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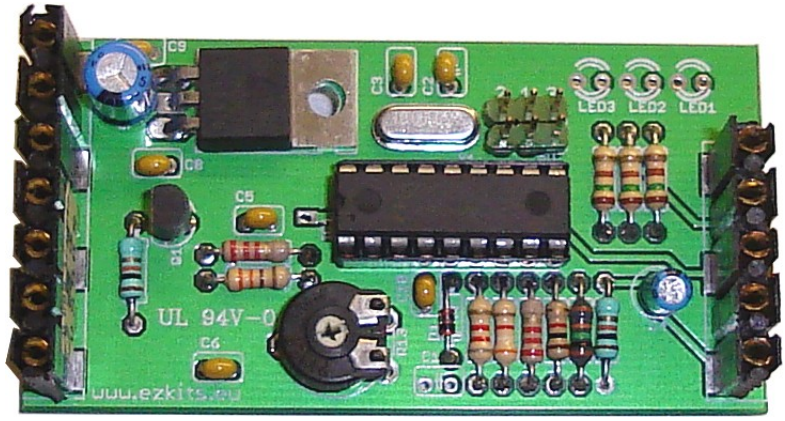
KF161-Tracker



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Contents

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APRS is a trademark of Bob Bruininga
TinyTrak is a trademark of Byon Garrabrant
SmartBeaconing was invented by Steve Bragg and Tony Arnerich
Soldering tips and graphics kindly provided by Dolf Spoor PA3EGT

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.

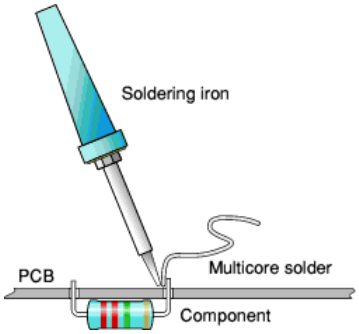
Design Considerations

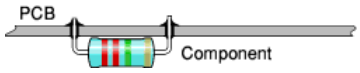
There is plenty of room inside the KF161 to fit an APRS tracker PCB assembly. All the necessary signals are available on the connections to the tone decoder. This tone decoder is not used anymore, so it is a logical choice for fit the APRS tracker in its place.

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

Soldering Tips



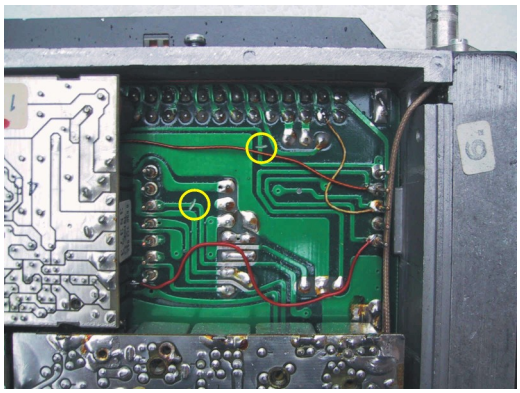


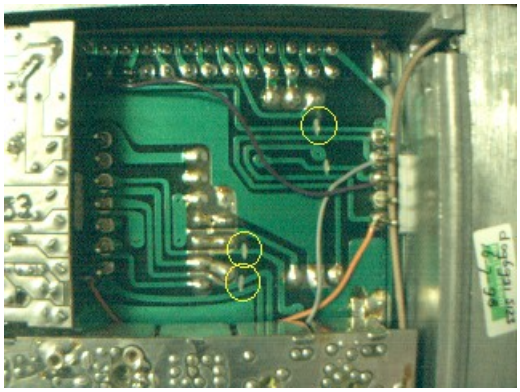
Soldering is not difficult. However, if you are completely unexperienced, or if it has been a long time ago since you've last soldered electronic components, you may wish to practice a bit on some old PCBs and components. If you still don't feel confident, ask an electronics hobbyist for assistance. There are many electronics enthusiasts around and most of them will be delighted to help you out. The PCB in the kit is of professional quality. It contains tracks on both sides and the holes are through plated. The latter is particularly useful as it will help the solder to flow better, resulting in a better connection. Use a good quality soldering iron with a small tip of about 25 to 40 Watt. If the iron is too hot, you are likely to damage the components. If it's too cold, it takes too long for the solder to start flowing, which may also cause damage. Wipe the tip often on a wet sponge or cloth to keep it clean. Then apply solder to the tip to give it a wet look. This will protect the tip, improve transfer of heat and enables you to to make good quality solder joints. Always use appropriate multi-core solder. Don't use solder paste or solvents. You may want to bend the leads of the component a little bit, to ensure that they stay in position when you turn the PCB upside down. Don't bend the leads too much! Some components get easily damaged when the leads are bent too far. Furthermore, it may result in badly soldered connections and may even lead to short circuits. You may also use a sponge to keep the components pressed to the PCB when turning the board. Please note that the PCB has two sides. One side has got the numbers of all components printed on it. This side is called the Component Side. Unless stated otherwise, all components must be fitted at the component side. The leads of each component must be soldered at the other side of the board (at the soldering side). Please note that some components, such as resistors, have no polarity and may be fitted either way around. Other components, such as diodes, transistors and ICs, MUST be fitted exactly in the way it is printed at the component side of the PCB.

