

TUCSON AMATEUR PACKET RADIO

Packet Radio

Terminal Node Controller

TNC 2, Rev 2

ASSEMBLY MANUAL

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June 1985
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SPECIAL EDITION FOR ASSEMBLY OF PC BOARDS
EXCLUSIVE OF THE COMPLETE KIT
1991

The information contained in this document has been carefully checked and is believed to be entirely reliable. However, no responsibility is assumed for inaccuracies. Tucson Amateur Packet Radio Corporation (TAPR) reserves the right to make changes to any products to improve reliability, function or design without obligation to purchasers of previous equipment. TAPR does not assume any liability arising out of the application or use of any product or circuit described herein; neither does it convey any license under its patent rights or the rights of others.

This document was originally prepared for assembly of the TAPR TNC 2 kits. These kits are no longer available from TAPR, nor are any of the parts, with the exception of programmed EPROMS for the state machine and firmware. This document has been revised for use with bare printed circuit boards furnished by TAPR. Some of the assembly techniques described and parts shown may be unique to the parts contained in the TAPR TNC 2 kit. This does not imply that substitutions are not possible, however TAPR has not evaluated all of the possible effects of parts substitution, and assumes no responsibility for any peculiarities in performance. In selecting parts for use with these boards, you should become familiar with both the layout of the board itself and the assembly techniques described herein, in selecting the proper part for the application, prior to assembly. Included in the revision is the deletion of the MF-10 switched capacitor filter, which results in increased dynamic range for the XR2211 demodulator and the upgrade to 32K RAM, which was not part of the original kit, but is required for use with the current version of TAPR firmware. In addition, it is HIGHLY RECOMMENDED that you modify the DCD circuit as described by Eric Gustafson, N7CL in an article published in the Proceedings of the 7th ARRL Computer Networking Conference (American Radio Relay League, 225 Main Street, Newington, CT 06111). TAPR offers a kit for this purpose which makes the modification fairly painless.

Parts List

Resistors

1/4 watt, 5%

() 1 47 ohm (yellow-violet-black-gold)
 () 6 100 ohm (brown-black-brown-gold)
 () 1 200 ohm (red-black-brown-gold)
 () 5 470 ohm (yellow-violet-brown-gold)
 () 1 560 ohm (green-blue-brown-gold)
 () 7 1k ohm (brown-black-red-gold)
 () 2 4.7k ohm (yellow-violet-red-gold)
 () 1 5.6k ohm (green-blue-red-gold)
 () 26 10k ohm (brown-black-orange-gold)
 () 1 27k ohm (red-violet-orange-gold)
 () 4 47k ohm (yellow-violet-orange-gold)
 () 15 100k ohm (brown-black-yellow-gold)
 () 1 150k ohm (brown-green-yellow-gold)
 () 2 470k ohm (yellow-violet-yellow-gold)
 () 1 510k ohm (green-brown-yellow-gold)
 () 3 1M ohm (brown-black-green-gold)

1/8 watt, 1%

() 1 16.2k ohm (brown-blue-red-red-brown)
 () 1 22.1k ohm (red-red-brown-red-brown)
 () 1 30.1k ohm (orange-black-brown-red-brown)
 () 1 47.5k ohm (yellow-violet-green-red-brown)
 () 1 100.k ohm (brown-black-black-orange-brown)

Trimpots

() 2 10k ohm (3299W-10K)
 () 1 20k ohm (3299W-20K)
 () 1 50k ohm (3299W-50K)

Capacitors

Mylar or Monolithic

() 1 10 pF (10, 10J or 100)
 () 1 100 pF (101)
 () 1 220 pF (221)
 () 1 0.001 uF (.001 or 102)
 () 1 0.0015 uF (.0015 or 152)
 () 1 0.0022 uF (.0022 or 222)

- () 1 0.0047 uF (.0047 or 472)
- () 8 0.01 uF (.01 or 103)
- () 2 0.022 uF (.022 or 223)
- () 29 0.1 uF (.1 or 104)
- () 1 0.15 uF (.15 or 154)

Electrolytic (and Trimmer)

The electrolytic capacitors may have voltage ratings equal to or greater than those listed below, but not less.

- () 1 1 uF, 16v Radial TANTALUM
- () 4 1 uF, 16v Radial
- () 8 10 uF, 16v Radial
- () 1 100 uF, 16v Radial
- () 1 1000 uF, 16v Axial
- () 1 60 pF Trimmer

Integrated Circuits

Integrated circuits may come from various manufacturers and may have differing prefixes and/or suffixes. For example, if the part is listed as a 74LS00, it may be marked SN74LS00N or MC74LS00P or DM74LS00N or F74LS00P or a similar variation. The key is that the sequence 74LS00 appears in the part number. A four-digit number, such as 8515, indicates the year and week of manufacture and should not be confused with the part number. Typical parts are shown in many instances.

WARNING: Exercise extreme caution when handling ICs. They should be kept in a black foam carrier or other anti-static protective container until you are ready to install them. This precaution cannot be overemphasized!

- | | | |
|-------|--|------------|
| () 1 | 324 Quad Op Amp | LM324 |
| () 1 | 358 Dual Op Amp | LM358 |
| () 1 | 556 Oscillator/Timer | LM556 |
| () 1 | 2206 FSK Generator | XR2206 |
| () 1 | 2211 PLL Demodulator | XR2211 |
| () 1 | 2764/27C64 EPROM, Programmed, "STATE MACHINE" | |
| () 1 | 27C256 CMOS EPROM, Programmed, "TAPR FIRMWARE" | |
| () 1 | 32K CMOS Static RAM | 43256C-15L |
| () 1 | 8440/84C40 SIO/0 Dual Serial Port | Z8440 |
| () 1 | 84C00 or 70008 CMOS Z80 CPU | Z84C00 |
| () 1 | 4040 CMOS Divider | CD4040B |
| () 1 | 74HC4066 Quad CMOS Switch | 74HC4066 |
| () 1 | 74HCT04 Hex Inverter | 74HCT04 |

() 3	74HC14 Hex Schmitt Inverter	74HC14
() 1	74HC/HCT107 Dual J-K Flip Flop	74HC107
() 1	74HC/HCT139 Dual Decoder	74HC139
() 1	74HCT374 Octal Latch	74HCT374
() 1	74HC/HCT393 Dual Binary Divider	74HC393

Sockets

() 1	08-pin DIP Socket
() 11	14-pin DIP Socket
() 5	16-pin DIP Socket
() 1	20-pin DIP Socket
() 3	28-pin DIP Socket
() 2	40-pin DIP Socket

Connectors

() 5	2-pin male header
() 2	3-pin male header
() 1	5-pin male header with "wall"
() 1	14-pin male DIP header
() 1	16-pin male DIP header
() 1	5-pin DIN female, PC right angle
() 1	5-pin DIN male, cable type, with boot *
() 1	DB25S 25-pin female PC right angle
() 1	2.1mm Power PC right angle
() 1	2.1mm Power Cable w/connector
() 3	Jumper, Push-On

* The DIN5-180P consists of the following items:

1	Body, Connector
1	Boot, Insulating
1	Shield, Upper, Metal
1	Shield, Lower, Metal
1	Ferrule, Metal
5	Pins, Male

Diodes

() 2	1N754, Zener, 6.8v
() 6	1N4001, Rectifier, 1A
() 7	1N4148, Switching
() 1	1N4746, Zener, 18v
() 1	1N4752, Zener, 36v
() 5	LED, Red, Rectangular

Transistors and Voltage Regulator

- () 1 TX101 or VN10KM VFET
- () 9 2N3904 NPN Switching
- () 3 2N3906 PNP Switching
- () 1 7805CT +5v Regulator

Miscellaneous

- () 2 4-40 x 3/8 screw
- () 2 #4 Star Washer, Internal Tooth
- () 2 4-40 hex nut
- () 1 DIP Switch, 8-position, Right Angle
- () 1 Switch, DPDT, Push-On/Push-Off
- () 1 Cap, Grey, Push Button
- () 1 4.9152 MHz Crystal, HC-18/U
- () 1 10 uH inductor, molded, large
- () 2 10 uH inductor, molded, small
- () 5 Self-tapping screws, Phillips head
- () 4 Stick-on rubber feet
- () 1 Clip-on Heat Sink
- () 1 Shielded Jumper Wire
- () 1 Battery, Lithium, 3-volt

NOTE: The Lithium battery used in TNC 2 must be handled with extreme care. NEVER ALLOW A SHORT CIRCUIT ACROSS THE BATTERY TERMINALS OR THE BATTERY COULD EXPLODE AND CAUSE SERIOUS INJURY! Leave the battery in its envelope until called for in the instructions.

