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DEM Part Number 222-28

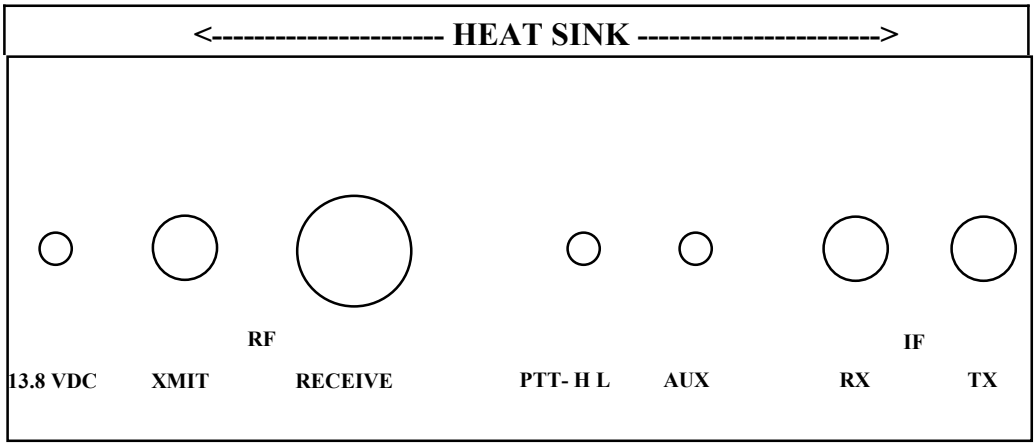
22_____ MHz Transverter, _____ MHz IF, S/N_____

Power Out:	25 W linear, 35 watts maximum; adjustable
Noise Figure and Gain:	0.8dB nominal, +17dB nominal (25 adjustable IF Attenuator)
DC Power Requirement:	12 - 15.5 VDC, 13.8 nominal, 8 amps Maximum
IF Option:	Common Split
IF Drive Level Maximum:	-20dBm 100 mW 1-10W Other_____
Keying Option:	PTT - to ground TTL - Positive Voltage
Aux. Connection Output Option:	TX RX High Low Open
Antenna Option:	Common Separate TX & RX
External preamplifier option:	YES NO

Operational Overview:

The DEM 222-28 is a 222 MHz to 28 MHz transmit and receive converter. It will operate with most High Frequency transceivers that are available on the market today. The 222-28 has a linear output power of approximately 25 watts. At full compression, the output power may reach 35 watts, but would be recommended 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 222-28 has a built in transmit / receive relay with provisions for external switching so that adding a high power amplifier to your 222 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 222 MHz connectors are BNC, UHF or Type 'N' (users choice). The 222-28 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.

This transverter, when assembled, has your requested options installed and will be configured to your transceivers specifications. It is important to fully understand the functions of your transceiver before interfacing the transverter. Please review your owners manual for any details regarding transverter operation. If necessary, you may consult us regarding interfacing. We have not interfaced every transceiver on the market, but could help you in making the correct decision regarding yours.



Connect your transceiver to the transverter:

Interfacing the transverter to the transceiver is easy. If your transceiver requires an additional interface such as a DEM TIB or AOS, follow those instructions for interfacing. If the transverter was configured for direct connection to your transceiver, follow the steps listed below.

