

**DEM Part Number 90X-144 PCB, K and CK
33 cm Transverter PCB, Board Kit, and Complete Kit**

Specifications

Frequency range:	902 or 903 MHz. = 144 MHz.
Noise Figure and Gain:	<1.5 dB NF, > 17 dB Gain with a +17dBm high level mixer
Power Output:	1 watt or 20 mW with low power level configuration
TXIF Drive level:	-20 dBm to 10 watts maximum dependant on IF configuration.
DC Power requirements:	13.8 VDC nominal. 11 to 16.5 VDC operational.
DC Current drain:	500 mA to 2.0 Amps depending on output power level.

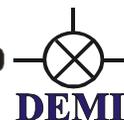
Operational Overview

The DEM 90X-144 is a 33 cm to 144 MHz transmit and receive converter. It has a linear output power of approximately 1 watt and may be achieved with as little as -20 dBm mW or a maximum of 10 W of IF drive with the correct IF configuration. The highlight of this transverter is the receive section. The design uses a PHEMT that has a high-pass tuned input circuit biased for High IP3 output performance. It is followed by a 2 and a 3 pole helical filters, a high output IP3 MMIC gain stage, and a high level mixer with a IP3 output of +30 dBm. This design provides a sensitive low noise receiver with superior out of band signal rejection that tolerates very large in and out of band signals. The base oscillator of the local oscillator circuit is housed in a shielded enclosure on the circuit board. This shield coupled with the higher frequency base oscillator operation, (189 MHz), reduces the amount of spurious output while providing greater temperature stability. The oscillator has "Hooks" includes in the design to enable the ability to be coupled to a PLL circuit. This will be covered in a future design note.

The transmit section of the DEM 90X-144 has 5 poles of filtering to eliminate all spurious emissions. It also has a built in transmit / receive relay on the RF side with provisions for external switching for adding a high power amplifier or preamplifier to your 33 cm system. The 144 MHz IF levels and options are adjustable on both transmit and receive with a dynamic range of approx. 25 dB. This is useful for adjusting your maximum output power and setting the "S" meter level on your IF receiver. BNC connectors are used for all IF connections. Options have been provided for a key line input PTT-H (+1 to 15 VDC) or PTT-L (a closure to ground) and auxiliary contacts on either transmit or receive with a common line for many applications. The control, power, and auxiliary connections are via RCA jacks. The 33 cm connectors are Type 'N' or SMA if separate TX and RX ports are chosen. The 90X-144 is housed in our standard 4.125" x 1.875" x 7.75" extruded aluminum enclosure that matches all of our other microwave transverters.

General Information

The generic technical design detail information is posted in the library section of the [Down East Microwave Web site](#). The paper shows the receive converters immunity to out of band signals and covers the design stage by stage. The 90X-144 kits and PCB are supplied with a schematic and component placement diagram. The PCB is made of 0.062" thick Fiberglass G10 material. It has plated 1oz. copper with plated through ground Vias and will only require a general understanding of the circuit design accompanied by good construction practices to produce a great working transverter. The circuit board alone may be assembled and used in many different configurations. It is perfect for the experimenter in the 33cm band and requires very little microwave expertise.



The PCB by itself doesn't require external mechanical support but will require a special mounting technique. Down East Microwave **will guaranty the performance** of our circuit board with your configuration but **will not repair any transverters built from the 90X-144PCB unless all components used are specified on the component list that accompanies the PCB when purchased!**

For a higher probability of success, and 100% support of Down East Microwave Inc., we recommend at the minimum, using the 90X-144K. The K includes the PCB and all components required to produce a 33 cm transverter. If higher output power is required, you may simply order one of our amplifier kits or take advantage of many surplus units available on today's market. The 90X-144CK (complete kit) includes the board kit and the necessary hardware, connectors and enclosure. Also included in the CK is a special mounting plate that allows the mounting of the assembled PCB into the enclosure provided. The [circuit board mounting plate](#) is machined so that the helical filters, PCB, local oscillator shield, and all external DC and RF connectors are mounted together as a complete assembly before installing in to the enclosure. This plate is the key to the maximum reliability of the transverter (heat transfer and spurious oscillations) and allows complete alignment before final assembly into the enclosure. If you wish to upgrade to the complete kit after reading this document, please call and you will only be charged the difference in price of the 2 kits.

Circuit Description

A local oscillator of 189.xxx MHz is multiplied X 4, filtered, and amplified to the +17dBm level and is injected into a high level mixer. In receive; the 33 cm signal enters through either the RX port or the common antenna port. It is amplified by a high level, tuned input PHEMT low noise amplifier that has approximately 16-17 dB of gain with <1.0 dB noise figure. The input circuit is designed to attenuate signals lower in frequency than the desired 33 CM band. The amplified signal then passes through a 2 pole helical filter that allows approximately 26 MHz. of amplified bandwidth. This signal is then amplified by a high level MMIC before being filtered by a three pole helical filter that restricts the receivers operation to a narrow segment of the 33 CM amateur band. This signal enters the high level mixer and exits the IF port passing through a VHF low pass filter and optional IF gain stage with a variable attenuator. Then depending on the configuration, it will pass through the IF switch or not before becoming available to the 2 meter receiver.

On transmit, it is a reverse process. The 2-meter transceiver applies a signal of up to 10 watts of drive and is then attenuated or amplified before being filtered and enters into the mixer. The 33 cm transmit signal then exits the mixer and is filtered by the three pole helical before being passed through the transmit gain stages. It is amplified up to approximately +15 dBm before it is filtered again to narrow the pass band energy. At this point, the signal can be used as is or be amplified up to the 1-watt level before either exiting the TX port or the common antenna port.

Different LO input, RF and IF frequency schemes may be used with the 90X-144K or CK such as 902 =144 or 903 =144. Simply specify at the time of ordering. If something other than the two standard frequencies are required, do the math and order a special frequency crystal! There are a few limiting factors for different frequencies of operation. The IF will operate on any frequency between 100 and 185 MHz. The RF filters will cover the whole 33 cm band. The LO will tune within the range for a 144 MHz. IF but all filters included in the kit will need to be re-tuned and the levels will need to be checked. Therefore, if attempting a large frequency change or using an odd IF frequency is not recommended unless you have a known signal source and a spectrum analyzer to determine your desired outcome of the transverter.

For a more detailed circuit description about any component or circuit in particular, or if you have questions about a desired scheme, we recommend you contact Down East Microwave before proceeding with a modification to the kit.

Assembly Tips

It is recommended to read the entire document before you begin to assemble the kit, but the following few paragraphs is a compilation of assembly techniques used and required to assemble this kit. These various assemble techniques will be used for more than one component and may determine the outcome of this kit. Review the examples shown and become familiar with the components described in the text.

Soldering surface mounted active components

The dots or angle cut leads on the MMICs IC1-IC3, IC5-IC7 and IC11 are as shown on the component placement diagram and determine their correct orientation. IC3 and IC7 have the dots on the output lead. IC10 is a three-leaded package with a solder tab. Its orientation is shown on the component placement diagram. IC12 is the 1-watt power amplifier and pin one is indicated. Special installation instructions will be covered later in this manual. All MMIC's must be positioned correctly prior to soldering. Removing a MMIC without damage is difficult. The PHEMT, Q3 has a wide lead for one of the source leads. (See figure 1B) Leads on all active surface mounted components should be somewhat flat against the mounting surface, if they are not, a small tool such as a small bladed screw driver can be used to flatten them before attempting to solder (See Figure 2). Solder only after leads have been pre-formed if required.

