BYONICS

TinyTrak4 Owner's Manual

Version 0.20

http://www.byonics.com/tinytrak4

Overview

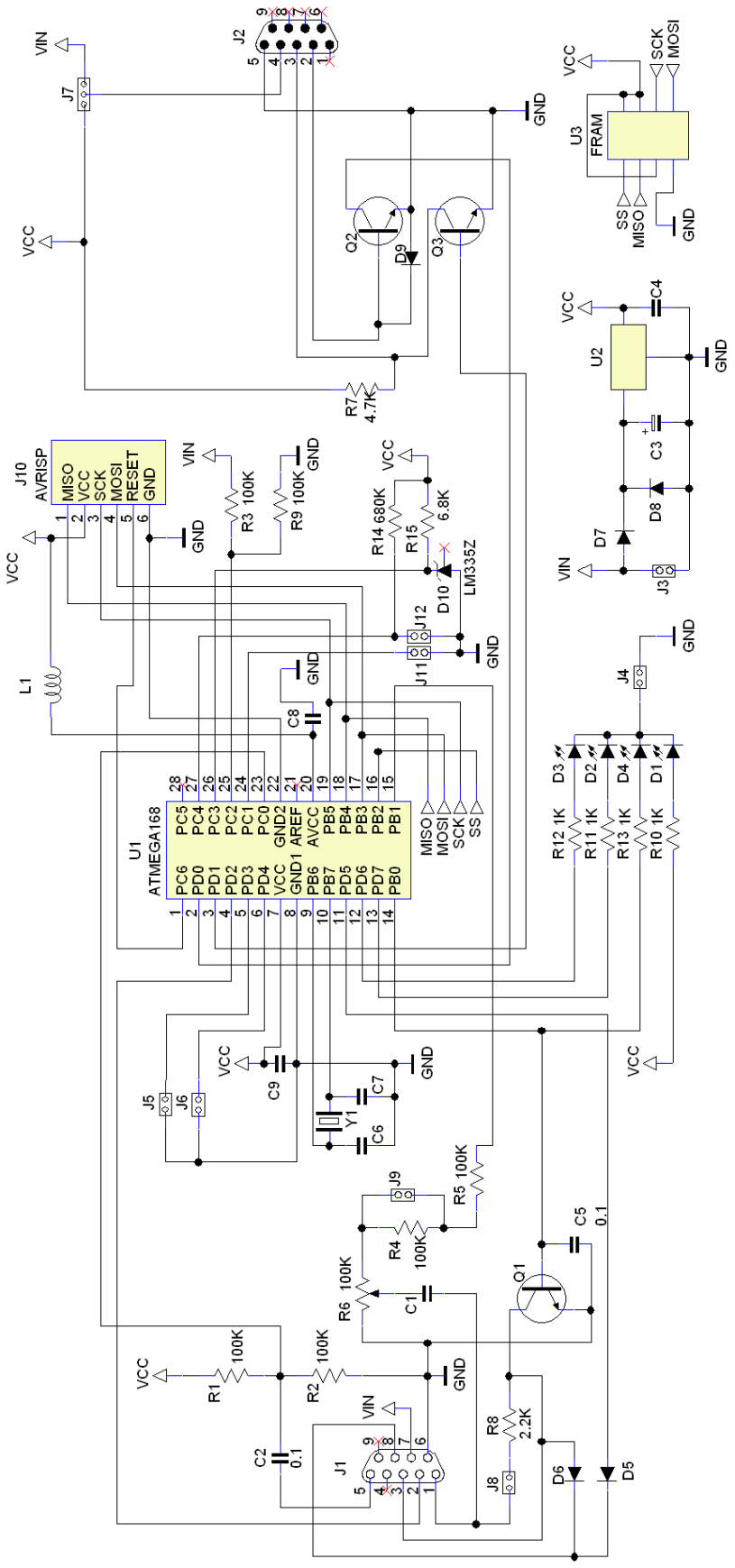
TinyTrak4 is a radio controller similar to a packet TNC which can transmit and receive signals over a two-way radio. It is the successor to the TinyTrak3 controller, which could receive and broadcast position reports from a GPS receiver. The TinyTrak3 could not decode incoming packet tones, and was not field programmable. The TinyTrak4 adds both of these features and more. The TinyTrak4 can be interfaced to a radio transceiver so it can cause the radio to transmit and send audio tones, and also listen to the received audio from the radio and decode and react to that information. The TinyTrak4 can be re-programmed at any time with a computer's serial port as new functionality is created or problems are fixed. A common use of the TinyTrak4 will be an APRS Tracker, which will take position information from a connected serial GPS, and transmit that over the APRS network. Which TinyTrak4's ability to also decode packets, the track can also display other nearby stations on the display of the GPS (when supported), or be commanded to from other packet stations. The TinyTrak4 APRS Tracker firmware will support the TinyTrak3 features, such as text, MIC-E, and NMEA output formats, altitude, speed, and heading reporting, timestamps, burst after voice, time-slotting, and Smart Beaconing. The TinyTrak4 microcontroller is not backward compatible to older TinyTrak circuit boards. All TinyTrak devices have been created by Byon Garrabrant, N6BG. More information can be found at the Byonics web site at http://www.byonics.com.

