

## WIRING

**Wiring is just as important as any other component in the starting and charging system. It must be capable of delivering the amount of current that the load is demanding.**

When electrical systems are designed, the wire size is calculated for the specific requirements of the electrical components being used. **When electrical components are added or upgraded, the wire size has to be upgraded also. For example, replacing a low torque starter with a high torque starter will normally require the battery cables and possibly the battery to be upgraded. WHEN IN DOUBT, ALWAYS USE A BIGGER WIRE.**

### A word about wire gauge

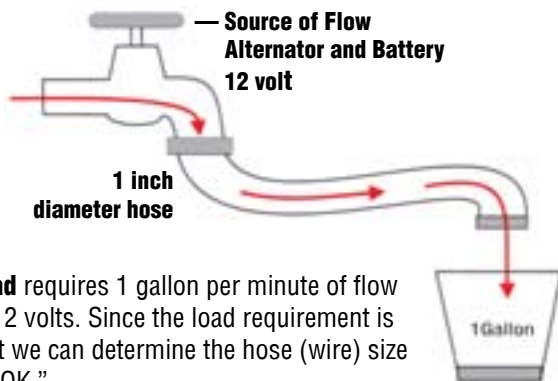
The size of a wire (gauge) is expressed in terms of a standard American Wire Gauge (AWG) measurement.

The higher the AWG number, the smaller the wire. For example, a 14 gauge wire is smaller than a 10 gauge wire. The smaller the wire, the greater its resistance to the flow of electrons and the greater the heat generated when the wire is conducting electricity. The heat can destroy insulation and even kindle a fire. **THE LARGER THE AMPERAGE OF A CIRCUIT, THE LARGER THE WIRE THAT IS NEEDED.**

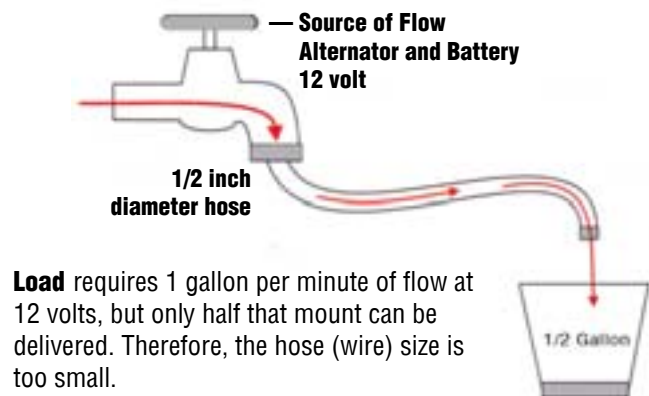
### Think of wiring as a water hose.

The electrical current is like water flowing through the hose. The source or supply of this water would be the battery and alternator. Look at the diagrams below. The first diagram shows a one inch diameter hose which allows one gallon per minute of flow. Since the load requires only a gallon per minute of flow, we can say that this hose (wire size) is of sufficient size to carry the supply of water (current) to the load. This all changes when we reduce the water hose (wire size) to one half inch as shown in the second diagram. The hose (wire) can only deliver half the current needed by the load— this hose (wire) is NOT of sufficient size to carry the needed supply of water (current) to the load.

