

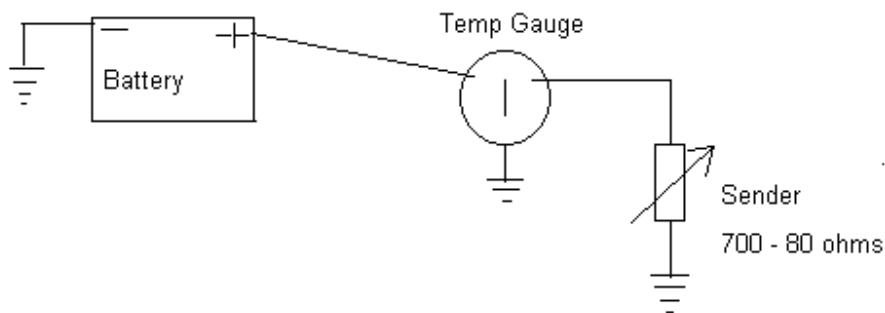
## Troubleshooting Corvette gauges

This troubleshooting guide covers Corvettes that have gauge systems similar to the 63-67 cars. This should include most of the earlier cars and some of the cars through the late seventies.

**Temperature gauge.** This metering circuit consists of a thermistor sending unit installed in the intake manifold, a gauge, and the connecting wiring.

A thermistor is a resistance element that has a large change in resistance over its intended operating range. For Corvette applications, the resistance is high at low temperatures and low at high temperatures. Each sender will vary in its resistance by a certain amount but some of the replacement senders from GM and others may be off significantly.

In general, Corvette gauges will read about 180 degrees F when the resistance of the sender is about 125 ohms. The range of values for a **typical** sender are:



Temp	Resistance
75	569
80	539
90	477
100	410
110	355
120	300
130	240
140	187
150	171
160	150
170	134
180	123
190	112
200	94
210	83.5
211	83.0

As you can see, there is a large change in resistance at the low temperature end of the table and as the temperature reaches the "normal" range the change in resistance per degree gets less. This means the sender is non-linear and is most accurate in the range from about 160 to 210 degrees.

Anything in the circuit that will add resistance to the circuit will tend to lower the gauge reading. This can be one or more of the following:

1. The body of the sender that is screwed into the manifold serves as the ground for the sender. If the threads are corroded in the manifold or if a sealant is used on the threads, the gauge will read low. If the sealant effectively insulates the threads from the manifold the circuit will be "open" and the gauge will read 100 degrees or less under all circumstances.
2. If any of the connection points are corroded, the increased resistance will cause the gauge to read low. The amount the gauge reads low is a function of the amount of corrosion (resistance) on the terminals. This can appear at the connector to the sender, at the bulkhead connector, or at the plug on the back of the panel gauge.

Mid year and earlier cars have an internal meter shunt. One side of the shunt is grounded through the gauge case and then through the instrument cluster. If the instrument cluster does not have a good ground, the temperature gauge will read high.

Later model cars have a wire wound resistor mounted on the back of the gauge to serve as a shunt.

Meter shunts are typically wire wound resistors since their values are typically on the order of 0.1 ohm or less. These shunts fail by open circuiting and the meter will read as if the ignition is off.

Assuming that the engine temperature is normal and that the gauge is at fault, there are two checks that can be made to determine if the sender is bad or if there is a problem in the wiring or gauge.

Warm the engine up to normal operating temperature. Disconnect the connector at the temperature sender and measure the resistance between the center contact of the sender and the sender body. Compare the resistance reading obtained with the above table to see if the sender is within +/- 10 ohms of the table values. If so, the sender is good.

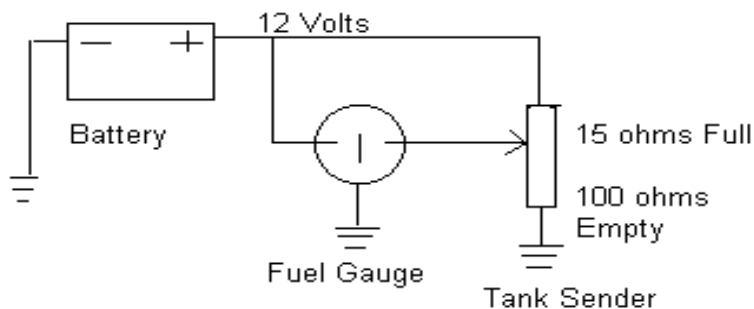
Check the resistance between the center contact and an engine ground. If the threads are making a good ground, the resistance should be the same as previously read within a few ohms.

To check the wiring and the panel gauge, obtain a 1000 ohm potentiometer. Solder two wires on the potentiometer, one to the center lug and one to one of the end lugs. Attach alligator clips to the ends of the wires.

