



Technical information: Compact PIC 16F84A APRS Tracker for Portable Rigs

Rev: 101008

INTRODUCTION TO APRS:

WHAT'S APRS?

In its simplest form, APRS allows the tracking of mobile amateur radio stations. Developed by Bob Bruninga, WB4APR, it is a packet radio system, which permits any number of stations to exchange position data just like voice users would in a net.

APRS versatility is most evident during emergency or special event situations where the tracking of key assets in real-time is possible. Where is the Event Leader? Where are the emergency vehicles? What's the Weather at various points in the county? Where are the power lines down? Where is the head of the parade?

APRS has been described as the answer to a problem that doesn't exist - but do we always have to do things for a reason? With such a narrow approach to life we would all be surfing the net and talking on cell-phones.

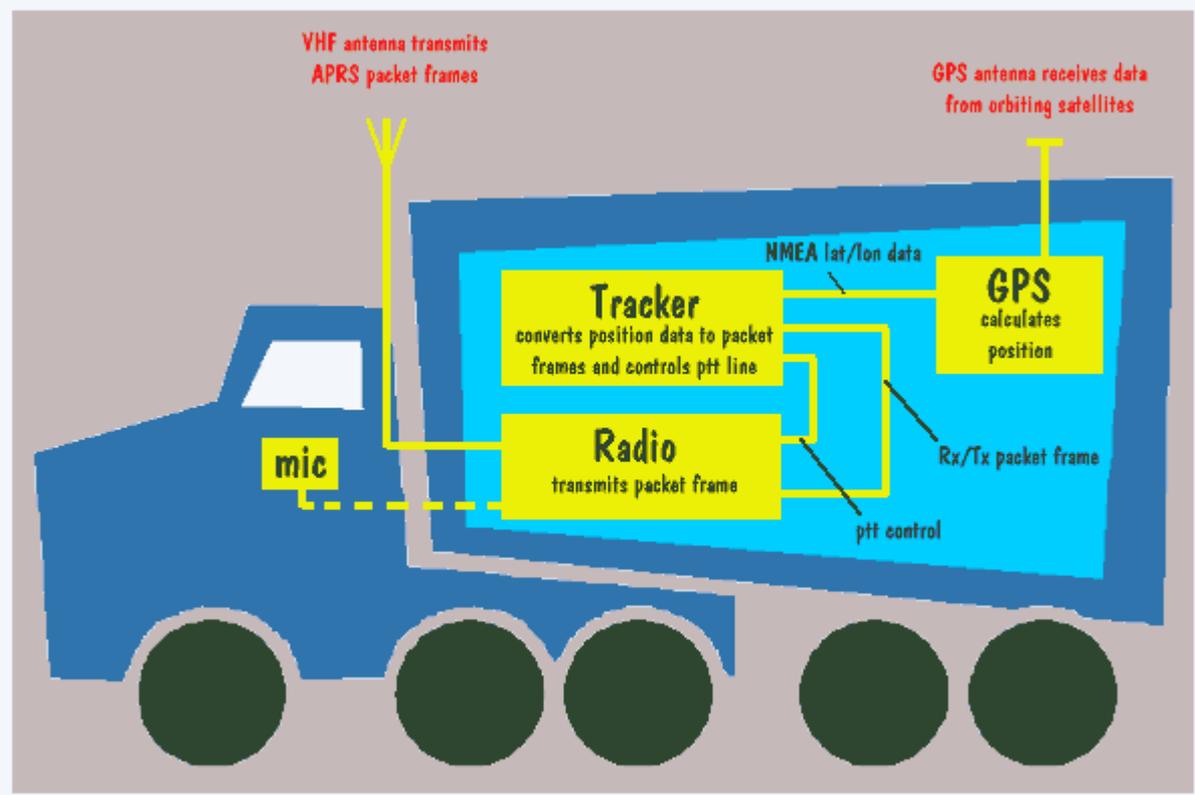
The same goes for most of the activities in ham radio - why do we work rare DX on cw, collect prefixes, operate from rare IOTA islands in the middle of nowhere, bounce signals off the moon, spend 48 hours continuously transmitting ...UR 599 = QRZ?... during the weekend contests when we could be enjoying the warm weather with the XYL. Who was it that said "...why climb Everest – there is nothing up there!".

What's a Tracker?

A tracker is the means by which a mobile station can be tracked.

