SkyTracker APRS

Rev 25.03.09
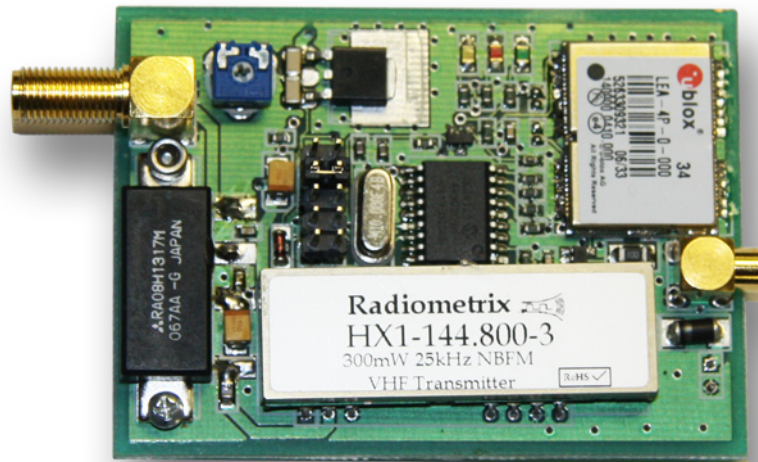
WARNING : DO NOT POWER UP THE UNIT WITHOUT AN RF ANTENNA

Contents

APRS is a trademark of Bob Bruininga
TinyTrak is a trademark of Byon Garrabrant
SmartBeaconing is invented by Steve Bragg and Tony Arnerich

1   Introduction

APRS stands for: Automatic Positioning Reporting System. It is possible to report your current position with a transceiver when it is connected to a suitable modem. Such a modem, also called a tracker, is a microcontroller circuit which needs firmware (embedded software) to be able to work.

Aprstracker is an open source firmware for PIC based trackers like the SkyTracker, TinyTrak, KF161-Tracker, or KF163-Tracker.

Aprstracker is originally written by Jeroen/PE1RXQ. Version 0.7 was the first public release of aprstracker. This was also the version that had been used in the first series of KF161-Trackers. Currently, aprstracker is being maintained by Arno/PE1ICQ. At time of writing of this document the current release of aprstracker is version 0.11. Recent and up-to-date information can be found on the aprstracker project web-page.

2   Features

The following new features have been added in aprstracker v0.11.

Added support for RMC. Aprstracker can now operate, incl. SmartBeaconing, when RMC is the only available NMEA sentence. GGA is only needed if transmission of altitude information is enabled. As with previous versions, aprstracker can also operate with just GGA sentences without SmartBeaconing. Or with GGA and VTG sentences with SmartBeaconing.

The GPS LED now doubles as a "GPS alive" and a "GPS lock" indicator. In previous releases the GPS LED toggled every time the characters $GP were received. In this release the GPS LED goes on after power-up, and goes off when the first $GP is received. Next the GPS LED will start flashing. There are 2 types of flashing. If the GPS is not locked yet, then the LED is mostly off, and will flash on every time $GPRMC or $GPGGA is received. If the GPS is locked, then the LED is mostly on, and will flash off every time $GPRMC or $GPGGA is received. Because of this new behavior of the GPS LED, the possibility to change the function of the STATUS LED with SW1 is now superfluous and has been removed. Shortening of SW1 now activates a new feature (see below).

An output signal is available to control a PLL synthesizer of a transceiver. This enables the usage of a transceiver for both voice and APRS communications. This control signal is activated 130 ms before activating PTT. With the16f636 variant a XOFF character is sent on serial out 130 ms before PTT line goes low. And a XON character is sent when RF transmission is completed. XON-XOFF are used in the KF163 to control the PLL.
With the 16f626, and 16f648 variants: If SW1 is shorted the Status LED output can be used to control a PLL synthesizer. If SW1 is shorted then the Status LED output will go high 130 ms before the PTT line goes low. The Status LED output will go low again when PTT goes high. (I.e. when transmission is completed)

Status type APRS frames can now have a user configurable text. This feature is not available in the build for the pic16f628 because this microcontroller does not have enough EEPROM storage. The status text can be maximum 127 characters long in this release. Future releases may have a smaller length if memory space is needed for other features. Status packets are transmitted by the tracker using the standard APRS decay design. I.e. the status packet is transmitted shortly after power-up, then 8 seconds later, then 16, then 32, then 1 minute, then 2 mins, then 4 mins, then 8 mins and then 16 mins and then 30 mins. Thus there is excellent probability that the packet is delivered quickly, but then there is redundancy in case of collisions.

