

The Real McCoy
80 Meter SSB Transmitter
Homebrewed by KG7TR

Technical Description



Built by Mike Bohn, KG7TR

February, 2020

1.0 Introduction

“The Real McCoy” shown on the cover page is a vacuum tube, single sideband (SSB) transmitter that was homebrewed by KG7TR. The radio operates lower sideband (LSB) only, at any frequency from 3.5 to 4.0 MHz, with nominal 100 watts peak envelope power (PEP) output. I built this radio primarily for use on the west coast Vintage SSB Roundtable that meets Tuesday nights on 3.895 MHz. Its design and construction meet all of the vintage criteria for use on that net.

Construction of the radio was prompted by acquisition of a McCoy 9.0 MHz crystal filter and matching carrier crystals from NU6X. This was a new-in-the-box (NIB) kit, as seen in Figure 1. The filter inside was the premium “Golden Guardian” model, manufactured sometime in the 1960s by McCoy Electronics in Mt. Holly Springs, PA. Its specified 6 dB bandwidth of 2.7 KHz is printed on the filter itself. What looks like a QST ad for McCoy filters was inside the box. It was scanned and is shown in Figure 2.



Figure 1 –McCoy Filter Kit

In 1952 Lew McCoy, W1ICP (SK in 2000), founded the company that bears his name. The McCoy product line spanned several decades, and consisted of quartz crystals, quartz crystal filters, crystal ovens, and other frequency controlling devices. Lew McCoy was also one of the pioneers of amateur radio. He authored many articles in QST and CQ magazines, and was known for explaining technical subjects in practical terms for his readers. I had the pleasure of meeting Lew at the Ft. Tuthill hamfest in Flagstaff in the early 1990s. So like it says on the box, and as a tribute to Lew and his many contributions to the hobby, I decided to name this radio “The Real McCoy”.

As a way to try something unique and different, I packaged the radio into a repurposed cabinet and chassis from a parted-out Tektronix 465B oscilloscope. Construction was a real challenge, particularly in the areas of parts layout tradeoffs, thermal management, and shielding. One of my goals was to achieve a symmetrical and pleasing arrangement of front panel controls. Another was to include a built-in power supply, which was made possible by use of a modern toroid power transformer that just fits at the rear of the chassis. The completed radio weighs in at 24 lbs.

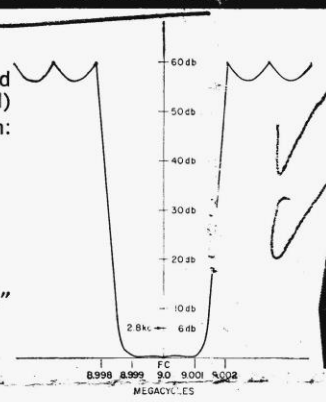
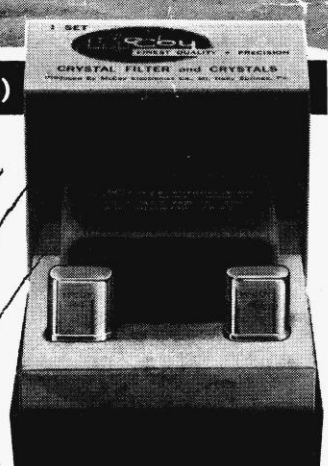
Now!

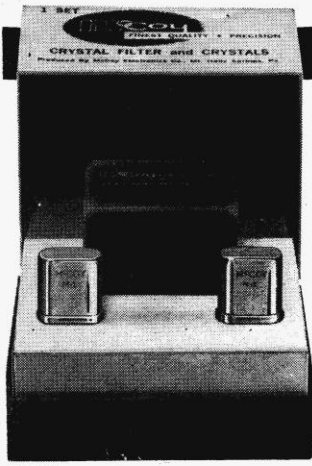
for discriminating amateurs
who are satisfied
with nothing less than *THE VERY BEST*

mccoy SINGLE SIDE BAND FILTERS

The GOLDEN GUARDIAN (48B1)

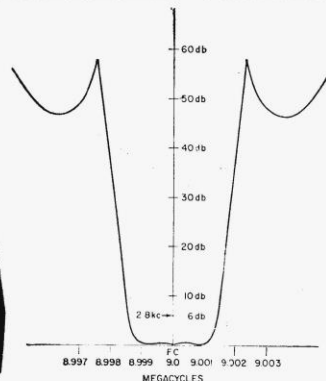
TECHNICAL DATA
 Impedance: 640 Ohms in and out (unbalanced to ground)
 Unwanted Side Band Rejection: Greater than 55db
 Passband Ripple: $\pm .5$ db
 Shape factor: 6 to 20db 1.15 to 1
 Shape factor: 6 to 50db 1.44 to 1
 Package Size: $2\frac{7}{16}$ " x $1\frac{1}{32}$ " x 1"
 Price: \$42.95 Each



The SILVER SENTINEL (32B1)

TECHNICAL DATA
 Impedance: 560 Ohms in and out
 Unwanted Side Band Rejection: Greater than 40db
 Passband Ripple: $\pm .5$ db
 Shape factor: 6 to 20db 1.21 to 1
 Shape factor: 6 to 50db 1.56 to 1
 Package Size: $1\frac{3}{4}$ " x $1\frac{1}{4}$ " x 1"
 Price: \$32.95 Each



Both the Golden Guardian and the Silver Sentinel contain a precision McCoy filter and two of the famous M-1 McCoy Oscillator crystals. By switching crystals either upper or lower side band operation may be selected. Balanced modulator circuit will be supplied upon request.

Both sets are available through leading distributors. To obtain the name of the distributor nearest you or for additional specific information, write:

mccoy

SUBSIDIARY OF OAK MANUFACTURING CO

ELECTRONICS CO.
 Dept. Q-7
 MT. HOLLY SPRINGS, PA.
 Phone: HUnter 6-3411

Figure 2 – Ad for McCoy Filters (from QST?)

Locating all tubes in the center of the chassis allows easy access to point to point wiring, and provides optimal cooling via a small fan mounted on the rear panel. With this arrangement, cooling air is drawn in through the original vent holes at the sides and bottom of the cabinet front, flows down the center of the U-shaped chassis frame over the tubes, and is exhausted at the rear by the fan. The power amplifier (PA) tubes are directly in front of the fan, where they see maximum airflow. The variable frequency oscillator (VFO) tube and associated components are at the very front of the radio, where they pick up the least amount of heat from other tubes and components.

The VFO is a stable Colpitts circuit I have employed many times in my other homebrew radios. It covers the classic range of 5.0 to 5.5 MHz, and uses vintage components from WWII ARC-5 transmitters. The VFO output is mixed with the 9.0 MHz SSB intermediate frequency (IF) to produce the desired 80/75 meter output. A large six digit LED counter/display module shows the transmitter frequency to a nominal accuracy of ± 10 Hz.

The PA uses a pair of 6883s, which are identical to 6146s with the exception of 12.6 volt heaters. These tubes are generally less expensive than 6146s.