Acknowledgments

Thank you to all the testers and users of the TinyTrak4, TinyTrak3, TinyTrakII, and TinyTrak. Without your suggestions and support, TinyTrak4 could not have been created.

Construction

Schematic

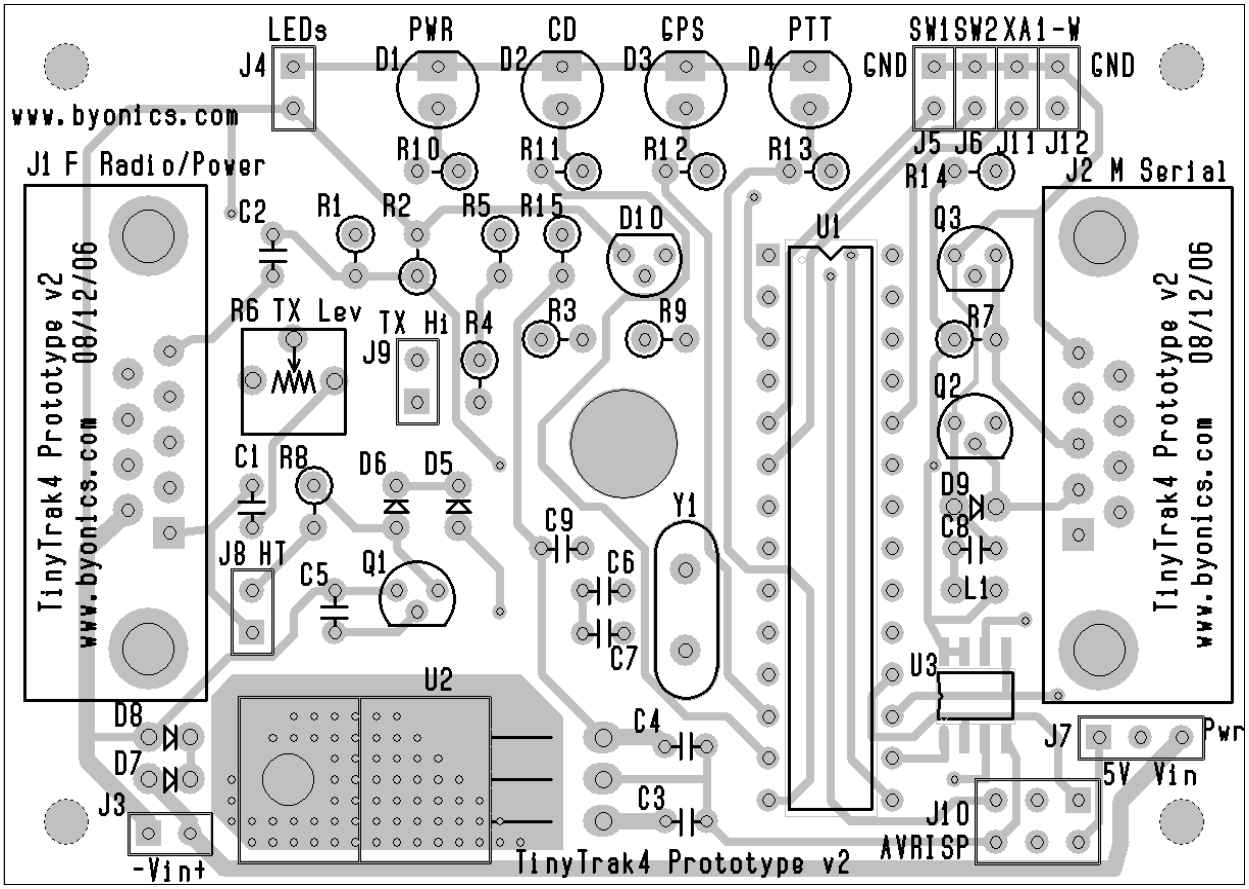


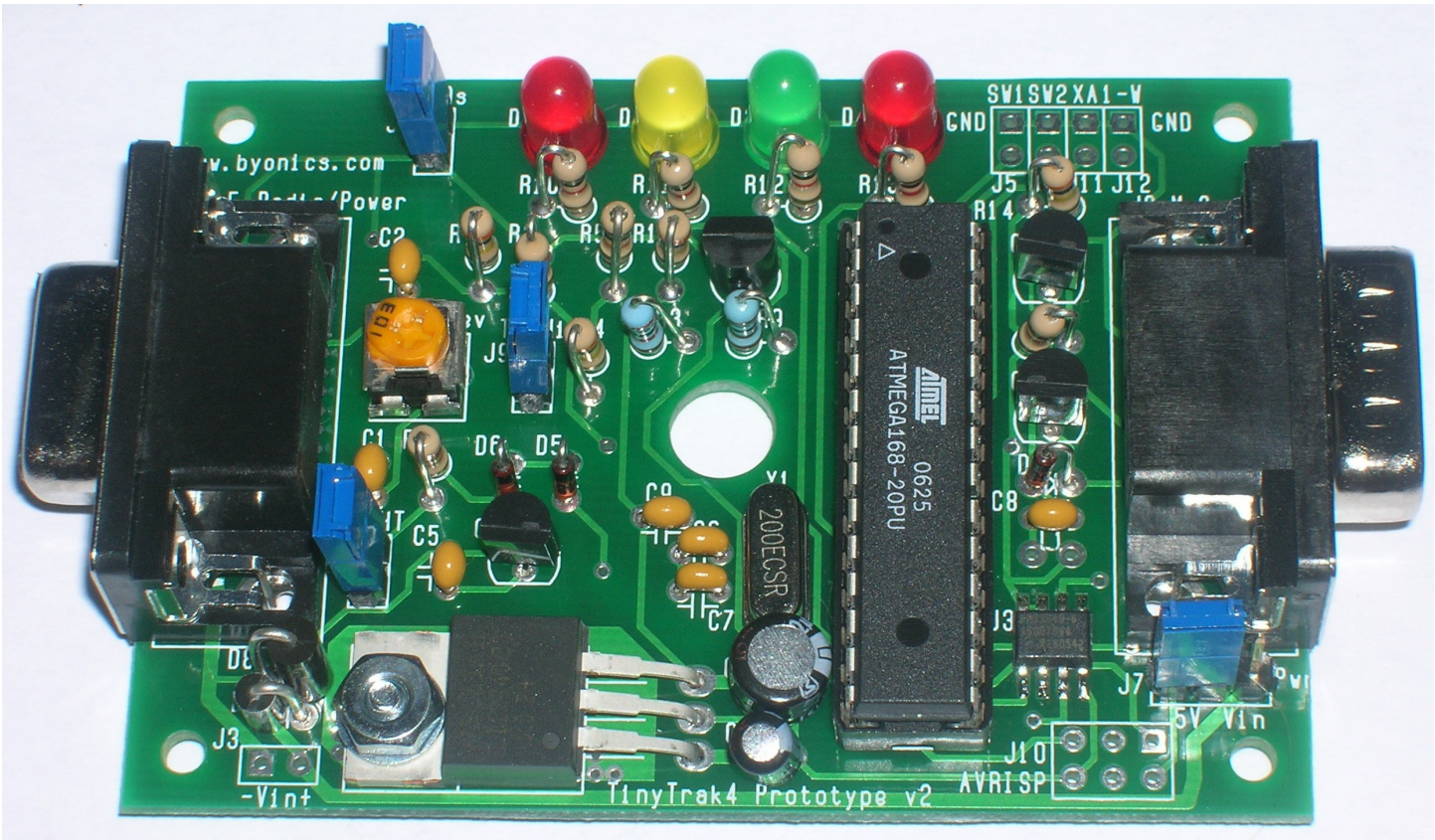
Parts List

U1	ATMEGA168-20PU programmed with TinyTrak4 firmware
U2	LM2940CT-5.0 LDO voltage regulator
U3	FM25640-G FRAM memory chip SOIC-8
Y1	20.0 MHz Crystal
Q1, Q2, Q3	2N7000 MOSFET
R1, R4, R14, R15	300K ohm resistor (org-blk-yel)
R2	39K ohm resistor (org-wht-org)
R3	20K ohm resistor 1% (red-blk-blk-red-brn on blue)
R5	10K ohm resistor (brn-blk-org)
R6	10K trimmer pot (103)
R7, R10, R11, R12, R13	1K ohm resistor (brn-blk-red)
R9	1K ohm resistor 1% (brn-brn-blk-blk-brn on blue)
R8	2.2K ohm resistor (red-red-red)
C1, C2, C5, C8, C9	0.1uf cap (104)
C3	0.33uf cap
C4	22uf cap
C6, C7	18pf cap (BC 18J)
D1, D4	Red T 1-3/4 LED
D2	Yellow T 1-3/4 LED
D3	Green T 1-3/4 LED
D5, D6, D9	1N4148 diode
D7	1N4001 diode
D8	SA30CA diode
D10	LM335Z temerature sensor
J1	Female right-angle DB-9 connector
J2	Male right angle DB-9 connector
J4	1x2 jumper
J7	1x3 jumper
J8	1x2 jumper
J9	1x2 jumper
Socket	28 pin socket
PCB	TinyTrak4 Prototype v2 PCB
Hardware	#4-40 5/16" screw, washer, net, jackscrews
Shunts	4 jumper shunts

Printed Circuit Board

The TinyTrak4 printed circuit board (PCB) is double sided, silk-screened, and solder masked.





Assembly Instructions

TinyTrak4 is a fairly simple construction project that can usually be built in less than an hour. You will need a low wattage pencil-type soldering iron with a small tip, some thin solder, and a pair of diagonal cutters. The chips (U1 and U3) are static