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DEM Part Number 902/3-144 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:	10 watts. Lower levels with different configurations
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 3.0 Amps depending on output power level.

Operational Overview

The DEM 902/3-144 is a 33 cm to 144 MHz transmit and receive converter. It has a linear output power of approximately 9 watts 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 will tolerate IP3 input signals > +5 dBm! Other improvements over the previous versions of 33 cm transverters are in the Local Oscillator and TX section. 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 transmit section has improved filtering to eliminate all other spurious emissions. The DEM 902/3-144 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 902/3-144 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 detailed technical design 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 902/3-144 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 902/3-144PCB 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 902/3-144K. The K includes the PCB and all components required to produce a low transmit level 33 cm transverter. If higher output power is required, you may simply order the hybrid power module that the circuit was designed for but physical mounting may be difficult due to components located on both sides of the circuit board. For this reason, if you wish a 10 watt unit, we recommend using the complete kit version. The 90X-144CK (complete kit) includes the board kit and the hybrid power module along with all the necessary hardware, connectors and enclosure. Also included in the CK is a special mounting plate that allows the mounting of the assembled PCB and hybrid module into the enclosure provided. The circuit board mounting plate is machined so that the helical filters, PCB, local oscillator shield, the hybrid power module, 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 10-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. The 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.

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.

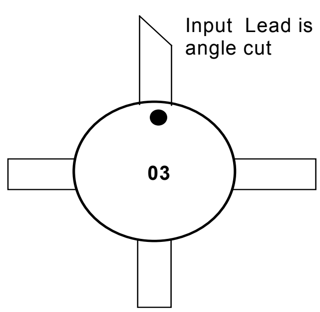


Figure 1A

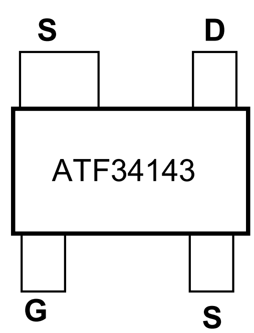
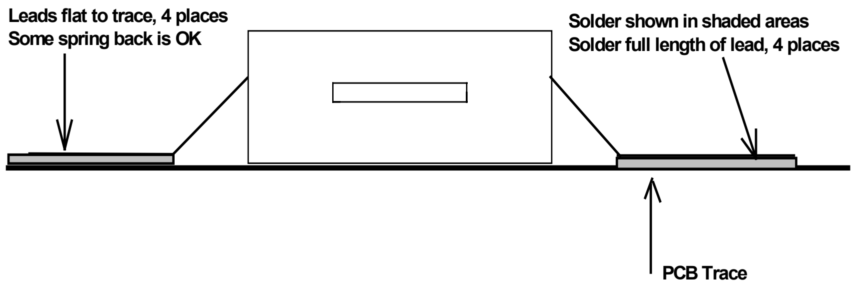


Figure 1B



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

Figure 2

<u>Soldering surface mounted passive components such as chip resistors and capacitors:</u>

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.

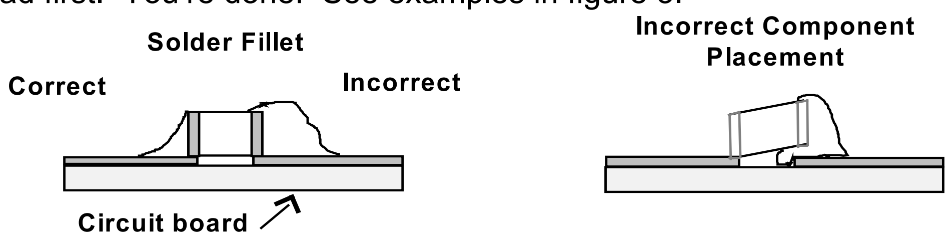


Figure 3. Proper SMD Assembly.

<u>Soldering leaded components (resistors, capacitors, diodes, and inductors) :</u>

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 draw backs 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 C49, 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.

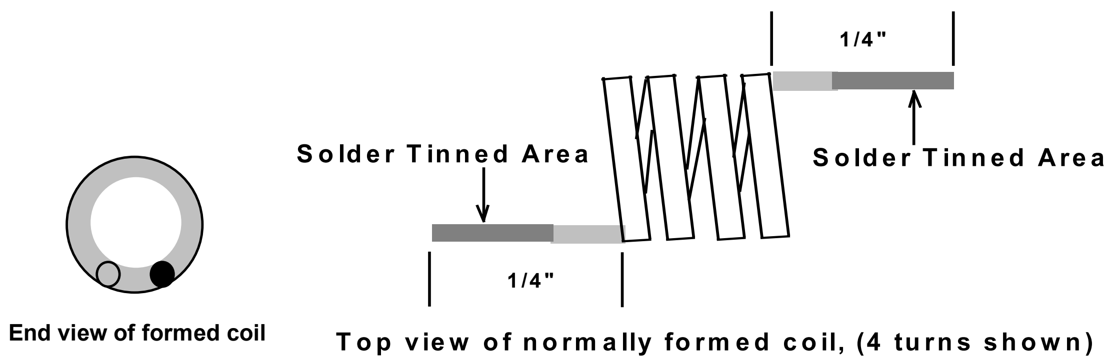


Figure 5.

