cause signal loss from the sender.
9. Dual stations: the sender will drive two tachometers. Simply connect "IGN" to "IGN", "GND" to "GND", etc. **NOTE:** mixing brands/types (such as 2-wire/3-wire, see paragraph 2 above) may cause problems.



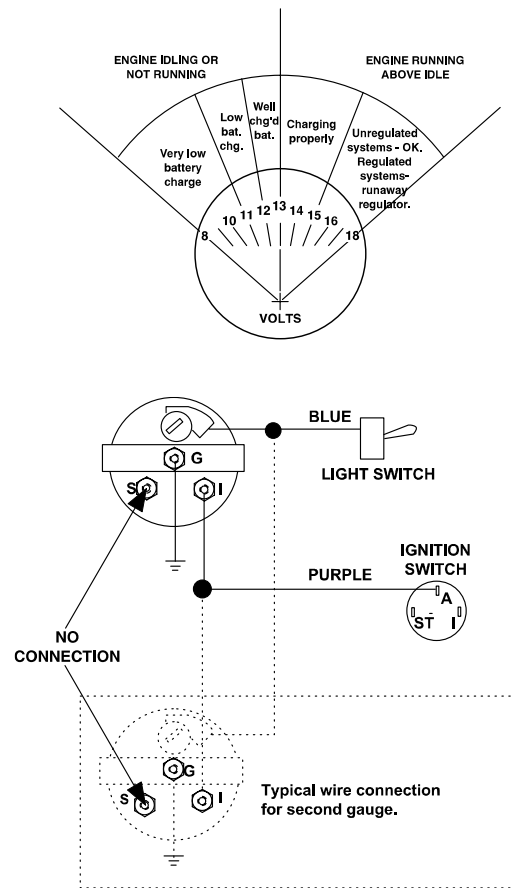
The back of your tach may look like either one of these. Please use the schematic appropriate to the appearance of your tachometer.



Teleflex Marine Instruments

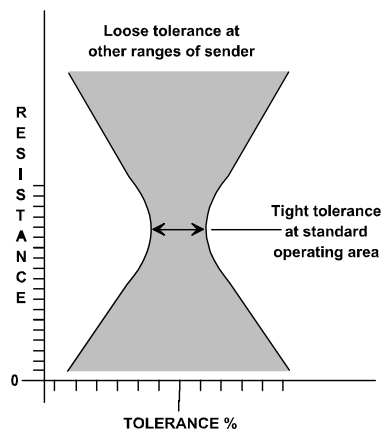
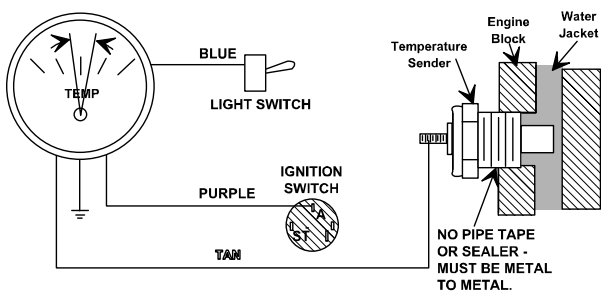
Voltmeter

1. A voltmeter operates in nominal 12 volt systems.
2. It is not to be connected where an ammeter was wired.
3. A voltmeter will alert you to the operation of your electrical system.
4. A voltmeter will not indicate battery condition.
5. When wiring voltmeter, **no connection is made to the "S" terminal.**
6. Gauge part number is stamped on the housing.
7. Accuracy is $\pm 3^\circ$ at 14 VDC (about 1/3 volt on 8-18 volt gauge or 1/4 volt on 10-16 volt gauge).
8. **To test gauges, check resistance between the "I" and "G" terminals, which should be approximately:**
 - 150 ohms (18 volt gauge)
 - 130 ohms (16 volt gauge)
9. The schematic shows connections required for dual voltmeters. If one gauge fails, it will not affect the reading of the other voltmeter.
10. When turning the voltmeter on for the first time, note pointer movement. If pointer does not leave the pointer stop pin, the gauge is probably connected backwards. If so, reverse "I" and "G" connections.



