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Wire and Cable Facts

by Bill Kenney

The controversy rages on over wire, both speaker cables and line-level interconnects. Since I've been an audiophile—and that's a lot of years—it's been a never-ending list of announcements, claims, counter-claims and just plain nonsense. It's now possible to spend literally thousands of dollars on cables and interconnects. Is it worth it, does it make a difference? Well, maybe.

When I was working as a young engineer for General Electric in Pittsfield, Massachusetts, I had the opportunity to do some basic engineering and research on cables and contacts for a low-voltage, low-current application. The application was for the United States Navy and involved the taking of test data on board submarines. The challenge was to make measurements of potentially failing reed relays used in logic control systems. Contact resistance of these devices typically runs in the milliohm region with signal levels in the 1- or 2-volt range and currents in the milliamps. How are you to tell if a relay is defective or about to go bad? On board ship you only have a few tools at hand. The operator is always a competent Navy technician, but things must be kept simple, quick, repeatable and reliable. The signal and current levels were very nearly the same as those found between an amplifier and preamp in a typical stereo system.

My tasks: Build a test fixture that could be connected to an automatic system to measure the complex resistance (ac and dc) of a reed-relay contact. Then write the test procedure, demonstrate the system and get it bought off for use in the fleet.

All the wire lengths to the test system were to be held to less then one meter. I had to design the connections to the system and figure out how to cycle the fixture repeatedly without breakage.

I gathered the usual pile of commonly available connectors—RCA plugs and sockets, five-way binding posts, RG-59 coax cables with F connectors, and so on. The test system could apply any number of voltages and frequencies from 0 to 40V, either do or ac up to 1kHz. The system could measure voltages within 1% and place 1%-precision resistors in the circuit under test. It could also measure a phase-angle shift from an applied small-signal ac voltage, at frequencies from 1Hz to 1kHz, within one degree. This was all done automatically, which was pretty good for 1967.

After trying several different combinations of connectors and cables it became obvious that I could make a single measurement, but I could not make repeatable measurements. A relay that measured 12 milliohms would measure 6 milliohms the next day. The pattern of the differences was random.

In frustration, I connected a normal audio cable into a Wheatstone-bridge test setup and passed a precision one-milliamp dc current through the wire. **So long as I made what I call a "smash" connection between bare copper wire and a five-way binding post, the one- or two-milliohm readings were consistent and repeatable. Any time I introduced any kind of connector—banana plug, RCA jack, or whatever-the readings would become random again.** If memory serves, the measurements were in the 5 to 25 milliohm range, and showed some phase shifting with ac signals.

Things were always worse if the metals in the connection were dissimilar. A gold-contact RCA plug in an aluminum socket would produce enough galvanic voltages to make Wheatstone-bridge readings impossible. Aluminum banana plugs into gold-plated five-way binding posts produced similar results. I should note here that the common banana plug proved to be mechanically very unstable. Resistance readings would vary widely, sometimes reaching hundreds of milliohms. Even a slight jiggle of the plug would swing resistance measurements wildly.

Since the relays themselves were considered to have failed when they developed a contact resistance of 10 to 25 milliohms, it was obvious that any connector in the test fixture was going to be unacceptable. As long as the relay (which had gold spade contacts) was plugged into a gold-flash socket, and that socket was connected directly to the test fixture with copper wire (I think it was 14 gauge), the measurements were consistent and repeatable.

I then constructed a connectorless test fixture. Two heavy-gauge wires came from an aluminum mini-box and were tightly connected to the heavy gold-plated five-way binding posts of the test system. There was enough wire that if a few strands broke off in heavy use the jacket could be stripped back and reconnected. The fixture, although it looked a little unprofessional, did the job it was designed for, and was duly shipped off to the customer and accepted.

As a young engineer who loved stereo, I found this project enjoyable and informative. I believe that the interconnect debate should become instead a connector debate. I think the connector has a much larger effect on the quality of the sound than the cable. If you're hearing a difference from one cable to another, just disconnect and reconnect it again. Maybe it will sound different.