Implementing the X-Lock-3 on the Heathkit HW-101

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I had previously installed the X-Lock-2 in a Ten Tec Corsair I and a TR-7. Subsequently I installed an X-Lock-3 in a second TR-7. I guess you can say I am hooked! Recently I got the urge to try updating and remodeling a Heathkit HW-101 SSB/CW Transceiver. That effort entailed replacing many components and making some of the well-documented improvements. To add a modern touch I installed a digital dial from Almost All Digital Electronics (AADE). Now with the digital dial not only do I know that the radio drifts but can tell precisely "how much." That led me to install the X-Lock-3 in the HW-101. This paper documents what and how it was implemented in the HW-101. Did I mention that it was a successful install?

Just as I spent a great deal of time thinking how to install the digital dial the same applies to the X-Lock-3. The install in the Corsair I and both TR-7's was relatively easy as I simply tapped into the RIT lines and that was it. The HW-101 uses a VFO as opposed to a PTO as used in the Ten Tec and Drake radios. That meant that the VFO had to be accessed – not a hard task but one requiring some planning and thought.

This project has five distinct tasks/phases:

1. Building the X-Lock-3
2. Modifying the VFO to accept the X-Lock-3 correction voltage
3. Installing the X-Lock-3 in the HW-101
4. Building the X-Lock-3 Power Supply
5. Final Integration

Ron Taylor, G4GXO, has done a superb job in developing the X-Lock kits. The documentation is well organized and provides a step by step instruction of what to do to successfully build the kit. Since this was my third kit, the elapsed time was about an hour to build the X-Lock-3. The first build took much longer and there is much to be said for the learning curve. Once built check your wiring and for the obvious solder bridges and the wrong components in the right place. Ron has taken care to sequence and identify which parts go where and at what time. Follow the instructions!

In modifying the VFO it has to be removed from the radio! To gain access to the VFO circuits here is the sequence to follow:

- Start by removing the main tuning knob and panel mounted vernier drive. Two screws attach the vernier drive to the front panel and there are two set screws on the vernier that fasten the external panel mounted vernier to the internal vernier inside the VFO enclosure. There are four screws that are seen once you remove the knob. Two fasten the vernier to the front panel and two fasten the vernier to an adapter plate. You want the two that hold the adapter plate to the front panel. Finally loosen the two

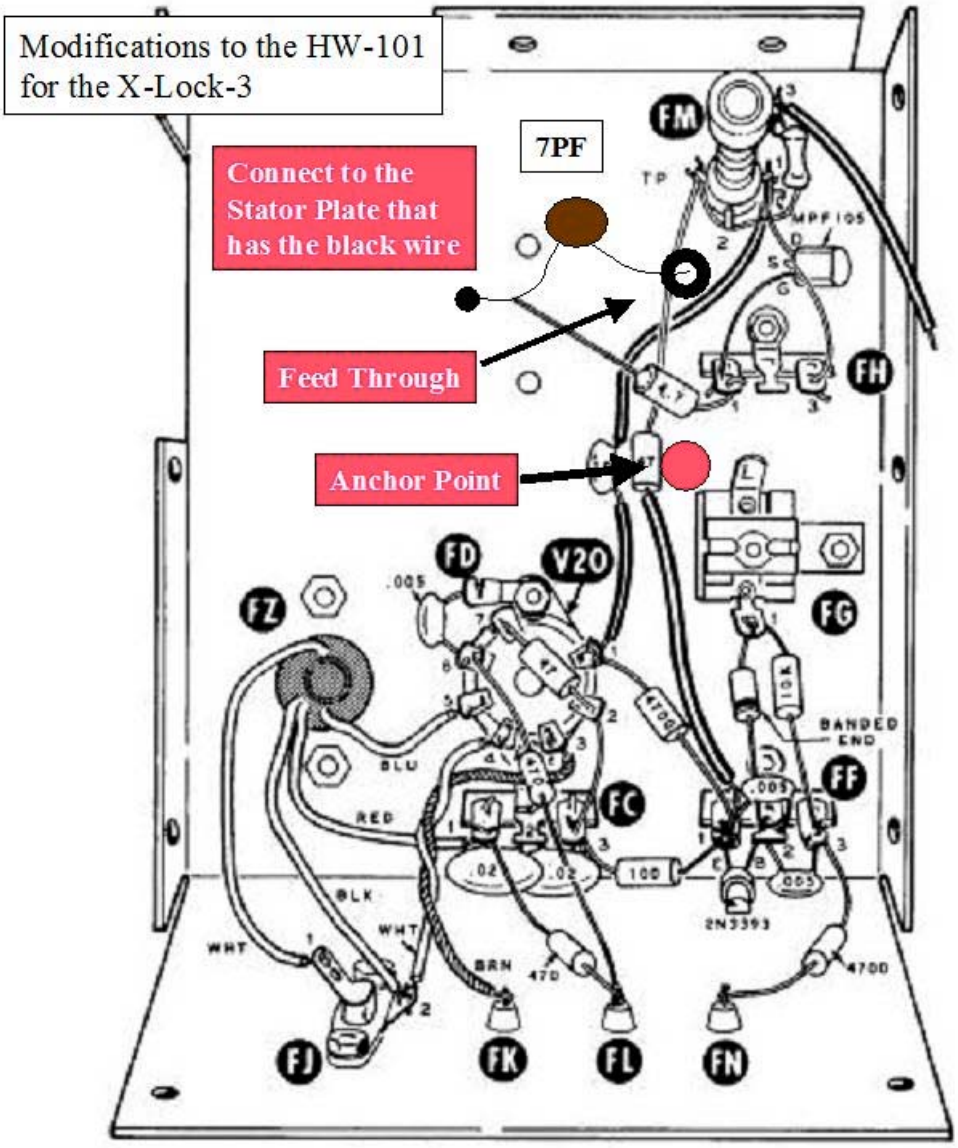
setscrews and remove the vernier. Set that in a safe place along with the panel mounting screws.