Water Temperature System Accuracy?

Temperature systems used on boats and other vehicles give a general indication of the temperature in which the sender is operating. We use the term "general" as the system can vary to a maximum $\pm 15^{\circ}\text{F}$ from actual temperature.



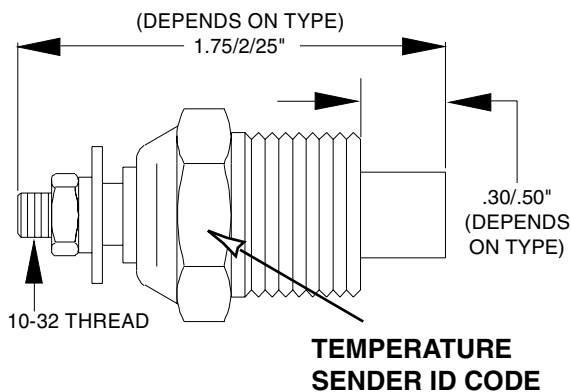
NOTE: Engine designs are subject to change. All data shown is based on the latest information available at the time of publication. Teleflex assumes no responsibility for the accuracy of the information contained herein.

The gauge itself is accurate to within about $\pm 5^{\circ}\text{F}$ at the mid-scale position. The sender is accurate to within $\pm 10^{\circ}\text{F}$ at 200°F (as are competitive units). The sender tolerances widen as temperatures become higher or lower than 200°F . (cont'd. on next page)

Teleflex Marine Instruments

Although sender/gauge tolerances rarely run to the maximums (at the same time), the system can possibly indicate up to 15°F difference from actual temperature at 200°F. These specifications are developed at a system voltage of 14 volts. The sender is also susceptible to “self heating” when electrical current passes through the sender. The self heating causes the sender to become warmer than the actual temperature of the fluid (the gauge is compensated for this effect at 14 volts). If the system voltage is varied to 13 or 15 volts the gauge may read 5 to 6°F higher also.

In a few cases it is necessary to put a temperature sender and a temperature switch (to operate a light or buzzer) in the only engine opening. In this case a “tee” is used. However, when the sender (or switch) is moved away from the water flow, the water around the sender bulb tends to run cooler. The gauge will also show a cooler reading than the actual water temperature inside the engine. Use of “extenders” or “tees” is generally not recommended.



Water Temperature System (Inboards & Stern Drives)

1. To test gauge, voltage from “I” to “G” terminals must be 10-16 VDC. No wire on “S” terminal. Gauge pointer should rest below 120°. Next, connect the “S” terminal to the “G” terminal (leave “I” and “G” terminals connected). The gauge pointer should rest above 240°.
2. The resistance of the sender can be measured to determine the sender’s correct operation. Remove wire to gauge. Connect an ohmmeter to terminal of sender and to engine block. Approximate values are: 75°F (room temperature) = 600 to 800 ohms; 212°F = 55 ohms. (These are single station values — twin station values would be 1/2 these numbers).
3. If sender is shorted (0 ohms) gauge will read above 240°F.
4. If sender has infinite resistance (Open) gauge will read below 120°F.
5. If the gauge reads lower than expected, was sealer used on the sender threads? (See illustration.)
6. The accuracy of the system (gauge, sender, voltage range) can vary as much as $\pm 16^\circ$ at 180°F.
7. Use of pipe extenders to plumb both a sender and temperature switch (for horn or warning light) from one port is not recommended. The amount of weight extended on the fitting of a vibrating engine could cause fatigue-related breakage. Also, the sender is removed from

Tech Reference: information and troubleshooting

water flow inside the engine and will probably read cooler.

8. Teleflex does not offer senders for metric threaded ports.
9. Dual Station installations:
 - a. When replacing one gauge in a two station installation, the second gauge may need to be replaced as well.
 - b. Mixing two gauges from different manufacturers to one sender may cause an error in both gauges.
 - c. If one gauge fails the second gauge will read much higher than expected.
 - d. If sender fails "open", both gauges will read below 120°F.
 - e. If sender fails "short", both gauges will read above 240°F.