sensitive, so use standard precautions. U3 is a surface mount chip, and all others are through holes components. For the through hole components, insert on the component side (white silk-screened side), then turn the board over and solder the leads to the pads on the trace side. Be sure to only solder the correct pad, and do not let any solder touch any other pad or trace. Trim any excess leads with diagonal cutters after soldering each component. The following checklist will be useful to insure all components are properly assembled. This list is ordered by component height, which is a convenient way to build because leads do not need to be bent apart to keep them from falling out, but components can be added in any order.

- Install U3, the 8 pin surface mount memory chip. Orientation is important. Pin 1 is nearest the circle on the circle on the chip top, and should be nearest U1. The text on the tip of the chip should be in the same orientation of the silkscreen text, not upside-down. A good way to solder this chip is to put a very small amount of solder on a single corner pad on the PCB, without the chip. Then place the chip or near the pads, and re-heat the placed solder to allow the chip to fall or be pushed into place. When all 8 pins are centered well over the 8 pads, then add a small amount of solder to each remaining pin and pad.

- Install 5 capacitors C1, C2, C5, C8, C9 (0.1uf, 104). Direction does not matter.

- Install 2 capacitors C6, C7 (18pf, BC 18J). Direction does not matter. The text on these two are difficult to read, and look similar to the 5 caps above.

- Install the 20.0 MHz crystal Y1. Direction does not matter.

