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DEM Part Number 1296-144 PCB, K and CK

23 cm Transverter PCB, Board Kit, and Complete Kit

Specifications

Frequency range:	1296 MHz. = 144 MHz.
Noise Figure and Gain:	<1.5 dB NF, > 17 dB Gain with >+5dBm IP3 Input
Power Output:	3 watts. Lower levels with different configurations
TXIF Drive level:	1 mW 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 2.5 Amps depending on output power level.

Operational Overview

The DEM 1296-144 is a 23 cm to 144 MHz transmit and receive converter. It has a linear output power of approximately 3 watts and may be achieved with as little as 10 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 two 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 1296 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, (192 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 1296-144 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 23 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. The IF connections are via BNC connectors. 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 23 cm connectors are Type 'N' or SMA if separate TX and RX ports are chosen. The 1296-144 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 stresses the receiver's immunity to out of band signals and covers the design stage by stage. The 1296-144 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 1 oz. 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 23 cm 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 1296-144PCB 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 1296-144K. The K (kit version) includes the PCB and all components required to produce a low transmit level 23 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 3 Watt unit, we recommend using the complete kit version. The 1296-144CK (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.

Circuit Description

A local oscillator of 192.00 MHz is multiplied X 6, filtered, and amplified to the +17 dBm level then is injected into a high level mixer. In receive, the 23 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 all signals out side of the desired 23 CM band. The amplified signal then passes through a 3 pole helical filter that allows approximately 30 MHz. of amplified bandwidth. This signal is then amplified by a high level MMIC before being filtered by the next 3 pole helical filter that restricts the receivers operation to a narrow segment of the 23 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 28 MHz. receiver.

On transmit, it is a reverse process. The 2 meter transceiver applies a signal of up to 10 watts of drive and it is then attenuated and filtered before entering into the mixer. The 23 cm transmit signal then exits the mixer and is filtered by the 3 pole helical before being passed through the transmit gain stages. It is then 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 3 watt level before either exiting the TX port or the common antenna port.

Other LO input, RF and IF frequency schemes may be used with the 1296 transverter such as our other 28 MHz IF versions or the 1268/9 transmit converters. Simply do the math. There are a few limiting factors for different frequencies of operation. The IF will operate on any frequency between 28 and 188 MHz. With the correct LO filters. The RF filters will cover the whole 23 cm band. The LO filters in this kit will not tune to a 28 MHz IF range. All filters included in the kit may need to be re-tuned or replaced 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 are as shown on the component placement diagram and determine their correct orientation. IC10 is a 3 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). After verifying that the leads are flat to the surface, you will be ready to solder.

1. To begin to solder, pick one pad on the circuit board that you wish to attach the active device to. 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 all 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.

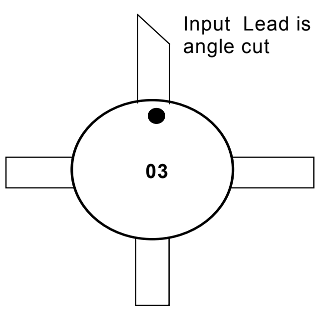


Figure 1A

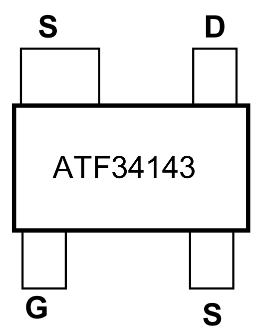
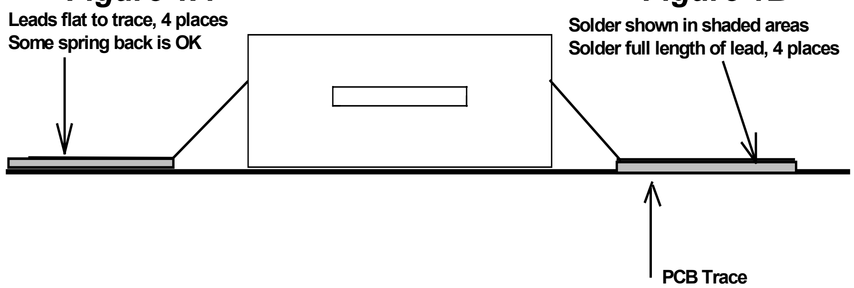


Figure 1B



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 are done! See examples in figure 3.

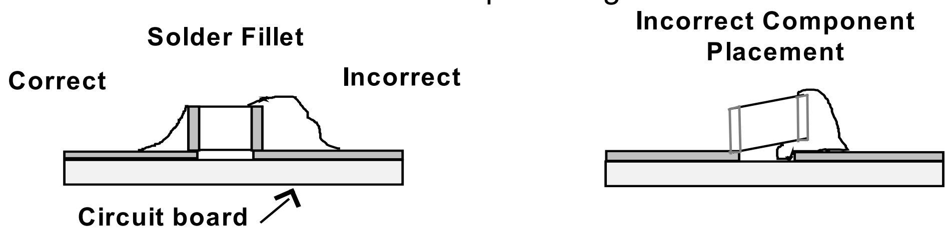


Figure 3. Proper SMD Assembly.

