

## Low Cost Intermediate 144 MHz Transverter Kit

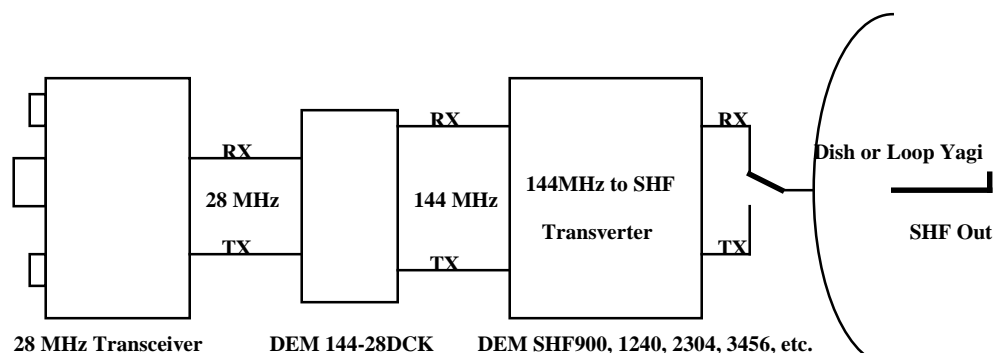
### DEM Part Number 144-28DC

#### Operational Overview:

The DEM 144-28DC is a low power, high performance 144 MHz to 28 MHz transmit and receive converter. It is intended for use with Super High Frequency transverters with a 144 MHz Intermediate Frequency (IF) to allow operation with a 28 MHz radio. Although this is the primary design intent, it can be placed directly on the air. 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 5.0 to 10 milliwatts with 0dBm 28MHz input signal. On the receive side, a double balanced mixer with a level of +7.0 dBm and a three chamber helical filter is employed providing superior out of band rejection and a conversion gain of +3.0 dB. The DEM 144-28DC has a built in relay for external switching duties. Options have been provided for a key line input (+8 to 15VDC TTL or PTT to ground) for transmit switching. 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. All board interface connections are via direct pad soldering on the printed wiring board.

#### DEM 144-28DCK Operating Specifications

Operating Voltage:	12.0 - 15.5 VDC, 13.8 nominal
Current Drain:	Receive / Transmit 200 mA maximum
Output Power:	5 to 10 mW linear, Output has 25 dB of adjustable range.
Maximum Transmit IF Power:	200 mW (+23 dBm) with 25 dB IF adjustment range
Receive Noise Figure:	4.0 dB maximum, 3.0 dB nominal
Conversion Gain:	+3 dB nominal (25 dB adjustable IF attenuator)



Typical setup of SHF / 28MHz using the DEM 144-28DCK Intermediate stage

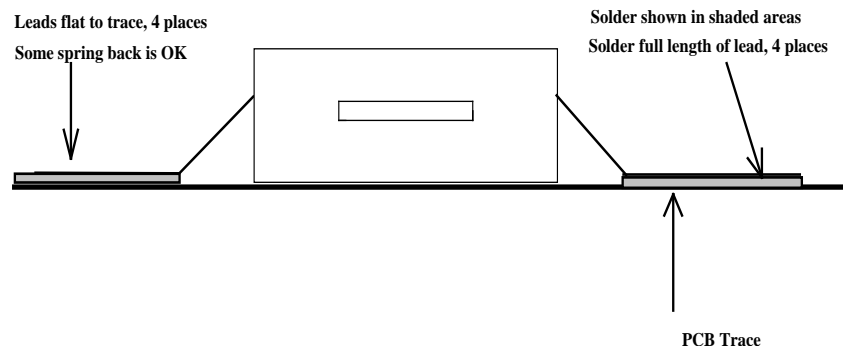
**Printed Wiring Assembly Notes:**

Your kit is provided with easy to read placement diagram that show the component layout and the reference designators that correspond to the provided component list.