- Install the voltage regulator U2 (LM2940CT-5.0). Bend the leads so that the large mounting hole at the top is aligned with the hole on the PCB.

- Install the 28-pin IC socket for U1. Be sure to align the notched end of the socket with the marked end on the silk screen. First solder just two diagonally opposite pins of the socket, and check that the socket sits flat on the PCB. Then solder the remaining socket pins. Do not insert the chip into the socket at this time.

- Install 3 glass diodes D5, D6, D9 (1N4148). Direction is important. For each diode, bend the lead nearest the black stripe 180 degrees at the end of the glass so that both leads are parallel and 0.1 inch apart. Install vertically on the board such that the bent lead (on the stripe side) goes in the hole nearest the line on the silkscreen. The non striped side should be nearest the silkscreen triangle side hole.

- Install MOSFETs Q1, Q2, and Q3 (2N7000). Direction is important. The leads may need to be slightly bent to fit into the holes. Be sure to orient flat side to match the flat side shown on the silk-screen pattern.

- Install temperature sensor D10 (LM335Z). Direction is important. The leads may need to be slightly bent to fit into the holes. Be sure to orient flat side to match the flat side shown on the silk-screen pattern.

- Install potentiometer R6, (10K, 103) which adjusts audio output level. Make sure the short middle lead pokes through the hole enough to be soldered.

- Install capacitor C3 (0.33 uf). Direction is important. This is the smaller of the two round capacitors. The white stripe should be nearest U1.

- Install capacitor C4 (22 uf). Direction is important. This is the larger of the two round capacitors. The white stripe should be nearest U1.