1. To begin to solder, pick one pad on the circuit board that you wish to attach the active device. Without the component in place, heat one side of the mounting area and Tin the area by flowing a small amount of solder on it. Allow it to cool.
2. Align the desired component on the circuit board based on the placement diagram. While holding the component in place, apply heat to the tinned pad and re-flow the existing solder until the component lead "drops" into the solder. Allow to cool and observe the alignment of the leads.
3. If the alignment is acceptable, solder the remaining leads. You need enough solder to cover the lead and mounting surface of the entire lead length. (See Figure 2 shaded areas) If necessary, re-solder the original lead.

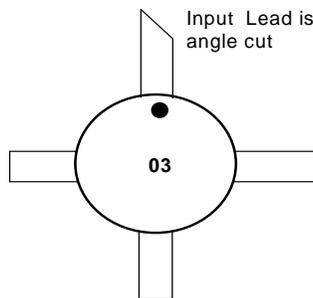


Figure 1A

Leads flat to trace, 4 places
Some spring back is OK

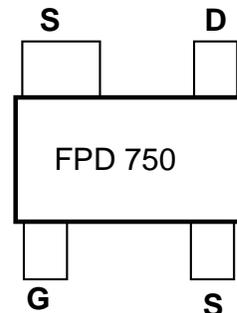
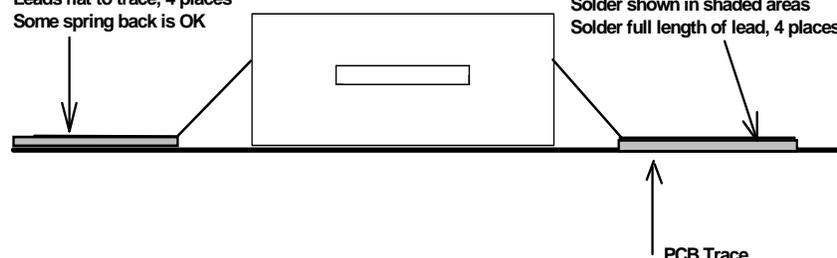


Figure 1B

Solder shown in shaded areas
Solder full length of lead, 4 places



Typical side view of four leaded surface mounted device, lead bending close to body.

Figure 2

Soldering surface mounted passive components such as chip resistors and capacitors:

1. Determine the component mounting position based on the assembly diagram.
2. Without the component, tin one of the mounting pads not shared by another component. (flow a small amount of solder on it)
3. After cooling, place the component in the correct position per the assembly diagram; it should now have one end over the tinned area.
4. Holding the component in place with tweezers or other soldering aid, heat the tinned area and allow the solder to flow around the component. Remove the heat.
5. Once solidified, remove holding tool and heat and flow solder to the other side of the component only if it is not shared by a second component. If so, solder the component that shares the pad first. You're done! See examples in figure 3.

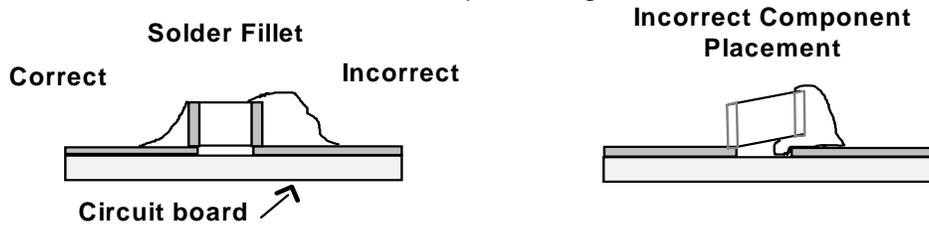


Figure 3. Proper SMD Assembly.

Soldering leaded components (resistors, capacitors, diodes, and inductors) :

Depending on your available tools, you can solder your transverter's leaded components from either the top or bottom of the PCB. It is suggested for the home assembler to use a method that is comfortable. A simple holding vise can be utilized to allow the components to be 'dropped in' from the topside and soldered on this side without flipping over the assembly. As an alternate method, you can insert one component at a time in the correct mounting location and gently push down to the circuit board, while holding the component, flip over the circuit board and bend the leads over in opposite direction to hold the component in place. Although this is the most reliable method, there are some drawbacks if the component must be removed when the PCB is installed in the enclosure.

Some leaded components may need to be surfaced mounted either on one or more leads. If this is the case, the leads need to be pre-formed before soldering. If you see a leaded component on the component placement diagram without a circle at the end of the lead such as R25 and R12, those leads will need to be surfaced mounted as shown in the drawings below. **DO NOT** install any leaded components in the ground via holes if it is shown as a surface mount lead. The PCB mounts to a pallet and if there is any solder or extended lead interference, the PCB will not be flush with the pallet.



Figure 4.

Some inductors are pre-formed and some will need to be formed such as L1. It is suggested that the coils be formed on the supplied wooden dowel. Winding coils is not an exact science and you should not be intimidated by it. Using the enamel wire supplied, extend about ¼" in a perpendicular direction off of the dowel and wind the wire around it, counting each revolution as one turn. When the total number of turns is completed (see the component list) cut the wire an additional ¼" beyond the dowel. Form the two ¼" leads so they are pointing in the direction as shown in the detail below.

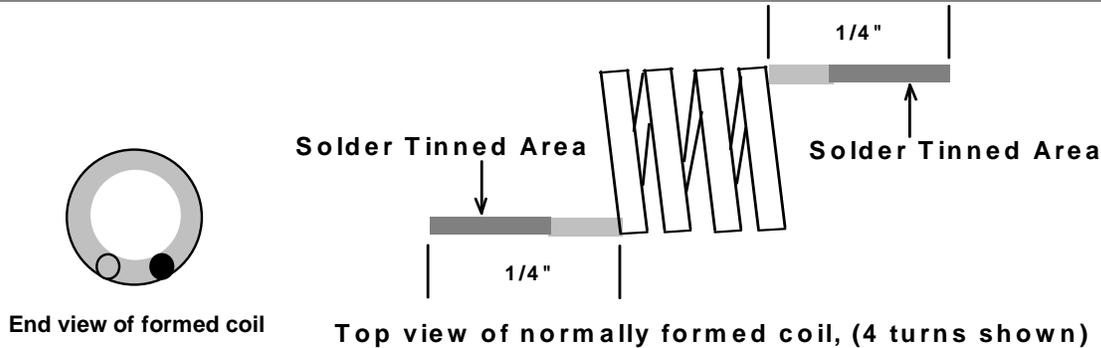


Figure 5.

Dress the turns together if they are out of shape from winding, remove the coil from the dowel. The coil forming is complete! To ensure a positive solder connection, the ¼" leads should be solder tinned as follows. With a solder iron, flow a pool of solder on the tip. Place the desired end of enamel wire in the pool of solder. It may take a few seconds depending on the iron temperature, but the red enamel will melt and be replaced with a solder tinning. Also tin L8. It is pre-wound.

Rework of soldered components if needed

The easiest method to rework soldered components is to employ a de-soldering braid that is specifically designed for this purpose. It can be purchased at most electronics component distributors. Place the de-soldering braid on the lead that you are removing and apply heat to it. **Without excessive pressure**, the solder will flow into the braid leaving the lead or component ready to be removed.

Printed Circuit Assembly Notes

Your kit is provided with easy to read component placement diagrams that detail every component placement and the reference designators that correspond to the provided component list (Bag 1 - Bag 4). Each side of the printed circuit board (PCB) is also shown to eliminate mirror image assembly errors. The top and bottom side assembly operation should always begin by aligning the PCB outline with the out line of the component placement diagrams. The top side of the circuit board is the side with the printed lettering on it. Most of the soldering will be done on the top side. Again, when soldering on the ground plane, be sure that solder does not flow and pool on the bottom side of the PCB.