**Assembly Tips:**

**Soldering surface mounted active components (transistors etc.):**

- Position the component based on the assembly diagram. The DOTS on the MMICS (IC1, IC2) determine their orientation and must be observed and positioned correctly prior to soldering. Leads on 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 1).
- 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 the 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 1 shaded areas)



***Typical side view of four leaded surface mounted device, lead bending close to body  
Figure 1***

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

- Determine the component mounting position based on the assembly diagram.
- Without the component in place, heat one side of the mounting area and flow 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 previously melted solder.
- Holding the component in place with tweezers or other soldering aid, heat the end with the previously melted solder and allow it to flow into the solder, once solidified, remove holding tool.
- Now heat and flow the 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 PWB. 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 draw backs if the component must be removed when the PWB is installed in the box.

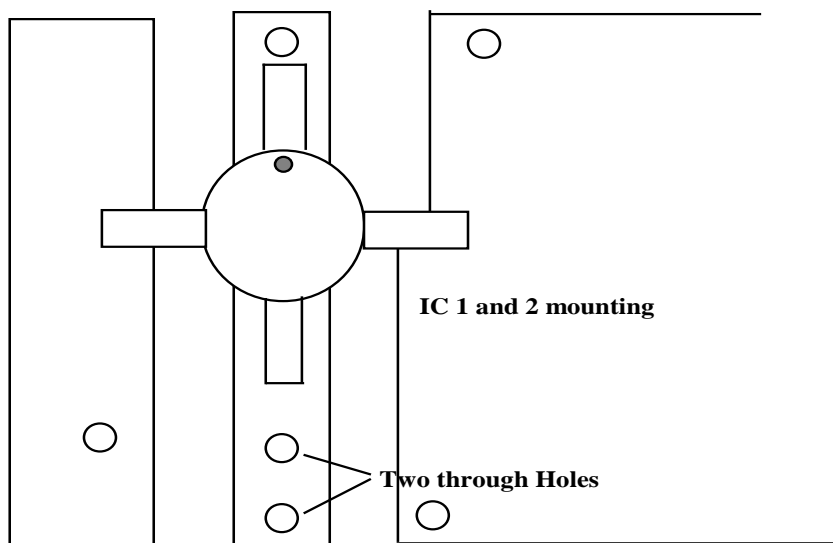
**Rework of soldered components if needed:**

The easiest method to rework soldered components is to employ a desoldering braid that is specifically designed for this purpose. It can be purchased at any electronics store. Place the desoldering 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.

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

**Bottom Side Suggested Assembly:**

Referring to the bottom of the PWB you will see that there are two (2) surface mounted active components (MMIC). The placement of IC1 and IC2 are shown on the top side assembly drawing, they are depicted as looking through the board. When mounting observe the DOT on the IC package, it should be placed on the on the shorter pad (the pad with one plated through hole) on the bottom side.

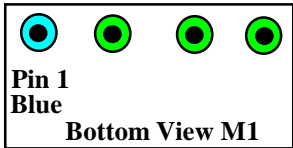
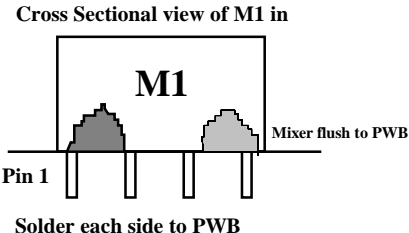


Solder IC1 and IC2 based on the surface mounted active components section of this document. The bottom side is complete, observed your soldering and component orientation one more time to ensure everything is correct.

