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Non-Profit Research and Development Corporation

# TrakBox

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## TrakBox Assembly Manual

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This document was written by Gary Hauge, N4CHV, and Lyle Johnson, WA7GXD, 3/92. Edited and later changes by Jack Davis, WA4EJR. 1st Rev 4/92. 2nd Rev 7/92. 3rd Rev 8/93. 4th Rev 1/94. 5th Rev 11/94. ©1992 Tucson Amateur Packet Radio Corp.

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### INTRODUCTION

The TAPR TrakBox is an accessory for the Radio Amateur that was originally built for satellite antenna rotor control. This board has the advantage of being able to perform the functions of a multi-purpose station controller.

The TrakBox Kit is the original design of Bruce Lockhart, SM0TER/K3ZQA. The TrakBox design was further updated by Sueo Asato, JA6FTL and JA1OGZ with a PC board layout, and by JG6MCG who wrote the original code in the 'C' language. TAPR would like to acknowledge the beta-testers: SM0TER, WA4EJR, JA6FTL, JR1EDE, JA1OGZ, and JG6MCG. TAPR also extends its gratitude to JAMSAT for permission to duplicate the TrakBox design.

This manual provides sufficient information for the advanced experimenter to build and operate the TrakBox kit. This kit includes all parts and components necessary to fully populate the PC board and mating connectors. It does *NOT* include the case, front panel, rear panel power connector, knobs, fuses, etc. Refer to the additional documentation included with this kit for a detailed circuit description, operational hints and operating principles.

Please check the shipment for any possible errata sheet(s) and/or additions/corrections to instructions provided in this manual.

*Please read this manual completely prior to assembly.*

Access to an ohmmeter may aid in identifying some resistor values.

**NOTE:** Requests for assistance in building this kit should be directed to:

Postal mail with SASE

**Jack Davis - WA4EJR  
25341 Orellano Way  
Laguna Hills, CA 92653.**

Electronic Mail

Compuserve I.D. is **72356,441**  
From the INTERNET use:  
**WA4EJR@tapr.org**

## PARTS LIST

This parts list is organized by quantity and part type. Please verify that all parts are present, checking the space provided. You may wish to take this opportunity to sort the parts into a compartmented container, such as an egg carton or muffin tin.

### Capacitors

#### Ceramic, Monolithic

- ( ) (25) 0.1 uF (104) C1, C2, C4, C5, C6, C7, C8, C9, C10, C11, C12, C13, C16, C18, C20, C21, C22, C23, C24, C25, C27, C31, C32, C33, C34
- ( ) (2) 33 pF (330 or 33J) C14, C15

#### Electrolytic, Radial Lead

- ( ) (2) 10 uF (106) C3, C36
- ( ) (4) 47 uF (476) or
- (4) 10 uF (106) C28, C29, C30, C35

### Connectors

- ( ) (2) 2 pin header CN11, JP13
- ( ) (1) 3 pin header CN1
- ( ) (2) 5 pin header CN4, CN12
- ( ) (3) 8 pin header CN3, CN8, CN9
- ( ) (1) 10 pin header CN5
- ( ) (1) 5X2 pin header CN10
- ( ) (1) 14 pin header, solder to the LCD (cut if necessary, provided in breakable strips)
- ( ) (1) Push-on Shunt
- ( ) (1) 2-pin connector shell
- ( ) (1) 3-pin connector shell
- ( ) (2) 5-pin connector shell
- ( ) (3) 8-pin connector shell
- ( ) (1) 10-pin connector shell
- ( ) (49) Pins for connector shells

### Diodes

- ( ) (9) 1N914 or 1N4148 D3, D4, D5, D6, D7, D8, D9, D10, D11
- ( ) (1) 1N4003 D1

### Integrated Circuits

ICs are inserted in anti-static foam. Please do not remove them until they are called out in the construction steps that follow. ICs often contain many numbers, and the "core" number may have a prefix and/or a suffix. A 74HC14, for example, may be marked MC74HC14P or SN74HC14N.