<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 top side 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 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.

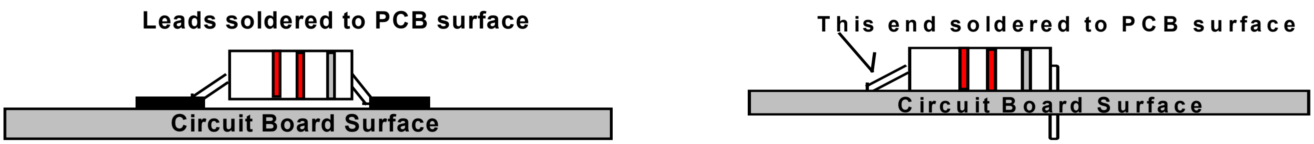
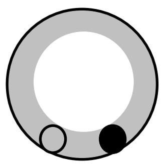


Figure 4.

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 Figure 5.



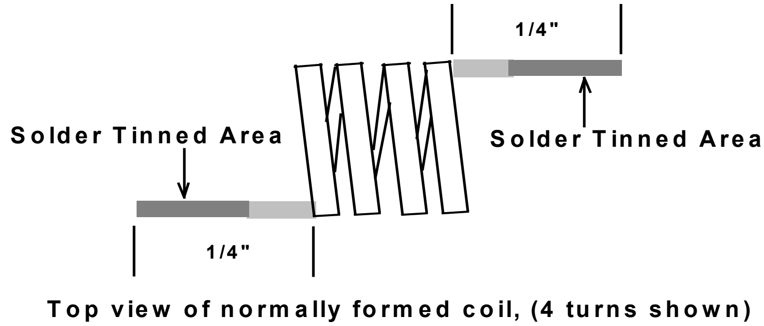


Figure 5.

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 L5. 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 diagram that details every components 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 topside. 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 a average to experienced RF circuit builder. To align this kit, it will only require a volt meter, a 23 CM signal, and a power meter that will measure up to 5 watts maximum. If you have access a frequency counter, a signal generator, and a mW power meter it would be a plus. Please note that this document assumes the Complete Kit. If you have purchased the 1296-144K, only use construction details that pertain to the circuit board.

Inventory the parts list. Every part in this kit is important and should be identified. Bag 1 contains resistors, Bag 2 contains capacitors, Bag 3 contains the inductors and Bag 4 contains 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 through 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 the effort and techniques required 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 values to the component placement document. We do not do this because the values will change over time depending on availability, engineering changes, or obsolesces. The component list is easier to update and maintain providing all users 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. K1-K3, Q1, and Q2. Do not solder the cans of Q1 and Q2. All 5 filters are already installed and adjusted!
2. Install all active surface mount active components, Q3, IC1- IC3, IC5- IC7, and IC10 on the topside of the circuit board per the topside component placement diagram. Do not install IC4, VR1-VR4, or D1-D9
3. Install all surface mount capacitors and 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 (C57 and C59) or split transmit and receive (C57A and C59A).
4. Wind inductors L1, L3, L9 and L10 as specified in the Bag 3 parts list. Then install all inductors L1-L31. L5 or L5A placement is dependent on the placement of C59. The molded chokes L2, and L30 should be surface mounted. L12 is optional and should be installed if you wish to activate the PTT circuit through your Transceiver's IF cable.
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, or the LED's. Do a surface mount installation of C49, VR3, VR4, R25, R24, R10, R18, D2, D3, D8, and D9. When soldering the leaded surface mount components, 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 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.

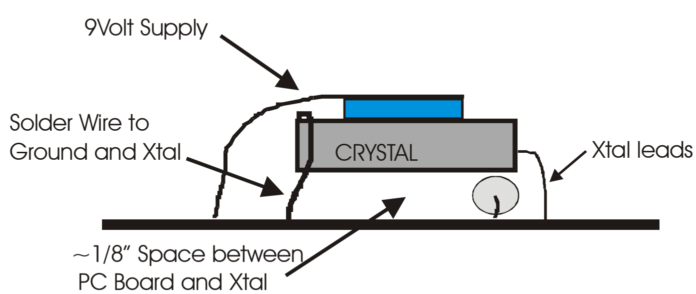
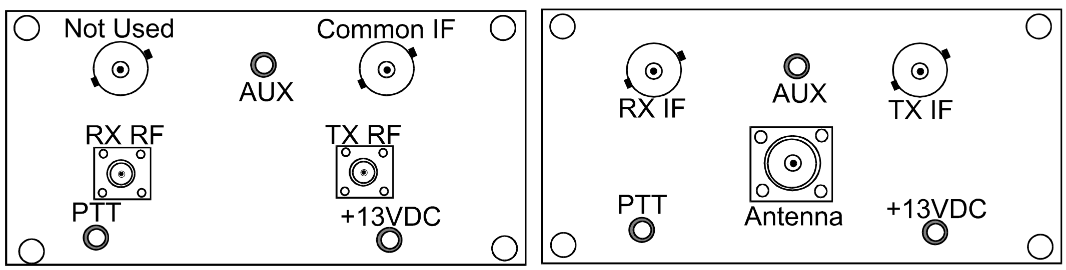


Figure 6. Crystal and PTC-60 installation detail.