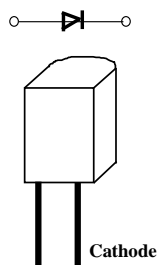
**Top Side Suggested Assembly:**

If your kit does not contain pre-formed coils, it is suggested that they be made at this time. L7, L8, L9, must be formed prior to installation. The coils should be wound around an appropriate size mandrel. It is suggested that the 3/32" inside diameter coils be formed on an appropriate size drill bit. Winding coils is not an exact science and you should not be intimidated by it. Using the supplied wire, extend about 1/4" in a perpendicular direction off of the drill bit 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 1/4" beyond the mandrel. Form the two 1/4" 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 mandrel. The coil forming is complete! To ensure a positive solder connection, the 1/4" 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, if not repeat the process). As an alternative, the enamel can be removed by scrapping the 1/4" leads with a razor blade until the base copper is exposed. Solder coat the exposed base copper, do not allow the outside diameter to increase so that the coil will not fit in the mounting hole. The top side assembly operation should begin by orienting the PWB with the top view assembly diagram.

Assemble and solder the components in the following suggested order while observing all polarities as shown on the assembly diagram.

STEP	OPERATION and NOTES
1	Form, install and solder CR1, CR2, CR3, CR4, CR5, CR6 <b>Note: Ensure proper polarity.</b> See figure below.
2	Form, install and solder L1, L2, L3, L4, L5, L6 (molded inductors)
3	Form, install and solder all leaded resistors including R7 and R10
4	Form, install and solder all leaded capacitors <b>Note: Ensure proper polarity</b>
5	Install and solder Q1, Q2, Q3, VR1 <b>Note: Ensure proper polarity</b>
6	Install L7, L8, L9
7	Install Y1 116 MHz crystal
8	Looking at the exit point of the leads of mixer M1, notice that one is colored blue (see below), this is pin 1 and should be installed in the Pin 1 hole on the PWB (This is marked by a DOT on the assembly diagram). Solder the leads, then on the top side apply solder from the case to the PWB surface, one spot on each side  <div style="text-align: center;">  <p>Bottom View M1</p> </div> <div style="text-align: center;">  <p>Cross Sectional view of M1 in</p> <p>Solder each side to PWB</p> </div>
9	Install Relay K1
10	Install Filter F2, Solder all leads on the bottom side. Note: this filter are not polarized.

MPN3404 diode



The following is a listing of connections and their purpose.

**Connection Table**

Connection	Operation
E1	TTL +8 to 15 VDC to toggle on transmitter
E1B	-13.7 VDC Main ground power
E2	PTT Ground this point to toggle transmitter
E3	28 MHz input signal from transceiver
E4	28 MHz output signal to transceiver
E6	144 MHz output signal
E7	144 MHz input signal
E8	+13.7 VDC Main power
E11	Relay K1 common switch line
E12	Relay K1 Normally Open position
E13	Relay K1 Normally Closed position
E14	28 MHz output signal ground to transceiver
E15	28 MHz input signal ground from transceiver
E16	144 MHz output signal ground
E17	144 MHz input signal ground

Inspect all components and solder connections to ensure there are no solder shorts. **Trim all leads protruding through the circuit board as short as possible** to eliminate potential shorting to your housing.

**Electrical Test Verification:**

The following information is provided to electrically test the transverter. If you have a frequency counter it would be helpful but is not mandatory.

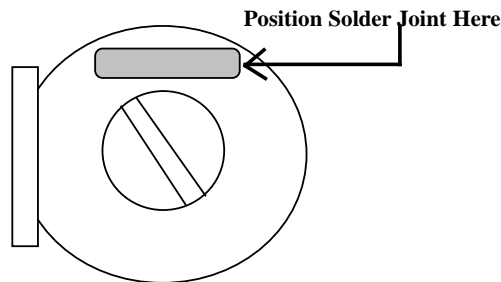
Apply 13.8 volts per the above connection table. The voltage check list below is for the transverter, values are given in the RX mode only. Check the voltages in the order shown, then continue by checking the oscillator section.

MODE	LOCATION	VOLTAGE (Reference to Ground unless Specified)
RX	E8	13.8±1VDC
RX	Junction of R14 & C8	3.5 ± 1VDC
RX	Junction of C25 & R17	8.0± 0.5VDC

**Oscillator Testing:**

Connect the positive lead of a Voltmeter to R15 on it's isolated pad. Connect the negative lead to ground.