- ( ) (1) 74HC373 or 74HCT373 U1
- ( ) (3) 74HC245 or 74HCT245 U2, U20, U22
- ( ) (2) 74HC541 or 74HCT541 U3, U5
- ( ) (1) 80C31 or 80C51 U4
- ( ) (1) 7404, 74LS04 or 74HC04 U6
- ( ) (1) 74HC08 or 74HCT08 U7
- ( ) (1) 62256L/AL or 43256L U8

- ( ) (1) 27C512 (programmed) U9
- NOT USED U10
- ( ) (1) ULN2803/A or 62803 U11
- ( ) (1) RTC-62421A U12
- NOT USED U13
- ( ) (1) PST532/A U14
- NOT USED U15
- ( ) (1) 74HC139 or 74HCT139 U16
- ( ) (1) 74HC138 or 74HCT138 U17
- ( ) (1) uPD7004C U18
- ( ) (1) 8255A U19
- ( ) (1) DS1228 or MAX232 or TSC232 U21

### Resistors (1/4 w, 5%)

- ( ) (9) 1K  $\Omega$  (brown-black-red-gold) R6, R12, R13, R14, R15, R16, R17, R18, R19
- ( ) (3) 10K  $\Omega$  (brown-black-orange-gold) R8, R9, R10
- ( ) (1) 4.7K  $\Omega$  (yellow-violet-red-gold) R11

### Resistor Network (9-pin, pin 1 common)

- ( ) (2) 8X47K  $\Omega$  (473) RP1, RP3

### Transistors

- ( ) (1) LM7805 or L7805CV Q1

### Battery

- ( ) (1) Lithium Battery BT1

### Crystal

- ( ) (1) 11.0592 MHz X1

### I.C. Sockets

- ( ) (1) 8 pin socket U14
- ( ) (2) 14 pin socket U6, U7
- ( ) (3) 16 pin socket U16, U17, U21
- ( ) (2) 18 pin socket U11, U12
- ( ) (6) 20 pin socket U1, U2, U3, U5, U20, U22
- ( ) (2) 28 pin socket U8, U9
- ( ) (1) 28 pin socket U18 (narrow) pin spacing (U18 may be provided as single row socket strips)
- ( ) (2) 40 pin socket U4, U19

### Miscellaneous:

- ( ) (1) PC Board, "VersaBoard 8052"
- ( ) (1) 2x16 LCD Display Module
- ( ) (1) 14 pin male header, solder to component side of LCD
- ( ) (1) 14 pin connector used with ribbon cable to LCD
- ( ) (1) 10-pin cable,  $\approx$ 12" long, unterminated at one end
- ( ) (1) 14-pin cable,  $\approx$ 12" long, used with LCD connector
- ( ) (1) Assembly Manual (this manual)
- ( ) (1) Firmware Manual
- ( ) (1) Heatsink
- ( ) (1) 16-position BCD switch with left & right side plates
- ( ) (1set) 6-32 (or 4-40) screw, nut, lockwasher

## **CONSTRUCTION NOTES**

The PC board silkscreen legend shows the placement of all parts on the circuit board. Pay particularly close attention to:

- 1) Some resistor values may seem unclear as to color and value. Be very sure of value prior to installation. Use an ohmmeter if in doubt!
- 2) **Lithium batteries can be very dangerous!** Do not allow the battery to become shorted. Keep the battery away from small children. The Lithium compound within the battery can explode if shorted, and the chemicals are highly toxic!

The PC board has two trace sides with plated-through holes joining them. This means that you must use a temperature-controlled soldering iron, fine 60/40 or 63/37 rosin core solder and painstaking care when making each and every joint. The reward will be a superior device of excellent reliability. The alternative will most likely be erratic operation. Keep the tip of your soldering iron bright and clean, wiping it frequently on a wet rag or sponge. Make solder joints carefully, but swiftly. Prolonged heat on a PC board pad can be as disastrous as too much heat, and ruining this PC board can be expensive! Two to three seconds should be enough time to apply heat to any joint.

In addition to the soldering iron and solder, you will need small flush or semi-flush cutting pliers and small-tipped long nosed pliers. A magnifying glass may prove helpful to identify the values of the small components. A lead-bending jig will help maintain a neat appearance for the resistors and other axial leaded parts.

If you exercise care, construction of this kit should take you just a couple of hours, depending on your experience.

So, clear off your workbench, warm up your soldering iron, and enjoy!

### **IC SOCKETS**

Check the PC Board and verify that the exposed, tinned pads are clean and shiny. If they are not, scrub the board lightly with a household cleanser (such as "AJAX" or "COMET"), rinse with clean water, then dry with a clean soft towel.