1. Open lid of transverter by removing 6 screws.
2. Depending on the make and model of your transceiver, it may or may not be necessary to enable the transverter ports. Follow whatever instructions you have in your transceiver's operation manual to enable transverter operation. If it requires a special connector or cable assembly, it should be made now or contact Down East Microwave for assistance.
3. Connect all IF cables. Both receive and transmit are BNC connections on the transverter. Use good quality coax cable to connect the 28 MHz. transverter ports from your transceiver to the TXIF and RXIF connectors on the transverter.
4. Connect the Push to Talk line out of your transceiver to the transverter. It is labeled PTT-H or PTT-L on the transverter and uses a RCA connector. The correct keying type is already configured for your transceiver.
5. Connect the 222 MHz. antenna system or a dummy load with a power meter to the transverter. If one of the "N" connectors is labeled 'Antenna" then the internal transfer relay in the transverter is installed. Both transmit and receive functions will be provided through this connector. If the "N" connectors are labeled "Transmit" and "Receive", the internal transfer relay has been bypassed and the separate ports will provide the labeled functions.
6. Connect the DC power to the transverter. It uses a RCA type connector. 13.8 volts is optimum but the transverter will operate normally from 12 to 15 volts.
7. Preset the TXIF and RXIF gain controls. Turn the TXIF (R7) fully counter-clockwise (maximum attenuation) and the RXIF (R10) fully clockwise (minimum attenuation).
8. Power your transceiver on and leave it in the Receive mode on 28.100 MHz.
9. Apply power to the transverter and turn on the power switch. The power LED should light and the transmit LED should not.
10. Adjust the RXIF gain control counter-clockwise until a slight noise increase is heard in the transceiver or just a slight movement in the "S" meter is detected. Power the transverter on and off to verify the change. The RXIF gain may be increased beyond this point, but it will start to degrade the dynamic range of your transceiver. Find a signal on the band or use a signal generator to determine correct frequency, or minimum signal level. Out of band signals such as local repeaters will be attenuated if their output frequency is above 224 MHz or below 222 MHz.
11. To test the transmit section, place your transceiver in the CW mode. It is recommended to test the transverter in the CW mode because most transceivers have carrier level controls in this

mode only. If your transceiver has FM, it may be use to test the transverter if it has a power output control. Do not use SSB or AM because it is not possible to obtain maximum output power with a transceiver in these modes. Set the carrier/output power control to minimum or "0" output power. Place the transceiver into transmit and verify the transmit LED on the transverter is lit. While observing the power meter, slowly increase the carrier control (with key down) or power output control to maximum on the transceiver. If the transverter is configured correctly for your transceiver, minimal power may be detected on the power meter. Now slowly adjust the TXIF control in the transverter in a clockwise direction while observing the power meter. Set it to obtain a maximum of 35 watts. If a power meter is not available, you may use a current meter on the DC power line to determine if the transverter is transmitting. A maximum of 8 amps should be maintained and it will vary very little as the TXIF control is adjusted. Switch the transceiver to USB and make a transmission. The power output and current drain should correlate to your speech pattern.

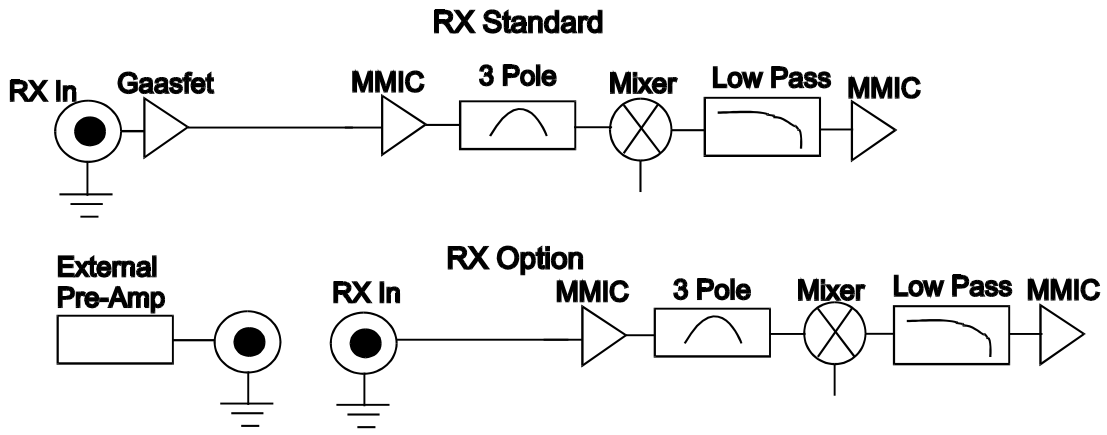
12. You may re-adjust both RXIF and TXIF again if desired. The adjustments of the receive preamplifier and local oscillator frequency do not need to be touched but you may if you wish. Do not adjust any of the helical filters unless you have access to a spectrum analyzer at the minimum.
13. Put the top on the enclosure and install the screws. Your transverter system is ready to use. Connect as you wish to use it in your 222 MHz. system and have fun!