Set C24 to midrange capacitance (see diagram below). Spread or compress the turns of coil L9 for maximum voltage, once obtained, adjust C24 for maximum voltage, it should be approximately 1.0 - 2.0 volts. If a frequency counter is available connect it to the lead of C19 closest to mixer M1, tune C24 for 116 MHz. If the voltage or frequency can not be obtained, check all components in the oscillator circuit for proper installation.

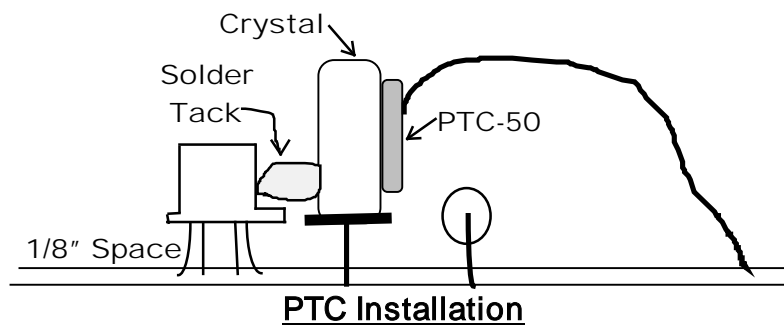


**C24 Midrange Capacitance Position**

The voltage check list below is for the transverter in the TX mode. To place the transverter into the TX mode either apply  $\approx 13$  volts to the TTL input or ground the PTT line. The choice is made by you depending on your transceiver.

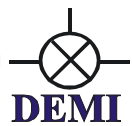
MODE	LOCATION	VOLTAGE (Reference to Ground unless Specified)
TX	Relay K1	Audible Click
TX	Junction of R4 & C12	$3.5 \pm 1$ VDC
TX	Junction of CR4 & L1	$1.5 \pm 0.5$ VDC
TX	Junction of CR6 & L5	$1.5 \pm 0.5$ VDC

If any of the above voltages can not be verified, check component values and rework as necessary. Your transverter is complete, have fun.



**Operation:**

The DEM144-28DCK is a no-tune transverter, output power is adjusted by R7. Receiver conversion gain is adjusted by R10.



**DEM 144-28DCK Component List**

Resistors (R) values are in Ohms and are 1/4W unless otherwise specified.

R1 1K	R9 220	R16 680
R3 1K	R10 1K POT	R17 1.5K
R4 330	R11 220	R18 470
R5 47	R12 220	R20 1K
R6 100	R13 1K	R21 470
R7 1K POT	R14 470	
R8 220	R15 100	

All capacitors are disc ceramic and the values are pF unless otherwise specified. "ELECTR" = Tantalum Electrolytic "Trimmer" = Variables

C1 0.1μF (104)	C11 120	C21 39
C2 0.1μF	C12 120	C22 270
C3 1000 (102)	C13 1000	C23 68
C4 1000	C14 15	C24 1-6 Trimmer TH
C5 1000	C15 39	C25 1000
C6 1000	C16 270	C26 2.2μF ELECTR
C7 1000	C17 1000	C27 1000
C8 120	C18 0.1μF	C28 0.1μF
C9 270 (271)	C19 270	C30 2.2μF ELECTR
C10 1000	C20 120	C31 120

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.