- ( ) PC board clean

**NOTE:** The IC sockets are polarized, with the end nearest pin 1 marked with a notch, beveled corner or numeral 1 embossed in the body of the socket. When installing an IC socket, be sure all pins are through the PC board, then tack solder a diagonally opposite pair of pins. Double check that the socket is flush against the PC board surface and that all pins are through, then solder the remaining pins. Finally, re-solder the original two tack-soldered pins.

**NOTE:** Socket U28 may be provided as single-row socket strips. If this is the case, cut the strip so you can form two (2) 14-pin lengths and install the two lengths to form the 28-pin socket. Be sure the strips are perpendicular to the PC board!

Install the following IC sockets:

- |     |     |                               |
|-----|-----|-------------------------------|
| ( ) | U1  | 20 pin IC socket              |
| ( ) | U2  | 20 pin IC socket              |
| ( ) | U3  | 20 pin IC socket              |
| ( ) | U4  | 40 pin IC socket              |
| ( ) | U5  | 20 pin IC socket              |
| ( ) | U6  | 14 pin IC socket              |
| ( ) | U7  | 14 pin IC socket              |
| ( ) | U8  | 28 pin IC socket              |
| ( ) | U9  | 28 pin IC socket              |
|     | U10 | NOT USED                      |
| ( ) | U11 | 18 pin IC socket              |
| ( ) | U12 | 18 pin IC socket              |
| ( ) | U13 | NOT USED                      |
| ( ) | U14 | 8 pin IC socket               |
|     | U15 | NOT USED                      |
| ( ) | U16 | 16 pin IC socket              |
| ( ) | U17 | 16 pin IC socket              |
| ( ) | U18 | 28 pin IC socket              |
|     |     | (2) 14-pin narrow pin sockets |
| ( ) | U19 | 40 pin IC socket              |
| ( ) | U20 | 20 pin IC socket              |
| ( ) | U21 | 16 pin IC socket              |
| ( ) | U22 | 20 pin IC socket              |

Solder connections should appear bright and shiny, with a concave fillet between the PC board pad and the socket pin. Gray, grainy-looking joints, round solder blobs or pads not completely and evenly covered with solder will result in an unreliable joint. These joints should be re-soldered, using a good grade of rosin-core flux to ensure the joint is clean and that the solder adheres.

Now, double check the solder connections you have made.

- ( ) Solder joints OK.

Take this opportunity to verify that there are no leftover IC sockets.

## **RESISTORS**

Discrete resistors have color-coded bands denoting their value. The color code will be given in each step to aid you in identifying the value. If you have any doubt about a resistor's value, we suggest you measure it with an ohmmeter before you install it. We have tried to limit the number of different values, but it is better to be careful than to try and remove and reinstall a resistor on a plated-through-hole PC board!

When installing discrete resistors, bend the leads and then insert the resistor so that its body is flush with the PC board surface. Then bend the leads slightly to secure it in place. If you are using a lead-bending jig, resistor leads are on 0.4" (12.7 mm) centers. After placing a number of resistors, you will be instructed to solder the leads and clip the excess lead lengths. At that time a count of solder joints will be given as an aid to ensure you don't overlook a lead or two. Again, be sure of the component before you solder it on the board.

Install the following resistors:

- ( ) R6 1K  $\Omega$  (brown-black-red-gold) near U14
- ( ) R8 10K  $\Omega$  (brown-black-orange-gold) near CN10
- ( ) R9 10K  $\Omega$  (brown-black-orange-gold) near CN10
- ( ) R10 10K  $\Omega$  (brown-black-orange-gold) near CN10
- ( ) R11 4.7K  $\Omega$  (yellow-violet-red-gold) near CN11

( ) Solder and clip ten (10) leads.

- ( ) R12 1K  $\Omega$  (brown-black-red-gold) near U17
- ( ) R13 1K  $\Omega$  (brown-black-red-gold) near U17
- ( ) R14 1K  $\Omega$  (brown-black-red-gold) near U17
- ( ) R15 1K  $\Omega$  (brown-brown-red-gold) near U17

( ) Solder and clip eight (8) leads.

- ( ) R16 1K  $\Omega$  (brown-black-red-gold) near CN12
- ( ) R17 1K  $\Omega$  (brown-black-red-gold) near CN13
- ( ) R18 1K  $\Omega$  (brown-black-red-gold) near CN13
- ( ) R19 1K  $\Omega$  (brown-black-red-gold) near CN13

( ) Solder and clip eight (8) leads.

( ) No discrete resistors remaining.