- () 1 Printed Circuit Board, TNC 2, Rev 3

TAPR TNC 2 Assembly Directions

This section will proceed in a step-by-step fashion. Please mount and solder the components to the board in the order given. It has been tested on numerous units and found to be a very efficient order for assembly.

When mounting axial lead discrete components, such as resistors and certain diodes, grasp the body of the part in one hand and bend the leads of the device with the other, such that the leads will pass through the holes provided on the board. Note that all axial lead components (except C12 and R80) are on 0.5 inch lead centers. Place the part so the body is parallel to, and flat against, the circuit board unless instructed otherwise. Next, bend the leads on the bottom of the board slightly to secure the part. Then proceed to mount the next component. Do not solder the part until directed.

NOTE: The tab of regulator Q3 (7805CT) can be used as a bending jig! Simply place the resistor or diode across the tab on Q3 and form the leads around the tab. The leads will then be spaced at 0.5".

Soldering

When soldering parts to the printed circuit board, use only a very small tipped controlled temperature (700 degrees F., 371 degrees C. maximum) soldering iron and fine (.050 inch) rosin-core solder. 63/37 (eutectic) solder is preferred, but 60/40 is acceptable.

To ensure the joint is properly soldered, the iron should be placed so that it contacts the pad on the board and the lead to be soldered. Solder should then be applied to the pad and the opposite side of the lead from the iron. Thus, the iron must heat both the pad and the lead to cause the solder to melt. This helps prevent cold solder joints. Also, keep a wet sponge handy and wipe the soldering iron tip on it frequently to keep it (and your connections) clean.

Care must be taken to ensure that the pad is not overheated, or it may lift from the PC board! Apply heat only when ready to solder. Do not apply heat longer than necessary to complete a good joint, but be sure to heat adequately for the solder to flow completely.

NOTE: All modern components are designed for soldering and you should not worry about 5-10 seconds of heating.

Board Mapping

Place the circuit board on a clean working surface. Orient the board so the lettering is in normal reading position. For purposes of description, the board consists of four sectors. The top of the board is the edge nearest the large axial capacitor (C12). The bottom, left and right follow in natural order. The upper left is quadrant one, the upper right is quadrant two, the lower left is quadrant three and the lower right is quadrant four. The board assembly will proceed by quadrants.

Board Modification

The TNC 2 was originally designed to use two (2) 6264 static RAM ICs, giving a total memory of 16K. TAPR firmware revisions 1.1.4 and later require 32K of RAM. This uses a single 32K RAM chip (U24 is not used). This change requires a slight modification to the PC board.

() Locate JMP12 on the board. It is in quadrant 2 near the bottom and to the right of U6 with the board oriented as described above.

() Turn the board over so that the circuit side can be seen. There is a trace connecting the top and center pads of JMP12. Cut this trace.

() Add a jumper between the bottom and center pads of JMP12.

() Turn the board over again so that it is in the position described above.

IC Sockets

NOTE: If any socket pins are bent, carefully straighten them with a pair of long-nose pliers.

When installing IC sockets, tack-solder two diagonally opposite corners first (such as pin 1 and pin 8 on a 14-pin socket). Double check to ensure that the socket is seated properly against the board with the notch, bevelled corner or "1" nearest pin 1 (pin 1 is the upper left corner when viewed from the component side of the board on all socketed ICs) and that all IC socket pins are showing on the solder side of the board. Then solder the remaining pins of that socket before proceeding to the next one.

NOTE: Take care now to avoid solder bridges!

If you find a socket is difficult to install, remove it, as you are probably bending a pin!

Now begin installing sockets.

(quadrant 1)

- () U1 16-pin
- () U2 14-pin
- () U7 14-pin
- () U8 8-pin
- () U3 14-pin
- () U9 14-pin

(quadrant 2)

- () U4 14-pin
- () U10 14-pin
- () U11 14-pin
- () U5 20-pin
- () U6 28-pin

(quadrant 3)

- () U15 14-pin
- () U16 16-pin
- () U19 16-pin
- () U20 14-pin

(quadrant 4)

- () U21 40-pin
- () U22 40-pin
- () U12 16-pin
- () U13 14-pin
- () U14 14-pin
- () U23 28-pin
- () U25 28-pin

Now check your work. All leads should be soldered. There should be no solder bridges (a blob of solder that shorts two adjacent soldered connections) or cold (grey and/or grainy-looking) solder connections. The positions on the printed circuit board for U17, U18 and U24 will be empty. You should have one (1) 16-pin IC

socket remaining.

() OK so far.

Since we have deleted the MF10 switched capacitor filter, a jumper must be connected to route the received audio signal to the demodulator.

() Solder an insulated wire from the plated through holes of U17 pin 8 to U18 pin 1 (no sockets are mounted in these positions).

Resistors

Install the following 5% resistors on the board:

(quadrant 1)

() R1 47 ohm (yellow-violet-black-gold)
 () R2 10k ohm (brown-black-orange-gold)
 () R3 100k ohm (brown-black-yellow-gold)
 () R5 100k ohm (brown-black-yellow-gold)
 () R7 10k ohm (brown-black-orange-gold)
 () R8 1k ohm (brown-black-red-gold)

WARNING: Be careful when clipping leads, as they may have a tendency to fly towards your eyes! Take appropriate precautions (grasp leads and provide eye protection).

() Solder and clip the leads (12 total)

() R14 100 ohm (brown-black-brown-gold)
 () R15 100 ohm (brown-black-brown-gold)
 () R16 100 ohm (brown-black-brown-gold)
 () R17 100 ohm (brown-black-brown-gold)
 () R18 100 ohm (brown-black-brown-gold)
 () R19 100 ohm (brown-black-brown-gold)
 () R20 100k ohm (brown-black-yellow-gold)
 () R21 100k ohm (brown-black-yellow-gold)
 () R22 10k ohm (brown-black-orange-gold)
 () R23 10k ohm (brown-black-orange-gold)
 () R6 100k ohm (brown-black-yellow-gold)

() Solder and clip leads (22 total)

() R24 100k ohm (brown-black-yellow-gold)
 () R25 27k ohm (red-violet-orange-gold)
 () R26 10k ohm (brown-black-orange-gold)

- () R27 100k ohm (brown-black-yellow-gold)
- () R28 10k ohm (brown-black-orange-gold)
- () Solder and clip leads (10 total)
- () R36 1k ohm (brown-black-red-gold)
- () R37 100k ohm (brown-black-yellow-gold)
- () R38 10k ohm (brown-black-orange-gold)
- () R39 150k ohm (brown-green-yellow-gold)
- () R40 100k ohm (brown-black-yellow-gold)
- () R41 470k ohm (yellow-violet-yellow-gold)
- () Solder and clip leads (12 total)
- () R42 100k ohm (brown-black-yellow-gold)
- () R43 100k ohm (brown-black-yellow-gold)
- () R44 47k ohm (yellow-violet-orange-gold)
- () R45 47k ohm (yellow-violet-orange-gold)
- () R46 1k ohm (brown-black-red-gold)
- () R47 1k ohm (brown-black-red-gold)
- () R48 1k ohm (brown-black-red-gold)
- () Solder and clip leads (14 total)

(quadrant 2)

