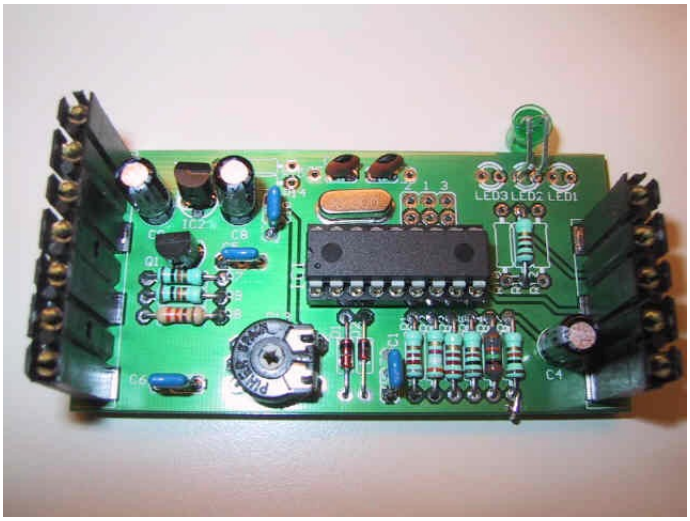
KF161-Tracker

(Doc. Version 1.30 2005-10-13)



http://www.jancorver.org/bouw/track/

An APRS tracker printed circuit board assembly that fits inside the Bosch KF161 tranceiver. The assemby fits the space reserved for the tone-call PCB assemby.

This description is a concise translation of the original Dutch document.

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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. The KF161-Tracker is such a modem. It is designed to fit inside a Bosch KF161 mobile transceiver.

2 Design Considerations

There is plenty of room inside the KF161 to fit an APRS tracker PCB assembly. All the necessary signals are available on the connections to the tone decoder. This tone decoder is not used anymore, so it is a logical choice for fit the APRS tracker in its place.

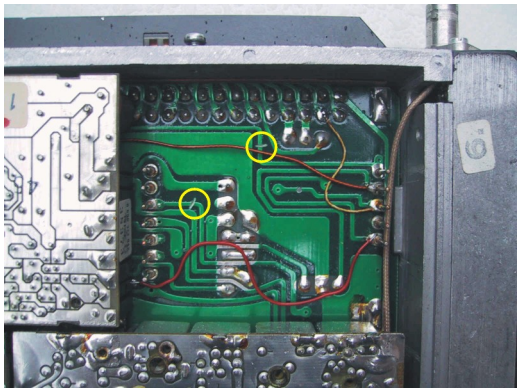
I chose to have as little wiring as possible inside the KF161. The PCB has room for 3 LED indicators for TX/PTT, Carrier Detect and GPS-data. But mounting this serves little purpose unless the module is used outside the KF161. Only the terminals for the GPS-data LED have been routed to external connections. The other LEDs are nice for decoration, but serve no real purpose during normal operation. The GPS-data indicator can be useful for debugging purposes when the unit is put into service for the first time. The other LEDs and current limiting resistors (R10, R12 = 150 Ohm) are not part of the kit.

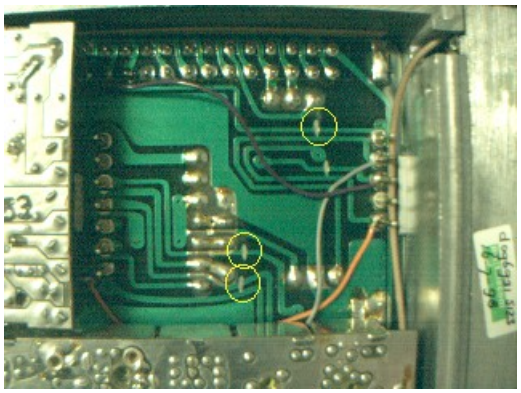
The PCB also has room for a 3x2 header. These are for future use, and could be used to mount configuration jumpers. (SW1, SW2, SW3)

3 Disassembly

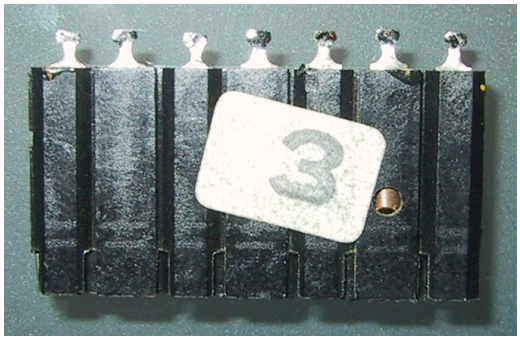
Open the KF161 and remove the tone-call assembly from its connectors. You can do this by carefully prying the PCB assembly from all sides with a flathead screwdriver. Remove the shielding foil which is laying under the PCB assembly.

