A "Smart" Car-Battery Booster Cable

Simple project makes jump-starting a motor vehicle nearly foolproof

By Thomas R. Fox

Starting up a car that has a weak or dead storage battery by using cables to boost the latter with another car's good battery is commonplace. None of us do this regularly, though, so which polarity goes to what polarity can be vexing at the moment. Even if someone is rock-sure about this, a dark night without benefit of a flashlight with fresh batteries will give the best of us some pause. The same will be true if a battery's polarity markings are obscured.

Guessing which connection points to use can be dangerous since wrong connections can damage a vehicle's electrical system or even harm one's flesh. The "Booster Smarts" device we are about to describe, however, will clearly guide you so that you just cannot make a mistake even if you make the wrong connections! Moreover, it is cheap to build and permanently attaches to existing booster cables.

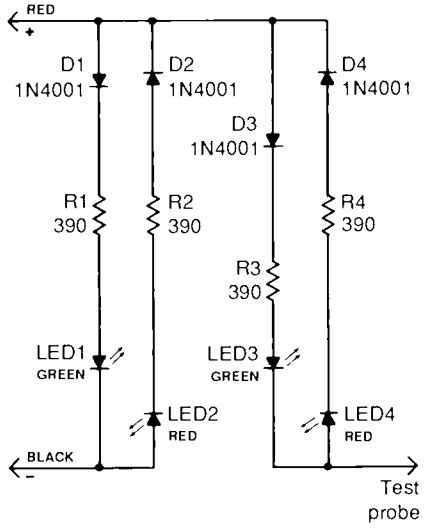
About the Circuit

Before describing how the Booster Smarts circuit works, let's understand just what jump-starting a vehicle is all about. Jump-starting is a method of getting a motor vehicle's engine operating when it will not start because of a weak or dead battery. To get the engine running, you connect the positive terminal of a good battery to the positive terminal of the weak or dead battery and the negative terminals of both batteries together.

Jumper (or so-called "booster") cables are the means by which the two batteries are linked to each other during the operation (hence the name "jump-starting"). Care must be taken to assure that positive is connected to positive and negative is connected to negative. Then, with the engine of the vehicle that contains the good battery running, the ignition of the car whose engine is not running is turned on. The object is to have the good battery supply sufficient power to crank the other car's engine until it can run on its own. That is all there is to jump-starting a vehicle, assuming of course that the problem is with its battery and not the engine itself.

Using the Booster Smarts circuit with your jumper cables takes the guesswork out of possible incorrect connections. It assures the user that when a green LED lights on the project the proper connections are being made and warns him with a red LED that tells him when a wrong connection is being made *before* the final connection is made.

Shown in Fig. 1 is the schematic diagram of the Booster Smarts circuit. The light-emitting diodes (*LED1* through *LED4*) serve as polarity indicators. Rectifier diodes *D1* through *D4* serve as protection devices for re-



PARTS LIST

D1 thru D4—1N4001 or equivalent silicon rectifier diode
LED1,LED3—Green light-emitting diode
LED2,LED4—Red light-emitting diode
R1 thru R4—390-ohm, ½-watt, 10% tolerance resistor
Misc.—Printed-circuit board; suitable enclosure (optional; see text); pc encapsulating compound (see text); automotive booster cables (see text); test probe or alligator clip (see text); stranded hookup wire; solder; etc.

Fig. 1. Schematic diagram of Booster Smarts reveals that its circuit is very simple, consisting of just four each light-emitting diodes (in two different colors), current-limiting resistors, and protection rectifier diodes.

verse-biased LEDs, while resistors *R1* through *R4* limit current flow through the LEDs to a safe level.

You can see that if connections to two batteries are properly polarized only green light-emitting diodes *LED1* and *LED3* will light. Conversely, if improper connections are made, only red light-emitting diodes *LED2* and *LED4* will light. In no case will all four LEDs be on simultaneously.