The radio incorporates a number of features to optimize performance and functionality, including:

- Push To Talk (PTT) switching at microphone connector
- Built-in antenna relay
- Relay switching for linear amplifier and receiver muting
- Automatic Level Control (ALC)
- Provision for linear amplifier ALC input
- Metering of PA plate current and ALC action
- Frequency spotting switch and advisory LED
- Built-in tone oscillator for tune up
- Original Tektronix multi-position handle and new cord-wrap feet

Overall performance is comparable to most commercial vacuum tube SSB transmitters built during the 1960s and early 1970s.

2.0 Physical Layout

Just like the original Tektronix scope, the carrying handle can be positioned to prop up the front of the radio or moved out of the way as desired. To do this, the radio can be set vertically on its cord wrap feet at the rear, and the sides of the handle pushed in to allow rotation and locking to any of several positions.

New front and rear panels were fabricated from blank .062" aluminum sheet. The front panel controls and switches are shown in Figure 3. The front panel microphone connector is a standard four pin configuration used on some vintage SSB radios (e.g., Drake TR-5 and TR-7, Galaxy V), and is shown in Figure 4.



Figure 3 – Front Panel Controls and Switches

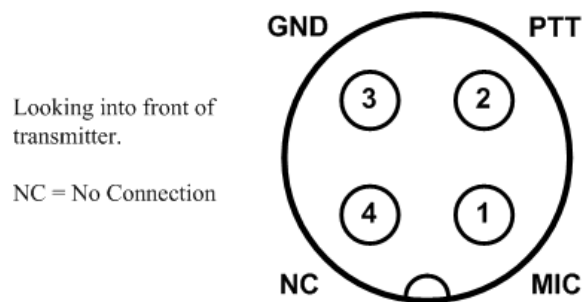


Figure 4 – Front Panel Microphone Connector

The station interconnects on the rear panel are shown in Figure 5. SO-239 jacks are provided for RF output and receiver antenna coax cables. RCA jacks are used for linear amplifier ALC, linear amplifier transmit/receive (T/R) switching, and receiver muting.

The linear ALC jack accepts a negative going voltage to reduce transmitter output. When properly implemented, the linear ALC voltage will control the transmitter output.

The muting line is grounded in receive and opened in transmit. The receiver is normally placed in standby mode for T/R switching to occur. The linear T/R relay line is grounded in transmit and opened on receive. These two lines share the same relay contact set since the grounded states are mutually exclusive.

The compression trimmer above the coax connectors allows coarse adjustment of the PA loading capacitance. The two potentiometers on the upper left are used to zero the meter in the ALC position and set the idle PA plate current.



Figure 5 – Rear Panel Connections

Figures 6 through 9 show the locations of major components on the three sides of the U-shaped chassis. Reference designators point out components identified on the schematics shown in Figure 11. Visible in all the photos is a groove around the perimeter of the front die cast frame. There is a similar groove in the original plastic frame that fits over the rear of the chassis when the cabinet is installed. These grooves contain embedded electromagnetic interference (EMI) gaskets that ground the cabinet to the chassis at the front and rear, just as in the original scope.

Looking at the top of the radio in Figure 6, the display mixer U1 and associated circuitry is assembled on a prototype circuit board mounted to the front panel directly behind the display module.

VFO components V6, L8 and C9 are mounted at the right front of the chassis. V6 is not shielded to provide better heat dissipation. C9 was mounted vertically to provide the best position of the main tuning knob. Because of space constraints, it was not practical to shield L8. As a result, this coil is very sensitive to metal objects moving in proximity to it or not securely grounded. These can cause changes in frequency. It was found that the very thin metal used in the Tektronix cabinet would flex when pressed at the top and cause frequency shifts. So a shield is mounted across the top of the chassis to isolate the cabinet from VFO circuitry. There is a second shield mounted over the PA compartment. Both are made from .062" perforated aluminum sheet, and have been removed for the Figure 5 photo. When in place, these shields complete a box structure for the U-shaped chassis, thereby increasing structural and torsional rigidity. Other modifications to improve mechanical and electrical stability involved changing to a fiberglass shaft for the main frequency control, adding a spring loaded wiper contact on C9's input shaft to ensure a stable ground at this point, and applying conductive silver grease to all rotating surfaces.

A black heat dissipating shield is used on V7. A piece of perforated sheet was mounted to the bottom of the PA compartment over the two large oval holes in the original chassis. This provided a ventilated surface to mount the sockets for PA tubes V9

and V10. A vertical piece of perforated sheet in front of V9 completes the PA compartment and separates it from the low level circuits. The cooling fan is a 3.25 inch, 12 VDC unit mounted to the rear panel over the hole that originally housed the scope's CRT socket. This hole had to be enlarged to fit the fan properly.

Figure 7 shows the underside of the horizontal chassis section. White Teflon wire was used throughout, and was zip-tied into bundles after construction was completed. Standoffs provide tie points for most circuit components and wiring. Toroid coils and associated ceramic trimmers are mounted to small pieces of fiberglass board, which are in turn mounted to the chassis on aluminum standoffs. A helical cut flexible coupling is used to connect the main tuning shaft to C9. Millen flexible couplings are used for the fiberglass shaft extensions on C8, C9 and C11 that come out of the front panel.

The high and low B+ rectifier diodes, filter capacitors and bleeder resistors are mounted inside the compartment that originally housed the scope's high voltage power supply. A shield (removed for the photo) is mounted over this compartment to prevent accidental contact with the high voltages inside. At the rear of the chassis are the +12 VDC rectifier, filter capacitor and U2 voltage regulator.

There are two small parts modules mounted to the chassis bottom that were repurposed from scrapped ARC-5 receivers. The one next to V3 contains the phase shift circuit for the tone oscillator. The module between V9 and V10 contains the ALC circuitry.

Turning to Figure 8, C9 is securely mounted to the right side panel of the chassis. A piece of .062" perforated sheet is mounted under C9 to further strengthen the installation. The rear section of C8 is thoroughly shielded to prevent coupling between V7 grid and plate circuits. This view also clearly shows how toroid power transformer T1 just fits into the radio.

In Figure 9, it can be seen that T2 is mounted to the front panel frame. This is a typical example of how several components had to be mounted wherever there was space to do so. The 9 MHz carrier oscillator and balanced modulator circuits are in the lower right section of this picture. These circuits are shielded with pieces of .062" perforated sheet. There are access holes in the left side of the cabinet (visible on the cover page photo) to allow adjustment of C1, C2 and C3 with the cabinet installed. The edges of the two shields over the top of the chassis frame described earlier can be seen in this picture. Carrier balance pot R5 is mounted away from the chassis on a bracket so that its shaft can be extended and brought out the front panel. The shaft and couplings were repurposed from the original scope.