- Unsolder the three wires at the back of the VFO enclosure and unplug the VFO output cable. With a pencil I marked on the top of the VFO enclosure the wire colors that went to the feed through devices, W for the Bias, O for the B Plus and B for the Filament. [The wire colors were white, orange and brown.]
- Disconnect the SSB filter (and CW filter if installed). Remove the filter (s) from the L Bracket. Remove the L bracket by unloosening the two nuts. You will hear the two holding screws drop into the VFO enclosure. [Upon re-assembly I taped the screw heads to the chassis using masking tape. This will hold the screws in place until you can put the lock washers and nuts back on.] The reason the filter L Bracket must be removed is to provide access to two of the four bolts holding the VFO assembly on to the main chassis. Put the L Bracket and hardware in a safe place. Next remove the four nuts holding the VFO enclosure to the chassis and put the 4 lock washers and nuts in a safe place. [Long ago I purchased a multi compartment plastic box, which I use to collect the parts and hardware. It has been a lifesaver. This has greatly reduced lost parts and lost hardware.]
- Gently pull up and back on the VFO enclosure until it is free of the chassis. The underside of the VFO enclosure is open and provides ample room to make the necessary modification to the VFO. The VFO box could be further disassembled but I was unable to loosen the two setscrews that hold the internal vernier to the tuning capacitor. But in retrospect that was probably a good thing and in the final analysis not required.
- The first modification is to remove the fiber standoff that was originally a part of the dial correction “zero set” mechanism. The removal is necessary to provide clearance for the tri-color LED that will fit in the front panel hole. This LED is needed to observe the “LOCK” state.

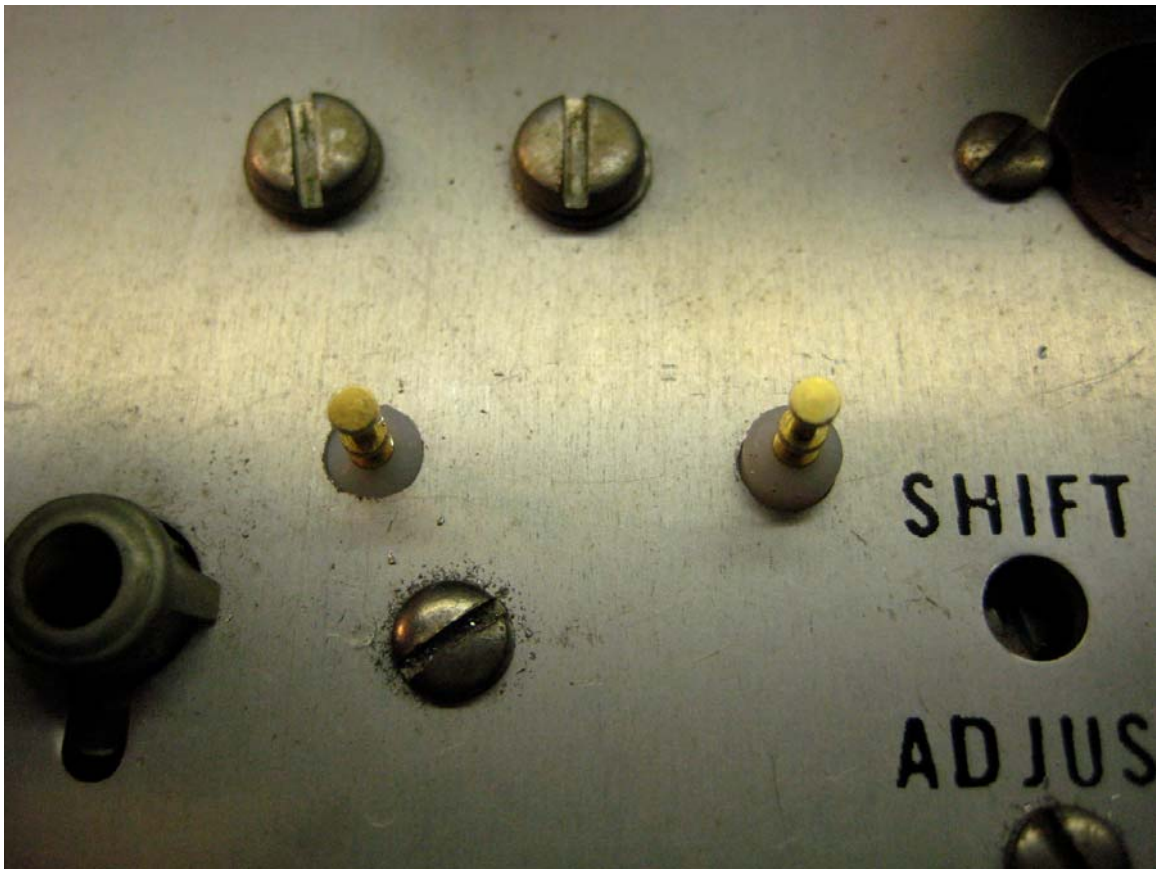
In the X-Lock-3 installation instructions several key points were made and this is where paying attention is important. Since a connection to the VFO tank circuit must be made, the caution here is to keep leads short and direct. Another caution is that there must be some “diddling” of the tank coupling capacitor to assure optimum operation. In practice you want the VFO to change frequency about 20 kHz as a voltage from 0 to 12 VDC is applied to the 1N4004 Diode. Two capacitors were supplied with the kit, a 22 PF and a 68 PF. As is mentioned in the instructions a smaller value of capacitance may be required depending on the individual tank circuit components. I found that it only required 7 PF for the 20 kHz shift based on where I connected the X-Lock-3 to the tank circuit. An adjustment to coil L941 must be made to reset the tuning range once the new cap is installed. So the questions are where to connect to the tank circuit and how do you do that so that frequency stability is not impacted. Refer to the two diagrams out of the Heathkit HW-101 manual to see where to put the holes and the second shows the connection point in the VFO circuit.

Following are a series of photos that detail the actual modifications. In the first one I show where to locate the two holes as seen from the underside. The second shows the actual location of the two small holes fitted with the feed through and the anchor point.

The third photo shows how the interface electronics following the X-Lock-3 are installed on the top of the enclosure. The fourth photo shows the schematic of where to install the 7 PF Silver Mica coupling capacitor. The fifth shows the install in the VFO.