- () R9 10k ohm (brown-black-orange-gold)
- () R10 10k ohm (brown-black-orange-gold)
- () R11 1k ohm (brown-black-red-gold)
- () R12 10k ohm (brown-black-orange-gold)
- () R13 47k ohm (yellow-violet-orange-gold)
- () Solder and clip leads (10 total)
- () R29 10k ohm (brown-black-orange-gold)
- () R30 10k ohm (brown-black-orange-gold)
- () R31 100k ohm (brown-black-yellow-gold)
- () R32 4.7k ohm (yellow-violet-red-gold)
- () R33 1k ohm (brown-black-red-gold)
- () R34 470 ohm (yellow-violet-brown-gold)
- () R35 470 ohm (yellow-violet-brown-gold)
- () Solder and clip leads (14 total)

(quadrant 3)

- () R55 10k ohm (brown-black-orange-gold)
- () R56 5.6k ohm (green-blue-red-gold)

- () R57 560 ohm (green-blue-brown-gold)
- () R58 1 Megohm (brown-black-green-gold)
- () R59 1 Megohm (brown-black-green-gold)
- () Solder and clip leads (10 total)
- () R60 200 ohm (red-black-brown-gold)
- () R61 10k ohm (brown-black-orange-gold)
- () R62 47k ohm (yellow-violet-orange-gold)
- () R64 100k ohm (brown-black-yellow-gold)
- () R65 100k ohm (brown-black-yellow-gold)
- () Solder and clip leads (10 total)
- () R67 10k ohm (brown-black-orange-gold)
- () R68 10k ohm (brown-black-orange-gold)
- () R69 10k ohm (brown-black-orange-gold)
- () R70 10k ohm (brown-black-orange-gold)
- () Solder and clip leads (8 total)
- () R71 10k ohm (brown-black-orange-gold)
- () R72 100k ohm (brown-black-yellow-gold)
- () R73 470k ohm (yellow-violet-yellow-gold)
- () R74 10k ohm (brown-black-orange-gold)
- () R98 4.7k ohm (yellow-violet-red-gold)
- () Solder and clip leads (10 total)

(quadrant 4)

- () R49 10k ohm (brown-black-orange-gold)
- () R50 10k ohm (brown-black-orange-gold)
- () R51 10k ohm (brown-black-orange-gold)
- () R96 10k ohm (brown-black-orange-gold)
- () R97 470 ohm (yellow-violet-brown-gold)
- () R52 10k ohm (brown-black-orange-gold)
- () R53 470 ohm (yellow-violet-brown-gold)
- () R54 470 ohm (yellow-violet-brown-gold)
- () R75 10k ohm (brown-black-orange-gold)
- () Solder and clip leads (18 total)

There should be two 5% resistors remaining, one 510k (green-brown-yellow-gold), and one 1 Megohm (brown-black-green-gold).

- () Two 5% resistors remaining.

The following devices are trimpots. When you install one, tack solder the center lead to the PC board. Do not solder the other leads, nor clip any leads, until directed. This enables you to line up all the trimpots neatly before you commit any of them to a "final" position.

NOTE: Orient each trimpot with the adjustment screw toward the left edge of the board.

(quadrant 3 only)

- () R76 50k
- () R77 10k
- () R78 20k
- () R79 10k
- () Line up R76-79.
- () Solder and clip leads (12 total)

Now check your work. All leads should be soldered and clipped close to the bottom of the PC board. You should have all thirteen 1% and two 5% resistors remaining. There should be no solder bridges nor cold solder connections.

- () OK so far.

Diodes

WARNING: Diodes are polarized! The marked (banded or tapered) end of the diodes (cathode) should match the banded end of the silk screen. You may need to use a magnifying glass to read the diode part numbers.

(quadrant 1)

- () CR22 1N4001 (cathode to the top of the board)
- () CR1 1N4746 (cathode to the top of the board)
- () CR2 1N4001 (cathode to the top of the board)
- () CR3 1N4001 (cathode to the top of the board)
- () CR4 1N4001 (cathode to the top of the board)
- () CR5 1N4001 (cathode to the top of the board)
- () CR6 1N754 (cathode to the bottom of the board)
- () Solder and clip leads (14 total)
- () CR9 1N4148 (cathode to the top of the board)
- () CR13 1N4148 (cathode to the left of the board)

() CR10 1N4148 (cathode to the bottom of the board)

() Solder and clip leads (6 total)

() Save one of the clipped 1N4148 leads for use during modem calibration.

(quadrant 2)

() CR7 1N4001 (cathode to the top of the board)

() CR8 1N754 (cathode to the top of the board)

() CR11 1N4148 (cathode to the top of the board)

() CR16 1N4148 (cathode to the top of the board)

() Solder and clip leads (8 total)

NOTE: The LEDs will be installed later.

(quadrant 3)

() CR12 1N4752 (cathode to the top of the board)

() CR14 1N4148 (cathode to the top of the board)

() CR15 1N4148 (cathode to the top of the board)

() Solder and clip leads (6 total)

(quadrant 4 -- none)

Now check your work. You should have 5 LEDs remaining. All leads should be soldered and clipped close to the bottom of the PC board. There should be no solder bridges nor cold solder connections.

() OK so far.

Capacitors

WARNING: The electrolytic capacitors are polarity sensitive. The silk screen indicates the positive lead, while most electrolytic capacitors have the negative lead marked. Be careful to ensure the parts are correctly installed or damage may occur at power up!

NOTE: All capacitors, especially electrolytic, should be mounted as nearly flush to the surface of the PC board as practical

without overstressing the leads.

(quadrant 1)

- () C1 0.1 uF (104)
- () C2 0.01 uF (103)
- () C3 10 uF 16v radial electrolytic
- () C4 0.1 uF (104)
- () C5 0.001 uF (102)
- () C6 10 uF 16v radial electrolytic
- () C7 10 uF 16v radial electrolytic
- () C58 1 uF 16v radial electrolytic
- () C10 10 uF 16v radial electrolytic
- () C11 0.1 uF (104)

- () Solder and clip leads (20 total)

- () C31 10 uF 16v radial electrolytic
- () C56 0.1 uF (104)
- () C32 0.1 uF (104)
- () C21 0.1 uF (104)
- () C22 10 uF 16v radial electrolytic
- () C23 0.1 uF (104)
- () C59 0.01 uF (103)
- () C24 0.01 uF (103)
- () C51 10 pF (10 or 100)

- () Solder and clip leads (18 total)

(quadrant 2)

- () C8 10 uF 16v radial electrolytic
- () C9 0.1 uF (104)
- () C60 220 pF (221)
- () C13 0.1 uF (104)
- () C14 0.1 uF (104)
- () C25 0.1 uF (104)
- () C26 0.1 uF (104)
- () C61 100 pF (101)

- () Solder and clip leads (16 total)

- () C12 1000 uF25v axial electrolytic

- () Solder and clip leads (2 total)

- () C15 0.1 uF (104)
- () C17 0.1 uF (104)
- () C19 0.01 uF (103)

- () C20 1 uF radial TANTALUM (105) (+ to bottom of board)
- () C18 10 uF 16v radial electrolytic
- () C16 100 uF 16v radial electrolytic

- () Solder and clip leads (12 total)

(quadrant 3)

- () C33 1 uF 16v radial electrolytic
- () C34 1 uF 16v radial electrolytic
- () C35 0.01 uF (103)
- () C57 0.1 uF (104)
- () C36 0.0015 uF (152)
- () C37 0.1 uF (104)
- () C38 0.1 uF (104)

- () Solder and clip leads (14 total)

- () C39 0.01 uF (103)
- () C40 0.1 uF (104)
- () C41 0.1 uF (104)
- () C42 0.01 uF (104)
- () C43 0.1 uF (104)
- () C44 1 uF 16v radial electrolytic
- () C45 0.15 uF (154)
- () C46 0.1 uF (104)

- () Solder and clip leads (16 total)

- () C47 60pF trimmer capacitor
- () C48 0.1 uF (104)

- () Solder and clip leads (2 total - none on trimmer)

(quadrant 4)

- () C27 0.1 uF (104)
- () C28 0.1 uF (104)
- () C29 0.1 uF (104)
- () C30 0.1 uF (104)
- () C49 0.1 uF (104)
- () C50 0.1 uF (104)

- () Solder and clip leads (12 total)

You should have six (6) monolithic capacitors remaining: one each of 0.0022 uF (222), 0.0047 uF (472), 0.01 uF (103) and 0.1 uF

(104); and two each of 0.022 uF (223).

