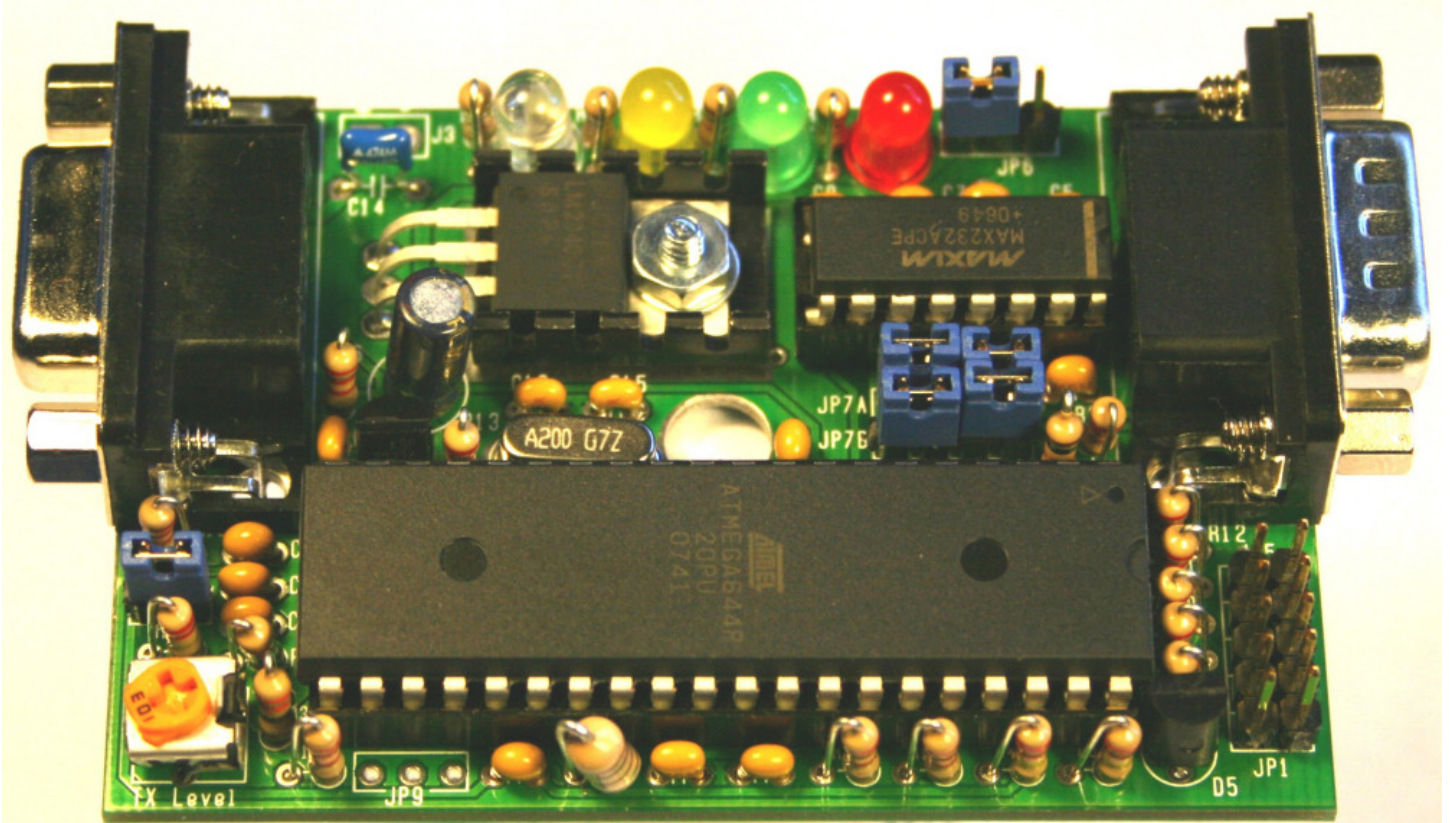


# BYONICS

## TinyTrak4 Hardware Manual

Version 0.6

<http://www.byonics.com/tinytrak4>



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## Overview

TinyTrak4 is a radio controller similar to a packet TNC, which can transmit and receive signals over a two-way radio. It can receive and broadcast position reports from a GPS receiver, decode incoming packet tones, is field programmable, and more. The TinyTrak4 is interfaced to a radio transceiver so it can cause the radio to transmit 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. With TinyTrak4's ability to also decode packets, the tracker can also display other nearby stations on the display of the GPS (when supported), or be commanded 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 SmartBeaconing. Other TinyTrak4 firmware programs will provide different functionality. 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>.