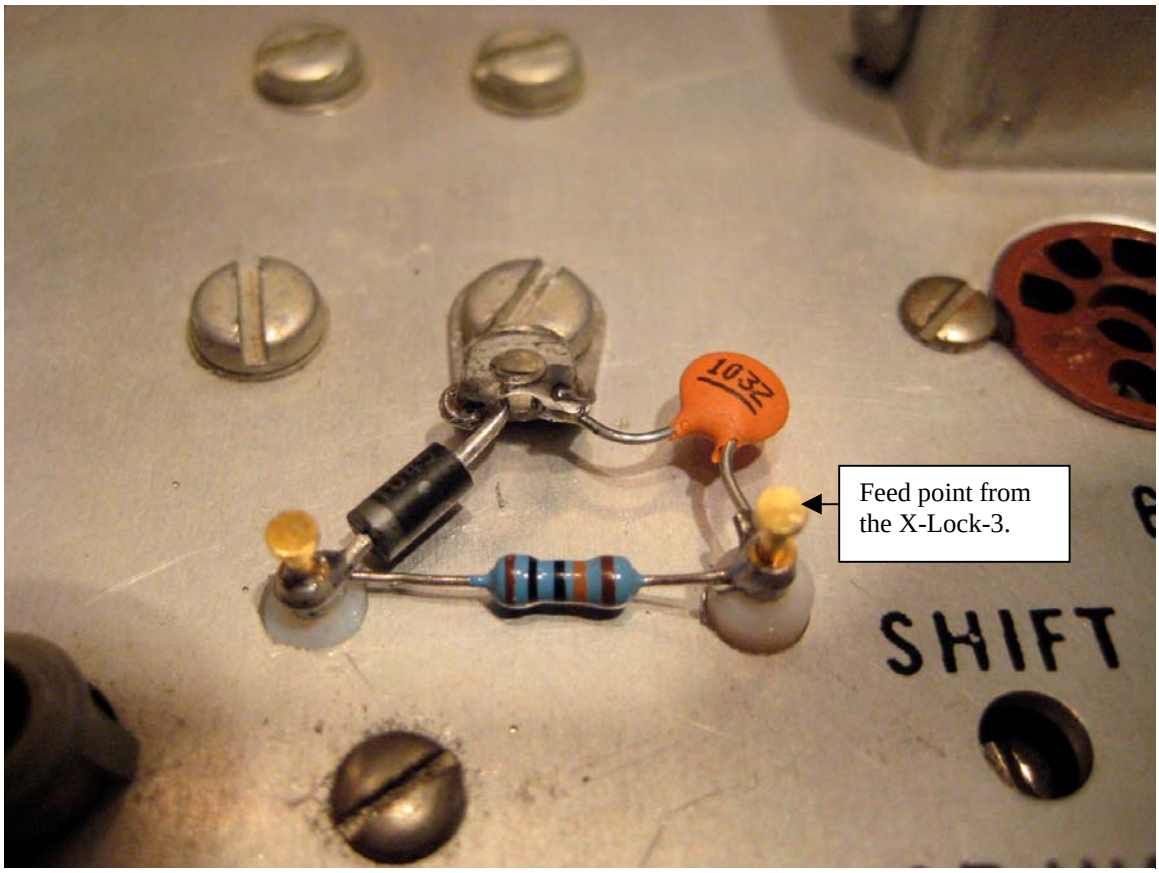
Two pass through devices are installed in the HW-101 VFO Case. One is modified to act as a "feed through" type and the other is an anchor point that is used to make connections on the top side of the case. The 100K resistor is connected to these two points on the outside of the VFO. The 7PF cap is connected from the Feed Through to the Tank.