Start the Assembly

This is a basic assembly instruction document for the 90X-144 kits and is for an average to experienced RF circuit builder. The 1 watt PA (IC12) is pre installed but may be bypassed if you only require less than 20 mW. The filters have been tested and should not require alignment. To align this kit, it will only require a volt meter, a 33 CM signal, and a power meter that will measure up to 3 watts maximum. If you have access a frequency counter, a signal generator, and a milli-watt power meter it would be a plus.

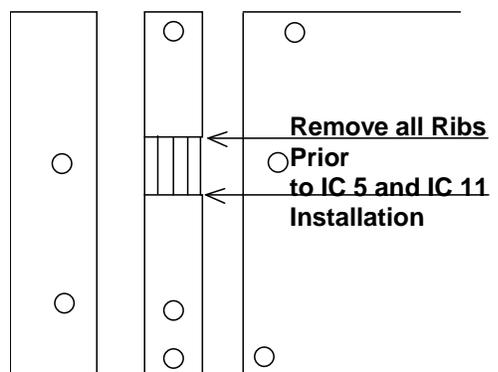
Inventory the parts list because every part in this kit is important and should be identified. Bag 1 are the resistors, Bag 2 are capacitors, Bag 3 are the inductors and Bag 4 are the semiconductors and relays. The filters are listed on the components list but may be installed. Take your time to get familiar with the kit contents and verify it is complete. There are extra chip components packed in the vials, so no need to count them. Just verify that the value is included.

The hardware should be sorted and identified. There are some extras. But remember, **No substitutions or you are on your own!!** Review the schematic and the component placement diagram. Read all of the assembly steps 1 - 13. Identify every component used. This will ensure that you have the correct tools and supplies required to complete the transverter. It is also time to make the last minute decision on building the kit or not. A full exchange towards an assembled version will be provided if you do not go past this step. We want you to be on the band and operating not struggling to assemble this because you were not aware of what it takes to assemble this transverter!

At this time, you may want to mark the component placement diagram with the associated component values by the designators. Simply transpose the component list to the component placement. We do not do this because the values of the components will change over time depending on availability, engineering changes, or obsolesces. The component list is easier to update and maintain providing all of our builders the latest improvements or changes to the design. Updates to the design will be maintained on the DEMI web site in the future. Now, start the assembly!

1. Install all bottom side components of the PCB first. Start with K1-K3, then Q1 and Q2. Do not solder the cans of Q1 and Q2. Then, install the filters. Be sure they seat flat and square and solder all pins.

2. On the topside, install Q3, IC1- IC3, IC6- IC7, and IC10 per the component placement diagram. Install IC11 if your TX drive level is going to be less than 1 mW. If you elect to install IC11, a modification must be performed to the printed circuit board. Referring to the diagram below and the assembly document, remove the "Ribs" by cutting at the two indicated points with a sharp razor knife or blade and heating with a soldering iron to remove. Proceed to install IC11 using the procedures outlined previously. Do not install IC5 at this time. It may or may not be installed after final testing of the unit. If you do decide to install IC5, use the same procedure as IC11.



3. Install all surface mount capacitors, resistors and L9 per the topside component placement diagram. Do not install C47 and C55 if you do not need more than 20 mW of TX power. Review the assembly tips if necessary pertaining to multiple components sharing the same pad. Be sure of the placement of C57 and C59. They are dependent of the configuration of the transverter you require, common antenna port (pads marked with a "A") or split transmit and receive (paths marked with a "B"). Orientation of C60, and positioning of C61, C62, C50 and C54 is critical to the transverter's operation.

4. Install L1-L10 after winding inductors L1, L4 and L5 as specified on the Bag 3 parts list. L7's placement is dependent on the placement of C59 (A or B). All inductors should be surface mounted and lay flat on the board. L12 is an option and will be discussed later

5. Now, install all left over leaded components, (pots, resistors, capacitors, diodes, transistors and regulators). **Do not install** IC4, Y1, SW1, PTC1, R22, C77, or the LED's.

Do a surface mount installation of VR1, R25, R26, R10, R12, D2, D3, D8, and D9. R16 is installed if IC11 is installed. R18 will be covered later. Install VR3 if you desire 1 watt of TX power. Do not allow solder to leak through the ground plane of the PCB. It will pool up and interfere with the pallet assembly. If you have a question, place the PCB on the pallet to check.

6. Install Y1, the crystal as shown in Figure 6. The heater assembly will occur later after testing. The topside component placement shows the crystal standing up but lay it down over L2 as shown in this pictorial.

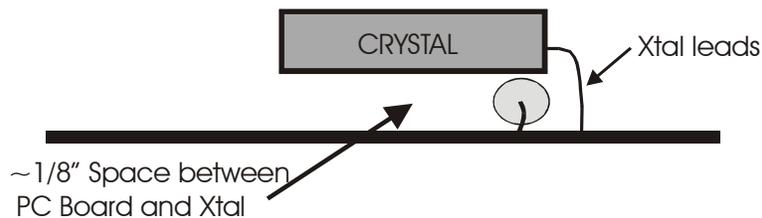
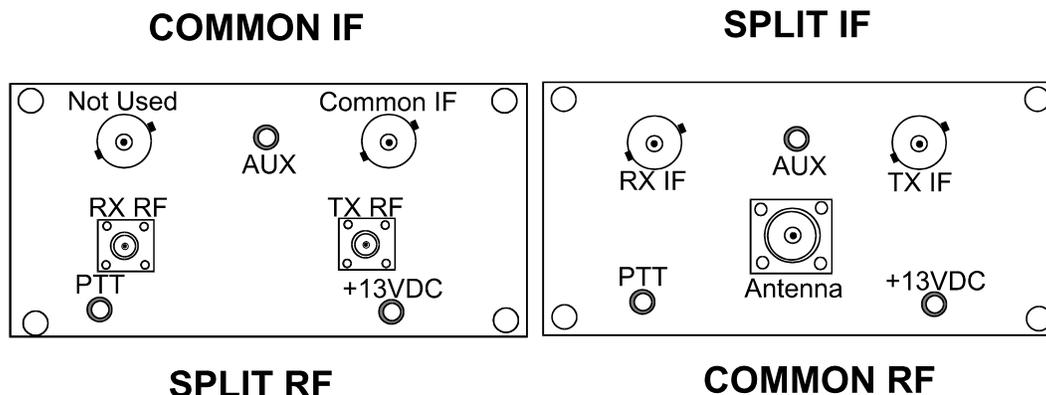


Figure 6. Crystal and L2 installation detail.

7. Attach the PCB to the pallet. Use 4-40 x 3/16" screws by K1 relay and in the PA section and two 4-40 x 1/4 " screws by the oscillator section. If you find interference between the PCB and the pallet from solder, remove the solder by wicking or filing! Make the board fit flat on the pallet.

8. Attach the connector panel to the pallet. Review the configurations below. Your panel has all of the holes in it. You may install all of the connectors or just the connectors you desire. Trim the Teflon on the connectors flush with the panel. Use the 3-48 screws for the SMA connectors or 4-40 screws for the N connector. The longer screws (3/8") go through the connector and panel, then into the pallet. The short screws (3/16") hold the connectors to the panel. You may use the screws to plug the holes if you do not use the connector. After the connectors are installed, verify that the panel is a flush mount with the pallet and then solder the pins. If you need to re-position the PCB or re-trim the Teflon for the panel to be flush, do so.



9. Use the bottom side assembly as a guide and wire the connections with the supplied #24 Teflon wire. Make the connections from the +13.8 VDC and PTT connector to the PCB. Install the ground lugs as shown with the short 4-40 x 1/8" screws and solder the 1000 pF caps in place.