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. Every filter has been installed and tested in the circuit board. Adjustment should not be required. As of now, this kit is for an average to experienced RF circuit builder. To align this kit, it will only require a volt meter, a 33 CM signal, and a power meter that will measure up to 15 watts maximum. If you have access a frequency counter, a signal generator, and a milli-watt power meter it would be a plus.

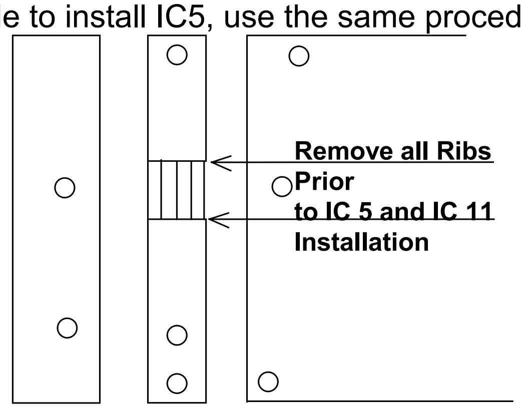
Inventory the parts list because every part in this kit is important and should be identified. Bag 1 are the resistors, Bag 2 are capacitors, Bag 3 are the inductors and Bag 4 are the semiconductors and relays. The filters are listed on the components list but are installed. Take your time to get familiar 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. All five filters are already installed and adjusted!

2. On the topside, now install Q3, IC1- IC3, IC6- IC7, and IC10 per the component placement diagram. Do not install IC4, IC9, VR1-VR4, or D1-D9
Only install IC11 if your TX drive level is 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 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 L31 per the topside component placement diagram. Review the assembly tips if necessary pertaining to multiple components sharing the same pad. Be sure of the placement of C57and C59. They are dependent of the configuration of the transverter you require, common antenna port or split transmit and receive. They will be listed as C57A and C59A on the component placement.

4. Install L1-L12 after winding inductors L1, L3, L9 and L10 as specified on the Bag 3 parts list. L5's placement is dependent on the placement of C59. L2 should be surface mounted

5. Now, install all left over leaded components, pots, resistors, capacitors, diodes, Q4 and regulators. ***Do not install*** IC4, IC9, Y1, SW1, PTC1, R22, C72, R36, or the LED's. Do not insert any negative or ground leads of the electrolytic capacitors into via holes that are in the ground plane. Solder all grounded leads to the topside of the PCB. Do a surface mount installation of C49, VR3, VR4, R25, R24, R10, R18, D2, D3, D8, D9, R40 and R37. 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. Do not install the PTC1. It will occur later in the assembly instruction after testing. The topside component placement shows the crystal standing up but lay it down over L2 as shown in this pictorial. Again, do not install the PTC.

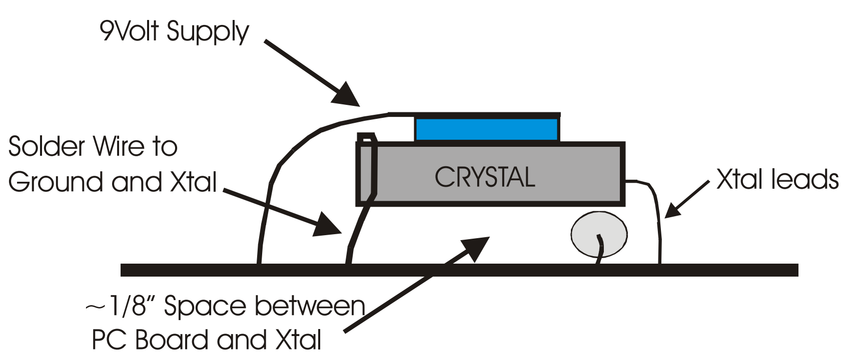
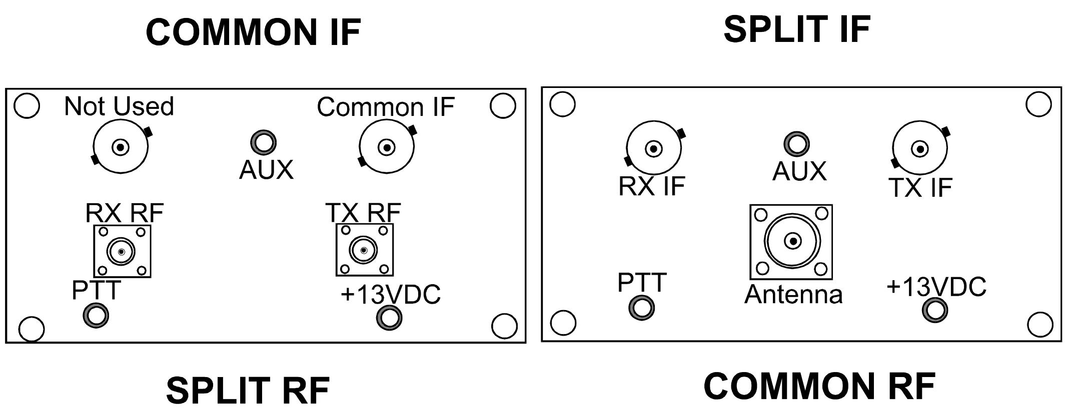