### Adequate Wire Size (gauge)



### Inadequate Wire Size (gauge)



**BIGGER (LARGER) IS BETTER!**

**The higher the AWG Number, the smaller the wire.**

**The larger the amperage of a circuit, the larger the wire that is needed.**

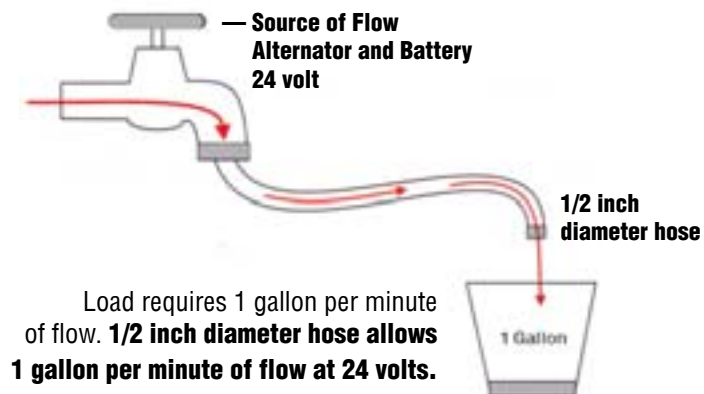
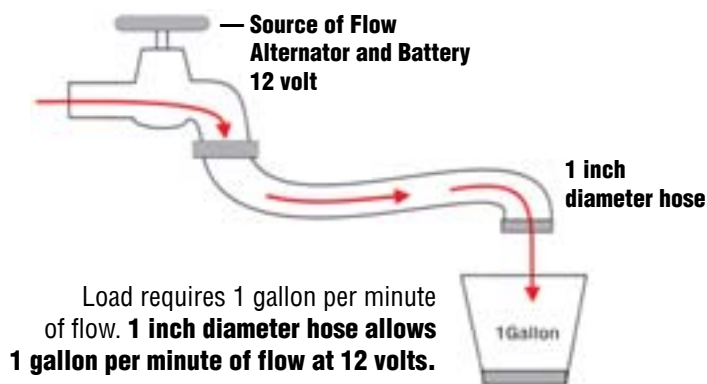
## WIRING AND VOLTAGE

### VOLTAGE IS MUCH LIKE WATER PRESSURE.

When calculating proper wire sizing, voltage plays a very important role. Voltage is much like water pressure. The higher the voltage, the faster the current flows.

### A 24 volt system can move the same amount of current through a wire one half the size required for a 12 volt system.

This is also shown in the charging cable size chart on the following page. Notice that the 24 volt cable size requirements are much less than that of the 12 volt.



**The higher the voltage, the faster the current flows.**



## RECOMMENDED WIRE SIZES

Below you will find the recommended wire sizes for charging and starting systems. **IT IS VERY IMPORTANT TO INCLUDE THE GROUND CABLE WHEN CALCULATING THE TOTAL LENGTH OF THE SYSTEM.**

**The ground cable must carry the same amount of current as the positive cable.**

**WHEN IN DOUBT - - - BIGGER IS BETTER!**

### MINIMUM CHARGING CABLE GAUGE SIZE

TYPE OF SYSTEM	OUTPUT IN AMPERES	TOTAL LENGTH INCLUDING GROUND CABLE							
		UP TO 4 FT.	4 FT. TO 7 FT.	7 FT. TO 10 FT.	10 FT. TO 13 FT.	13 FT. TO 16 FT.	16 FT. TO 19 FT.	19 FT. TO 22 FT.	22 FT. TO 28 FT.
<b>12 VOLT</b>	0-20 AMPS	14 GA.	12 GA.	12 GA.	10 GA.	10 GA.	8 GA.	8 GA.	8 GA.
	20-35 AMPS	12 GA.	10 GA.	8 GA.	8 GA.	6 GA.	6 GA.	6 GA.	4 GA.
	35-50 AMPS	10 GA.	8 GA.	8 GA.	6 GA.	6 GA.	4 GA.	4 GA.	4 GA.
	50-65 AMPS	8 GA.	8 GA.	6 GA.	4 GA.	4 GA.	4 GA.	4 GA.	4 GA.
	65-85 AMPS	6 GA.	6 GA.	4 GA.	4 GA.	2 GA.	2 GA.	2 GA.	0 GA.
	85-105 AMPS	6 GA.	6 GA.	4 GA.	2 GA.	2 GA.	2 GA.	2 GA.	0 GA.
	105-125 AMPS	4 GA.	4 GA.	4 GA.	2 GA.	2 GA.	0 GA.	0 GA.	0 GA.
	125-150 AMPS	2 GA.	2 GA.	2 GA.	2 GA.	0 GA.	0 GA.	0 GA.	00 GA.
<b>24 VOLT</b>	0-20 AMPS	14 GA.	14 GA.	14 GA.	12 GA.	12 GA.	12 GA.	10 GA.	10 GA.
	20-35 AMPS	12 GA.	12 GA.	12 GA.	10 GA.	10 GA.	8 GA.	8 GA.	8 GA.
	35-50 AMPS	10 GA.	10 GA.	10 GA.	10 GA.	6 GA.	6 GA.	6 GA.	6 GA.
	50-65 AMPS	8 GA.	8 GA.	8 GA.	8 GA.	6 GA.	4 GA.	4 GA.	4 GA.
	65-85 AMPS	6 GA.	6 GA.	6 GA.	6 GA.	6 GA.	6 GA.	4 GA.	4 GA.
	85-105 AMPS	6 GA.	6 GA.	6 GA.	6 GA.	4 GA.	4 GA.	4 GA.	2 GA.
	105-125 AMPS	4 GA.	4 GA.	4 GA.	4 GA.	4 GA.	4 GA.	2 GA.	2 GA.
	125-150 AMPS	2 GA.	2 GA.	2 GA.	2 GA.	2 GA.	2 GA.	2 GA.	2 GA.

