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# High Dynamic Range 144 MHz Transverter Kit

## *DEM Part Number 144-28K or CK*

### *Operational Overview:*

The DEM 144-28 is a 144 MHz to 28 MHz transmit and receive converter. It will operate with most High Frequency transceivers that are available on the market today. The 144-28 has a linear output power of approximately 25 watts and will compress at 35 watts for CW or FM operation only. On the receive side, a GaAs-FET preamplifier, a high level mixer (+17 dBm Local Oscillator), and a 3 chamber helical filter provide a sensitive, yet over-load proof front end with superior out of band rejection. The DEM 144-28 has a built in transmit / receive relay with provisions for external switching so that adding a high power amplifier to your 144 MHz system is easy. Options have been provided for a key line input of PTT Low (ground) or PTT High (+Voltage). Auxiliary contacts are included for either transmit or receive with a common line for many applications. The 28 MHz IF levels are adjustable on both transmit and receive and have a dynamic range of approximately 25dB. This is very useful for adjusting your maximum output power and setting the "S" meter level on your IF receiver. IF connections are via BNC connectors. The control, power, and auxiliary connections are via RCA jacks, and the 144 MHz connectors are BNC, UHF or Type 'N' (users choice). The 144-28 is housed in a 7.4" x 4.7" x 2.2" aluminum die cast enclosure with an external 7" x 4" x 3/4" heat sink to provide cool operation under any condition.

### *DEM 144-28 Operating Specifications:*

| | |
|---|---|
| Operating Voltage: | 12.0 - 15.5 VDC, 13.8 nominal |
| Current Drain: | 5 amps maximum on Transmit, 350 mA on Receive |
| Output Power: | 25 –30 W linear, +35 watts maximum. Output has 25 dB of adjustable range. Minimum 1 mW (0dBm) for 10 watts output power. |
| Maximum IF Drive Power: | 200 mW (+23 dBm) with 25 dB IF adjustment range (Standard Setup) |
| Receive Noise Figure: | 1.0 dB maximum, 0.8 dB nominal |
| Conversion Gain: | +17 dB nominal with 25 dB adjustable IF attenuator |

### *DEM 144-28 Assembly Options:* (*purchased separately)

| | |
|---|---|
| External TR switching control | TXIF amp for < 0 dBm input @28 MHz |
| Separate Transmit and Receive ports | Common IF port with 10 watts input * |
| PTT high and PTT low Keying (not RF sensed) | Optional LO crystal for full band operation* |
| Type N, UHF or BNC connectors on 144 MHz ports | Factory alignment available on all kits* |

### *Pre-Assembly Notes:*

This document covers both the complete kit and the PCB kit of this transverter. Please read the document completely before starting assembly to become familiarized with the assembly and test procedures. If you decide that this kit is too difficult or you do not have the time to assemble it correctly, you may return it now for full credit towards and assembled version. We will not accept partially built units for any credit and will only finish the assembly of your kit for a fee depending on the level of assembly and repair required. With over 1000 of these units out in the amateur radio population, we have a high confidence level regarding the quality and reliability of the kit and the final product whether it is assembled by you or DEMI. If you are ready to start the assembly, and have read through the document, proceed to the pre-assembly step on page 3 and have fun!!

## ***Printed Circuit Assembly Notes:***

Your kit is provided with easy to read assembly diagrams that show the component layout and the reference designators that correspond to the provided component list. Each side of the printed circuit board (PCB) is also shown to eliminate mirror image assembly errors. All holes under or at the end of a component are for lead insertion. Some components will be surface mounted and will be described at the time of assembly. All holes with an "X" indicates a wire insertion. Nine large holes in the PCB are mounting holes and are indicated by double circles.

## ***Assembly Tips:***

**Soldering surface mounted active components (MMIC's and FET's):**

- The printed DOTS on the MMIC's IC2, IC4, IC7 and the raised DOTS on IC1 and IC8 determine their orientation and must be observed and positioned accordingly to the component placement diagram prior to soldering. The GaAs-FET (Q4) orientation is determined by it's angle cut lead and dot. (see figure 1) This is the Gate.
  Leads on all of the 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 (See Figure 2).
- Align the component in place based on the diagram.
- While holding the component in place, solder one lead to hold the component in place and observe the alignment of all leads.
- If the alignment is acceptable, solder the remaining leads. You need enough solder to cover the lead and mounting surface for the entire lead length. Additional amounts results in a smaller solder roll! (See Figure 2 shaded areas)

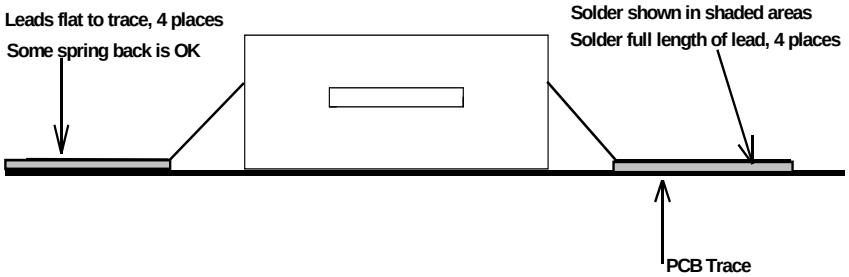
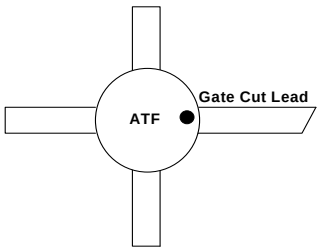



***Figure 2***
***Typical side view of four leaded surface mounted device, lead bending close to body***




***Q4 Figure 1***

## ***Soldering surface mounted passive components (chip resistors / capacitors):***

- Determine the component mounting position based on the assembly diagram.
- Without the component, Pre-tin the circuit area by heating one side of the mounting area and flowing a small amount of solder on it.
- Place the component in the correct position per the assembly diagram, it should now have one end over the now solidified solder..
- Holding the component in place with tweezers or other soldering aid, heat the end with the previously melted solder,(not the component edge!) , and allow it to flow into the solder, once solidified, remove holding tool.
- Now heat and flow solder to the other side of the component and your done!

***Soldering leaded components (resistors, capacitors, diodes, etc.):***

Depending on your available tools, you can solder your transverter's components from either the top or bottom of the PCB. Use what ever method that you feel comfortable with. 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 the topside without flipping over the assembly. You could use the enclosure if you have the complete kit to support the PCB during 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 for repair when the PCB is installed in the enclosure.

***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 any electronics store. Place the de-soldering braid on the lead that you are removing and apply heat to it. Without excessive pressure the solder will melt and flow into the braid leaving the lead or component ready to be removed.

Most leaded components can be re-heated and removed from the circuit board first. Then before re-installing, use the de-soldering braid to remove left over solder in the assembly holes be fore attempting to re-insert the new component.

If you have a component lead that has been removed from a “ground plane “ position, you may select a different ground via hole for re-insertion. Verify the schematic for the ground connection and check with an ohm meter if un-certain.

***Pre- Assembly:***

The DEM 144-28K and CK is fairly easy and fun to assemble even for the first time kit builder. This kit can be completed in any order that is comfortable, however DEM Inc. suggests the following assembly procedure to minimize errors and possible frustration.

Start by inventorying the four component bags and the one hardware bag. There is always a chance that a component is missing or not identified correctly. This is the time to sort this out. Sometimes we need to use replacement components and an addendum sheet may be found in the bags. If so, please make changes to the component list as required. If there are any questions about the components or something is missing, please contacts us.

***Bottom Side Suggested Assembly:***

The bottom assembly operation should begin by orienting the PCB with the bottom side assembly diagram. Orientation can be determined by aligning the words “BOTTOM SIDE “ on both PCB and diagram. Now while observing the polarity using either the DOTS or lead configuration as explained in the Assembly Tips section**,** install and solder the active components IC1, IC2, IC7 and IC8. If you observed your soldering and component orientation, the bottom side is complete, but it doesn’t hut to recheck it!

***Top Side Suggested Assembly:***

The top side assembly is the bulk of the assembly. All remaining components are inserted on or through the topside. If you will not be using the common IF option, go to page 17 of this document and cross off the components listed from the assembly diagram. This will eliminate searching for those components. If you wish to use the option and it is included in your kit, you may install it now. Follow the steps listed on page 17. If not, proceed to the next paragraph.

