# Radio and Electronics Restoration–
# AM and FM –
# AC and AC/DC -
# Basic and Modern Fixes

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In summarizing what will be discussed here, this is a rough outline:

1. Radio circuit safety and operation
2. Authenticity and component substitution
3. Alignment Order of Battle
4. Powering Up the Restored Radio/Electronics
5. Test/Restoration Equipment Options

SAFETY in circuit restoration

- AC/DC radios and phonographs
- The GFCI Issue and Radio Chasses

Several restorers have written that the safe way to modify AC/DC hot chassis radios is to use a two-wire cord and be sure the wide plug blade is **tied to chassis in the radio, and the radio's ON-OFF switch is moved to the "hot" power wire** rather than leave this switch connecting one input wire to chassis.

Implied here is the idea that workingness trumps original configuration. This is a valid option in radio restoration. * It was the most popular option in the days of radio repair shops, and today, for some collectors.

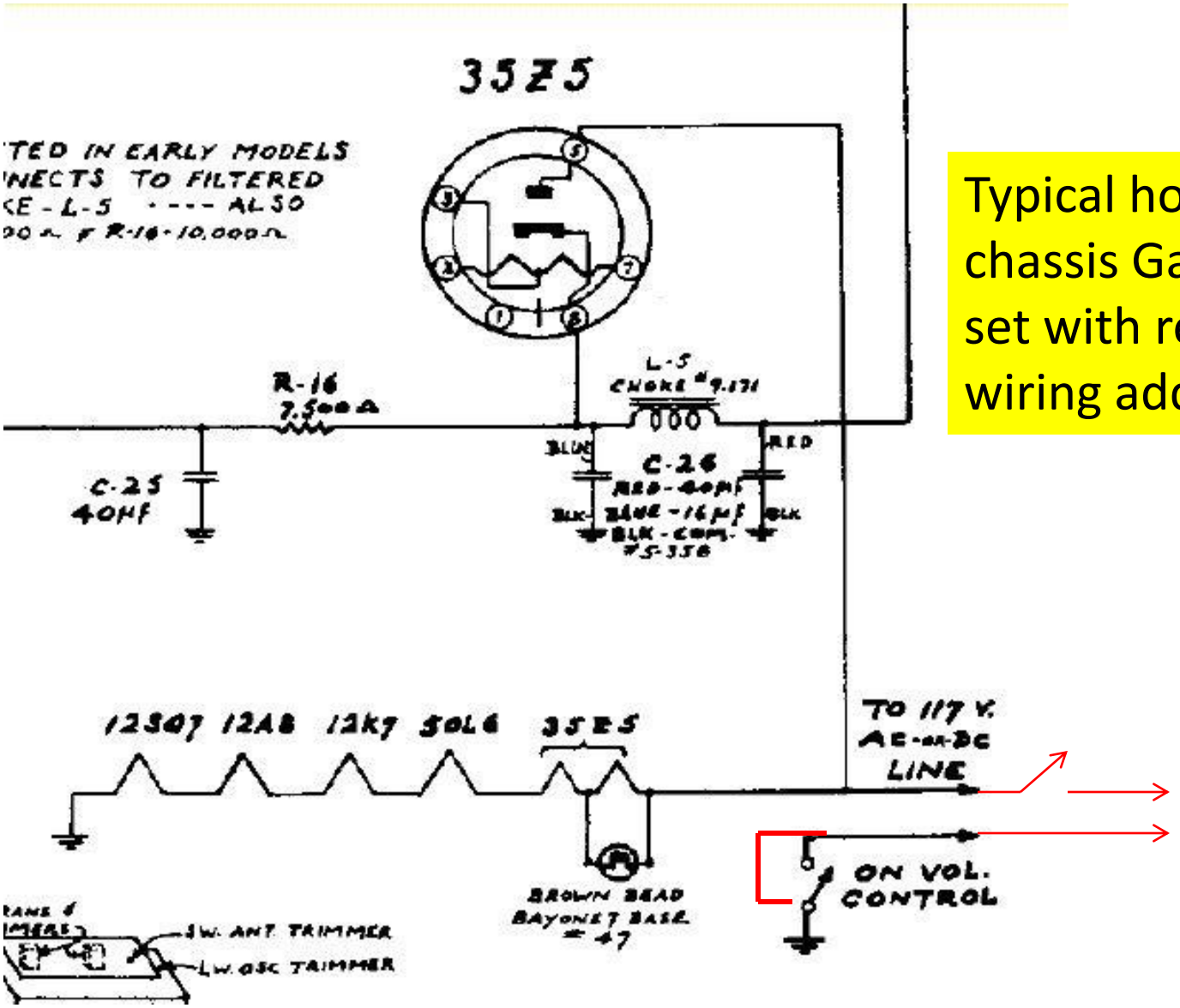
Unfortunately it runs counter to the NEC – The National Electric Code, which prohibits connection of the neutral conductor to the framework of a portable device (the radio).