Underneath this foil there are a number of wire jumpers on the motherboard. You will see that 3 traces have been cut on the motherboard. 2 of these cuts need to be repaired. These 2 are marked with the yellow circle in the picture to the right. Carefully scrape off some of the green lacquer on both sides of the cuts. Then solder a small piece of wire over the cuts to repair the connections.





The picture to the left shows the inside of a KF161 from a different production batch. If you have a KF161 like this, then you need to repair 3 PCB traces.



The 5 and 7-pin connectors are difficult to find. (Who knows the manufacturer's name and type numbers?) Therefore we are going to re-use the connectors on the tone-call assembly on our tracker assembly. The solder pins have some sort of hook that holds them into the PCB, but can be easily removed.

You should know that the PCB holes in the tone-call assembly are not round. Instead these are small slits. The pins of the connector are pushed through these slits, and then turned approximately 45 degrees. In some cases up to 90 degrees. First remove any excess solder with a vacuum pump or desoldering-wire. Then using small pliers turn back the soldering pins until these are in line again. Wiggle them a bit until they come loose from any remaining solder (clicking sound). The connectors can now be removed form the

PCB. Don't pull to hard on them. Instead push the pins back from the soldering side using small pliers or other suitable tool.

4 Assembly Instructions

When assembling the tracker PCB it is recommended to mount the components in order of size. First mount the smaller components, followed by the slightly taller components.. The last components to mount are the 2 connectors we just salvaged.

But before you begin with the assembly, you need to check the revision of your PCB. A PCB with revision R1A needs a small modification. Resistor R6 should be grounded on one side. Carefully scrape off some of the green lacquer and solder R6 to ground as shown on the photo on the cover page.
If you have revision R1B of the PCB then there is no need to make this modification.

Next, mount all axial resistors and both diodes.

D1 and D2 both have a small glass DO35 package, and at times the printing on these can be hard to read. Fortunately both diodes are parallel to each other in the circuit, so it doesn't matter if we switch these two. What does matter is the orientation of the diodes. The marking band (cathode) should be towards IC1.

Mount the crystal so that it is just slightly off the board.

Mount the 18 pin socket for IC1.

Mount potentiometer R13.

Mount all ceramic capacitors. The PCB has mounting holes for capacitors with either a 2.5 or 5 mm pitch. If you mount capacitors with 2.5 mm pitch make certain that you use the correct holes.

Next, mount Q1 and IC2. Carefully bend the middle lead a bit forward. Use small pointed pliers to do this. Avoid bending the leads close to the plastic housing. If the leads are bent close to the housing there is a risk that mechanical stress will cause the connection to break internally.

Mount C4, C8 and C9. Keep in mind that these are polarized.

The green LED can be mounted on the PCB, but this is not useful when mounted inside the KF161. The short lead is the cathode. The connection for the GPS-data LED is also available on the external connector on the backside of the KF161 (see chapter 6).

Instead of IC2 (78L05) it is also possible to mount IC3 (LM317). But if IC3 is mounted then 2 extra resistors also need to be mounted. (R14 = 240 Ohm 1% en R15 = 720 Ohm 1%).

Put the shielding foil back in its place in the KF161.

Mount the 5 and 7 pin connectors on tracker PCB. Make certain that these are mounted straight otherwise the tracker module may not fit onto the headers in the KF161. The easiest way to align the connectors is to first insert the connectors on the headers in the KF161, and then place the tracker PCB through the holes of these connectors. Then solder the connectors to the PCB.

Power up the KF161 and verify if the output of IC2 provides +5V. There may be up to 0.2V deviation.

If the +5V measurement is OK, then insert IC1 in its socket. Make certain that orientation of IC1 is correct. Between pins 1 and 18 there is a small indentation in the package. Line up the indentation with the marking on the PCB.

5 Adjustments

The only trimming needed on the tracker is R13. The setting of this resistor is not critical. Simply turn the resistor to the position as shown on the photo on the cover page.