### MINIMUM STARTING CABLE GAUGE SIZE FOR MOST INBOARD GASOLINE ENGINE APPLICATIONS

#### 4 - 6 - 8 Cylinder Gasoline Engine

Total Cranking Circuit Length in Inches	UP TO 75"	75" - 125"	125"-175"	175"-225"	225"-275"	275"-325"	325"-425"
Minimum Battery Cable Size	4	2	1	0	2/0	3/0	4/0



## SOLENOID TYPES AND CIRCUITS

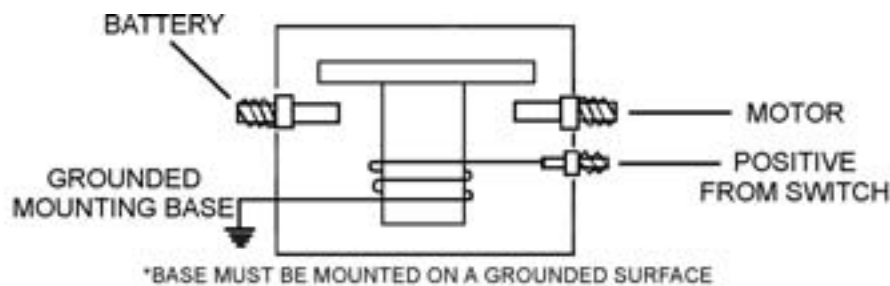


**Many of the remote mount solenoids look identical on the outside.**

However, they can be very different on the inside. Beside the different internal circuits, these can be rated for continuous duty or intermittent duty use.

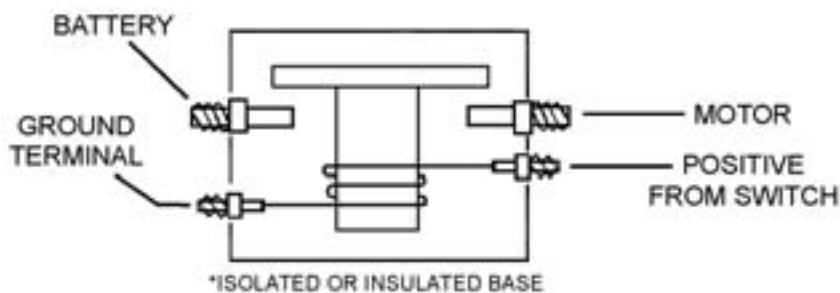
**Continuous duty solenoids** are wound with very fine wire and draw very little amperage. The contacts in continuous duty solenoids will usually have a lower amperage rating than that of the intermittent duty type. These are normally used as tilt trim relays. This type of solenoid can also be used for a variety of applications where a remote relay is needed to power a motor or other device.

**Intermittent duty solenoids** are wound with much heavier wire and draw more amperage. The contacts have a very high amperage rating. If these stay energized for extended periods of time they heat up and eventually burn out the coil inside the solenoid. This type of solenoid is normally used as a starter motor relay.