Carefully inspect the board for any poor solder joints, and correct any that you find.

( ) All solder connections look simply wonderful!

### **Resistor Networks**

The next parts are resistor SIP networks. These are polarized parts. The end of the part with the dot or stripe is pin 1 and goes into the marked silkscreened hole.

When installing the SIPs, tack solder the two end pins, verify the SIP's position against the PC board, then solder the remaining pins. Finally, resolder the two end pins.

**NOTE: Do not use RP2**

- ( ) RP1 47K ohm (473)  
near U2, pin 1 near board edge
- ( ) RP3 47K ohm (473)  
near U22, pin 1 towards RP2

( ) You should have no remaining resistors or resistor networks.

## **CAPACITORS**

The next components to be installed are capacitors. These come in ceramic monolithic radial-leaded devices which are non-polarized, and electrolytic radial-leaded devices which are polarized. You will first install the ceramic, non-polarized parts.

### **Ceramic Capacitors**

These parts should be mounted close to the top surface of the PC board. You will be instructed when to solder, so just install parts and secure by bending leads until then. You may need to straighten or bend some leads to make them fit the PC board hole spacings.

Install the following Ceramic Capacitors:

- ( ) C1 0.1  $\mu$ F (104) near U1
- ( ) C2 0.1  $\mu$ F (104) near U1
- ( ) C4 0.1  $\mu$ F (104) near U1
- ( ) C5 0.1  $\mu$ F (104) near U2
- ( ) C6 0.1  $\mu$ F (104) near U3
- ( ) C7 0.1  $\mu$ F (104) near U4
- ( ) C8 0.1  $\mu$ F (104) near U5

( ) Solder and clip fourteen (14) leads.

- ( ) C9 0.1  $\mu$ F (104) near U7
- ( ) C16 0.1  $\mu$ F (104) near U12
- ( ) C10 0.1  $\mu$ F (104) near U8
- ( ) C11 0.1  $\mu$ F (104) near U9
- ( ) C12 0.1  $\mu$ F (104) near U10
- ( ) C13 0.1  $\mu$ F (104) near U6
- ( ) C14 33 pF (330 or 33J) near U4
- ( ) C15 33 pF (330 or 33J) near U4

( ) Solder and clip sixteen (16) leads.

- ( ) C18 0.1  $\mu$ F (104) near U14
- ( ) C20 0.1  $\mu$ F (104) near U16
- ( ) C21 0.1  $\mu$ F (104) near U17
- ( ) C22 0.1  $\mu$ F (104) near U18
- ( ) C23 0.1  $\mu$ F (104) near U19
- ( ) C24 0.1  $\mu$ F (104) near U20

( ) Solder and clip twelve (12) leads.

- ( ) C25 0.1 uF (104) near U21
- ( ) C31 0.1 uF (104) near U17
- ( ) C32 0.1 uF (104) near U17
- ( ) C33 0.1 uF (104) near u17
- ( ) C34 0.1 uF (104) near u17
- ( ) C27 0.1 uF (104) near U22

( ) Solder and clip twelve (12) leads.

You should have no ceramic capacitors remaining.

( ) All ceramic capacitors have been used.

### Polarized Capacitors

The next component you will install is the polarized capacitor. This may be an aluminum electrolytic or tantalum type.

Electrolytic capacitors are cylindrical with radial leads (meaning both leads come out one end). The negative lead is usually marked with a black band filled with minus signs. In addition, this lead is usually shorter than the positive one.

Tantalum capacitors, in addition to having incredibly small, hard to read print, mark the positive lead with little plus signs on one side of the part. Tantalums are usually a sort-of teardrop shape.

The PC board silkscreen is marked with a plus (+) sign near the positive lead. The positive lead pad is square.

Be sure to get the positive lead in the square pad, no matter which type of part you are installing.

Install the following Polarized Capacitors:

- ( ) C3 10 uF (106) near U1
- ( ) C28 47 uF or 10 uF (476 or 106) near U21
- ( ) C29 47 uF or 10 uF (476 or 106) near U21
- ( ) C30 47 uF or 10 uF (476 or 106) near U21
- ( ) C35 47 uF or 10 uF (476 or 106) near CN10
- ( ) C36 10 uF (106) near CN11

( ) Check placement , Solder and clip twelve (12) leads.

You should have no polarized capacitors remaining.

( ) All polarized capacitors have been used.