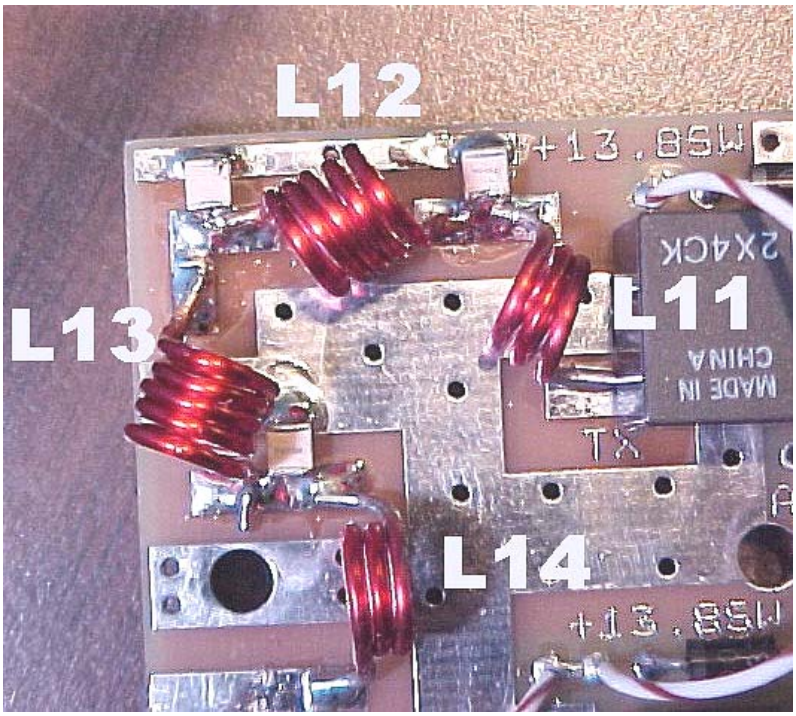
Prior to installation, L9 must be formed on a 1/8” drill bit or mandrel. Winding coils is not an exact science and you should not be intimidated by it. Using the supplied enamel wire, extend

about ¼" in a perpendicular direction off of the mandrel 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 mandrel. Form the two ¼" leads so they are pointing in the same direction. Dress the turns together if they are out of shape from winding, remove the coil from the drill bit. The coil forming is complete! To ensure a positive solder connection, the ¼" leads should have the enamel insulation removed prior to soldering. This can be accomplished by applying solder to a hot soldering iron tip and placing the lead in the molten solder, you will see the insulation bubble indicating that it has melted. The tinned lead should be a silver color indicating that the insulation has been removed and the solder has tinned the base metal.

The top side assembly operation should begin by orienting the PCB with the top side assembly diagram. Orientation can be determined by observing the words “TOP SIDE” You will notice on the assembly diagram that there are circles shown which will provide locating help when installing components. These have the following meaning:

**Double Circles = Mounting Holes Circles with Xs = Wire Connections**

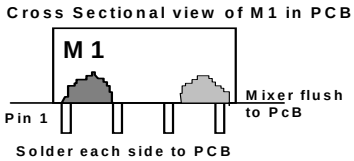
Topside assembly starts by installing Q4. Note its orientation and solder into place. Now install C41, C42, R21, R22, C64 and C11. These are the surface mount components around Q4. Install C36 and C40 next. Be sure to pick the 2 surface mount trimmer capacitors that are in Bag 2. Then Install C46, C48,C49 and C50. Install C46 and C49 closest to the board edge. R35, R37 and C37-C39 should be installed next. Now install R33 and R24 next. R24 and R33 are formed by bending one lead in a right angle and placing this lead in the proper via hole. "Trim to fit" the other lead to the transmission line keeping the leads as short as possible and the body of these components as close to the PCB as possible. L11 - L14 are preformed and wound in different directions. Install as shown in the figure below paying attention to the direction of the turns. Use the left-over 5 turn for L15 on the assembly diagram. Turn direction doesn’t matter on L15.




If you require the TX optional gain stage, IC4, refer to the *User Options* section on page 14 before installing. The circuit board will require a simple modification as shown.

All surface soldering is now complete. To assemble the rest of the PCB you can just populate the board in areas. At the DEMI factory, all resistors, capacitors and diodes are

assembled at the same time. Then we install the active components, leaving the relays and filters for last. ***OR*** Assemble and solder the rest of the components in the following suggested order while observing all polarities as shown on the assembly diagram. Its your choice.

| STEP | OPERATION and NOTES |
|---|---|
| 1 | Form, install, and solder CR1, CR2 and CR7. **Ensure proper polarity.** Install CR3 and CR4 |
| 2 | Form, install and solder L1, L2, L4, L6, L10, L17,L18, L26, and L27 (molded inductors) |
| 3 | Form, install and solder all leaded resistors including R20 if using optional Gain Stage. Install Pots R7 and R10 |
| 4 | Install and solder all leaded capacitors including C24. **Check polarity when applicable.** |
| 5 | Install and solder Q1, Q2, VR2, and VR3. Do not install VR1 |
| 6 | Install Q3 with a ¼" gap between it and the PCB. See figure 6 in the oscillator test section. |
| 7 | Install Y1, 116 MHz. crystal. Leave a 1/8" space between it and the PCB. See figure 6 |
| 8 | Looking at mixer M1, notice the "MCL" marking on the top of it's case. This corresponds to the M on the component placement document. Be sure that the mixer is seated flush with the PC board and solder. Then on the top side, tack solder the case to the PCB surface, one spot on each side.   |
| 9 | Install Relays K1, K2. Be sure they are flush with the PC board |
| 10 | Install Filters F1, F2, F4. Note these filter are not polarized, do not bend over the leads. Be sure they are flush with the PC board and solder all leads on the bottom side |

When complete with step 10 or your version of assembly, there should be a 78S09 regulator (VR1) left over. This will be installed during the hardware installation of the 144-28CK. If you are just assembling a 144-28K PCB kit, you may install it now. Then install and solder the wires in the areas on the board indicated by circles with an "X" using the sizes shown in the table below. Strip and Tin ≈ ¼" from each end prior to installing.

**Note:** Flying Leads are wires that will be connected later in the assembly process.

| WIRE | FROM | TO | SIZE |
|---|---|---|---|
| #26 Teflon | TXON | TXON | 5½" |
| #26 Teflon | RXON | RXON | 1 3/4" |
| #26 Teflon | TR | TR | 2" |
| #26 Teflon | +13.8 SW near L26 | +13.8SW near R23 | 2 3/4" |
| #26 Teflon | TXLED | Flying Lead | 2½" |
| #26 Teflon | +13.8 SW near CR1 | +13.8SW near R23 | 3 ¼" |
| #26 Teflon | +13.8 SW near CR7 | +13.8SW near CR1 | 2" |
| #26 Teflon | TTL and PTT | Flying lead | 2½" |
| #26 Teflon | +13.8SW near R23 | Flying lead | 2½" |
| #26 Teflon | +13.8V | Flying lead | 3¼" |
| #26 Teflon | RXIF | Flying Lead | 1½" |
| #26 Teflon | TXIF | Flying Lead | 1¼" |
| #26 Teflon | JUMPER see Top side Assembly Layout | | 1" |
| * #26 Teflon | *TXON | *TXOPT | 1" |

***Only if the optional TX gains stage is installed**

After the wiring is complete, verify that all leads, including the wires are **trimmed as short as possible** on the bottom side to eliminate possible shorting to the external enclosure when installed. Look your work over for solder bridging to adjacent traces, incorrectly installed components, etc. If you have the 144-28CK continue with the Enclosure assembly. If you have the 144-28K PCB kit, and have installed it in your own enclosure, skip to the receive electrical verification test. If you have a bare PCB for testing, use the test steps for reference and electrical verification only. Valid

receiver and transmit performance is not possible unless the PCB is installed in an enclosure with suitable RF and DC connectors with proper grounding.

***PCB assembly into the enclosure:***

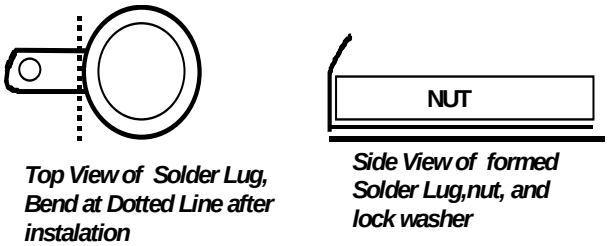
Assembly of the enclosure and installation of the PCB is easy if the suggested steps are followed. The heat sink and enclosure are machined to match the circuit board and have corresponding holes which must be aligned correctly. The heat sink and the enclosure will be attached with a common screw / nut combination and the PCB will fit separately.

Start by wiping the inside of the enclosure clean to remove any remaining metal particles that may have been left during the machining process. Align the enclosure and heat sinks holes by placing the heat sink on the bottom of the enclosure. Now use the PCB to determine which two holes will not be used for mounting it to the enclosure. Thread the two 6-32 screws hand tight through the inside of the box into those holes in the heat sink. This is for alignment only. Now place one cap screw in a hole from the "fin" side of the heat sink. While holding the screw in the heat sink with the provided Allen Key wrench, start a 4-40 nut on the screw threads inside of the enclosure and hand tighten only. Then install the balance of the cap screws from the 'fin' side of the heat sink and install the nuts hand tight. When complete, tighten all of the 4-40 nuts with a ¼" nut driver or wrench then remove the 6-32 screws.