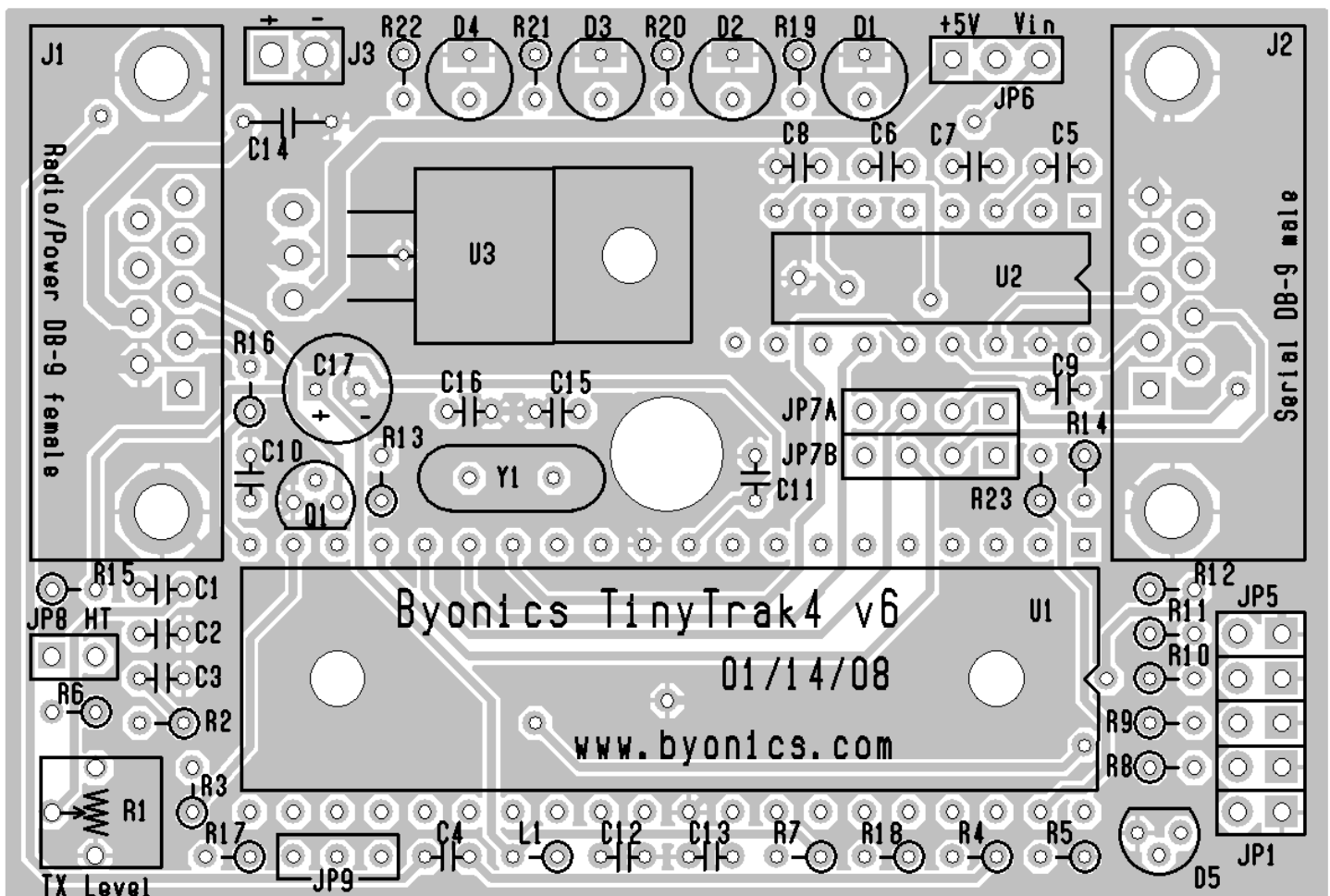
## Acknowledgments

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. Special thanks to Sean Sheedy, AI4ID, Matt Krick, KC7GSA, and Scott Evans, VK7HSE who each gave excellent help and suggestions during TinyTrak4 beta development. Finally, Extra Big Thanks to the Wonderful Lara Garrabrant, KD6AYO, who kits and ships all the TinyTrak products.