### REMAINING COMPONENTS

You will now be instructed to install the remaining parts on the PC board. Some of these parts are polarized, so continue to pay careful attention to the directions.

### Diodes

Diodes are polarity sensitive. Diodes are mounted flat near the surface of the board like the resistors previously installed. The cathode end of the diode is banded, and corresponds to the banded silkscreen legend on the PCB. The two diode types used are similar in appearance, match the part number of the diode to the callout before soldering.

Install the following diodes:

**NOTE:** Diodes leads are on 0.3" spacing (except D1 which is on 0.4" centers).

- ( ) D1 1N4002 near U1
- ( ) D3 1N914 or 1N4148 near CN11
- ( ) D4 1N914 or 1N4148 near U17
- ( ) D5 1N914 or 1N4148 near U17
- ( ) D6 1N914 or 1N4148 near U17
- ( ) D7 1N914 or 1N4148 near U17

( ) Solder and clip twelve (12) leads.

- ( ) D8 1N914 or 1N4148 near CN13
- ( ) D9 1N914 or 1N4148 near CN13
- ( ) D10 1N914 or 1N4148 near CN13
- ( ) D11 1N914 or 1N4148 near CN13

( ) Solder and clip eight (8) leads.

### Male Headers

The male headers will next be installed. The plastic body of the part should rest flush with the top surface of the PC board. The short end of the pins goes into the PC board, the long end sticks up.

**NOTE:** Do not solder the pin which you are holding with your finger! The pins quickly get very hot and you may injure yourself!

After you tack-solder the header in place, inspect it for mechanical placement and appearance. It should sit firmly against the surface of the PC board and rise perpendicularly from it. If it doesn't, re-heat the tacked joint(s) and re-position the part until you are satisfied with it. Then solder the remaining pins. Finally, re-solder the tack-soldered connection(s).

- ( ) CN1 3-pin header (bend mounting pins if vertical mounting is preferred)
- ( ) CN2 NONE!
- ( ) CN3 8-pin header
- ( ) CN4 5-pin header
- ( ) CN5 10-pin header
- ( ) CN6 NONE!
- ( ) CN7 NONE!
- ( ) CN8 8-pin header
- ( ) CN9 8-pin header

**NOTE:** The PC board clearance holes are too small at CN10, so some force must be **carefully** applied.

- ( ) CN10 5x2-pin header
- ( ) CN11 2-pin header (RESET connection)
- ( ) CN12 5-pin header
- ( ) CN13 NONE!
- ( ) CN14 NONE!

**NOTE:** The PC board clearance holes are too small at JP13, so some force must be **carefully** applied.

- ( ) JP13 2-pin header near U14
- ( ) Inspect the solder connections and repair any that aren't perfect.

### **Crystal**

The crystal should lay flat against the surface of the PC board. Do not bend the leads sharply at the body of the crystal. Instead, form a large radius curve with the leads to act as a strain relief.

- ( ) X1 Crystal 11.0592 MHz

### **Jumpers**

Jumpers are formed from the clipped leads of the installed resistors or capacitors. Form a lead into a loop of about 1/8" diameter (wrap one loop around a drill bit or similar item). The loop should stick up from the PC board. Pin 1 is marked on the 3-pin jumpers with the numeral "1".

- ( ) JP1 pins 1 and 2 near U9
- ( ) JP3 pins 2 and 3 near U4
- ( ) JP4 pins 1 and 2 near U7
- ( ) JP5 pins 2 and 3 near U7
- ( ) JP7 pins 1 and 2 near U7
- ( ) JP12 pins 1 and 2 near U20
- ( ) JP16 pins 2 and 3 near U22

Use short pieces of **insulated** wire to make the following two jumpers on the bottom of your VersaBoard PC board. *This step is necessary only if the kits serial number is preceded by X.* If your kit contains an older board, the serial number will begin with X and the newer boards start without the X.

- ( ) U6 pin 2 to U6 pin 11
- ( ) U6 pin 10 to CN4 pin 3

The TrakBox is nearly complete. Every part should be installed except the integrated circuits, lithium battery and voltage regulator. These will be installed shortly. At this point, you should take a break for at least five or ten minutes and relax.

Now that you are back, you need to perform a careful inspection of the PC board. Once again inspect each of the solder connections, preferably with a magnifying glass. We cannot over-emphasize the importance of these connections.

- ( ) All solder joints inspected and look great to me!