* A different option might be to restore to originality, whether or not allowing workingness.

And, as a result, it causes GFCI breakers to trip, if the radio is plugged into one of them, and anything even slightly grounded touches the radio chassis.

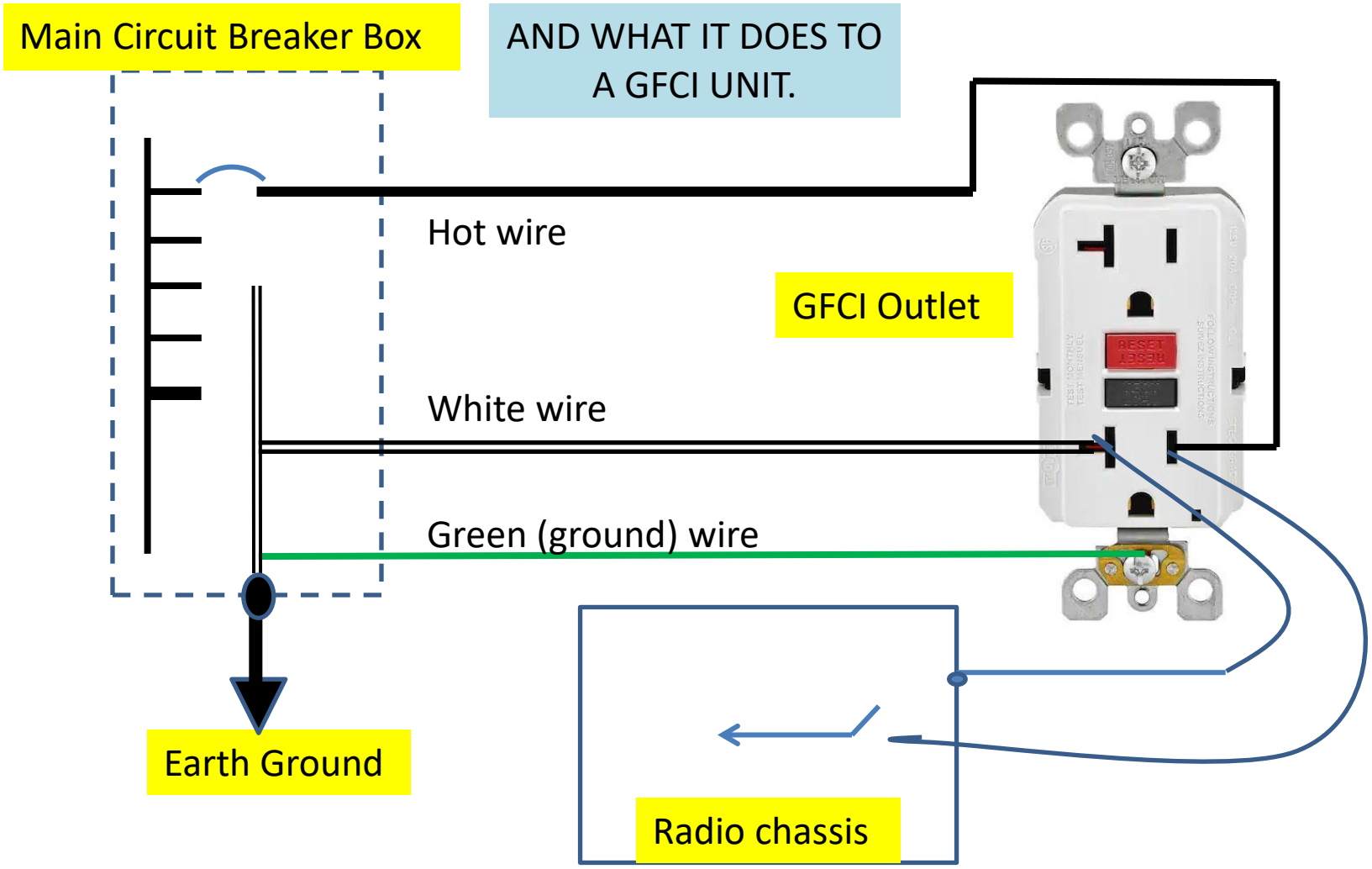
For a portable power strip which has GFCI-equipped outlets, it would be a slight nuisance. But if the whole household circuit had been equipped with a central GFCI breaker in the Main Circuit Box, it might shut down several outlets in the home, and could ruin someone's TV evening – or quilting pattern.