Disassembly

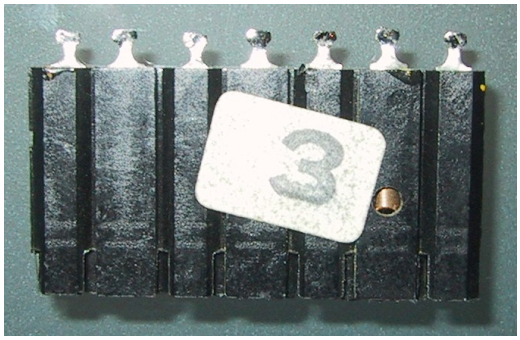
Open the KF161 and remove the tone-call assembly from its connectors. You can do this by carefully prying the PCB assembly from all sides with a flathead screwdriver. Remove the shielding foil which is laying under the PCB assembly.

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.

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.

Start with mounting all resistors and diode.

When mounting the crystal make certain to insert it in the mylar spacer to isolate it from copper traces and pads on the board.

Mount the 18 pin socket for IC1.

Mount potentiometer R13.

Mount all ceramic capacitors.

Next, mount Q1 and IC2.

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

The LEDs 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).

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.

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.

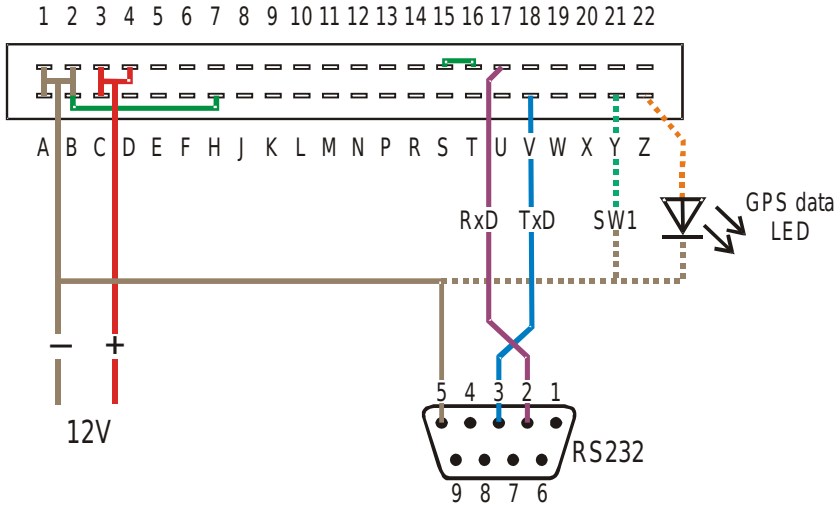
The KF161 transceivers, which are available for purchase from the Museum Jan Corver, have been used in a mobile network using Phase-Modulation (PM). For packet radio we use Frequency-Modulation (FM). By placing one wire jumper on the modulation amplifier the KF161 is suitable for FM. On the PCB this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

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.

Software

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

- Firmware
- Configuration software

Firmware

Firmware is the embedded software that controls the PIC micro-controller. The PIC micro-controller that is included with the KF163-Tracker has been pre-programmed with firmware. We chose to use the open source Aprstracker firmware which provides all functions that you expect of a tracker. This firmware understands GPRMC, GPGGA and GPVTG GPS data, does smart beaconing, proportional pathing, is configurable via a serial null-modem cable, and rapports course, speed and height.