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 with #4 flat washers by the oscillator section. If you find solder interference between the PCB and the pallet, remove it by wicking or filing!

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 3/8" screws go through the connector and panel, then into the pallet. The short 3/16" screws 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.

COMMON IF **SPLIT IF**



SPLIT RF **COMMON RF**

9. Use the bottom side component placement as a guide and wire the connections with the supplied #24 Teflon wire. Install them all as shown. The connection from the +13 VDC connection and the RCA connector is done with the heavier green wire. Make the connection from the PTT connector to the PCB. Install the ground lugs as shown with the short 1/8" 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 into its position but do not solder. Install the switch panel with 2 flat head screws then solder the exposed leads of the switch. Install the LED's. The short lead is ground. Now remove the pallet from the enclosure and trim all excess leads from the bottom side of the PCB and solder the mounting leads of the switch.

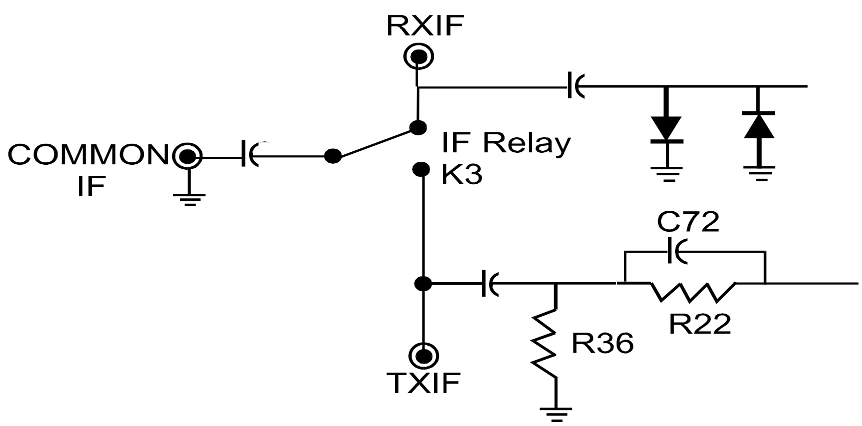
11. Attach the M67715 to the pallet. Use the thermal compound supplied, line up the pins with the PCB and use the 4-40 x 1/4 " screws. Solder the 5 pins. Now make a determination of what keying scheme you will use, PTT-H (+ voltage) or PTT-L (Ground to transmit) and make the appropriate jumper connection from the PTT connection on the top side of the PCB.

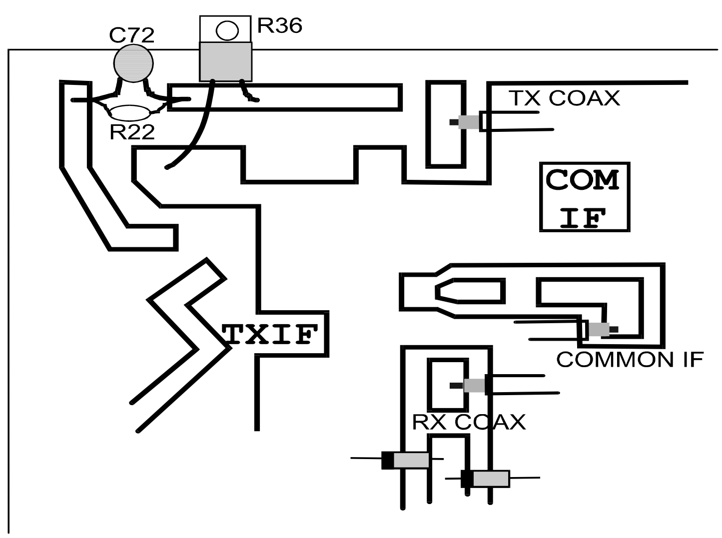
12. Using the matrix below, make a determination of the required IF drive level and decide if you want a common or split IF. All IF drive levels may be achieved from 1 mW to 10 watts by following the supplied schematic, matrix, and simplified component layout. The 50 ohm load (R36) is mounted on the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

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 for the correct configurations.