You also need to carefully inspect the top of the board in case some solder accidentally found its way through the holes and flowed to cause a short circuit somewhere. Or, perhaps a component got damaged while work was proceeding elsewhere on the board. It is better to find and fix all such problems now.

- ( ) This board is inspected and looks good.

### **Voltage Regulator**

The voltage regulator is mounted on a heatsink.

- ( ) Lay the regulator flat on the PC board at Q1.
- ( ) Bend the leads so they pass through the PC board with the mounting hole of the regulator's tab lined up with the mounting hole in the PC board.
- ( ) Pass a 6-32 (or 4-40) screw through the regulator tab and the heat sink, then through the PC board.
- ( ) Place a #6 (or #4) lockwasher on the screw beneath the PC board.
- ( ) Fasten a 6-32 (or 4-40) nut on the screw and tighten snugly.
- ( ) Solder the three leads from the regulator to the PC board, then clip off the excess lead length.

### **Initial Check**

- ( ) Connect a source of +7 to +15 volts DC to the center pin of CN1.
- ( ) Connect the negative (return) lead of the same power source to pin 1 or pin 3 of CN1. Measure the voltage across IC socket U2. Place the negative lead of the voltmeter at pin 10 and the positive lead at pin 20.
- ( ) The voltage should measure in the range of +4.75 to +5.25 VDC. If it does not measure correctly, you will need troubleshoot the board to determine the problem. Do not install ICs if the voltage is incorrect.
- ( ) Remove power and disconnect the voltmeter.

## Observing static handling precautions, install the ICs in their sockets:

- ( ) U1 74HC373 or 74HCT373
  - ( ) U2 74HC245 or 74HCT245
  - ( ) U3 74HC541 or 74HCT541
  - ( ) U4 80C31 or 80C51
  - ( ) U5 74HC541 or 74HCT541
  - ( ) U6 7404, 74LS04 or 74HC04
  - ( ) U7 74HC08 or 74HCT08
  - ( ) U8 62256L, 43256L or similar  
(may vary with manufacturer)
  - ( ) U9 27C512
  - U10 (not used)
  - ( ) U11 ULN2803 or 62803
  - ( ) U12 RTC-62421A
  - ( ) U13 (not used)
  - ( ) U14 PST532
  - U15 (not used)
  - ( ) U16 74HC139 or 74HCT139
  - ( ) U17 74HC138 or 74HCT138
  - ( ) U18 uPD7004C
  - ( ) U19 8255A
  - ( ) U20 74HC245 or 74HCT245
  - ( ) U21 MAX232 or DS1228
  - ( ) U22 74HC245 or 74HCT245
- ( ) Verify the ICs are correctly oriented and that no leads are bent under the body of a chip or hanging over the side of a socket.
  - ( ) Carefully install the Lithium Battery, observing polarity and ensuring the battery cannot short circuit.

## Jumper Settings

The following jumper selections must be made on your VersaBoard to enable the TrakBox firmware. Check the PC board at the following jumpers, and insure that the default traces are in place. If the default trace is not in place, solder a jumper to form the path. Jumpers may be formed from clipped resistor or capacitor leads.

- ( ) JP6 1 and 2 near U7
- ( ) JP8 1 and 2 near U8
- ( ) BR1 1 and 2 near U10
- ( ) BR2 1 and 2 between U9 and U10
- ( ) BR4 1 and 2 near U11
- ( ) BR5 1 and 2 near U11

## Final Assembly

The TrakBox will usually be installed in a cabinet. The cabinet is not provided with the kit. Therefore, the following directions are less detailed than the preceding. Please also find attached an article by Felton Mitchell, WA4OSR, concerning TrakBox Layouts and boxes (reprinted PSR #53 Winter 1994).

**NOTE:** Be certain the kit functions properly BEFORE installing in any kind of case. The PC Board is very difficult to work on when in the enclosure.

The following section is based on information provided by JAMSAT and has been used to get many TrakBox units successfully interfaced.

*NOTE: There are five (5) sheets of schematics provided with this kit. Please refer to them for clarification of the hookup instructions which follow.*

## Hardware Connections

The following section outlines wiring to various options, indicators, switches and connectors.

## Header Connector Assembly

The mating connectors to CN8 and other single-row header locations are assembled by crimping (or crimping then soldering) the provided pins to the end of a wire, then pressing the pin into the connector shell until it "clicks" in place. Examine the connector and you will see a small rectangular cutout on one side. Examine a pin and you will see a projecting tab. This tab mates with the slot in the connector housing. Slide the connector pin into the housing so these parts line up in accordance with the sketch below.