The rear section of the left side panel of the chassis contains the output pi-network components and filter choke L9. PA loading capacitor C11 is a 365 pf unit, and is the largest that could be fit here because of the rectifier/filter compartment behind it. The C12 coarse loading capacitor in parallel with C11 is mounted to the rear panel. A piece of RG-58 coax connects C11 to relay K2 and C12.

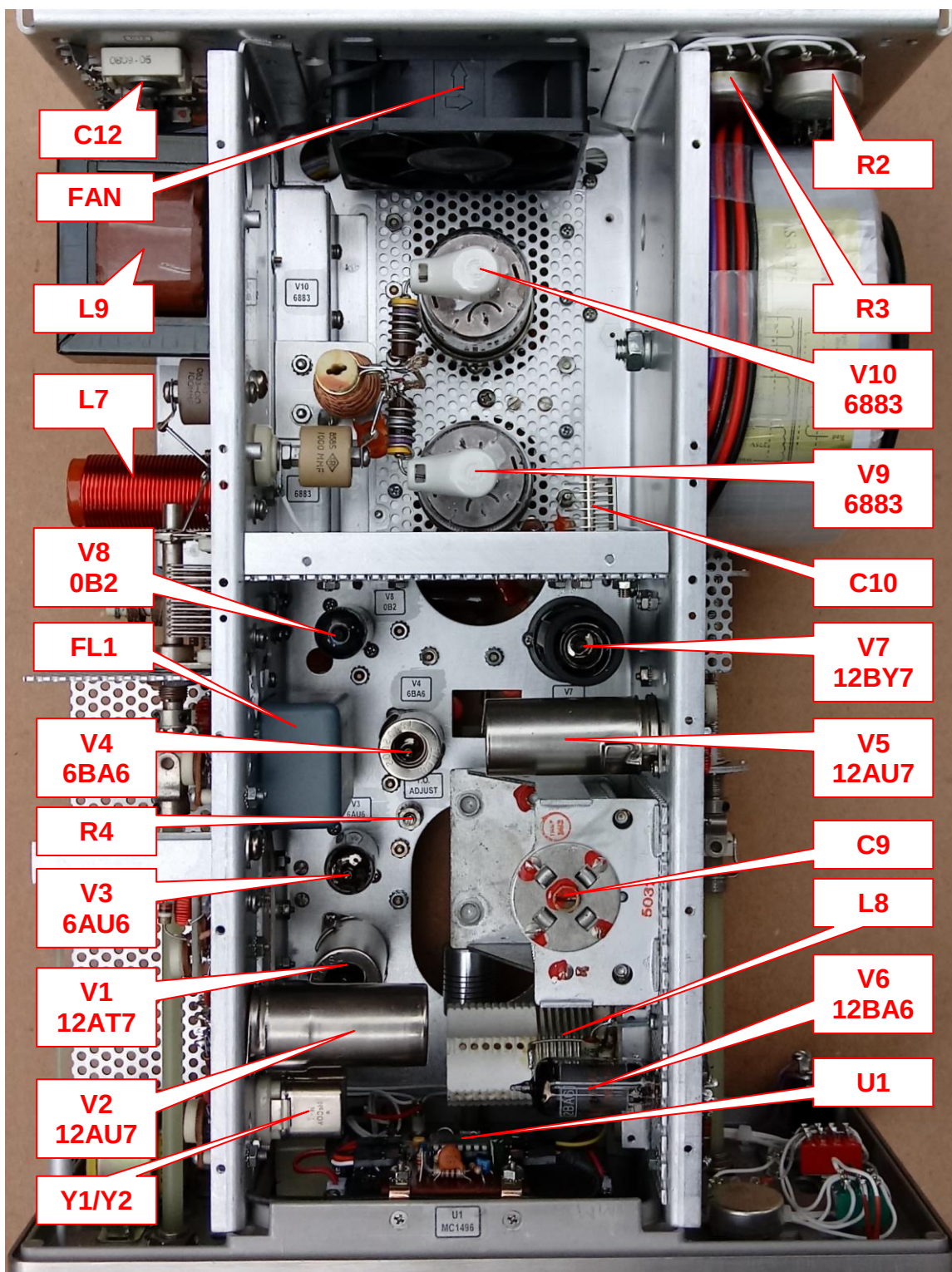


Figure 6 – Chassis Top View

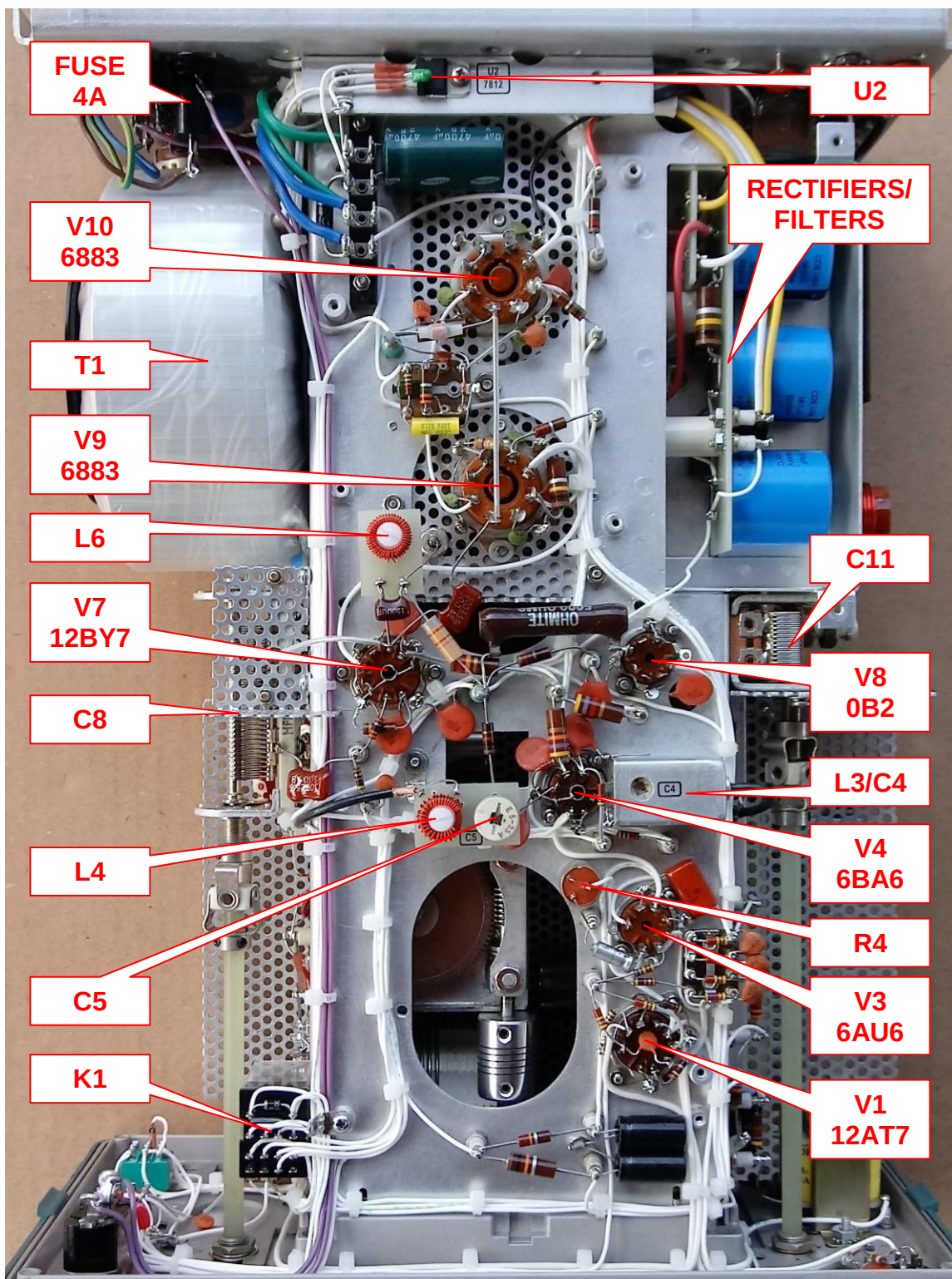


Figure 7 – Chassis Bottom View

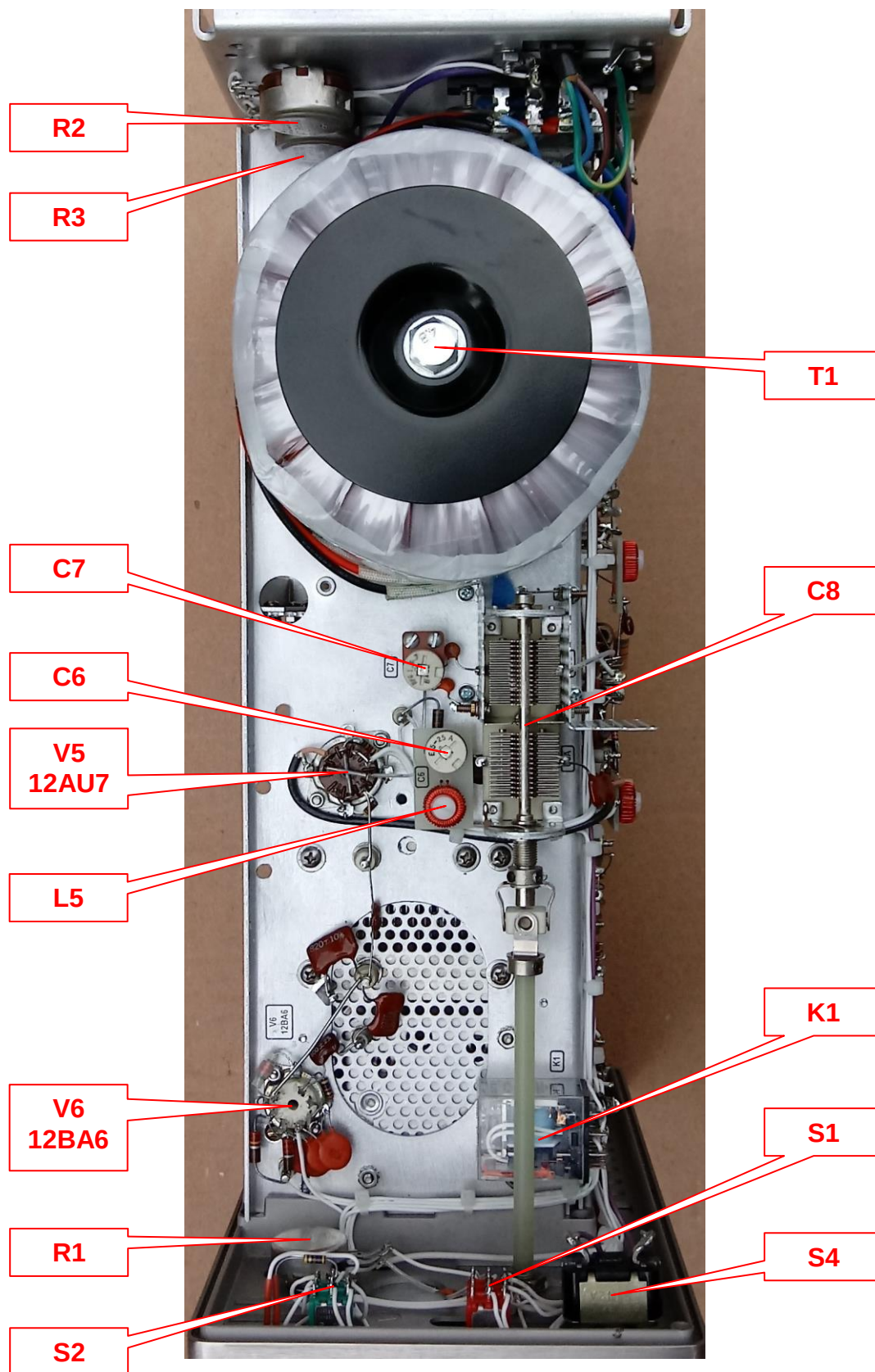


Figure 8 – Chassis Right Side View

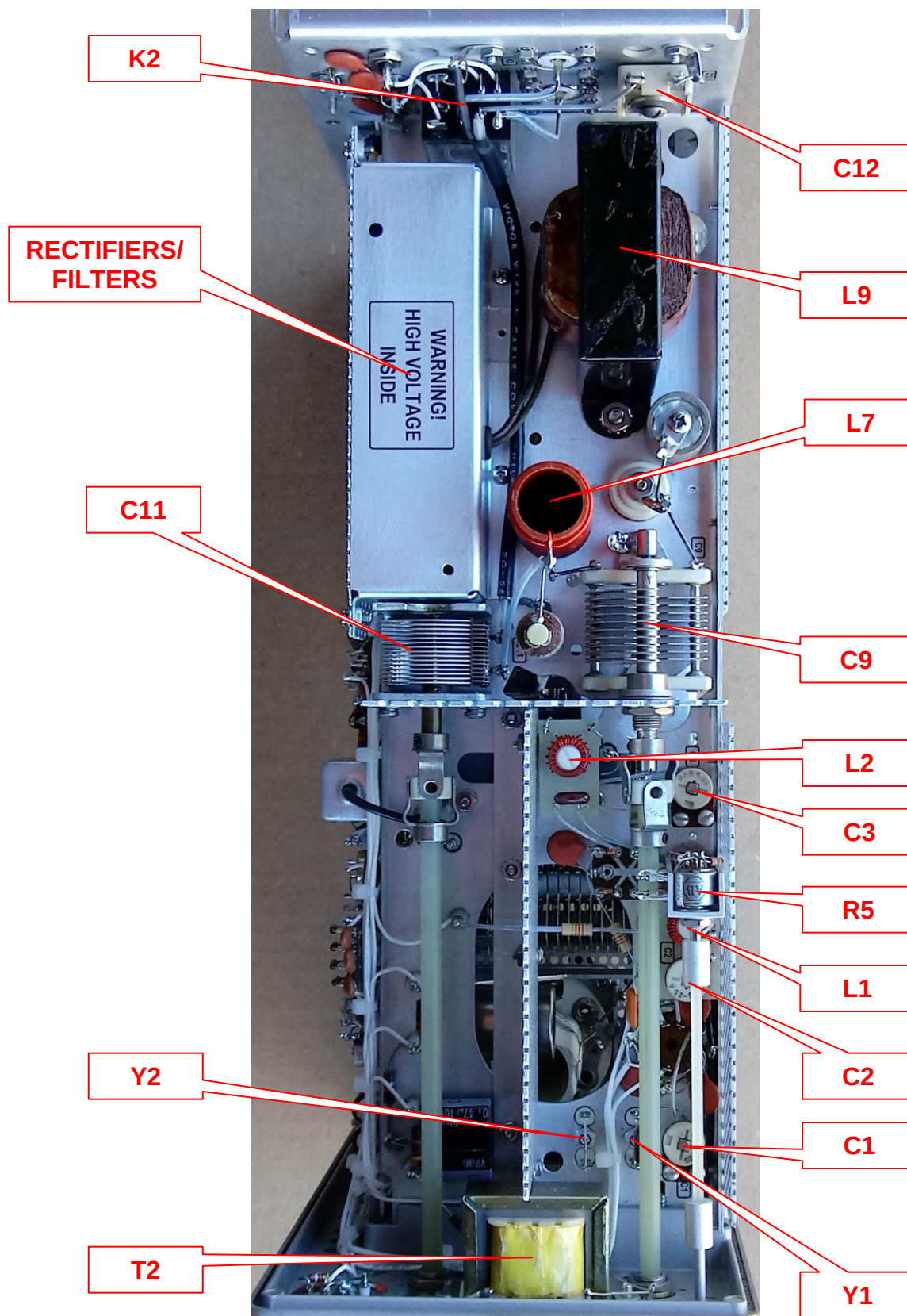


Figure 9 – Chassis Left Side View

3.0 Circuit Description and Design Details

Refer to the block diagram in Figure 10 and the schematics in Figure 11 for the following discussion.

V1A and V1B amplify the microphone signal at J1. Use of a high impedance microphone is required. A low pass filter on the input to V1A's grid filters out any RF coming in from the microphone. When S1 is in the OP position, amplified microphone audio at the plate of V1B is applied through S1D across MIC GAIN pot R1. When S1 is in the TUNE position and S2 is in the OP position, tone oscillator V3 is enabled by grounding its cathode. The resulting audio output tone at V3's plate is applied to R1 through S1D. T.O. ADJUST pot R4 is set to produce maximum tone amplitude consistent with the best waveform. V2A is a cathode follower that provides low impedance audio drive to the balanced modulator. Its output voltage is set by R1.

V2B is the 9.0 MHz carrier oscillator. Crystal Y1 places the carrier at the high end of the FL1 filter passband, thereby allowing the lower sideband to pass through. C1 trims the frequency of Y1, and determines where the carrier is placed relative to the filter slope. Output of V2B is resonated in a tank circuit and fed to the balanced modulator circuit from a link on L1. C2 adjusts the tank circuit to resonance. Y2 is plugged into a dummy socket below Y1 because it came with the filter kit and should stay with it. Its terminals are shorted together to prevent any adverse effects from series resonances.