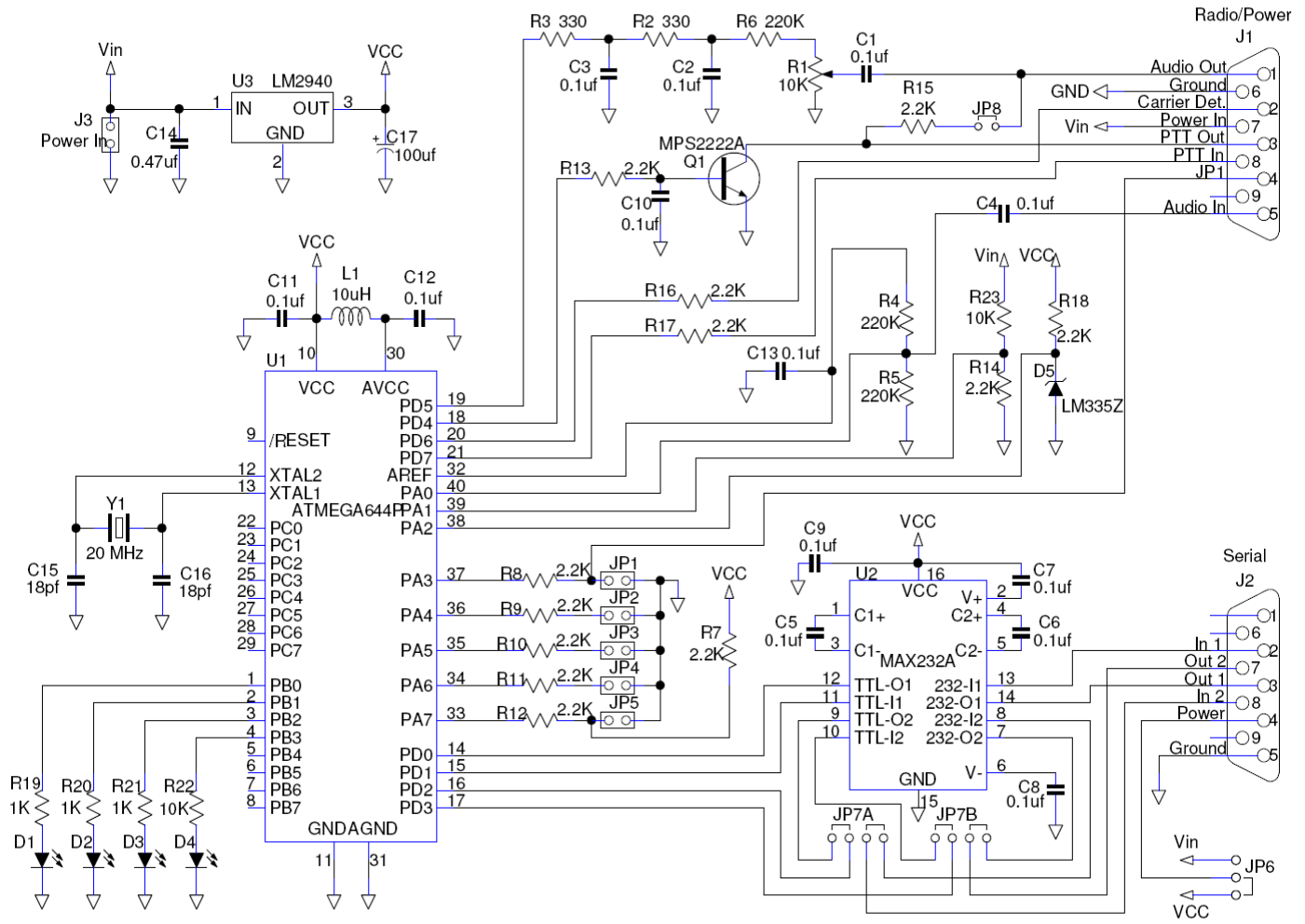
## Construction

### Printed Circuit Board

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



## Schematic



## Parts List

| Identifier                                              | Name                                                                             |
|---------------------------------------------------------|----------------------------------------------------------------------------------|
| C1,C2,C3,C4,C5,C6,C7,C8,C9,C10,C11,C12,C13              | 0.1 uf capacitor (104)                                                           |
| C14                                                     | 0.47 uf capacitor                                                                |
| C15, C16                                                | 18 pf capacitor                                                                  |
| C17                                                     | 100 uf electrolytic capacitor                                                    |
| D1                                                      | Red T1-3/4 5mm LED                                                               |
| D2                                                      | Green T1-3/4 5mm LED                                                             |
| D3                                                      | Yellow T1-3/4 5mm LED                                                            |
| D4                                                      | Blue T1-3/4 5mm LED (Clear Case)                                                 |
| U1                                                      | ATMEGA324P20U (40 pin DIP) microcontroller<br>programmed with TinyTrak4 firmware |
| U2                                                      | MAX232A (16 pin DIP)                                                             |
| U3                                                      | LM2940CT-5.0 LDO voltage regulator                                               |
| Y1                                                      | 20.0 MHz Crystal                                                                 |
| R1                                                      | 10K trimmer potentiometer (103)                                                  |
| R2, R3                                                  | 330 ohm resistor (org-org-brn)                                                   |
| R4, R5, R6                                              | 220K ohm resistor (red-red-yel)                                                  |
| R7, R8, R9, R10, R11, R12, R13, R14, R15, R16, R17, R18 | 2.2K ohm resistor (red-red-red)                                                  |
| R19, R20, R21                                           | 1K ohm resistor (brn-blk-red)                                                    |
| R22, R23                                                | 10K ohm resistor (brn-blk-org)                                                   |