It may consist of a radio, antenna, TNC and GPS but since most of the time the mobile just transmits unconnected UI frames, the receiver part of the TNC is redundant. Therefore more and more stations are using small-dedicated tracker units instead of full-featured TNCs. These trackers can have various operating abilities. The simplest will just transmit a UI packet indicating their position every few minutes, others have more functions.

Basic Tracker System Setup:



Completed FoxTrak: Rev 101008



The position data in NMEA format (\$GPRMC) delivered from a GPS is decoded and a 1200 bps packet radio signal is generated from it. This can be fed directly into a Radio Transmitter without the need of an expensive TNC. Because of not having enough program memory left on PIC & to make hardware simple, circuit does not decode received APRS signals.

This APRS interface has a serial interface for connecting to the GPS and for programming user parameters into PIC's memory.

The main new features compared to other trackers besides some hardware variations is, speed dependable beacon rates and beacon transmissions at major course changes.

Firmware is developed by DK7IN who has also made a nice configuration utility to write user parameters in PIC. However, TinyTrak windows & DOS configuration utilities may also be used for the same purpose.

FoxTrak may be configured for various firmware, you may update FoxTrak with better & smarter Firmware simply by changing the Firmware & if necessary, changing the PIC, to 16F628A. The Basic hardware remains the same.

Like TinyTrak 3, this tracker also uses **larger 5V regulator** to supply GPS power. With suitable header installations, you may supply GPS with either 12V or 5V.

FoxTrak is designed on a Double Sided PTH PCB, using standard right angle D9 connectors.

Both FoxTrak D9 Sockets, Radio side & RS232/GPS side, have exactly the same connection plan as used with TinyTrak & Open tracker.

PIC FIRMWARE:

Present firmware for PIC16F84A is written by DK7IN and may be downloaded from his website.

Besides the fixed beacon rates this extended firmware supports a smart beacon control. With that the beacon rate changes depending on your speed, according to two selectable tables.

| Maximum speed | < 4 km/h | > 4 km/h | > 11 km/h | > 24 km/h | > 50 km/h | > 100 km/h | > 150 km/h |
|----------------------|-------------|-------------|--------------|--------------|--------------|---------------|---------------|
| H4 on: beacon every | 25 min | 4 min | 120 sec | 60 sec | 30 sec | 20 sec | 10 sec |
| H4 off: beacon every | 30 min | 5 min | 160 sec | 80 sec | 40 sec | 30 sec | 20 sec |

Relevant is the maximum value of the speed since the last beacon transmitted.

For a better track accuracy at street edges, a beacon will be transmitted if there is a major change in the driving direction, while the speed is more than 15 km/h.

That is, if the current course differs more than 40 degrees (60 ° if H4 is off) from the course at the time the last beacon was transmitted. The beacon will be delayed, if the last beacon was less than 10 sec ago.

For checking the modulation or the frequency shift the circuit can produce some constant frequencies. This can be controlled with DK7IN Configuration program or by entering special commands with a terminal program (4800 baud, 8N1). Using the last another arbitrary character ends the tone and reinitializes the circuit.

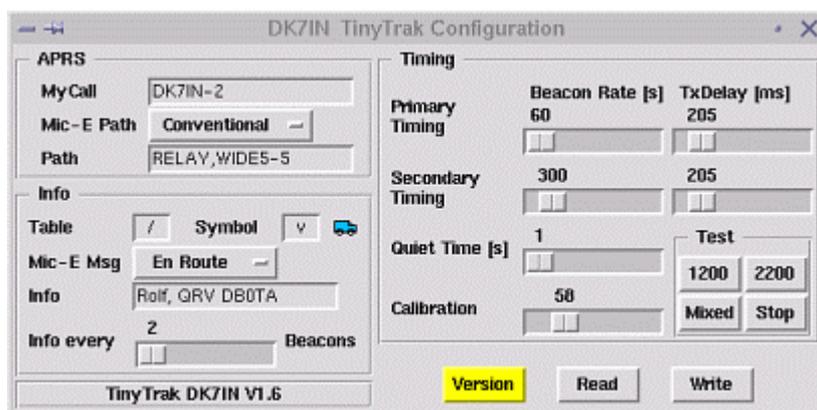
- ESC T 0 generates a 1200 Hz tone
- ESC T 1 generates a 2200 Hz tone
- ESC T M generates a mixed 1200/2200 Hz tone

Configuration of PIC parameters:

A DOS based utility is supplied with FoxTrak to configure your call sign & other parameters for APRS operation.

A Tinytrak config program for windows may also be used for the same purpose.