Note that an electron coupled oscillator (ECO) circuit is used for the carrier oscillator, where V2B's screen grid is the active element in the feedback loop. This avoids problems encountered in a typical tuned grid-tuned plate (TGTP) crystal oscillator employing a triode or pentode. In a TGTP configuration the plate is the active feedback element, and tuning the plate tank circuit for maximum output amplitude can have a marked effect on the frequency of oscillation. This can cause a lot of confusion and frustration when trying to place the carrier frequency at the correct spot on a steep filter slope. In the ECO, the plate tank circuit can still be tuned for maximum output, with virtually no effect on the frequency of oscillation due to the isolation afforded by the screen grid.

The balanced modulator is a ring diode type employing four silicon diodes. The carrier voltage is coupled to R5, which is adjusted for best carrier suppression. The two 360 ohm resistors across R5 create a vernier arrangement to facilitate carrier null adjustment. The plate circuit of V2B is thoroughly decoupled to keep the carrier out of other circuits for best suppression. A sample of the 9.0 MHz carrier is picked off the L1 link and sent to the display mixer.

The V2B carrier oscillator is operated from 225 volts B+ to produce a high enough RF voltage to properly switch the diodes in the ring. This is necessary to reduce audio distortion in a diode modulator. Because the oscillator is crystal controlled, changes in B+ voltage cause only very minor frequency changes.

Output of the balanced modulator is coupled to filter FL1 through L2, which is broadly resonated by the 160 pf capacitor across it. C3 compensates for capacitive imbalances in the circuit for optimum carrier suppression.

The only technical data I had for the filter was the Figure 2 ad packed inside the box. This specifies the input and output impedance of FL1 as 640 ohms, unbalanced.