## LCD Display

The LCD display provides a local indication of TrakBox activity. It is wired using a 2-line by 16-character LCD display module and a 14-pin ribbon cable with connector attached. The connector plugs into the mating connector on the LCD display module. The newer LCD displays use a 2x7 connector on the left end when faced from front.

The provided LCD module has "1" and "14" etched in the copper. Unfortunately, the connector is not in conformance with standard pinout conventions, so the pin number of the provided cable does not match the pin number of the connector on the LCD module.

*Follow the color code guidelines below very carefully!*

Install the connector of the provided cable so the side with the "arrow" and "notch" is adjacent to the edge of the LCD module PC board. Once you examine the cable assembly, this description will become very clear.

The pinout of the 2x7 connector looking at the face with connector at the left is:

14	13
12	11
10	9
8	7
6	5
4	3
2	1

**NOTE:** The ribbon cable has a brown wire at one edge and a yellow wire at the other edge. The brown edge is pin 1 on the LCD module connector. The brown wire not at the edge is called "2nd Brown" in the description below, followed by 2nd red, 2nd orange and ending with 2nd yellow at the "pin 14 edge."

<u>CN8 Pin</u>	<u>Color</u>	<u>LCD</u>	<u>Function</u>
1 bit0	Gray	7	DB0
2 bit1	Violet	8	DB1
3 bit2	Black	9	DB2
4 bit3	White	10	DB3
5 bit4	2nd red	11	DB4
6 bit5	2nd brown	12	DB5
7 bit6	2nd yellow	13	DB6
8 bit7	2nd orange	14	DB7

<u>CN3 Pin</u>	<u>Color</u>		
1 P1.0	Green	6	E
2 P1.1	Blue	5	R/W
3 P1.2	Orange	4	RS

<u>Other</u>	<u>Color</u>		
+ 5V	Brown	2	Vdd
- GND	Red	1	Vss
- GND	Yellow	3	Vcont

**NOTE:** There may be another pair of pins on the LCD display module. These are for backlighting. The TrakBox LCD doesn't require backlighting. Most modules' backlights are EL based and require low-current AC in the range of 80 to 140 volts.

### Reset Swtich (CN-11) Switch

CN11 is the "reset" connection and a Normally Open/Momentary push button should be use.

## Further Testing

It is best to test and get familiar with the software with only three connections made. The RS232, power and the reset. Add the LCD, BCD switch and any other connections only after you are certain the board functions properly. Once the TrakBox is wired to power and an RS232 port on your computer, you may exercise its functions as follows.

- ( ) Start your communications program and set the computer's serial port to 9600 bps, no parity, eight data bits, one or two stop bits.
- ( ) Apply power to the TrakBox. It should sign on with a version number and a menu of options. Refer to the included firmware documentation for information on the menus and functions available.
- ( ) Place the push-on shunt at JP13 to enable the battery-backup for the time-of-day clock and the satellite data storage RAM.
- ( ) Refer to the firmware manual for further details on TrakBox commands and operation.LED AOS Indicator

### LED AOS Indicator

You may wish to supply an LED for the AOS (acquisition of satellite) function. This is a handy indicator which flashes when the satellite is slightly below, at or above the local horizon. It is off if the satellite is lower than the local horizon and steadily on if the satellite is in view and is being tracked. The wiring information below is a representation of the wiring; refer the schematics diagrams for further clarification.

LED2 (AOS indicator)

#### CN5 Pin

6 bit 5 — (-)LED2 (+) — 470 Ω — +5V (BR4-)

### Satellite Selection Switch

The TrakBox kit includes a BCD-encoded 16-position switch to allow for satellite selection.

<u>CN9 Pin</u>	<u>Binary SW (real logic)</u>	<u>Supplied Switch</u>
1 bit0	----- bit0	1
2 bit1	----- bit1	2
3 bit2	----- bit2	4
4 bit3	----- bit3	8
GND	----- common terminal	C



## Antenna Control Switch

This switch is used to command the TrakBox to track the selected satellite. Ground CN9 Pin 5 to accomplish this. This selection will be synchronized with the "E" and "\*" indications on the display.

<b>CN9 Pin</b>
5 bit4 — <u>Switch</u> — GND

Closing the switch commands tracking to occur; opening the switch stops the rotator outputs, but the TrakBox will continue to display tracking information.