() 6 capacitors remaining.

Now check your work. All leads should be soldered and clipped close to the bottom of the PC board. There should be no solder bridges nor cold solder connections.

() OK so far.

Transistors

NOTE: Transistors have three leads and are polarity sensitive! Be sure to properly match the transistor outline with the silkscreened image on the PC board. The transistors have a flat side and the directions will call out the orientation of this outline as an additional precaution. When installing a transistor, be careful not to overheat the device.

Before installing a transistor, carefully bend the center lead away from the flat side of the transistor body and slightly spread the two outside leads apart.

(quadrant 1)

() Q8 2N3906 (Flat side to the left edge.)

() Q9 2N3904 (Flat side to the left edge.)

() Solder and clip leads (6 total)

(quadrant 2)

() Q1 2N3904 (Flat side to the lower edge.)

() Q2 2N3904 (Flat side to the left edge.)

() Solder and clip leads (6 total)

() Q4 2N3904 (Flat side to the lower edge.)

() Q5 2N3906 (Flat side to the lower edge.)

() Solder and clip leads (6 total)

() Q6 2N3904 (Flat side to the lower edge.)

() Q7 2N3904 (Flat side to the left edge.)

() Solder and clip leads (6 total)

() Q15 2N3904 (Flat side to the lower edge.)

- () Solder and clip leads (3 total)

(quadrant 3)

- () Q10 VN10KM/TX101 (Flat side to the left edge.)
- () Q12 2N3906 (Flat side to the right edge.)
- () Solder and clip leads (6 total)
- () Q13 2N3904 (Flat side to the right edge.)
- () Q14 2N3904 (Flat side to the right edge.)
- () Solder and clip leads (6 total)

(quadrant 4 -- none)

You should have no transistors (but one voltage regulator) remaining.

- () No transistors remaining.

Remaining Components

NOTE: In the following steps you will complete soldering parts on the TAPR TNC 2 printed circuit board. Solder each component as you install it in this assembly phase. Be sure to proceed carefully and continue to exercise good workmanship!

(quadrant 1)

- () SW1 Locate the DPDT Power switch. Note that it has two sets of contacts; one set consists of 6 pins while the other set consists of 6 lugs with holes in them.

- () Carefully install SW1 on the PC board with the white plastic actuator extending over the left edge of the PC board. Be sure the switch is "square" with the PC board and resting on the small legs protruding from the switch bottom.

- () Clip off the 6 (six) lugs on the top of SW1.

- () Now firmly press on the grey cap on the power switch shaft. The cap should be horizontal, that is, parallel to the PC board. Press it on until it "snaps" in place on the switch shaft.

- () P1 Locate the 2.1mm Power Connector. This device has

three lugs on the bottom surface and one lug on the top surface.

() Install P1 on the PC board. Be sure it rests firmly on the PC board surface.

() Clip off the lug on the top of P1.

() SW2 Install the 8 pole DIP switch. Note that SW2 "rides" about 1/16" (1.6 mm) above the surface of the PC board.

() BE SURE THAT ALL SWITCHES OF SW2 ARE IN THE OFF POSITION (or you may cause damage to integrated circuit U1 in a later step)!

NOTE: When installing jumper strips, be sure that the shorter pins are soldered to the PC board and the longer pins stick up.

WARNING: Don't grip jumpers with your fingers while soldering. The pins quickly get very hot!

() JMP4 Install a 2-pin header.

() L2 10 uH choke (this is one of the smaller chokes)

(quadrant 2)

() L1 10 uH choke (this is the larger choke)

() JMP5 Install a 2-pin header.

() Q3 Place the 7805CT regulator at location Q3, with the metal tab side of the part away from the near (right) edge of the PC board (do not solder yet).

() Using one of the #4 black self-tapping screws, secure Q3 to the case or other heat sink. Be sure it is vertical, and that the leads are passing through the corresponding holes in the PC board.

() Solder the three leads of Q3 in place.

() Now unscrew Q3 and remove the PC board from the case. Set the case aside until called for later.

() Trim the leads on Q3.

(quadrant 3)

() J1 25-pin female DB-25 connector. Attach this connector with two 4-40 x 3/8 screws, #4 lockwashers and 4-40 nuts. The screw heads should be on the solder side of the PC board. Be careful not to damage the traces near the power switch end of the connector. Be sure to solder all 25 pins after fastening this connector!

() J2 Install the 5-pin DIN connector.

() JMP7 Install a 2-pin male header

() JMP8 Install a 2-pin male header

() JMP9 Install two 3-pin male headers

() JMP10 Install a 2-pin male header

() J3 Install a 5-pin male header (wall toward U20)

() Y1 Install the 4.9152 MHz crystal (Do not overheat!)

(quadrant 2 and quadrant 4)

NOTE: When soldering the LEDs in place, use a pair of long-nose pliers and carefully bend the leads at right angles so the LED will lie flat on the PC board, with the shorter of the two leads (cathode) towards the bottom edge of the board and the "lens" end of the LED hanging over the right side of the PC board. The LED leads should be bent at the point where the leads become narrow after exiting the plastic body of the device. Solder and clip both leads before proceeding to the next LED.

WARNING: When installing LEDs, do not spread the leads to secure the LED to the board. Bending the leads can fracture the plastic casing and cause the device to fail. Instead, hold the LED while soldering it.

NOTE: Remember that all LEDs are oriented with the cathode towards the bottom edge of the PC board. The LED cathode lead is the shorter of the two.

() CR17 LED "PWR"

() Solder and clip leads (2 total)

() CR19 LED "CON"

() Solder and clip leads (2 total)

() CR18 LED "STA"

() Solder and clip leads (2 total)

() CR21 LED "PTT"

() Solder and clip leads (2 total)

() CR20 LED "DCD"

() Solder and clip leads (2 total)

Bottom of PC Board

There are two bypass capacitors, one rf choke and a shielded, insulated jumper that mount on the underside of the PC board. There are no silkscreened locations for these parts, so pay especially close attention to the schematic diagram and board layout.

- () C63 0.1 uF (104) (at SW1)
- () C62 0.01 uF (103) (at J2)
- () L3 10 uH choke (this is a smaller choke) (at J1)
- () Shielded jumper. Solder one end at the hole near SW1.
- () Shielded jumper. Solder the other end at the hole near Q3.

Now lay the PC board aside and prepare to wire the DIP headers. These are the devices that plug into an IC socket but have notched pins above the plug to allow soldering discrete components to the header.

NOTE: DO NOT overheat the headers when soldering or they may deform! To help prevent heat damage to the header, put the extra 16-pin DIP socket in a vise and insert the header in the socket. Then, solder the parts to the header.

U15

The following devices mount on a 14-pin DIP header, U15. Form the leads on the parts so the components lay in the slots provided on the top of the header. Solder the two leads, then clip them flush with the sides of the post. Note the bevelled corner or notch marking pin 1 of the header.

NOTE: The resistor in the next step is 5%.

- () R83 1 Meg 5% (brown-black-green-gold)
(pins 3 and 12)
- () C55 0.022 uF monolithic (223)
(pins 5 and 10)
- () R81 16.2k 1% (brown-blue-red-red-brown)
(pins 6 and 9)
- () R82 30.1k 1% (orange-black-brown-red-brown)
(pins 7 and 8)

- () Set the header aside until it is called for later.

U19

The following devices mount on a 16-pin DIP header, U19. Note the bevelled corner or notch marking pin 1 of the header.