Figure 6. Crystal and PTC-60 installation detail.

7. Attach the PCB to the pallet. Use two 4-40 x 3/16" screws by the antenna connector 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 for the panel to be flush, do so.



9. Use the bottom side component placement as a guide and wire the connections with the supplied #24 Teflon wire. The connection from the +13VDC connection and the RCA connector is done with the heavy green wire. Make the connection from the PTT connector to the PCB. Install the ground lugs as shown with the short 4-40 screws and solder the 1000 ρF 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.

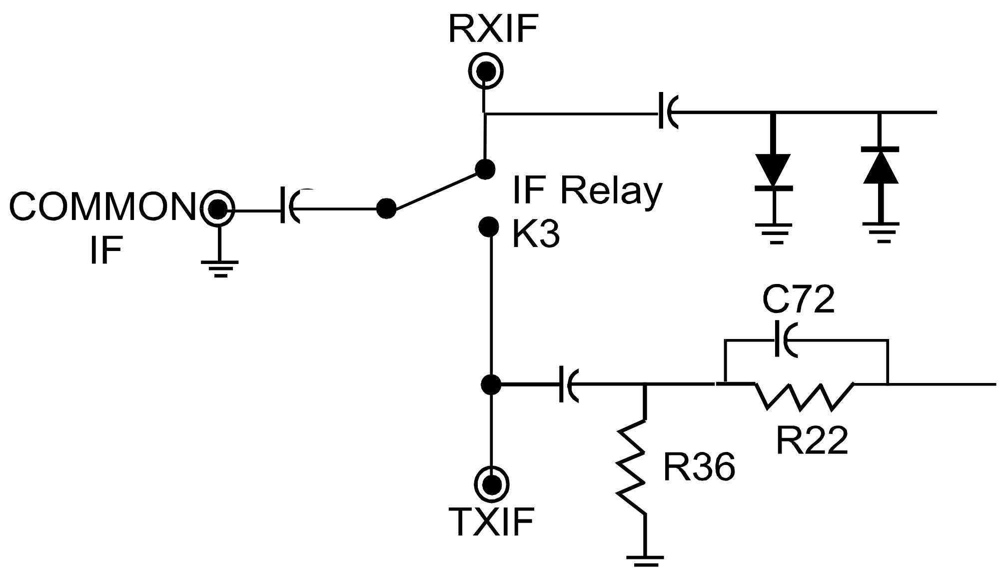
11. Attach IC9, the PF0011 to the pallet. Use the thermal compound supplied, line up the pins with the PCB and use the 4-40 x 1/4 " screws. Solder the 4 pins. Next, make a determination of what keying scheme you will use, PTT-H (+ voltage) or PTT-L (Ground to transmit) and make the appropriate jumper connection from the PTT connection on the topside of the PCB.