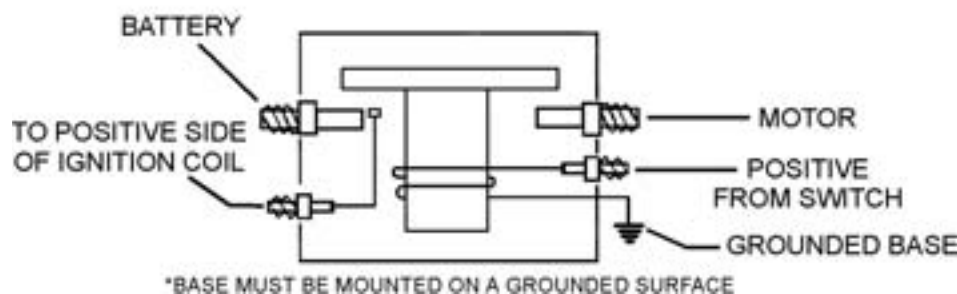
### GROUNDING BASE SOLENOIDS

One end of the coil is grounded to the mounting base. This type solenoid must mount on a grounded surface or a ground must be attached to the base.



### INSULATED BASE SOLENOIDS

Both ends of the coil in this unit are insulated. A separate ground must be connected and this type of solenoid can be mounted on any surface.

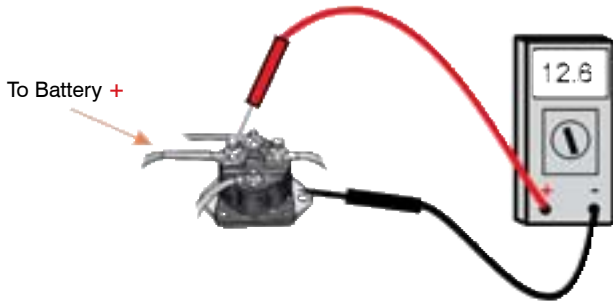


### SOLENOIDS EQUIPPED WITH RELAY TERMINAL

This type of solenoid is normally used for starting motors. Since conventional ignition coils operate on 7 volts, the relay terminal supplies 12 volts to the ignition coil during starting for easier starts. The base of this solenoid must be grounded.

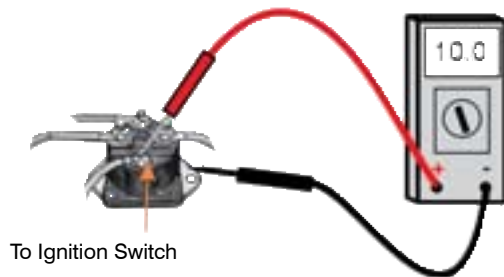
## SIMPLE SOLENOID TESTING: GROUNDED BASE REMOTE SOLENOIDS

**NOTE:** Before Performing These Tests You Must Fully Charge and Load Test The Battery to Verify It Is Good.

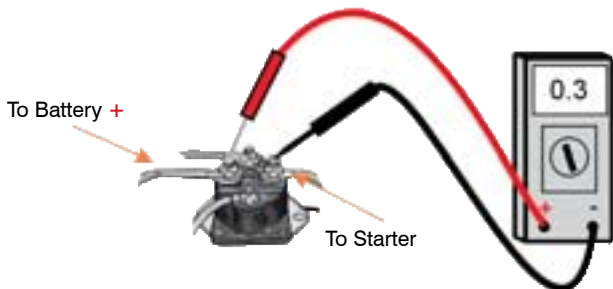


**Step 1:** Check the voltage on the battery side of the solenoid as shown on the left. The reading should be the same as the battery reading (12.6V = Full Charged Battery).

**Step 2:** With the voltmeter still connected, turn the key to the start position and read the voltage. The voltage should not drop below 10.0 volts on this terminal. If the voltage drops below 10.0 volts, The battery cable should be cleaned or replaced. If the reading is 10.0 volts or more move on to step 3.



**Step 3:** Keep the negative voltmeter lead on the metal base of the solenoid and move the positive voltmeter lead to the terminal marked "S" on the solenoid. Turn the key to the start position and read the voltage. The Voltage could read a little lower than the previous reading but should never be below 10.0 volts. If the voltage is lower than 10.0 volts, You must troubleshoot the start circuit (ignition switch, voltage supply to the ignition switch, neutral safety switch).



