Advanced Wiring Upgrade

By Tony Rhodes, Delaware Valley Triumphs

For about half of our cars (TR2-4) upgrading the wiring is mostly a moot issue because the generator is so weak. They were rated for about 22 amps when new and functioning well. These days most probably produce somewhat less. For those with later cars, the alternators were somewhat less anemic and your wiring is already "upgraded" as a result. For all of us, time and corrosion have probably made all of our terminals less than perfect, so cleaning and repairing the stock wiring would be helpful. However, if you have retrofitted a higher output alternator to your car and have not upgraded some of your wiring, then you may be losing the full benefits of the improvement, and may have taken an added risk of major wiring melt-down.

Check the VTR website (www.vtr.org) for instructions on performing alternator conversions. The author of these articles (Dan Masters) has also produced a wonderful replacement wiring harness for the TR6 models. If you are ever going to replace your harness, use one of his. See his website at www.advanceautowire.com.

Modern alternators are available in many configurations. Many of them have an output of 60 amps or more. They do not ALWAYS provide 60 amps, but they can do so if there is sufficient power consumption. This consumption may be caused by various new, power-hungry accessories such as electric radiator fans, high wattage halogen headlights, driving lights, seat heaters and so on. An invisible but significant power drain is your battery. If it has had time to discharge, then it will gladly allow your alternator to recharge at a very high amperage.

The wiring of many of our cars was barely adequate for the 22 amp output of a generator. If we look at the "Olde English" Wire Table (Table I) we see that the wires are graded by the number of individual tiny strands of wire that make up the whole thing. As a general rule-of-thumb approximation, each tiny strand is rated to carry about ½ amp.

For instance, on a TR4, and probably the TR2 through TR4, the "heavy" wire from the generator to feed the battery and entire rest of the car is 44 strand (the TR6 uses a 65 or 84 strand). The same wire is then run all the way to the ammeter (late TR6 models use a voltmeter) and thence to the battery (by way of the starter solenoid). If your alternator is feeding the battery 50 amps (maybe only 80% of the average modern alternator's maximum output), then you are seriously overloading the biggest wire in your car, and much of it runs under your dash in the passenger compartment!! This is a fire hazard, and at the very least, this wire needs to be replaced (or bypassed).

Table I
Olde English Wire Table

Strands	Max Amps
9	5.75
14	8
28	17.5
44	25.5
65	35
84	42
120	60

As if that is not enough, you are getting voltage losses in your lighting wiring. The voltage loss depends on the size of the wire and the length. Smaller and longer wires have greater losses. The wires for the headlights are some of the longest in the car! Current runs from the alternator or battery to the ignition switch (but not switched by it), then to the lighting switch, to the dip switch, and then out to the lights. That run may be 6 feet or more, and has at least 6 terminals and 2 switches in the circuit! Each of those connections causes voltage loss. The wiring on most of these cars was designed for 40 watt high beams! That means the headlight wiring only needs to be rated for about 7 amps (probably 14 strand). On top of that the old tungsten filament bulbs are somewhat more forgiving about voltage losses than halogens. Modern halogen headlights have a worse proportional drop in light output for the same voltage loss. If you have 55 watt (38% more current than 40 watt) halogen headlights running on wiring that was barely adequate for 40 watt regular bulbs then you are

English/AWG
Equivalence (approx)

Strands	AWG
14	18
28	14
44	12
65	10

certainly suffering from "brown-out".

So, what do you do to improve the wiring? Well, that will require running new wires here and there. The modern technique of powering headlights is to use relays to switch the high currents for the lights, and use a low power system (the old original wires) to trigger the relays. Wire size selection is based on maximum current demand and run length. Use Table III to find the smallest size wire that will work. The table is based on 0.5 volt drop over the length of the run. Just for a safety margin, go up one wire size. For example, if you had a 10 amp load with a 15 foot run, then 18 awg wire would be sufficient. For a safety margin, use 16 awg wire. A more real-world example might be that you need to feed power to a pair of 100 watt high beams. Each of these draws about 8 amps, and 16 amps in the combined main run to the front of the car. You would then read from the 20 amp column. The first entry is 14 awg, which is good for 18 feet. Move up one wire size for safety and this means you should run 12 awg for the high beams. As a practical matter, for the non-primary circuits, you can have a selection of three wire sizes: 14, 12 and 10. Sizes smaller than 14 may get delicate due to small size, and sizes larger than 10 are hard to handle and crimping of terminals is difficult.

