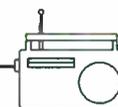


Radio Guide



Radio's Technology Forum

October 1994

Short Fuses

On page 5 of this issue, Gordon Carter tells us about a unique type of fuse failure. This got me to thinking about fuses and the problems they can cause when they blow.

Fuses are, by design, used to protect your gear — but oh, the headaches they can cause when they burn out. First of all, how many times have you had to replace a one amp fuse with a five or even a ten, just to get back on the air? All right — it was an emergency, and it was all you had. But how long has that “temporary” fuse been in there? How many months did you say?

Unfortunately, not having the right size fuse in stock seems to be the rule at more than a few stations. I've even seen a few places with more spare light bulbs stockpiled, than fuses. Go figure. Although the rise in the cost of fuses seems to have outstripped inflation by a factor of ten, this shouldn't prevent you from obtaining a complete stock of fuses for all transmitter and studio sites.

Go to each of your sites and simply jot down the number, style and size of every fuse in each piece of equipment. Now go out and buy ten of each type found at each site, and keep them in the proper locations. It might be handy to keep copies of the lists you've made at each site, so you'll be able to check your stock.

It's never easy to know just how many of a given type you're going to need, but sometimes you can blow four or five just getting close to the problem — especially in the transmitter. My experience has shown that ten of each type should be a good starting number, but of course your specific equipment history could modify this.

Even if your transmitter, for example, has not blown a fuse for a couple of years, you may burn out quite a few before you get a handle on the problem. My point is, don't underestimate the number you may need, just because your equipment has been behaving.

A convenient and complete fuse supply, at every studio, STL, and transmitter site, can help to reduce initial equipment down-time, while maximizing your peace of mind. Knowing that you've got the right fuse in the gear, and in stock for future emergencies, is a good feeling. And . . . it's good engineering practice.

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Force of Habit

Creatures of habit are we, and sometimes to the exclusion of common sense. I had this brought home to me last night when I went to see why a Continental 314 had ceased to function.

When I arrived at the transmitter about 10:30 p.m., the filaments were on, but the high voltage had dropped out. No breaker trips, no overloads showing, nothing to indicate catastrophic failure anywhere. When I pushed the high voltage "on" button, there was no clunk, no real action of any kind, *except*, (here's where I let habit take over and ignored the next fact) the plate "off" light would extinguish.

I have always been taught, and have taught others, that if a transmitter does absolutely nothing when you push the "go" button, it almost has to be an interlock or air switch open. So, I proceeded in that direction out of habit — if nothing happens, check the interlocks.

However, something had happened! The plate "off" light had gone out when the plate "on" button had been pushed. There actually was a very small relay clicking at that time. However, due to the filament operation in the 10 kW daytime transmitter, the air conditioner running, and my "over 50" hearing, I did not notice the tiny sound as the button was pushed.

After about an hour of checking everything in the interlock circuits, and mumbling to myself, I finally gave up and called Continental field service. Within 30 seconds, he had established that when the plate "on" button was pushed, there were actually *two* things happening that were readily visible. The plate "off" lamp was going out, and the 28 volt control voltage was taking a dip. Either one of these is a sure tip-off that there is nothing wrong with the interlocks. And the dip in voltage, coincident with pushing the "on" button, is a sure tip-off that you have a shorted diode, or something, in the high voltage control circuit. Before long I had found the "something" to be the high voltage contactor itself. The diode across it was OK, but the windings had gone south.

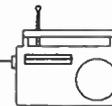
I had allowed my set ways of thinking about things to cause me to ignore some obvious clues. Twenty-five years ago I would have not been so sure of my original thoughts and would have looked at things a little longer before taking any real action. Years ago I had a manager complain because I was just sitting and looking at the transmitter. I told him that thinking it through was much faster in the long run than going off in all different directions with your VOM. I should have remembered that last night.

I've shared this with you to remind some old-timers that, even though we pride ourselves on how fast we can diagnose a problem, we can sometimes move too quickly.

George

Remote Control Checkout Device

Paul Rebmann — Lakeland, Florida



Here in the lightning capital of the country, even the best equipment sometimes suffers from damage. After I installed the Burk ARC-16 remote control system at the studio and both transmitter sites, I have occasionally had a status or analog malfunction. These were usually related to a particularly nasty storm.