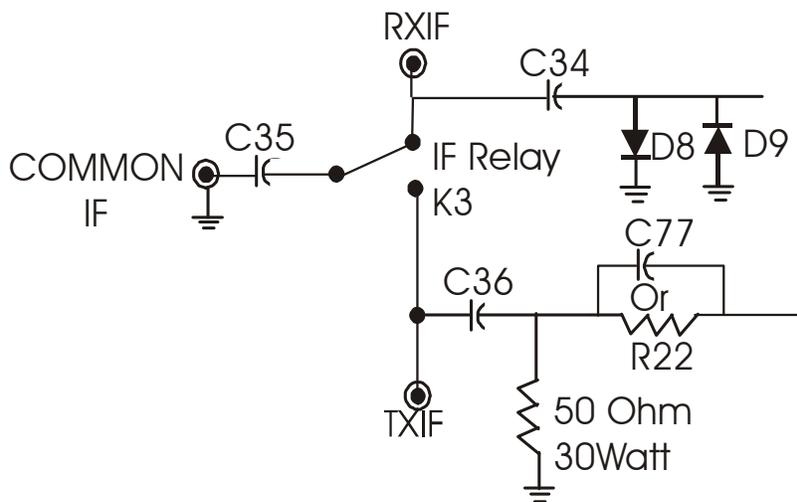
10. Find the bottom half of the enclosure (the one with the holes in it) and line up the pallet with the mounting holes. Insert any two 4-40 x 7/16" screws and start them. Install 2 flat head screws in the rear panel. Be sure the wires are clear of the ribs and filters and tighten all screws. If the pallet wobbles, something is being pinched!! Insert the switch (SW1) into its position but do not solder. Now install the switch panel with 2 flat head screws positioning the switch to fit then solder the exposed switch leads. Install the LED's. The short lead is ground. Now remove the pallet from the enclosure to trim all excess leads and solder the mounting leads of the switch.

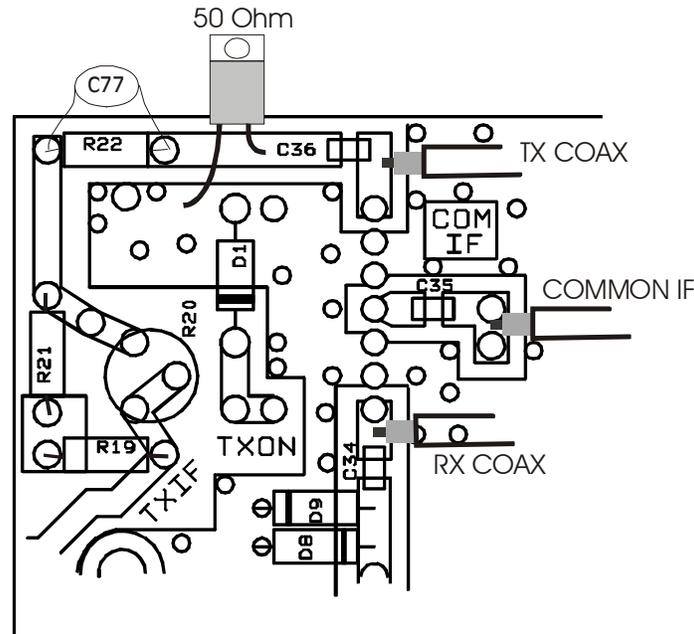
11. Next, make a determination of what keying scheme you will use, PTT-H (+ voltage) or PTT-L (Ground to transmit) and make the appropriate jumper connection from the PTT connection on the topside of the PCB. If you desire the 20 mW output, connect a coax jumper between the pads shared by C47 and C55. Look for the "C" designator on the component placement. Be sure C47, C55 and VR3 are not installed and the coax shield is soldered to ground. Connect a short #24 wire between the pads labeled "A" by R29 and C56.

12. Using the matrix below, make a determination of the maximum required IF drive level and decide if you want a common or split IF. All IF drive level maximums may be achieved from -20 dBm to 10 watts by following the supplied matrix, schematic, and simplified component layout. The 50-ohm load is mounted on the front panel (heat sink) and is installed after pallet alignment with the front panel. Only install IC 11 if you have less than 1 mw of drive.

144 MHz. IF Configurations

	-20 dBm to 0 dBm	1-200 mW Drive	200 mW-1W Drive	1-10W Drive
C77	Not Installed	Not Installed	Not Installed	Installed
50 Ohm	Not Installed	Not Installed	Installed	Installed
R22	Replace with short	Installed	Installed	Not Installed
IC11,R16	Installed	Not Installed	Not Installed	Not Installed





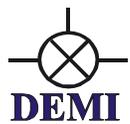
IF Connections, Common or Split

13. Install the IF coax between the IF connector (s) on the rear panel and their proper locations on the PCB. Refer to the custom pictorial and the IF configurations matrix.

Start the Testing Procedure

1. All of the initial testing of the transverter is done with the pallet assembly only. Before you start, verify that all components are installed except for IC4 and the 50 ohm load. Connect a 13.8VDC supply capable of 2 amps to the +13.8VDC connector. Flip the switch to the on position (Up) and verify that the LED lights.
2. Test the receive voltages of the transverter first. Use the RX matrix below.

LOCATION	RX VOLTAGE Matrix referenced to Ground
Junction of C68 and VR4	+13.8VDC (power supply voltage)
Output of VR1, C10	+9.0VDC \pm 0.2V
Output of VR4, C66	+5.0VDC \pm 0.2V
Junction of IC1 and C7	Between 1.5 and 2.5. Depends if Oscillator is running or not
Junction of IC1 and C9	Between 2.5 and 3.5. Depends if Oscillator is running or not
Junction of IC2 and C12	2.5VDC \pm 0.3V
Junction of IC2 and C13	3.5VDC \pm 0.5V
Junction of IC3 and C13	1.5VDC \pm 0.3V
Junction of IC3 and C16	6.0 VDC \pm 1.0V
Junction of IC5 and C29	2.5VDC \pm 0.5V (Optional)
Junction of IC5 and C31	5.0 VDC \pm 0.5V (Optional)
Junction of IC10 and C74	2.5 VDC \pm 0.5V
Junction of IC10 and C70	4.8 VDC \pm 0.5V
Junction of Q3 and R30	2.0VDC \pm 0.5V
Junction of Q2 and C6	8.8VDC \pm 0.5V
Junction of Q1 and C3	9.0VDC \pm 0.5V



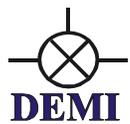
If any voltages are found to be out of tolerance, check for assembly errors, opens, shorts, or wiring mistakes on the bottom of the pallet. Some voltages may exceed the tolerances listed. This is because MMIC's vary lot to lot. MMIC's will exhibit a current drain if working. They will either drop all of the voltage across the resistor if shorted or not draw any current if blown. If the test voltages are close, assume the MMIC is working correctly but verify the associated circuitry.

3. Read all of the RF testing procedure through before starting. If you have test equipment like a signal generator, spectrum analyzer, and mw power meter, you may decide not to install the mixer to complete the testing. The test procedure will cover both methods of testing

If you do not have an mW power meter, spectrum analyzer, or anything to determine the level of the LO power output (+17dBm) install IC4, the mixer after verification of the RX voltages. If you have a milli-watt meter, connect a coax pigtail to the open pad on C17. This will be the LO circuit's output and the Mixer's LO input. This pigtail should have a good quality RF connector so it can be used for measuring the power level and frequency. Start the oscillator tune up by applying DC power and probing the junction of R6 and C7. There should be minimum of approximately 0.4 VDC. If the oscillator isn't running, spread or compress the windings of L1. Do not go more than one wire thickness at a time. After the LO is running, adjust C2 to peak the voltage. If you have a power meter connected, verify that the output is +17 dBm. (+15 dBm minimum) You may want to slightly "Tweak" F1 and F2 for maximum power. Do not adjust F1 or F2 after the mixer is installed! After the voltage is peaked, verify the frequency of operation if you have a frequency counter. If you installed the mixer, you can probe C17 with a frequency counter. The frequency should be approximately 758 or 759.000 MHz. depending on chosen IF frequency. You may not be able to adjust C2 to net the frequency. It is not important at this time and will be adjusted after the final assembly. Just be sure the voltage is peaked and frequency is within 20 KHz. If you can measure it.

