Solving Problems Using Relays
Or
Four Handy Uses for Bosch Relays

A relay is simply an electrical device designed to switch a large amount of current using a smaller amount of current. Some, like the fender-mounted starter relays on Ford vehicles of the 60's through 80's, were made to carry several hundred amps for a short duration.

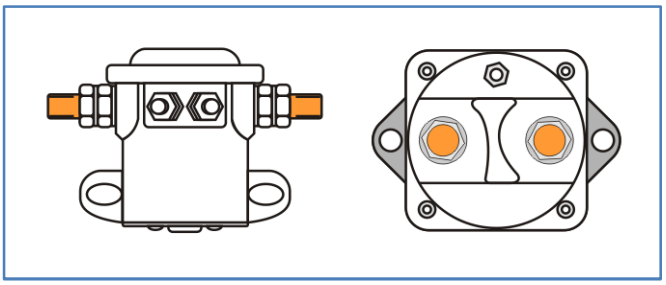


Figure 1 – Early (left) and Late (right) Ford Starter Relays

Figure 2 – Mini-Relay

Others, like the small Bosch relays, (now manufactured by Tyco), are designed to carry smaller loads of up to 40 amps for unlimited lengths of time and are known as continuous duty relays.

This article will deal with a few common electrical problems you can easily solve using relays.

There are many different relays available in the aftermarket, in a variety of amperage and voltage ratings. Many have a mounting bracket built onto the case. The pinout numbers and internal diagrams are usually printed on each relay. The relay shown in *Figure 2* is the style most commonly used by rebuilders. It is based on standards set by the International Standards Organization (ISO) and its technical name is ISO Mini-Relay. ISO Mini-Relays are built into a 1" square cube, and the pinouts are standardized as shown in the following diagrams. In the rebuilding industry, ISO Mini-Relays are usually referred to as "Bosch Relays".

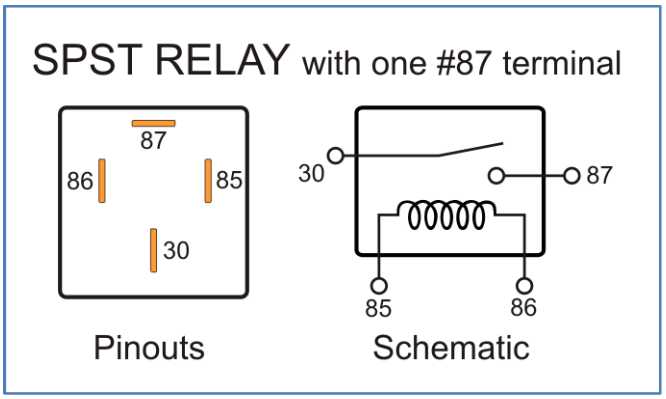


Figure 3 – Single-Pole Single-Throw with one #87 terminal

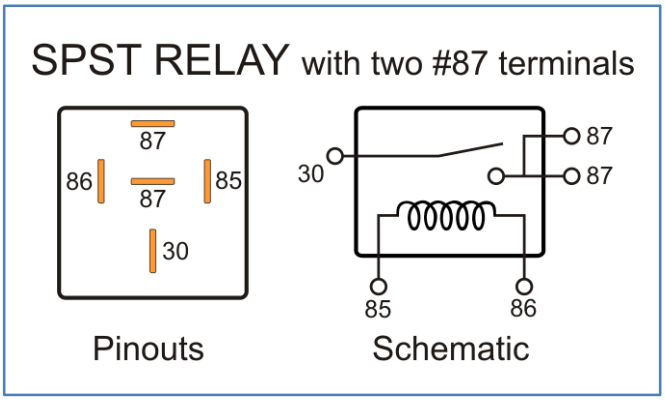


Figure 4 – Single-Pole Single-Throw with two #87 terminals

SPST (single-pole single-throw) Relay:

Terminals 85 and 86 are connected to the coil. Terminal 30 is common and usually connected to B+ through a fuse. Terminal 87 is where the load is connected. When power is applied across the coil, the contacts close to connect 30 to 87. Some relays have two 87 load terminals *(Figure 4)*. SPST relays may have four or five terminals.