The MAARC restorer who suggested that "safe" way rewired the hot-chassis radio, by moving the radio's on-off switch to the powerline "hot" blade, and chassis-connect the neutral wire.

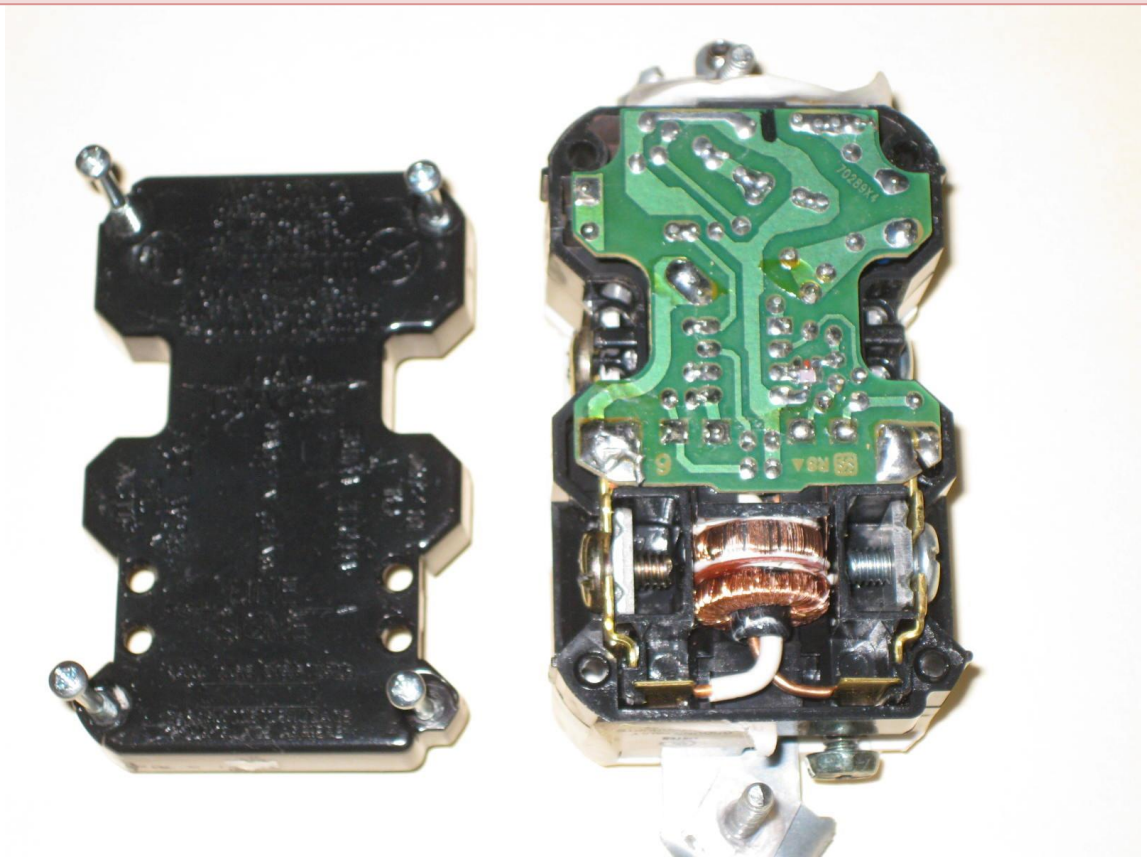



Typical hot-chassis Garod set with red wiring added.

# Here's that "Safe" power wiring for a Hot-chassis set.



Here's what's inside a GFCI duplex outlet. Note the toroids wound with a many-turn secondary winding, and two pass-thru wires (one-turn each), one carrying the hot-wire to its output terminal, the other carrying the neutral-wire to its terminal. If their currents are not identical and opposing, the electronics will trip the circuit-breaker under the PC board.