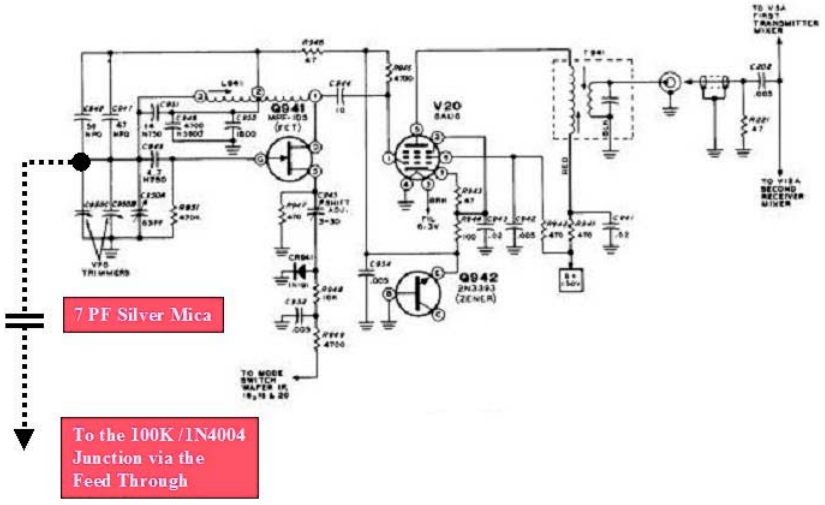


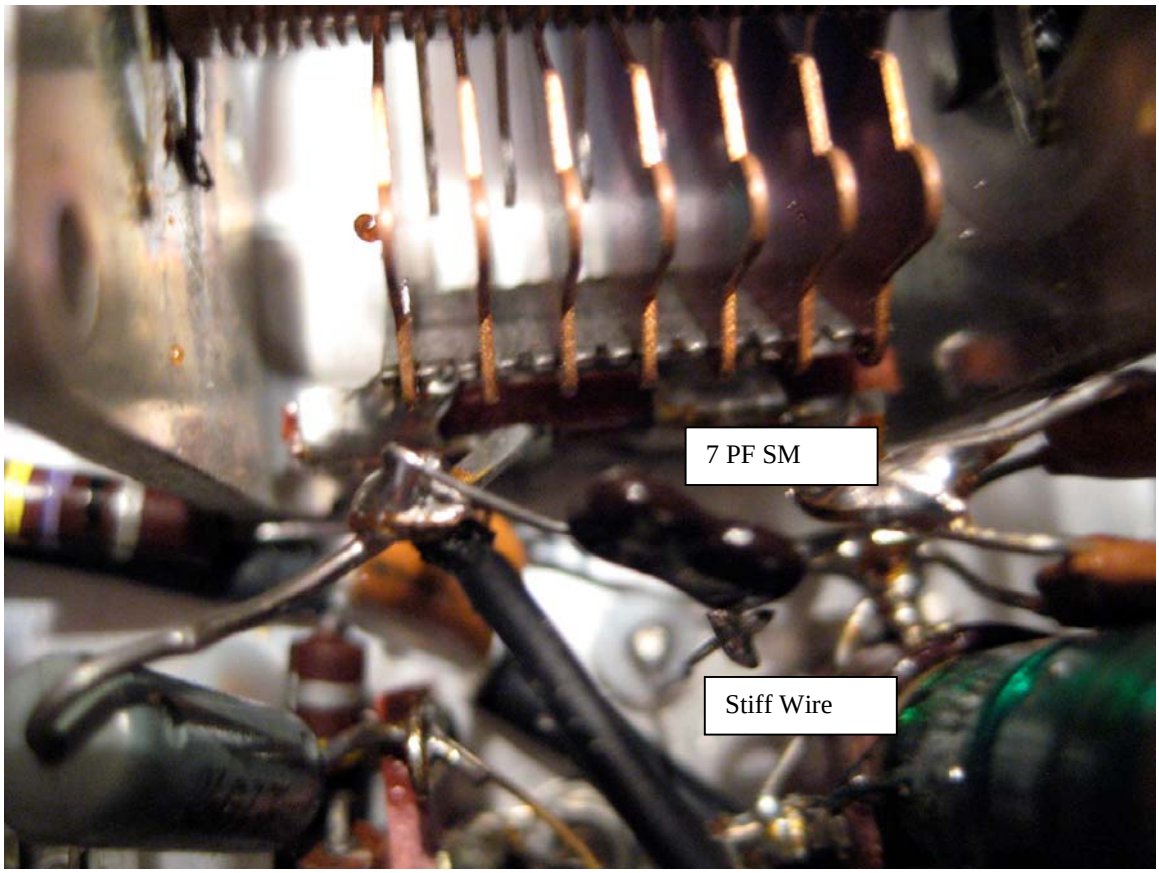
Note that the feed through was made from a second standoff. I simply cut the insulating teflon about 1/16 inch from around the barrel and then cut a hole in the bottom of the teflon barrel. I was able to push the gold pin through the hole and there is a stop on the shaft to stop the shortened teflon barrel. Thus I had a connection points at either end. You can observe the shortened barrel and length of the gold post in the left feed through. On the underside of the feed through I soldered a very stiff wire as an anchor point since I would be testing various coupling caps and this enabled making component changes.

A note about the feed through and the anchor point in terms of installation. When drilling the holes in the top of the chassis use a drill smaller than the Teflon barrel diameter. Then with a small fine round file carefully enlarge the hole while constantly testing if the teflon will fit into the enlarge hole. Stop just at the point where it almost fits and then “press fit” the feed through and anchor point so it is a tight fit. This will anchor them so there is no movement. This takes time to do –so don’t rush it!

A solder lug was fitted to one of the screws which anchor the variable capacitor and this provided a convenient connection point for grounding the anode end of the 1N4004 and the 10 NF bypass cap. This arrangement provides for short component connection leads. This is a very stout install so there is no physical movement of the components. [Keep in mind where prior planning makes the job easier.]