Removed 2nd, 3rd, and 4th beacon comment texts because memory space was needed for the user configurable status text.

The following is not really a new feature, but should be mentioned anyway. The modem tone generation interrupt service routine and the EEPROM read routines have been further optimized in v0.11.

This is a concise list of aprstracker features.

- ✔ SmartBeaconing
- ✔ Proportional pathing
- ✔ Height information in APRS beacon can be enabled/disabled
- ✔ Course and speed information in APRS beacon can be enabled/disabled
- ✔ Configurable beacon comment

- ✔ Configurable APRS status text (not available in PIC16F628 variant)
- ✔ Variants available for
  - ✔ PIC16F628 (eg. TinyTrak or KF161-Tracker)
  - ✔ PIC16F648 (eg. TinyTrak, or KF161-Tracker)
  - ✔ PIC16F636 (KF163-Tracker)
- ✔ Control signal for PLL synthesizer (use transceiver for both voice and APRS)
- ✔ Decodes every combination of $GPRMC, $GPGGA and $GPVTG NMEA strings
- ✔ User definable configuration string for connected GPS receiver
- ✔ Auto-detect GPS data rate (4k8 or 9k6)

3   Configuration software

To configure the tracker a Linux tool is available. There is no need to install Linux. A bootable CDROM image is available that contains all needed software. Simply insert the CDROM in your PC and boot your PC.

The following will appear on the screen:

```
****************************************************************************
APRSTracker programmer
Copyright 2003-2005 Jeroen Vreeken (pe1rxq@amsat.org),
        2005-2006 Arno Verhoeven (pe1icq@amsat.org)
memver: 4
****************************************************************************

Initializing serial port...
Trying 4800 baud.
Connect APRSTracker to the serial port (/dev/ttyS1 or COM1) and press Enter _
```

If you did not yet connect the tracker, do this now, and press   *Enter*

If a tracker is found, the following text will appear:

```
****************************************************************************
Found APRS Tracker software version 11 in 4800 baud mode.
256 bytes EEPROM contents:
----------------------------------------------------------------------
[1] Source address:    NOCALL-0        [P] Using New-EU Paradigm Digi Path
[2] Proportional Pathing: 3
[3] Beacon interval:   0 (SmartBeaconing enabled)
[4] TX Delay count:    60
[5] Symbol table:      /
[6] Symbol id:         >
[7] Beacon comment:
[8] Comment interval:  2
[9] Status text:       aprstracker-0.11-16f648
[C] GPS Config String:
[D] Slow beacon rate:  20 (minutes)   [E] Slow speed threshold:  3 (knots)
[F] Fast beacon rate:  90 (seconds)   [G] Fast speed threshold:  50 (knots)
[H] Course/Speed are enabled
[I] Altitude is disabled

****************************************************************************
Type your choice and press Enter (? for help): _
```

This screen displays the current configuration. You can now select one of the following options:

? *Help*
    Gives an overview of all available options. Not all options are available in all aprstracker variants. The variant for the PIC16F628 has less EEPROM memory. It does not have enough memory for the user definable status text feature.

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1 *Set Source address*
Used to program your call-sign followed by a dash (-) and a number between 0 and 15. The number is the SSID (Secondary Station ID) which makes it possible to have 16 stations using an unique address. SSID -9 is commonly used for mobile APRS stations (eg. ZS1ABC-9).
Currently only a SSID in the range 0-9 can be entered with the config tool. For the time being a work-around is possible by entering.

-:	for SSID -10	-=	for SSID -13
-;	for SSID -11	->	for SSID -14
-<	for SSID -12	-?	for SSID -15

3 *Set Txdelay*
Txdelay is the time between activation of the transmitter and actual transmission of data. The unit of measure is the time to transmit one byte (0.833ms). A value of 60 is a good starting point when using the tracker with a SkyTracker, KF161 or KF163.

4 *Set Beacon interval*
Time between two transmissions. A setting of 0 will activate SmartBeaconing. A value greater than 0 disables SmartBeaconing. 0 is the default and the recommended setting.

5 *Set Symbol table*
This is one of the two settings that will determine which icon will be used to display your station on an APRS map. There are two symbol tables to choose from, / and \.

6 *Set Symbol id*
For each symbol table various icons have been defined. See chapter 6 for an overview.

7 *Set beacon comment text*
It is possible to add a short string of text with each position report (max. 39 characters). Use with care... adding text will increase the time needed to transmit your report. Longer airtime means that you have less chance to a successful transmission as it increases the chance of collisions. Also adding text has in most cases no added value.