- () C52 0.022 uF monolithic (223)
(pins 2 and 15)
- () R92 22.1k 1% (red-red-brown-red-brown)
(pins 3 and 14)
- () R93 47.5k 1% (yellow-violet-green-red-brown)
(pins 4 and 13)
- () C53 0.0047 uF monolithic (472)
(pins 5 and 12)
- () C54 0.0022 uF monolithic (222)
(pins 6 and 11)
- () R94 100k 1% (brown-black-black-orange-brown)
(pins 7 and 10)

NOTE: The resistor in the next step is 5%.

- () R95 510k (green-brown-yellow-gold)
(pins 8 and 9)
- () Set the header aside until it is called for later.
- () Discard the extra 16-pin socket.

Initial Checkout of TNC 2

For initial checkout you will need a voltmeter capable of measuring up to 30 volts dc. If you encounter any problems, such equipment as an ohmmeter, oscilloscope, and logic probe will prove very useful.

NOTE: Be sure to insulate the TNC 2 PC board assembly from any conductive work surface during testing!

- () Locate the 2.1mm power connector/cable.
- () Strip about 1/4" (0.6 cm) of insulation from each lead on the free end of the cable.

NOTE: The power supply used should be current limited to or fused for 500 mA.

- () Connect the lead with a white stripe to a source of +10 to +15 volts dc.
- () Connect the other lead to the (-) return side of the +10 to

+15 volts dc power source.

() Depress the power switch on your TNC 2 a couple of times. Note that it latches in two positions alternately.

() Cycle the power switch until it latches in the OFF (out) position.

() Connect the 2.1mm power cable to P1.

In the following steps, power will be applied to your TNC. Be ready to remove power quickly! If you smell anything that resembles a burning TNC, remove power immediately.

If you have problems at any point, disconnect power and determine the cause of the problem before proceeding!

() With power switch SW1 still in the out, or OFF position, apply 10 to 15 volts dc to the power cable.

() Using an accurate dc voltmeter, measure the voltage between ground (at - lead of C12 in quadrant 2) and either of the lug stubs on top of switch SW1 nearest the push button. Record the voltage in the space below.

(Measured value: _____)

() If the voltage recorded in the step above is below +10v, greater than +15v or is negative, take corrective action. DO NOT PROCEED UNTIL THIS MEASUREMENT IS CORRECT OR YOU MAY CAUSE SERIOUS DAMAGE TO YOUR TNC 2!

() Switch SW1 to the in, or ON position. The PWR, PTT and DCD LEDs should glow.

() Measure the voltage at the input side of Q3. This is the lead closest to LED CR17 (PWR). BE CAREFUL TO NOT SHORT THE INPUT LEAD TO ANYTHING WHILE MAKING THIS MEASUREMENT!

(Measured value: _____)

() The voltage measured in the above step should be no more than 2 volts below the input voltage measured earlier. DO NOT PROCEED UNTIL THIS MEASUREMENT IS CORRECT OR YOU MAY CAUSE SERIOUS DAMAGE TO YOUR TNC 2!

() Measure the voltage at the output side of Q3. This is the lead farthest from LED CR17. BE CAREFUL TO NOT SHORT THE OUTPUT LEAD TO ANYTHING WHILE MAKING THIS MEASUREMENT!

(Measured value: _____)

() The voltage measured in the above step should be between +4.7 and +5.3 volts dc. DO NOT PROCEED UNTIL THIS MEASUREMENT IS CORRECT OR YOU MAY CAUSE SERIOUS DAMAGE TO YOUR TNC 2!

() Switch SW1 to the out, or OFF position.

At this point, your TNC 2 positive voltage supply is checked and verified. If the above tests were not successful, refer to the Troubleshooting chapter of the TNC 2 System Manual for help. In the following steps you will verify the operation of the negative supplies used in the modem and computer interface circuits.

First, however, it is necessary to review proper IC handling procedures.

IC Installation

The ICs should be shipped to you in an anti-static carrier. Many of them are VERY sensitive to static discharge. The probability of them being defective as shipped is extremely low. They should be handled with extreme care. If you live in a climate with low humidity, or if you have carpeting in your work area, take special precautions. You might try spraying the carpet with some sort of fabric softener/anti-static preparation (such as a 50% solution of "Downy" and water) to reduce static.

If you have a metal working surface, ground it! Place a hand on the working surface before you touch the ICs and be sure to frequently ground yourself to the working surface. If you don't have such a surface, use a large cookie sheet or aluminum foil. Handle ICs only while sitting quietly, never while moving or walking!

Avoid static discharge near the ICs!

() Anti-static precautions understood and implemented.

Install the ICs using special IC handling tools, such as those produced by OK Machine Tool. If you lack these, you may gently rock both sides of an IC on your metal work surface to make the leads straight and parallel to each other and install it in its socket with firm, even pressure applied over the length of the IC body.

WARNING: The TNC circuit board may flex excessively (when installing ICs) if it is laid on a hard, flat surface, due to the mounting screws on J1 and the components on the bottom of the PC

board. Do not allow the board to flex when inserting ICs.

If you make a mistake, or have to remove an IC for any reason, special anti-static removal tools are available. If you don't have access to such tools, you may try using a small screwdriver and gently pry the IC out of the socket, a little at a time, from alternate ends of the IC, but to use other than the proper tools exposes you to risking damage to your IC.

NOTE: It is very easy to bend a pin or fold it under the IC during installation. Be sure to check each IC as you install it in the steps below to be sure that all pins are actually in the socket and not tucked under the IC or hanging over the socket! It is easy to make this error!

Now you may begin.

() Locate the LM556 IC.

() Install this IC in socket U2. Be careful to ensure that no leads are bent. Pin 1 of this IC goes to the upper left corner of the socket (as do all pin 1s on all ICs).

() Switch SW1 to the in, or ON position.

() Measure the voltage between ground (the negative lead of C12) and the top end of R14 in quadrant 1. This is the end of R14 immediately adjacent to socket IC1 pin 9.

(Measured value: _____)

() The voltage measured in the above step should be more negative than -6 volts. For a +12 volt input to TNC 2, it will typically measure around -11 v (around -7.5 v when all ICs are later installed). DO NOT PROCEED UNTIL THIS MEASUREMENT IS CORRECT OR YOU MAY CAUSE SERIOUS DAMAGE TO YOUR TNC 2!

() Switch SW1 to the out, or OFF position.

() Locate the LM324 IC

() Install this IC in socket U3. Be careful to ensure that no leads are bent. Pin 1 of this IC goes to the upper left corner of the socket (as do all pin 1s on all ICs).

() Switch SW1 to the in, or ON position.

() Measure the voltage at the end of R5 nearest the edge of the PC board in quadrant 1.

(Measured value: _____)

() The voltage measured in the above step should be between - 4.7v and -5.3v. DO NOT PROCEED UNTIL THIS MEASUREMENT IS CORRECT OR YOU MAY CAUSE SERIOUS DAMAGE TO YOUR TNC 2!

() Switch SW1 to the out, or OFF position.

You have now verified the operation of all the power supplies of your TNC 2. Once again, check for any loose wire clippings, solder splashes or other possible problem areas on your TNC 2.

() OK so far.

In the next steps you will be installing the digital ICs on your TNC 2. Exercise extreme care when handling the ICs!

Install the following ICs:

(quadrant 1)

() U1 CD4040
() U7 74HC14
() U8 LM358
() U9 74HC14

(quadrant 2)

() U4 74HCT393
() U5 74HCT374
() U6 2764 (or 27C64) "STATE MACHINE"
() U10 74HCT04
() U11 74HC107

(quadrant 3 - none)

(quadrant 4)

() U21 8440 (or 84C40)
() U22 84C00
() U12 74HCT139
() U13 74HC4066
() U14 74HC14
() U23 27C256
() U25 43256C-15L

Double check to be sure that all ICs are in their correct sockets and that there are no bent or tucked under leads. Pin 1 of all ICs should be at the upper left corner.

- () All ICs installed correctly.

You should have two ICs remaining (XR2206, XR2211) and all three headers. These will be installed later.