I came up with a device to quickly identify all of the defective inputs, even if they were not being used at the time. This handy tool consists of a 37-pin female D-connector and an AA battery holder. When plugged into an analog/status connector on the ARC-16, all eight status inputs are activated, and 1.5 volts is placed on the associated analog inputs. Use and removal of the plug, while noting changes, allows quick confirmation of proper operation and identification of faulty inputs. I keep one of these at each site.

The test plug is constructed by first connecting each of the status inputs (pins 2-9) to the nearest ground (pins 21-28). Then take two wires, and strip the ends back about an inch. Solder one end of the first wire to pins 12-19, and then connect the other end to the positive terminal of the battery.

The other wire is soldered to pins 30-37 and connected to the negative battery terminal.

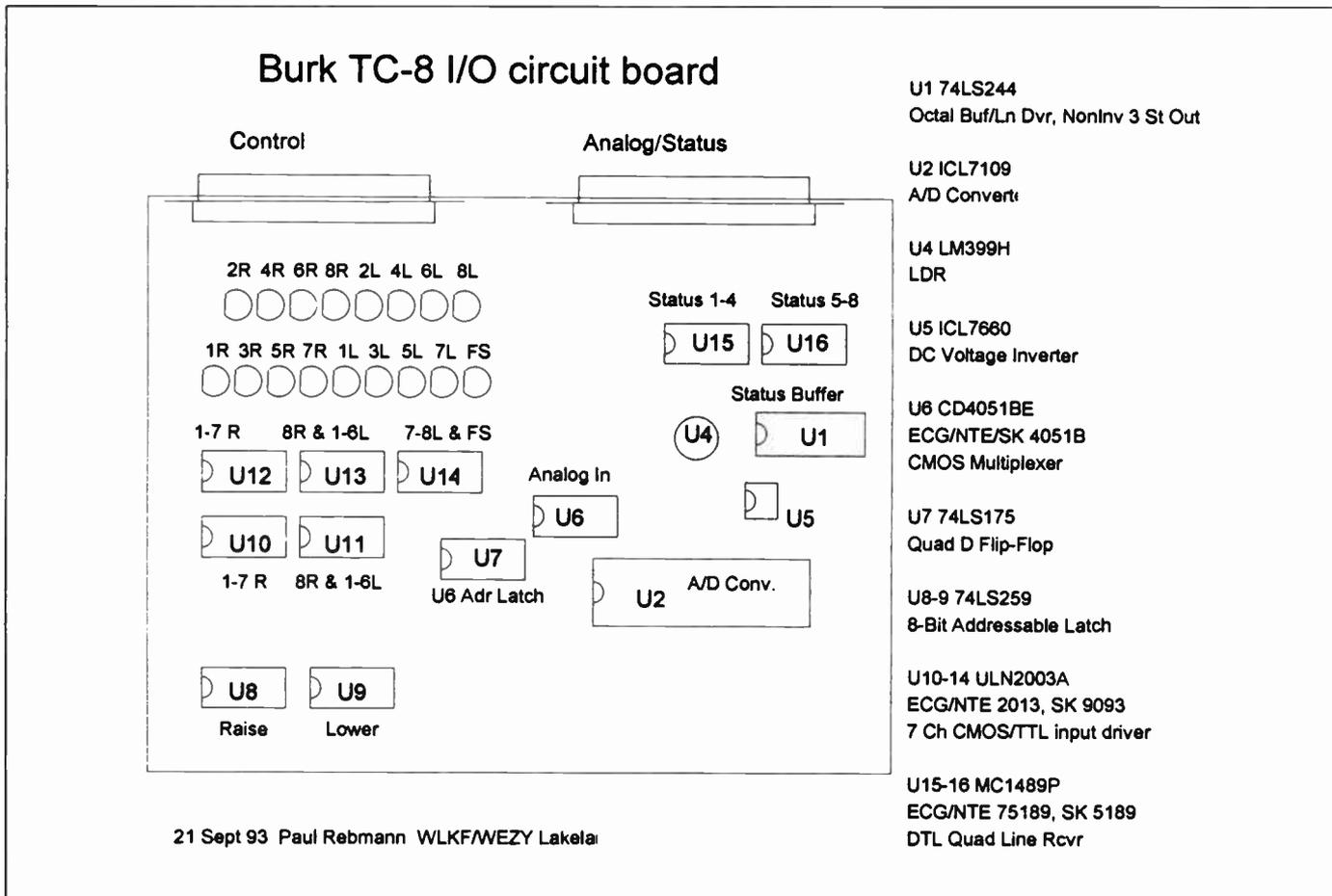
I was then able to use some short pieces of solid telco wire to tie the AA battery holder to the back of the D-connector (mine had those little ears with slots on each end, for the ribbon cable cover to snap into). I used a AA battery because the 1.5 volts is well below the recommended maximum, and, if I have to, I can use the battery from my pager, if there is no other available.