## Antenna Rotator Controller

These outputs are used to control the antenna rotator(s):

CN5 Pin	Function
1 PC0 -----	CCW(left)
2 PC1 -----	CW (right)
3 PC2 -----	DOWN
4 PC3 -----	UP
8 PC7 -----	

These inputs are needed from the rotator(s) to allow the TrakBox to know when to command the rotator(s) on and off.

CN12 Pin	Function
1 ADC0 -----	Azimuth position sense (0-5V)
2 ADC1 -----	Elevation sense (0-5V)
5 GND -----	GND

### NOTES:

- 1) Cut rear BR4 pattern if your rotator(s) use more than +5 volts in the actuator (relay or solid-state switch) control line.
- 2) You must prepare the interface for your antenna rotator(s).
- 3) KENPRO and YAESU rotators can be connected directly to the TrakBox control outputs. Cut the BR4 pattern per 1), above.
- 4) See the schematics for information on connecting a "HAM M" or similar rotator to the TrakBox.

## Doppler Frequency Control to Receiver

### a) CAT option

Many modern transceivers use a Computer Aided Tuning (CAT) interface. This includes late-model ICOM, Kenwood and Yaesu equipment. If your radio is so equipped, you may connect it to the TrakBox as follows:

**NOTE:** TrakBox provides both RS232 and TTL levels of the correct polarity for various radios. If you don't already have the TTL/RS232 translator box for your rig, you can save considerable money by using the TTL interface.

**NOTE:** If you are using an ICOM radio with CI-V interface circuits (e.g., IC275, 475 or 970), the TrakBox will act as a master -- the TrakBox uses active pull-ups as well as pull downs, so you can't have another master on the line.

**NOTE:** You must make your own interface cables:

<b>CN4 Pin</b>
1 LPT (RS232C) ---- to TRX CAT terminal interface (RS232C)(KENWOOD, YAESU, ICOM)
2 LPT (TTL) ----- to KENWOOD CAT terminal (TTL)
3 LPT (TTL) ----- to YAESU, ICOM CAT terminal (TTL)
5 GND -----

**NOTE:** CAT Data rates are fixed and are as follows:  
YAESU, KENWOOD = 4800 bps 8-N-2  
ICOM = 1200 bps 8-N-2

These data rates are automatically selected by TrakBox when you configure it for the radio type. See the firmware manual for details.

### b) Doppler Correction using Mic Up/Down inputs:

TrakBoxes using the ENHANCED firmware (27C512 EPROM as supplied by TAPR) may use UP/DOWN correction for tracking satellite doppler. This is faster and more accurate than the CAT type, but requires signals from your modem(s) to function and is not suitable for modes other than data communications. This "mic click" interface has not been tested with all radio types.

CN12 Pin	Function
4 CH3 -----	from RX discriminator DC voltage for FSK (9.6 kbps) or TAPR modem PLL error voltage.
5 GND -----	GND

### CN9 Pin

7 bit 6----- modem LOCK signal (active low)

**NOTE:** CN9 pin 7 must be grounded for this option to work.

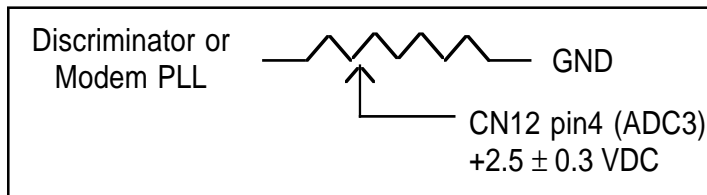
### CN5 Pin

5 bit 4----- Mic Click DOWN

7 bit 6----- Mic Click UP

9 GND --- GND

**NOTE:** The ADC input must be near +2.5 VDC when the received signal is properly centered in the modem. You may need to add a potentiometer to scale the voltage from your modem or radio as shown below.



The mic click interface is not shown on the attached schematics.

The Up/Down polarity is specified for the Kenwood TS-790. Other rigs may require the use of opposite polarity. The Yaesu FT-736 requires pull-up resistors as well.

## Firmware Change Procedure

1. Remove JP-13
2. Remove U-8 and place it in a piece of the black conductive foam for five minutes.
3. Replace the firmware EPROM with the new replacement part.
4. Replace U-8.
5. Reload the configuration data.
6. Replace JP-13 as a last step when everything appears to be operating properly.