| L1                                                      | 10uH inductor                                                                    |
| J1                                                      | Female right-angle DB-9 connector                                                |
| J2                                                      | Male right-angle DB-9 connector                                                  |
| JP1, JP2, JP3, JP4, JP5, JP8                            | 1x2 0.1" header posts                                                            |
| JP6                                                     | 1x3 0.1" header posts                                                            |
| JP7A, JP7B                                              | 1x4 0.1" header posts                                                            |
| D5                                                      | LM335Z temperature sensor                                                        |
| Q1                                                      | MPS2222A transistor                                                              |
| Shunts                                                  | 0.1" jumper shunts (6)                                                           |
| Heat Sink                                               | TO-220 Heat sink                                                                 |
| Screw                                                   | #4-40 3/8" screw                                                                 |
| Washer                                                  | #4-40 washer                                                                     |
| Nut                                                     | #4-40 nut                                                                        |
| PCB                                                     | TinyTrak4 Printed Circuit Board                                                  |
| 40 pin socket                                           | 40 pin DIP socket (for U1)                                                       |
| 16 pin socket                                           | 16 pin DIP socket (for U2)                                                       |

## 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. You will also need small pliers and Phillips head screwdriver for mounting U3. Desoldering braid (Radio Shack part 64-2090) may be required to correct soldering mistakes. The chips (U1 and U2) are static sensitive, so do not remove the chips from the conductive foam, and follow the steps for installing them carefully. Insert parts 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 batch of components. The following checklist will be useful to ensure 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. Build slowly and follow the instructions. Look at the photograph and PCB image above to confirm component placement.