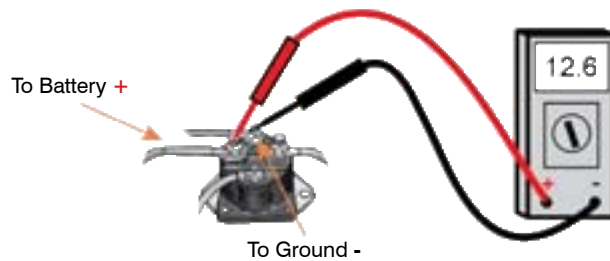
**Step 4:** Move the positive voltmeter lead to the battery terminal on the solenoid and the negative voltmeter lead to the terminal that the starter cable is attached. Turn the key to the start position and read the voltage. The voltage should read no more than .3 volts. If the reading is more than .3 volts the contacts have excessive resistance and the solenoid should be replaced.



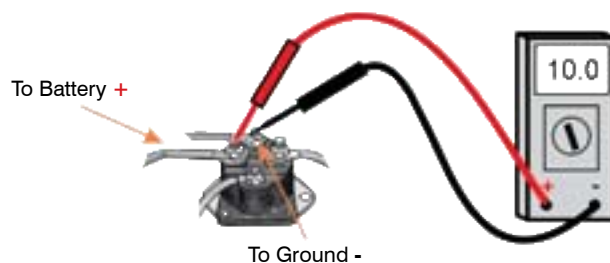
**Step 5:** Some solenoids use a relay terminal on the solenoid to power fuel pumps or supply full battery voltage to ignition coils when the starter is activated. This terminal is usually marked "I" or "R". Connect the voltmeter as shown. Turn the key to the start position. You should read no more than 0.3 volts. If you have more than 0.3 volts the solenoid should be replaced.

## SIMPLE SOLENOID TESTING: **INSULATED BASE** REMOTE SOLENOIDS

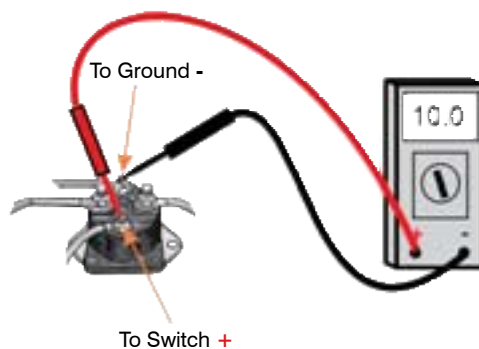
**NOTE:** Before Performing These Tests You Must Fully Charge and Load Test The Battery to Verify It Is Good.



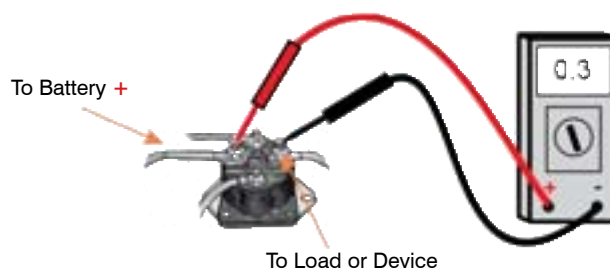
**Step 1:** Check the voltage on the battery side of the solenoid as shown on the left. The reading should be the same as the battery reading (12.6V = Full Charged Battery).



**Step 2:** With the voltmeter still connected, activate the switch and read the voltage. The voltage should not drop below 10.0 volts on this terminal. If the voltage drops below 10.0 volts, the battery cable should be cleaned or replaced. If the reading is 10.0 volts or more move on to step 3.



**Step 3:** Keep the negative voltmeter lead on the ground terminal of the solenoid and move the positive voltmeter lead to the terminal marked "S" on the solenoid. Activate the switch and read the voltage. The Voltage could read a little lower than the previous reading but should never be below 10.0 volts. If the voltage is lower than 10.0 volts, you must troubleshoot the switch circuit (toggle switch, push button switch, or voltage supply to these switches).



**Step 4:** Move the positive voltmeter lead to the battery terminal on the solenoid and the negative voltmeter lead to the terminal that the starter cable is attached. Activate the switch and read the voltage. The voltage should read no more than .3 volts. If the reading is more than .3 volts the contacts have excessive resistance and the solenoid be replaced.