If the test probe is connected to the wrong (positive) terminal of the "dead" battery, red *LED4* will light, assuming there is enough residual charge in the battery to light it.

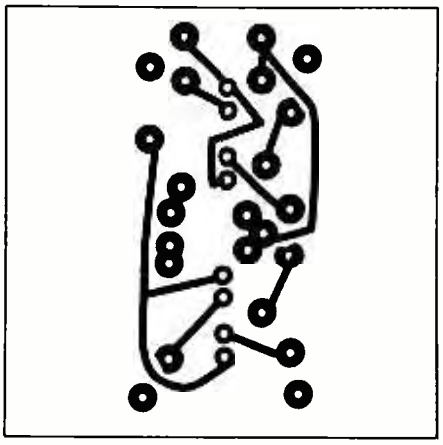


Fig. 2. Actual-size etching-and-drilling guide for project's printed-circuit board.

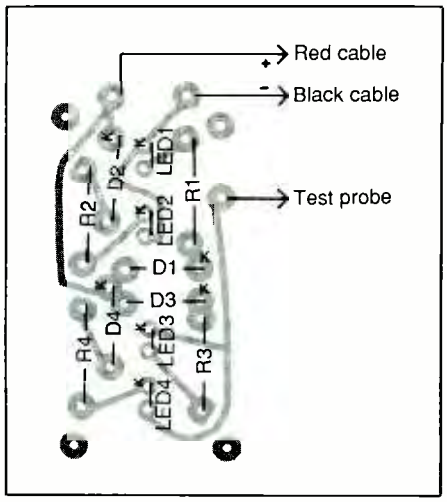


Fig. 3. Wiring diagram for pc board.

Construction

Despite the circuit's simplicity, a printed-circuit board on which to mount and wire the components that make up Booster Smarts is recommended. A pc board not only serves as a convenient wiring medium, it also provides much greater mechanical strength than does a perforated board. Since jumper cables, on which the project will be mounted, are usually kept in the unfriendly environment of a vehicle's trunk, you want the maximum in mechanical strength.

Fabricate your pc board using the actual-size etching-and-drilling guide shown in Fig. 2. When the board is ready, install and solder into place first the resistors, then the diodes and, finally, the light-emitting diodes. Make sure you properly polarize the diodes and LEDs before soldering their leads to the pads on the bottom of the board. (Note: If you wish to mount the project's circuit-board assembly inside a durable plastic or metal enclosure, the LEDs should mount on the enclosure and be connected to the board with short lengths of well-insulated stranded hookup wire.)

Strip ¼ inch of insulation from both ends of two black-insulated and one red-insulated 24-inch or so *stranded* hookup wires. Tightly twist together the fine conductors at both ends of the wires and tin with solder. Terminate one end of one black-insulated wire in an alligator clip or pointed test probe. Plug the other end of the wire into the hole labeled TEST PROBE and solder it into place. Plug one end of the red-insulated wire into the + hole and the black-insulated wire into the – hole in the board and solder into place.

No enclosure is required for the project, though you do have the option of housing in a small metal or plastic box. If you decide not to use a box, however, to assure the maximum in ruggedness, it is a good idea to protect the circuit-board assembly from rough handling. This can be accomplished by partially encapsulating the assembly. Ideally, the only components that should be left exposed should be the tips of the LEDs. The preferable encapsulant is the potting compound frequently used in commercial electronic equipment. If you cannot find this, you can substitute the more readily available silicone sealant.

Four holes are required, in the corners of the circuit-board assembly, through which plastic cable ties must pass to secure the assembly to the jumper cables. If the potting compound or sealant gets into these holes, clear it away. Then secure the Booster Smarts module to the jumper cables about 18 inches from the clamps at one end of the cable, snugging down the cable ties to assure the module will remain in place, as illustrated in Fig. 4. (Take a turn or two of the test probe wire around one tie before snugging it to serve as a strain relief.)