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:

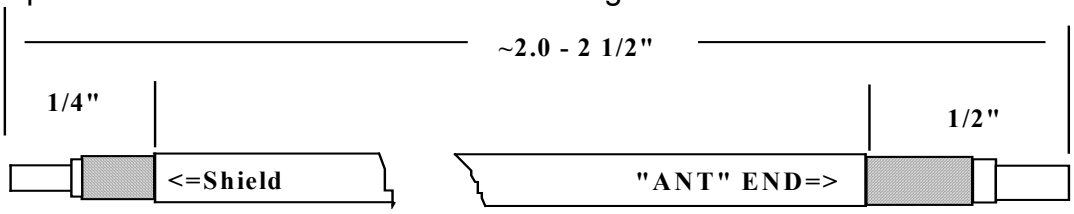
The auxiliary contacts in K1 are labeled C (common) NO (normally open) and NC (normally closed). The contacts are marked for the receive mode. The C connection can be wired to ground or +13.8 VDC or any other external signal. The NC and NO connections may then be connected as desired to he AUX connector. 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.

DEM 222- 28 User Options

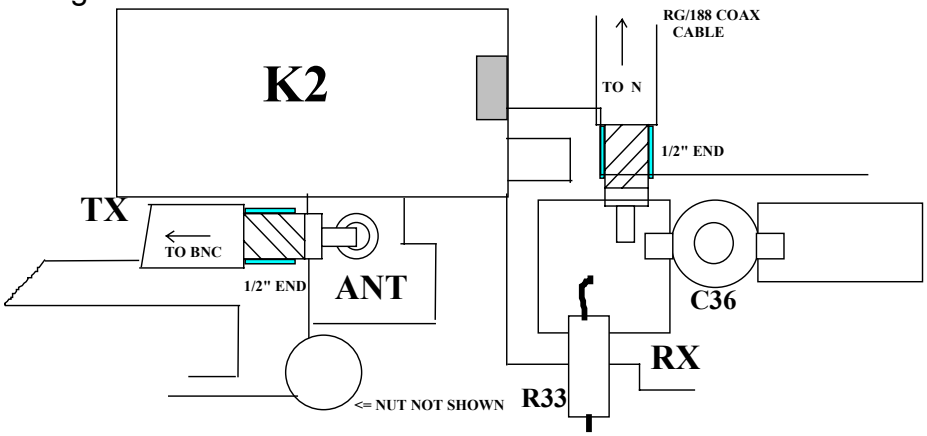
1. Split RX / TX connectors or Common antennae connection

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.

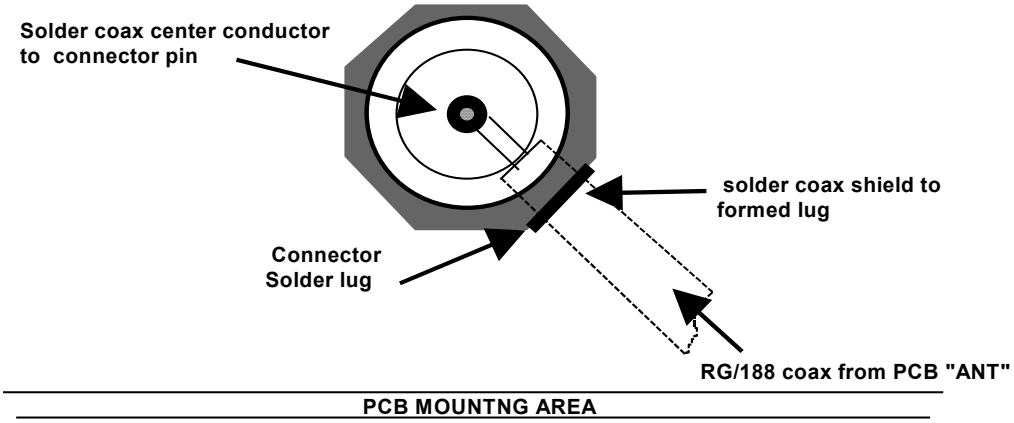
1. Remove the chip capacitor C64. It is located near the C36 trimmer capacitor.
2. Prepare one RG/188 coax as shown in the figure below.



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



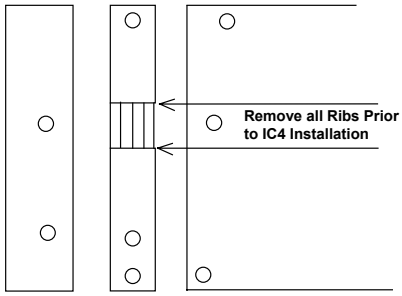
4. Route the RX cable to the N connector, remove excess solder from the ground lug and install the RX coax as shown.