144 MHz. IF Configurations

	1-250 mW Drive	200 mW-2W Drive	1-10W Drive
C72	Not Installed	Not Installed	1ρF
R36	Not Installed	50Ω, 30W	50Ω, 30W
R22	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	+13.8 VDC
Output of VR1 (+9)	+9.0 VDC ±0.2V
Output of VR4 (C66)	+5.0 VDC ±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 3.5 and 2.5. Depends if Oscillator is running or not
Junction of IC2 and C12	2.5 VDC ±0.3V
Junction of IC2 and C13	3.5 VDC ±0.5V
Junction of IC3 and C13	2.5 VDC ±0.3V
Junction of IC3 and C16	5.0 VDC ±0.5V
Junction of IC5 and C29	2.8 VDC ± 0.3V
Junction of IC5 and C31	5.0 VDC ± 0.3V
Junction of IC10 and F5	0 VDC
Junction of IC10 and C70	5.0 VDC ± 0.3V
Junction of Q3 and R30	3.8 VDC ± 0.5V
Junction of Q2 and C6	8.5 VDC ±0.5V
Junction of Q1 and C3	9.0 VDC ±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 inoperative. If the test voltages are close, assume the MMIC is working correctly for now.

3. Be sure to read all of the RF testing procedure. 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, (after verification of the RX voltages). If you have an mW 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 SMA or BNC type connector so it can be used for measuring the power level and frequency. Start the oscillators tune up by spreading the turns of L1 to 1 wire diameter. Probe the junction of R6 and C7 with a voltmeter. There should be minimum voltage of approximately 0.4 VDC. Adjust C2 to peak the voltage. You may need to compress L1 if you cannot find a peak. 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 1152.000 MHz. 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.

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 the PTC to the crystal as shown in figure 6. Attach a wire from the crystal case to ground. Keep the 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. If OK, attach 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. Position the shield as shown on the component placement diagram. If you are unsure about the shield shorting the F1 filter, you may cut a small notch in the shield by C12.

5. The RX testing is as follows. Install IC4 now if not previously done. Connect the IF port of the transverter to a 144 MHz transceiver or spectrum analyzer and adjust R14 counter clockwise. Inject a 1296 signal into the antenna or RX port (-30 dBm or so) with a signal generator or use a signal on the 23 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. If you have a analyzer, this would also be the time to "Peak" F5 and F3 but it shouldn't be necessary.

6. Transmit testing is next. Disconnect all cables from the transverter and install the pallet into the bottom enclosure 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. Connect a 50 ohm load either on the TXRF port or the antenna connector. Then connect the DC voltage and power it on. To test the TX voltages, key the PTT line (PTT-H or –L) and measure to verify against the TX voltage matrix. If any voltage is out of tolerance, verify all surrounding components and recheck bottom side wiring. Remember, MMICs draw a specified amount of current but may be a bit out of tolerance

LOCATION	TX VOLTAGE Matrix referenced to Ground
Output of VR3 (C55)	+9.0 VDC ± 0.3V
Junction of IC6 and C38	+2.5 VDC ± 0.5V
Junction of IC6 and C39	+4.5 VDC ± 0.5V
Junction of IC7 and C39	+1.5 VDC ± 0.5V
Junction of IC7 and C42	+6.0 VDC ± 1.0V
Junction of R12 and D2	+1.6 VDC ± 0.3V
Junction of D3 and L10	+0.7 VDC ± 0.3V
Junction of D1 and K3	+13.8 VDC (if K3 is not installed, no need to test)
Junction of D7 and K1	+13.8 VDC (if K1 is not installed, no need to test)
Junction of L30 and C53	+9.0 VDC ±0.3V

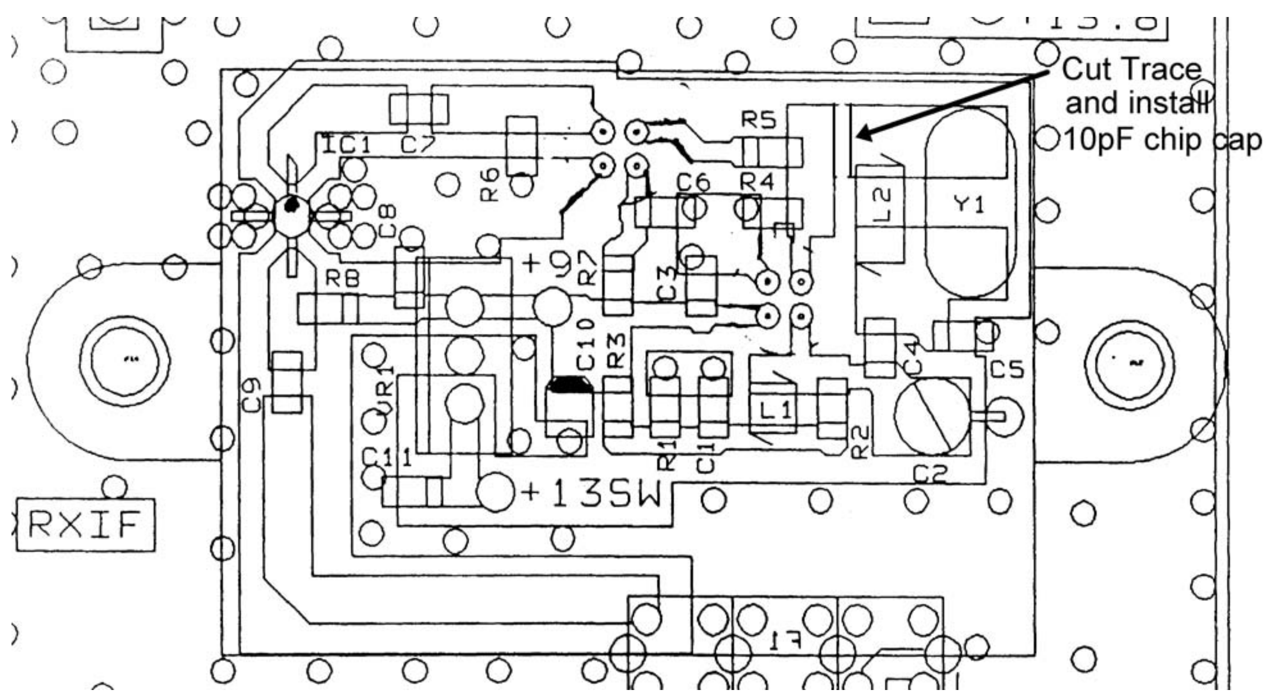
7. To RF test the transmit section, If you need to use your 2 meter transceiver, install the 50 ohm load if it is required for your configuration. Connect a power meter that can measure 5 watts @ 1296 MHz to the TXRF or ANT connector Connect your IF drive source to the BNC connector (common IF or TXIF). 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 a desired output power. The output power will depend on the IF drive level setting of R20. 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 unit will not make the output power specification and change the attenuation values. 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. This is when the output power does not increase when the drive level is increased. If this happens, 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 23 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 to 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. Net the frequency, install the shield and allow the unit to warm for 10 minutes before the final adjustment is made.