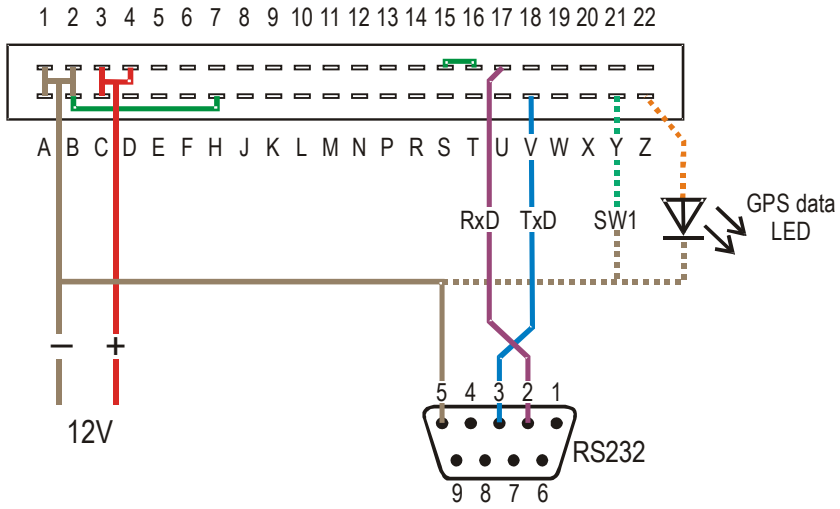
The KF161 transceivers, which are available for purchase from the Museum Jan Corver, have been used in a mobile network using Phase-Modulation (PM). For packet radio we use Frequency-Modulation (FM). By placing one wire jumper on the modulation amplifier the KF161 is suitable for FM. On the PCB this spot is marked with **F**.

Modification of the receiver module is not necessary for use with the KF161-Tracker. We don't decode the received signals, we only need to detect if we receive anything at all (channel busy indication).

In some cases the audio produced by the tracker is too loud. In this case R1 on the “NF-Teil-Senden” module needs to be trimmed back. The hole to access R1 is visible on the above photo, just below the spot where we made the FM-modification.

6 Connections

The following signals are available on the connector in the cradle of the KF161.



Both connectors are shown from the soldering side.

The connection between 2 and H, and the connection between 15 and 16 is in most cases already in place when you acquired your KF161 from Museum Jan Corver. The connection between 2 and H is a substitute for the on/off switch. The connection between 15 and 16 activates the squelch.

SW1 and the GPS data LED are optional. The LED will flash if (1 second period) if GPS data is being received, and will be constant (on or off) if no GPS data is received.

Caution! Bosch has not always been accurate when mounting the connector in the cradle. In some cases the connector is rotated 180°. This can easily be recognized by checking the connection of pin 1. Pin 1 is normally connected to ground. If pin Z is connected to ground, then you should take the changed marking of the pin numbering into account.

7 Software

An important part of the functionality is implemented in software. We distinguish 2 main parts.

- Firmware
- Configuration software

7.1 Firmware

Firmware is the embedded software that controls the the PIC micro-controller. The PIC micro-controller that is included with the KF161-Tracker kit has been pre-programmed with firmware. We chose to use the APRS-tracker firmware designed by Jeroen, PE1RXQ. This firmware is freely available (Open Source Software) and provides all functions that you expect of a tracker.
This firmware understands GPGGA and GPVTG GPS data, does SmartBeaconing, is configurable via a serial null-modem cable, and rapports course, speed and height.

Current version is 0.8. More information and possible future updates can be found on the Internet at http://sharon.esrac.ele.tue.nl/users/pe1rxq/aprstracker/aprstracker.html

New in version 0.8 is the automatic detection of GPS data signal levels. GPS data can be standard RS232 signals or logic level inverted signals. The latter is the case if an OEM GPS module is used.
Another new feature is the possibility to decode GPS data at speeds of 9600 bps. (set with SW2).
Version 0.8 also has an improved SmartBeaconing algorithm.

SW1 does not have any function yet with the current firmware version, but this may change in the future.
If SW2 is shorted then the tracker expects GPS data at 9600 bps. According to the NMEA standard, serial data rate is specified at 4800 bps. This means that in most cases you will need to leave SW2 open.
Jumping SW3 causes an immediate transmission of a position report.