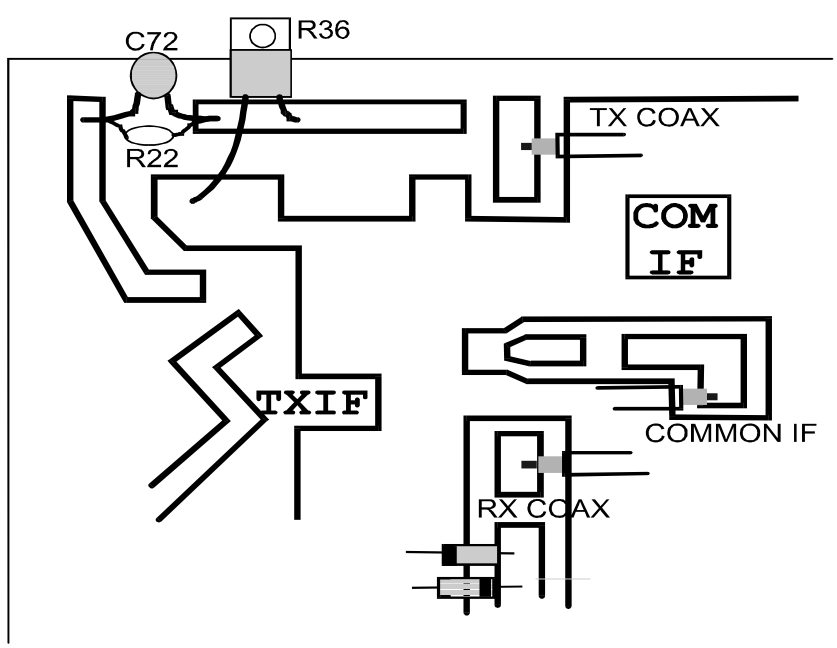
12. Using the matrix below, make a determination of the required IF drive level and decide if you want a common or split IF. All IF drive levels may be achieved from –20 dBm to 10 watts by following the supplied schematic, matrix, and simplified component layout. The 50-ohm load (R36) is mounted on the front panel and is installed after the pallet is aligned with the front panel during final test. Only install IC 11 if you have less than 1 mw of drive.

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.

144 MHz. IF Configurations

	-20 dBm to 0 dBm	1-200 mW Drive	200 mW-1W Drive	1-10W Drive
C72	Not Installed	Not Installed	Not Installed	1ρF
R36	Not Installed	Not Installed	50Ω, 30W	50Ω, 30W
R22	Replace with short	220Ω, 1/4W	220Ω, 1/4W	Not Installed





IF Connections, Common or Split

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 the mixer, IC4 and the 50 ohm load. Connect a 13.8VDC supply capable of 3 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 C47 and C48	+13.8VDC (power supply voltage)
Output of VR1, C10	+9.0VDC ± 0.2V
Output of VR4, C66	+5.0VDC ± 0.2V
Junction of IC1 and C7	between 1.5 and 2.5. Depends if Oscillator is running or not
Junction of IC1and C9	Between 2.5 and 3.5. Depends if Oscillator is running or not
Junction of IC2 and C12	2.5VDC ± 0.3V
Junction of IC2 and C13	3.5VDC ± 0.5V
Junction of IC3 and C13	1.5VDC ± 0.3V
Junction of IC3 and C16	6.0 VDC ± 1.0V
Junction of IC5 and C29	2.5VDC ± 0.5V (Optional)
Junction of IC5 and C31	5.0 VDC ± 0.5V (Optional)
Junction of IC10 and F5	2.5 VDC ± 0.5V
Junction of IC10 and C70	5.0 VDC ± 0.5V
Junction of Q3 and R30	3.8VDC ± 0.5V
Junction of Q2 and C6	8.8VDC ± 0.5V
Junction of Q1 and C3	9.0VDC ± 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 the mentioned test equipment, install the mixer, IC4 (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. Adjust C2 to peak the voltage. You may need to spread or compress L1 if you cannot find a peak. Do not go more than one wire thickness at a time. If you have a power meter connected, verify that the output is +17 dBm. (+15 dBm minimum) You may want to slightly "Tweek" 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 0r 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.

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 find and un-solder one lead from PTC1. Attach PTC1 to the crystal as shown in figure 6. Attach a wire from the crystal case to ground. Keep lead as short as possible. The voltage lead is attached to the output pad of VR1, labeled on the component placement as +9. Power up oscillator to verify operation. Allow a 5-minute warm up and re-peak the oscillator. If OK, attach the shield over the oscillator with two 4-40 x 1/4" screws and two #4 flat washers. Be sure not to short the output of F1 to the case. 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 "Tweek" 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. Drop the pallet into the bottom enclosure 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. 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, C55	+5.0VDC ± 0.3V
Junction of IC6 and C38	+2.5VDC ± 0.5V
Junction of IC6 and C39	+4.5VDC ± 0.5V
Junction of IC7 and C39	+1.5VDC ± 0.5V
Junction of IC7 and C42	+6.0VDC ± 1.0V
Junction of R12 and D2	+1.6VDC ± 0.3V
Junction of D3 and L10	+0.7VDC ± 0.3V
Junction of D1 and K3	+13.8VDC (if K3 is not installed, no need to test)
Junction of D7 and K1	+13.8VDC (if K1 is not installed, no need to test
Junction R23 and D4	+.7 VDC ± .3 VDC
Pin 2 of IC9	< 4.0 VDC, > 2.5VDC