Insert the PCB into the enclosure. If you find any 4-40 screws that do not clear the mounting holes, loosen the nut and reposition the screw. If satisfied with the PCB fit, install a nut on any two screws to hold the PCB in place .Find the VR1 regulator and trial fit it in the PCB. It bolts to the enclosure after it is soldered in the PCB. Use the 4-40 screw for alignment to the enclosure. If it is close, attach a 4-40 nut and tighten into place. The leads may bend a bit but tack solder one or two leads of the regulator to the PCB. Remove the 4-40 screw and PCB from the enclosure. Finish soldering the regulator one lead at a time being careful that the tack soldered lead does not move. Clip off any excess lead and re-try the PCB fit. If satisfied with the fit, remove the PCB from the enclosure and proceed with the Hardware installation. If not, rework VR1

***Hardware Installation:***

Install the Type "N" or UHF and hardware in the RX antennae position (figure 4) as shown in figure 3A. Then tighten with ground lug in the position as shown in figure 3B.




*Top View of Solder Lug, Bend at Dotted Line after instalation*

*Side View of formed Solder Lug,nut, and lock washer*

***Figure 3A***

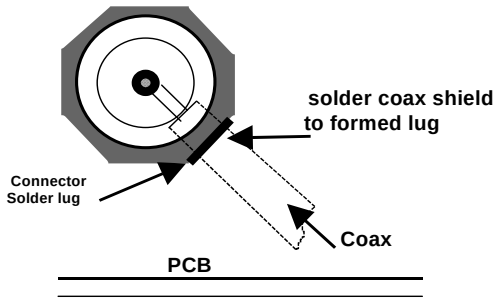



***Figure 3B Inside View***

When complete, proceed to install the rest of the rear wall mounted connectors per Figure 4. Install two BNC connectors at the RXIF and TXIF positions using the supplied 3/8" nuts. If washers are supplied, install them on the inside of the enclosure. If you have difficulty tightening the connector, connect an adapter or cable connector and hold this while tightening to keep it from spinning. Install one BNC connector at the TX Antenna position following figure 3A and 3B. Bend the lug away from the wall to form a right angle. Install three RCA connectors for auxiliary, PTT

and 13.8VDC using the supplied hardware. The flat washer and the solder lug should be installed on the inside. After tightening, the lug should be bent away from the wall.

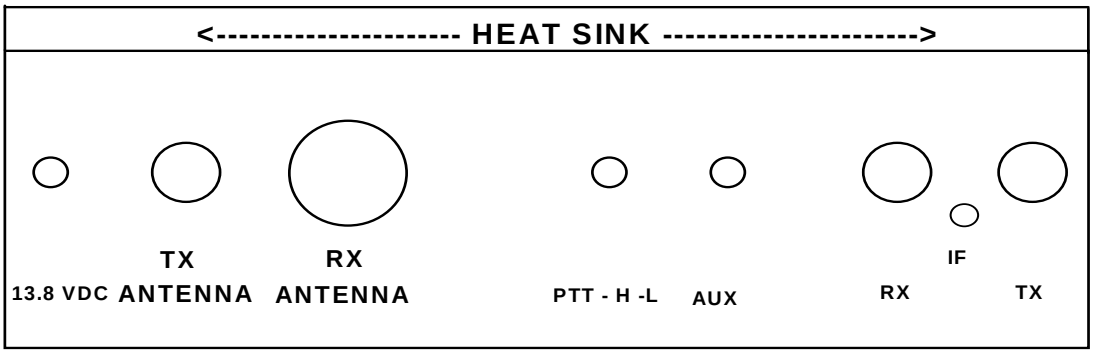



***Figure 4 Jack Mounting Positions Outside View***

Place the finished circuit board in the enclosure and place two nuts on opposite corners on the screws extending through the PCB then tighten evenly. *Do not install or tighten other nuts in place until electrical testing is completed.* You don't need to install the VR1 mounting screw until the assembly is complete. For now, install the power switch in the remaining 1/4" hole using the supplied hardware. Mounting of the switch should be so it is toggled per Figure 5.

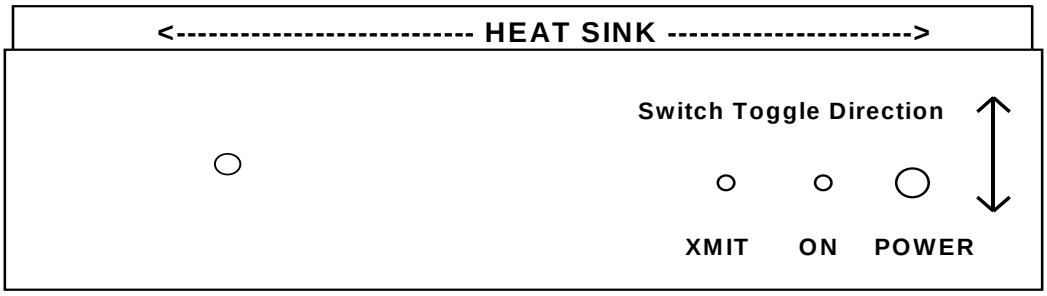



***Figure 5 Switch / LED Mounting Positions***

At this point, some of the flying wires will need to be connected in the enclosure to allow preliminary electrical testing. Depending on the keying circuitry required by your IF transceiver, connect the #26 Teflon from either the TTL or PTT point on the board to the RCA jack mounted and labeled PTT- H –L in the enclosure. Solder it after connecting a 1000 pF capacitor to the center pin and ground lug (See Figure 4 for jack location). Then connect and solder a 1000 pF from the center pin and ground lug of the AUX jack.

Connect and solder the flying lead from the +13.8V to the middle terminal on the wall mounted switch and solder. Connect the #26 Teflon wire from +13.8SW to the terminal on the wall mounted switch that is the closest one to the top opening of the enclosure. Then strip and tin a 2-½" #16 Teflon wire (Blue) and surface mount solder it to the +13.8V pad on the PCB. Then, solder it to the center lug of the 13.8VDC connector in the enclosure(see figure 4)

***Receive Electrical Test Verification:***

The following information is provided to electrically pre-test the transverter prior to final assembly. If you have a frequency counter it would be helpful but is not mandatory. Apply 13.8 volts to the DC Power jack. The center pin is positive. Turn on the power switch, the transverter will now be in the receive mode. Check the voltages in the order shown. If voltages are not in

spec, refer to the trouble shooting table below. All tests **need to be in or near spec** before oscillator testing can begin. The die cast enclosure is ground.

| TEST | LOCATION | VOLTAGE referenced to Ground |
|---|---|---|
| RX 1 | RXON | 13.8 ±1 VDC ( power supply voltage) |
| RX 2 | Junction of C11 & R24 | 2.0 – 3.0 VDC |
| RX 3 | C11 pad opposite of R24 | 2.5 VDC ±1 VDC |
| RX 4 | Junction of C26 & VR1 | 9.0 VDC ± 0.2 VDC (regulator output) |
| RX 5 | Junction of R28 & C61 | 5.0 ± 1.0 VDC |
| RX 6 | TP1, junction of R15 and Q2 | .3 - 1.5 VDC |

| TEST | Symptoms | Probable Cause |
|---|---|---|
| RX 1 | Low or High VDC | Power supply not adjusted correctly or current limited |
| RX 1 | 0V or low voltage | 100μF capacitor or 13.8 VSW shorted to ground. Also check RXON. |
| RX 2 | Voltage < 2.0 VDC | If VR2 has 9 V output, L15 missing or open or remove R21 |
| RX 2 | Voltage > 3.0 VDC | Install a 36 ohm resistor across R21 position |
| RX 3 | Voltage > 3.5 VDC | IC1 installed wrong or failed |
| RX 3 | Voltage < 2.5 VDC | R 14 open, input lead shorted or C8 shorted to ground |
| RX 4 | Voltage > 9.3 VDC | Regulator in backwards |
| RX 4 | Voltage < 8.7 VDC | Short in oscillator circuit (Q2, Q3, IC7) or C26 installed backwards |
| RX 5 | Voltage < 4.0 VDC | R28 wrong value or open. IC7 installed wrong |
| RX 5 | Voltage > 6.0 VDC | R28 wrong value, R28 Shorted. IC7 installed wrong |
| RX 6 | Not in range | Check all components in oscillator section for shorts or opens |

***Oscillator Testing:***

Pre-set the spacing of the L9 turns by spreading 1 or 2 turns. Then with the positive lead of a Voltmeter probe TP1,either Q2 or R15. Adjust C24 for maximum voltage If the voltage can not be peaked try compressing or spreading the turns of L9 with C24 in the mid range position. If the diameter is not 1/8", it may be difficult to adjust! The final voltage after peaking should be > 1.2 VDC but it may be OK if below. Just be sure to peak it. If a frequency counter is available probe TP2 and fine tune C24 for 116.000 MHz. If at any time the voltage or frequency can not be obtained in this test, check all components in the oscillator circuit for proper installation and re-verify the RX test voltages.