There are two general types of booster cables on the market. The less expensive ones usually have the two cables separated, while the more expensive ones have the two cables attached to each other via the insulation (and sometimes with reinforcing plastic clips) throughout most of their length. For this project, you want the latter to simplify securing the cables to it. If you already have the less-expensive variety of cables, you can still use them, but solidly bind them to each other for a distance of 6 to 8 inches, starting 15 inches from the clamps. Waxed lacing cord or plastic cable ties work well as a binding agent here. Then mount the assembly on the cables.

Solder the free ends of the red- and black-insulated wires to the jumper-cable clamps with the same color coding. Then use cable ties or waxed lacing cord to secure the wires in place as illustrated. As an aid in using Booster Smarts at the project end of the booster cables use black paint or

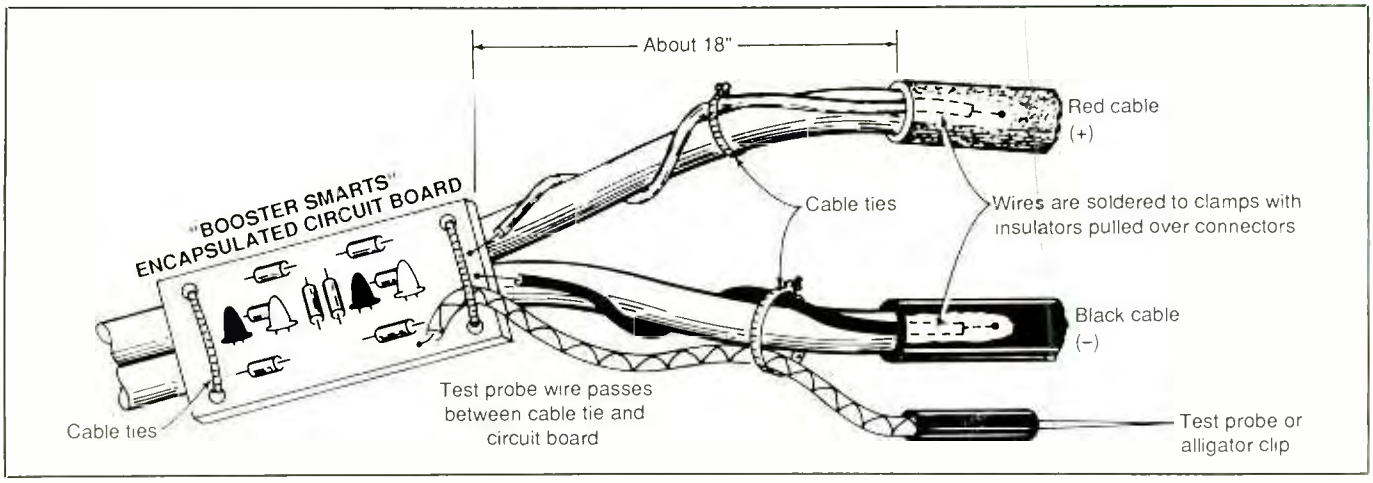


Fig. 4. Booster Smarts circuit-board assembly mounts directly to jumper cables with two plastic cable ties. Label cable clamps at end nearest project assembly "GOOD" and at other end "DEAD" for identification purposes.

permanent marker to put the legend DEAD on the handle of the red-coded cable clamp. Similarly, use white paint to put the same legend on the black-coded clamp. In like manner put the legend GOOD on both cable clamps on the other end of the cables.

Using the Project

There are two ways to use Booster Smarts. These are as follows:

• *Standard Method.* When a vehicle must be jump-started, attach the red-handled cable clamp with the GOOD legend on it to the positive (+) terminal or post of the good battery and the red-handled cable clamp with the legend DEAD on it to the + terminal or post of the dead battery. Then connect the black-handled cable clamp labeled GOOD to the negative (–) terminal or post of the good battery. If the connections are correct, only a green LED should be lit. A lit red LED indicates the wrong polarity and you must transpose the clamps on the battery terminals or posts. If no LED turns on, there is no electrical continuity, which means that you must thoroughly clean away from the battery terminals or cable clamps whatever is interfering with continuity.