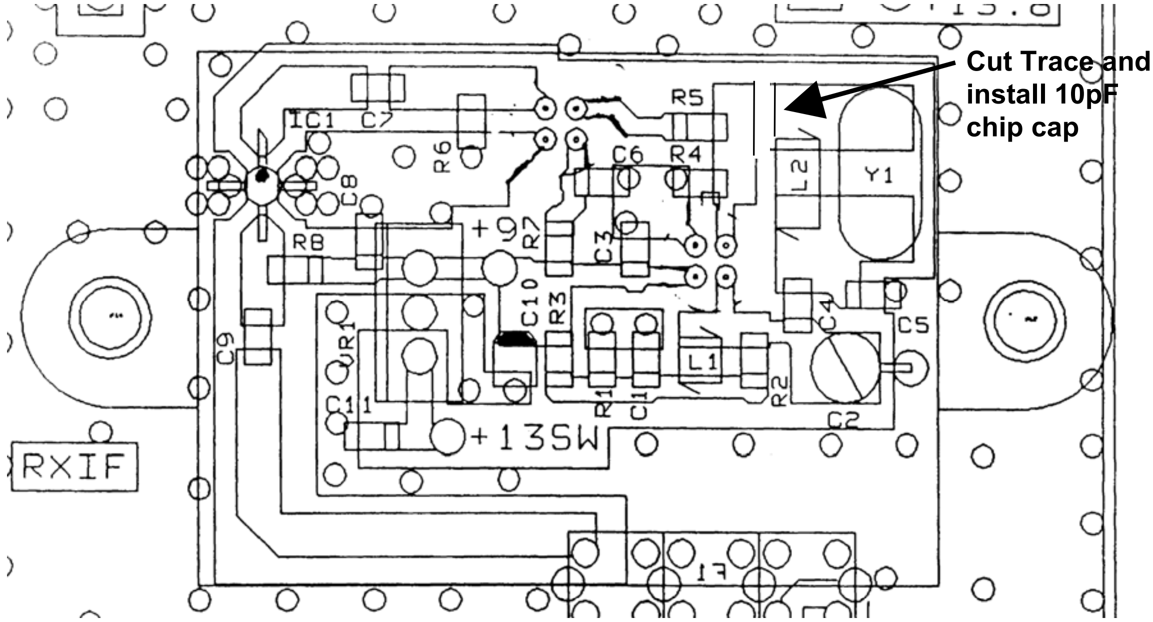
If any voltage is out of tolerance, verify all surrounding component values and recheck bottom side wiring. Remember, MMIC current drain is a specified amount, but due to tolerances, they may differ a bit.

7. To RF test the transmit section, if you need to use your 2meter transceiver or a 2M signal from a generator. Install the 50 ohm load if it is required for your IF configuration. Connect a power meter that can measure 15 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, 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.

Final Assembly

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 to match the frequency of a know signal or measure the LO frequency at C17. If the desired frequency cannot be obtained before the oscillator either shuts off or becomes unstable, determine if it is to high in frequency or low. If it is to high, remove the LO shield and compress the L1 inductor and readjust C2. If the frequency is to low, spread the coil slightly and re-adjust C2. If the frequency is still to low a circuit modification will be required. The circuit modification is described below but technical details are covered in our Design Note #16 found in the library section of DEMI web site. (www.downeastmicrowave.com) The modification is simple.

After the shield is removed from the base oscillator section, remove the crystal and L2. Do not remove the PTC form the crystal!! Cut and remove the now empty pad still connected to R5 and R4 between the placement of L2 and the R4, R5 combination. Install a 10 pF chip cap across the gap in the cut pad. See figure below.



The chip cap becomes a series cap between the L2 /crystal and the R4/R5 connection. Then re-install L2 and the crystal and retest. You may need to spread or compress the L1 inductor for best results. If the frequency is still low, please consult us with Data. (How low is it in KHz.) If you can net the frequency, install the shield and allow the unit to warm for 10 minutes before the final adjustment are made.

When complete you may retest the RX and TX section and re-adjust the IF levels as desired. If you find that the RX gains is to low for your requirements, go to the user options section of this document and install IC 5. If complete, attach the lid and the 4 screws or you may also wish to install some other user options.

Completion

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.

The receive conversion gain is limited for a reason. This receive section will 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 be required and the use of the IF amplifier may need to be omitted. Simply adding a LNA to the front of the transverter will improve the noise figure but will degrade its dynamic range by the amount of gain added. It is not recommended to add an LNA unless it is mast mounted. If a higher power amplifier is added, also consider and additional filter and isolator.

DEM 90X -144 User Options and performance Improvements:

Add an external preamplifier for noise figure improvement.

If a better noise figure is desired, simply placing a LNA with a modest gain at the antenna will solve that problem. 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 a way 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 L5, C59, R31, L31, 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.

Another option is to remove the IF amplifier if you have it installed. If you need to reduce the gain by less than 10 dB, remove IC5 and R18. Then you may use a 100 pF disc capacitor across the input and output of IC5. You may then adjust the RXIF control to your desire.