1032
Feed point from the X-Lock-3.
SHIFT


7 PF Silver Mica
To the 100K /1N4004 Junction via the Feed Through

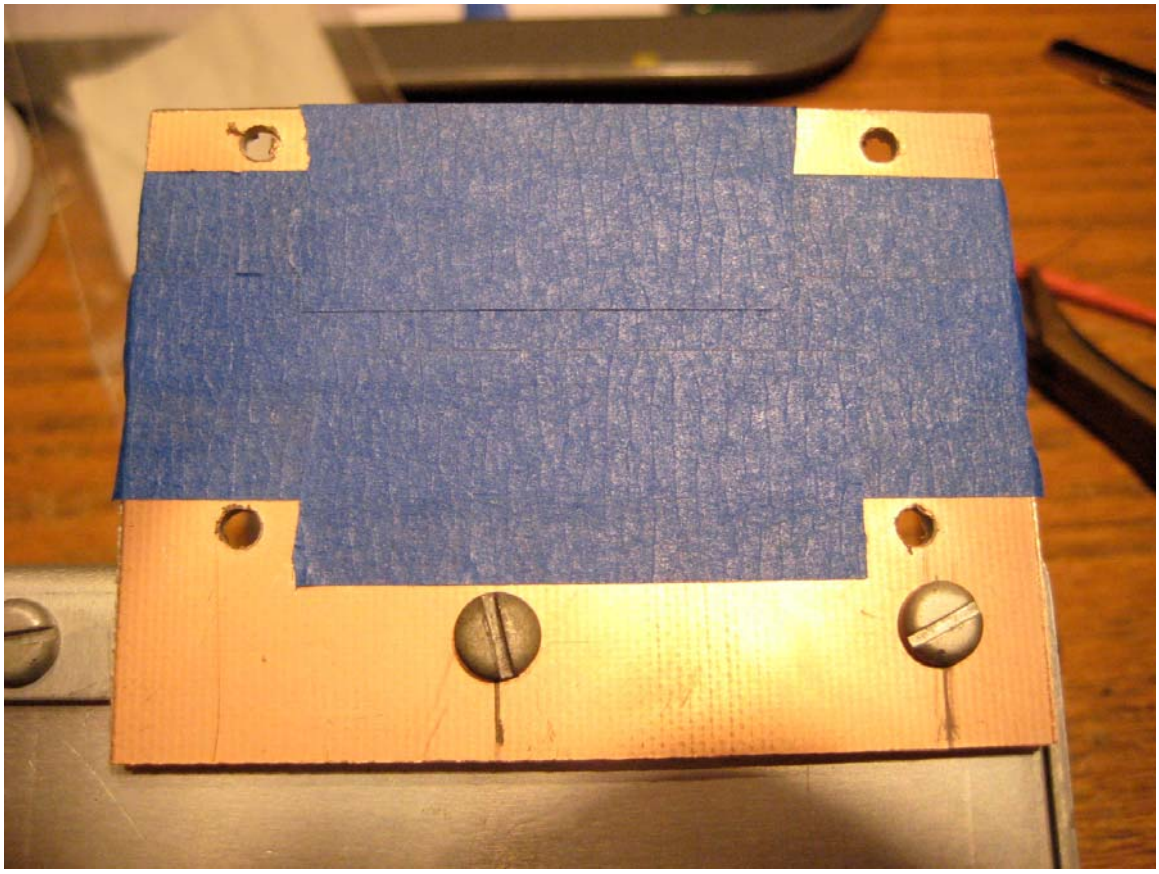


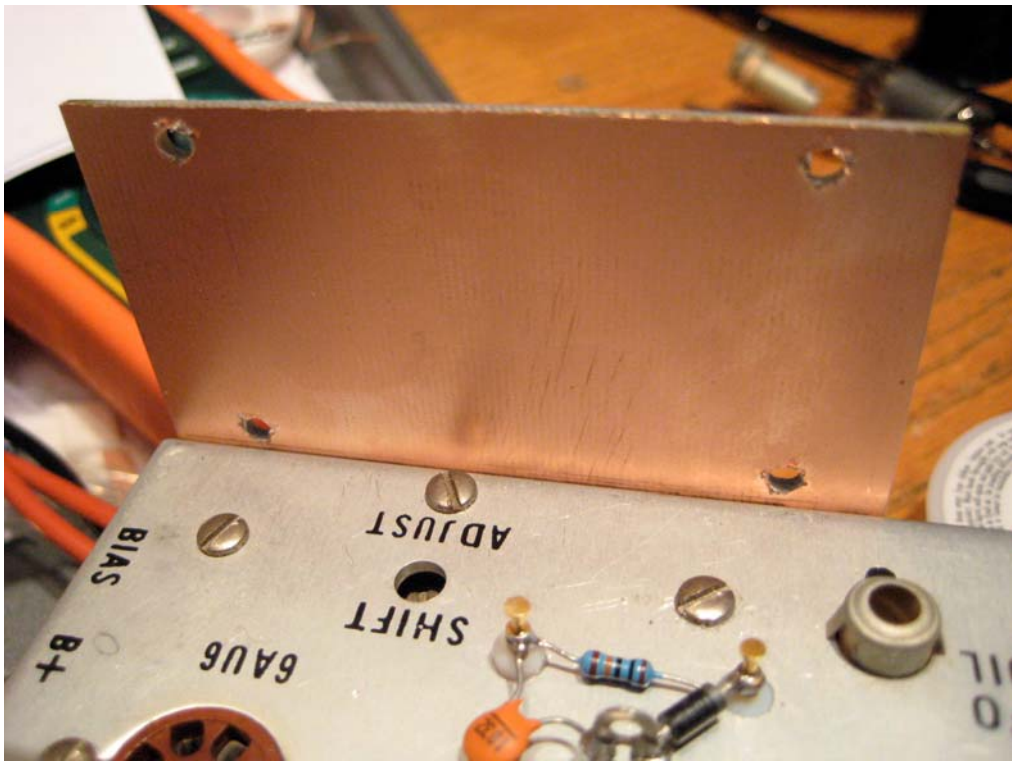
At this point it would be a good idea to test the VFO with the modifications BEFORE re-installing the unit back into the radio. This can be done in several ways. I happen to have a power supply that will supply 6.3 VAC and +108 VDC Regulated. I temporarily hooked up this supply to the VFO. To the 100K resistor at the supply end I applied a variable DC voltage of 0 to +12 VDC. Using a frequency counter connected to the output I was able to determine the optimal value of the coupling capacitor. Initially I started with the supplied 22 PF and running the DC voltage through its range found the Delta frequency change to be on the order of about 60 kHz – way too large. I then tried a 4.7 PF NPO capacitor and the Delta frequency change was only about 14 kHz –too small. So then I tried the 7 PF Silver Mica and that was almost exactly 20 kHz –which is what G4GXO suggested as optimal.

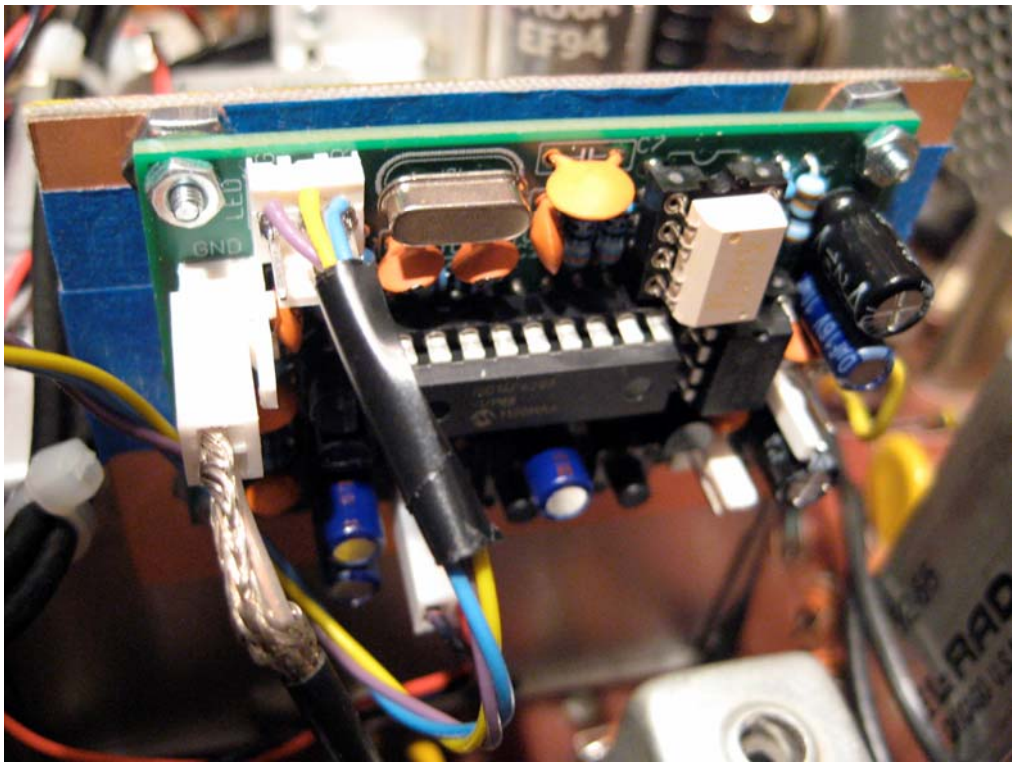
So what do you do if you do not have the digital dial installed and do not own a frequency counter and don't have a special power supply? Improvise! You can make a short power cable of about two feet of wire and hook up the power cable to the HW-101 connection points and then connect to the VFO. Be sure to include a ground wire as the VFO gets its ground return through the metal to metal connection. In my case I have the digital dial installed and could have read the frequency by connecting a jumper cable from the VFO output port to the input on the HW-101 VFO input port. This gives a whole new meaning to "remote VFO". But if you lack some sort of digital display or counter you can listen to the output on a general coverage receiver tuned to 5 MHz and listen for the VFO output. I did that too in addition to having the frequency counter on the