8 *Set beacon comment interval*
The number of beacons that will be sent without a comment before another beacon with comment will be sent. If you insist on having a beacon comment then this feature is a compromise to lighten the load of the APRS frequency. It is recommended to use an interval of at least 2. And a larger number in case of long beacon comments.

9 *Set status text*
This option allows you to define the text that will be send as APRS status frames. The maximum length is 127 characters.

C *GPS Config String*
You can enter a string that will be sent to the connected GPS receiver as soon as the first $GP characters are received by the tracker. This feature can be useful for GPS receivers that loose their setting after a long period of not being powered up. Not required for LEA-4P GPS inside SkyTracker.

D *Set Slow beacon rate*
The interval (in minutes) at which beacons are sent when the speed is below the Slow speed threshold. Basically consider this to be the stopped beacon rate. This parameter is not used at all when traveling at a rate of speed higher than "Slow speed".

E *Set Slow speed threshold*
The speed threshold (in knots) that will cause beacons at the rate specified above.
(1 knot = 1.852 km/h = 1.1508 mph)

F *Set Fast beacon rate*
The interval (in seconds) at which beacons are sent when the speed is above the Fast speed threshold. This parameter is also used to compute a beacon rate based on speed when traveling between the high and low speeds.

G *Set Fast speed threshold*
The speed threshold (in knots) that will cause beacons at the rate specified above.
(1 knot = 1.852 km/h = 1.1508 mph)

H *Enable/Disable sending of Course and Speed*
Excludes of includes course and speed information in APRS beacons. The APRS spec defines a maximum frame length. If the entered beacon comment is too long, then it will overrule this setting. I.e. course and speed will not be transmitted.

I *Enable/Disable sending of Altitude*
Excludes of includes height information in APRS beacons. The APRS spec defines a maximum frame length. If the entered beacon comment is too long, then it will overrule this setting. I.e. course and speed will not be transmitted.

N *Set GPS config string for enabling VTG on a Garmin GPS*
Preset for a Garmin GPS receiver. This preset disables RMC and enables VTG. N/A for SkyTracker

P *Switch Paradigm*
Select a digi path according to the new-EU paradigm, or new-N paradigm. new-N paradigm recommended

S *Enable SmartBeaconing*
This option is a short-cut for setting 3 "Beacon interval" at zero (0).

R *Set GPS config string for enabling VTG on a SiRF GPS*
Preset for GPS receiver with a SiRF chipset. This preset disables RMC and enables VTG.

Y *Set GPS config string for enabling VTG on a Sony GPS*
Preset for GPS receiver with a Sony chipset. This preset disables RMC and enables VTG.

Leave the program by simply switching off the PC, or restart the PC by pressing Ctrl-Alt-Del.

4   Configuration Jumpers

Aprstrackers built around a PIC16F628 and 16F648 have 3 jumpers, SW1, SW2, and SW3. Trackers that are using a PIC16F636 (KF163-Tracker) do not have any configuration jumpers.

SW1 changes the purpose of the output for the status LED. Without SW1 the status LED output is used as a channel free/busy indicator.

If SW1 is shorted then the status LED output is not being used for a LED indicator, but as a control signal for a PLL synthesizer. It can be used to change the frequency of a transceiver from a voice channel to the APRS channel. This output will go high 130 ms before PTT will be activated.

SW2 does not have a purpose yet.

SW3 can be used to force transmission of an APRS beacon. When SW3 is shortened then an APRS beacon will follw within one second. But only if a GPS receiver is connected, and if valid GPS data is present.

5   SmartBeaconing

SmartBeaconing™ was invented by Steve Bragg (KA9MVA) and Tony Arnerich (KD7TA). The purpose of SmartBeaconing is to vary time between transmissions depending on speed and changes in course. As of version 0.8 the aprstracker firmware contains an improved SmartBeaconing implementation.