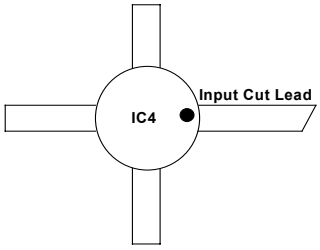
5. Route the TX cable (old antenna coax) from the antenna position on the PCB to the BNC connector and solder.

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 0dBm 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.



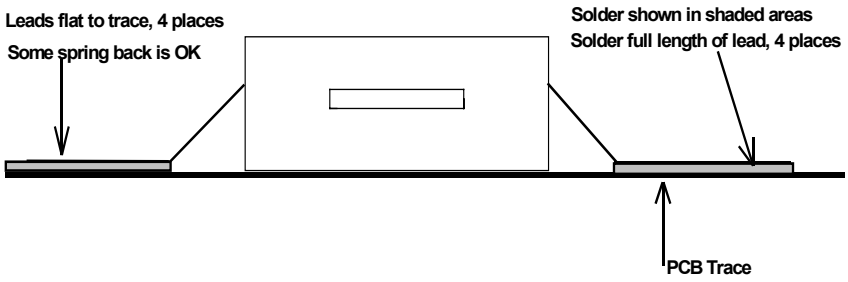


Figure 2 Typical side view of four leaded surface mounted device, lead bending close to body

DEM 222-28 Component List

R1 1K	R8 220	R16 680	R24 100 1/2W CC	R33 1K
R3 1K	R9 220	R17 1.5K	R25 150 1/2W	R35 330 Chip
R5 47	R10 1K POT	R18 470	R26 240	R37 51 Chip
R6 100	R11 220	R20 330	R27 47	
R7 1K POT	R12 220	R21 24 CHIP	R28 56 1/2W	
R8 220	R14 180 1/2W	R22 24 CHIP	R29 330	
R9 220	R15 150	R23 1K	R32 51 Chip	

C1 0.1μF (104)	C16 120	C38 18 ATC	C54 0.1μF
C2 0.1μF	C18 0.1μF	C39 15 ATC	C55 0.1μF
C3 1000 (102)	C20 120	C40 1-6 Trimmer SMD	C56 0.1μF
C4 1000	C22 1000	C41 0.1μF CHIP	C57 0.1μF
C5 1000	C24 1-4 Piston Trim.	C42 0.1μF CHIP	C59 0.1μF
C6 1000	C25 1000	C43 2.2μF ELECTR	C61 1000
C7 1000	C26 2.2μF ELECTR	C44 120	C62 0.1μF
C8 120 (121)	C27 1000	C45 100 μF ELECTR	C63 120
C9 39	C28 0.1μF	C46 0.1μF CHIP	C64 100 CHIP
C10 1000	C30 0.1μF	C48 100 Chip	C67 120
C11 100 CHIP	C32 1000	C49 0.1μF CHIP	C68 2.2μF ELECTR
C12 120	C33 270 (271)	C50 100 Chip	C69 100μF ELECTR
C13 120	C34 270	C51 120	C77 1000
C14 18	C36 1-6 Trimmer SMD	C52 18	
C15 22	C37 15 ATC	C53 1000	

L1 1.0μH (Brown/Black)	L10 0.22μH (Red/Red)	L15 3 Turns 3/16" ID (HW
L2 0.33μH (Orange/Orange)	L11 3 Turns 3/16" ID (HW)	L17 0.22μH
L4 0.33μH	L12 4 Turns 3/16" ID (HW)	L18 0.22μH
L6 0.10μH	L13 4 Turns 3/16" ID (HW)	L26 1.0μH
L9 3 Turns 1/8" ID (HW)	L14 3 Turns 3/16" ID (HW)	L27 1.0μH

M1 TUF-1H or TUF-1HSM Mixer	IC4 MAR6 (optional)
Q1 KN2222	IC7 AG-604
Q2 MPS5179	IC8 MAV11
Q3 2N5179 (Metal Can)	VR1 78S09CV
Q4 ATF 21186	VR2 78L09
CR1 1N4000 Type Diode	VR3 78L05
CR2 IN914 (Glass Diode) or 1N4148	F1 TOKO 1164A
CR3 MPN3404	F2 TOKO 1146A
CR4 MPN3404	F4 TOKO 1166
K1 G5V-2	Y1 Crystal 194.000 MHz 5th Overtone HC 18/U
CR7 1N4000 Type	K2 G6Y
IC1 MAV11	PTC-50 Thermistor
IC2 MAR3	IC5 RA30H2127M

222-28 Common IF Input Circuit Option

This option is used for common IF input for the 222-28 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 1mW. 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 250mW or less drive.