After the Oscillator voltage or frequency is set, disconnect the voltage from the transverter. Now install the PTC Thermistor as shown in the next diagram. Heat the Thermistor with a solder iron and remove one wire. Then tin one side of the crystal case. Holding the Thermistor in place, re-heat the crystal and flow the solder to attach the Thermistor to the crystal. Squeeze Q3 and the Crystal together until their cases touch each other. Tack solder the crystal and Q3 together. This is important. The case of Q3 is ground and completes the DC circuit for the Thermistor. This will also keep the temperature of Q3 stable which in turn minimizes frequency drift. Solder the PTC flying lead as depicted in Fig. 6. The frequency of the oscillator will need to be readjusted, but the final frequency adjustment should be done after 72 hours of operation to insure that there will not be any more drift from aging.

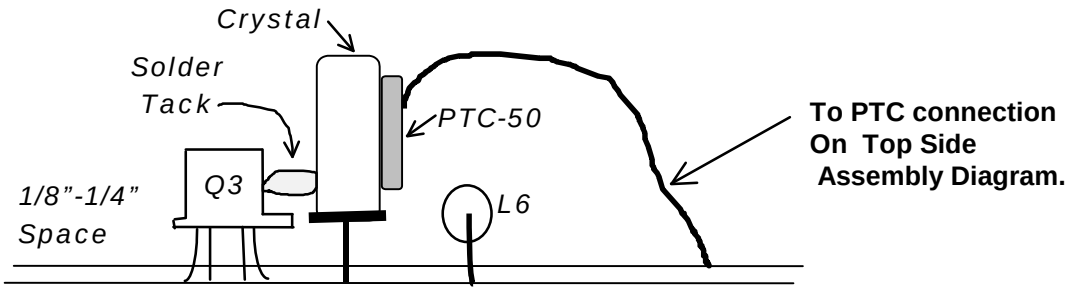



**Figure 6.**

***Transmit Electrical Test Verification:***

The voltage check list below is for the transverter in the TX mode. Connect the Dc voltage and place the transverter into the TX mode by either applying a Positive voltage > 1.5 volts to the TTL input or ground the PTT line. The choice is made by you depending on your transceiver operation. If the Test voltages do not check, refer to the trouble shooting table below.

| MODE | LOCATION | VOLTAGE Reference to Ground unless Specified |
|---|---|---|
| TX 1 | Relay K1 | Audible Click (when Transverter is keyed) |
| TX 2 | Relay K2 | Audible Click(when Transverter is keyed) |
| TX 3 | TXON | 13.8±1VDC( supply voltage) |
| TX 4 | TXLED | 13.8±1VDC (supply voltage) |
| TX 5 | Junction of R26 & C12 | 3.5±1VDC |
| TX 6 | Junction of C13 & IC2 | 2.5±0.5VDC |
| TX 7 | Junction of R25 and C63 | 5.5 ± .1 VDC |
| TX 8 | Pad of C46,C45, and C48 | 5.0±0.3VDC |
| TX 9 | Junction of CR4 and L1 | 1.4±0.3VDC |
| TX 11 | Junction of R20 &C32 | 3.5±1VDC (optional gain stage) |
| TX 12 | Junction of C7 & IC4 | 2.5±0.5VDC (optional gain stage) |

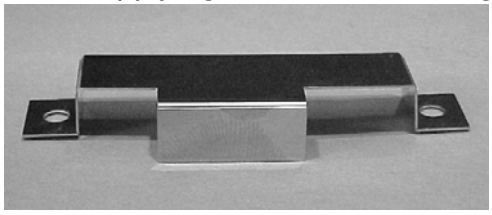
| TEST | Symptoms | Probable Cause |
|---|---|---|
| TX 1 | No Click | +13.8SW wire missing or K1,Q1,R1,CR2 installed incorrectly or defective |
| TX 2 | No Click | +13.8SW or TR wire missing or K2,CR7 defective or installed incorrectly. |
| TX 3 | No voltage | K1 Relay not functioning, or wire shorted to case |
| TX 4 | No Voltage | R29 open or C54 shorted |
| TX 5 | Voltage > 5 VDC | Ground leads not soldered on IC 2 or R26 wrong value. |
| TX 5 | Voltage < 2.0 VDC | R 26 wrong value. C12 or IC 2 shorted to ground |
| TX 6 | Voltage < 2.0 VDC | Input of IC 2 or C13 shorted to ground |
| TX 6 | Voltage > 3.0 VDC | If TX5 Test OK, Replace IC2 |
| TX 7 | Voltage < 4.5 VDC | R25 wrong value or open, input of IC8 shorted to ground |
| TX 7 | Voltage >6.5 VDC | R25 wrong value or IC8 installed backwards or blown |
| TX 8 | Voltage > or < | VR3 Installed backwards, R37 open, C 68,45,46,48,shorted ,open. |
| TX 9 | Voltage <1.0VDC | Missing TXON wire , R3 or L1. CR4, L2. C34, C4 shorted to ground |
| TX 9 | Voltage >2.0VDC | CR3 ,CR4, L2 missing or open |
| TX 11 | Voltage > 5.0VDC | Ground leads on IC 4 not soldered |
| TX 11 | Voltage < 2.5VDC | Ribs not removed under IC 4.TXOPT Jumper not installed |
| TX 12 | Voltage > 3.5 VDC | IC 4 backwards or damaged |

***** DO NOT PROCEED UNTIL ALL RX AND TX TESTS POINTS ARE VERIFIED *****

Once check points are verified, install the remaining six 4-40 nuts on the screws holding the PCB.

***Power Module Installation:***

Remove the 6-32 screws and place the power module (IC5) on the enclosure floor in its mounting location. Trim the leads so they do not extend past the mounting pads. They should be approximately 3/8" long once trimmed. Wipe the mounting surfaces of the enclosure floor and flange of IC5, verify the surfaces are free of any foreign matter before applying a thin even coating of the supplied thermal compound to the mounting flange.



Place IC5 on the enclosure floor while lining up the leads with the traces of the circuit board. Find the brass shield and form to fit as shown. Install two 6-32 x 3/8" screws through the shield, the mounting flange, and the enclosure floor, then tighten evenly into the heat sink. **NOTE:** Make sure IC5 is mechanically sound to the bottom of the enclosure. Improper seating of the hybrid could result in poor grounding and heat transfer causing damage to the power module. Form the leads flat to the traces, solder all leads of IC5 to the circuit board. Now observe where the shield contacts the PCB. Tack solder along that edge. It will require a lot of heat so take your time. It helps if you loosen the mounting nut near by. Re-tighten when complete.

***LED Installation:***

**Note:** The longer lead on the LED is positive. Prepare both LED's by supporting the **SHORT** lead (negative) at the LED body and bend the lead 90º away from the longer lead. Place the "ON" LED in the wall mounting hole (see Figure 5) and place the previously formed lead in a plated through hole closest to the edge of the board and solder. Find the black plastic retainer and insert it from the outside of the enclosure so it snap fits around the LED. Repeat this process for the "XMIT" LED placing the formed lead in the next plated through hole away from the other and solder. Install the retainer. Cut the positive lead of the "XMIT" LED to approximately 3/8". Form a "J" in the lead by bending with pliers. Connect the #26 Teflon wire from the hole in the PCB near filter F4 labeled TXLED, to the "J" formed positive lead on the "XMIT" LED. Bend the positive lead of the "ON" LED to fit in the hole in the circuit board near R23. Solder in place.

***Final Connector assembly:***

Connect and solder a 100 μF capacitor to the DC power jack. Observed the polarity, (positive lead to the center pin). Unless you have installed the common IF option, connect the #26 Teflon wire from the via hole in the PCB near R10 labeled RXIF to the BNC RX IF jack and solder. Then connect the #26 Teflon wire from the via hole in the PCB near R7 labeled TXIF to the BNC TX jack and solder. If you have the common IF option installed, connect a 1000 pF capacitor from the RXIF connector and the via hole marked common IF IN/OUT on the assembly diagram.

The following assembly order is recommended for completion of the transverter for a common RX/TX connector. For split TX / RX refer to section 1 of DEM 144-28 user options.