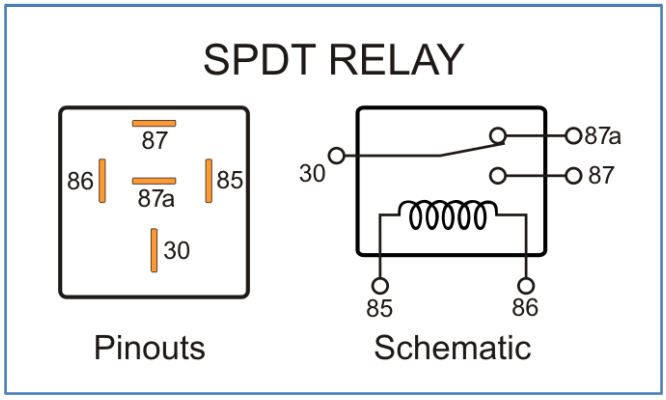


Figure 5 – Single-Pole Double-Throw

SPDT (single-pole double-throw) Relay:

Terminals 85 and 86 are connected to the coil. Terminal 30 is common and usually connected to B+ through a fuse. Terminal 87 is where the load is connected. Terminal 87 will be connected to 30 when power is applied across the coil. When the relay is inactive, terminal 30 will be connected to 87a. SPDT relays always have five terminals. This type of relay is sometimes referred to as a *changeover relay* because the current flow changes from terminal 87a to terminal 87 when the coil is energized.

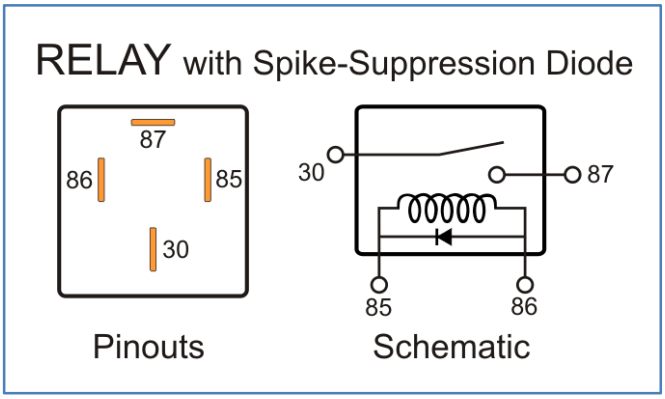


Figure 6 – SPST Relay with Diode

Spike-Suppression Diode:

When a relay is switched off, the collapsing current in the coil can cause a small voltage spike. If the relay is controlled by a solid-state device, such as the PCM, this spike can cause damage. One method of protecting the relay control circuit is to install a diode in parallel with the coil (see Figure 6). The purpose of the diode is to bleed off voltage spikes generated each time the relay is switched off. If there is no diode connected in parallel with the coil, polarity does not matter. But when a diode is used in the relay, power must be applied to only the negative side of the diode, or terminal 85. The diagram printed on the relay will show a diode if one is used.

This isn't a style of relay that you are likely to buy from any rebuilder supplier, but you should be aware of its existence, especially if you are wiring up a used relay. Hooking it up the wrong way will cause a direct short between terminals 85 and 86.