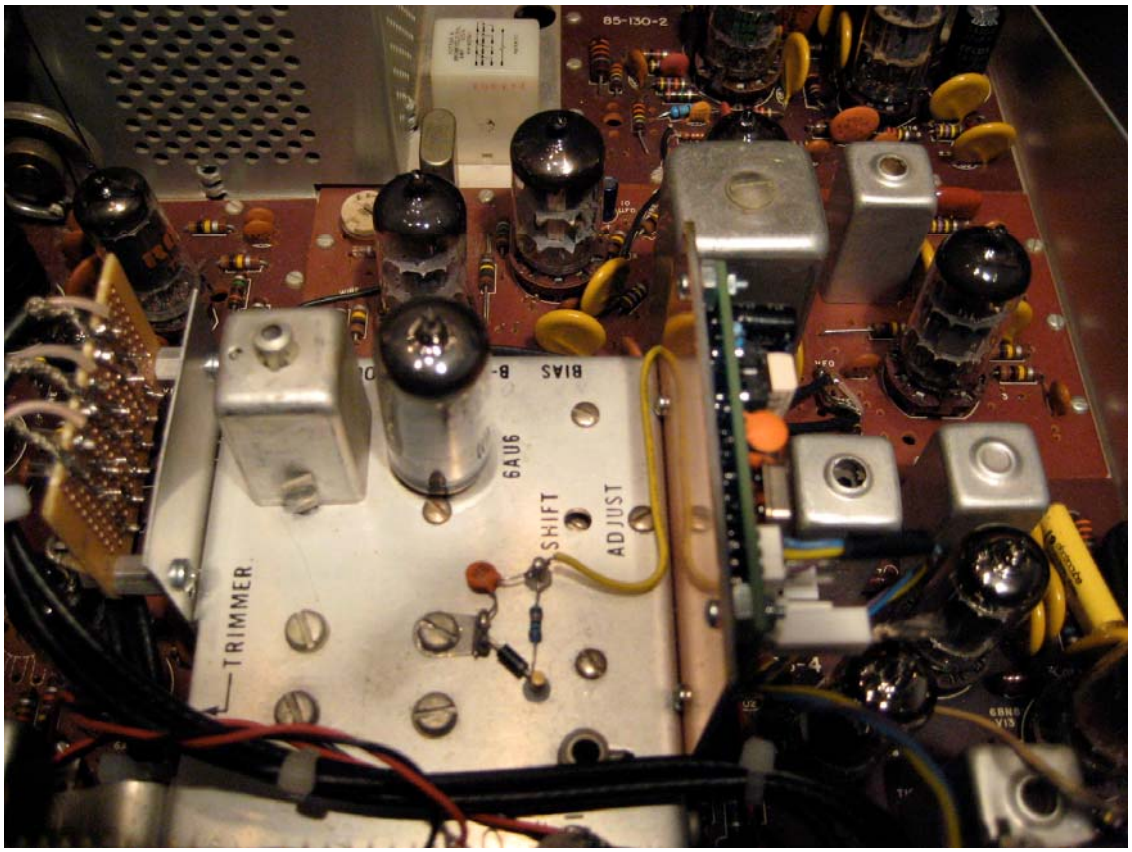
output. Once you are assured that the VFO is working and the frequency spread is as it should be disconnect the wiring and re-install the VFO in the reverse sequence. Start first by taping down the two screws that hold the L shaped crystal filter bracket. Next install the VFO enclosure etc.

Now where to install the X-Lock-3 in the HW-101. As luck would have it there is a perfect place right on the VFO enclosure. This will keep the leads short while providing access to the X-Lock-3 for any on-board adjustments. The “magic answer” to install the X-Lock-3 is a piece of scrap double-sided copper PC Board. Along the left edge of the VFO enclosure are two large sheet metal screws that connect the two sections of the VFO enclosure. These provide anchor points to vertically mount the PC Board while at the same time the PC Board serves as a base plate to mount the X-Lock-3. There is nothing critical about the size of the PC Board other than it be large enough to hold the X-Lock-3 and provide a mounting lip to mount to the VFO enclosure. I used four large 6-32 nuts as spacers to elevate the X-Lock-3 from the mounting board. To assure no shorts I covered the PC Board with a layer of 3M masking tape. See below.




