Making British Car Connections…

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The phrase “Making British Car Connections” can mean a couple of things. Of course, it can mean attending the National Vintage Triumph Register meet or heading up to Watkins Glen to chat with other British car denizens. For this article, let’s take it literally to mean connecting two wires together in a British car.

We all know the old joke that Mr. Lucas put connectors in his wire harnesses as a place to let smoke out. The ironic part is this is partially true since most wire harness issues can be traced back to the connectors. A wire is for the most part static and can carry its rated current for many, many years as long as wire corrosion doesn’t set in. The connectors, on the other hand, are the variable element in a wire harness. They are exposed to the environment and can and do change over time- sometimes with catastrophic results. The key is to keep the connector interface resistance as low as possible and as stable as possible for as long as possible.

Wire harness connections in our cars can be split into separable and non-separable. Each have their place in our cars and can be reliable when done properly. Separable connections we see most often are the infamous “LUCAS® Bullet” connectors and the “LUCAR®” spade/receptacle type. Non-separable connections we see are either permanent mechanical connections such as screw terminations, permanent soldered terminations or those “creative” terminations done by previous owners. Let’s talk about the non-separable connections first and then delve into LUCAS® Bullet and LUCAR® connections along with some things that can be done to make them more reliable.

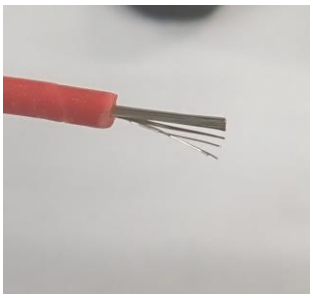
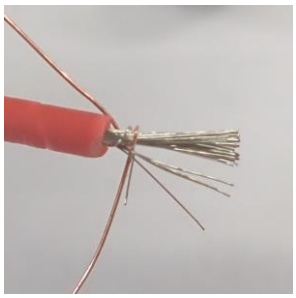
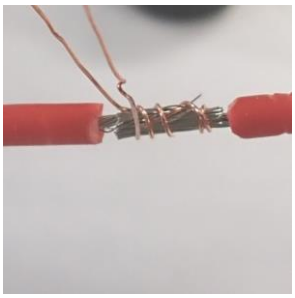
When permanently connecting two wires together, there are a number of options available. Soldering and crimped splices are two proven options. Both have their pros and cons.

Solder termination is easy, reliable and can be used to make inline butt splices or pigtail splices. The key to soldering successfully is using a properly sized soldering iron to get heat into the joint quickly. Using a 15W Radio Shack pencil iron that’s been in the bottom of your junk drawer for 30 years to solder two 14 gauge wires together won’t cut it so get the proper iron for the job. An iron of ideally 60W is about right for most soldering you’ll encounter. When the right iron is used, the joint heats up quickly such that lightly feeding solder into the joint causes it to instantly wick throughout the joint. The resulting joint should be nice and shiny. If it is dull, “blobby” and frosted-looking, the solder was not hot enough and is called a “cold-solder” joint that won’t be reliable (figure 1) and note how the solder didn’t flow into the wire strands. If this happens, reheat until all the solder reflows into the joint again and cools to a nice, shiny surface.

Figure 1

Once the joint is cool, wrap with electrical tape to insulate or, even better, use shrink tubing for a neat, professional look. When using heat shrink to insulate a butt joint, make sure to slip the heat shrink on one wire before soldering to the other.

Here's a sequence showing the steps to properly butt-joint solder two wires…


TIP: It's often tough to keep one or more wires together to solder them. Pull a single wire strand from a piece of scrap wire and use it to tightly wrap the joint before soldering. Snip off any excess wire and cover with shrink tubing.

TIP: Make sure you only use rosin core solder on electrical terminations. NEVER use acid core solder products. Secondly, unless you're an expert solderer, stay away from lead-free solders. 60/40 tin-lead solder is fine for most everything you need to solder.

One relatively new solder termination option worth mentioning is called a solder sleeve. A solder sleeve combines a ring of solder inside a clear plastic shrink tube and works well for making a butt splice termination (see Figure 2). When heated properly, the tube shrinks and holds the wires together until the internal solder ring melts and solders the wire. The best products on the market are arguably RAYCHEM® solder sleeves but they are expensive. Much less expensive ones can be found on Amazon but these are pretty sensitive to temperature. I've found the best way to heat these is to use a two speed Harbor Freight Heat gun (Figure 3) set on the low setting. Do not use a propane torch on solder sleeves! It takes a couple minutes to heat with the heat gun but the result is a really nice, sealed and soldered connection.

Figure 3

Figure 2

A permanent mechanical connection for two wires is typically a crimped butt-splice although there are also insulation displacement (IDC) options (Figure 4). I'll be blunt about the latter – they have no place under the dash of our cars. Use them on your boat trailer if you want but they are far too unreliable in the long-term to use in our cars.