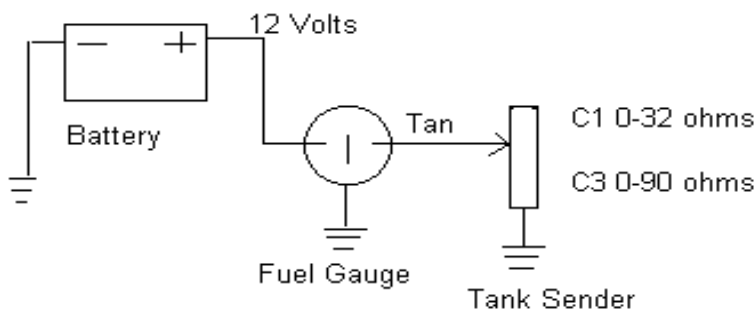
Disconnect the temperature sender connector at the sender. Connect the center lead of the potentiometer to the connector in the wiring harness and the other to a ground. With someone in the car, turn the ignition switch to ON or ACC and adjust the potentiometer until the gauge reads 180 degrees. Turn off the ignition and disconnect the potentiometer from the sender connector and ground without changing the position of the pot. Read the resistance of the pot from one lead to the other and compare it to the above table. If the resistance reading is within the expected range for the sender, the wiring and gauge are working correctly. If it takes less resistance on the pot to make the gauge read 180, then you have a corroded contact somewhere that is adding resistance to the circuit.

If both the sender and the gauge check out within the expected range, there is probably nothing wrong with the metering circuit and the car is actually running hot. This is the time to get an infrared heat gun (Ray Tek) and start checking temperatures at various points in the cooling system.

**Fuel Gauges.** Simplified circuit diagrams for the fuel gauge are shown below.



#### 63-67 Corvettes only



#### C1 and C3 Corvettes

The circuit consists of a sender in the fuel tank and a gauge. The sender resistance element is a wire wound resistor bent into an arc. A metal slider connected directly to the float arm moves this slider along the sender resistance unit.

The sender resistance is shown in the above diagrams. As with all things, these resistance values will vary somewhat from sender to sender but the values will be much closer than the temperature sender since the physical makeup of the resistance unit can be more closely controlled.

#### **For C2 Corvettes:**

At the sending unit, there are three connections, a black wire to ground, a tan wire from the slider and a pink wire that supplies 12 volts to the sender.

You will note from the diagram that the top of the sender and one side of the gauge are both hooked to the battery.

A constant current flows through the sender resistance unit. This can be calculated using Ohms Law ( $I=E/R$ ) or about 0.125 amps. The power consumed by the circuit is given by  $P=EI$  giving about 1.56 watts. Kirchoff's Law states that the voltage drops around a circuit must equal the applied voltage. Since the only resistance in the sender circuit is the resistance unit of the sender, the entire 12 volts must be dropped by the sender. The slider picks off the voltage drop of the sending unit as it moves from full to empty. You can use Ohms Law ( $E=IR$ ) and plug in

various values of resistance between 15 and 100 ohms to determine the actual voltage drop as the slider moves.

Referring to the above figure, you have one side of the meter hooked to battery voltage and the other side hooked to the slider. The voltage at the slider terminal will be less than the battery voltage since the sender resistance is dropping some of the voltage. As the fuel level changes, the slider picks off more or less voltage depending on the tank level and the gauge sees a difference in voltage proportional to the position of the slider. The gauge is responding to the difference in voltage between the battery voltage and the voltage picked off by the slider.

To test the sender there are two measurements. Disconnect all leads to the sender. Measure the resistance between the Pink lead terminal of the sender and the ground lug of the sender. This should read about 100 ohms.

Connect the ohmmeter between the Pink terminal and the Tan terminal on the sender and have someone carefully move the float arm through its full range of motion. The resistance should vary between 100 and about 15 ohms. If these resistance values are correct, the sender is working properly.

Measure the voltage at the pink lead of the wiring harness with a voltmeter and the ignition ON. This should be battery voltage. Turn off the ignition and measure the resistance to ground at the black lead of the wiring harness. This should read zero.

Connect the Pink and black leads to the sender. Connect a voltmeter to the sender terminal for the tan lead and to ground. Turn ON the ignition and move the float arm through its range of motion. As you move the float arm from the full to empty position the voltage should decrease from near battery voltage to near zero. The actual values you get will be dependent on battery voltage and the resistance characteristics of the sender. In general, you should get about 10 volts when full and zero volts when empty.

If all these tests are OK, then the problem is in the gauge or wiring. It is not necessary to use a potentiometer to test the gauge or wiring since you have one built in to the sender. If the sender checks out OK then you can move the float arm of the sender and check the gauge.

If you want to substitute a potentiometer in the circuit in place of the sender, obtain a 100 ohm 2-watt potentiometer. Set the pot at 100 ohms and mark the position of the pot shaft. Set the pot to 15 ohms and also mark this position. Set the pot back to 100 ohms. Solder three leads to the pot with alligator clips on each lead. Connect one of the end leads to the pink wire, one of the end leads to ground and the center lead to the tan wire. Adjust the pot to obtain the gauge readings for empty,  $\frac{1}{4}$ ,  $\frac{1}{2}$ ,  $\frac{3}{4}$ , and full marking the position of the shaft for each gauge reading. Disconnect the pot and read the resistance between the lead you connected to the pink terminal and the center lead of the pot.