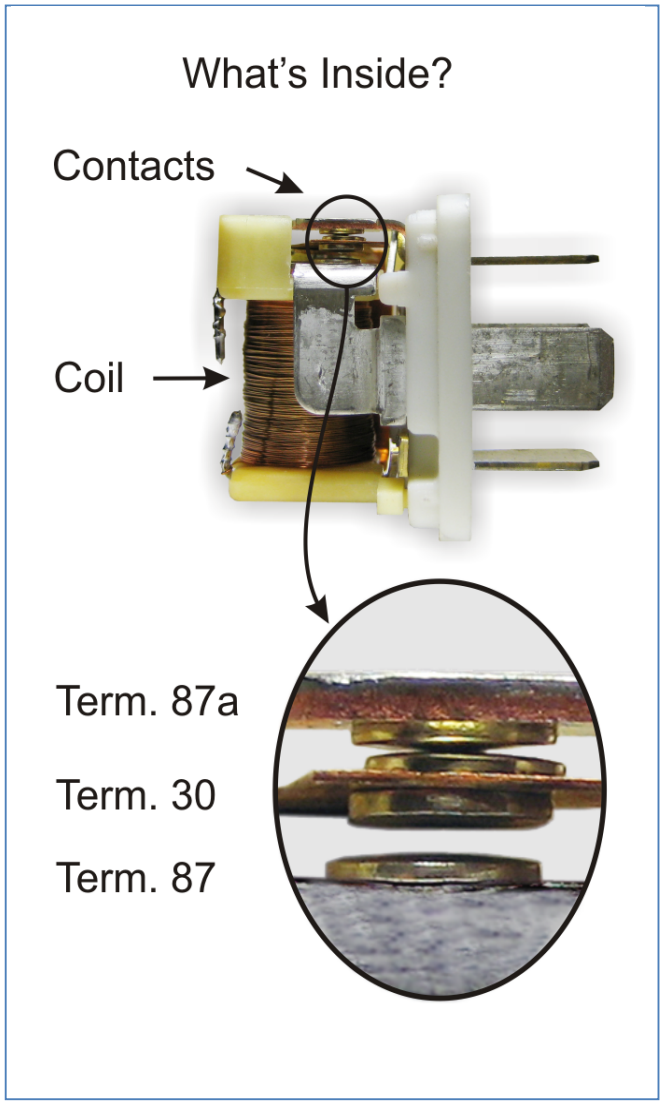


Figure 7 – What's Inside a SPDT Relay

Problem Fix #1:

Low Voltage at Starter S Terminal

PROBLEM: There is low voltage at the S terminal of the starter solenoid due to worn contacts or poor connections in the switch circuit. This could be caused by the ignition switch, neutral-safety switch, old harness connections or a combination of more than one source of resistance. Often on older vehicles, the solenoid only clicks. This happens when there is not quite enough voltage at the S terminal to close the contacts every time.

SOLUTION: Install a SPST relay to activate the starter solenoid, and control the relay using the original start circuit. The relay needs only a fraction of an amp, so the voltage drop becomes negligible, and full battery power will be applied to the S terminal every time.

CAUTION: Be careful not to bypass any safety switches when installing a relay. All neutral-safety switches, operator-present switches, and equipment-disengaged switches should be included.

NOTE: This is a simplified diagram and does not show all circuits present on the equipment/vehicle. Always install a fuse on all circuits that carry current to the relay terminal 30.