When using the default settings the tracker will have the following SmartBeaconing behavior;
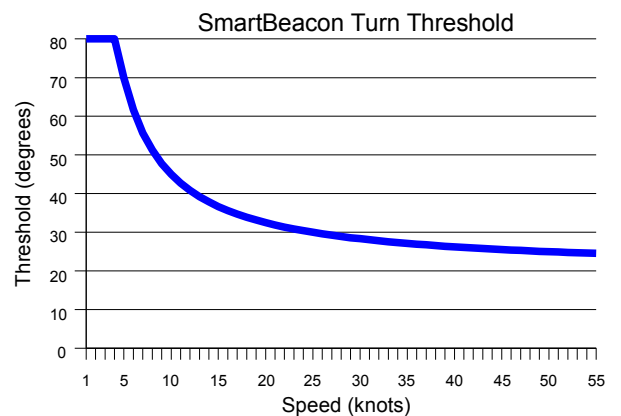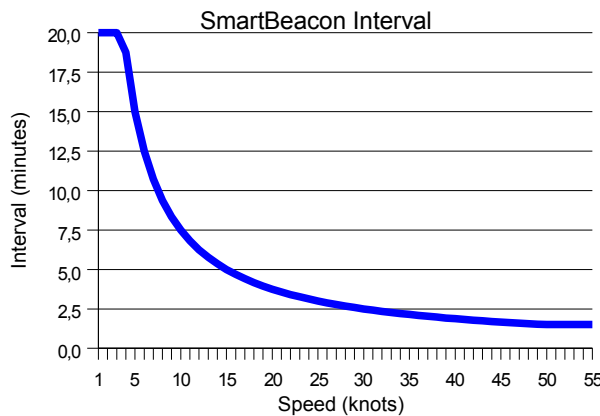
When stationary the time between transmissions is 20 minutes. This interval becomes gradually shorter as speed increases. When traveling at a speed of 50 knots (93 km/h) the interval has decreased to 90 seconds. A higher speed than 50 knots does not decrease beacon interval.

Independent of the time that has passed since last beacon, a new beacon transmission can be triggered by a change of course. At low speed (3 knots (5 km/h)) a change of course of 80 degrees will cause a beacon transmission (if radio channel is free).

The sensitivity for course changes will increase at higher speeds. At a speed of 50 knots a 25 degrees course change will trigger a beacon transmission.

No beacon will be transmitted if the last beacon was transmitted less than 5 seconds ago (irrespective of speed and change of course).

6   APRS Symbols

Select one of these characters as Symbol ID and the corresponding icon, indicating your position, will be displayed on an APRS map in eg. Xastir or UI-View. The fields showing a black cross with a red dot do not have an officially assigned icon yet.

Primary symbol table. Used if / is entered with option no. 5 in the config tool.

Secondary symbol table. Used if / is entered with option no. 5 in the config tool.

Some of the secondary table symbols can have an alphanumeric overlay. The alternate symbols that can have an overlay are highlighted in yellow in the text grid above. The overlay character can be a single digit 0 through 9 or letter A through Z, and are used if they are entered with option no. 5 in the config tool instead of / or \.

7 Frequently Asked Questions

1. Help! SmartBeaconing doesn't work. But when I enter a Beacon Interval, then beacons are transmitted at the set beacon rate.

2. Proportional Pathing, Wat is it, and what happens if I change the default value?

3. What will happen if I change 'Beacontext interval'?

4. How can I enter Carriage Return and Line Feed characters in the GPS config string?

5. My GPS outputs NMEA-data at 9600 bd. How do I set the tracker to receive data at 9600 bd?

6. I would like to upgrade my tracker with the latest firmware. Can you help me?

7. I've upgraded my tracker's firmware, but it doesn't seem to work. The config utility doesn't see the tracker. What could be wrong?

8. The status beacons have something like {AT0B2} in the text. What is the meaning of this?

Question: Help! SmartBeaconing doesn't work. But when I enter a Beacon Interval, then beacons are transmitted at the set beacon rate.
Answer: The connected GPS does not provide $GPVTG strings. Manually configure your GPS to enable VTG strings, or make use of the trackers capability to configure the GPS. To do this look up the format and exact content in your GPS' manual and enter this string in the tracker using config option *'C - Set GPS Config String'*. If the connected GPS receiver has a SiRF chipset then you can set the needed string with config-option *'R - Set GPS config string for enabling VTG on a SiRF GPS'*. If the connected GPS receiver has a Sony chipset then you can set the needed string with config-option *'Y - Set GPS config string for enabling VTG on a Sony GPS'*.

Question: Proportional Pathing, Wat is it, and what happens if I change the default value?
Answer: Here you can find a description of Proportional Pathing. In short it means that when *'Proportional Pathing = 4'*, beacons are transmitted with a digi path that increases with consecutive beacons to a maximum of 4 hops.
The 1st beacon is transmitted without digi path,
the 2nd beacon with a digi path of RELAY
the 3rd beacon with a digi path of RELAY, WIDE2-1
the 4th beacon with a digi path of RELAY, WIDE2-2
and the 5th beacon with a digi path of RELAY, WIDE3-3.
With the next beacon the cycle starts over again. Proportional Pathing will be disabled if a value of 6 or higher is entered in the config utility. When disabled all beacons will be send with a digi path of RELAY, WIDE2-2. (Or is the new-N paradigm is selected, with a digi path of WIDE1-1, WIDE2-2).