Accordingly, 620 ohm resistors were connected across the filter to provide a proper match.

Output of FL1 is coupled to IF amplifier V4 through L3. C4 resonates this circuit. Because the gain of V4 is very high, it was found necessary to shield L3 and C4, and run a shield between V2B and V4 circuits. This eliminated pick up of stray carrier signals that were preventing adequate carrier suppression. Some say that toroid coils like the ones used throughout this radio are self-shielding, such that external shields are not required. While that may be true for low voltage, low impedance solid state circuits, I have found it is not always the case in high gain vacuum tube circuits. RF voltages across a coil in a plate tank circuit can exceed 100 volts peak to peak (Vp-p) at resonance, which can couple into typically high input impedances nearby. Although they are several inches apart, there was enough coupling between L1 and L3 to cause carrier suppression problems, which were very confusing and hard to troubleshoot at first. Without the shields I could just wave my hand around the circuits and see the carrier suppression go south. Decoupling V2B's plate with a choke also helped immensely. With these modifications in place and careful adjustment, carrier suppression exceeds 50 dB.

V4 amplifies the 9.0 MHz SSB signal and applies it to one of the grids in mixer V5 through L4. C5 resonates the tank circuit. The other grid in V5 receives a 5.0 to 5.5 MHz RF voltage from VFO tube V6. Mixing action takes place in V5 as a result of common cathode and plate connections. Note that the single conversion scheme used in this radio does not cause a sideband inversion. The resulting 3.5 to 4.0 MHz difference signal at V5 plates is filtered in the tank circuit and applied to the grid of driver tube V7. C8 is a dual section capacitor used to resonate tank circuits in the grid and plate of V7 to the operating frequency. C6 is used to compensate for differences in the two tank circuits and provide tracking across the 80/75 meter band.