ADJUST
SHIFT
6AU6
BIAS
B+

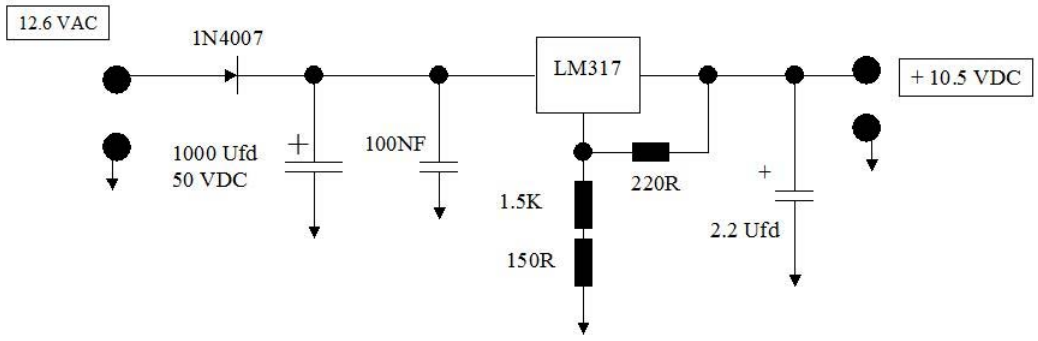

LED
GND



The above is a plan view of the X-Lock-3 installed along the right hand edge of the VFO enclosure and the yellow wire carries the correction voltage to the 1N4004. The circuit board along the left-hand edge is part of the signal level adjustment for the digital dial. The tri-color status LED has the normal 3-pin connector installed so it can plug onto the X-Lock-3. But I also installed an eight-inch long 3-wire cable to the X-Lock-3 board LED connector and put a mating plug on the end of the cable. This enables remote viewing of the status LED. I bent the LED at a right angle so it would fit in a panel mounted LED socket than now occupies the space where the Zero Set Control was located. I used some electrical tape around the exposed LED wires to prevent any shorts to the chassis. See below.

The next phase is to build the DC Power Supply to power the X-Lock-3. G4GXO recommends a supply voltage in the range of +10 VDC to no more than +16 VDC. The reason for the + 10 VDC is that the X-Lock-3 has two on board regulators, one at + 5 VDC and the other at + 8 VDC. You need a several volt differential to have the + 8 VDC regulator to work properly thus the + 10 VDC. On the other end you need a several volt differential to produce + 10 VDC. The source that was chosen was the 12.6 VAC filament supply that was run into a 1N4007 diode that is configured as a simple diode rectifier. Given the low current draw you would expect around 13 or so VDC coming from that rectifier which is more than ample to drive an LM317 Adjustable voltage regulator. By selecting two values of resistors it is possible to develop a whole array of fixed output, regulated voltages. There are calculators and look up tables on the Internet that give the values and expected outputs. I chose 220 Ohms and 1650 Ohms. With these values the LM317 outputs +10.5 VDC –perfect! Below is the schematic of the power supply to power the X-Lock-3. The LM317 has another function in that it will “clean up” the input signal, so that is a bonus. The power supply was built on a small piece of Radio Shack Perforated Board and mounted on the underside of the chassis.

X-Lock-3 Power Supply



The 220 Ohm and 1650 Ohm Resistances set the 10.5 VDC level

Note the HW-101 is primarily a vacuum tube radio and therefore there must be a low level power source to power the X-Lock-3. The 12.6 VAC Filament Supply is used to provide the final source voltage of 10.5 VDC to power the X-Lock-3.

