Substituting Parts

You need to replace a 470-ohm resistor in your 2-meter power amplifier. Any 470-ohm resistor you have in your junkbox should do the trick—or will it? Did you check to see if the substitute resistor was a carbon-composition or wire-wound type? Contrary to what you may think, it makes a big difference in RF applications! ARRL Laboratory Engineer Zack Lau, KH6CP/1, offers many important tips to consider before *you start swapping parts in your equipment.—WB8IMY*

Q: Many construction articles say that I can substitute higher-wattage resistors for lower-wattage ones. Are there cases where this doesn't work?

A: The most obvious problem results from the larger size of the higher-wattage resistors: They may not fit in the same space as smaller resistors. Inductance is also related to size. At VHF and above, larger resistors may have too much inductance for circuits to work properly.

Q: How does the inductance of metal-film resistors compare with that of carbon-composition resistors?

A: The metal-film resistors made today seem to be quite low in inductance, and are comparable to carbon types. I've used them well into the VHF range with little difficulty. However, these should not be confused with *wirewound* resistors, which are probably too inductive even in the MF/HF spectrum.

Q: How about capacitors? Why is a given value available in so many types?

A: Manufacturers usually use the cheapest capacitor that will work well in a given circuit. Depending on the application, you end up with a menagerie of capacitors made from various materials, including ceramic, mica, polystyrene and so on.

Q: I can't seem to find the polystyrene capacitors specified in an oscillator project. Is there another type of capacitor I can use?

A: If it's an RF project, NP0-type (that's zero, not "oh") ceramic disc capacitors work just as well or better. For audio or very-low-frequency projects, polyester capacitors are a good substitute. If you manage to find polystyrene capacitors, take care when you solder them in place. Polystyrene capacitors are easily damaged by defluxing solvents and heat.

Q: The mica capacitors in my transmitter filter are getting awfully warm, yet I used the 500-volt capacitors specified in the article. What's going on?

A: When you're using capacitors in power circuits, the *current* rating of the capacitor is just as important as the voltage capacity. Unfortunately, current ratings are not usually specified. I look for larger capacitors with thicker leads when I have an application that requires the capacitor to handle high currents. An alternative is to use several smaller capacitors in parallel.

Q: I want to use disc capacitors to filter my ac line cord. How can I convert the dc voltage rating of the capacitors into an ac voltage rating?

A: Rather than use the conversion approach—which is a bit risky—the better course of action is to use ac-rated capacitors intended for across-the-line use. Another option is to use filtered line-cord connectors. They're often very cheap on the surplus market.

Q: I know that the tuning range and plate spacing of air-dielectric variable capacitors is important. Is there anything else I should worry about?

A: Size can be an important consideration—especially if the capacitor has to fit inside the box you're using! Loss is sometimes a factor as well. For instance, small tuned loops for transmitting require low-loss tuning capacitors to work efficiently. Expensive vacuum-dielectric variables are often used in these applications. However, if the author got away with an air variable, chances are you can, too. Some types of equipment, such as VFOs, also require capacitors with a high degree of mechanical stability.

Q: How come an author merely specified "ferrite bead" without specifying its size or material type?

A: In many cases, the ferrite bead was added as insurance against RF intrusion and the author merely grabbed whatever was available. It's difficult, but not impossible, to differentiate the various ferrite materials by color and texture. For example, type 43 material has a pronounced metallic sheen compared to type 72. Type 75 material usually appears to be dull and dark.

Q: I've purchased some mystery toroids at a recent hamfest. I'd like to substitute them in one of my amplifiers. How do I calculate the proper number of windings to use?

A: First, you have to determine the inductance, and possibly the Q, of the inductors you're replacing.

Once you've determined the inductance of the inductor you want to replace, make your best guess at the number of windings required on your mystery toroid. Wind the wire through the toroid and measure the resulting inductance.

If you find that it's impossible to maintain the proper turns ratio to get the inductance you need, your toroid is unsuitable. Also, if the loss is excessive, the Q of your toroid probably isn't high enough.

Q: I checked my parts-substitution directory and found that a 1N5767 PIN diode is similar to a 1N914 small-signal diode. I thought they were completely different. What gives?

A: A PIN diode is a specialty device that shares *some* characteristics with small-signal diodes. However, the publisher of your directory failed to take the special characteristics of PIN diodes into account. To add to the confusion, 1N914s *can* be used as RF switching diodes, but they have much higher losses (often approaching 50%) compared to a few percent or less for a properly designed PIN diode switch.

Q: Why do some circuits require a specific transistor while others operate with just about anything?

A: Good designers add extra parts to compensate for device variations. This allows a wide variety of devices—transistors, for example—to function in the circuit. In some cases, designers find that optimum performance can only be obtained by using a specific device. In other cases, cost calls the tune. A circuit designed to accommodate a variety of substitute parts requires extra effort...and extra expense!

Q: The project I'm building specifies a certain wire gauge to use when making the inductors. Can I get away with using a different wire size?

A: Maybe—if the size of your substitute wire is reasonably close. Much thinner wire will result in more inductance and lower Q—even if you're winding a toroid. This can make the difference between a working circuit and a dead circuit! Too much Q, on the other hand, can result in unwanted oscillation. Broadband circuits are usually less critical with regard to circuit Q.

Q: I want to replace the tubes in my radio with solid-state devices. Isn't there a company that sells replacements?

A: Sorry. The last manufacturer of solid-state tube replacements closed up shop a long time ago. Even building your own isn't easy. The necessary high-voltage field effect transistors are difficult to find these days.

Q: Why can't I use the fifth overtone of a cheap microprocessor crystal for my microwave transverter?