Worst case spurious emission occurs at 4.0 MHz output frequency. Here the VFO is only 1.0 MHz higher at 5.0 MHz, so the level of this spurious signal at the RF OUT connector depends on the selectivity of L5, L6 and L7 tank circuits. Measurements show that when the transmitter is properly tuned for 4.0 MHz output, the maximum RF voltage appearing across a 50 ohm dummy load is 200 Vp-p at 100 watts PEP, as observed on an oscilloscope. With the carrier nulled and MIC GAIN set full CCW, the residual RF output on the scope is about .7 Vp-p. This level is entirely due to the 5.0 MHz VFO signal, and is about -49 dB down from the desired single tone output at 4.0 MHz. If this were referenced to a two tone signal, the value would be reduced by 6 dB to -43 dB. As the transmitter's output frequency is decreased the spread between VFO and desired signal increases, so the level of the spurious signal decreases. It is less than .05 Vp-p at 3.5 MHz. External selectivity provided by a linear amplifier, antenna tuner and antenna itself will provide additional rejection of the VFO signal.

Driver V7 amplifies the desired SSB signal to a level of 100 Vp-p and applies it to the grids of PA tubes V9 and V10. A sample of RF at the plate of V7 is fed back to the low side of L5 to neutralize the driver circuit. Adjustment is via C7.

V9 and V10 bring the SSB signal up to a level of 100 watts PEP. They operate with nominal 750 volts on their plates, with zero-signal plate current set to about 40 ma by R3. A pi-network is used to match the output to a 50 ohm load. C9 and the 100 pf doorknob capacitor across it resonate the plate circuit, while C11 and C12 adjust the loading for maximum power output. As mentioned earlier, due to size and location constraints, C11

is only about one third the required capacitance for the pi-network. To allow wider range adjustment, compression trimmer C12 is connected across C11 and mounted to the rear panel. A sample of RF on the plates of V9 and V10 is fed to the low side of L6 for neutralization. C10 provides the adjustment.

V6 serves as the VFO tube and is connected as a Colpitts oscillator. Feedback for oscillation is provided through the 560 and 820 pf capacitors connected at the cathode. A small “antenna” is mounted next to tank coil L8 to provide a VFO signal to the display mixer. VFO voltage to mixer V5 is taken from the cathode of V6. Regulated voltage for the plate and screen of V6 is provided by V8. In addition, the heater of V6 is operated from regulated 12 VDC. These features ensure VFO frequency is unaffected by changes in AC line or 225 B+ voltages.

A 47 pf/N750 capacitor is connected across L8 to provide temperature compensation for the VFO. Several experiments were conducted using 22 pf, 33 pf and 47 pf capacitors, all N750 types. Placement of this capacitor was also adjusted. The final location is between the base of V6 and the mounting frame of L8. Here the capacitor picks up a small amount of heat from the tube to provide quicker time to stabilization. The 47 pf value also results in equal lower and upper band margins of about 3.433 and 4.066 MHz respectively.

Several 120 minute temperature runs were conducted from a cold start during the experimental phase to select the final configuration. A transmitter frequency of 3.900 MHz was chosen to be close to the Vintage SSB Roundtable’s 3.895 MHz. Room temperature was around 70F. Results of the final configuration run are shown in Figure 12. After a 20 minute warm up, drift stayed within 60 Hz over the next 100 minutes. Most commercial tube rigs from the era that bothered to specify long term drift stated it was within 100 Hz “after warmup”, whatever that meant. At any rate, this homebrew radio is well within those parameters. It’s as good as any tube radio gets.

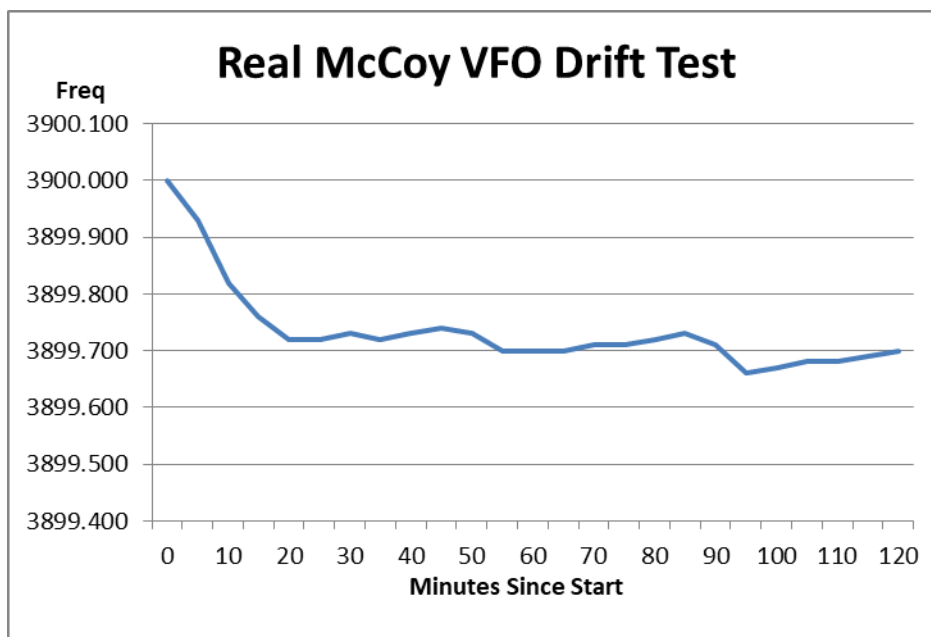


Figure 12 – VFO Drift Test

Complete T/R switching is accomplished by relays K1 and K2. The control logic is designed so that if SPOT/OP switch S2 is in the SPOT position, K1 and K2 cannot be energized and no RF can be transmitted. The tone oscillator is also inhibited in SPOT mode to prevent spotting on the tone oscillator instead of the carrier.

If SPOT/OP switch S2 is in the OP position, K1's coil can be energized by grounding the PTT line or setting TUNE/OP switch S1 to TUNE. The PTT line has 12 VDC on it in standby and is grounded for transmit. In transmit, about 75 ma of relay coil current will sink through the PTT line.

K1's four contact sets (or poles) perform the following functions when its coil is energized for transmit:

- Contact set A connects the meter to the cathode of V4 when the meter switch is in the ALC position. This keeps the meter from pegging full scale in the receive position, which removes V4's screen voltage and causes its cathode voltage to go to zero.
- Contact set B applies B+ to the screens of V4, V7, V9 and V10 to make them active.
- Contact set C removes the ground from the ALC line.
- Contact set D applies +12 VDC to the coil of antenna relay K2 to energize it to the transmit state.

As with K1, K2 cannot be energized in the SPOT mode. When K2's coil is energized for transmit, its two contact sets perform the following functions:

- Contact set A switches the rear panel ground states from receiver mute to linear T/R relay.
- Contact set B switches the antenna (labeled RF OUT) from the receiver input to the transmitter output.