Prepare the common output coaxial cable as follows: (See Figure 7) Cut the coax 2" - 2 1/2" and remove the outer insulation 1/2" from one end and 1/4" from the other. Solder tin the complete exposed shield. Then cut the shield to size with wire stripers. Continue to prep the coax as shown. Solder tin the center conductor on both ends. Position the 1/4" stripped end on the circuit board by placing the center conductor in the hole on the board labeled "ANT". This hole is located near relay labeled K2. Angle the coax so that it is facing the trimmer capacitors C36 and C40 (See Figure 8). Solder the shield to the ground area adjacent to the "ANT" hole for the center conductor, then solder the center conductor in the "ANT" hole. Route the coaxial cable around the

relay to the solder lug on the wall mounted 'N' connector. Push the center conductor through the hole in the solder lug and allow the shield to penetrate the hole (See figure 3B). Solder the shield to the solder lug, then solder the center conductor to the 'N' connector center pin.

If you prefer to use a common RX/TX BNC connector, prepare the coaxial cable as stated above and rout the cable in the opposite direction away from the trimmers C36 and C40. Finish by soldering the coax the BNC connector the same as instructed for the N connector.

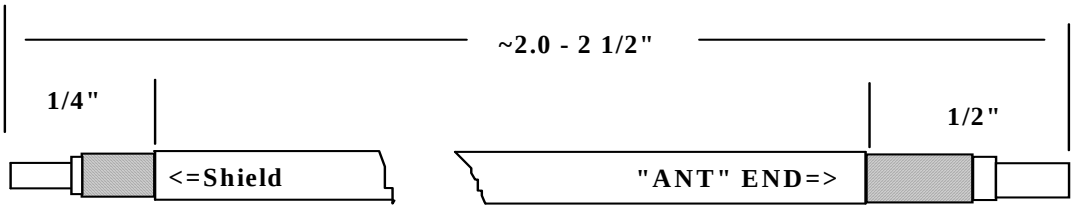



***Figure 7* Cable shown broken for clarity**

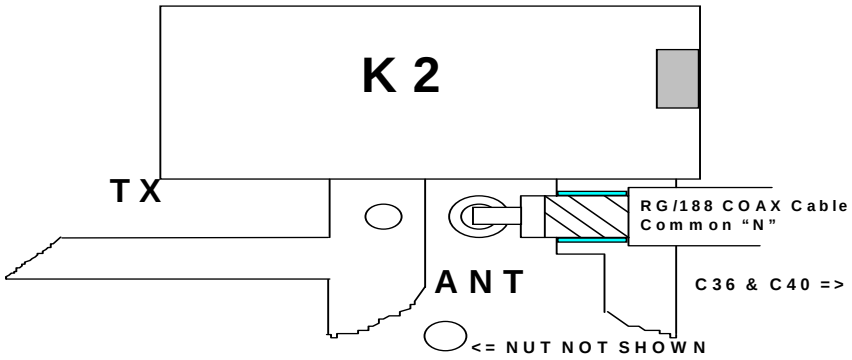



***Figure 8* Coaxial Cable mounting on PCB shaded areas are solder points**

## *Transverter Final Tune Up*

The assembly portion of your kit is complete. You will now proceed with the final tune up as follows after connecting your transverter to your IF rig. If you have purchased a transverter interface such as a TIB or an AOS, refer to its Transverter interfacing document for your application. This Final tune up section assumes that you will be interfacing this transverter directly to your 28 MHz. transceiver transverter ports.

**1.** Connect the DEM 144-28 to your transceiver. Consult your transceiver's manual for its transverter connection details. Verify the drive level your transceiver has and what ports will be connected to the transverter. If you require a single IF cable (common IF connection) be sure that your transceiver is in "Transverter Mode" before making a transmission. If you require a separate TXIF and RXIF, be sure that the port that the RXIF is connected to will not have transmit energy when the transceiver is in the transmit mode. Set the frequency of the transceiver for the weak signal portion of the band.

**2.** Set R7 to the maximum value by turning fully counter-clockwise, this sets minimum TX gain. Set R10 to the minimum value by turning fully clockwise, this sets full receive gain

**3.** Connect DC power to the transverter., turn on the power switch and observe the power "ON" LED. Connect the "Push to Talk" line between the transceiver and transverter. You have two options depending on your transceivers Input/output. PTT-L or PTT-H

**4.** Place an Antenna or Signal Generator on the RF connector and adjust C36 and C40 for maximum receiver signal strength in the IF receiver. Minimum noise figure and maximum gain occur at nearly the same point so tune for maximum signal strength. If a signal generator or "On the Air" signal is not available a fifty ohm coaxial termination maybe connected to the RF connector and adjust C36 and C40 for maximum noise in the IF receiver. **Note:** If the receiver is to be aligned on a noise figure meter, L15 can be "tweaked" in conjunction with C36 and C40 for desired noise figure and gain.

**6.** Your "On the air no signal present" 'S' meter resting position can now be set by adjusting R10. This control adjusts the 28 MHz. RX output signal.

**7.** If you have a power meter or in-line forward SWR meter available for the rated output frequency and approximate 35 watt power level, connect it to the antenna jack (or TX jack).

**8.** After verifying that the IF transmitter signal level is below 250 mW allowed by the stock transverter, (1 mw maximum if the TXIF gain stage is installed) change the transceiver to the CW position with the carrier level set to minimum.

**9.** Switch the transceiver into the transmit mode and observe the “XMIT” LED. Then while observing the power meter slowly increase the carrier control to maximum keeping the power output below 25 watts for linear operation.

**10.** If the carrier control is at the maximum and the power output is below 25 watts, slowly turn R7 increasing the output power to 25 linear watts.

**11.** The low pass filter in the output section should not be adjusted unless power output levels can not be achieved. If power output is low, connect an Ampere meter in line with the power source to the transverter. If the current level is +6 Amperes, use an insulated tool to slightly spread or compress coils L11 - L14 while observing the output power, adjust for maximum. If current consumption is below this value, the transverter may be under driven. Make sure that your transceiver’s transverter port is up to spec before setting R7 to minimum attenuation. If the current consumption still can not be obtained check all connections and voltages. If you feel that your transverter is not living up to it's specifications, please consult the factory after verifying all voltages, components and IF drive level.

**12.** If the RF output power is set at the correct level (you may adjust it to any desired level under 25 watts ) verify that the RX gain is acceptable and install the top on the enclosure with the six mounting screws.

**13.** Attach the 3/8" adhesive backed rubber feet to the cover.

**14.** Attach the supplied jack / switch labels to the enclosure by first cleaning the mounting surface with a multi-purpose household surface cleaner. Use figure 4 and 5 for placement location.

After 72 hours of operation, if you have a frequency meter, the Local oscillator may then be adjusted for the final time. Please allow the transverter to remain on in the receive mode with an antennae or load connected to the RXRF port for at least 24 hours. Constant ON/OFF periods of brief operation will not correctly age the crystal in the oscillator. Also be sure when you do adjust the frequency that the unit has been on for at least 15 min. with the cover closed. If you adjust the transverter’s frequency in a environment that has a cooling effect on the transverter when the lid is open, expect different results after the transverter temperature stabilizes when the lid is re-installed.

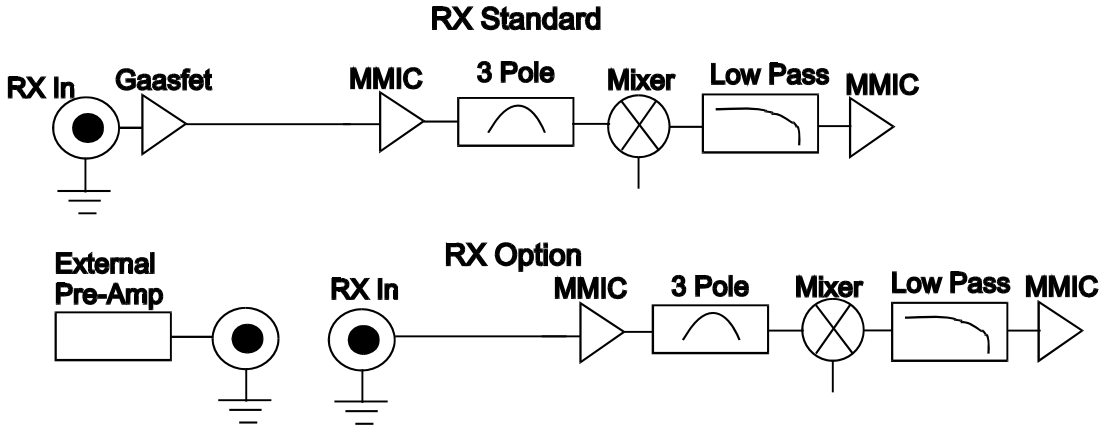
# DEM 144- 28 User Options

## Add an external preamplifier and bypass the internal GaAs-FET:

Below is block diagram of the receive converter. It shows the standard and an option of using an external preamplifier. It is recommended that if you use a external or mast mount preamplifier, you should bypass the internal one. The transverter may be configured this way very easily.