When complete you may retest the RX and TX section and re-adjust the IF levels as desired. If complete, attach the lid and the 4 screws or you may also wish to install some or all of the user options. They are listed starting on the bottom of this page.

Completion

This completes the assembly and testing of the 1296-144CK. 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 1296 -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, (25-30 db) 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, L31, C59, R31, 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 need to reduce the gain by less than 10 dB, remove IC5 and R18. Then you may use a 100 pF disc capacitor and place it from where the input and output leads of IC5 was. You may then still adjust the RXIF control to your desire.

Install / Remove RXIF gain stages:

This was briefly discussed in the external preamplifier section. For whatever reason, you may require additional gain or have too much IF gain. 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 ERA 6 MMIC. You may choose a higher gain unit. The ERA 6 was chosen for its IP3 output performance. Using this MMIC doesn't degrade the transverters overall performance. A high gain MMIC will not only reduce the IP3 by the difference in gain but will also degrade the system if a lower IP3 output device is used. In the future, this MMIC will change as soon as something better become available.

If changing or removing the MMIC, be sure to add or remove the correct choke and bias resistor for the desired MMIC. The RXON signal is the same voltage that the transverter operates on so calculate the new bias resistor based on that voltage.

Additional RX selectivity:

If you find yourself requiring more selectivity from lower frequency out of band products, a modification can be performed. The alignment is very critical and virtually cannot be done without test equipment. A minimum of a steady level, signal source is required. In the factory, we would not ever think about doing this with out a noise figure meter. The mod goes like this. In bag 3 of your kit you will find a 2 turn red coil and a piece of buss wire. The coil is designated L6A. First, remove L6 from the circuit. It is a single turn and blue. Install L6A and the same side as L6 but as close to the gate lead of Q3 as possible. Do not stretch the coil! Solder the other end on the ground. Then cut 0.400" of buss wire. This wire will form a shunt inductor. Put a slight bend in the wire and attach it on the same side as L6A but as close to the FET side of C59 as possible. Tack solder the other end to ground. Then push the wire close to the boars as possible without touching. Now measure 0.250" from C59 and put a solder bead on the wire to ground. You may now re-tune the front end for maximum gain. You may do an on the air test to check for additional selectivity. It should perform better and if not there is little hope with out and external bandpass filter! What is the noise figure? We have seen the best at 1.5 dB and the worst at 3.5 dB by tuning for maximum gain. In the factory we assemble all of the transverters with this mod. They are all tested on a noise figure meter and we find at some time we need to sacrifice some gain to improve the noise figure. Good luck with this mod!

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 positive voltage such as the source +13.8 VDC. The K2 common connection will then be toggled depending on what state the transverter is in. 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 a 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 amount of 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 23 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 1296 -144K and CK Component List

BAG 1 CONTENT

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

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

BAG 2 CONTENTS:

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

C1 0.01µF	C20 100	C39 33	C60 0.3-3 VAR.
C2 1 - 4 Piston	C21 18	C40 0.1µF	C61 0.1µF 1008
C3 0.01µF	C23 18	C41 33	C62 0.1µF 1008
C4 18	C24 100	C42 33	C63 33
C5 22	C25 0.01µF	C43 0.1µF	C64 33
C6 0.01µF	C26 100	C47 0.1µF	C65 0.01 µF
C7 0.01µF	C27 18	C48 100	C66 1.0 µF Tant.
C8 0.1µF	C28 18	C49 2.2 µF Elect.	C67 33
C9 33	C29 100	C50 0.1µF	C68 0.1µF
C10 1.0 µF Tant.	C30 0.1µF	C51 100	C69 0.01 µF
C11 0.1µF	C31 100	C52 100	C70 33
C12 33	C32 100	C53 1.0 µF Tant.	C71 0.01 µF
C13 33	C33 0.1µF OPT.	C54 0.1µF	C72 1 ρF leaded
C14 0.1µF	C34 100	C55 1.0 µF Tant.	C73 0.1µF
C15 0.1µF	C35 100	C56 0.1µF	10 pF optional (1)
C16 33	C36 100	C57, A 33	
C17 33	C37 0.01µF	C58 100µF Elect.	
C18 33	C38 33	C59, A 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)
L5, A 5 Turns 0.05"ID #28 Wire (pre wound)	L30 0.33 µH(Green body, orange bands)
L6 1T, BLUE Body (pre wound)	L31 10 ηH (0603 chip inductor)
L6A 2T, RED Body (pre wound) optional	1" # 18 buss wire
L8 5 Turns #28 Wire (pre-wound)	1 - wooden dowel

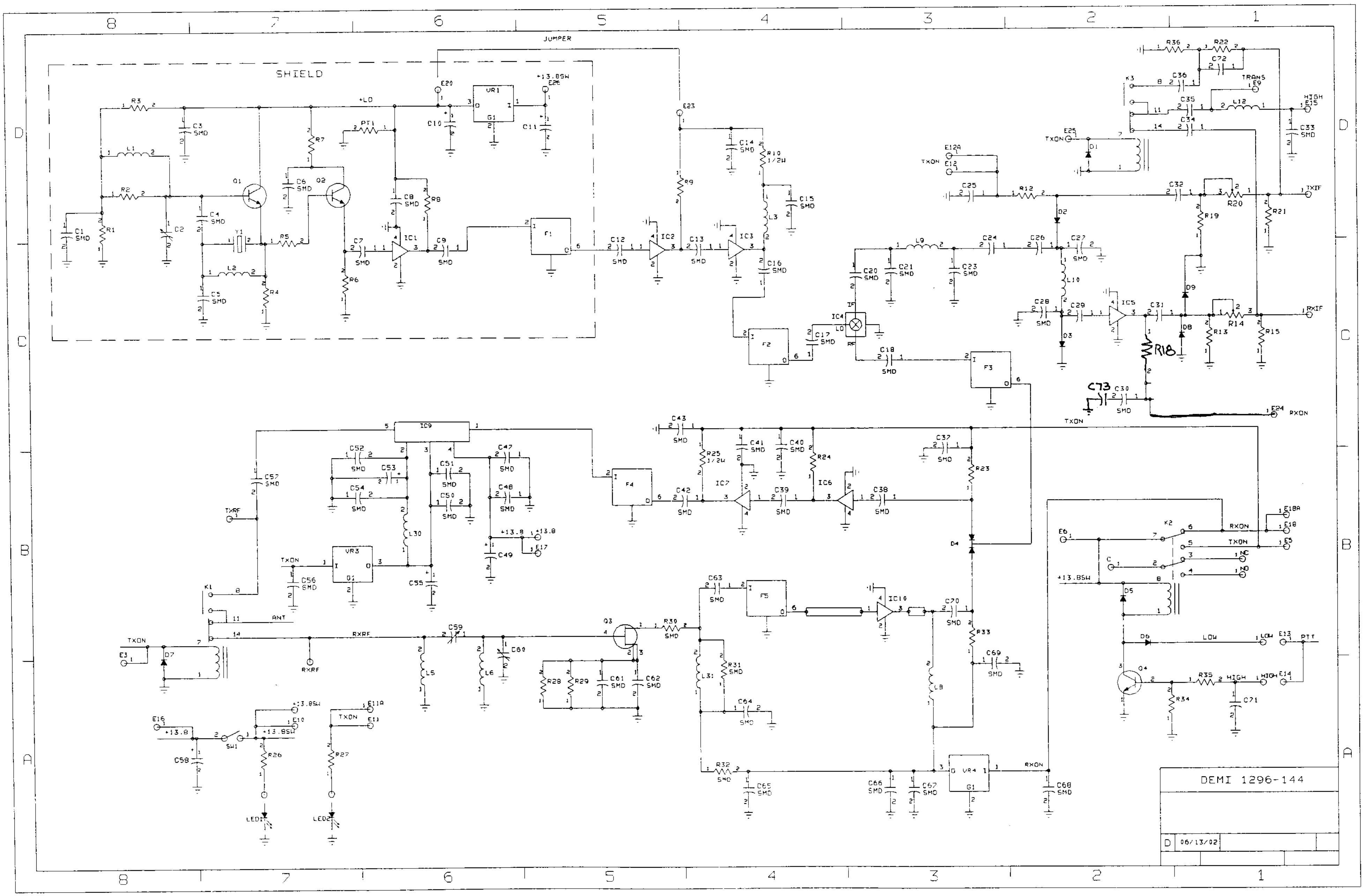
BAG 4 CONTENTS:
Note that all filters (F1-F5) are pre-installed in your PCB.