This device is good for double-checking after repairs, and before putting the cover back on the unit and re-installing it back into the rack. Remember, if you have any of the status inputs programmed for inverse operation, be aware that your indications will be reversed.

The basic idea for this particular test device can certainly be adapted for use with other remote control systems, using appropriate connectors and voltages.

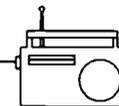
Figure 1 was made up to assist in repairs, as I found the manual lacking a locator diagram for the I/O board. Common IC substitution numbers are also shown.

Figure 1



Impedances and Audio

Gordon S. Carter — Owner, Professional Audio Services, LaGrange, IL & C.E. WFMT, Chicago



Last time we looked at what impedance is. This time we are going to look at some real-world applications of impedance as it relates to audio.

For starters, let's make a distinction between impedance designations for RF and for audio. In RF, if the impedance has a reactive component at the operating frequency (whatever it may be), it is usually written as $R \text{ ohms} \pm j X$, where R is the resistive component and X is the reactance. The $+$ or $-$ sign denotes inductive or capacitive reactance respectively. This is possible because you are really only concerned with one frequency or a narrow band of frequencies around one frequency.

In audio, however, the range of frequencies is much broader, covering at least three decades of frequency. The impedance can change dramatically over this broad a range of frequencies, even going from primarily resistive to primarily reactive.

Fortunately, in a well-designed circuit this variation is minimal over the audio range and can normally be primarily resistive. In those cases where the reactance may be a problem (such as a high-impedance input) it is usually designated as an equivalent resistive-reactive circuit. For instance, an input may be designated as $R \text{ k}$ shunted by $C \text{ pF}$ where R is the resistive component and C is the capacitive component. We will look more at this type of circuit next time.

Why are we concerned with impedance in audio circuits at all? The hi-fi people just connect things together with those funny phone plugs and don't care about impedance. Why do we need to worry about it?

First of all, the hi-fi people don't just connect things together with no thought. Standards have been set up that insure compatibility from one device to another. Again, we will look at that in more detail next time.

Impedance is important for two reasons. One is that careful matching of impedance provides for maximum transfer of power from one device to another. There is some sophisticated math that could be used to prove this, but that is beyond the scope of this discussion. If you want to prove this to yourself, consult some good texts on basic electronics. The other is that proper impedances in a circuit insure optimum transient response of the circuit.

In the "good old days" of tubes and transformers, it was very important to make sure all the impedances were correct. Transformers are essentially a power-operated device. If it were possible to apply a voltage to the primary of a transformer without delivering any current to it (zero-power condition) you would not get any output. The transformer needs power to generate the magnetic field to induce a current into the secondary. The current in the secondary, when

applied to a load, delivers power to the load. Because of this it was essential that the impedance of the tube be matched to the transformer, the transformer to the load, and so on. Any mismatch in this type of circuit would mean that the power delivered to the device had to be dissipated in the device rather than being delivered to the load.

Since the load presented to the secondary of a transformer will affect the reflected impedance of the primary of the transformer, a mismatch is set up between the tube and the transformer. Both the tube and the transformer dissipate more power than they should, but usually the transformer can tolerate more abuse than the tube. That is why it was possible to damage a tube-type power amplifier by not having it connected to a speaker.

Of course, when the whole world was made up of tubes and transformers this was fairly common and the problems were routinely addressed. Impedance matching pads were necessary if two pieces of equipment did not operate at the same impedance. 600 ohms was the standard established by the telephone company and commonly accepted by broadcasting, but it was far from universal.

While it was not any more difficult to connect two pieces of equipment together than with modern equipment, you ran into severe complications when you wanted to feed the output of one device to more than one device downstream. It was even more complicated if you needed to change the configuration frequently. The common way of doing this was with a splitting pad, which is a circuit made up of resistors configured to present the proper impedance to all the devices. Of course the trade-off in this was a loss through the pad, which had to be made up by more gain in the electronics. The more devices hanging on an output the lower the level delivered to each device.