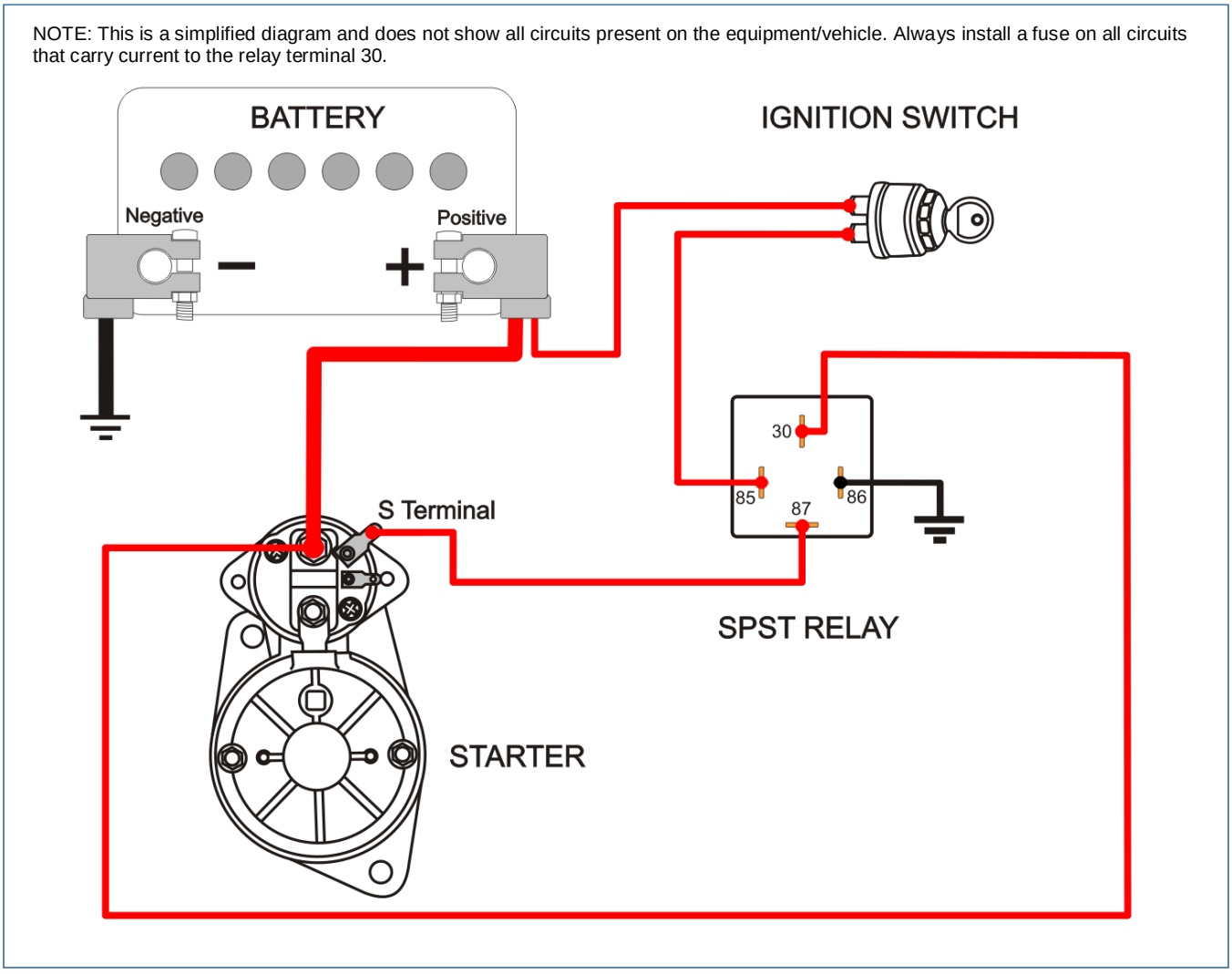


Figure 8 – Amplifying "S" Terminal Voltage

Problem Fix #2:
Create a Starter Lock-Out

PROBLEM: The starter is being accidentally engaged while the engine is running because of a fault in the control circuit or by the operator. This can quickly destroy a new starter. Because it can be intermittent, the exact cause may be difficult to pin down.

SOLUTION: Lock out the starter when the engine is running by placing a SPDT relay in the switch circuit using terminal 87a, which is normally closed. Wire the relay coil to a diode trio in the alternator to activate the relay once the alternator begins charging. If the alternator does not have a trio in it, you can add a small diode trio just to run the relay. You cannot use a trio that is attached to a charge-light circuit, because the current passing through the bulb is enough to activate the relay and prevent starting. Once the relay is activated, the starter-switch circuit is broken, preventing accidental starts.

NOTE: This is a simplified diagram and does not show all circuits present on the equipment/vehicle. Always install a fuse on all circuits that carry current to the relay terminal 30.