4. After the LO has been tested, remove the DC power from the pallet and solder the cans of Q1 and Q2 to the ground plane. Next, see the attached addendum labeled PTCSK for installing the PTC crystal heater and follow the procedure. After the assembly is attached to Y1, power up the oscillator to verify operation. Allow a 5-minute warm up and re-peak the oscillator. You may now attempt to "Net " the frequency if you have a meter. If the frequency is low or will not re-start after netting the frequency, replace C78 with the optional 8pF chip cap and re-test. What is desired is that the oscillator will adjust 2-3 kHz high and function normally before the shield is installed. If OK, install the shield over the oscillator with the two 4-40 x 1/4" screws and two #4 flat washers. Be sure not to short the output of F1 to the case or touch the legs of the switch with the shield. Position the shield as shown on the component placement diagram. If you are unsure if the shield will not short the F1 filter, you may cut a small notch in the shield by C12.

5. The RX testing is as follows. If the mixer is not installed, connect a power meter or spectrum analyzer to what would be the RF port of the mixer with a pigtail coax. If the mixer is installed, connect the IF port of the transverter to a 144 MHz transceiver and adjust R14 counter clockwise. Inject a 902/903 signal into the antenna or RX port (-30 dBm or so) with a signal generator or use a signal on the 33 CM band. Adjust C59 and C60 for maximum signal strength on the spectrum analyzer or in the 144 MHz transceiver. Tune for max gain. This will be very close to best noise figure. When complete, cycle the transverter power on and off to detect the gain in the receiver. A final adjustment will be made after the final assembly is complete so you do not need to make it perfect. Just verify that the receiver has gain. This would be the time to "Tweak" F5 and F3 if you desire and have the required test equipment but not with an on the air signal.



6. Transmit testing is next. If IC4, the mixer is not installed, do it now. Now to test the TX voltages, key the PTT line then measure and verify the TX voltages against the TX voltage matrix. Be sure to have a 50-ohm load on the antenna or TXRF connector.

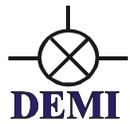
LOCATION	TX VOLTAGE Matrix referenced to Ground
Output of VR3, C76, 1 watt version only	+5.0VDC \pm 0.3V,
Junction of IC6 and C41	+2.5VDC \pm 0.5V
Junction of IC6 and C44	+4.5VDC \pm 0.5V
Junction of IC7 and C44	+1.5VDC \pm 0.5V
Junction of IC7 and C45	+6.0VDC \pm 1.0V
Junction of R12 and D2	+1.6VDC \pm 0.3V
Junction of D3 and L5	+0.7VDC \pm 0.3V
Junction of D1 and K3	+13.8VDC
Junction of D7 and K1	+13.8VDC
Junction R40 and D4	+0.7 VDC \pm 0.3 VDC
Junction of C53 and IC12	+ 5.0 VDC, \pm 0.3 VDC
Junction of C52 and IC12	+5.0 VDC, \pm 0.3 VDC

If any voltage is out of tolerance, verify all surrounding component values and recheck bottom side wiring. Remember, MMIC current drain is a specified amount, but due to tolerances, they may differ a bit.

7. To RF test the transmit section; you need to use your 2meter transceiver or a 2M signal from a generator. Anything less than 1 watt of IF drive can be tested without installing the pallet in the enclosure but be sure to install the 50 ohm load if required in your configuration. If more than 1 watt, the load needs to be heat sunk to the front panel so install it in the enclosure.

Connect a power meter that can measure 3 watts @ 900 MHz to the TXRF or ANT connector. Connect your IF drive source to the BNC connector (common IF or TXIF). Check your drive power level before applying drive. Adjust R20 clockwise for maximum attenuation. Key the PTT line and apply TX drive either from your generator or transceiver and adjust the R20 to obtain the desired 900 MHz output power. If you cannot obtain the correct output power by adjusting R20, (10 mW for the low power, 1/2 watt for the 1 W version) check your configuration and measure your drive level. Do not assume that there is too much attenuation in the IF section. If the IF is configured for a lower drive level, damage may occur to the mixer if it is over driven even for a short period of time. If you have variable output power on your 2 meter transceiver or generator, set it to the minimum and raise it until saturation occurs. If this happens, before maximum power is reached on the transceiver, suspect a problem in the TXRF section of the transverter. If the transverter does not appear saturated, suspect a problem in the IF section and revisit the IF configuration section.

In the 1 watt version, if saturation occurs, it is possible that the positioning of C50 and C54 may be off. Be sure that C50 is as close to IC12 as possible. If OK, find the extra 1.5 pF chip and solder it on one side or the other of C54 and retest. If it decreases the output power, place the 1.5 pF on the other side of C54. You may do this even if you have a full 1 watt of output to possibly increase the efficiency of the amplifier.



Final Assembly

Drop the pallet into the bottom enclosure (in not installed previously) and start all 6 of the 4-40 x 7/16" screws. Do not tighten. Start the rear panel screws. Then install the front panel and gradually tighten all of the 10 screws together to ensure a good fit. Tighten everything evenly to be sure that the pallet is resting on the ribs in the enclosure. Be sure not to pinch any wires. Check all screws and connectors for tightness. Place the top lid on the enclosure and allow the unit to operate in receive for 1 hour with either a load or an antenna connected. The unit will become warm to the touch. If you have a 33 cm signal and the IF transceiver connected, you may notice some frequency drift. After the first hour of operation, the majority of frequency drift is complete and the oscillator will be stable enough for netting the frequency if required. Remove the cover and adjust C2 through the adjustment hole for the final "Tweak" to match the frequency of a known signal or measure the LO frequency at C17 to "Net".

When complete you may retest the RX and TX section and re-adjust the IF levels as desired. The standard RX gain of the transverter is over 25 dB so in all but a mast mount installation, the RXIF gain stage, IC5, should not be required. In case your system gain does not come up to spec, do not just add IC5 to compensate. Find the problem in the transverter if you wish to maintain its strong signal handling performance. If you wish to install any user options, see the next sections of this document or just attach the lid with the 4 screws and get on the air.

Peak Performance

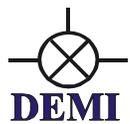
So, you want the best possible performance possible? Unless you have a signal generator, noise figure meter, spectrum analyzer, and a microwave power meter, you have given it your best shot. If you do have this equipment, then have at it. Every filter can be optimized to your operating frequency for maximum selectivity and minimum insertion loss. All of the filters have been tuned into 50 Ohm system. Once they are connected to the active components, they now have some mismatches. Please understand that these mismatches are not crucial to the operation of the transverter, but they can be minimized. Do what your engineering skills allow you to do. You could always find a dB or two in gain, reduce the spurious emissions, or improve the system noise figure. You may also find out that if you reduce your TX drive level, the spurious improve. A lesson well learned in mixer saturation. Have fun!!

Frequency Stability

If the frequency stability is the problem, remove the shield and re-peak the voltage. When adjusting for netting of the frequency, the oscillator is sometimes left on the edge of operating. When on this edge, the frequency will be unstable. After the voltage is peaked, replace the cover on the LO and allow it to warm. Check for stability. If stable, follow the frequency netting instructions in our DN016 design note found on our web site. If the voltage is peaked and you still experience drifting (greater than 300 Hz. After a 10 minute warm up), record its tendencies and consult DEMI with the problem. Stability is the function of temperature and component tolerance. If you are sure the LO section is assembled correctly we may be able to help.