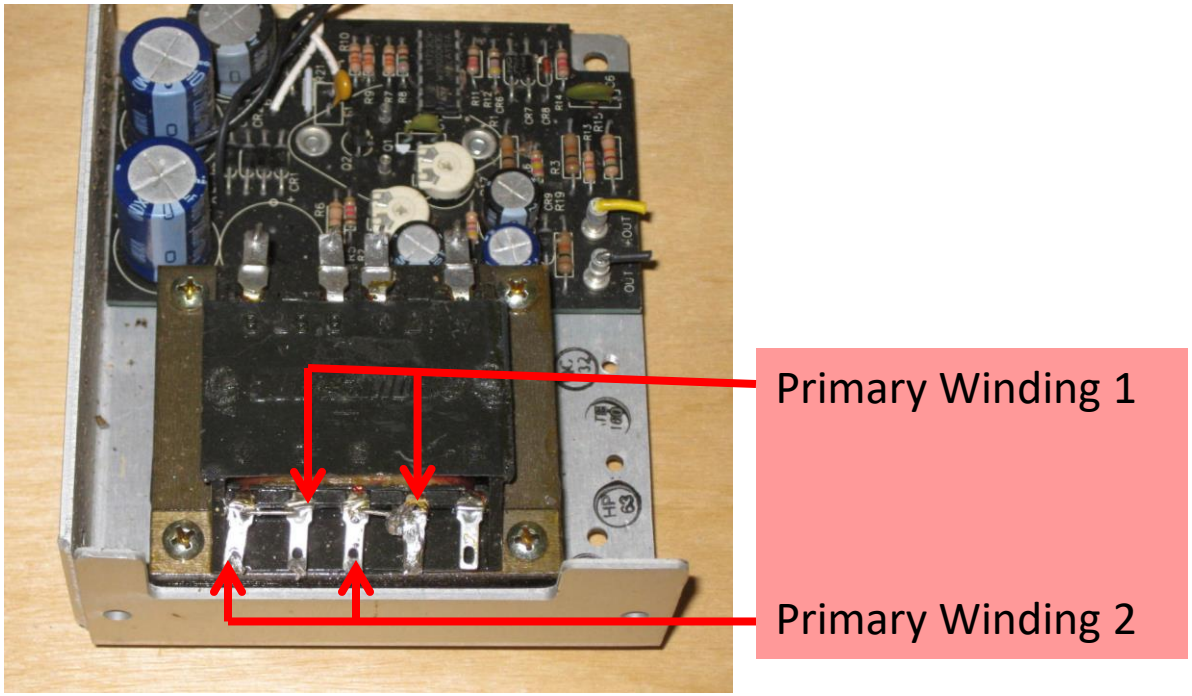


AND, while on that subject, here are two more tips:

1. When you mount your new isolation transformer in its cabinet, use a single outlet, never a DUPLEX.

2. The standard VARIAC does not isolate its input from its output, You still need an isolation transformer.

If you're thinking of making up a power supply for a vintage battery-operated set (think Leutz, Freshman, Lacault, Eisemann, or such), a hefty already-made 5- (or 6-) volt linear regulated supply can be had for a few dollars, and if it is more than thrice the capacity that is needed, it can also supply the B-voltage and C-voltage needs of the battery set.  This is done by splitting the parallel-connected primary transformer windings, using one as the new primary and the other as an isolated secondary.



Of course, if that old battery set is a Leutz C, and if you're a pure collector, it will be outfitted with 201s and not 01-As. So you're a supply will have to be rated at something like 5 or 6 volts at 8 or more amps.

My philosophy here is to have a full set of 201s or 301s boxed and placed behind the set, while there are 01-As inside in the sockets, so you can fire it up for occasional demonstration.

And here are a few tips on the home-brew power supply you make for those battery sets:

1. Use a series solid-state regulator (Like type LM317T) for the 125-volt “B” supply, but:
   - Be sure there is a slight load on it at all times, probably about 5-8 milliamps (15K-27K ohms)
   - Rather than use more LM317Ts for the lower “B” voltages needed, you can step down from the 125-volt in stages with power-type zener diodes of from 15 to 30 volts each, 5-watt rated.
   - Always put a high-voltage diode (1N4006 or 1N4007) across the LM317T, polarized to conduct from output to input of the LM317T.

For ”A” voltage generation, there are options:  You can use a 5  or 6-volt linear regulator itself, which produces very clean 5 or 6 volts at from 2 to 6 amps, depending on the size of the regulator.  This will work well with that 3-dialer.

However, if you do not need 5 or 6 volts, but , say, 2 volts or less, you can still use a 5-volt linear regulator, and then step it’s output down with a power Zener diode (they make 3.3-volt zeners).

