



Technical information: Compact PIC 16F84A/628A APRS Tracker for Portable Rigs

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.

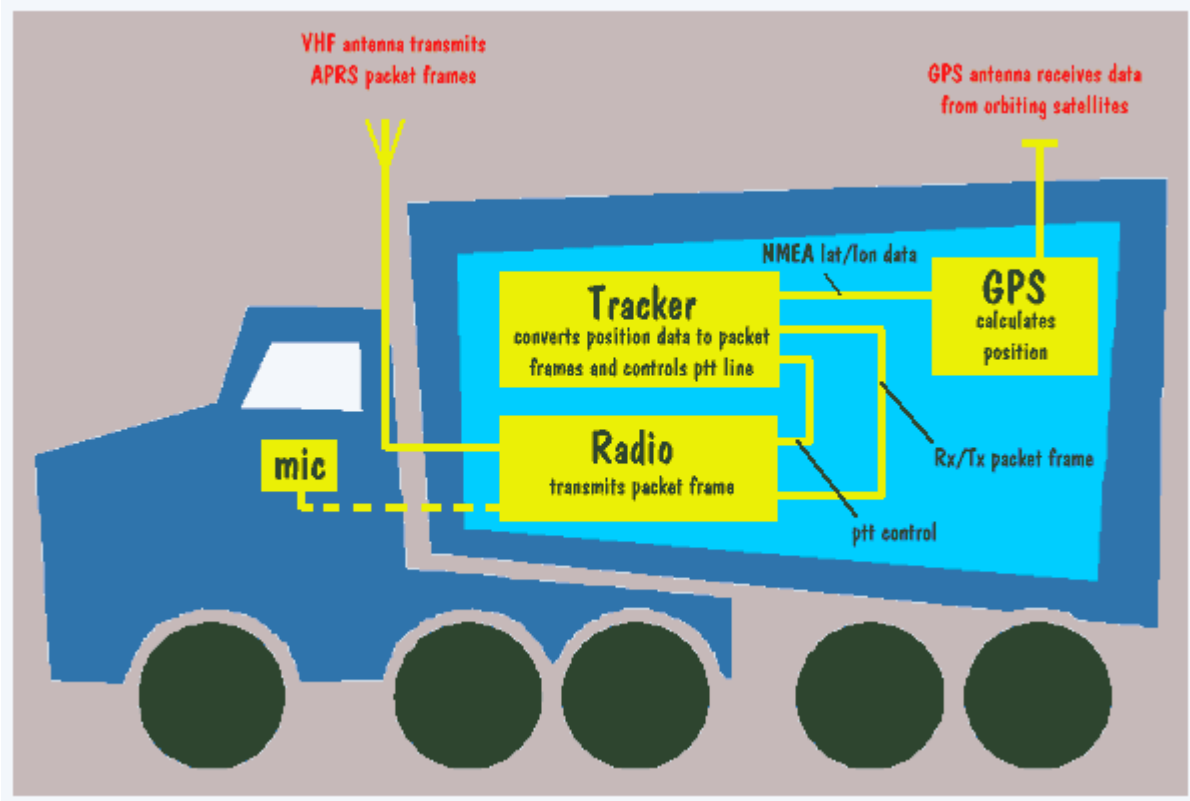
The same goes for most of the activities in ham radio - why do we work rare DX on cw, collect prefixes, operate from rare IOTA islands in the middle of nowhere, bounce signals off the moon, spend 48 hours continuously transmitting ...UR 599 = QRZ?... during the weekend contests when we could be enjoying 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:



Picture of the Completed FoxTrak:



FoxTrak is designed on a Double Sided PTH Board Measuring 7 x 4.5cm

The Schematic & Technical Information presented here generates an APRS signal with very little effort. It's a TinyTrak type of tracker hardware with small changes, where all functions are controlled by PIC16F84A.

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 TinyTrak (Byonics) 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 also includes an **Instant Transmit Push Button**.

FoxTrak is designed on a Double Sided PTH PCB & measures only 7cm x 4.5cm. I am using standard right angle D9 connectors.

FoxTrak also comes with null modem adapter. This adapter uses two R/A D9F connectors, PTH PCB and has possibility to use RS232 Driver such as MAX232. Null-Modem gets its power from FoxTrak and if no MAX232 is installed, no power is required.