Completion and Conclusion

This completes the assembly and testing of the 90X-144CK. You now have enough knowledge of how this assembly works that implementing it into a complete working transverter system should not be a technical problem. We hope you had fun with this kit and that you enjoy many hours of operation with this transverter. The goal of this kit was to economically provide the



radio amateur with the highest performance available in a 33 cm transverter while maintaining a compact and portable design.

We wish you years of fun and excitement working many contacts both local and DX!
Good luck on the band!

DEM 90X -144 User Options and performance Improvements:

Add an external preamplifier for noise figure improvement.

The receive section of this transverter is designed to not overload in a RF dense environment. If the transverter is to be used in a high performance terrestrial or EME set up, a mast mount LNA that has better noise figure performance will be desired. If so, additional filtering may also be required. It is not recommended to add an LNA unless it is mast mounted and it is of a modest gain. Understand that the addition of gain in front of this stock transverter will degrade the IMD performance, and reduce the dynamic range of the transverter by more than the amount of gain added. You may get away with doing nothing more than adjusting the RXIF gain control if you operate in a non hostile RF environment. If your LNA is a ultra low noise unit, it most likely will not have the IP3 performance the transverter has. It will overload before any component in the transverter will. So, your receive system now becomes limited by it's external LNA's performance. If you increase the gain performance of your external LNA, (25-30db) you may consider bypassing the transverters LNA completely because it's IP3 performance is totally controlled by the external LNA. To do so, remove L7, C59, R31, L9, and R30 from the circuit. Then connect a short piece of coax between the RX antenna and C63. Be sure to keep it as short as possible and solder the grounds.

Install / Remove RXIF gain stages:

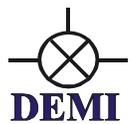
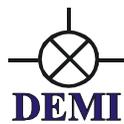
Installing the RXIF gain stage with the supplied IC5, will not decrease the IP3 performance of the transverter, but depending on the IF transceiver being used, the system dynamic range may degrade unless its receiver is of the highest quality. This may be possible with some of the 28 Mhz IF's on the market but doubtful with a 144 Mhz IF. It is better not to use IC5 in the circuit if you will be using it in a High RF environment. Also understand that adding the IF gain stage and then increasing the attenuation of the RFIF gain control to optimize your IF's ability to handle the strong signals, still degrades the system dynamic range. Using the supplied MMIC doesn't degrade the transverters overall IP3 performance, but as stated before, it puts the stress on your IF transceiver. **A higher gain MMIC will reduce the IP3 by the difference in gain and degrade the systems IP3 output performance**

So, for whatever reason, you may require additional gain or find out you have too much IF gain with IC5 installed, understand it can be installed or removed at any time. If installing IC5, be sure to add or remove the correct bias resistor for the desired MMIC. Cut the ribs as shown in step #2 of the assembly section if required. If removing, replace the circuit board opening with a large value capacitor. The RXON signal is the input voltage of the transverter (13.8VDC) so calculate the new bias resistor based on that voltage.

Auxiliary switching contacts:

The auxiliary contacts in K2 are labeled C (common) NO (normally open) and NC (normally closed). The C connection can be wired to ground or +13.8 VDC. This will then be connected or disconnected depending on whether the transverter is in transmit or receive. The contacts are marked for the receive mode. The NO or NC can be wired to the AUX connector on the enclosure.

PTT-H on IF Coax:



If you IF transceiver applies a positive voltage to the coaxial line during transmit, then you should consider this simple option to install. Find the left over molded choke, L12 and install it on the circuit board as shown on the component placement. C79 should already be install but if not, do so. Then run a #24 wire on preferably on the bottom side of the board from the COM IF connection to the PTT-H connection, the transceiver can now have a external PTT-L and a coaxial PTT-H keying circuit.

DEM 90X-144 Component List

BAG 1 CONTENTS

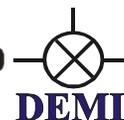
Resistors (R) values are in Ohms and are chips unless otherwise specified.

R1 470	R12 1K 1/4 leaded	R23 1K 1/4W leaded	R33 24
R2 470	R13 220 1/4W leaded	R24 330 1/4W leaded	R34 5.1K 1/4W leaded
R3 1.5K	R14 1K POT	R25 150 1/2W leaded	R35 5.1K 1/4W leaded
R4 100	R15 220 1/4W leaded	R26 330 1/4W leaded	R36 24
R5 51	R16 330 1/4W leaded OPT	R27 51	R37 12
R6 100	R18 150 1/2W leaded OPT	R28 100	R38 12
R7 100	R19 220 1/4W leaded	R29 24	R39 470
R8 130	R20 1K POT	R30 12	R40 470
R9 130	R21 220 1/4W leaded	R31 51	
R10 56 1/2W leaded	R22 220 1/4W leaded OPT	R32 51	

BAG 2 CONTENTS:

Capacitors (C) values are in pF and are chips unless otherwise specified.

C1 0.1µF (1210)	C23 18	C43 0.1µF (1210)	C63 33
C2 1 - 4 Piston	C24 1000	C44 33	C64 0.1µF (1210)
C3 0.1µF (1210)	C25 1000	C45 33	C65 33
C4 18	C26 1000	C46 0.1µF (1210)	C66 1.0 µF Tant.
C5 22	C27 18	C47 33	C67 0.1µF (1210)
C6 0.1µF (1210)	C28 18	C48 33	C68 0.1µF (1210)
C7 1000	C29 1000	C49 33	C69 33
C8 0.1µF (1210)	C30 0.1µF (1210) OPT.	C50 8	C70 33
C9 33	C31 1000	C51 0.1µF (1210)	C71 1000
C10 1.0 µF Tant.	C32 1000	C52 1000	C72 1.5 pF (in bag 4)
C11 0.1µF (1210)	C33 0.1µF (1210) OPT.	C53 1000	C73 33
C12 33	C34 1000	C54 8	C74 33
C13 33	C35 1000	C55 33	C75 0.1µF (1210)
C14 0.1µF (1210)	C36 1000	C56 1000	C76 1.0 µF Tant.
C15 0.1µF (1210)	C37 1000	C57 A,B 33	C77 1.0 pF leaded
C16 33	C38 100µF leaded	C58 33	C78 33
C17 33	C39 33	C59 A or ,B 0.3-3 VAR.	C79 1000
C18 33	C40 1.0 µF Tant.	C60 0.3-3 VAR.	
C19 18	C41 33	C61 0.1µF (0805)	
C20 1000	C42 33	C62 0.1µF (0805)	



BAG 3 CONTENTS:

All inductors are specified. #24 is enamel. Identify the molded chokes by body color and band colors. All others are as indicated.

L1	4 Turns 1/8" ID #24 Wire (HW)	L7	A or ,B 2T, RED (pre wound)
L2	0.10 μH (Small body, Brown/Black)	L8	4 T BLUE (pre-wound)
L3	0.33 μH (Small body, Orange/Orange)	L9	12 ηH (0603 chip inductor)
L4	5 Turns, 1/8" ID #24 WIRE (HW)	L10	6 BLUE (pre wound)
L5	5 Turns 1/8" ID #24 Wire (HW)	L12	1.0μH (Brown/Black) OPT
L6	1T, BLUE (pre wound)		1/8" wooden dowel

BAG 4 CONTENTS:

Note: IC12 is pre-installed.