A: Nothing says you can't. However, the microprocessor crystals I've examined have strong spurious responses. If you attempt to use the fifth overtone of these crystals, be prepared to see your oscillator unexpectedly jumping frequencies. Unlike your microprocessor crystal, a crystal made for a particular overtone is cut to keep spurious responses to a minimum.

Q: I have a bad crystal in an FT-243 case. Can I replace it with a crystal in an HC-6 case?

A: Possibly, but be careful. The HC-6 crystal is a more modern vintage. Older crystals generally can handle more power than most modern crystals. This means you have to be cautious when using a modern crystal as a replacement in an older piece of equipment. Crystals will fracture if you apply too much power to them!

Q: What about using plastic-insulated wire when copying antenna designs that use bare or enameled wire?

A: Insulated wire will make a difference in the antenna's resonant frequency, though for HF antennas the antenna's placement has just as much effect. Besides, if the finished antenna isn't resonant on the desired frequency, a little shortening or lengthening will do the trick. For VHF and microwave antennas, the effect is more pronounced, and correcting the problem is more difficult.

Q: Does it make any difference whether I use phenolic or glass-epoxy circuit board?

A: Yes! Phenolic boards are junk compared to glass-epoxy boards. Assuming that you'll have to make a modification or repair to the circuit at some point, glass-epoxy is a wise investment. A phenolic board is brittle and will break easily.

Q: Is it really necessary to have my PC boards tin plated?

A: Not at all. They'll look better and won't oxidize as quickly as unplated copper, but you can always scrape the copper clean if you need to do a modification in a couple of years.

Q: What can I use for coil forms?

A: Polystyrene and Teflon make great coil forms, even though polystyrene cracks and melts easily. Fiberglass, Delrin and wood have also been used, apparently with good results. Some hams have tried PVC, but I've heard several reports of problems with this material. (One ham reported melting an antenna coil wound on PVC!)

Q: I can't seem to find audio-taper potentiometers. Can I use linear-taper potentiometers instead?

A: It depends on the circuit and how fussy you are. The wrong taper can make the difference between a smooth control and a touchy control. Audio tapers provide the smoothest adjustment for audio circuits, assuming the designer used them in the right place.

Q: Can I use anodized aluminum for my antennas?

A: Anodizing is an electrochemical process that has one huge disadvantage—it forms an excellent *insulator* on the surfaces of metal objects. I once encountered a TV antenna that seemed to be mysteriously nonfunctional—until I sanded off the coating to establish electrical contact!

Q: When is it appropriate to use IC sockets in a circuit?

A: Let the author's design be your guide. Sockets are usually safe for RF applications, although the author may have a perfectly valid reason to avoid them (too much inductance, high reliability requirements and so on).

Q: Can I use UHF connectors instead of those N, BNC, or SMA connectors so often specified in UHF and microwave projects?

A: No. Despite their name, UHF connectors have poor SWR characteristics at UHF and higher frequencies. They should not be used above 420 MHz. However, if the rig in question uses UHF connectors, its circuitry is probably designed to accommodate the mismatch they cause.

Q: Can I substitute a 6146B RF power amplifier tube for an ordinary 6146?

A: In most cases you can, although the B-suffix version's slightly higher grid-to-plate capacitance may cause problems if the range of the neutralization circuit is marginal. In addition, while the plate dissipation of the new tubes may be greater, don't try to squeeze more power out of the circuit. Your power supply may not survive the additional stress! For tube-type amplifiers, it's often the power supply that limits the amplifier, not plate dissipation.

Q: I found some high-quality Teflon cable at a hamfest. Can I use it in place of regular coax to reduce loss?

A: This is actually two questions. Yes, you can usually replace regular coax with its Teflon dielectric equivalent *in applications where the velocity factor doesn't matter.* But Teflon cable generally isn't less lossy than standard cable of the same impedance and diameter.

Q: How can I determine the impedance of the cable I bought?

A: Unless it has an RG-type number, forget about looking it up. It's easier just to measure the dimensions and calculate it. You can confirm your calculation by attaching a long piece of the cable to a dummy antenna and measuring the SWR.

Q: I copied an antique transmitter almost exactly, except that I used aluminum instead of steel for the chassis and shields. How come it's full of unwanted oscillations?

A: Assuming the original design didn't have oscillations its builder didn't know about, the aluminum is probably the problem. The use of steel, a lossy material, effectively lowers the gain of RF circuits, making it difficult for oscillations to occur. This is why old steel chassis were often copper plated—and one reason why old rigs on bare-steel chassis were relatively easy to tame.

We welcome your suggestions for topics to be discussed in *Lab Notes*, but we are unable to answer individual questions. Please send your comments or suggestions to: Lab Notes, ARRL, 225 Main St, Newington, CT 06111.

New Products

KEYER AND MICRO-SIZED KEY

□ Gordon Crowhurst, G4ZPY, claims his new ultraminiature model is the smallest operational Morse code key in the world, unless someone knows otherwise. This new "baby" (not yet christened with an official name or model number), has a one-inch arm, fully adjustable silver contacts, adjustable spring, and sits on a 1.18 × 1.0 × 0.24-inch base of polished Paxolin.

If you want to save space, the Miniature Iambic Electronic Keyer measures just 3.15 × 3.15 × 0.78 inches and is housed in a vinyl/steel cabinet to keep out stray RF. It uses a new microprocessor programmed to the manufacturer's specifications. It could be just the thing for backpack, mobile or crowded tabletop use.

All G4ZPY keys are handcrafted. For a color brochure and prices, send two IRCs or $2 to G4ZPY Paddle Keys International, 41 Mill Dam Ln, Burscough, Ormskirk L40 7TG England.