Picture of the simple null-modem adaptor:

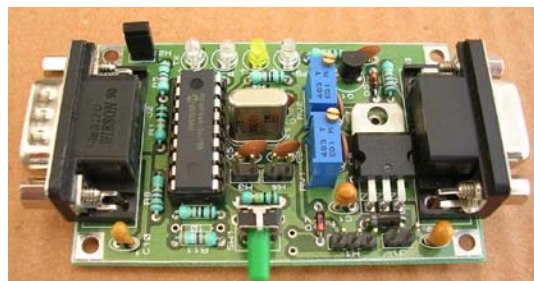


This null modem is a simple 2 x Female D9 PCB which shifts pin 2/3 at one end to 3/2 at the other end.

In addition, when connected to FoxTrak, it also indicates presence of power required for GPS.

This basic null modem may be made “Active” by simply installing a MAX232 chip & 5 1uf Tantalum capacitors. Suitable header configuration will be required. Please refer to schematic for more details.

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



Green Button visible at the center is for Instant TX of your position info.

Note the two R/A D9F/M Connectors and large 7805 Regulator.

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.

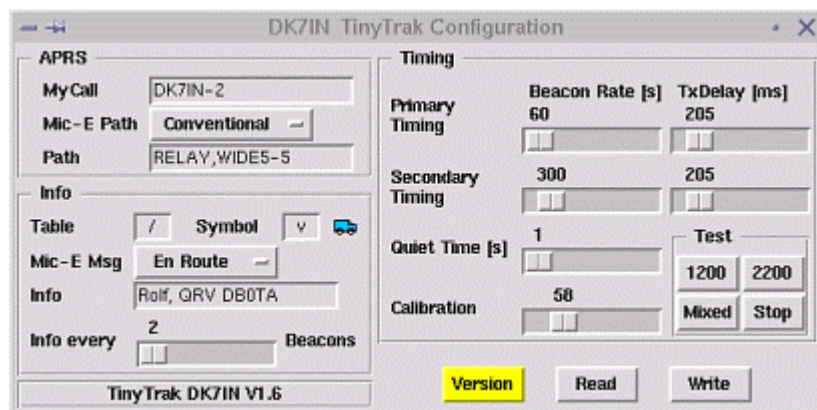
- ESC T 0 generates a 1200 Hz tone
- ESC T 1 generates a 2200 Hz tone
- ESC T M generates a mixed 1200/2200 Hz tone

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)

Headers, LEDs & Switches:

The two switches select the operation mode. With Header 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 high quality 10 turn presets to adjust audio to & from transceiver. Both need to be adjusted for proper operation.

External Power:

Although, designed to receive power from radio, FoxTrak may be powered at J1. DC 8 to 14 Volts may be applied at J1. J1 looks like a header but never put a shorting pin here. It will short-circuit your entire radio supply.

If you decide to apply external power, ensure that you study schematic & use two pin header female to supply + & - ve supply line.

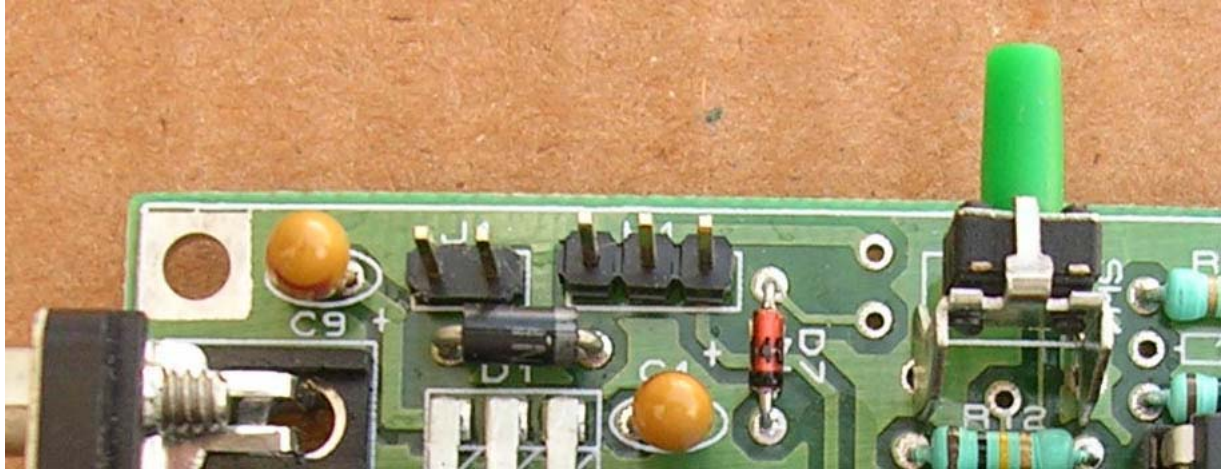
LED off:

LEDs, all of them, may be switched off to conserve power, by simply removing shorting pin at header H2.