Reference books contained pages of various types of pads and either charts or formulas to calculate the proper resistor values. Of course, you never had the resistor value you really needed (it may not even be a standard value), so the pad you ended up building was never totally accurate unless you had lots of resistors and time.

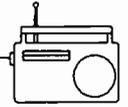
The other way of dealing with this type of problem was to terminate the output of the first device with a resistor of the proper value and then use a bridging pad to match it to the following device(s). This technique gave you a lot of flexibility, since you could move things around as much as you wanted, but the trade-off was a large amount of loss in the bridging pad.

If you were bridging a 600 ohm circuit you would typically use a bridging pad with an input impedance of about 10 K. Of course you had to match this into the next device

(continued on page 5)

Impedances and Audio

(continued from page 4)



which had an input impedance of 600 ohms. The net result was many dB of loss. It didn't take long for you to run out of gain in the system or have so many gain and loss stages that the noise build-up was intolerable.

The other aspect of proper impedance has to do with frequency and transient response of the circuit. If a transformer is not properly loaded it will not perform as expected. Loading of a transformer relates to matching impedances. Again there are a number of good texts on this subject so I won't explain it here.

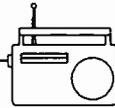
An improperly loaded transformer will not perform as expected. Typically the frequency response will not be flat over the entire range of operation. You can check this with a simple frequency response check. However, a less severe mismatch may not be as easily seen. A quick check of square-wave response may give some more clues. An improperly matched transformer will distort the square wave, most commonly by introducing some ringing. This may cause all sorts of strange sounds in the audio, depending on its severity and location in the system.

While most modern equipment no longer uses tubes and transformers, you may encounter some older equipment and need to know how to match it. A general rule of thumb is that the load on a transformer should match the transformer's impedance. If you no longer have information that tells you what the impedance is, you may need to measure it as explained in George Whitaker's article in the May-94 issue of Radio Guide.

Probably the most common place you will have to match impedances in a modern audio facility is where you interface to equalized phone lines or passive equalizers. These devices depend on the proper load and/or source impedances to work properly. Failure to match impedance will usually result in very poor frequency response. If your lines have a repeat coil on the feed side, you will need to drive them with the proper source impedance (usually 600 ohms). Likewise the passive equalizers commonly used will require a proper load (again usually 600 ohms). Mr. Whitaker's article mentions how to deal with these situations.

Patch Bay Installation

Howard Enstrom — Mt. Dora, Florida



Editor: Howard Enstrom with FM Technology Associates of Mount Dora, FL (A mount in Florida?) has a tip on patch bays that I have personally run into one time before and thought it was the greatest thing since pockets on shirts. He suggests that you ...

Hinge Your Patch Bays

For those who use and maintain audio (or RF) jack panels, you know, the old WE type with normal-through circuits, it's always dark and difficult to inspect and clean contacts if you have to reach in from the back of an equipment cabinet.

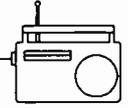
Well, the way to fix the problem is to mount the jack strips on a 19" rack panel. Then, instead of affixing the panel to the rack with 10/32 screws, use a hinge on the side. Leave enough slack in the bundle of cables running down to the "Christmas tree" or punch block so that one may swing the "door" all the way out to provide easy access.

If you need to check or change the normal jumpers you will really appreciate the extra install work. Cleaning is a breeze also.

I've built 18 AM or FM stations, and I wish all of them would have had their studio racks wired this way. Its too late now, because at age 72, all my work is armchair engineering.

Fuse Failures

Gordon Carter — CE, WFMT, Chicago, IL



The next time you have a piece of equipment that doesn't work, and you are sure the problem is a fuse, make sure to check the fuse with an ohmmeter or continuity tester. I have frequently seen fuses that are open that appear to be fine until you check the continuity.

Fuses blow when the current flowing through the fuse creates enough heat in the fuse element to melt it. However, as fuses remain in use for an extended period of time the heat will weaken the element. Eventually it may collapse under its own weight or from a mechanical shock. When it does, it may have no visible signs of a problem since it will often break near the end where the metal caps hide the damage. Also, when they "blow" in this manner they will usually not discolor the inside of the glass.