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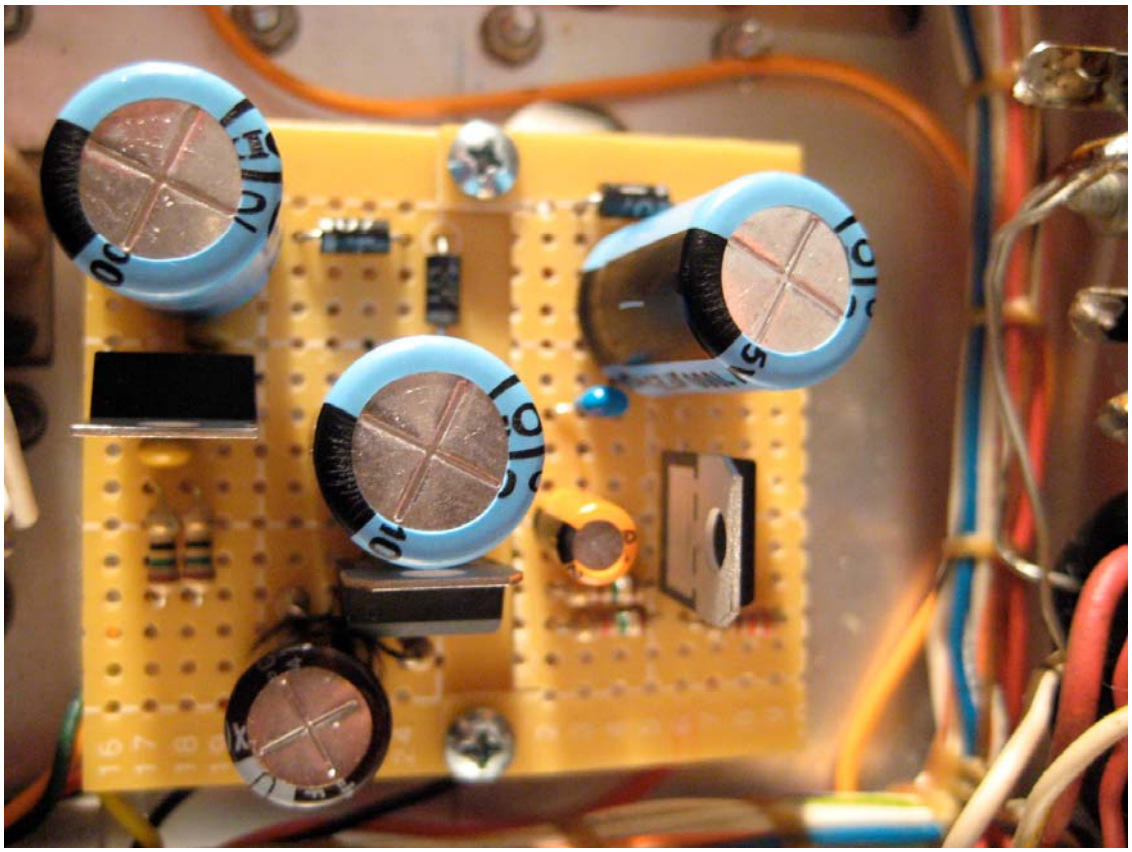
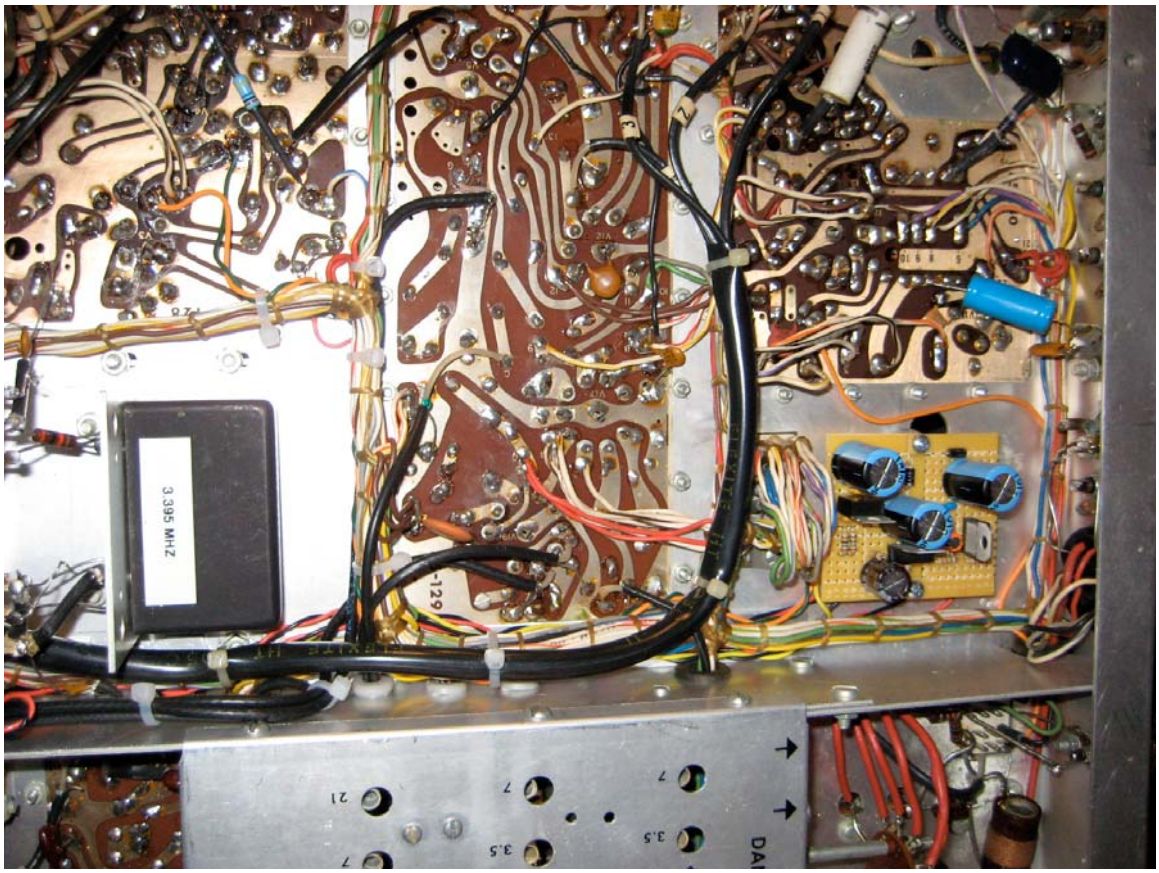
In the Drake vacuum tube radios of the same vintage, that frequently had solid state as well as vacuum circuitry, the Drake engineers simply used dropping resistors off of the low voltage screen/plate supply. Needless to say there was a lot of heat just to get +12 VDC.



These are the two power supply boards, one for the digital dial and the other for theX-Lock-3. The one of the right is the X-Lock-3. It was difficult to find space on the underside of the HW-101 to add circuit boards. I found one spot where I could install two aluminum pillars approximately 3/8 inch high that were spaced the exact width of the Radio Shack Perforated Board. One of the pillars mounting holes was actually inside the PA cage. So as you can well understand – measure 40 times and cut once. In order to utilize a single set of pillars to support both power supply boards, I notched the power supply board for the X-Lock-3 so that the board mounting holes could be utilized and yet the board itself not interfere with already installed components. If you look carefully at the top mounting screw you will see three diodes, which are all 1N4007. These three diodes are fed with 12.6 VAC from the filament rail to develop three separate DC voltages. The point is that I was able to make relatively short connections from the 12.6 VAC rail to the three supplies that are on the two boards. Measure 40 times and cut once. It was no accident that the boards were laid out this way! The three supplies develop 9.66 VDC and 5 VDC for the Digital Dial plus 10.5 VDC for the X-Lock-3. For those skilled at making printed circuit boards this of course would make the install much easier as a smaller footprint board could be developed. Below is a birds eye view of the bottom side of the HW-101 to give you a feel of the not too much available space to add circuit boards.



The last phase is the final integration and that is to simply connect the VFO input that was sampled from the lead going to HW101 circuit board. The power was connected to the X-Lock-3 and a lead was connected from the voltage correction pin to the correction circuit installed on the top of the VFO enclosure. At power on the status led goes through its start up sequence only it will blink “red” for several seconds – the buffer stage following the solid state oscillator is a vacuum tube and will have no output until it is warmed up. Then it will lock “green” indicating that it is working. Now the digital dial reading does not move!

One very nice feature of the X-Lock-3 is that operating CW. It is so cool to key the radio and see the digital dial display change to the CW offset frequency and then return to the stored frequency when you have completed the CW keying sequence. Thank you Ron for including this feature in the X-Lock-3!

With the Digital Dial and the X-Lock-3 this is about a $120 upgrade. To breathe new life into an older vintage radio that is less expensive than buying a whole new radio! The X-Lock-3 kit costs about $55 as delivered from the UK and is well worth the cost. The digital dial once set on frequency does not move. The HW-101 by itself was a well - designed radio for its time. The updating of the radio with the known circuit improvements and addition of some current technology now makes the HW-101 a modern radio.

73’s
Pete N6QW