Install / Remove RXIF gain stages:

This was briefly discussed in the external preamplifier section. It is better not to use IC5 in the circuit than to increase the attenuation of the RFIF gain control. For whatever reason, you may require additional gain or have too much IF gain if IC5 was installed. IC5 can be installed or removed at any time. Be sure of your systems performance when deciding to make a change. You are also not limited to the supplied ERA6 MMIC. The ERA6 was chosen for it's IP3 output performance. Using this MMIC doesn't degrade the transverters overall performance. **A higher gain MMIC will reduce the IP3 by the difference in gain and degrade the systems IP3 output performance**. In the future, this MMIC type may change as better devices become available.

If installing the MMIC, be sure to add or remove the correct choke and bias resistor for the desired MMIC. Cut he ribs 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 weather 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.

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 and reduce the spurious emissions. 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 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 instruction (DN016) found in the final assembly section of this document. 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 can help.

Conclusion

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 Component List

BAG 1 CONTENTS

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

R1 470	R10 56 1/2W leaded	R22 220 1/4W leaded	R31 330
R2 1K	R12 1K 1/4 leaded	R23 1K	R32 12
R3 1.5K	R13 220 1/4W leaded	R24 330 1/4W leaded	R33 330
R4 100	R14 1K POT	R25 180 1/2W leaded	R34 5.1K 1/4W leaded
R5 51	R15 220 1/4W leaded	R26 1K 1/4W leaded	R35 5.1K 1/4W leaded
R6 100	R18 150 1/2W leaded OPT	R27 470 1/4W leaded	R37 470 1/4W leaded
R7 100	R19 220 1/4W leaded	R28 24	R38 130
R8 130	R20 1K POT	R29 24	R40 110 1W leaded
R9 130	R21 220 1/4W leaded	R30 12	R41 330 1/4W leaded OPT

BAG 2 CONTENTS:

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

C1 0.01μF	C19 18	C38 33	C61 0.1μF (1008)
C2 1 - 4 Piston	C20 100	C39 33	C62 0.1μF (1008)
C3 0.01μF	C21 18	C40 0.1μF	C63 33
C4 18	C23 18	C41 33	C64 33
C5 22	C24 100	C42 33	C65 0.01 μF
C6 0.01μF	C25 0.01μF	C43 0.1μF	C66 1.0 μF Tant.
C7 0.01μF	C26 100	C47 0.1μF	C67 33
C8 0.1μF	C27 18	C48 100	C68 0.1μF
C9 33	C28 18	C49 2.2 μF leaded	C69 0.01 μF
C10 1.0 μF Tant.	C29 100	C52 100	C70 33
C11 0.1 μF	C30 0.1μF OPT.	C53 1.0 μF Tant.	C71 0.01 μF
C12 33	C31 100	C54 0.1μF	C72 1 ρF leaded OPT
C13 33	C32 100	C55 1.0 μF Tant.	C73 100ρF
C14 0.1μF	C33 0.01μF OPT.	C56 0.1μF	C74 0.1μF OPT
C15 0.1μF	C34 100	C57, A 33	C75 0.1μF
C16 33	C35 100	C58 100μF leaded	C76 33ρF

C17 33	C36 100	C59, A 0.3-3 VAR.	
C18 33	C37 0.01μF	C60 0.3-3 VAR.	

BAG 3 CONTENTS:
All inductors have the enamel wire size and turns specified. Identify the molded chokes by body color and band colors. All others are as indicated.

L1 3 Turns 1/8" ID #24 Wire (HW)	L9 5 Turns, 1/8" ID #24 WIRE (HW)
L2 0.10 μH (Small body, Brown/Black)	L10 5 Turns 1/8" ID #24 Wire (HW)
L3 6 Turns 1/8" ID #24 Wire (HW)	L12 1.0μH (Brown/Black) OPT
L5, A 2T, RED (pre wound)	L31 10 ηH (0603 chip inductor)
L6 1T, BLUE (pre wound)	1 - 1/8" wooden dowel
L8 5 T Red pre-wound	