Or, for the low “A” voltages needed, such as 1.5 to 3 volts, for that mid-30s battery set, the LM317 regulator can do it.

2.  And, if you need a shunt regulator for “A” voltages, use a short string of 1N4006s connected forward (conducting). Experiment as to how many are needed (probably 2 to 5, depending on how high an “A” voltage you need. Each drops about 0.7 V.

The power supply for this Chinese military radio was required to produce two “B” voltages and an “A” voltage of 1.5 volts. The series regulator could be set to produce a minimum of 3.2 volts, so the extra 1.7 volts was taken up by 3 1N4005 diodes in series.

We seem to have been stuck on power and power supply issues today. Well, that's how it goes, some days.

One of the club's restorers asked about those selenium rectifiers that were popular in the late 1930s and 1940s. If they still rectify, why replace them? What to replace them with?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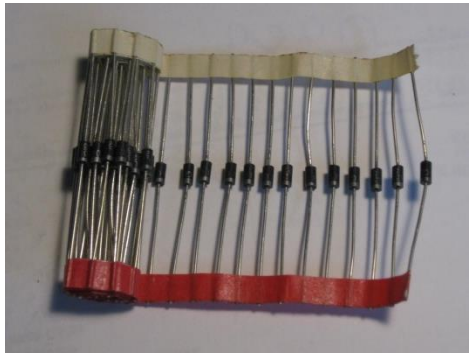

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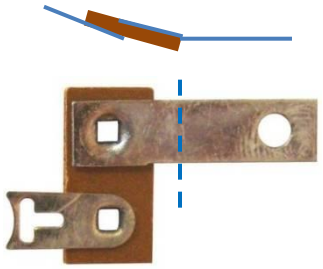
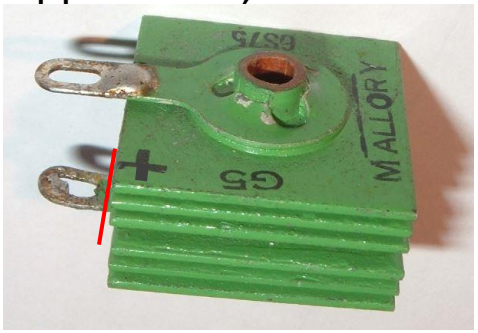
Short answer is: always replace them, if the radio is going to be played.

Reason is that they develop a significant resistance, and will heat up (and simultaneously reduce their useful output voltage) and become leaky in the reverse direction as well.

If it is important to try to preserve the appearance, we have a suggestion:






They can be replaced by a 1N4007 silicon rectifier, wired with its anode tied to a cleverly-disguised lower tab (see above sketch) made up of a single-point terminal strip, and its cathode to the top (+) terminal of the selenium unit. Cut off the lower selenium terminal tab and wire to the new terminal strip. The output voltage will be about 6 volts higher than with the selenium unit when it was brand new.

Just had a message request for information on rubber-tired parts for a Zenith tuner, and on feasibility of making a fancy escutcheon for a radio.

Some of the phonograph restorer sites on the web handle those rubber-tire-equipped idlers and drive wheels/rollers.

And here is a 3-D printed version of a radio escutcheon someone made, along with its heat-warped original.

But back to the basic plan:  Is there a set method for receiver alignment?

Answer is that it depends on the type of radio, but if it's a superhet, the best approach is:

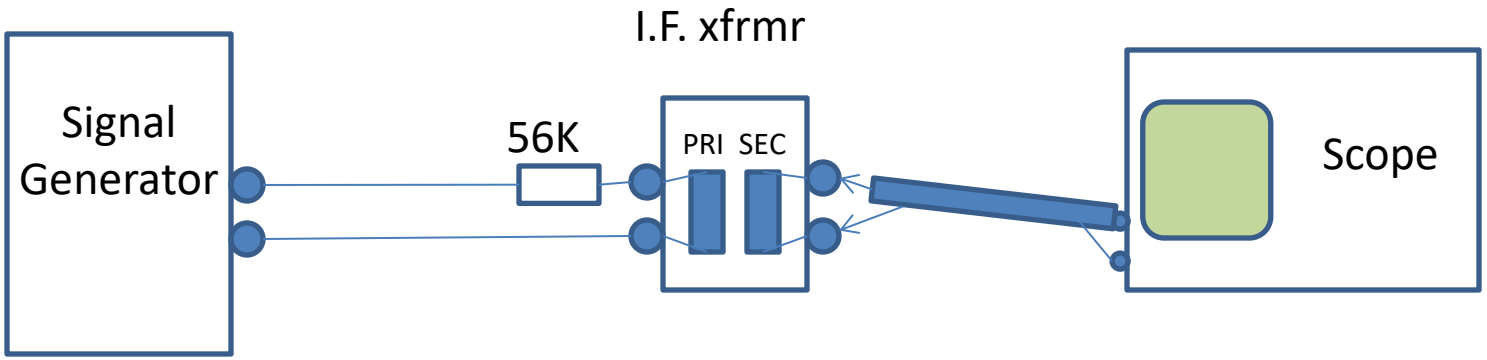
1. Get the IF aligned on its proper frequency
2. Then get the low end of the RF span approximately tuned, say, for AM, at 600 kHz.  Do this tuning by adjusting the osc. coil, if adjustable, and/or the padding capacitor
3. Then get the high end tuned , say, at 1500 kHz, by adjusting the oscillator variable cap's trimmer only.
4. After repeating steps 2 and 3 to be sure both ends tune at their proper dial settings, then go back and make adjustments to the RF (antenna coil and/or trimmers) for best sensitivity at both ends of the dial.

Such re-tuning of the front end of the radio should be required mainly when some critical component up front has been changed or renewed. Routine restoration should require simple touch-up of those adjustments.

Alignment when the radio has had many RF and/or IF components restored or replaced is another story, and generally begins with pre-adjustment of IF and RF transformers before installation. These are easy to pre-adjust on the bench, but you must realize that installation and wiring always adds capacitance and lead inductance, to say nothing of incidental coupling of one circuit to another.

But pre-adjustment of coils, trim and pad capacitors, and IF transformers before they are installed always makes the later tune-up simpler and faster.

In pre-checking the settings of an IF can, for example, feed the generator signal via a resistor of about 56K-68K resistance to simulate the plate resistance of the radio's tube that drives the IF transformer.



Finally, should the AVC be disabled during the alignment process?

Many technicians say yes, because the AVC action dilutes the output response to any and all changes in output, whether from natural signal fading or changes in signal path losses, inside or outside the receiver.

I think the alignment should be done with AVC off (Shorted to its no-signal “remote” bias level, probably about -2 volts), but checked with the AVC operating, as well.

A good digital scope might work well enough for you, but they are programmed to think out what you need to know about the voltage to which you have touched the probe, and they adjust the display to show that.

My OWON SDS 1202, ($250) , for example, persists in changing the sweep speed I have selected and, if I try too many times, it reverts to Chinese writing on the screen instead of my chosen English.

# Instrumenting the bench:

Restoration of the electronics portion of the collectable, whether radio or audio or TV is facilitated by having the right instruments and tools:

1. Instruments recommended:

- Portable solid-state multimeter
- RF Signal Generator (making sine waves)
- AF signal generator (especially if you do audio)
- VTVM or FETVM (measures WRT chassis/B-)
- Tube tester
- Oscilloscope (especially to find intermittents, spurious oscillation or bursts, etc.)
- Isolation Transformer and Variac.

But, then, what kinds of these instruments are best?

Well, this is only a suggestion, based on e-mail complaints and messages requesting help in restoration problems.

Multimeter: Fluke is best brand, but cheaper ones also stand out, like Ideal, Klein, etc., but try for 3 samples/sec speed.

RF/AF Sig. Gens.: HP , or those with good sine wave output.

VTVM: Absolute best is military TS-505/U or HP 410, but Heathkit models are universally good.

Tube Tester: Hickok best circuit, often copied by others.

'Scope: Tektronix 422 or BK-Precision 2160, both are analog. A digital 'scope might work for you, but many are too set in their decisions as to what you want to know, and they don't want you to think it out.

Of course, there are many other instruments that can be of great benefit in the restoration of electronics – whether radio, audio, or TV. Some of these are worth mentioning:

- Lab power supplies
  - Low voltage (0 to perhaps 30 volts, at ~3 or 4 Amps)
  - Mixed Voltage (0-300 V at 100 mA and 6.3 Vac and 0-minus 100 volts for bias)
- Electronic counter (optional)
- Transistor tester/classifier
- Specialized TV instruments (for those classic old sets)
- Signal and noise analyzer (mainly for audio work)
- Reactance slide rule (sponsored by Shure, Ohmite, Allied Radio, etc.)

Questions??