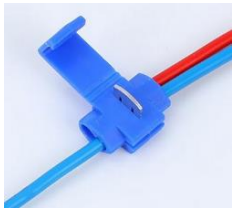


Figure 4

The crimped butt-splice is a great solution to join two wires IF it is terminated with the proper tool. A pair of pliers is not the right tool. A good crimp tool is typically a ratcheting tool that only releases when the crimp is complete (Figure 5). A good crimp tool can accommodate wide range of 22-18AWG Red, 16-14AWG Blue, and 12-10AWG Yellow splices and terminals (Figure 6).

Figure 5

Figure 6

Switching to separable connectors, there are two types used in our cars. The most common one is the LUCAS® bullet/barrel-style connector system (Figure 7). The other is a blade and receptacle (Figure 8) also called "LUCAR®" connectors in our LBCs. The former can be crimped or soldered whereas the latter must only be crimped with the correct crimp tool. Again, a pair of pliers is NOT the correct tool.

Figure 7

Figure 8

The bullet connectors come in a wide range of sizes and can be crimped (again with the proper tool) or soldered onto the end of the wire. The negative to these is each splice requires an insulated metal barrel to bridge two bullet-terminated wires together making it a three piece wire splice termination. This means for every splice, there are two interfaces that can go bad. The issue with these connections is they are tin plated and rely on relatively light press fit into the barrels. Without getting into the intimate details of contact physics, the tin used is subject to oxidation. These tin oxides are resistive (aka oppose current flow). As current is turned on and off (such as a headlight circuit), the connector thermally grows and shrinks ever so slightly due to the current flow heating up the connector. This movement exposes fresh tin that then oxidizes and thickens as current is cycled over time resulting in an ever-thickening resistive oxide layer where the contacts come together (contact interface). As resistance builds, the contact interface heats up more as current flows through it. Eventually the heat anneals the contact material which then decreases the contact force which allows even more oxides to build in the interface which further increases interface resistance. You can see a nasty cycle here that eventually ends up with the connector self-destructing. This nasty cycle is called "Fretting Corrosion" in case you want to do more research on it. Eventually, enough resistance builds up in the connector interface that it heats up enough to melt and ignite insulation, or, in severe cases, melt the metal itself.

All is not lost with bullet connectors. If you're reusing old ones, be sure they still have good retention. You should require a pair of slip-joint pliers or special bullet connector pliers to mate the bullet connectors into the splice tube. If you can fully mate them by hand, they're shot and you'll need to replace splice tube with a new one since the tube is annealed (see prior paragraph). While you're at it, use a good contact lubricant since it can dramatically improve long term reliability. If you're installing a new harness, dip or brush each contact with a quality contact lubricant (such as CAIG Labs Deoxit®, Newgatesimms Tribosyn®, or ECG Contact Cleaner and Lube to name a few). It's is worth mentioning a bad recommendation I've read on forums- whatever you do, DON'T use dielectric grease since it is non-conductive! If you're refurbishing an existing harness or connector, clean the bullet connector with some 0000 steel wool and use a brass 0.177 caliber pellet gun cleaning brush to clean out the connecting barrel. Lubricate, reassemble and you're good for many more miles.

The LUCAR® contacts are typically used to connect to a device (like a voltage regulator) with the receptacle terminated to the wire. These terminations are pretty reliable given their relatively high-pressure contact forces yet they can still suffer from fretting corrosion under the right circumstances. Like the bullet connector, LUCAR® connectors can benefit from a quick wipe of contact lubricant on the blade side to prevent contact oxidation and improve long term reliability. Theses receptacle contacts are harder to replace if needed and require a proper crimp tool to terminate to wire in order to ensure a properly rolled crimp to the wire. If the crimp is done properly, the result is a gas-tight, permanent termination to the wire. Resist the urge to solder a crimped receptacle terminal of any type to a wire. Most of these terminals are made of brass so the heat from the soldering operation will anneal the contact beams of the terminal. This will dramatically reduce the force that the contact needs to maintain a good connection and you're all but guaranteed problems in the future if you do this.

Lastly, the one thing you should never, ever do is simply twist wires together and wrap with some tape (Figure 9). To do so is asking for problems in the future. Here's picture of one of many wire to wire terminations I found on the harness of my TR3 when I was disassembling it. It was loosely wrapped with electrical tape. Again, don't do this. Ever. Terminations like this inevitably become a gremlin as they age, sometimes working and sometimes not.

Figure 9

I hope this little electrical overview helps you keep your LBC on the road and trouble free. Spend the time to take care of the electrical terminations in your LBC and rest easy that the smoke will stay in the wire harness where it belongs.