1. Refer to the component placement diagram, unsolder, and lift up the end of R24 that is attached to the pad shared by Q4 and C11.
2. If you do not wish to have the receive signal routed through the T/R relay in the transverter, use a small length of coax to connect the Q4-C11 pad to the spare BNC connector.
3. If you wish to still use the T/R relay in the transverter, remove C64 from the PCB. Then run a jumper coax from the pad extending from the relay to the Q4-C11 pad connection.

**NOTE:** Leaving Q4 connected to the shared pad will offer some minimal attenuation. If you find this level of attenuation un-acceptable, use solder wick and lift the Drain lead of Q4 up so it is disconnected from the circuit.



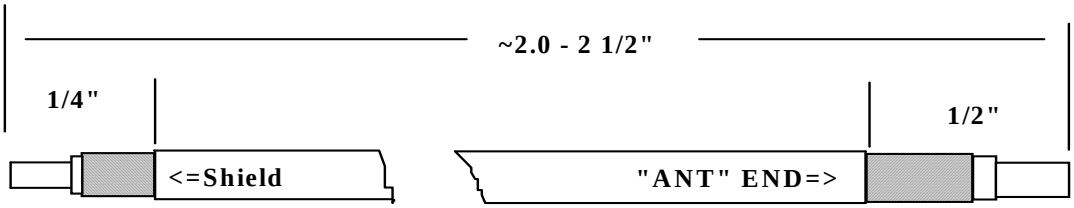

## Auxiliary Switching contacts:

The auxiliary contacts in K1 are labeled C (common) NO (normally open) and NC (normally closed). The contacts are marked for the receive mode. The C connection can be wired to ground or +13.8 VDC or any other external signal. The NC and NO connections may then be connected as desired to he AUX connector. The relay contacts are rated for 3 amps. Do not exceed and it is suggested that a fuse is installed if you are switching voltage.

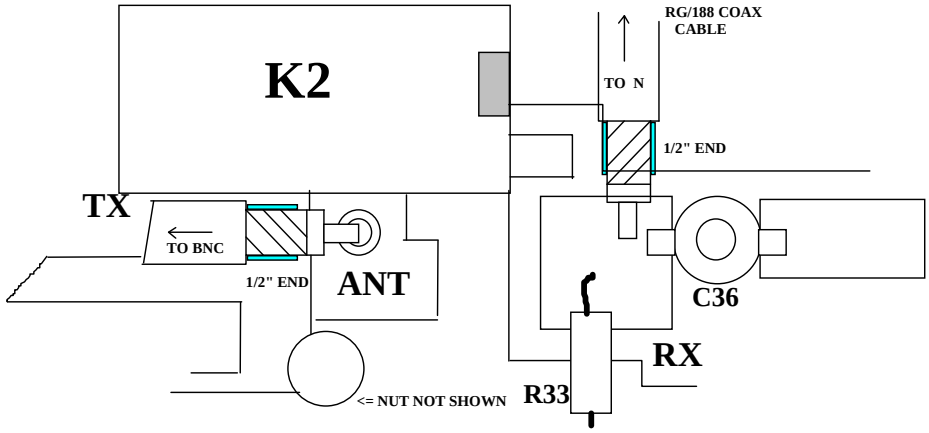
### 1. Split RX / TX connectors or Common antennae connection

To operate with split TX / RX connectors it is necessary to perform the following modification. If you have the split option and desire a common connection, reverse the process below.

1. Remove the chip capacitor C64. It is located near the C36 trimmer capacitor.
2. Prepare one RG/188 coax as shown in the figure below.



3. Remove the coax end attached to the N connector then attachment the RX coax to the circuit board per the figure below.

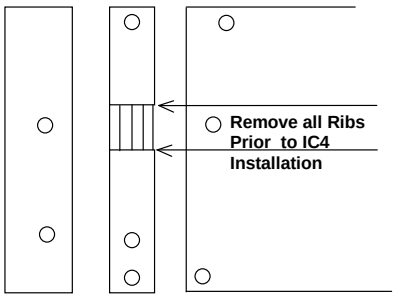



4. Route the RX cable to the N connector, remove excess solder from the ground lug and install the RX coax as shown.

5. Route the TX cable (old antenna coax) from the antenna position on the PCB to the BNC connector and solder.

**2. Optional Gain Stage**

You have the option of installing a additional gain stage (IC4) in the transmit section of the transverter if you neglected to do so at the time of ordering or if you decide to interface to a different IF rig. Only consider this option if your transceiver has less than 0 dBm output. Please feel free to consult Down East Microwave Inc. for the proper MMIC and bias resistor. If you elect to install a gain stage, a modification must be performed to the printed circuit board prior to continuing. The TXIF path will need to be broken before installation. 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.




To install, first check the alignment. The DOTS on the MMIC's determine their orientation and must be observed and positioned correctly prior to soldering. Align the component in place based on the component placement diagram. While holding the component in place, solder one lead to hold the component in place and observe the alignment of all leads. If the alignment is acceptable, solder the remaining leads. You need enough solder to cover the lead and mounting surface for the entire lead length.

# Toko Filter Addendum

Due to the obsolesces of the CBW and CBT type of 2 and 3 poles filters manufactured by Toko, we have been forced to retrofit a newer design filter in all of our existing designs. Because of the physical size of the new filter design, it requires an adapter circuit board to be correctly installed in the circuit board for this kit. Instead of originating a new document detailing the assembly of the new filter assembly, we have pre-installed the new filters in this and other kits. The performance of the new filters will exceed the original CBW and CBT types. All other assemble and test instructions in this kit will not vary except for the actual wording of Toko filters scattered about the assemble document. As in the past, no adjustment to the filters will be required to achieve the final specifications of this kit . In the future, the next revision of this design will include the new filters as part of the design. Please enjoy the assembly of your new kit and thank you.

## ***DEM 144-28K Component List***

**BAG 1 CONTENTS**: Resistors values are in Ohms and are ¼W unless otherwise specified. "CC"= Carbon Composition. There may be extra components in the bags not found on the parts list.

### BAG 1

| | | | | |
|---|---|---|---|---|
| R1 1K | R9 220 | R16 680 | R23 1K | R29 330 |
| R3 1K | R10 1K POT | R17 1.5K | R24 100 1/2W CC | R33 1K |
| R5 47 | R11 220 | R18 470 | R25 150 1/2W | R37 51 Chip |
| R6 100 | R12 220 | R20 330 | R26 240 | |
| R7 1K POT | R14 180 1/2W | R21 36 CHIP | R27 47 | |
| R8 220 | R15 150 | R22 36 CHIP | R28 56 1/2W | |

**BAG 2 CONTENTS**: All capacitors are disc ceramic and the values are pF unless otherwise specified. "ELECTR" = Electrolytic "Trimmer" = Variables. "Chip" are surface mount components. Extra components are possible.

### BAG 2

| | | | |
|---|---|---|---|
| C1 0.1μF (104) | C16 120 | C40 1-6 Trimmer SMD | C54 0.1μF |
| C2 0.1μF | C18 0.1μF | C41 0.1μF CHIP | C55 0.1μF |
| C3 1000 (102) | C20 120 | C42 0.1μF CHIP | C56 0.1μF |
| C4 1000 | C22 1000 | C43 2.2μF ELECTR | C57 0.1μF |
| C5 1000 | C25 1000 | C44 120 | C59 0.1μF |
| C6 1000 | C26 2.2μF ELECTR | C45 100 μF ELECTR | C61 1000 |
| C7 1000 | C27 1000 | C46 0.1μF CHIP | C62 0.1μF |
| C8 120 (121) | C28 0.1μF | C48 100 Chip | C63 120 |
| C9 39 | C30 0.1μF | C49 0.1μF CHIP | C64 100 CHIP |
| C10 1000 | C32 1000 | C50 100 Chip | C68 2.2μF ELECTR |
| C11 100 CHIP | C33 270 (271) | C51 120 | C69 100μF ELECTR |
| C12 120 | C34 270 | C52 18 | C77 1000 |
| C13 120 | C36 1-6 Trimmer SMD | C53 1000 | |

**BAG 3 CONTENTS:** Hand wound (HW) inductors are #24 enamel wire, close wound unless otherwise specified. All molded chokes have GOLD and SILVER multiplier and tolerance bands. Please identify desired value by the significant color band combination. "ATC" are surface mount components.