7.2 Configuration Software

Initially the tracker will contain the default configuration data. You will at least need to configure it with your own call-sign. Configuring the tracker can be done by connecting it to the serial port of a PC using a null-modem cable. Such a cable can easily be made. Take two 9-pin Sub.D female connectors. Make the following connections.:

- Pin 5 to Pin 5
- Pin 2 to Pin 3
- Pin 3 to Pin 2

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 Jeroen Vreeken (pe1rxq@amsat.org) 2003, 2004, 2005
memver: 2
*************************************************************************

Initializing serial port...
Trying 4800 baud.
Connect APRSTracker to the serial port (/dev/ttyS0 or COM1) and press Enter
```

If you did not yet connect the KF161, do this now, and press *Enter*

If a KF161-Tracker is found, the following text will appear:

```
********************************************************************************
Found APRS Tracker software version 8 in 4800 baud mode.
********************************************************************************
Eeprom contents:
--------------------------------------------------------------------------------
Source address:         NOCALL-0
Beacon interval:        0 (SmartBeaconing enabled)
TX Delay count:         50
Symbol table:           /
Symbol id:              >
Beacontext:
Slow beacon rate:       20 (minutes)    Slow speed threshold:   3 (knots)
Fast beacon rate:       90 (seconds)    Fast speed threshold:   50 (knots)
********************************************************************************
Options:
--------------------------------------------------------------------------------
0   Reread EEPROM                       1   Set Source address
2   Set Txdelay                         3   Set Beacon interval
4   Set Symbol table                    5   Set Symbol id
6   Set Beacontext
8   Set Slow beacon rate (minutes)      9   Set Slow speed threshold (knots)
A   Set Fast beacon rate (seconds)      B   Set Fast speed threshold (knots)
********************************************************************************
Type your choice and press Enter:
```

You can now select one of 12 options:

- **0** Reread EEPROM
  The contents of EEPROM (non-volatile memory in the micro-controller) will be read and displayed.
- **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. *PE1RXQ-9*)
- **2** 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 50 is a good starting point when using the tracker with a KF161.
- **3** 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.
- **4** 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 \.
- **5** Set Symbol id