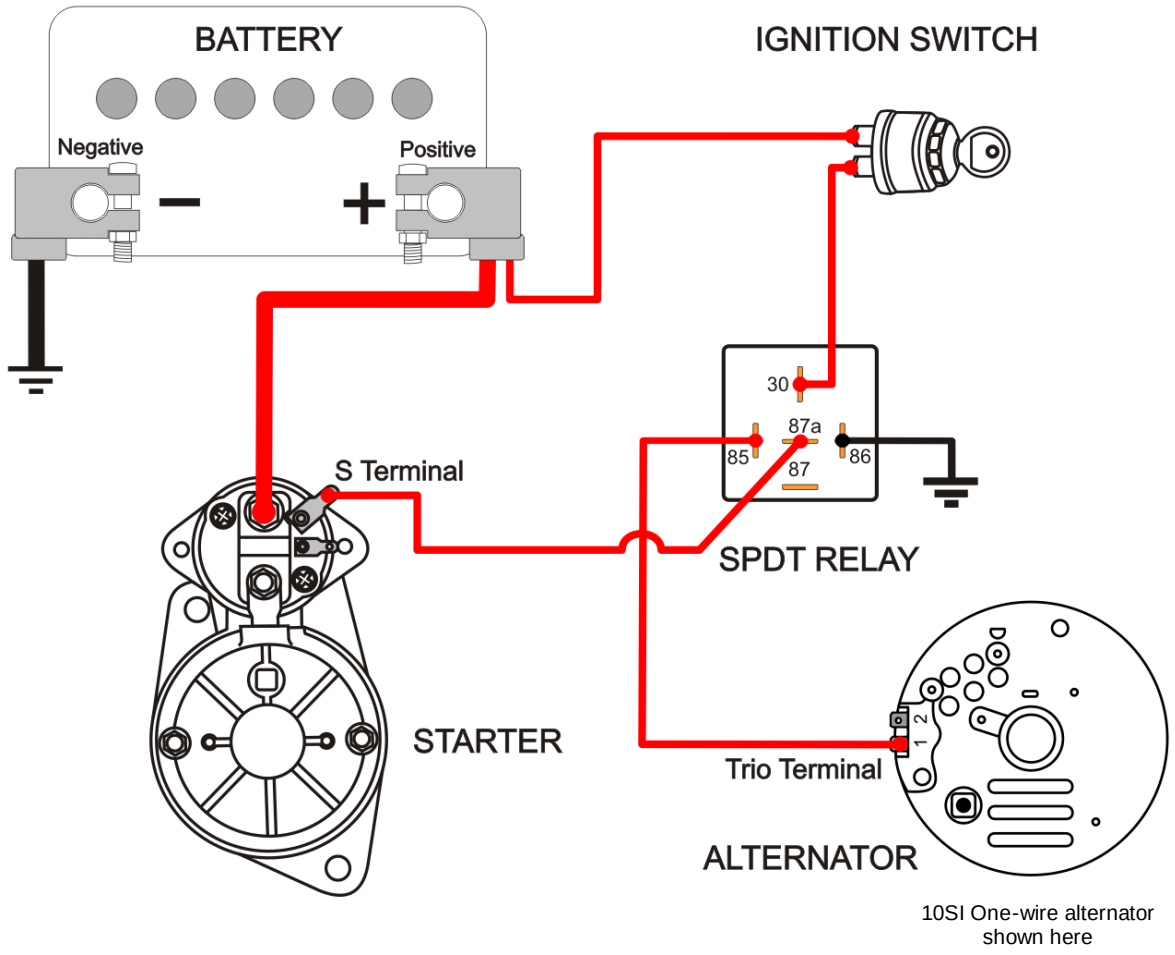


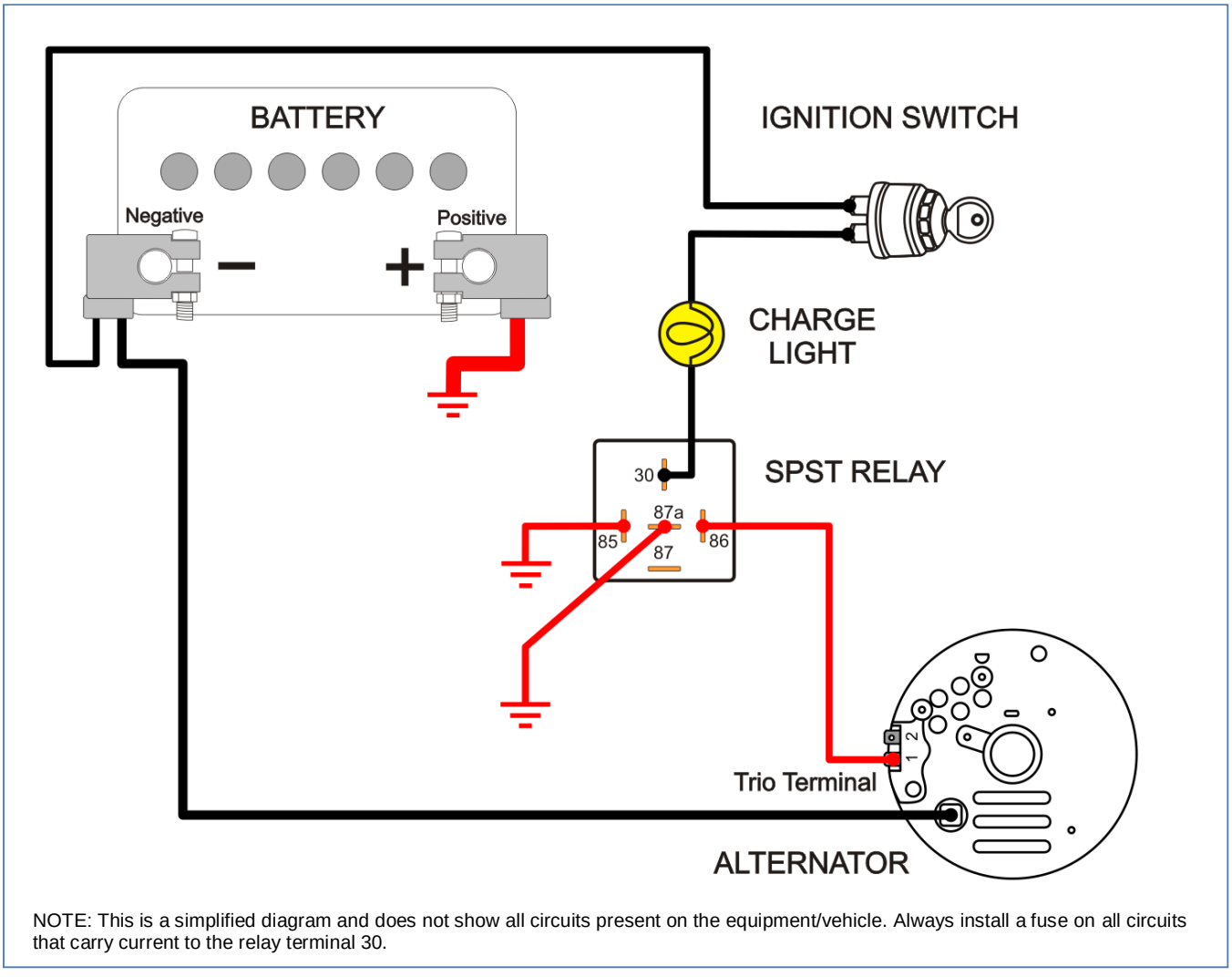
Figure 9 – Starter Lock-Out

Problem Fix #3:

Control Charge Light in Positive-Ground 10SI System

PROBLEM: You sold a 10SI alternator to replace a generator on a positive-ground system, and now the charge light won't work. The trio output is positive voltage, which is now ground on a positive ground system.

SOLUTION: Control the charge light with a SPDT relay, and control the relay with the trio terminal on the 10SI alternator.



NOTE: This is a simplified diagram and does not show all circuits present on the equipment/vehicle. Always install a fuse on all circuits that carry current to the relay terminal 30.