- Install resistors R1, R4, R14, R15 (300K org-blk-yel). Direction does not matter. For each resistor, bend one lead 180 degrees at the end of the bulb so that both leads are parallel and 0.1 inch apart. Install vertically on the board.

- Install resistors R2, (39K org-wht-org). Direction does not matter. Bend like R1.

- Install resistors R3, (20K 1% red-blk-blk-red-brn on blue). Direction does not matter. Bend like R1.

- Install resistors R5, (10K brn-blk-org). Direction does not matter. Bend like R1.

- ❑ Install resistors R7, R10, R11, R12, R13, (1K brn-blk-red). Direction does not matter. Bend like R1.
- ❑ Install resistors R9, (1K 1% brn-brn-blk-blk-brn on blue). Direction does not matter. Bend like R1.
- ❑ Install resistors R8, (2.2K red-red-red). Direction does not matter. Bend like R1.
- ❑ Install LED D1, D4 (red). Be sure to align the flat side of all LEDs with the shape on the silk-screen, nearest the top edge of the PCB. The short lead on an LED is nearest the flat side (square hole). The LED should be touching the PCB.
- ❑ Install LED D2 (yellow).
- ❑ Install LED D3 (green).
- ❑ Install jumper posts J4, J8, J9 (1x2) and J7 (1x3). These posts come as a 1x10 strip which must be cut into 3 1x2s and 1 1x3 and 1 leftover 1x1. Insert the short side into the PCB. The jumper shunts can be placed on the long side after soldering as needed.
- ❑ Install diode D8 (SA30CA). Direction is not important. Bend like the resistors.
- ❑ Install diode D7 (1N4001). Direction is not important. Bend like the resistors and be sure to have the lead with the stripe nearest U2.
- ❑ Install female DB-9 J1. This is the connector with the holes. Do not confuse with J2, as these are difficult to remove. Solder all 9 pins, plus the mounting tabs on either side.
- ❑ Install male DB-9 J2 as you did for J1. This is the connector with the pins.
- ❑ Add the #4-40 screw through the hole on U2 to mount the voltage regulator to the PCB. On the other side, use the washer and nut. Do no over tighten.

Assembly Completion

After all components have been installed, inspect the solder side of the board for poor or cold solder joints. All pads should be shiny and smooth. Inspect for any undesired solder bridges. Use an ohmmeter to be sure power in, ground, and 5V (the 3 pins of U2) are not shorted. You can then also provide power to the board (see below), and confirm +5 volts at U2 pins 2 and 3. If the board looks ready, complete the assembly as follows.

- ❑ Insert programmed microprocessor U1. The chip is static sensitive, so ground yourself by touching a large metal object before touching the chip. The rows of pins may need to be bent slightly. Be sure to align the notch on the chip with the notch on the socket, as well as the notch on the silk-screen (nearest the LEDs). An improperly inserted chip may become permanently damaged.

Interfacing

The following are the interface connections for the TinyTrak4, which are needed before operation.

Radio – J1

PIN	Function
1	Audio out to microphone
2	Carrier Detect
3	PTT OUT to radio
5	Audio in from ear/speaker jack
6	Ground
7	Power In (6 – 18V)
8	PTT IN from microphone

Female DB-9 connector J1 is used to interface TinyTrak4 to a radio transceiver. It is compatible with the radio connector on Kantronics TNC, such as the KPC-3. Connect AUDIO OUT (J1 pin 1) to the radio's mic input. If the transmitter transmits when the microphone input is grounded (most handheld (HT) radios do, except the Kenwood brand), jumper R8 must be installed, but PTT OUT (J1 pin 3) will not need to be connected to the transmitter. For all other transmitters, PTT OUT (pin 3) will be needed, and should be connected to the transmitter's PTT input. If J8 is closed, you should not wire PTT OUT to the radio. PTT OUT is grounded when the transmitter is to be keyed. To prevent transmissions over other stations, connect the receiver's audio out (earphone) jack to the AUDIO IN (pin 5). Also connect J1 GROUND (pin 6) to the radio's ground. Refer to the transceiver's manual for more information, and look for a section on installing a terminal-node controller (TNC) for packet operation, as TinyTrak4 is interfaced in a similar manner. J1 can also be used to supply or receive TinyTrak4's power, via pin 7 and pin 6.