### BAG 3

| | | |
|---|---|---|
| L1 1.0μH (Brown/Black) | L15 5 Turns 3/16" ID | C39 27 ρF ATC |
| L2 0.33μH (Orange/Orange) | L17 0.22μH | F1 TOKO 1153A Filter |
| L4 0.33μH | L18 0.22μH | F2 TOKO 1119 Filter |
| L6 0.33μH, small | L26 1.0μH | F4 TOKO 1159 Filter |
| L9 9 Turns 1/8" ID (HW) | L27 1.0μH | #24 enamel wire, 9" |
| L10 0.22μH (Red/Red) | C14 15 ρF | R35 470Ω Chip |
| L11 3 Turns 3/16" ID | C15 39ρF | Y1 Crystal 116.000 MHz 5th Overtone HC 18/U |
| L12 5 Turns 3/16" ID | C24 1-6 ρF leaded Trim. | |
| L13 5 Turns 3/16" ID | C37 27 ρF ATC | |
| L14 3 Turns 3/16" ID | C38 33 ρF ATC | |

## BAG 4

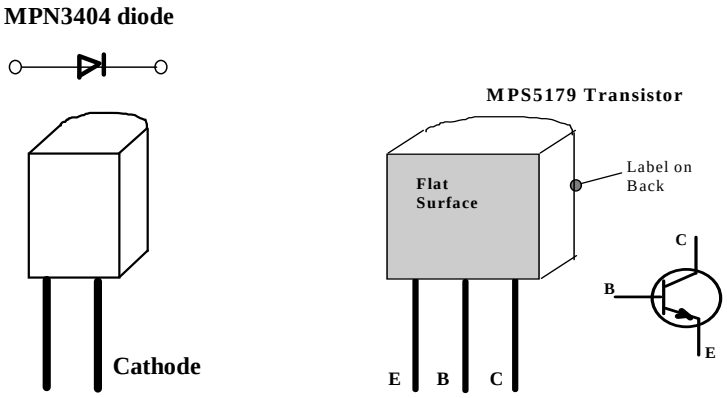
| | |
|---|---|
| M1 TUF-1H or TUF-1HSM Mixer | IC1 MAV11 |
| Q1 KN2222 | IC2 MAR3 |
| Q2 MPS5179 | IC4 MAR6 (optional) |
| Q3 2N5179 (Metal Can) | IC7 ERA5 |
| Q4 ATF 10736 | IC8 MAV11 |
| CR1 1N4000 Type Diode | VR1 78S09CV |
| CR2 IN914 (Glass Diode) or 1N4148 | VR2 78L09 |
| CR3 MPN3404 | VR3 78L05 |
| CR4 MPN3404 | K2 G6Y |
| K1 G5V-2 | PTC-50 Thermistor |
| CR7 1N4000 Type | |

## HARDWARE KIT

| | |
|---|---|
| (2) 1000pF Capacitor | #26 Teflon Wire , 4’ |
| (1) 100μF Capacitor | #18 Teflon Wire 4", Blue |
| (2) LED, RED | RG/188U Mini Coax 6" |
| (2) plastic retainers for LED’s | (1) Hammond 1590D Enclosure, machined |
| (1) SW1 Power Switch | (1) 3/32" Allen key wrench |
| (3) BNC Female Connectors and hardware | (1) 5" x 7" Heat sink, machined |
| (3) RCA Jacks - Control, Aux., Power | (1) Labels |
| (1) Type “N” and UHF connector and hardware | (4) Adhesive Backed Rubber Feet |
| (11) 4-40 x 5/8" Cap Screws | (1) Heat Sink Grease |
| (22) 4-40 Nuts | (1) Brass Shield |
| (2) 6-32 x 3/8" Machine Screws for Power Module | (2) 4-40 x 5/16” screw |

**Miscellaneous Loose Parts:**

1. RF Power Module IC5, SAV33
2. Printed Circuit Board
3. Assorted dust particles and technical support from Live Oak, FL



## 144-28 Common IF Input Circuit Option

This option is used for common IF input for the 144-28 transverter. There are two versions of this option. It is a pin switch designed for High and Low Power. The Low Power version is used with a transceiver that has a less than 250 mW transverter port. If the transverter port has less than 0 dBm, the transverter will require the TXIF gain stage to be installed. This option should not be used if drive level is over 1 mW. The High Power version should be used with transceivers that have up to 10 Watts of output. It has a 50-ohm termination mounted on the case for power dissipation. There is a parts list for each version. The components designators are the same for both.

Components list to add to the standard components list. All components are shown on the component placement diagram.

### Low Power Option

For transceivers with 250 mW or less drive.

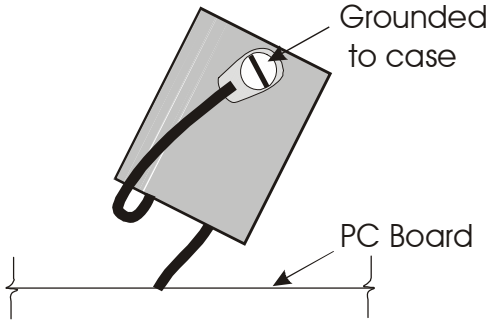
| | | |
|---|---|---|
| C71 1000 pF | C75 100 Pf | CR10 MPN3404 |
| C72 1000 pF | C76 1000 pF | CR11 MPN3404 |
| C73 1000 pF | C 1000 pF | L24 1.0 μH |
| C74 100 pF | R34 1KΩ | L25 10T #28 T25-10 |

### High Power Option

For transceivers with greater than 250 mW but not to exceed 10 Watts of drive.

| | | |
|---|---|---|
| C71 4.7pF | C75 100 pF | CR10 MA4P1200 |
| C72 1000 pF | C76 1000 pF | CR11 MA4P1200 |
| C73 1000 pF | C 1000 pF | L24 1.0 μH |
| C74 100 pF | R34 150Ω 1W | L25 10T #28 T25-10 |
| R 50 ohm load | | |

The 50-ohm high power resistor is installed on the transverter case. One leg is grounded to the case the other to the position indicated on the component placement diagram. If you are installing the option afterwards, you will need to drill a 1/8" hole for mounting. The 1000 pF "C" is installed from the RXIF BNC connector to the common input indicated on the component placement diagram. Install a jumper between the TXON pad and the TXOPT pad. Test the transverter PCB by measuring the junction of R34 and C73 for 0 volts on Receive and +1.7volts +/- 0.5 volts on Transmit.




***Transverter Operation Overview:***

Using the supplied schematic, follow this operation overview for a complete circuit description.

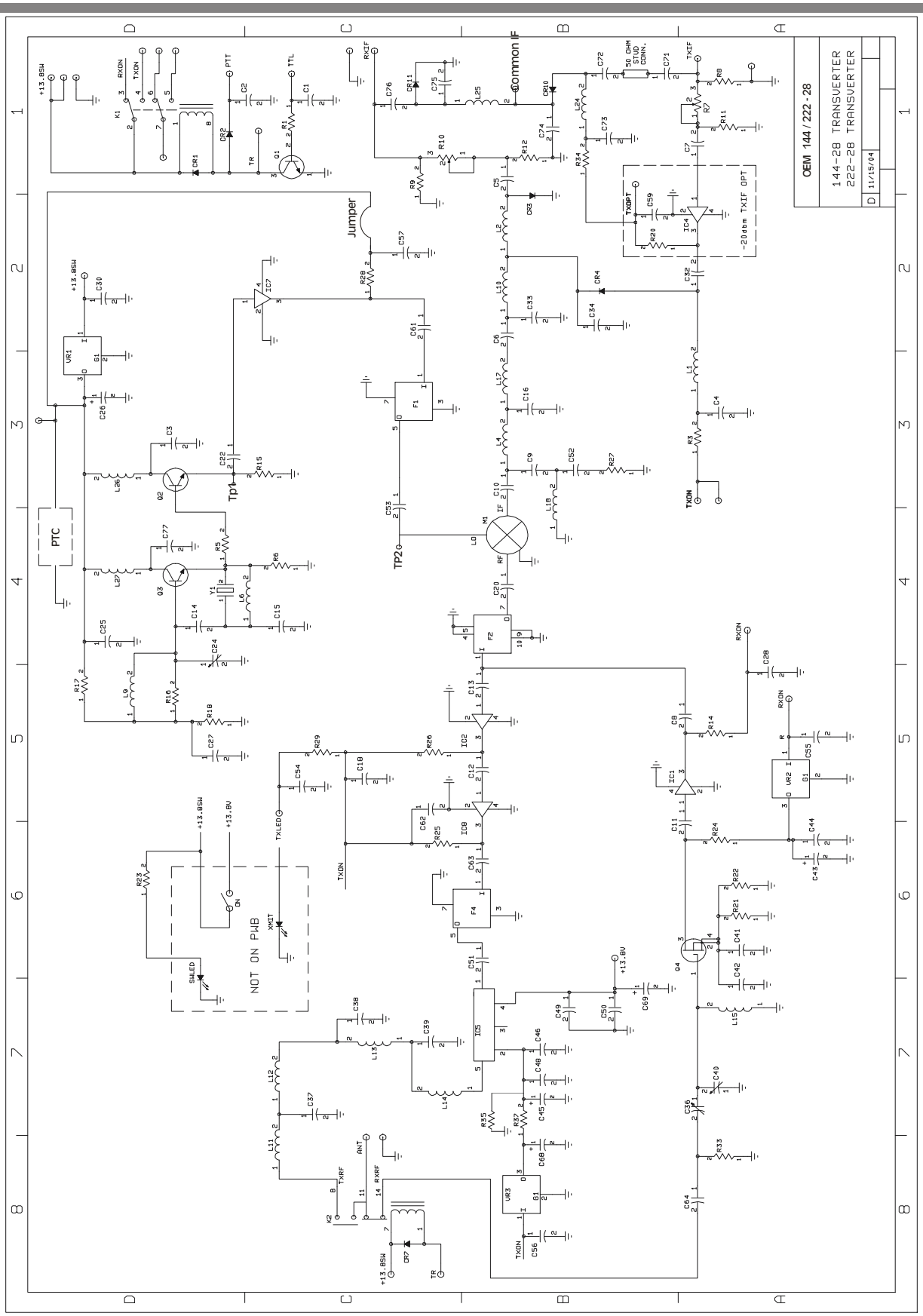
Receive signals enter through a type "N" connector and depending on your configuration, pass through the TR switch (K2) or by-pass the switch and enter the RX gain stage directly through C64. The RX gain stage is designed with Q4, an ATF21186 GaAs-FET, and IC1, a broad band MAV-11A MMIC. The circuit is designed for approximately 28 dB of combined gain. Q4,