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

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

C71 4.7 pF	C75 100 pF	CR10 MA4P1200
C72 1000pF	C76 1000pF	CR11 MA4P1200
C73 1000pF	C 1000 pF	L24 1.0 μH
C74 100pF	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 +5 volts +/- 0.5 volts on Transmit.

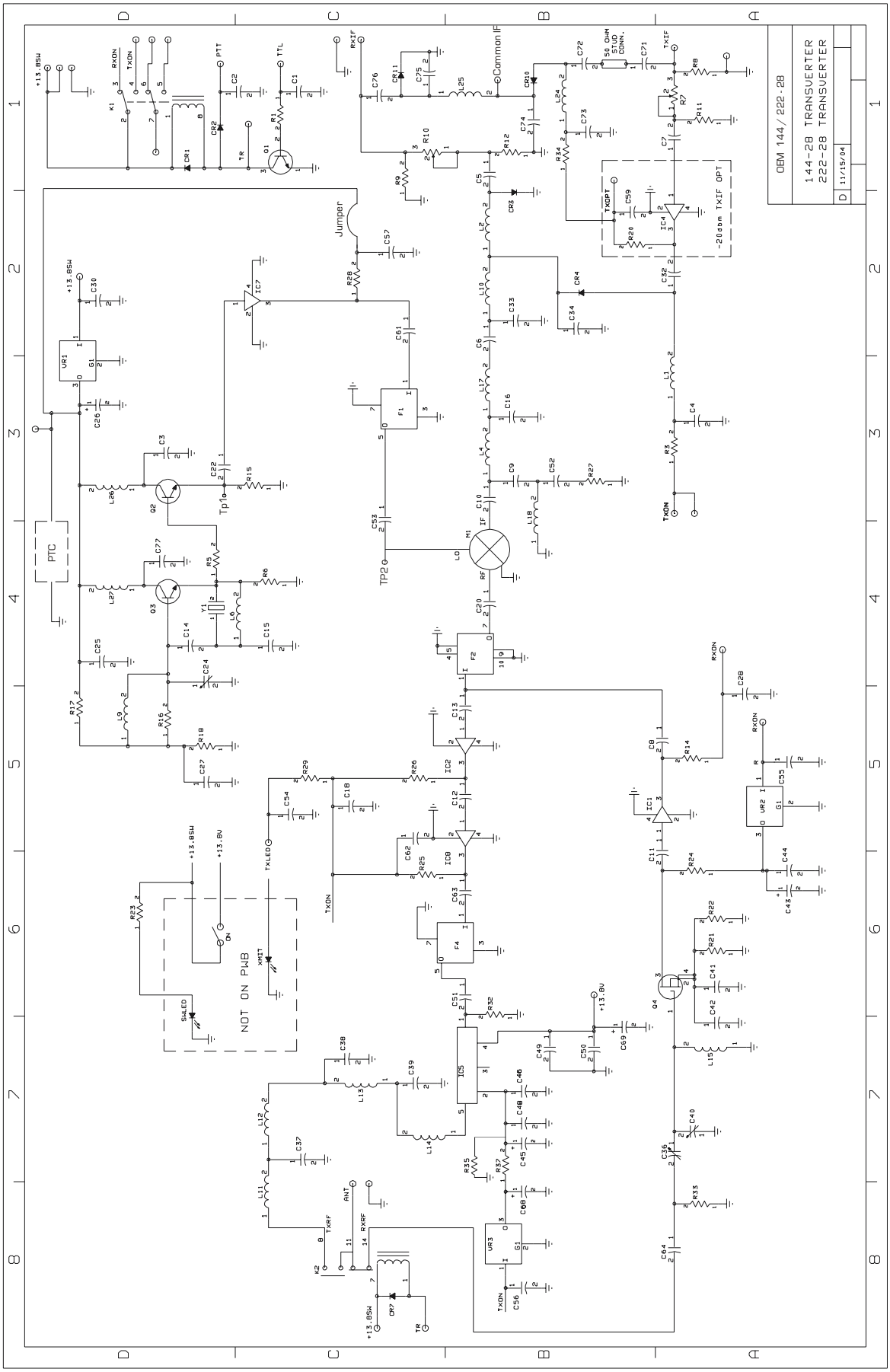
Transverter Operation Overview:

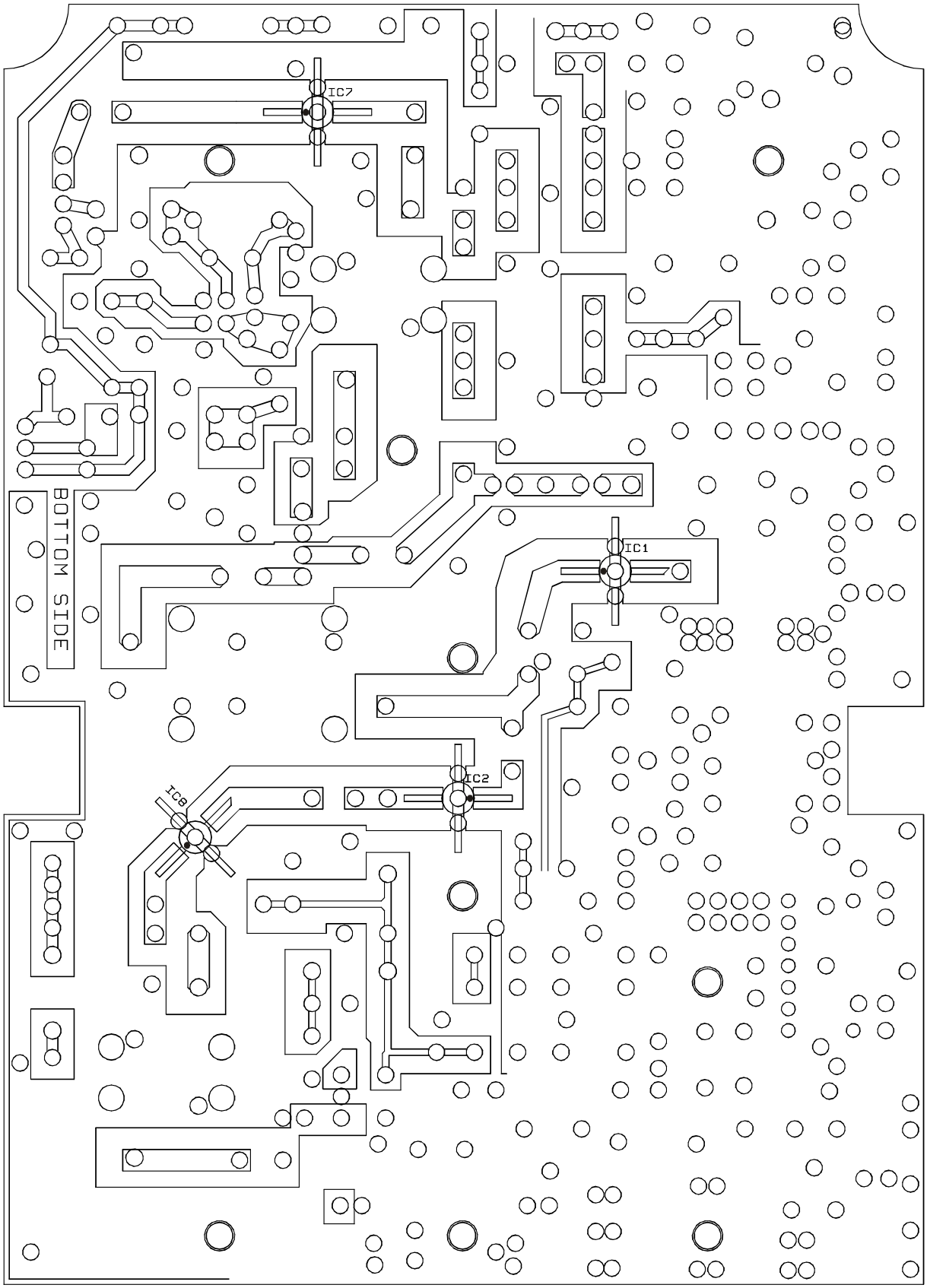
Using the supplied schematic, follow this operation overview for a complete circuit description. Receive signals enter through a type "N" connector and either pass through the TR switch (K2) or may go directly to the RX gain stage/filter combination (Q2 and F4). The gain stage/filter combination, depending on your desired configuration, is quite versatile. The standard receive line-up is a GaAs-FET preamplifier and a broad band MMIC (IC6) amplifier separated by a 2 pole 3dB insertion loss helical filter. The GaAs-FET has a tuned input circuit that is biased to utilize its 1 dB compression point spec. of ≅ +20dBm. Since the FET is designed for microwave frequencies, it has an inherent low noise figure at the frequency used in this transverter and results in less than 1.0dBNF for