I recently had a client bring me an audio power amplifier which was not working. The output to the speakers was low and distorted. He had checked his speakers, other amplifiers, and even the fuses inside the amplifier. When he looked at the rear panel fuses (the first thing he did) they looked fine so he assumed they were okay. When I checked them with an ohmmeter it was obvious they were open. A quick replacement and all was well. That was some of the easiest money I ever made, but the client could have saved a lot of trouble had he just checked the fuses for continuity.

Cooking Up a Ground — With Charcoal

J. David Riley — McAllen, Texas



Editor: This next tip arrived within days of my having received a call from a station in Oklahoma, asking if I had any information that could help them establish a better ground at their transmitter site. I was able to put this tip to use immediately. That's what this magazine is all about, and I was quite pleased to be able to forward this to them within a matter of days of their inquiry.

A common problem the world over is trying to get a decent ground in rocky terrain, as we learn from J. David Riley of McAllen, Texas. David tells us how to get ...

Ground Where There Isn't Any

It was around the late 60's that I pondered a problem that came up every time we had to put in an electrical ground system. I worked with Radio Cordac, a religious broadcasting system located in Burundi, just South of the now-famous Rwanda, in Central Africa. Our friendly hardware store in Bujumbura had simple plumbing supplies and tools, but they didn't stock grounding rods. Besides, almost any metal rod was very costly, if you could find one.

My eyes lit up, as a possible solution came to me. Amakara (ah-mah-kah-rah)! This is the indigenous language word for charcoal. It is used widely in the third world for cooking when one could not afford using propane, etc. Charcoal, while not nearly as good a conductor as many metals, is much better than normal soil. Why not have this between the metal conductor and the surrounding earth for a ground contact? It wasn't too much later that we needed a good ground in a place where soil was skimpy, but rocks and lightning were not. For the equivalent of about 15 cents, a local workman dug a hole wide enough for him to dig down to four feet or so, using a regular shovel (no posthole diggers at the friendly hardware store).

I then spread a bed of amakara on the bottom of the hole. Then came a length of cable with the insulation peeled off. I think it was around size #4 A.W.G.. The end of the electrical cable was made into a sort of loop, like the end of a lariat. This loop was laid on the charcoal and more was poured over it. The dirt from the hole was then replaced, leaving a pigtail sticking out of the ground. Although we didn't have a ground rod for resistance comparison, it seemed to work well. As time passed, we thought we noticed a definite taming of lightning problems in the immediate area of our construction.

Later, up in the interior of Haiti in the mid 80's, I used the same approach when a ground was needed, though it was again difficult to assess the advantages, or disadvantages. This time we were working with an AM station of Radio Lumiere that had radial wires in the ground; a part of the quarter wave antenna. These, in themselves, supplied an

excellent ground. A new wrinkle there was that households kept their charcoal in boxes and were more willing to give me the black dust that gathered in the bottom of the box than the real stuff (Hmm ... this might work even better). However, the chance for an A/B comparison would wait until this year.

It was South of Pharr, Texas, only a few miles from the Rio Grande border with Mexico. World Radio Network was to mount a satellite dish on an iron pipe set in cement. When the two-foot diameter hole was dug, I poured two sacks of Mexican mesquite charcoal on the bottom. The pipe was then assured a metallic connection into this black bed before concrete was poured. The system engineers stipulated a ground rod as the electrical connection. No problem — unless you count driving an eight-foot rod, seven-and-one-half feet into reluctant soil. This ground rod went into the ground some 30 inches from the dish post.

About ten feet from either of these was a metal stake, sticking out of the ground, supporting a PVC water pipe. I cleaned off the rust on one side with a file and connected it to a length of electrical wire, thanks to a vise-grip.

The ohmmeter read 12 ohms between the dish mast and the metal stake, with no other ground connected except the concrete and the charcoal at the bottom of the hole. The resistance between the metal stake and the ground rod was 30 ohms. Of course, some of the resistance in both tests would be common to both readings—the resistance of the grounding of the metal stake itself! Need I say more?

MRC-1 Remote Fix

Gordon Carter — CE, WFMT, Chicago, IL



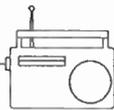
The MRC-1 is two microprocessors “talking” to each other. The data is conveyed in “packets” that ACK back and forth. The transmitter unit is connected to the transmitter fail-safe interlocks on both transmitters. I was having trouble with both transmitters going off the air, and then popping back on.