Q1 2N5179	D9 1N914	IC6 MAR3
Q2 2N5179	F1 112570C - Installed	IC7 MAV11
Q3 ATF34143	F2 112570C - Installed	IC10 AH31
Q4 KN2222	F3 123080C- Installed	VR1 78S09
D1 1N4000 type	F4 123080C - Installed	VR3 78S09
D2 MPN3404	F5 123080C- Installed	VR4 78M05
D3 MPN3404	IC1 ERA3	K1 G6Y-1
D4 HSMP 3814	IC2 ERA2	K2 G5V-2
D5 1N4000 type	IC3 ERA5	K3 G6Y-1
D6 1N914	IC4 SYM-14H	PTC1 PTC 60 Thermistor
D7 1N4000 type	IC5 ERA 50	Y1 Crystal 192.000 MHz HC 18/U
D8 1N914		

HARDWARE

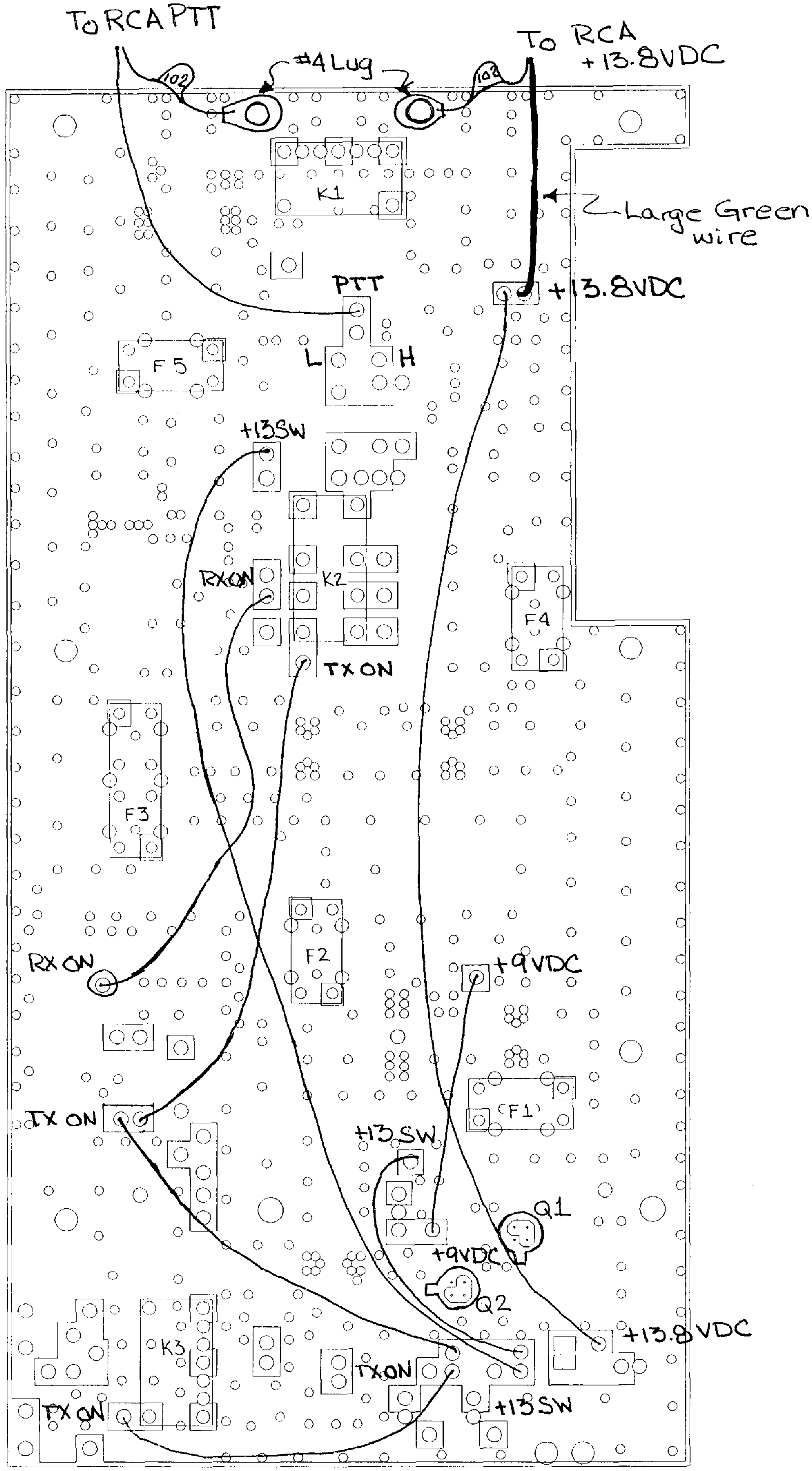
(2) 1000ρF leaded	R36 THC 50 Ω, 10 W Load
(1) Type ¾" "N" connector	SW1 Power Switch
(2) SMA connectors	(1) Shield- Prepped
(2) BNC Female UG1094/U Connectors	(3") #18 Teflon wire
(3) RCA Jacks (Control, Aux., Power)	(3') #24 Teflon wire
(4) 4-40 x 3/16" Screws	(20") Coax
(2) 4-40 x 3/8" Screws	(1) 3/8" 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
(5) 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
(2) #4 flat washers	(8) Flat Head
(2) #4 lugs	(1) Machined Enclosure
(2) LED, RED	(1) Thermal Compound
(2) 4-40 x 1/8" Screws	