- () Three ICs and three headers remaining.

() Carefully inspect all ICs again to be sure they are all seated in their sockets and there are no bent or otherwise improperly installed pins. Be sure pin 1 of each IC matches pin 1 of its socket or you may destroy the IC.

- () Attach a clip-on heat sink to Q3.

The next step will be to apply power to your TNC 2. Exercise care and be ready to remove power the instant any problems appear. Remember, if you let all the smoke out of a part during these tests, it may never work properly again! If it is working properly, you will see a certain sequence of LED activity. Please read the following five steps before you perform any of them!

() Read the following 4 steps through and understand them thoroughly before you perform any of them!

- () Switch SW1 to the ON position.

- () Observe that all LEDs except PTT glow.

() After a period of about 2 seconds, the CON and STA LEDs should extinguish (CR18 and CR19).

- () Switch SW1 to the OFF position.

Your TNC 2 has just exercised the power-on routines. The "CON" and "STA" LEDs turning off after first being on indicates that all the digital circuitry is probably working. If this test was not successful, please refer to the Troubleshooting chapter in your TNC 2 System Manual for helpful information.

The next thing to do is verify that your TNC 2 is able to communicate with your terminal, or computer running a terminal program. Please refer to the chapter on Computer Interfacing in your TNC 2 System Manual for details on fabricating an RS-232C serial cable. Once your cable is made, please return to this section and continue with the following steps.

- () RS-232C serial cable properly made.

Now set your terminal to 300, 1200, 2400, 4800 or 9600 baud (slower is better). Set the word length to 7 and parity to even.

If the number of stop bits is settable, select 1.

() Terminal set to one of the above baud rates with proper word length and parity.

() Now, connect your terminal (or computer) to your RS-232C cable.

() Connect the other end of the RS-232C cable to your TNC 2.

() Apply power to your terminal (or computer).

() If you are using a computer, load and run your terminal program.

() Set switches 1 through 5 of SW2 to correspond to your terminal (or computer) baud rate as shown below:

Baud Rate	SW2 Setting				
	1	2	3	4	5
300	ON	OFF	OFF	OFF	OFF
1200	OFF	ON	OFF	OFF	OFF
2400	OFF	OFF	ON	OFF	OFF
4800	OFF	OFF	OFF	ON	OFF
9600	OFF	OFF	OFF	OFF	ON

() In addition, set SW2 switch 7 on, and SW2 switches 6 and 8 off.

() Switch SW1 ON.

() Observe that all LEDs except PTT (CR21) glow.

() After a period of about 2 seconds, the STA and CON LEDs (CR18 and CR19) should extinguish.

() After the two LEDs turn off, the following message should appear on your terminal (or computer) display:

```
Tucson Amateur Packet Radio TNC 2
AX.25 Level 2 Version 2.0
Release nn
Checksum $xx
cmd:
```

(see software release notes for values of nn and xx)

() A message stating "bbRAM loaded with defaults" may

also appear. Do not be alarmed by this message!

() Now enter a <carriage return> (may be marked RETURN, ENTER, NEWLINE, etc. on your terminal or computer).

The display should now look like that below:

```
Tucson Amateur Packet Radio TNC 2
AX.25 Level 2 Version 2.0
Release nn
Checksum $xx
cmd:
cmd:
```

Note that the second "cmd:" line appears after you enter the carriage return.

() Switch SW1 OFF.

Congratulations! Your TNC 2's digital circuitry and computer interface circuitry has now been verified. If you didn't get the expected results, recheck the Computer Interfacing chapter in the TNC 2 System Manual and consult the troubleshooting section. After you have the problem (if any) resolved, the following steps will take you through verification of the digital portion of your TNC 2 radio interface, then the completion, calibration and verification of the modem section!

Digital Loopback Testing

You will now conduct a fairly thorough test of the digital portion of your TNC 2 radio interface system. Known as "digital loopback," this procedure will feed your packet transmit data signal at digital levels to your packet receiving circuitry.

Once these tests are successfully completed, you will be able to proceed with the final modem construction and testing with confidence that the digital portion of your TNC 2 is performing properly. This test facility may also prove useful for future troubleshooting of TNC 2.

In some of the following steps you will install push-on jumpers. They are installed by simply pressing them down over the indicated pins. DO NOT solder them in place!

() Install a push-on jumper at JMP10. The jumper should bridge both pins at JMP10.

() Place your terminal or computer in proper operating mode

as outlined in the previous test.

() Ensure that the RS-232C cable is properly attached between your terminal or computer and TNC 2.

() Switch SW1 to the ON position.

() After the signon message and the cmd: prompt, enter the following:

```
MY W1QRM
```

followed by a carriage return (abbreviated <cr> in all following steps).

() TNC 2 should respond with:

```
MYCALL was NOCALL  
cmd:
```

() Now enter:

```
MY<cr>
```

() TNC 2 should respond with:

```
MYCALL W1QRM  
cmd:
```

() Verify that SW2 switch 7 is in the ON position, and ensure that SW2 switches 6 and 8 are in the OFF position.

() Now enter the following command to your TNC 2:

```
FULL ON<cr>
```

() TNC 2 should respond with:

```
FULLDUP was OFF  
cmd:
```

() Enter:

```
C W1QRM<cr>
```

() You should observe the PTT LED (CR21) blink on then off. The CON LED (CR19) will then come on shortly after you enter the <cr> and the message:

```
cmd:*** CONNECTED to W1QRM
```

with NO cmd: prompt on the next line.

() Now enter:

```
hello self<cr>
```

() The PTT and STA LEDs should briefly come on, the PTT LED blink off then on, then both LEDs go off, after which the display should look like:

```
hello self
hello self
```

() Now enter a Control-C character. This is usually done by depressing the "CTRL" key on your terminal, then pressing and releasing the letter "C" key, then releasing the "CTRL" key. If your terminal or computer doesn't work this way, consult your terminal or computer manual for instructions on entering control characters.

() Your TNC 2 should respond with the cmd: prompt.

() Now enter:

```
D<cr>
```

() The PTT LED will blink, then the CON LED will turn off and your TNC 2 should respond with:

```
cmd:*** DISCONNECTED
```

followed by NO cmd: prompt.

If you are successful to this point, you have entered a call sign in your TNC 2, instructed the TNC to ignore the DCD LED (CR20), then established a "connection" with yourself. You had a brief packet QSO, then ended the QSO!

The next test will verify the operation of the DCD circuitry, at least from the digital point of view.

() Enter:

```
FULL OFF<cr>
```

() TNC 2 should respond with:

```
FULLDUP was ON
cmd:
```


() Now enter:

C W1QRM<cr>

() The cmd: prompt should appear. After ten or twenty seconds, enter:

D<cr>

() Your TNC 2 should respond with:

```
*** retry count exceeded
*** DISCONNECTED
cmd:
```

() Switch SW1 to the OFF (out) position.

() Using a VERY THIN piece of cut off lead (from the 1N4148 diode) place a short at socket U20 (quadrant 3) from pin 4 to pin 6. Be very careful not to stress the socket contacts.

() Switch SW1 to the ON (in) position.

() The DCD LED (CR20) should remain OFF.

() After the sign-on, enter:

```
MY W1QRM<cr>
C W1QRM<cr>
```

() The PTT LED should blink, TNC 2 should respond with:

```
cmd:*** CONNECTED TO W1QRM
```

and the CON LED should be illuminated.

() Now enter a Control-C character, then:

D<cr>

() The PTT LED should blink, your display should now read:

```
cmd:*** DISCONNECTED
```

and the CON LED should extinguish.

() Switch SW1 to the OFF (out) position.

() Remove the push-on jumper from JMP10.

() Remove the wire jumper from socket U20 pins 4 and 6.

If you experienced problems in the above steps, refer to the troubleshooting section of your TNC 2 manual for help.

In the next section, you will complete construction of the modem and calibrate it.

Keeping in mind the precautions regarding handling ICs, install the following ICs (quadrant 3).