Connect the red-handled clamp labeled DEAD to the dead battery's positive terminal. Before making the final connection with the black-handled clamp labeled DEAD, touch Booster Smarts' test-lead probe or clip to the negative terminal on the dead battery. If everything is okay so far, the other green LED should light. If the red LED lights instead, remove the red-handled clamp from the battery's positive terminal and replace it with the DEAD black-handled clamp. If no LED lights, either dirt, oxidation or other debris is interfering with electrical continuity (clean the battery's terminals and the cable's clamps to rectify this) or the battery is so far gone it does not have enough "juice" left to light a LED (which is unlikely).

Once you have only the second green LED lit when the probe or clip is touched to the dead battery's negative terminal, connect the last cable clamp to that terminal. With both green LEDs on, you can proceed to jump starting the vehicle.

• *Trial-and-Error Method.* Without taking any particular care to properly polarize them, connect the jumper cable clamps labeled GOOD to the good battery. If a green LED lights, fine, but if a red LED lights, transpose the clamps on the battery's terminals. Connect the red-handled clamp to either terminal on the dead battery and touch the probe to the other terminal and note which LED lights. If the red LED turns on, move the cable clamp to the other battery terminal.

Connect the final clamp to the one remaining terminal. Whichever method you use to connect the jumper cables to the two vehicles, it is recommended for reasons of safety that you connect the final black-handled DEAD cable clamp to a heavy metal bracket about 18 inches away from the dead battery itself and *not* directly to the battery's negative terminal. Also, make sure that the cables are not on or near pulleys, fans or other vehicle parts that are normally in motion when the vehicles' engines are turned on.

With the booster cables connected as described, start the engine of the vehicle that has the good battery. Run the engine at a moderate speed for several minutes. Then start the engine of the vehicle whose battery is dead.

Thus far, our discussion has assumed that your are dealing with vehicles that both have negative-ground electrical systems. Be aware, though, that there are still quite a few vehicles with positive-ground systems.

The type of grounding system a vehicle has can be checked as follows. Connect the black-handled cable

Jump-Starting Tips

Though "Booster Smarts" can make jump-starting a vehicle safer than without it, keep in mind that the procedure can still be dangerous to perform. Carefully follow the jump-starting instructions in your vehicle's owner's manual and add to them the following:

- Use only good-quality booster cables.
- Do *not* use a 12-volt battery to jump start a vehicle that uses a 6-volt battery. A dimly lit LED indicates a probable 6-volt battery.
- When using this project, make sure that both green LEDs are on before making the final connection.
- Do not let the vehicles touch each other—they may have different electrical grounds!
- Turn off the ignition and any lights and accessories that are not absolutely essential to the starting procedure to minimize the load on the good battery.
- Apply the parking brake and place automatic transmissions in park or neutral before starting the engines.
- Shield your eyes and avoid leaning over the battery at start-up.
- Do not expose the battery to an open flame or sparks. As the battery is charging, it gives off explosively combustible hydrogen!
- Make certain that batteries equipped with filler caps have enough fluid in them.
- Do not let battery acid get into your eyes or on your skin.

clamp labeled GOOD to an unpainted metal part of the vehicle and alternately touch the terminals of the vehicle's battery with the red-handled GOOD clamp while observing the Booster Smarts assembly for LED activity. If the green LED lights, the vehicle has a negative ground. However, it the red LED lights, the vehicle has the rare positive ground. To avoid confusion, if a vehicle has a positive-ground electrical system, connect *both* cable clamps directly to the battery's terminals to avoid having to deal with a "ground" altogether.

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