The resistance of the sender is fairly linear. If you plot the values you obtained using the pot on a graph, you should get a straight line, more or less.

Unlike the temperature gauge, corroded contacts can cause the fuel gauge to read either high or low depending on which side of the gauge the bad connection is located.

If the gauge continually wants to read high, then the bad contact is on the battery side of the gauge. If the gauge continually wants to read low, then the bad contact is on the sender side of the gauge. Recall that the meter is responding to the difference in voltage across the meter.

A bad ground could also insert some resistance into the circuit. In this case all of the voltage would not be dropped across the sender since the resistance added by the bad ground will also drop some voltage. In this case the gauge will read lower than the tank level.

### C1 and C3 Corvettes.

These cars use a two-wire circuit for the sender. Battery voltage is applied through the gauge to the Tan lead, which is connected to the slider. The circuit is completed by grounding one end of the sender through a Black lead.

The sender is a variable resistance that controls the current flow through the gauge. For the C1 cars the sender resistance is 0-32 ohms and for the C3 cars the sender is 0-90 ohms.

Since my hands on experience does not include either the C1 or C3 cars, the following references are offered. For the C1 cars refer to an article in the Winter 2001 Restorer by Dan Materazzi. For the C3 cars refer to the following web site – <http://members.core.com/~faldritch/fuelgauge.htm>.

**Oil Pressure Gauge.** This is a purely mechanical gauge. The only electrical connection is the dash light.

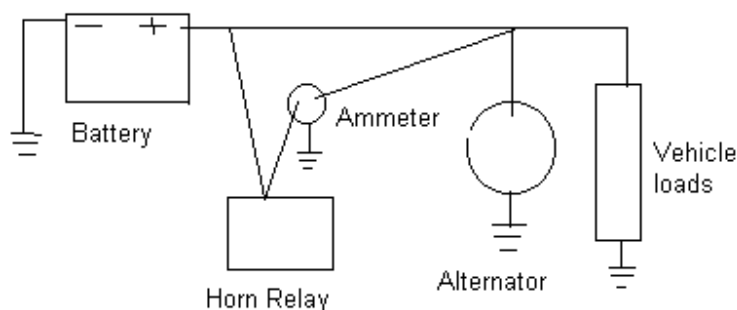
This gauge uses a Bourdon tube sensing unit. A Bourdon tube is a flattened tube closed at one end and bent into an arc.

Pressure is defined as Force per unit area ( $P=F/A$ ). If we solve this formula for Force we get  $F=PA$ . One of the properties of a fluid (either liquid or gas) is that pressure is exerted equally in all directions. This means that the **pressure** inside the Bourdon tube is the same everywhere.

The inside radius of the Bourdon tube is less than the radius of the outside of the Bourdon tube. This equates to the outside radius of the tube having more **surface area** than the inside radius of the tube. Since the force on the tube is  $F=PA$  where  $A$  is the Area, it follows that the force on the outside radius of the tube is greater than the force on the inside radius of the tube. Since there is an imbalance of forces on the tube, the imbalance tries to straighten out the tube to equalize the forces.

The closed end of the tube is connected to the gauge pointer through a mechanical linkage and the motion of the tube responding to changes in pressure causes the gauge needle to move.

**Ammeter.** Refer to the below figure.



Troubleshooting the ammeter circuit can be difficult. The following applies to cars equipped with alternators. In the Chassis Service Manual there will be a simplified diagram of the charging system similar in part to that shown above.

Possibly the biggest mistake that people make associated with the ammeter circuit is not turning the ignition switch to either ACC or ON when trying to decide if the ammeter is showing proper discharge. You can perform the following test and see if it makes a difference. Start the engine and let it run for a few minutes until the ammeter reads close to zero. Shut off the engine and with the ignition switch OFF, turn on the high beam lights. Make a note of the ammeter reading. Turn off the headlights. Turn the ignition switch to ACC and again turn on the high beams. The amount of discharge shown by the ammeter should be about twice, or more, what it was before.

By referring to the above diagram, it can be seen that the ammeter reads the difference in voltage between the battery and the alternator. The wire that goes directly from the battery to the alternator and appears to short out the ammeter is a meter shunt. What the ammeter actually reads is the voltage drop across this wire. The resistance of this wire is about 0.1 ohm. There is no physical resistor in the circuit, the resistance is due to the length of the wire required to get from the starter solenoid to the horn relay around the engine bay.

The horn relay is not in the ammeter circuit but is a convenient connection point for the alternator output and the voltage regulator.

When the output voltage of the alternator is greater than battery voltage, the ammeter shows a charge proportional to the difference in voltage. When the battery comes up to full charge, the ammeter drops to near zero. If the output of the alternator is less than the battery voltage, as under a heavy load, the ammeter will show a discharge proportional to the difference in voltage.

The voltage regulator is set to have a voltage slightly higher than the fully charged voltage of the battery so that the alternator will carry most of the vehicle loads and maintain a slight trickle charge on the battery at all times the engine is running. Under normal conditions, the ammeter will show a slight charge when the engine has been running for a few minutes and the system is working correctly.