() U16 XR2206

() U20 XR2211

Now install the headers as follows, being careful to align pin 1 of the header with pin 1 of the socket:

() U15 14-pin header with one (1) capacitor and three (3) resistors.

() U17 16-pin header with eight (8) resistors only.

() U19 16-pin header with three (3) capacitors and four (4) resistors.

CALIBRATION

Effective with TNC 2 firmware version 1.1.7, new calibration procedures have been established. These are described in the TNC 2 System Manual. The original calibrations described below should be compared to the new instructions to determine the differences.

In the following steps, you will calibrate your TNC 2 modem section. Exercise care, as a poorly calibrated modem may result in poor performance in packet operation, especially when dealing with weak signals.

If you have access to an accurate frequency counter, you may increase the calibration accuracy by using it as described in the calibration procedure below.

When adjusting the trimpots, you should hear a soft "click" when the element is adjusted to the end of its travel. Turning the element past this point will not result in damage to the trimpot; however, it is suggested that you do not make a practice of turning the adjustment screw past this point!

Use a small-tipped screwdriver or special trimpot adjusting tool

in the following steps as you adjust the four trimpots on your TNC 2.

() R76 Preset 20 turns counterclockwise (CCW) or until you hear the element "click" at full CCW rotation.

() Now turn the adjustment screw on R76 3-1/2 complete turns clockwise (CW).

() R77 Preset 20 turns CCW or until you hear the element "click" at full CCW rotation.

NOTE: R78 and R79 will be preset CLOCKWISE, not counterclockwise as the previous trimpots.

() R78 Preset 20 turns clockwise (CW) or until you hear the element "click" at full CW rotation.

() R79 Preset 20 turns clockwise (CW) or until you hear the element "click" at full CW rotation.

() Verify that your computer or terminal is still attached to your TNC 2 and the proper baud rate selected.

() Switch SW1 to the ON position.

() Three LEDs should illuminate (PWR, CON and STA), then CON and STA should extinguish. The DCD and PTT LEDs should remain off during the power-on cycle.

() After the sign-on message and cmd: prompt, enter the following to set the 1200 Hz tone:

```
CALSET 438<cr>
```

() Your TNC 2 should respond with:

```
CALSET was nn  
cmd:
```

where nn is a number from 0 to 65535

() Enter the command

```
CALIBRATE<cr>
```

() Push on a jumper at JMP9 pins 1 and 6 (the top two pins of JMP9).

() If you are using a frequency counter, place the probe at

the push-on jumper on JMP9.

- () Push on a jumper at JMP4.

NOTE: The STA and CON LEDs are used as a software- controlled frequency counter in the calibrate mode. STA means that the frequency is too high, go lower. The CON LED means that the frequency is too low, go higher.

- () Verify that the CON and STA LEDs are extinguished.

() Press the "K" key on your computer or terminal (no carriage return is needed for this command). Either the STA or CON LED should illuminate along with the PTT LED.

() Press the space bar on your keyboard and verify that the other LED (CON or STA) illuminates in place of the one illuminated in the preceding step.

() Press the space bar again until the CON LED is illuminated.

() Slowly rotate the adjustment screw on trimpot R78 in the CCW direction until both the STA and CON LEDs illuminate. The LEDs are a bit slow to respond, so be very careful when the STA LED begins to flicker. You will probably note a portion of the adjustment when both LEDs illuminate; set the adjustment screw to the center of this band. If you go too far, only the STA LED will be illuminated; in this case, turn the adjustment screw CW.

() If you are using a frequency counter, adjust R78 for a reading of 1200 Hz.

() When both LEDs are steadily illuminated, press the "Q" key (with no carriage return). Both LEDs (and PTT) should extinguish and the cmd: prompt should appear on your display.

() Enter the following command to set the 2200 Hz tone on your TNC 2:

```
CALSET 239<cr>
```

- () TNC 2 should respond with:

```
CALSET was 438  
cmd:
```

- () Type

```
CALIBRATE<cr>
```

() Now press the "K" key. Either the CON or the STA LED should illuminate as well as PTT.

() Tap the space bar until the STA LED glows.

() Slowly rotate the adjustment screw of trimpot R77 CW, following the instructions explained above in association with the setting of R78. Continue the adjustment until both the STA and CON LEDs glow steadily.

() If you are using a frequency counter, adjust R77 until the counter reads 2200 Hz.

() Remove the jumper at JMP4.

() Verify that the STA, CON and PTT LEDs extinguish after 5 to 40 seconds. This verifies the operation of the transmit watchdog timer.

() Press the "K" key twice. At the second press, the LEDs should again glow.

() While the LEDs are illuminated, and before the transmit watchdog times out, press the "Q" key. The LEDs should extinguish and the cmd: prompt should appear on your display.

() If you are using a frequency counter, remove the probe from JMP9.

() Remove the jumper at JMP9 pins 1 and 6.

In the next several steps you will be calibrating the demodulator portion of the modem. This is the most critical adjustment on TNC 2's modem. The first procedure uses the on-board calibration facility. If you have access to a frequency counter, it includes instructions for using it.

() To calibrate the 1685 Hz demodulator tone, enter the following command to your TNC 2:

```
CALSET 157<cr>
```

() Your TNC 2 should respond with:

```
CALSET was 239  
cmd:
```

() Type

```
CALIBRATE<cr>
```

- () Note that the STA and CON LEDs are extinguished.
- () Now place a jumper at JMP9 pins 2 and 5 (the center two pins).
- () If you are using a frequency counter, place the probe at the push-on jumper on JMP9.
- () The CON LED should illuminate.
- () SLOWLY rotate the adjustment screw of R79 CCW until the STA LED blinks.
- () Carefully rock the adjustment of R79 until both the CON and STA LEDs glow. This adjustment is very touchy. It should be possible to get them to both glow for a second or so before they begin alternately blinking.
- () If you are using a frequency counter, adjust R79 for a reading of 3370 Hz.
- () If you are using a frequency counter, remove the probe from JMP9.
- () Remove the jumper at JMP9.
- () Verify that the STA and CON LEDs extinguish.
- () Type "Q" and note that the cmd: prompt appears on your display.
- () Install a jumper at JMP8.

If you didn't have access to a frequency counter while performing the demodulator calibration above, but you do have access to a triggered-sweep oscilloscope (even if the oscilloscope timebase and/or vertical deflection system isn't well-calibrated), perform the following 11 steps.

If you used a frequency counter to calibrate the demodulator, skip the following 11 steps.

Be sure you have completed demodulator calibration as outlined above before proceeding.

- () Place a push-on jumper at JMP4.
- () Place a push-on jumper at JMP7.
- () Verify that a push-on jumper is installed at JMP8.

() Type

CALIBRATE<cr>

on your terminal, then press "K" followed by "D".
The PTT and DCD LEDs should glow.

() Place the oscilloscope probe at the top end of R68
(nearest Q12).

() You should observe a square-wave pattern, probably with
jittery edges.

() Adjust the timebase so one (1) cycle of the square-wave
fills the screen-edge horizontal calibrations marks exactly.
Thus, if your oscilloscope screen is calibrated 10 division wide,
one cycle of the observed waveform should be 10 divisions wide.

() Now, carefully adjust R79 so the transition near the
center of the oscilloscope screen occurs exactly at the center of
the screen. Again, the trace will probably be jittery, so use
the middle of the jittery area as if it were the edge of the
waveform.

() Press the "Q" key on your terminal. The PTT and DCD
LEDs should extinguish.

() Remove the jumper at JMP4.

() Remove the jumper at JMP7.

If you have access to a calibrated oscilloscope or a meter that
accurately reads low level audio, perform the following 7 steps.

() Enter the CALIBRATE command.

() Place a jumper at JMP4.

() Press the "K" key. The PTT LED should glow.

() Place the instrument probe at the right end of R56
(5.6k). This resistor is located in quadrant 3 just below U15.

() Adjust R76 for a level of about 300 mV peak- to-peak
(100 mV RMS) at this point.