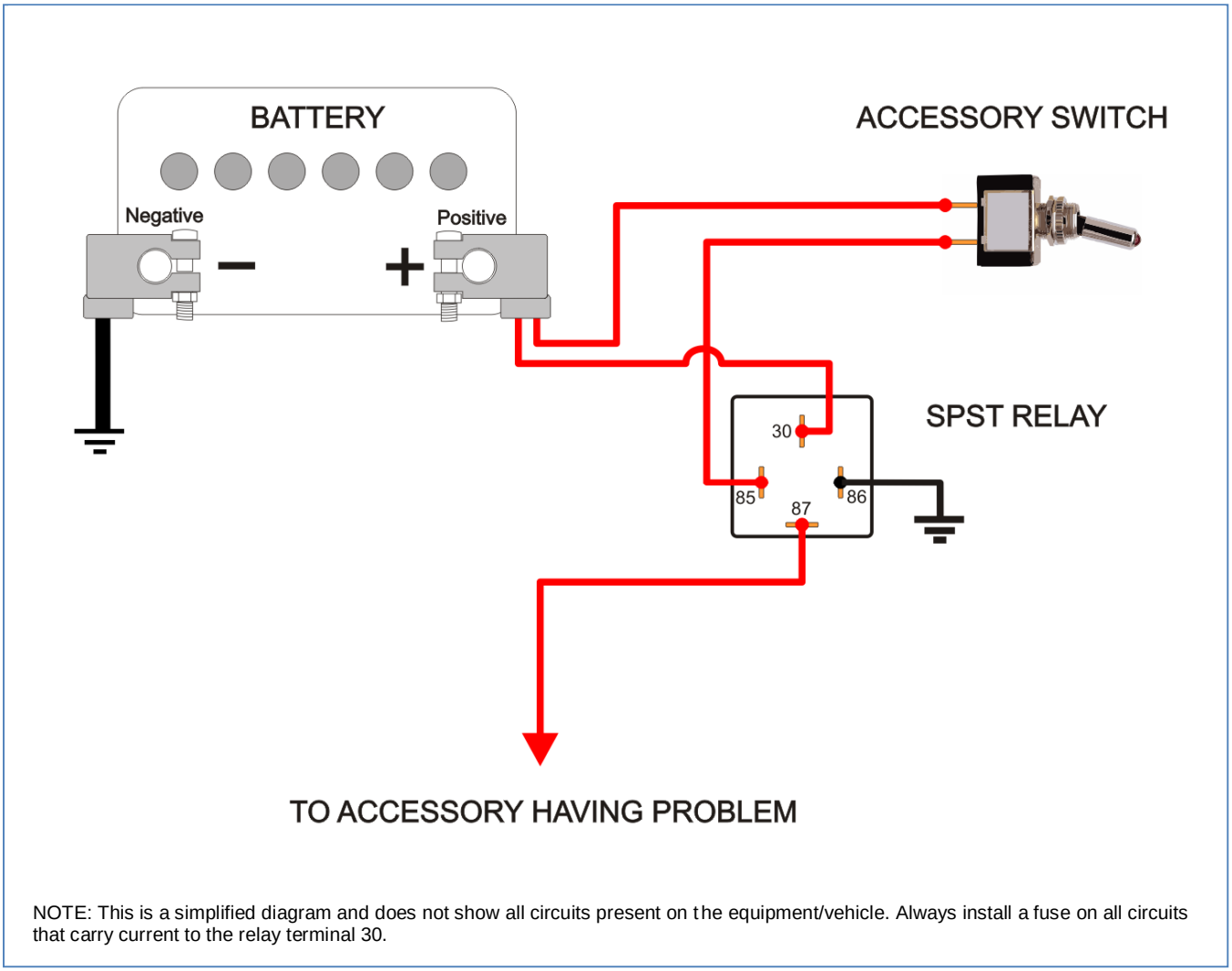
Figure 10 – Positive Ground Charge Light Circuit

Problem Fix #4:

Limit Voltage Drop to Accessories

PROBLEM: A customer has installed aftermarket driving lamps, fog lamps, cooling fans or horns that are drawing more amperage than the switch circuit can handle. The result is low voltage to the device and possibly low voltage on other accessories too. This can also be a problem with headlamps and electric fans on older vehicles when voltage drops through the various switches, and harness connections begin to add up to several volts.

SOLUTION: Use a SPST relay to operate the equipment suffering from low voltage, and control the relay with the original switch circuit. Mount the relay as close as possible to the power source and the device.



NOTE: This is a simplified diagram and does not show all circuits present on the equipment/vehicle. Always install a fuse on all circuits that carry current to the relay terminal 30.

Figure 11 – Reduce Voltage Drop To Accessories

- **Using Parallel Relays to Increase Current Capacity**
- **Exceeding the Relay's Amp Rating**

When adding a relay to any vehicle or piece of equipment, always consider the amperage needed to carry the load. Most Bosch-style relays are rated for continuous duty. If the load is over 40 amps, you'll need to use a higher capacity relay, or use two relays wired in a parallel circuit to split the load (*Figure 12*).

If you are using the relay to control a short intermittent load, like the starter switch circuit, you can increase the rated amperage. See *Chart 1* for load and time limits. It is also highly recommended that you always install a fuse in the wire going to terminal 30 of the relay to protect the wiring and relay. Of course, any wiring you add also needs to be heavy enough to carry the amperage.