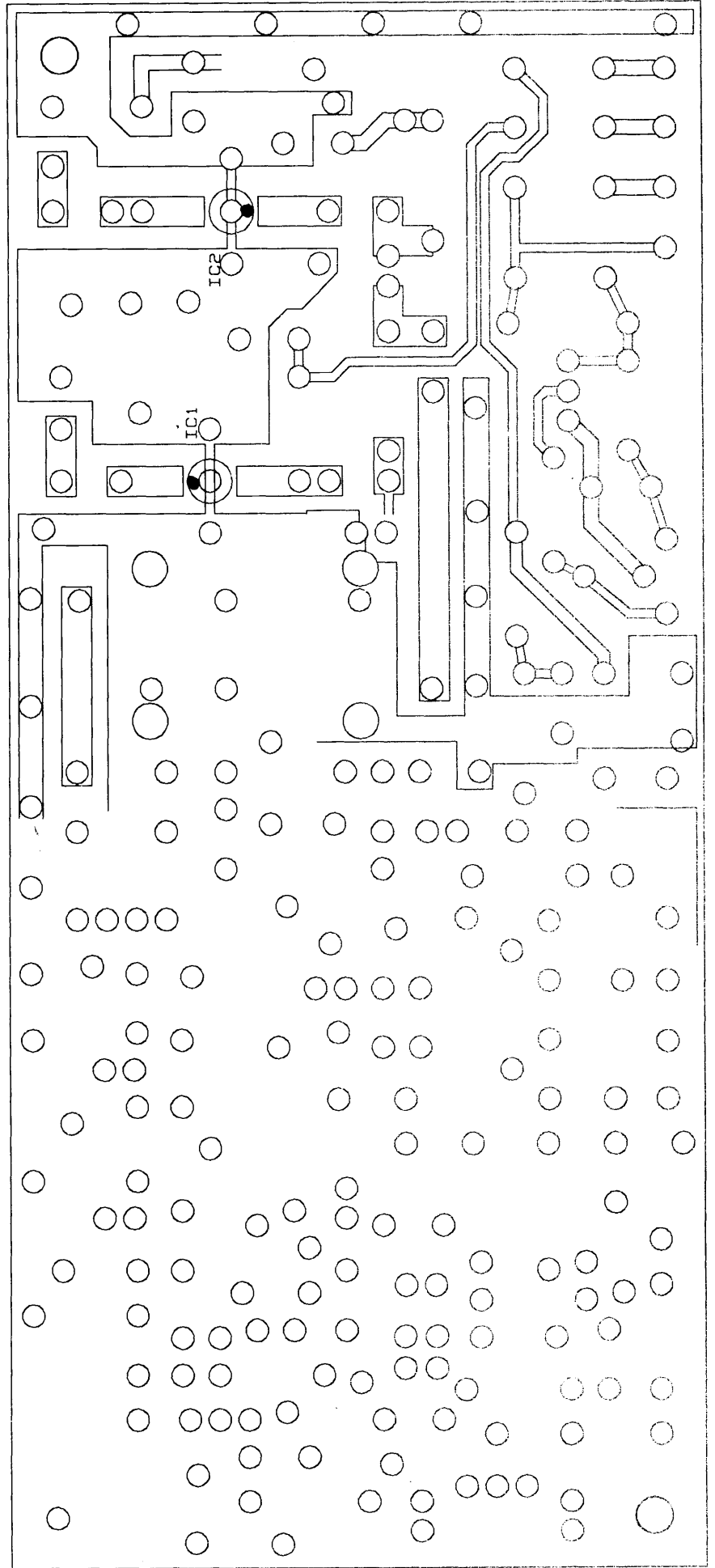
L1 1.0μH (Brown/Black)	L7 6 Turns 1/8" ID (HW)
L2 0.33μH (Orange/Orange)	L8 8 Turns 1/8" ID (HW)
L3 0.15μH (Brown/Green)	L9 8 Turns 1/8" ID (HW)
L4 0.22μH (Red/Red)	L10 1.0μH
L5 1.0μH	PTC-50
L6 0.33μH	#24 Enamel Wire 2'

CR1 1N4000 series	Q1 2N2222 OR PN2222
CR2 1N914 (Glass Diode) or 1N4148	Q2 MPS5179
CR3 MPN3404	Q3 2N5179
CR4 MPN3404	F2 TOKO 1119D
CR5 MPN3404	IC1 MAR 6
CR6 MPN3404	IC2 MAR 6
M1 TUF-1 or TUF-1SM Mixer	K1 DPDT 12VDC Relay (G5V)
Y1 Crystal 116 MHz 5th Overtone HC 18/U	VR1 78L09
Printed Circuit Board	