- ❑ Install 13 capacitors C1 – C13 (0.1uf, yellow, marked with 104). Physical orientation is not important.
- ❑ Install 2 capacitors C15, C16 (18pf, yellow). Physical orientation is not important. These two should be delivered on cardboard tape, and look similar to the 0.1uf caps above.
- ❑ Install the 20.0 MHz crystal Y1 (marked with A200). Physical orientation is not important.
- ❑ Install the 40 pin DIP socket for U1 and the 16 pin DIP socket for U2. Physical orientation is important. Be sure to align the notched end of the socket with the notch end on the silk screen (nearest J2 on the right hand side of the PCB). Insert both sockets before soldering, to keep them both flat on the PCB. First solder just two diagonally opposite pins of the each socket, and check that the socket sits flat on the PCB. Then solder the remaining socket pins. Do not insert the chips into the sockets at this time. You do not need to trim the short leads after soldering.
- ❑ Install transistor Q1 (2222A). Physical orientation is important. Q1 looks similar to D5 below. The leads will need to be adjusted with pliers to fit into the holes. Be sure to orient flat side to match the flat side shown on the silk-screen pattern (nearest the 40 pin U1 socket).
- ❑ Install temperature sensor D5 (LM335Z). Physical orientation 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 (up, furthest from the bottom edge of the PCB).
- ❑ Install capacitor C14 (0.47uf, blue, marked with 474). Physical orientation is not important.
- ❑ Install potentiometer R1, (10K, marked with 103) which adjusts audio output level. Make sure the short middle lead pokes through the hole enough to be soldered.
- ❑ Install 2 resistors R2, R3 (330 org-org-brn-gold). Polarity and physical orientation are not important. 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 3 resistors R4 - R6 (220K red-red-yel-gold). Polarity and physical orientation are not important. Bend and insert like R2.
- ❑ Install 12 resistors R7 – R18 (2.2K red-red-red-gold). Polarity and physical orientation are not important. Bend and insert like R2.
- ❑ Install 3 resistors R19 – R21 (1K brn-blk-red-gold). Polarity and physical orientation are not important. Bend and insert like R2.
- ❑ Install 2 resistors R22 & R23 (10K brn-blk-org-gold). Polarity and physical orientation are not important. Bend and insert like R2.
- ❑ Install 6 jumper posts JP1 – JP5 & JP8 (1x2). Physical orientation is not important. These posts come as 1 or 2 strips which will need to be cut apart. JP1-JP5 can be cut as 5 1x2 posts or 2 1x5 posts. Insert the short side into the PCB. The jumper shunts can be placed on the long side to help hold and align the posts. Solder just one pin first on each strip, and check that the strip is straight and flat. Some users may wish to use right angle header

posts. After soldering, a jumper shunt should be placed on JP8 if using a non-Kenwood hand held radio. No jumpers should be left on JP1-JP5.