Listening to the data leaving for the transmitter and returning, indicated the problem was in the MRC-1. It was not sending the packets to the transmitter. The remote unit was responding every time the studio unit polled it. The source of the problem turned out to be R-26, a 1 K resistor, on the CPU board at the studio. It was burned up and fell in two pieces when removed. I replaced it with two, 2 K resistors in parallel.

It has had no problems since. I also plan on replacing the same resistor on the transmitter CPU board.

Use a Scanner for SCPC

George Whitaker — Editor



Last month we looked at using a communications receiver as an emergency subcarrier receiver. Now we want to look at using a scanner in place of an SCPC receiver.

You still have to have some kind of satellite receiver to do the basic transponder tuning. Again, a high quality "home type" receiver will fill the need. However, the procedure for getting the signal to the scanner is a little more complex than with the subcarriers. This is due to the fact that we need to get access to the signal coming from the LNB and, at the same time, keep the LNB power supply isolated.

The fact that you need a splitter with a power pass means you need to plan ahead and acquire one of these before the emergency happens. What you need is a 950 to 1450 mHz splitter that will pass power to one port and block power to the other port. Any satellite supply will have these, but remember that nothing ever quits on Monday morning.

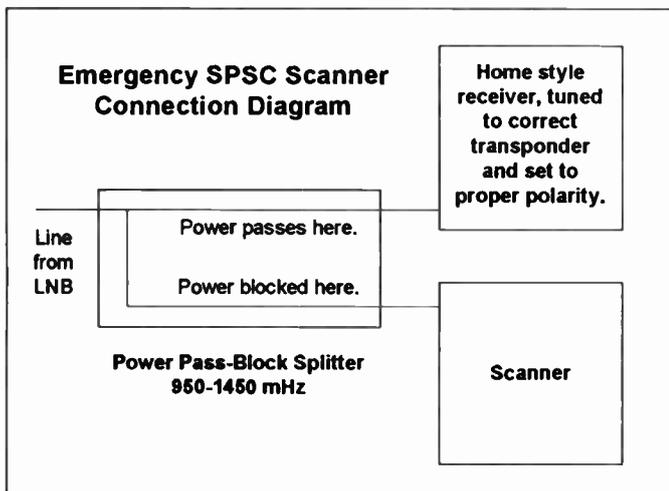
Take a look at Figure 1, and it will show you how to make the hook-up.

The scanner needs to have FM with wide and narrow bandwidth. Set the satellite receiver to the correct transponder and polarity. Then you will find the SCPC channels in groups between 950 and 1450. There will be space in between the different groups. If you know the SCPC frequency of the channel you are after, you can convert to IF and set the scanner to the proper frequency. Remember that you are tuning the IF of the frequency in question.

You may find that the scanner will need to be tuned slightly up or down from the calculated IF because of the drift in the LNB. Also, over a day's time you may have to retune the scanner because many LNB's have considerable frequency drift with temperature.

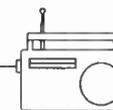
The methods described here should, at the very least, keep you going.

Figure 1



Harris HT-10 Noise

Glenn Finney — Macon, Georgia



Editor: I have always said that radio stuff can be weird. Sometimes the simplest, unsuspected, thing can cause misery. Glen Finney with the Good News Network of Macon, Georgia found this to be the case in ...

Solving an HT-10 AM Noise Mystery

For over a year now, I have been experiencing extremely poor AM noise performance on a three year old Harris HT-10 FM transmitter. Even after rebuilding the bias and screen supplies, and replacing all electrolytic capacitors in the unit, I was still unable to obtain an AM noise level (unmodulated) better than about -35 dB. The resulting signal quality and clarity of the audio was very noticeable. To make matters worse, the problem seemed somewhat intermittent.

After all attempts at finding the problem, the decision was made to call in Harris Field Service. The field engineer spent about 10 hours on-site eliminating all obvious possible causes, and insuring that the transmitter was back into factory specifications. A new tube was installed and still, no better performance.

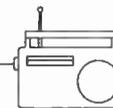
The next morning, the culprit was found. The "Hum Null" potentiometer was causing the problem! It seems that the 1K wire-wound pot had just too little adjustment resolution. We replaced the pot with the same size, but a different design, retuned and got a noise figure of better than -60 dB.