() Remove the jumper from JMP4.

() Switch SW1 to the OFF position.

Congratulations! Your TNC 2 modem is calibrated.

The next steps will guide you through a test known as "analog loopback" which exercises your modem as if you were sending and receiving signals on-the-air. In addition to modem testing, this is a useful technique for operating your TNC 2 and familiarizing yourself with its commands and features without actually placing a signal on the air.

() Verify that a push-on jumper is on JMP8.

() Install a push-on jumper at JMP7.

() Switch SW1 to the ON position.

() Three LEDs should illuminate (PWR, CON and STA), then CON and STA should extinguish. The DCD and PTT LEDs should remain off.

() After the sign-on message and cmd: prompt, enter the following:

```
MY W1QRM<cr>
```

() TNC 2 should respond with:

```
MYCALL was NOCALL  
cmd:
```

() Verify that SW2 switch 7 is in the ON position, and ensure that SW2 switches 6 and 8 are in the OFF position.

() Enter:

```
C W1QRM<cr>
```

() You should observe the PTT and DCD LEDs blink on then off, followed by the CON LED illuminating shortly after you enter the <cr>. Next, the PTT and DCD LEDs should again blink on then off, then the message:

```
cmd:*** CONNECTED to W1QRM
```

(with NO cmd: prompt on the next line) should appear.

() Now enter:

```
hello self<cr>
```

() The PTT, DCD and STA LEDs should briefly come on, then the PTT and DCD LEDs will turn off, after which the display should look like:


```
hello self
hello self
```

() Next, the PTT and DCD LEDs should again blink, then the STA LED should extinguish.

() Now enter a Control-C character, then:
D<cr>

() TNC 2 should respond with:

```
cmd:*** DISCONNECTED
```

followed by NO cmd: prompt.

() The PTT and DCD LEDs should blink on, then the PTT, DCD and CON LEDs should extinguish. This action occurs very rapidly and may be hard to see.

() Switch SW1 to the OFF position.

() Remove the push-on jumper from JMP7.

You have now verified the correct operation of the modem section. The next section deals with installing and checking out the battery-backed memory portion of TNC 2.

() Install a push-on jumper at JMP5.

() Apply power to TNC 2 and switch it on.

() Measure the voltage at the battery (BATT1) terminals of your TNC 2 PC board.

Measured value: _____

() The measured value should be well under 0.2 volts dc. If it is more, diode CR16 is probably installed backwards.

NOTE: If you do not have a microammeter for the following step, use a high-impedance (10 Megohms or more) voltmeter and measure the voltage drop across a 100 k ohm resistor used as a shunt. The conversion factor is 10 uA/volt.

() Using a microammeter, measure the current through the battery mounting holes on your TNC 2.

Measured value: _____

() The value measured should be less than 1 microampere

(less than 0.1 volt if using the voltmeter and shunt method).

- () Turn TNC 2 off and remove power.
- () Remove the jumper at JMP5.

NOTE: The Lithium battery used at BATT1 must be handled with extreme care. NEVER ALLOW A SHORT CIRCUIT ACROSS THE BATTERY TERMINALS OR THE BATTERY COULD EXPLODE AND CAUSE SERIOUS INJURY!

WARNING: Once the Lithium battery is installed, NEVER allow your TNC to rest on a conductive surface or you could short the Lithium battery with the attendant dangers!

- () I understand the danger of the Lithium battery.
- () Remove the Lithium battery from its envelope.
- () Note that there are two terminals on one side of the battery and one terminal on the other side. At the side with only one terminal there is a red-colored ring. This red-banded end is the NEGATIVE terminal of the battery.
- () Carefully install the battery on your TNC 2 PC board, then solder it in place. If you have to straighten the pins on BATT1, be careful to not short the battery terminals.

- () Install a push-on jumper at JMP5.

() Using a high-impedance (at least 20k ohms/ volt) voltmeter, measure the voltage across U25 pin 28 to ground.

Measured value: _____

- () The voltage should be greater than 2.5 volts.

() Using a voltmeter, measure the voltage across resistor R33 (the 1k resistor just below the battery and to the right of Q6).

Measured value: _____

- () The voltage should be under 5 millivolts.

- () Now apply power and switch TNC 2 on.

- () Measure the voltage across R33 again.

Measured value: _____

- () The voltage should be under 5 millivolts.
- () At the cmd: prompt, enter
MY W1QRM<cr>
- () Turn off power via SW1.
- () After a few moments, reapply power.
- () At the cmd: prompt, enter
MY<cr>
- () TNC 2 should respond with
MYCALL W1QRM
- () Remove power from the TNC.

You have just completed the battery-backed memory tests. TNC 2 is now fully assembled (except for the cabinet). In the future, you will only have to enter your call sign one time. TNC 2 will remember it for you until you decide to change it. Likewise, all other values that you set by non- immediate commands will be retained until you change them.

Now it is time to connect a radio to the TNC.

Please read through the chapter on Radio Interfacing in the TNC 2 System Manual before proceeding.

- () Radio Interfacing chapter read.

The TNC 2 radio port is designed to work with almost all common (and many not so common) transceivers or transmitter- receivers.

The instructions below assume you are using the "Method One" interface described in Radio Interfacing. This is a good way to get on the air quickly, but is not recommended as a permanent means of connecting a radio to TNC 2.

In constructing the radio interface cable, you will need to obtain a mating connector(s) for your radio's microphone and headphone or external speaker jack(s). We recommend you keep the length of the radio interface cable to under about four feet (1.2 m). Use shielded wire for all audio connections.

- () Locate the 5-pin male DIN connector pieces.

() Prepare a length of shielded wire. This means to separate the braided shield from the insulated center conductor, then strip about 1/4" of insulation from the center conductor.

() Solder the center conductor to the audio output terminal of your radio headphone/ speaker connector.

() Solder the shield to the audio common (or negative power common, NOT audio common if audio common is at a positive potential with respect to your radio's power "ground").

() Slide the backshell of your headphone/speaker connector over the shielded wire and fasten to the connector.

() Pass the shielded wire through the insulating boot and metal ferrule of the DIN connector and carefully solder the center conductor to a pin for the DIN connector

() Insert this connector pin at pin 4 of the DIN connector.

() Prepare another length of shielded wire.

() Solder the center conductor to the microphone audio input contact of your radio microphone connector.

() Solder the shield to the microphone audio common (this common MUST be at the same dc potential as the headphone/speaker audio common as well as dc power common).

() Slide the backshell of your microphone connector over the shielded wire.

() Pass the shielded wire through the insulating boot and metal ferrule of the DIN connector and carefully solder the center conductor to a DIN connector pin.

() Insert this pin at pin 1 of the DIN connector.

() Prepare a length of unshielded wire the same length as the microphone audio wire just completed.

() Solder one end of this wire to the PTT (transmitter key) contact of your radio microphone connector.

() Pass this wire through the microphone connector backshell and secure the backshell to the microphone connector.

() Pass the other end of this wire through the insulating boot and metal ferrule of the DIN connector and solder it to a

DIN connector pin.

() Insert this pin at DIN connector pin 3.

() Solder both shields to a DIN connector pin.

() Insert this pin at DIN connector pin 2.

() Inspect the DIN connector for any stray wires or other potential causes of shorts within the connector.

() Place the two shield halves around the DIN connector plug, then slide the metal ferrule over the shield halves.

() Slide the insulating boot over the DIN connector to secure the connector assembly.

() With your radio and TNC 2 switched off, attach the microphone and headphone/speaker connectors to your radio.

() Insert the DIN plug in the DIN receptacle on your TNC 2.

Now, refer to the Radio Interfacing chapter in the TNC 2 System Manual and verify that the DCD LED flickers with audio input.

() Audio causes DCD LED to flicker.

Congratulations! You are now finished with the assembly of your TNC 2! Refer to the Basic Operation chapter of the TNC 2 System Manual for guidance through the procedures of proper packet operation. And thank you for joining us in...

The Packet Radio Revolution!