- ❑ Install 2 jumper posts JP7A & JP7B (1x4). After soldering, jumper shunts should be placed on the left 2 pins of JP7A, and another on the 2 right pins of JP7A. Two more should be placed on the left and right pin pairs of JP7B.
- ❑ Install jumper posts JP6 (1x3). This jumper is normally pre-cut.
- ❑ Install LED D4 (blue, but case is clear when not lit). Physical orientation is important. Be sure to align the flat or notched 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 or notched side (square hole). The LED should be touching the PCB. Note that the LED order on the PCB from left to right is D4, D3, D2, D1. The color order of the LEDs, left to right, will be blue, yellow, green, red.
- ❑ Install LED D3 (yellow). Physical orientation is important. Align the flat or notched side as was done for D1.
- ❑ Install LED D2 (green). Physical orientation is important. Align the flat or notched side as was done for D1.
- ❑ Install LED D1 (red). Physical orientation is important. Align the flat or notched side as was done for D1.
- ❑ Install inductor L1 (10uH, brn-blk-blk-gold). Polarity and physical orientation are not important. This component looks like the resistors, but is larger. 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 the voltage regulator U3 (LM2940CT-5.0). Physical orientation is important. This will be mounted with the heat sink, and the screw, washer, and nut. The heat sink should be between the regulator and the PCB, with the fingers pointing up. Bend the regulator leads so that the printed text is facing up and the large mounting hole at the top is aligned with the hole in heat sink and the hole in the PCB and flat against the PCB. Prior to soldering, add the #4-40 screw through the holes. If the screw is inserted from the underside of the PCB, it will fit in the case. On the other side, use the washer and nut. Do not over tighten. Mount with screw before soldering leads
- ❑ Install capacitor C17 (100uf). Physical orientation is important. There is a stripe on the capacitor to mark the negative side, which should be nearest the center of the PCB through the round pad. Push C17 down as close as possible to the board to be sure it will fit in the case.
- ❑ 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. The 9 pins do not need to be trimmed after soldering, but the mounting tabs should be.
- ❑ Install male DB-9 J2 as you did for J1. This is the connector with the pins.

## ***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 U3) are not shorted together. There should be about 12K ohms resistance between power in and ground, and about 8K ohms between 5V and ground. You can then provide power to the board and confirm +5 volts at U3 between the center pin (ground) and lower pin, closest to C17 (+5V). If the board looks ready, remove power, and 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 2 rows of pins may need to be bent slightly to be parallel to each other. 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 JP1-JP5). An improperly inserted chip may become permanently damaged. The chip comes pre-programmed with the diagnostic program.
- ❑ Insert MAX232A chip U2. 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.

## Interfacing

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

### Radio – J1

| Pin | Function       | Description                                                                                                 |
|-----|----------------|-------------------------------------------------------------------------------------------------------------|
| 1   | Audio out      | Generated packet or other audio tones to be transmitted via the radio microphone jack.                      |
| 2   | Carrier Detect | Digital carrier detect state from radio. Can either be active high or active low.                           |
| 3   | PTT Out        | This line is grounded when the radio should transmit. Connect to radio PTT input.                           |
| 4   | JP1            | Optional J1 interface to the JP1 line. Can be an analog or digital input, or output, depending on firmware. |
| 5   | Audio in       | Audio received from the radio via the earphone or speaker jack.                                             |
| 6   | Ground         | Ground return for power, audio, PTT and all other signals.                                                  |
| 7   | Power In       | Power input to the TinyTrak4. Can be 6V to 18V.                                                             |
| 8   | PTT In         | State of optional external microphone PTT switch. Grounded during transmit.                                 |
| 9   | No connection  | May be end-user wired for custom features.                                                                  |

Female DB-9 connector J1 is used to interface TinyTrak4 to a radio transceiver. It is compatible with the radio connector on the TinyTrak3 and Kantronics TNCs, such as the KPC-3. Connect Audio Out (J1 pin 1) to the radio's microphone input. If the transmitter transmits when the microphone input is grounded (most handheld (HT) radios do, except the Kenwood brand), jumper JP8 must be installed, but PTT Out (J1 pin 3) will not need to be connected to the transmitter. For all other transmitters, PTT Out (J1 pin 3) will be needed, and should be connected to the transmitter's PTT input. If JP8 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 or speaker) jack to the Audio In (J1 pin 5). Also connect Ground (J1 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 is usually used to supply TinyTrak4's power, via pin 6 and pin 7. Current draw is approximately 50ma, and it can be feed with a voltage between 6 volts and 18 volts.

J1 also provides an optional PTT Input (J1 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 Detect input (J1 pin 2). To use this option, Carrier Detect should be grounded when the channel is busy. Some example radio interface diagrams are available at <http://www.byonics.com/>.

JP1 is available on the J1 connector at J1 pin 4 to add an optional interface point for that signal. Various firmware can use this as an option switch, an analog input, or a digital output.