Linux version is also provided, which looks like this:



Running any of the 3 config program works well, “Version” should display the version string of the connected FoxTrak as “DK7IN V.1.6”.

The fixed beacon rate could be set in 10 sec steps, the TX Delay with a resolution of 6.6 ms.

Calibration:

The mark and space frequencies can be adjusted slightly with the Calibration parameter. For Bell 202 they should be 1200 and 2200 Hz, but because of system limitations their distance is a bit too high.

| | | | | | | | | | |
|------------------|------|------|------|------|------|------|------|------|------|
| Calibration | 36 | 40 | 50 | 58 | 60 | 63 | 70 | 80 | 90 |
| Frequency 1 [Hz] | 1199 | 1197 | 1191 | 1187 | 1186 | 1184 | 1180 | 1175 | 1169 |
| Frequency 2 [Hz] | 2249 | 2244 | 2234 | 2225 | 2223 | 2220 | 2212 | 2202 | 2192 |

Here the influence of the calibration factor on the measured frequencies is shown. For the smallest symmetrical percentage error a value of 58 may be used. (TT Config. has default value of 63)

DIP Switches, LEDs & other Switches:

The two switches select the operation mode. With H3 open, a fixed beacon rate will be used, if closed smart beaconing is enabled, where the beacon rate is controlled by your speed and direction changes.

With fixed beacon rate, H4 decides whether to use the primary (H4 on) or the secondary timing (H4 off). With smart beaconing and H4 closed, beacons will be transmitted more often and direction changes of more than 40 degrees trigger a beacon. Otherwise transmissions occur less often and a direction change has to be more than 60 degrees. H4 always determines the TX Delay according to the primary or secondary timing.

The carrier detect LED at Marked "CD" (pin 17) is illuminated if another station is transmitting.

The GPS LED Marked "GPS" (pin 18) is on with valid data from the GPS receiver and blinks while receiving GPS data without a valid position.

The PTT LED is on while the transmitter is keyed.

During initialization at power up the yellow and green LEDs are blinking three times followed by a beacon. Automatic beacons will only be transmitted if valid NMEA data from the GPS receiver is received.

Audio Adjustments:

The audio level has to be adjusted for correct modulation of the connected transceiver. FoxTrak is pre-configured (In schematic & on assembled board) as portable unit. (PTT via MIC input). If you do not want this feature, you may remove R7.

RV1 & RV2 are standard single turn Presets to adjust audio to & from transceiver. Both need to be adjusted for proper operation.

DC Power:

New Revised FoxTrak is designed to receive power from radio at J1. DC 8 to 14 Volts may be applied at J1 PIN7 and Ground PIN6

SW1: DIP Switch :GPS Power & Battery Power

SW1 serves two Purposes:

1. Switch on the power to foxtrak by connecting internal 1.5V Cell and
2. Enable power to **GPS**

By putting on SW1: **GPS**, +5V is routed to PIN4 of D9M connector for GPS power. Since this version of FoxTrak uses 78M05 regulator dedicated for GPS, maximum available current is 500ma. However, most GPS requires +5V vat around 80 to 100ma

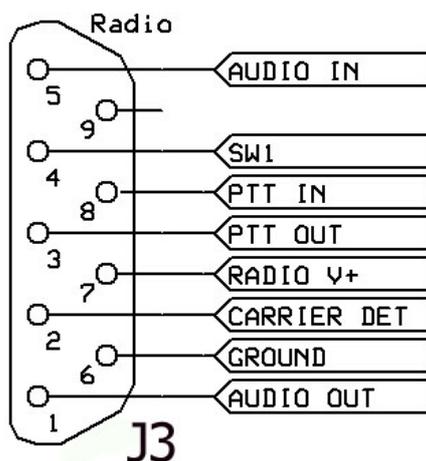
Battery operated version with internal 1.5V cell will be available later. Till then, there is no use of DIP Switch: **“BAT”**

Transceiver Connections:

Please refer to the schematic for Radio & GPS/Null-modem socket connection details. Connector details are also proved at the end of this document.