144-28 DCK

BOTTOM SIDE ASSEMBLY

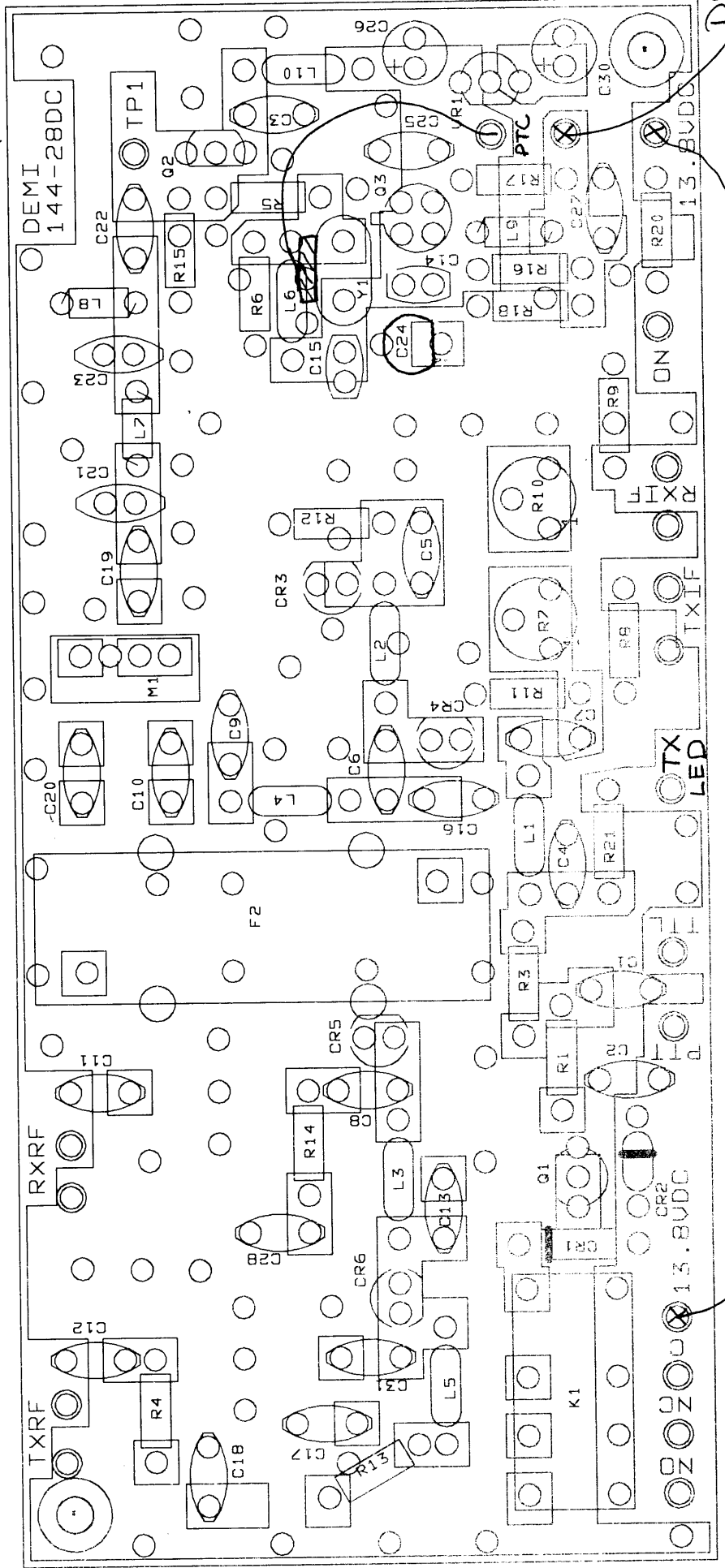
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144-28 DCK