the system. This signal passes through a 2 pole helical filter that is quite selective and filters out the out of band signals that may have been amplified by the preamplifier. The second stage is a MMIC with a 1dB compression point of≅ +18dBm, which amplifies the filtered signal. In this section, some assembly options may be installed. If you wish to use a mast-mounted preamplifier, the GaAs-FET (Q4) should be by-passed. There is a provision on the circuit board for the RX signal to be routed directly to the 2 pole helical filter (F4) then the MMIC amplifier. Other line-ups may be used such as the GaAs-FET being the only gain stage in the system before the mixer. With the standard line-up, the signal then passes through a 3 pole, 5 dB insertion loss, helical filter,(F2) to further eliminate out of band signals that would cause inter modulation products in the mixer. The high level mixer (M1) has a +17dBm local oscillator input, which is supplied after passing through a 2-pole helical band pass filter (F1). This mixer has a 1 dB compression point of +14dBm and an IP3 (3rd order intercept point) of approximately +29dBm. The mixer is then terminated into a diplexer band pass filter combination to reduce reflections back into the mixer further reducing intermod (This is the circuitry between C70 and C76). The IF signal then enters the IF amplifier stage (IC8) and a adjustable attenuator (R38). This IF amplifier stage is optional and would only be used if your 28 MHz. receiver can tolerate signals as high as +15dBm. If a cascade analysis were done with the standard line up, the math would show that weakest point in the converter system would be the MMIC in the RF stage (IC6). This means a -10 dBm (71mV) input signal would just start to compress the converter resulting a system with a IP3 of ≅ +25 dBm and a 1dB compression point of ≅ +15 after the IF gain stage. This is a large signal for anything but some of the newest and/or best receivers on the market. This level for some of the latter day transceivers could be as much as 35 dB into compression! The adjustable attenuator has about 25db of range and could be used to attenuate the IF signal, but could still fall 10 dB short. If the IF gain stage is not used, there would be maximum of ≅ +2 dBm signal at the input of a 28 MHz. receiver, which is still a large signal!

On transmit, as little as 0dBm will produce a minimum of 10 watts out. If your transceiver has a lower drive level than that, an optional gain stage may be installed on the transmit side (IC4). The signal proceeds through an adjustable attenuator, (R35) 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 (circuitry between C81 and C77). Although the mixer can handle up to +14dbm before compressing, that level is never needed or approached. The transmit signal also shares the mixer (M1), 3 - pole helical filter (F2), and pin diode switch with the receive side (circuitry between C35 and C67). It then proceeds to a 2-stage amplifier consisting of MMICs (IC4 and IC8). The two stages have approximately 22 dB gain. The signal is then filtered with a 2-pole helical band pass filter (F3) with about 3 dB insertion loss. With an +0 dBm IF level entering the transverter there should be ≅ 50 mW driving the Hybrid module (IC5). 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 (K2) or exits the transverter using its own TX port.

All switching functions are controlled by a Signal to Ground or a +1.5-15VDC 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.


OEM 144/222-28
144-28 TRANSVERTER
222-28 TRANSVERTER
D 11/15/04
NOT ON PWB
PTC
Jumper
-20dbm TXIF OPT
50 OHM SMD CONN.
CommonIF
RXIF
TXIF
TXON
RXON
TXLED
SWLED
XMIT
ANT
TXRF
RXRF
+13.8SW
+13.8V
TP1
TP2



144/222 - 28
Bottom Side Assembly

144/222 - 28
Top Side Assembly