Table III
Maximum length in feet for car wiring

Wire Gauge	Current Load in Amps @ 12 Volts DC							
	4 A	6 A	8 A	10 A	12 A	15 A	20 A	50 A
20 awg	26'	17'	13'					
18 awg	37'	25'	18'	15'	12'			
16 awg	56'	37'	28'	22'	18'	14'		
14 awg	90'	60'	45'	36'	30'	24'	18'	
12 awg	143'	95'	71'	57'	47'	38'	28'	
10 awg	227'	151'	113'	90'	75'	60'	45'	
8 awg	363'	241'	181'	145'	120'	96'	72'	29'
6 awg	585'	390'	292'	234'	194'	155'	117'	46'

Handling the line from the alternator to the battery is another issue altogether. You need to be sure to have adequate wire size here. If you have a later car with a voltmeter, then it is easier to upgrade the wiring because you do not have to run a big wire into the passenger compartment (to get to the ammeter). There is simply a big wire from the alternator to some place like the battery side of the starter solenoid. Check that wire and be sure it is large enough. If in doubt run a new wire to that location.

Cars with an ammeter will require a large (probably 120 strand) wire running from the alternator through the firewall to the large connector on the back of the ammeter, then the same size wire coming off the ammeter's other terminal, back out the firewall to the battery side of the starter solenoid. Now what about the ammeter itself? Well, it would probably be best to buy a 60 amp ammeter and replace the 30 amp unit usually installed in these cars.

What should you do to handle all those neat new accessories that your upgraded alternator is now capable of feeding? You could add more wires to the fused outputs of the existing fuse box. Our cars had inadequate fusing as it was, adding more draw on the existing fuses is silly. Just imagine the typical outlet nearest to a Christmas tree!

It is quite easy to add a new fuse box near the original and run a new wire (of adequate size for the worst-case scenario of power usage) to the new box directly from the alternator. An 8 awg wire to the new fuse box would probably be about right. This design is especially useful in the case of an alternator conversion. Dan Masters recommends connecting most of the wires that originally met at the generator control box all together in one huge twisted wad. While this is functional and practical, it is far from ideal. These wires (one from the alternator, others to the horns, ignition switch, coil, and ammeter) ought to be treated separately. Then you can fuse any output as the needs of each device may require. Remember, most of the important circuits were not originally fused at all! The purpose of a fuse in wiring design philosophy is to protect the wire and the car, not the device. For new circuits, use a fuse, and plan on using a wire one grade heavier than the expected maximum combined current draw so that the limiting factor will be the fuse or the device, not the wire. Remember that with a large enough fuse, a small wire will melt before the fuse blows. *[This is a good time to mention that UK fuses are rated differently than US fuses. The difference is about 50%. A common UK fuse of 35 amps is about the equivalent of a US fuse of 15 amps.]* For us TR2-4 owners, the TR6 has a nice 4-fuse box that is a reasonable match to the character of our cars and will triple the number of fused circuits available.

Fusing of headlights is a real issue, and a matter of debate. Originally our cars had NON-FUSED headlight circuits! It seems this was done for safety purposes. If there was some momentary short you would not suddenly blow the fuse and be driving at 60 mph in the dark. Instead the lights would blink off and return (hopefully) when the short vibrated free. With a real short you would still be in the dark, but the flames from the burning wires would light the way. So, should you fuse the headlights? You can go either way. What I did was to install resetable circuit breakers on the over-built wiring (capable of handling well more than the expected headlight loads) and then selected circuit breakers closer to the power handling of the wires (30 amps). If there is a sufficient short to pop the breaker, then it was probably a serious short and no matter what I was going to be without headlights.

So, now you have some extra information to allow you to rip into your wiring harness and make some upgrades without as much risk of, as they say, letting the smoke out.