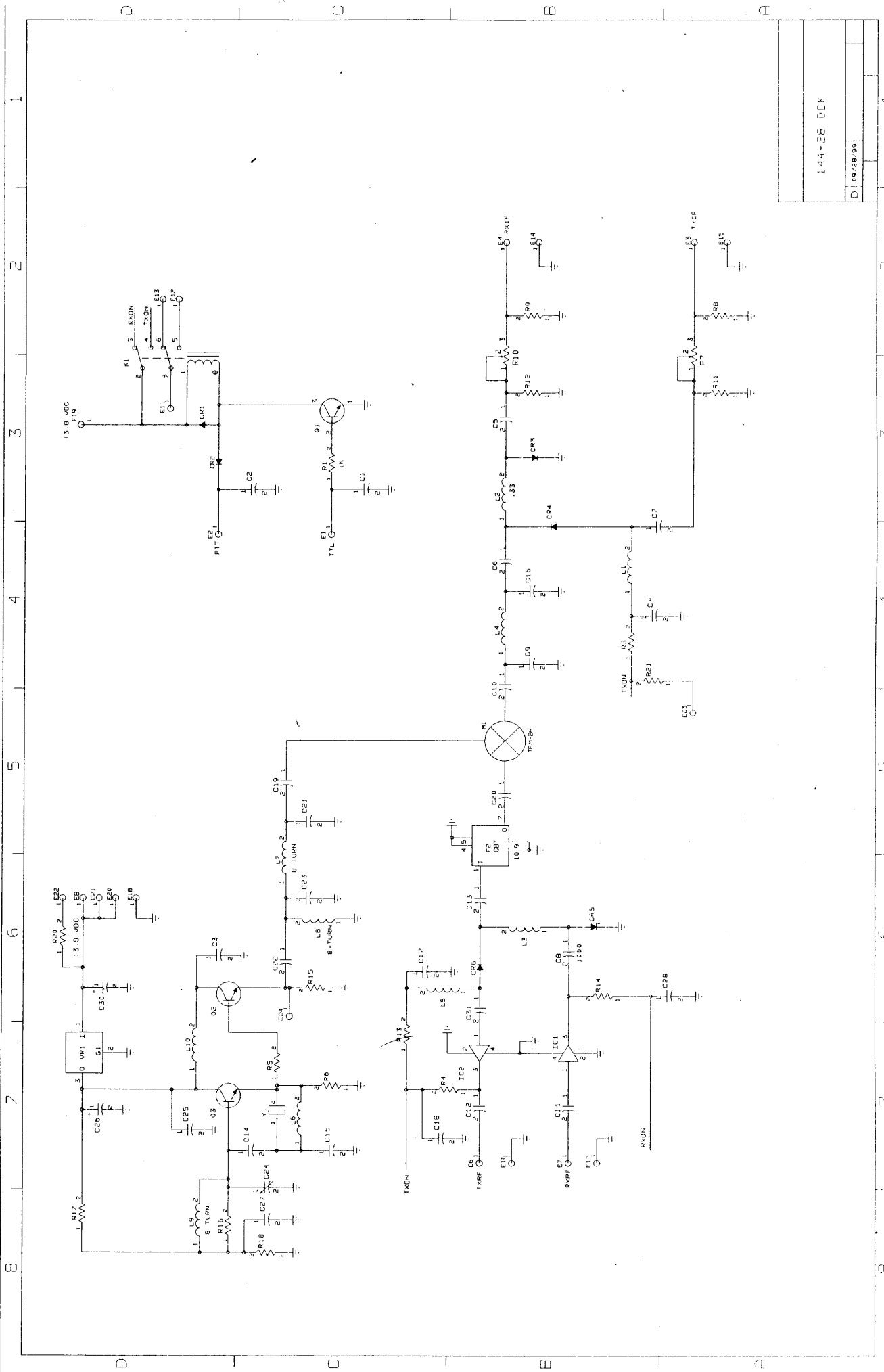
TOP SIDE ASSEMBLY

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DC Power Input

Jumper



144-28 CLK

D 100/28/70