J1 also provides a PTT INPUT (pin 8) to allow TinyTrak4 to transmit a data burst after the microphone is unkeyed after voice traffic. This input should be grounded when PTT is pressed, and floating when PTT is released. This input is not needed for normal operation. J1 also can optionally interface to a radio's carrier detect output via the CARRIER DET input (pin 2). To use this option, CARRIER DET should be grounded when the channel is busy. Some example radio interface diagrams are available at http://www.byonics.com/.

Serial – J2

PIN	Function
2	Serial data in (RS-232 levels)
3	Serial data out
4	Power out (Vin or 5V)
5	Ground

The male DB-9 J2 serial connector is used to connect to a computer, or a serial GPS. J2 pin 3 is used to transfer serial data from the TinyTrak4 to the computer. J2 pin 2 is used to transfer serial data from the computer or GPS to the TinyTrak4. J2 pin 5 is serial ground. Both a gender-changer (female-to-female) AND a null-modem adapter will be needed to interface the computer to TinyTrak4. A null-modem adapter swaps pins 2 and 3, and connects pin 5. Use a DB-9 serial extension cable if it is difficult to connect the gender-changer, null-modem adapter, and TinyTrak4 directly to the computer 9-pin serial port.

If using a GPS that plugs directly into a computer serial port, that GPS can be plugged directly into TinyTrak4's J2 serial connector. If the GPS does not connect directly into a computer's serial port, an interface will need to be built. The GPS should have a female DB-9 with GPS serial data out wired to pin 2, and ground to pin 5. GPS serial input is not used. J2 can also be used to supply or receive TinyTrak4's power. If this is desired, J7 can be set to send in incoming voltage (usually 12V) or 5V to the GPS via J2 pin 4. Set a jumper shunt on the left 2 pins of J7 for 5V, and the right two pins for Vin. When selecting 5V, do not use a GPS that draws more that about 120ma. The TinyTrak4 may get warm when providing 5V to most GPSs.

Power – J3 (also J1 and J2)

TinyTrak4 must be powered with an external source of 6-18 volts DC, such as a 9-volt battery, or a 12-volt cigarette lighter plug. TinyTrak4 is NOT powered via a computer's serial port. Power can be applied via J1, J2, or J3. J1 is the most common way to power the TinyTrak4. To use J1, connect pin 7 to positive voltage and pin 6 to ground. To use J2, connect pin 4 to positive voltage and pin 5 to ground. J7 must be set for Vin to apply power via J2 and 5V out will not be available on J2. To use J3, apply positive voltage to the plus (+) hole, nearest the U2, and ground to the minus (-) hole. Only one of the three jacks J1, J2, and J3 should be used to supply power to the TinyTrak4. If power is applied via J2 or

J3, the same power will be available on J1 to power a radio. If power is supplied via J1 or J3, the same power can be retrieved via J2 to power a GPS, if J7 is set to Vin. Be sure not to draw more current than your supply can handle.

LED Control – J4

This jumper enables the 4 LEDs, and can be removed to conserve power.

Jumper J5 and J6

These holes are available for input or output switches. For the TinyTrak4 APRS Tracker, J5 is SW1, used to switch between primary and secondary configurations and J6 is SW2 used to control power to the radio or GPS.

Serial Power - Jumper J7

This jumper controls what power is sent to the GPS via J2. When the left two pins are connected, 5V is available on J2 pin 4. When the right two are connected, Vin is available there. When none of the pins are connected (no jumper) J2 pin 4 is not connected.

PTT Control - Jumper J8

This jumper adds the resistor J8 to the radio mic line to allow PTT via the mic audio connector. It should be closed (shorted) for use with handhelds other than Kenwood. For mobile radios and Kenwood radios, J8 should be open.

Audio Out Level - Jumper J9

This jumper adds will increase the audio output level to the radio. It should be shorted only when R6 set to maximum is not providing enough audio drive.

Jumper J11 and J12

These jumper allow for external A2D readings

TinyTrak4 Adjustment

There is only one hardware adjustment required for proper operation of TinyTrak4. The transmit audio level should be adjusted at R6 for proper deviation. Use the transmit tones buttons (1200 Hz/2200 Hz/Send Both) in the configuration software to cause the TinyTrak4 to transmit while adjusting. You can listen on a separate receiver, and start the potentiometer at maximum drive. Lower the drive level until there is a noticeable change in the receiver. Overdriving the transmitter is a common cause of failure to decode. If more audio output is needed with R6 at maximum, short Jumper J9.

Troubleshooting

Frequently Asked Questions

Hints, Tricks, & Notes

- L1 and J10 on the schematic and PCB is not needed.