Miscellaneous Loose Parts if required in you kit (1) RF Power Module IC9, M67715. (2) Printed Circuit Board with filters installed. (3) Enclosure, two halves.

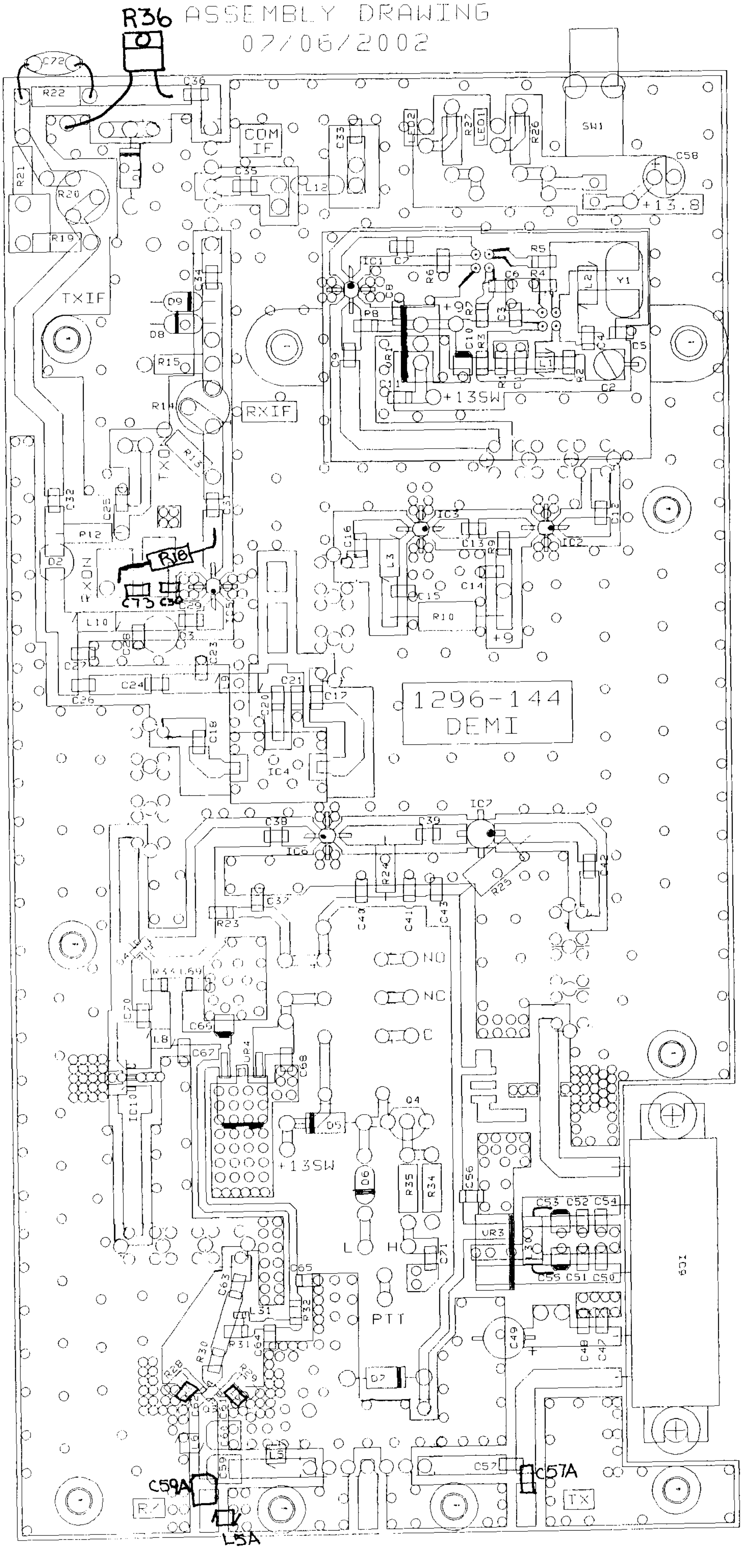


SHIELD
JUMPER
+LO
RXIF
TXIF
RXON
TXON
RXRF
TXRF
ANT
LOW
HIGH
PTT
TRANS
DEMI 1296-144
D 06/13/02

1296-144
PCB Bottom Side



1296-144
ASSEMBLY DRAWING
07/06/2002



PC Board
Top Side