TUNE/OP switch S1 has four contact sets that perform the following functions in the TUNE position:

- Contact set A grounds the ALC line for tune up.
- Contact set B grounds K1's coil, enabling it when not in SPOT mode.
- Contact set C grounds the cathode of V4 when not in SPOT mode, turning on the tone oscillator.
- Contact set D switches audio input to V2B from the microphone amplifier to the tone oscillator.

SPOT/OP switch S2 has three contact sets that perform the following functions in the SPOT position:

- Contact set A applies B+ to the screens of V4, V7, V9 and V10 to make them active. A 4.7k ohm resistor is inserted in series with the B+ to limit screen voltages and PA plate current in SPOT mode.
- Contact set B removes the ground from the tone oscillator circuit, thereby preventing it from operating in the TUNE mode.
- Contact set C removes +12 DC from K1's coil and applies it to the amber LED to remind the operator that SPOT mode is on.

The ALC circuit consisting of the two 1N4148 diodes and associated components is based on the Heathkit SB series of radios. PA control grid current and screen voltage vary at audio frequencies when the tubes are driven into saturation. These pulses are rectified by the voltage doubler formed by the two diodes, filtered for fast attack and hang time characteristics, and then applied to the control grids of V4 and V7. ALC from a linear can also be applied at J4. Applying ALC to the V7 driver is somewhat unusual, but does not cause any issues. One of the problems with a single conversion radio like this is that there is normally only one IF stage (V4 in this case) that can be controlled with ALC. This limits the ALC effectiveness. Applying ALC to the driver helps improve this situation.

The meter circuits are conventional. The meter was found in the “junkie” box, and appears to be from an old CB radio. Its small size and vertical orientation fit the available “real estate” nicely. Tests indicated its basic meter movement is approximately 250 μ a full scale. It was carefully disassembled and fitted with a new custom scale.

PA current at the cathodes of V9 and V10 creates a voltage across the 1.0 ohm resistor. This voltage is scaled to 250 ma at half deflection by a 2.2k ohm series resistor, and applied to the positive terminal of the meter when S3 is in the PLATE position. The negative terminal is grounded.

In the ALC position of S3, voltage at the cathode of V4 is applied to the negative terminal of the meter through a 1k ohm series resistor when K1 is energized. A balancing voltage from R2 is applied to the positive terminal of the meter. When no ALC voltage is present, R2 is adjusted to match the voltage on V4's cathode, thus causing zero meter deflection. When ALC voltage is generated, it decreases the voltage at V4's cathode, which causes upward deflection of the meter. In the ALC position, a pair of 1N270 germanium diodes is connected back-to-back across the meter to help prevent damage in the event of a gross misadjustment of R2, or a failure of V4.

The frequency display uses a frequency counter/display module acquired from MPJA (mpja.com). The front of the LED display is covered with a very fine mesh, flat black copper screen to prevent RF from the display circuits and display mixer from leaking out. The mesh was cut from an EMI filter screen from the parted-out oscilloscope's CRT. It also makes a nice optical filter for the LEDs.

Although the firmware in this module is capable of inputting certain types of fixed IF offset frequencies, it was discovered late in the build that it cannot perform the simple fixed IF minus VFO calculation needed for this radio. The solution was to build a balanced mixer circuit to mix the SSB carrier and VFO signals, and output only the actual

80/75 meter transmitted frequency to the counter. The mixer uses a vintage, mid-1970s MC1496 integrated circuit (U1) to do the job. A distinct advantage of this modification is that the indicated frequency is exact, eliminating any error caused by an incorrect IF offset number that might be stored in the counter's memory.

The display mixer circuit used here was taken from an old ARRL Handbook, and is a modification of the design appearing in the original Motorola datasheet that allows operation from a single sided DC supply. U1 has decent gain and fairly high input impedances, so only very light coupling to the two oscillators is required. And the counter module is quite sensitive, so high output voltage is not needed.

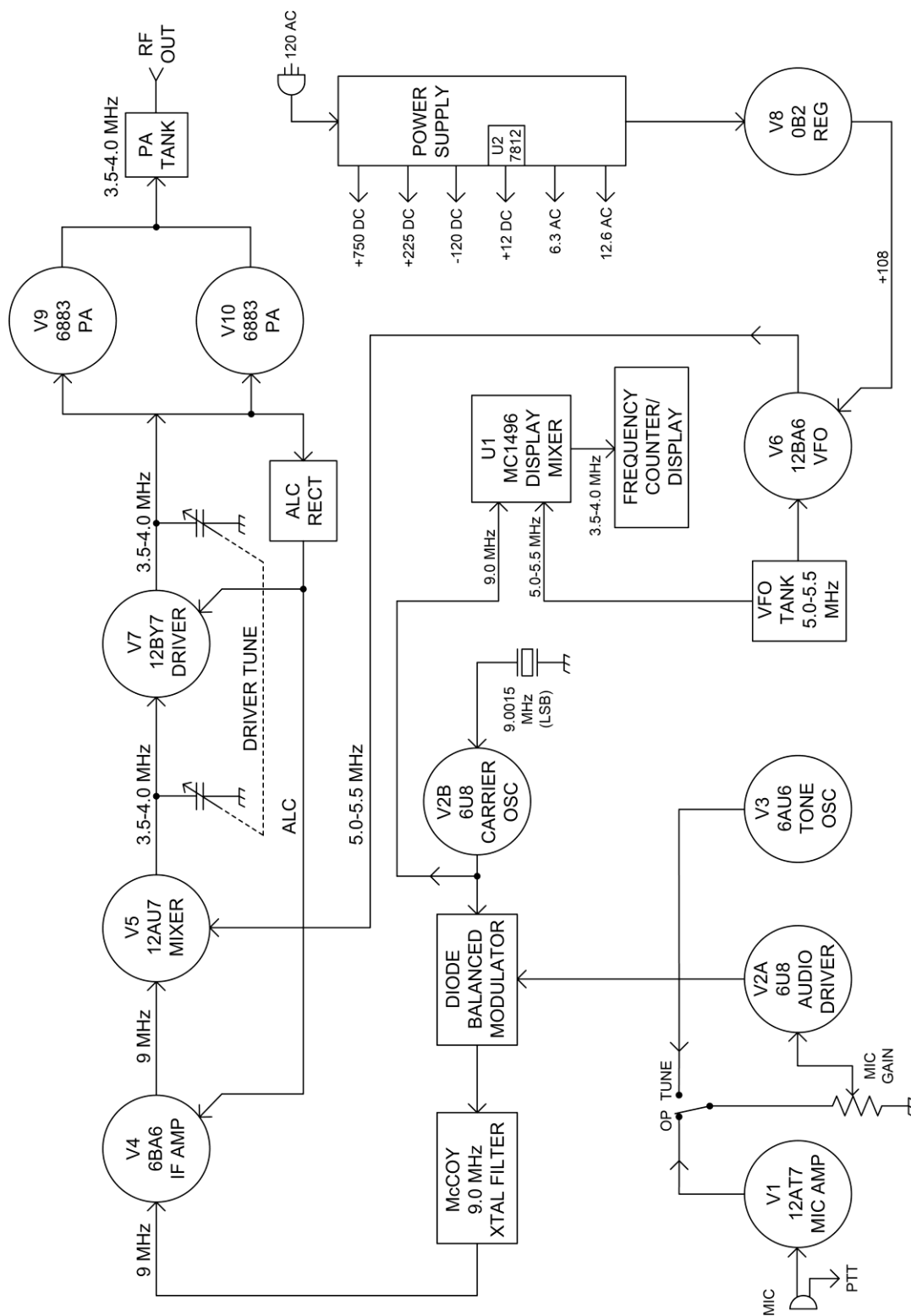
A balanced mixer was chosen because the desired output of 3.5 to 4.0 MHz is close to the corresponding VFO input frequencies, making it hard to filter out the undesired VFO signal across the entire band using an ordinary mixer. In the balanced mixer used here, the VFO and carrier oscillator signals are suppressed in the output. A pi-network filter at the output of the mixer also helps to eliminate these unwanted signals.