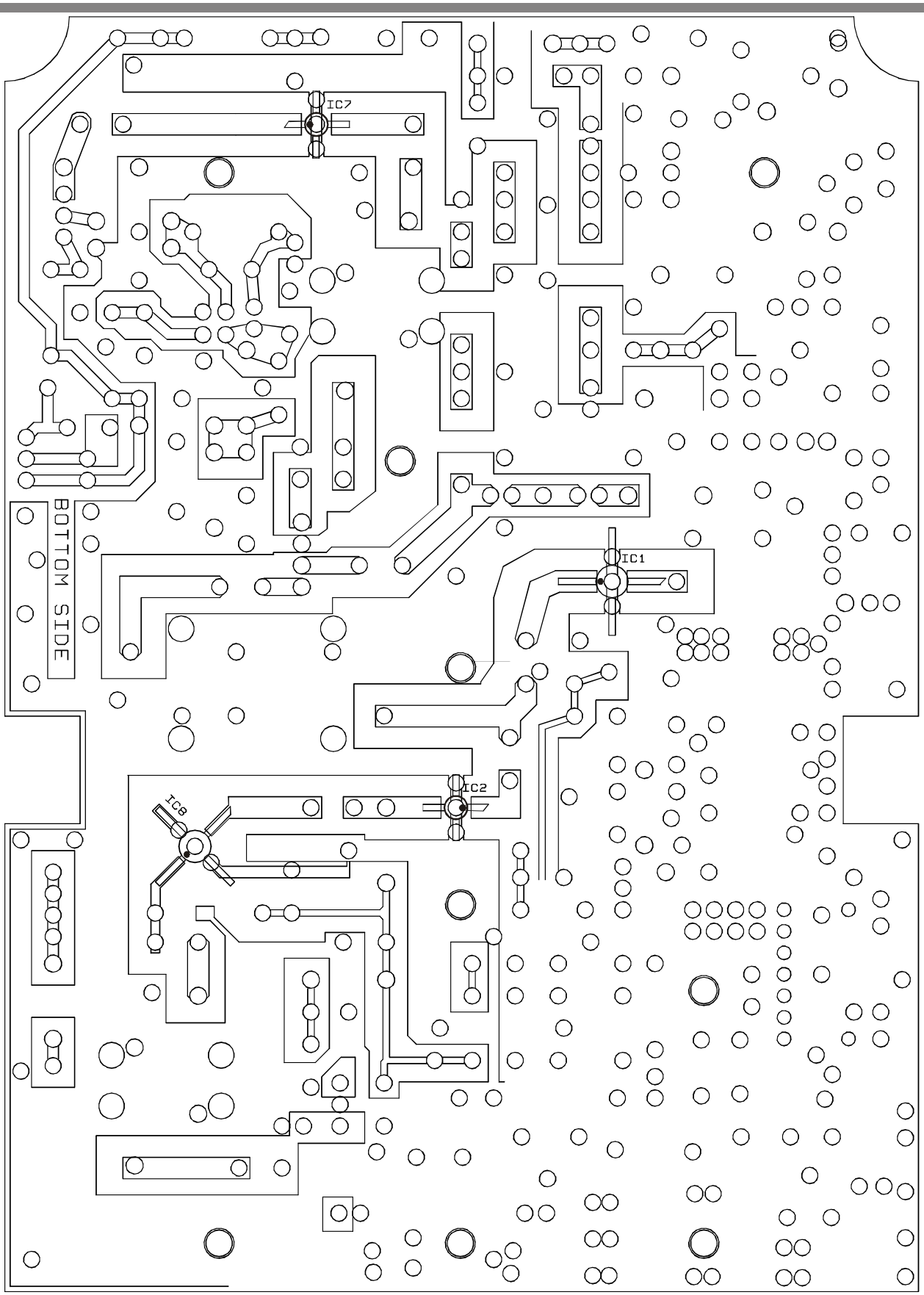
having a P1dB of +17 dBm, is biased to optimize its output IP3 (3rd order intercept point) performance of +27 dBm. Since the FET is intended for microwave frequency use, it has inherent low noise figure when optimized at the frequency used in this transverter. IC1 has an output IP3 of ≅ +35 dBm and a P1dB of +18 dBm. The amplified receive signal then passes through a three pole helical filter (F2) to eliminate out of band signals that would cause most intermodulation products in the mixer. The now filtered signal enters M1, a TUF-1H mixer, that has a 1 dB compression point of +14 dBm, but more important, an IP3 of approximately +29 dBm. This high level mixer requires a +17 dBm input that is supplied by the local oscillator after passing through a two-pole helical band pass filter (F1) to eliminate harmonics and spurious signals. The mixers IF output is then terminated into a diplexer band pass filter combination to reduce reflections back into the mixer. The IF signal produced (144 MHz. – 116 MHz = 28 MHz.) then enters an adjustable attenuator. No additional gain is designed into this system.

What does this all mean? If the math is done with the specifications given, it says that the weakest point in the converter system would be either the IC1 or the mixer M1 depending on the exact loss of the three pole filter (nominal 3-5 dB). When a -10 dBm (71 mV) signal is applied to the input of the transverter, it would just start to compress (either IC1 or M1) resulting a system with a IP3 output of ≅ +21 dBm. This input level, amplified by the nominal amount of RX conversion gain (minimum of +17 dB) of the transverter, could produce a ≅ +7 dBm output signal at the input of a 28 MHz. receiver. This is a large signal for anything but some of the newest and/or best receivers on the market. This transverter IF output level could be as much as 35 –40 dB above the compression level for most later day transceivers. The RXIF adjustable attenuator (R9, R10, and R12) can be used to reduce the gain of the transverter with little effect on the system noise figure. It has about 25 dB of range. Increasing the attenuation will decrease the dynamic range of the transverter (dB for dB) but will increase the dynamic range of your IF transceiver. It is most useful strong signal environments.

On transmit, with the proper options, any 28 MHz IF drive level from –20 dBm to 10 watts, will produce +60 watts of output power. This TX IF signal proceeds through an adjustable attenuator (25 dB range), then through the same filter diplexer combination as the receive signal. This is done with a pin diode switch which is biased in the transmit position only. Although the mixer can handle up to +14 dBm before compressing, that level is never needed or approached. The transmit signal also shares the mixer, 3 pole helical filter, and pin diode switch with the receive side. It then proceeds to IC 2 and IC 8. These stages have approximately 22 dB gain. The transmit signal is then filtered with a 2-pole helical band pass filter with about 3 dB insertion loss to eliminate LO signals and any other spurious. With +0 dBm entering the standard version transverter, there should be ≅ 5 - 10 mW driving the Hybrid module. The hybrid, IC5, is a MOSFET with >40 dB gain. The output of the hybrid then enters a low pass filter to eliminate the 2nd harmonic and above spurious. The signal then enters the TR switch or exits the transverter using its own TX port.

All switching functions are controlled by either a Signal to Ground or a +1.5-15 VDC that is provided by a transceiver on transmit. The transverter is in RX mode during standby. Isolated auxiliary contacts are provided for switching external equipment such as mast mounted pre-amps, power-amps, or T/R switches and controlled by K1.


OEM 144/222-28
144-28 TRANSVERTER
222-28 TRANSVERTER
D 11/15/04
Common IF
Jumper
PTC
NOT ON PWB
-20dbm TXIF OPT
TXOPT
RXIF
TXIF
RXON
TXON
PTT
TTL
ANT
TXRF
RXRF
TXLED
SWLED
XMIT
+13.8SW
+13.8V




144/222 - 28
Bottom Side Assembly

# 144/222 - 28
## Top Side Assembly