Aprstracker is originally written by Jeroen/PE1RXQ. Version 0.7 was the first public release of aprstracker. 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.

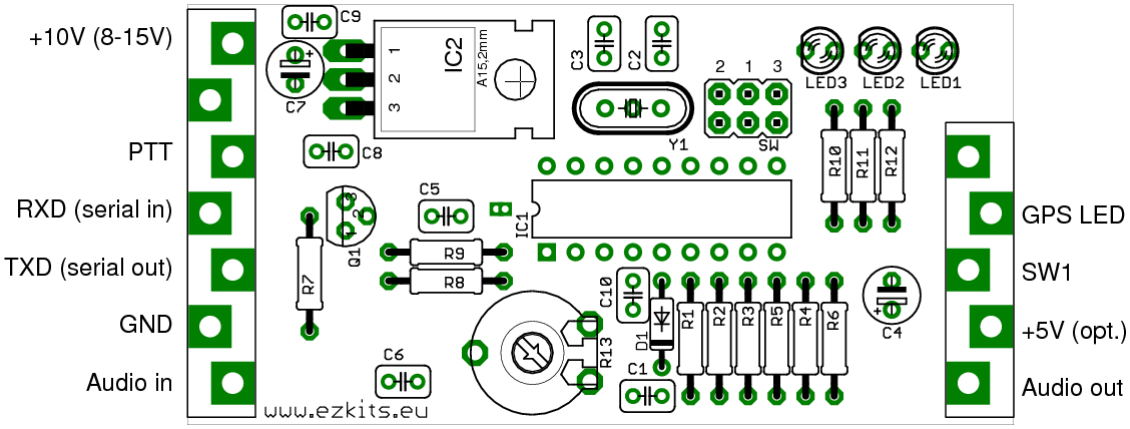
Configuration Software

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

Refer to the Aprstracker documentation for configuration instructions and information about firmware options.