A very minimal 75/80 meter signal leaks out of the transmitter from the display mixer, and has been noticed in the receiver when no antenna is connected to the system. However, this signal is well below the noise level on 75/80 meters, and disappears when an antenna is connected. It does not compromise reception of weak signals, so it was decided not to pursue it any further.

The heart of the power supply is T1, a modern, 300 volt-ampere (VA) toroid transformer from Antek (P/N AS-3T275). It is very efficient, runs cool, and its form factor allows a nice fit at the rear of the chassis. The primary windings are connected in parallel for 120 VAC input, while the secondary windings are connected in series.

The two ends of the high voltage secondary windings feed a full wave bridge rectifier and capacitor input filter that deliver nominal +750 VDC for the PA tubes. An "economy" connection to the center tap of the high voltage secondary windings is configured with a choke input filter to produce about +225 VDC B+ for the PA screens and low level circuits.

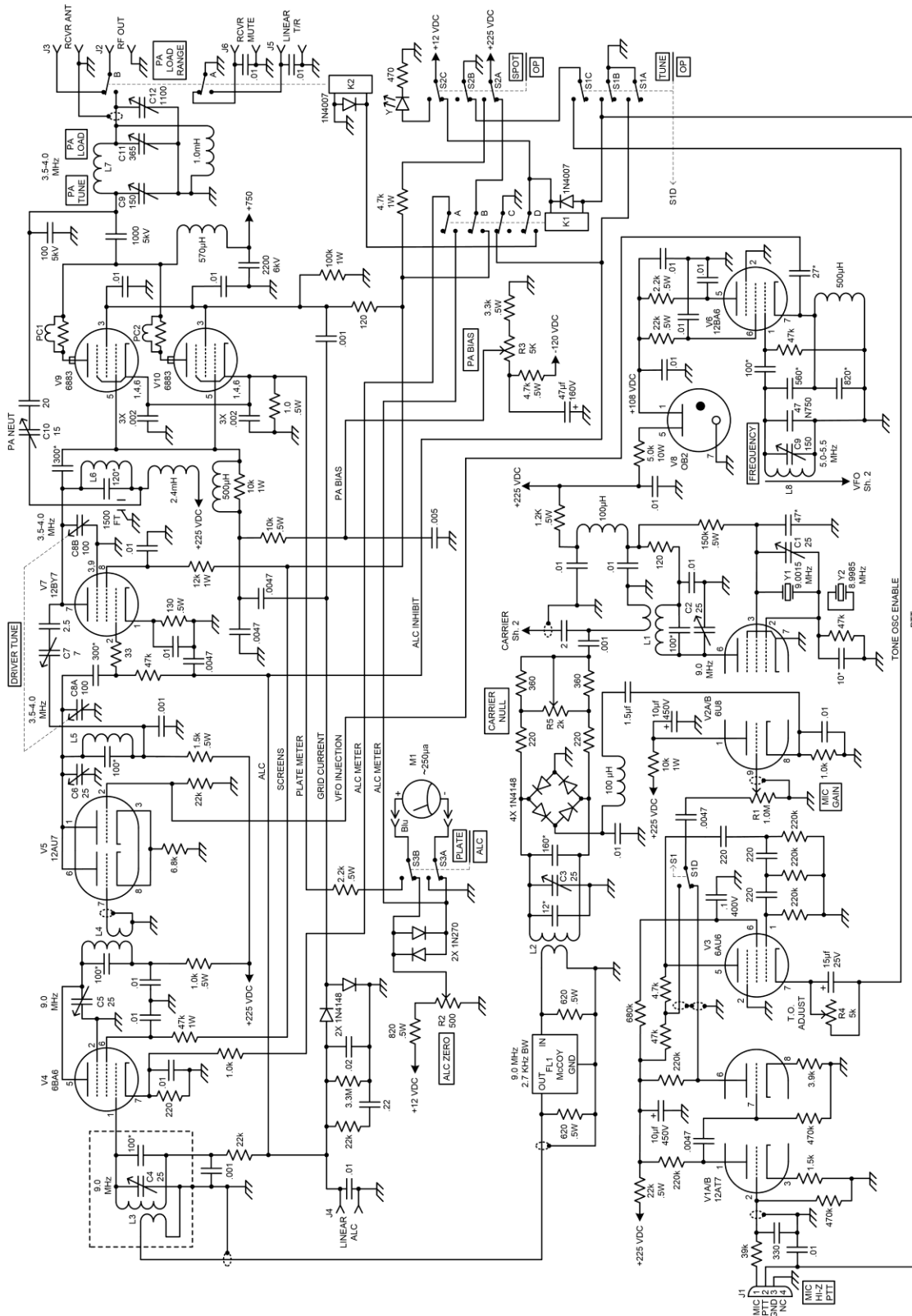
The low voltage secondary windings are configured to provide heater voltages to the tubes and other loads as indicated on the schematic. Since ample 12.6 VAC power was readily available, I decided to use 6883s for the PA tubes. Transformer T2 is reverse connected and its 120 VAC winding half wave rectified and filtered to provide grid bias for the PA tubes. 12.6 VAC power is also half wave rectified, filtered and regulated by U2 to provide +12 VDC to various circuits in the radio. U2 is fastened to a heat sink bracket at the rear of the radio that was used to mount several series pass transistors in the original Tektronix scope.



BLOCK DIAGRAM
23 FEB 2020

The Real McCoy
SON SSB TRANSMITTER
HOMEBREWED BY KG7TR

Figure 10 – Block Diagram



See sheet 2 for notes.
Sheet 1 of 2
TRANSMITTER
CIRCUITS
23 FEB 2020

The Real McCoy
SOM SSB TRANSMITTER
HOMEBREWED BY KG7TR

Figure 11 – Schematic Sheet 1

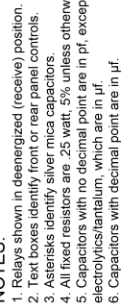


Figure 11 – Schematic Sheet 2