Q1	2N5179	F1	2787	IC11	MAR 6 OPT.
Q2	2N5179	F2	2787	IC12	AH215
Q3	FDP 750	F3	1260	VR1	78S09 or 7809
Q4	KN2222	F4	2737	VR3	78S05 or 7805
D1	1N4000 type	F5	2737	VR4	78M05
D2	MPN3404	IC1	ERA 3	K1	G6Y-1
D3	MPN3404	IC2	ERA 2	K2	G5V-2
D4	HSMP 3814 or 3824	IC3	MAV-11	K3	G6Y-1
D5	1N4000 type	IC4	SYM-14H	PTC1	PTC 60 Thermistor
D6	1N914	IC5	ERA 6 OPT.	Y1	Crystal 189.500MHz 902MHz
D7	1N4000 type	IC6	MAR 3	Y1	Crystal 189.750MHz 903MHz
D8	1N914 OPT	IC7	MAV 11		Crystal Brass Shield
D9	1N914 OPT	IC10	GALI 74		

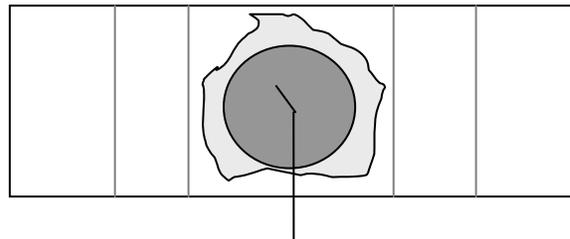
HARDWARE

(2) 1000pF leaded	(2) #4 flat washers
(1) Type ¾" "N" connector	(2) #4 lugs
(2) SMA connectors	SW1 Power Switch
(2) BNC Female UG1094/U Connectors	(3') #24 Teflon wire
(3) RCA Jacks (Control, Aux., Power)	(20") Coax
(7) 4-40 x 3/16" Screws	(1) 3/8" Hole Plug
(2) 4-40 x 3/8" Screws	(4) Adhesive Backed Rubber Feet
(4) 3-48 x 3/16" Screws	(1) set of Labels
(4) 3-48 x 3/8" Screws	(1) 1/4" Plate
(5) 4-40 x 1/4" Screws	(1) Switch Panel
(6) 4-40 x 7/16" Screws	(1) Connector Panel
(2) 4-40 Nuts	(8) Flat Head
50 Ω, 10 W Load	(1) Machined Enclosure, 2 halves
(2) LED, RED	(1) Printed Circuit Board
(2) 4-40 x 1/8" Screws	(1) Shield - Prepped

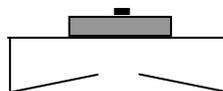
DEM PTCSK

The PTCSK is a kit containing a PTC-60 positive temperature coefficient Thermistor and a brass clamp that allows attachment of the PTC to a HC-49 size crystal with out soldering or heating of the crystal. All soldering is completed before installing on the crystal. The PTC is soldered to the brass before forming it in to a friction clamp. The brass is laser etched for easy forming. Follow the simple instructions and pictorials below.

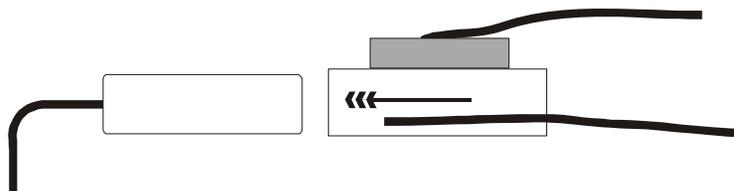
1. Remove one lead from the Thermistor with a soldering iron. Do not use excessive heat but do it as quickly as possible. Save the removed lead.
2. Position the brass flat on workbench with the laser cut marks facing you. Tin-plate the middle section of the brass indicated with the laser cuts with solder. While the brass is still warm, attach the Thermistor to the tinned area. Position the existing lead to exit away from the brass at the narrowest dimension of the brass.

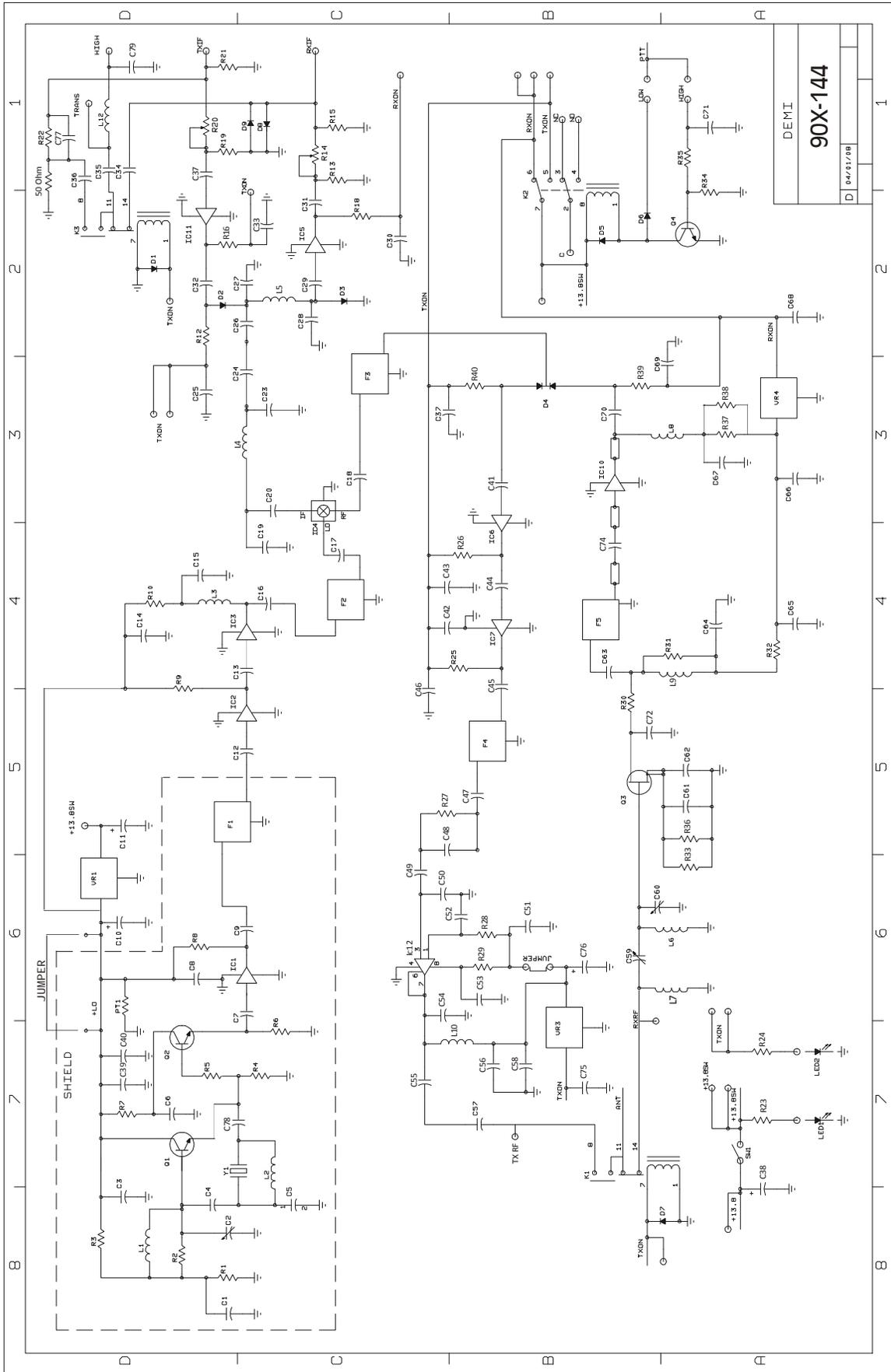
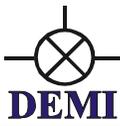