Header H1:

This three-pin header is to supply DC voltages to GPS, which is available at D9M connector used to interface GPS or PC.

Ensure that you install shorting pin at proper place.



H1 Details: (GPS Power)

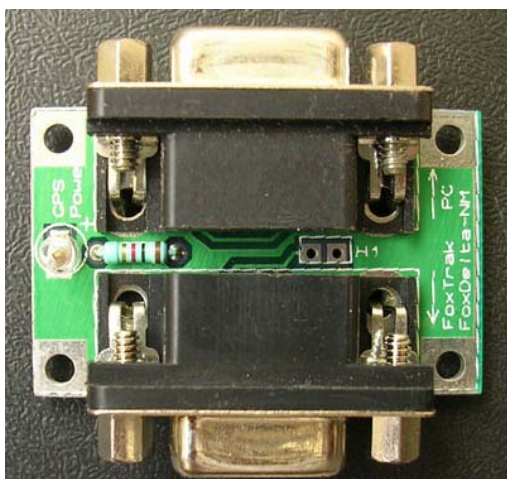
Center pin goes to J2 pin 4.
Left pin is DC supply coming from Radio.
Right pin is +5V from Regulator.

If your GPS requires +5V, install a shorting pin between Center & right header.
If supply equivalent of Radio Supply is required, install shorting pin between center & left.

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.

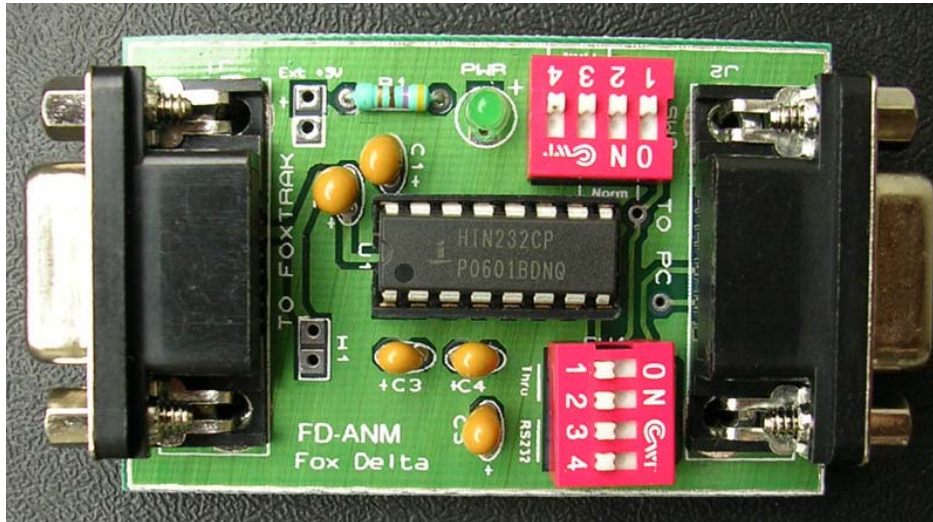
Null-Modem Adapter:



A special null-modem board is designed to use with FoxTrak to configure the PIC parameters. “Null-modem” uses 2 x D9F connectors at both ends and provides reversal of pin 2 & 3 between two sockets.

With Foxtrak kits, a simple, passive null-modem kit is enclosed for configuration purpose.

Null-Modem with RS232 chip:



By adding a MAX232 chip & associated components, you may convert passive null-modem adaptor into Active null-modem interface provides true RS232 levels to your PC.