Component Layout



Parts List

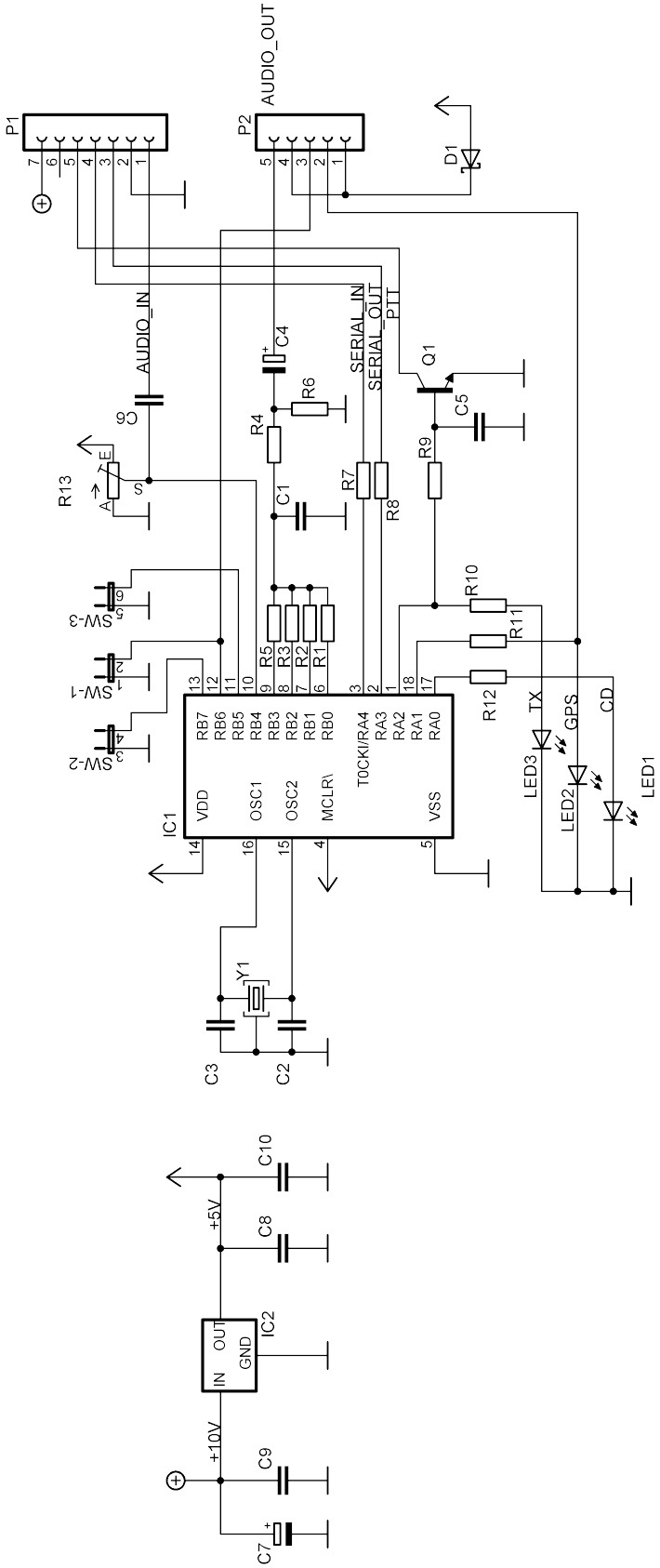
Qty	Part	Value
5	C5, C6, C8, C9, C10	CAPACITOR, CERAMIC 100nF 50V
2	C2,C3	CAPACITOR, CERAMIC 22pF 50V
1	C4	CAPACITOR, ELECTROLYTIC RADIAL 1µF (or 2µ2)
1	C7	CAPACITOR, ELECTROLYTIC RADIAL 47µF
1	D1	DIODE, SCHOTTKY, BAT85 (or BAT48) **(IMPORTANT: see note)**
1	IC1	MICROCONTROLLER, PIC16F648A-I/P
1	IC2	VOLTAGE REGULATOR, LM7805CT
1	Q1	TRANSISTOR, NPN BC547C TO-92
1	R1	RESISTOR, 0.25W 8k2Ω (color coded gray red red gold)
1	R2	RESISTOR, 0.25W 3k9Ω (color coded orange white red gold)
2	R3,R9	RESISTOR, 0.25W 2kΩ (color coded red black red gold)
1	R4	RESISTOR, 0.25W 100kΩ (color coded brown black yellow gold)
1	R5	RESISTOR, 0.25W 1kΩ (color coded brown black red gold)
2	R6,R7	RESISTOR, 0.25W 10kΩ (color coded brown black orange gold)
4	R8,R10, R11, R12	RESISTOR, 0.25W 330Ω (color coded orange orange brown gold)
1	R13	10 kΩ
1	Y1	Crystal 10 MHz HC49/4H
1	-	Mylar insulator for HC49 crystal
1	-	18 pins IC socket
1	LED1	LED yellow, (3 or 5 mm)
1	LED2	LED groen, (3 or 5 mm)
1	LED3	LED red, (3 or 5 mm)

Note: D1 is optional. It routes the 5V supply to the KF161 rear connector. But some KF161 are modified and use these lines for something else. Verify first if this connection is not used for some other signal. If in doubt, then do not place D1.
Even though C1 is drawn in the schematic and the component layout, it is not mounted on the PCB. The KF161 already has sufficient filtering of the audio input signal. By omitting C1 the audio will sound less dull.

Information

On the Internet you can find lots and lots of information about APRS. These are a few links:
http://info.aprs.net/
http://sharon.esrac.ele.tue.nl/~pe1icq/projects/aprstracker.shtml
http://sharon.esrac.ele.tue.nl/users/pd0sbh/
http://www.qsl.net/on6bvk/aprs.htm

Schematic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Document Number: SCH/PBA10101
REV: B
Date: 2007-03-15 02:13:07
Sheet: 1/1
P1
P2
AUDIO_OUT
AUDIO_IN
SERIAL_IN
SERIAL_OUT
PTT
D1
Q1
C1
C2
C3
C4
C5
C6
C7
C8
C9
C10
R1
R2
R3
R4
R5
R6
R7
R8
R9
R10
R11
R12
R13
SW-1
SW-2
SW-3
IC1
IC2
Y1
LED1
LED2
LED3
TX
GPS
CD
+5V
+10V
IN
OUT
GND
VDD
VSS
OSC1
OSC2
MCLR\
T0CKI/RA4
RA0
RA1
RA2
RA3
RB0
RB1
RB2
RB3
RB4
RB5
RB6
RB7