Harris has since replaced this potentiometer on all new models, but has not issued a service bulletin to our knowledge. The HT-3.5, HT-5, and HT-7 transmitters use the same design, by the way. If you are having a similar problem, this might prove to be an easy and inexpensive solution. The original pot was a 1K Allen-Bradley wire-wound, and the replacement pot we used was a 1K ceramic Ohmite.

Many thanks go to Rich Johnson of Harris Field Service for his patience and diligence with this annoying problem.

Fostex TT-15 Tip

George Whitaker — Editor



I love my little Fostex TT-15 oscillator. However, the battery always seemed to be run down every time I pulled it out of my tool box. Somehow, something always seemed to bump the "on" button and there would go the battery.

I cut two pieces of plastic, 2"x 4-1/4" and, using double face tape, fastened one to each side of the unit with 1/2 inch sticking up above the switches. This made a switch guard that has kept it from being accidentally being turned on while rattling around in my tool box.

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Transmitter Parts

RCA - Gates - Collins/Continental



Mica Transmitting Capacitors: Sangamo, CD, Sprague, Aerovox, Acushnet types: CM-15, CM-20, CM-25, CM-30, HT, HK, AT, AK, F1, F2, F3, 30B, E, 1998, 291, 292, 293, 294 & G5.

Fixed and Variable Vacuum Capacitors: Jennings, Doinko & Wilkins, Mounting brackets and flanges. Vacuum relays.

Oil Filled Filter Capacitors: Plastic Capacitor Corp., 600 to 40 kV, 1 mFd to 30 mFd with special mounting brackets. Non-PCB oil capacitor replacements are available for most transmitters.

Ceramic RF Capacitors: Centralab, Jennings, Sprague, High Energy, 5 kV to 40 kV.

Variable Transmitting Capacitors: E.F. Johnson Co., Cardwell Condenser Co., insulated shaft couplings as used in phasers, variable transmitting capacitors.

Weschler-Westinghouse: RF ammeters, 0-0.5 amps through 0-50 amps, internal and external thermocouples, expanded and linear or square-law scales. Sizes are 3 & 4 inch, round and square. Special meters are available.

RCA: Transmitter, phaser and antenna tuning unit parts.

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- Tower Maintenance and Painting
- New and Used, RF and Studio Equipment
- Antennas, Transmission Line, STL
- FCC Engineering Work
- Field Readings for AM Stations
- AM Ground System Work

FCC Rules on Kahn POWER-side

Motorola tried to deny broadcasters the right to increase coverage by using SSB — Kahn POWER-side™ equipment. But the FCC specifically ruled that the "Kahn POWER-side system ... may continue to be operated ..." as a monoimprovement system. So you can now use POWER-side with Kahn independent sideband exciters to immediately increase coverage to listeners using any and all type of AM receivers.

See FCC Order ⇨

Federal Communications Commission FCC 93-485

21. Kahn "POWER-side" Operation. Several parties express concern over the continued acceptability under our rules of operating using the Kahn POWER-side AM single-sideband system. POWER-side operation, as distinct from Kahn stereo operation, involves an AM transmitter with two independent sidebands, containing identical program material, but with intentional level and frequency response differences. This system is implemented with a Kahn independent sideband stereo exciter and is claimed to have certain advantages for reception with monophonic receivers, particularly in adjacent-channel interference situations. CTI and Furr argue that adoption of the proposed standard would prohibit such an implementation. Motorola maintains that the Kahn POWER-side mode of operation is not stereophonic and questions its legality under the present rules.

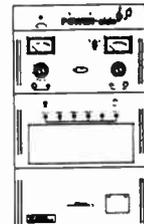
22. Our AM rules do not include a definition of the term "stereophonic." However, generally accepted definitions of stereo service infer two or more channels of audio information designed to produce an audio "image" when demodulated by an appropriate receiver. On this basis, we find that stations employing the Kahn POWER-side system are not subject to the provisions of the stereophonic transmitting standard adopted herein and may continue to be operated, provided that the program material fed to both channels of the exciter is identical in content.

POWER-side™

PROBLEMS

Adjacent Channel Interference
Antenna Null Distortion
Co-Channel Interference
Power Line Rf-Radiation
Building Rf-Radiation
Receiver Tuning
Low Fidelity Home Radios
Co-Channel Beat
Selective Fading

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