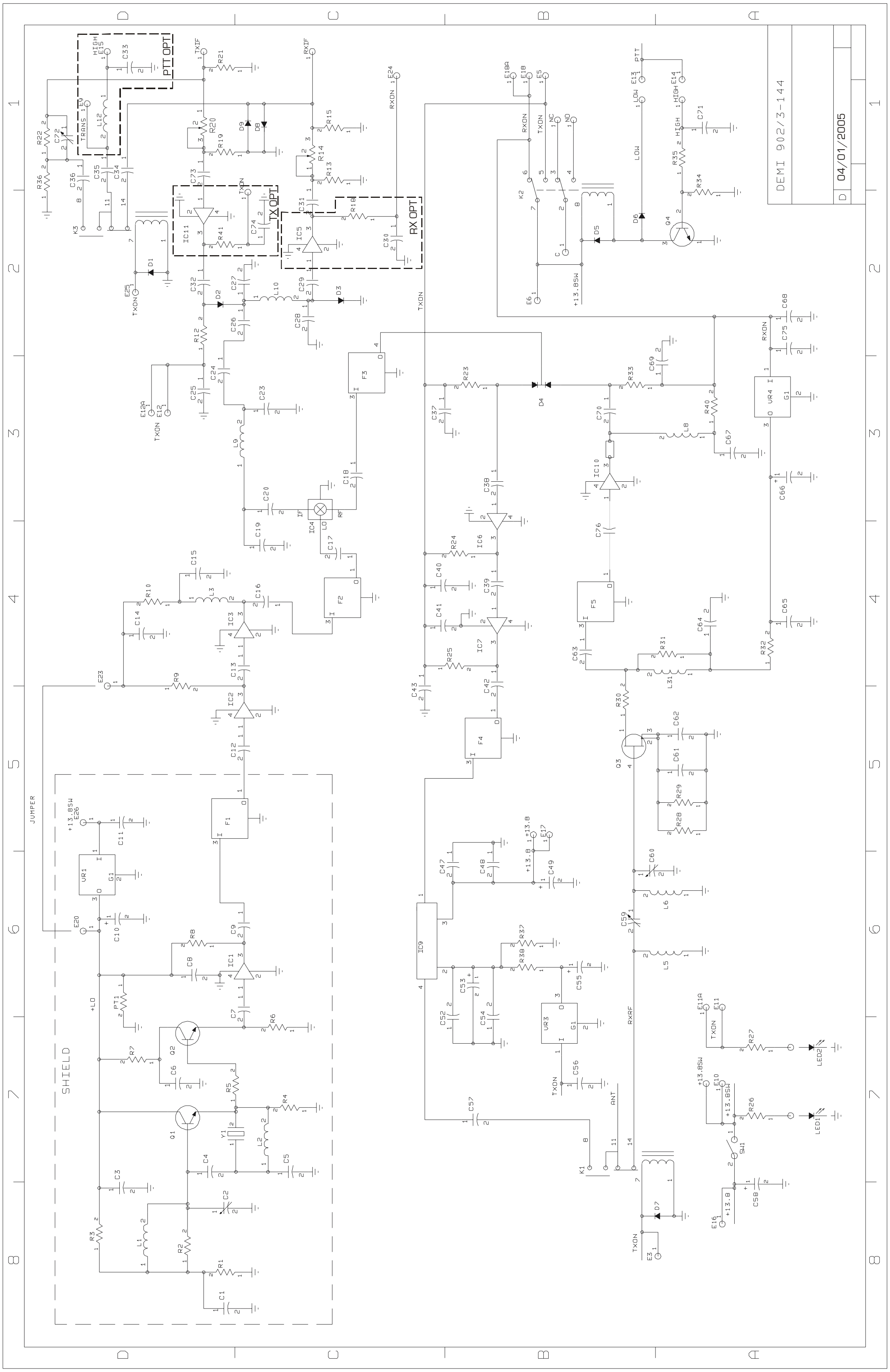
BAG 4 CONTENTS:
Note that all filters (F1-F5) are pre-installed and tuned in your PCB.

Q1 2N5179	D9 1N914	IC7 MAV11
Q2 2N5179	F1 2787 – Installed	IC10 GALI 74
Q3 ATF34143	F2 2787 – Installed	IC11 MAR 6 OPT.
Q4 KN2222	F3 1260- Installed	VR1 78S09
D1 1N4000 type	F4 2737 – Installed	VR3 78L05
D2 MPN3404	F5 2737- Installed	VR4 78L05
D3 MPN3404	IC1 ERA3	K1 G6Y-1
D4 HSMP 3814	IC2 ERA2	K2 G5V-2
D5 1N4000 type	IC3 MAV-11	K3 G6Y-1
D6 1N914	IC4 SYM-14H	PTC1 PTC 60 Thermistor
D7 1N4000 type	IC5 ERA6 OPT.	Y1 Crystal 189.xxx MHz HC 18/U
D8 1N914	IC6 MAR3	1 10pf chip