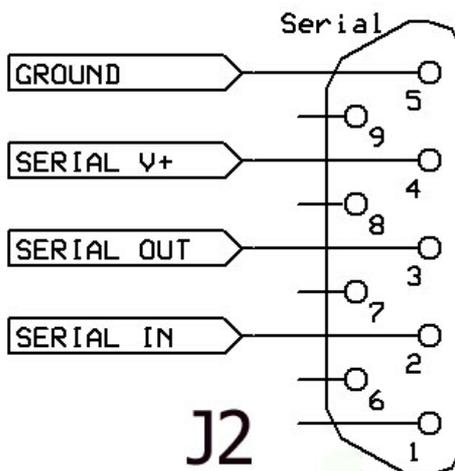
Radio Connections: J3: D9F

Connect your radio to this connector:



Audio in = Receive Audio from Radio
 SW1= Instant TX Switch
 PTT IN = Input of PTT from Radio
 PTT-OUT = PTT out from Tracker
 Radio +V = 9 to 15V DC Input
 Carrier Det. = Squelch from Radio
 Ground = Radio/Tracker Ground
 Audio Out: Tracker audio out to Radio MIC

J2 Connections:



This is a D9M connector on FoxTrak.

Connect your GPS here.

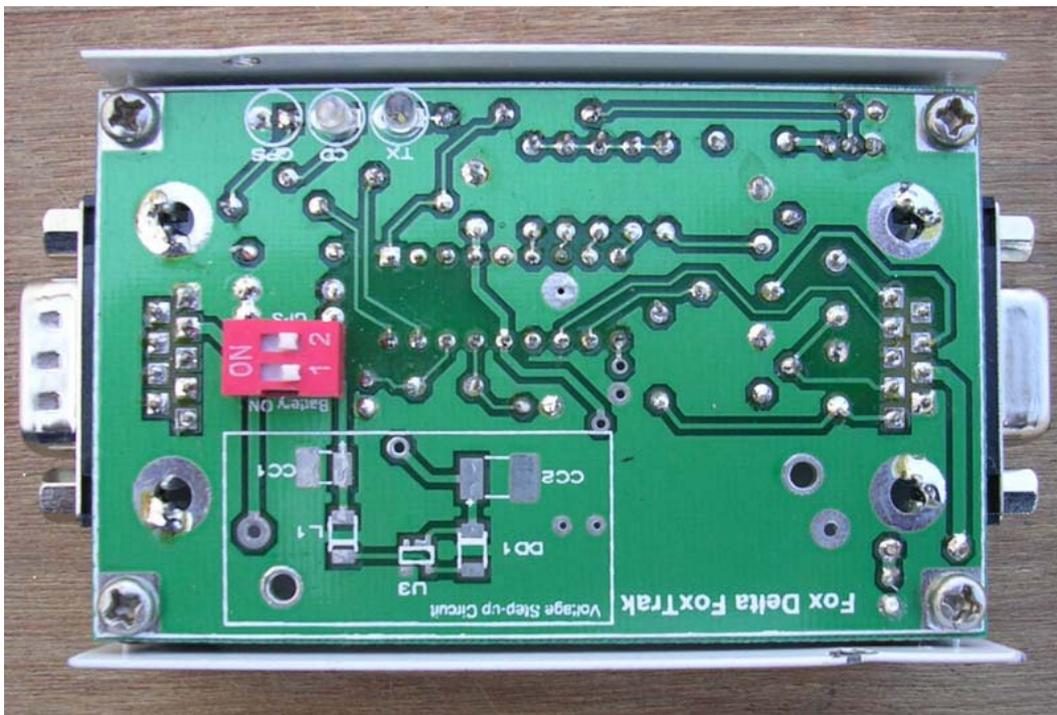
For configuration, use a null modem adepter.

You may power your GPS (+5V) by switching “On” GPS DIP Switch.

Completed New FoxTrak in Powder coated case:



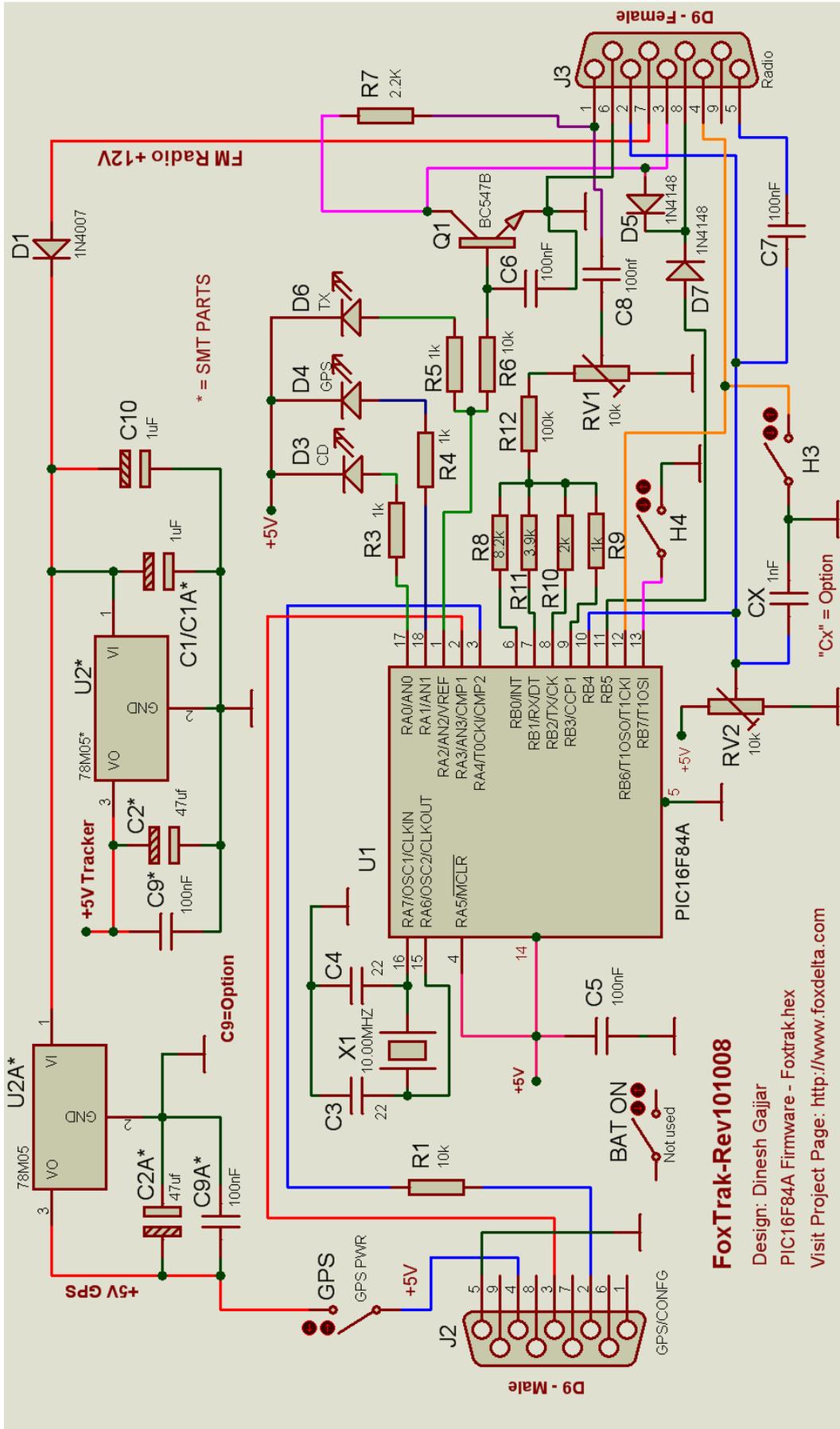
Inside case View:



This version of FoxTrak board is mounted upside down for the purpose to accommodated 1.5V cell and place DIP Switches on top: To have easy design of metal case.

“Voltage Step up Circuit” visible at the left bottom has few SMT parts and they need to be populated when a special version of FoxTrak is available using a Single 1.5V cell to power foxtrak.

Schematic of the FoxTrak Rev101008:



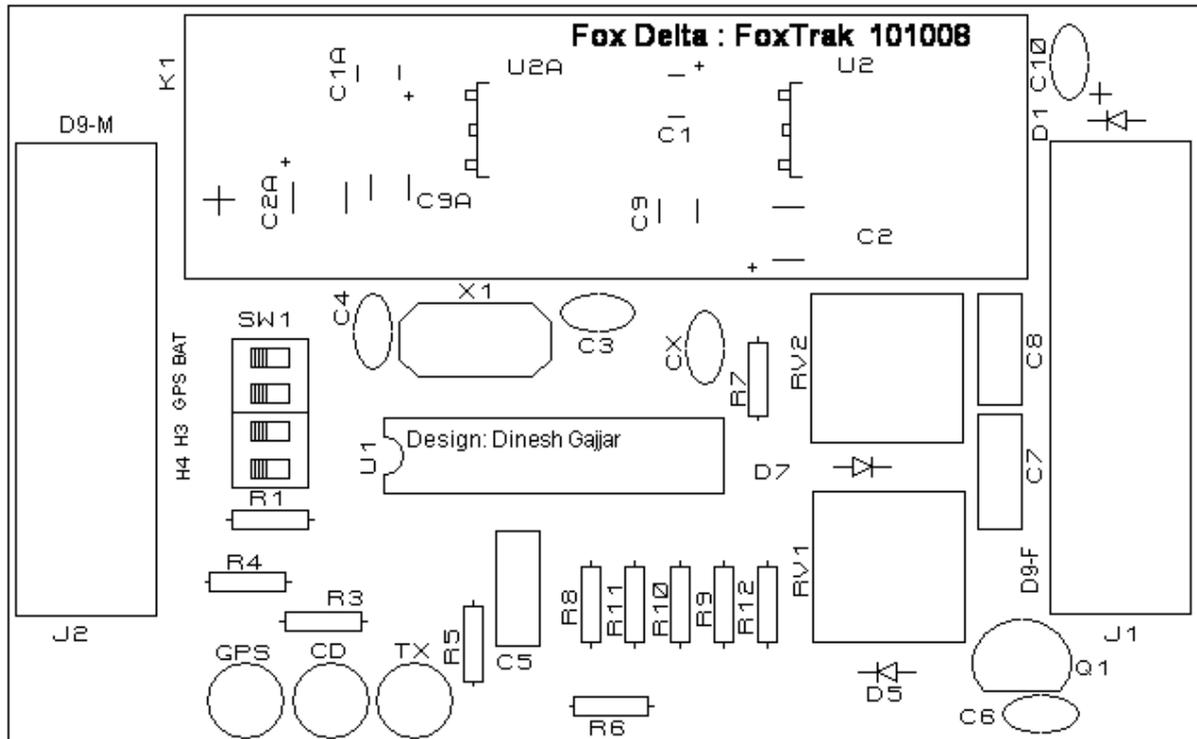
FoxTrak-Rev101008

Design: Dinesh Gajjar
 PIC16F84A Firmware - Foxtrak.hex
 Visit Project Page: <http://www.foxdelta.com>

FoxTrak Rev 11008 KIT Parts List:

| Quantity | Check | Part ID / Details |
|---|-------|--|
| 1 | | FoxTrak PCB REV 101008 |
| 1 Each=2 | | D9M(J2) & D9F (J3) R/A Connectors |
| 2 | | 1N4148 (D7, 5) |
| 1 | | 1N4007 (D1) |
| 1 | | U1: PIC16F84A Pre-Programmed with Foxtrak.hex |
| 1 | | 18PIN IC Socket |
| 1 | | 1uf/35V Tantalum (C10) |
| 3 | | 0.1uf Poly (C5, 7, 8) |
| 1 | | 0.1uf Ceramic (C6) |
| 1 | | 0.001uf Ceramic (CX) |
| 2 | | 22pf ceramic (C3, 4) |
| 1 | | Crystal 10.000MHZ (HC49US) X1 |
| 1 | | NPN Transistor BC547B (Q1) |
| 1 | | 4 Position DIP Switches SW1 (For Component side mounting) |
| 2 | | 2 Position DIP Switches (for mounting on either side of PCB) |
| 2 | | 10k Bourns Presets (RV1, 2) |
| 3 | | LEDs 3mm (1 green, 1 red, 1 Yellow) |
| 1 | | Free Powder Coated Metal case |
| | | |
| | | Resistors (Philips 0.25W 5%) |
| 4 | | 1k (R3, 4, 5, 9) |
| 1 | | 100k (R12) |
| 2 | | 10k (R1, 6) |
| 1 | | 2k (R10) |
| 1 | | 3.9k (R11) |
| 1 | | 8.2k (R8) |
| 1 | | 2.2k (R7) |
| Note: | | R2 not present on this new FoxTrak board/Kit |
| | | |
| Following SMT Parts are Pre-soldered on PCB: | | |
| 2 | | 78M05 |
| 2 | | 47uf/25V (C2/C2A) |
| 2 | | 1uf/25V (C1/C1A) |
| Not Supplied | | |
| xx | | 0.1uf SMT (Option) C9/C9A |

Silk Snap of FoxTrak Rev 101008:



Two 78M05 and associated components:



Please note C9 & C9A are 0.1uf SMT. They are unnecessary and not part of kit. However, user may install them if additional bypass requirement exists.

Both Regulators & 4 Tantalum SMT parts are pre-soldered on all PCBs supplied with Kits.

Dinesh Gajjar

Last Updated: 28th April 2009

Visit Project Page at: <http://www.products.foxdelta.com>