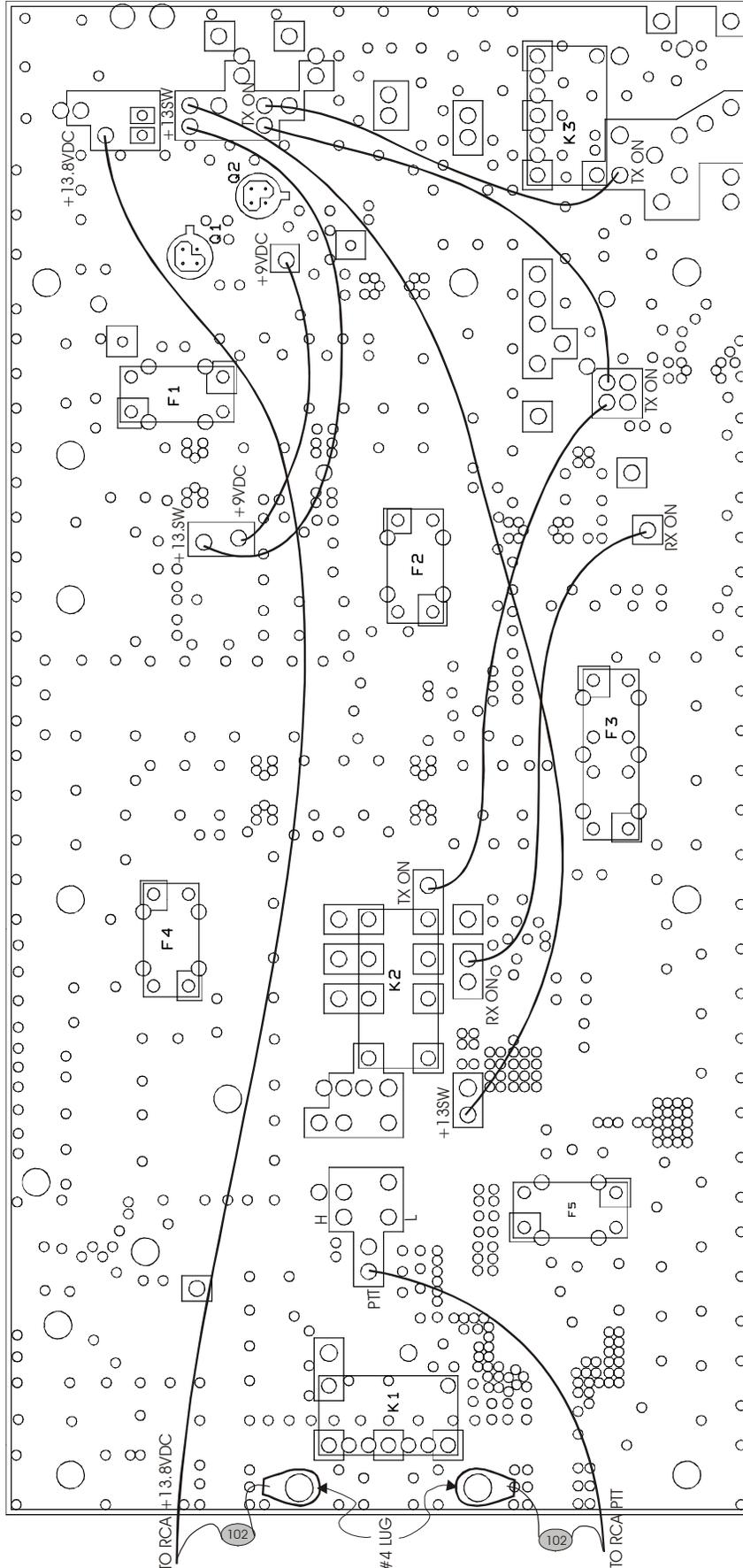
3. Shape the brass into a clamp by bending it away from the Thermistor to simulate the figure below. Do not bend the tabs excessively. One shot would be best! Repeatedly re-shaping will cause the brass to fatigue and break off.



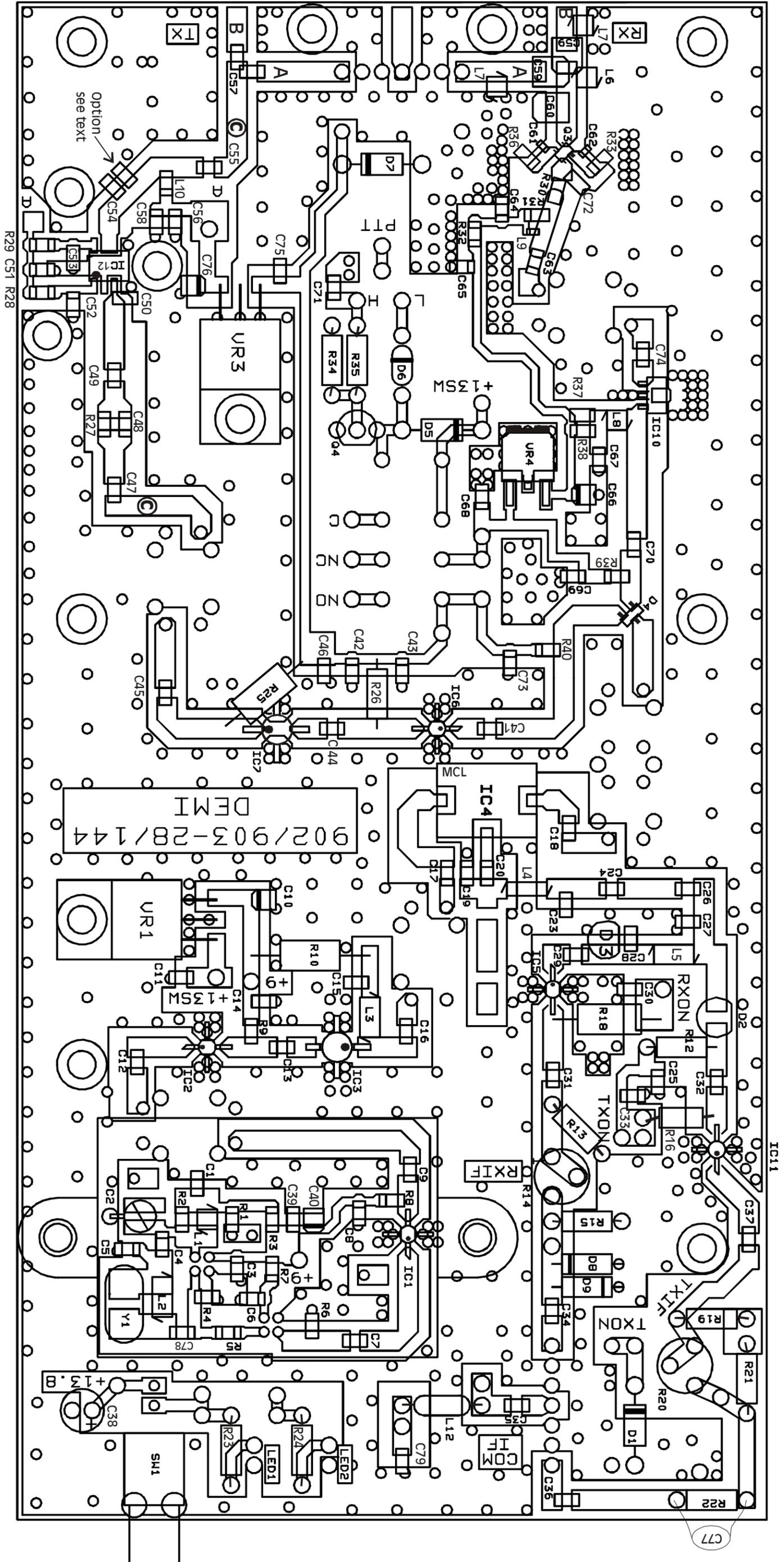
4. Tin-solder the laser "creased" edges to add strength to the clamp. Check for fit on crystal. If too loose, bend to snug fit.
5. Attach saved wire to clamp with solder. After crystal is installed, install clamp and attach Thermistor to +9 Voltage and Ground.







900 Mhz Bottom Assembly



90X-144 COMPONENT ASSEMBLY