Question: What will happen if I change 'Beacontext interval'?
Answer: 'Beacontext interval' controls how often the beacon comment text is transmitted with a position beacon. A value of 0 means that each position beacon is accompanied with a comment text.
If set to 1 the interval is 1, meaning every 2nd beacon will have the comment text added.
If set to 2 the interval is 2, meaning every 3rd beacon will have a comment text added. Etc.
'Factory' setting is an interval of 2. Including a comment text with each beacon is a waste of air-time.

Question: How can I enter Carriage Return and Line Feed characters in the GPS config string?
Answer: You can do this by entering \r and \n instead. These will be translated into Carriage Return and Line Feed characters. The 2 GPS chipsets that I know (SiRF en Sony), both expect to be terminated with Carriage Return and Line Feed. Other types might expect something different. The tracker only sends a CR/LF if you explicitly enter these in the config string. (If you use the presets for SiRF or Sony then these CR/LF will be included in the string)

Question: My GPS outputs NMEA-data at 9600 bd. How do I set the tracker to receive data at 9600 bd?
Answer: As of v0.10 there is no need to set the baudrate. The tracker automatically detects if data arrive at 4800 bd or 9600 bd. But the baudrate detection does take some time. An internal counter counts until 255. If the string '$GP' does not occur within 255 received characters, then the tracker will switch baudrate and tries again. Because NMEA strings are usually shorter than 255 characters the tracker will stay on the correct baudrate once the correct baudrate is detected.

Question: I would like to upgrade my tracker with the latest firmware. Can you help me?
Answer: Build a simple PIC-Programmer. The CDROM contains the schematic of a simple serial programmer which I have been using for a while. You can make it easy for yourself and get one here. Alternatively I can re-program your PIC, or send you a new programmed PIC micro-controller. Send me a mail to discuss practicalities.

Question: I've upgraded my tracker's firmware, but it doesn't seem to work. The config utility doesn't see the tracker. What could be wrong?
Answer: Use the version of the config utility that matches the version of your tracker firmware. If you use an old config utility with a new tracker firmware version, then this may not work (depending on version jump).
The config utility of v0.7 (the floppy) only works with aprstracker firmware v0.7.
The config utility of v0.8 and/or v0.9 only work with aprstracker firmware v0.7, v0.8 en v0.9.
The config utility of v0.10 works with aprstracker firmware v0.10 and all previous releases.
The config utility of v0.11 only works with aprstracker firmware v0.11.

Question: The status beacons have something like {AT0B2} in the text. What is the meaning of this?
Answer: This depicts the software name and version number. AT stands for AprsTracker, 0B for the version number (0B = 0.11) and 2 for the build target (2=PIC16F628, 3=PIC16F636, 4=PIC16F648).

8   Information

On the Internet you can find lots and lots of information about APRS. These are a few links.
http://sharon.esrac.ele.tue.nl/~pe1icq/projects/aprstracker.shtml

http://www.ezkits.eu (cheap PIC programmer kit)

http://info.aprs.net

http://www.veron.nl/tech/aprs/

http://sharon.esrac.ele.tue.nl/users/pd0sbh/

http://www.qsl.net/on6bvk/aprs.htm

Skytracker 10pin header pinouts.

With the GPS module on the bottom left, the Mitsubishi module on the right, Pin 1 is located at the top left corner of the header next to the crystal.
As supplied, Pins 7 and 8 are jumpered for normal operation.

1   PIC in circuit programming data input or SW1

2   PIC in circuit programming Vpp.

3   PIC in circuit programming clock in or SW2

4   AF in for channel busy TX hold off. Implemented but not used.

5   Ground. For Programming connects to DB9-Female Pin 5.

6   SW3. Grounding this pin will force a transmit of a position beacon.

7   GPS data out. Compatible with RS232 data levels.
     Link to pin 8 in normal operation. Connect to DB9-Female Pin 3 if
     GPS output strings are to be monitored with the u-CenterSoftware
     program on a PC. See http://www.u-blox.com/products/u_center.html

8   GPS data in to PIC. Also data in for configuration of firmware. (RS232
     levels). For Programming connects to DB9-Female Pin 3.

9   Configuration data out. (RS232 levels). For Programming connects to
     DB9-Female Pin 2.

10   GPS configuration data in. (TTL level in. RS232 levels need to be inverted)