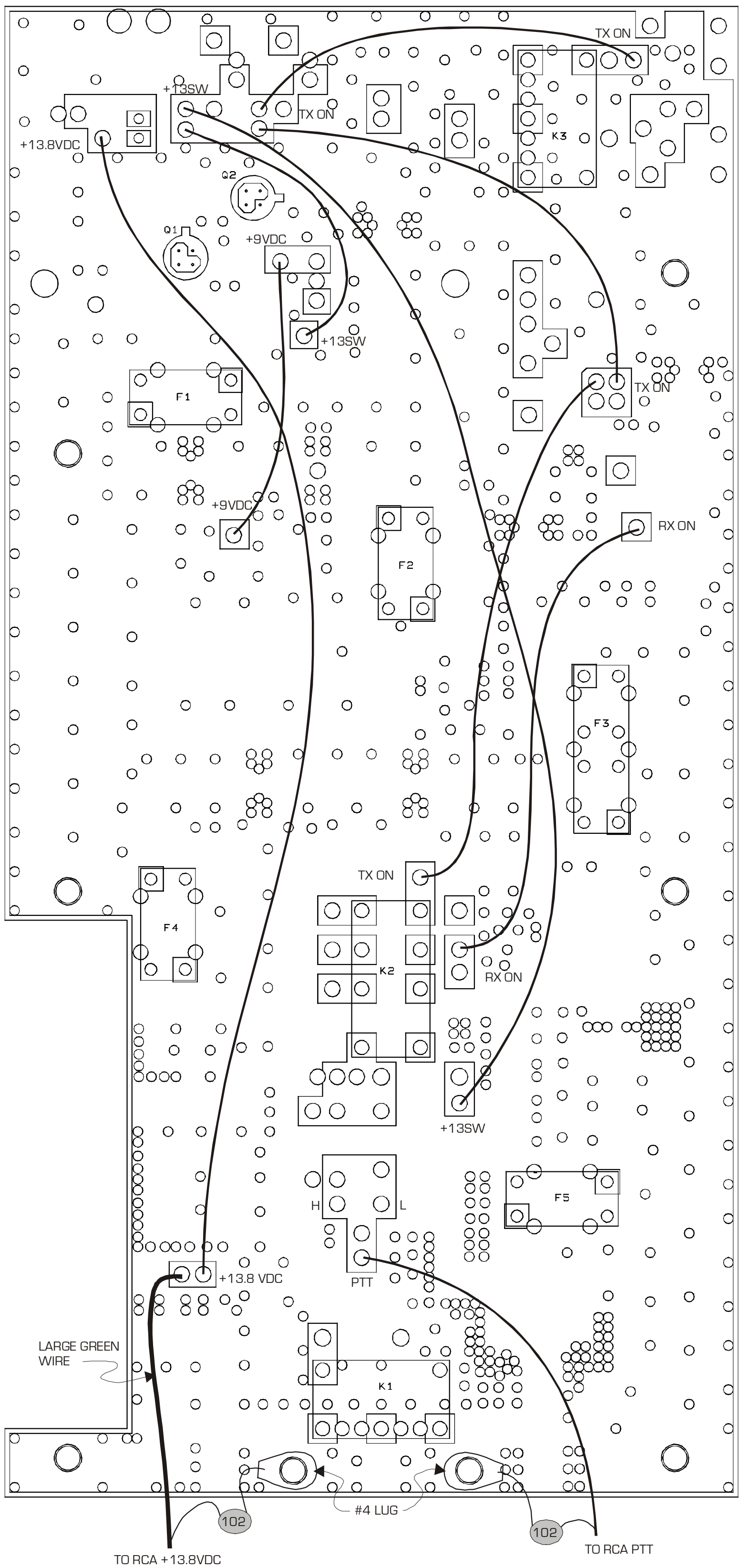
HARDWARE

(2) 1000ρF leaded	(2) #4 flat washers
(1) Type ¾" "N" connector	(2) #4 lugs
(2) SMA connectors	(1) Shield- Prepped
(2) BNC Female UG1094/U Connectors	SW1 Power Switch
(3) RCA Jacks (Control, Aux., Power)	(3') #24 Teflon wire
(4) 4-40 x 3/16" Screws	(20") Coax
(3) 4-40 x 3/8" Screws	(1) 3/8" Hole Plug
(4) 3-48 x 3/16" Screws	(4) Adhesive Backed Rubber Feet
(4) 3-48 x 3/8" Screws	(1) set of Labels
(4) 4-40 x 1/4" Screws	(1) 1/4" Plate
(6) 4-40 x 7/16" Screws	(1) Switch Panel
(2) 4-40 Nuts	(1) Connector Panel
R36 50 Ω, 10 W Load	(8) Flat Head
(2) LED, RED	(1) Machined Enclosure
(2) 4-40 x 1/8" Screws	(1) Thermal Compound
3" #18 Teflon (green)	

Miscellaneous Loose Parts (optional): (1) RF Power Module IC9, PF0011. (2) Printed Circuit Board with filters installed. (3) Enclosure, two halves.


DEMI 902/3-144
04/01/2005
D
SHIELD
JUMPER
PTT OPT
TX OPT
RX OPT

90X-144
BOTTOM SIDE ASSEMBLY
04/13/2005



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TOP SIDE ASSEMBLY DRAWING