Overload Current	Time
1.35 x Rated current	1800.0 sec.
2.00 x Rated current	5.0 sec.
3.50 x Rated current	0.5 sec.
6.00 x Rated current	0.1 sec.

Chart 1 – Tyco Relay Overload Capacities and Time

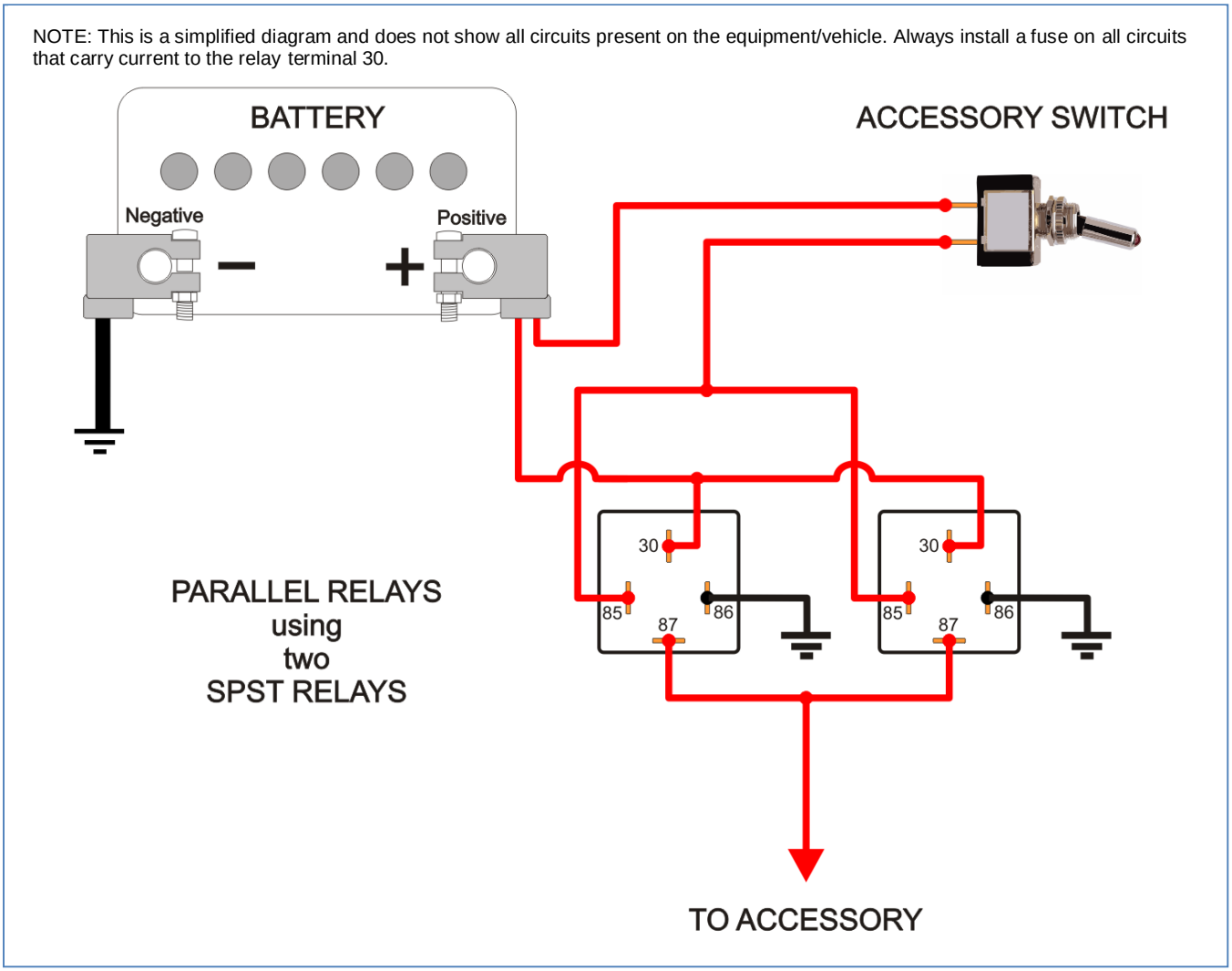


Figure 12 – Parallel Relays