### Serial – J2

| PIN | Function                                                |
|-----|---------------------------------------------------------|
| 1   | No Connection                                           |
| 2   | Primary Serial data in from a GPS or computer           |
| 3   | Primary Serial data out to a GPS or computer            |
| 4   | Power out for GPS (Vin or 5V), or alternate power input |
| 5   | Ground                                                  |
| 6   | No Connection                                           |
| 7   | Secondary Serial data out to a computer                 |
| 8   | Secondary Serial data in from a computer                |
| 9   | No Connection                                           |

The male DB-9 J2 serial connector is used to connect to a computer, or a serial GPS, or both. The primary serial port is on pins 2 and 3. J2 pin 3 is used to transfer serial data from the TinyTrak4 to a GPS or a computer. J2 pin 2 is used to transfer serial data from the GPS or computer 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 a 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.

The secondary serial port is available on pins 7 and 8. A “Y-adatper cable” can be built to separate the primary and secondary serial ports to separate connectors.

If using a GPS that normally 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. If GPS serial input will be used, it should be wired to pin 3. J2 can also be used to supply or receive TinyTrak4’s power. If this is desired, JP6 can be jumpered to Vin (the right 2 pins) to send in incoming voltage (usually 12V) to the GPS via J2 pin 4. Set a jumper shunt on the left 2 pins of JP6 to make 5V available on J2 pin 4. When selecting 5V, do not use a GPS that draws more than about 120ma. The TinyTrak4 may get warm when providing 5V to most GPSs. If JP6 is jumpered to Vin (the right two pins), power can be supplied to the TinyTrak4 via J2 pin 4.

The secondary serial port (J2 pins 7 and 8) can be set for either RS-232 levels, or TTL levels via jumper JP7A and JP7B.

## 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. JP6 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 J1, 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, power can be retrieved via J2 to power a GPS, if JP6 is set properly. Be sure not to draw more current than your supply can handle.

## Jumper JP1 – JP5

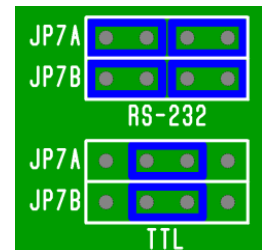
These jumpers are available for input or output, depending on the firmware loaded. They can be used for analog telemetry, selection of options, or driving external loads. JP1 is connected to J1 pin 4. JP5 is connected to pull-up resistor R7.

## Serial Power - Jumper JP6

This jumper controls what power is connected to the GPS via J2 pin 4. 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.

## Serial Level Jumpers - Jumper JP7A & JP7B

This jumper sets the level for the secondary serial port (J2 pins 7 & 8) to either TTL levels or RS-232 levels. When jumpers connect the two left and two right pairs of pins on JP7A and JP7B, the level is set to RS-232. When 2 jumpers are placed between the 2 middle pins of JP7A and JP7B, the level is set to TTL. Jumpers should NOT be placed connecting any pins from JP7A to JP7B.



## PTT Control - Jumper JP8

This jumper adds the resistor R15 (2.2K) 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.

## TinyTrak4 Adjustment

There is only one hardware adjustment required for proper operation of TinyTrak4. The transmit audio level should be adjusted at R1 for proper deviation. If using the TinyTrak tracker firmware, 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.

## Firmware Updates

The TinyTrak4 firmware can be updated at any time to new and improved functionality with just a computer serial port. This is done with the .TT4 files, which are new programs which can be burned into the main TinyTrak4 chip. See the TinyTrak4 Firmware Manual for more information.

## Troubleshooting

### Frequently Asked Questions

#### Hints, Tricks, & Notes

- JP6 is a jumper to GPS power output. It is not a power input.
- TinyTrak4 DB-9 connectors are pin compatible with TinyTrak3, so GPS and Radio/Power cables for one will work with the other.
- A Null modem adapter and gender changer, or a similar LapLink cable is needed whenever TinyTrak4 is connected to a computer serial port.
- R6 can be changed to 100K, or even shorted out (0 ohm) to increase audio output level if setting R1 to the maximum is not enough.