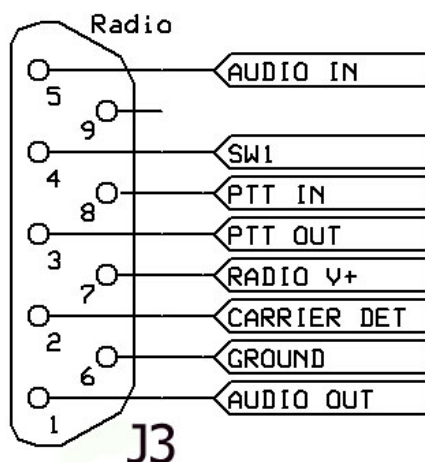
[This kit is available as an option and its not part of FoxTrak Kit.](#)

GPS Connections:

It will be required that you remove your GPS connector & solder a D9F connector to your GPS cable. Refer to schematic for Data & Power connections available at J2.

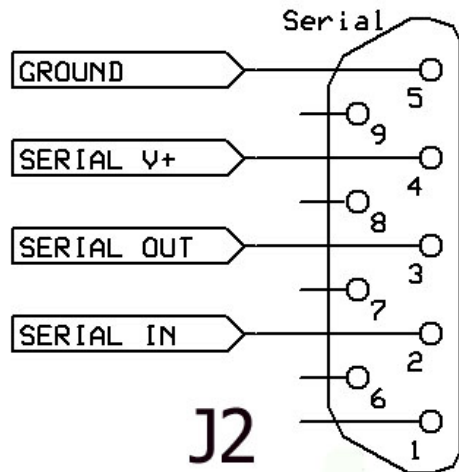
Radio Connections: J3: D9F

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:



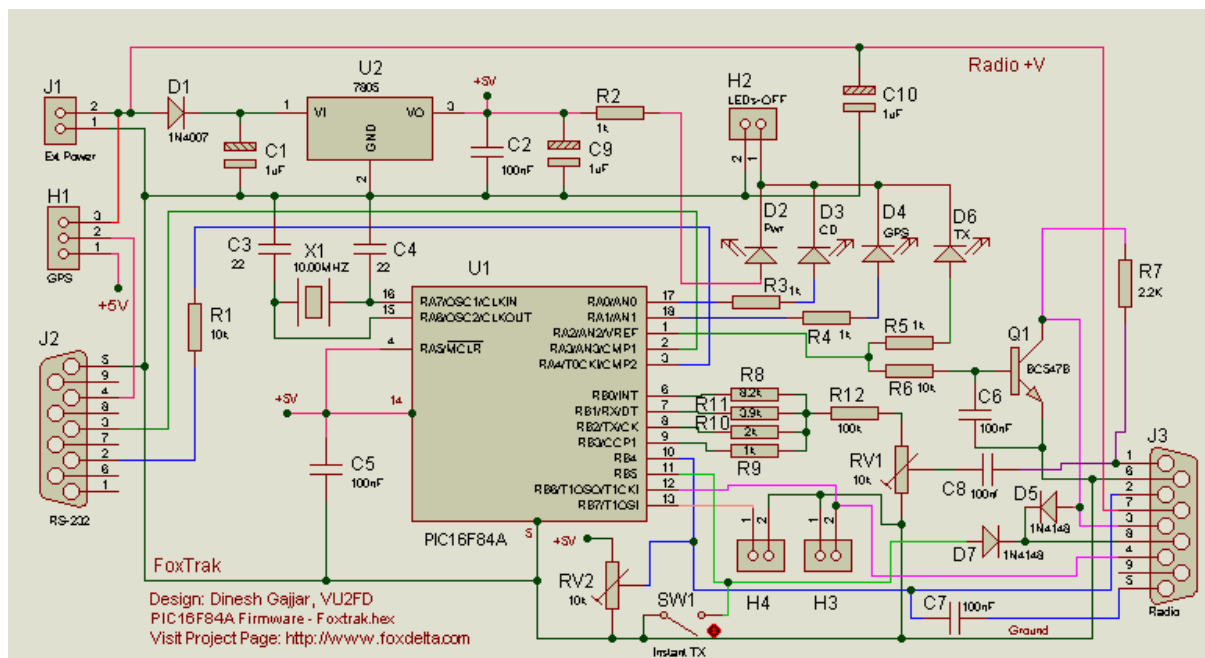
This is a D9M connector on FoxTrak.

Connect your GPS here.

For configuration, use a supplied null modem adapter.

You may power your GPS (+5V) by installing a shorting pin at header H1.

Schematic of the FoxTrak:



Last Schematic update: C8=0.1uf

I hope this tracker kit will be useful to many radio amateurs wish to join APRS and also wish to try their own firmware to make development of better APRS network.

Dinesh Gajjar

Last Updated: 28th August 2008

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