  For each symbol table various icons have been defined. Frequently used combinations of a symbol table and id are:
  - /> red car (default setting)
  - \> white car
  - /< motorcycle
  - /j jeep
  - /b bicycle
  - /e equestrian
  - /u (semi-)truck
  - /v van
  - /- house

- **6** Set Beacontext
  It is possible to add a short string of text with each position report (max. 31 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.
- **7** Enable SmartBeaconing
  This option is a short-cut for setting “3 Beacon interval” at zero (0). This option is not visible if SmartBeaconing is already enabled.
- **8** 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".
- **9** Set Slow speed threshold
  The speed threshold (in knots) that will cause beacons at the rate specified above.
  (1 knott = 1.852 km/h = 1.1508 mph)
- **A** 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.
- **B** Set Fast speed threshold
  The speed threshold (in knots) that will cause beacons at the rate specified above.
  (1 knott = 1.852 km/h = 1.1508 mph)

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

8 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 following SmartBeaconing™ behavior will our;

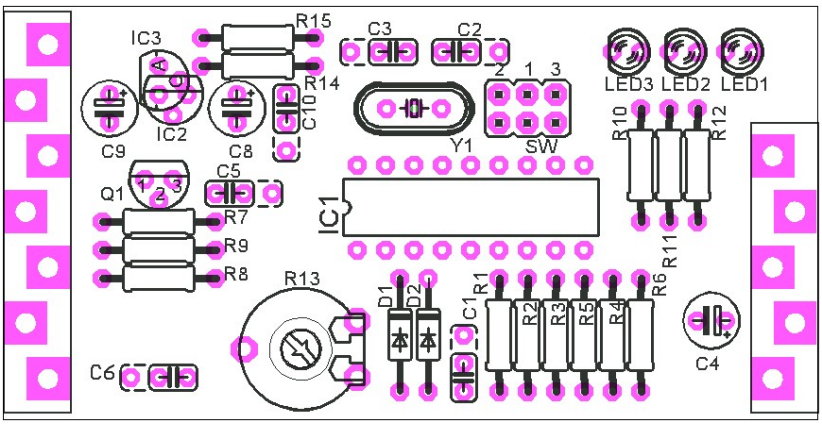
When stationary the time between transmissions is 20 minutes. This interval becomes gradually shorter as speed increases. When traveling at a speed of 50 knots (93 km/h) the interval has decreased to 90 seconds. A higher speed than 50 knots does not decrease beacon interval.

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).

9 Component Layout



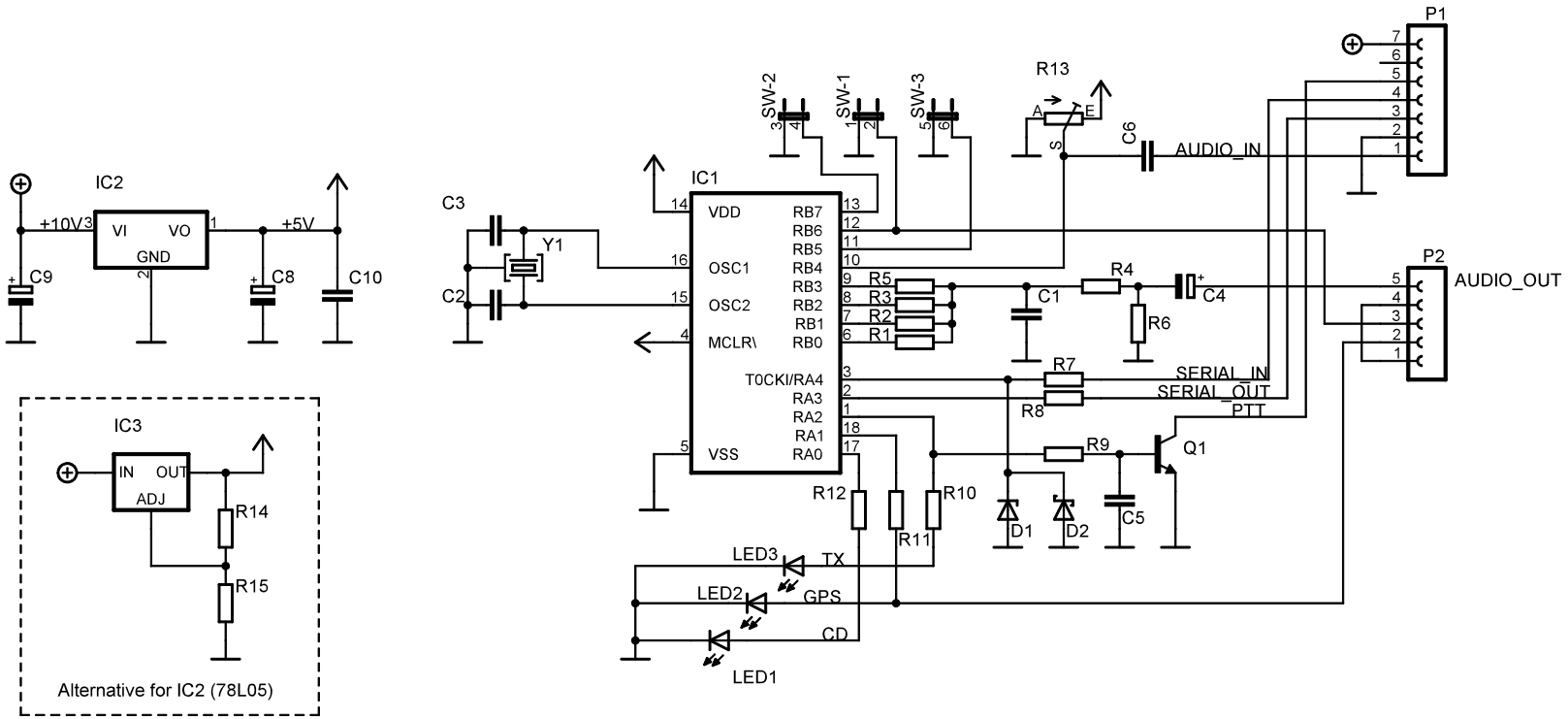
10 Parts List

C5,C6,C10	100n	ceramic 2.5 or 5 mm pitch	
C2,C3	22p	ceramic 2.5 or 5 mm pitch	
C4,C8,C9	2u2	electrolytic radial	
D1	BZX79C5V1	DO35	
D2	BAT85 of BAT43	DO35	
IC1	PIC16F628A-I/P	DIL18	
IC2	78L05	TO92	
Q1	BC547B	TO92	
R1	8k2	1/4W	
R2	3k9	1/4W	
R3,R9	2k	1/4W	
R4	100k	1/4W	
R5	1k	1/4W	
R6,R7	10k	1/4W	
R8	330	1/4W	
R13	10k	Adj. potm 10mm	
Y1	10MHz	crystal hc49/u	
IC voet	18 pins	turned contacts	
R11	150	1/4W	(optional)
LED2	LED groen	3 or 5 mm	(optional)

Even though C1 is drawn in the schematic and the component layout, it is not mounted on the PCB. The KF161 already has suffiencent filtering of the audio input signal. By omitting C1 the audio will sound less dull.

11 Information

On the Internet you can find lots and lots of information about APRS. These are a few links:
http://www.veron.nl/tech/aprs/
http://sharon.esrac.ele.tue.nl/users/pe1rxq/aprstracker/aprstracker.html
http://sharon.esrac.ele.tue.nl/users/pd0sbh/
http://www.qsl.net/on6bvk/aprs.htm



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