EZ Kits by illumicon

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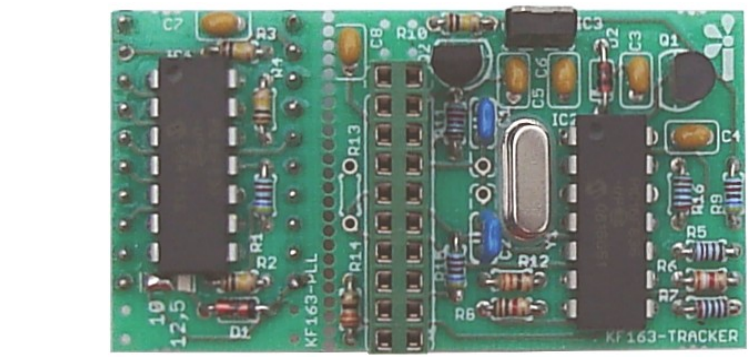
KF163-Tracker



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Contents

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Introduction

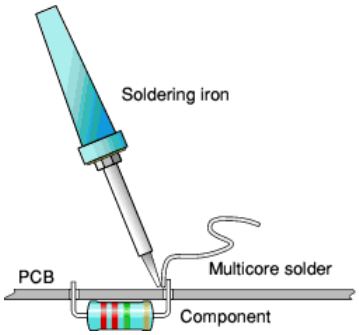
APRS stands for: Automatic Positioning Reporting System. It is possible to report your current position with a transceiver when it is connected to a suitable modem. The KF163-Tracker is such a modem. It is designed to fit inside a Bosch KF163 mobile transceiver.

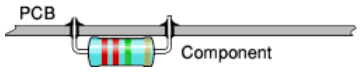
Design Considerations

There is plenty of room inside the KF163 to fit an APRS tracker printed circuit board (PCB) assembly. All the necessary signals are available on the connector 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. The KF163 uses an on-board supply of 8 V. The tracker will derive it's 5 V supply voltage from this 8 V. The tracker's 5 V regulator is powerful enough to also supply most external GPS receivers. It can supply up to 500 mA.

One of the design goals was to minimize the number of needed modifications to the KF163 itself. This means that all interconnections are made either on the KF163-Tracker PCB itself, or on the KF163's rear connector.

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.

Part List

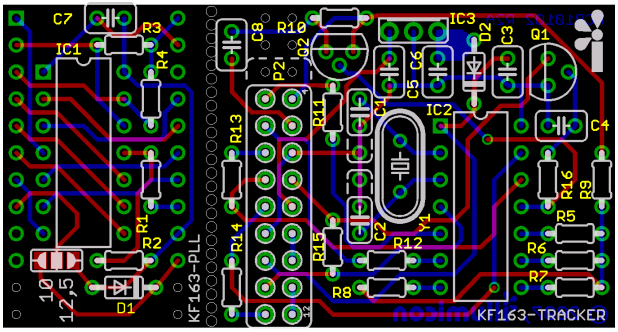
PLL Controller module

Qty	Part	Value
1	C7	CAPACITOR, 100nF 50V
1	D1	DIODE, ZENER 500MW 5.1V, BZX79-C5V1
1	IC1	MICROCONTROLLER PIC16F630-I/P
1	P1	HEADER, 1 ROW 20POL. DIL24/20
1	R1	RESISTOR, 0.125W 47kΩ (color coded yellow purple black red brown)
3	R2, R3, R4	RESISTOR, 0.125W 100kΩ (color coded brown black yellow gold)
1		PCB PLL CTL (combined with KF163-Tracker)

Tracker module

Qty	Part	Value
2	C1, C2	CAPACITOR, 22pF 50V
5	C3, C4, C5, C6, C8	CAPACITOR, 100nF 50V
1	D2	DIODE, SCHOTTKY DO-34, BAT85
1	IC2	MICROCONTROLLER PIC16F636-I/P
1	IC3	VOLTAGE REGULATOR 0.5A +5.0V, 78M05
1	P2	SOCKET 2x10 POL. FE16-2-4/12B
1	Q1	TRANSISTOR, NPN BC547C TO-92
1	Q2	JFET P-CHANNEL J177 TO-92
2	R9, R15	RESISTOR, 0.125W 47kΩ (color coded yellow purple black red brown)
1	R11	RESISTOR, 0.125W 10kΩ (color coded brown black black red brown)
2	R12, R14	RESISTOR, 0.125W 330Ω (color coded orange orange brown gold)
-	R13	Not used
1	R10	RESISTOR, 0.125W 100kΩ (color coded brown black yellow gold)
1	R5	RESISTOR, 0.125W 8k2Ω (color coded gray red black brown brown)
1	R6	RESISTOR, 0.125W 3k9Ω (color coded orange white red gold)
2	R7, R16	RESISTOR, 0.125W 2kΩ (color coded red black black brown brown)
1	R8	RESISTOR, 0.125W 1kΩ (color coded brown black red gold)
1	Y1	Crystal 10 MHz HC49/4H
1		Mylar insulator for HC49 crystal
1		PCB KF163-Tracker (combined with PLL CTL)

Assembly



Just like a sheet of stamps, the PCB is divided in 2 parts by a line of holes closely drilled next to each other. You can separate the PCB before or after mounting the components on the board. Do not bend and break the board. When bending the board hairline cracks could break the copper traces on he board. Use cutting pliers to cut across the first few holes of the perforation. By doing this the board will break nicely across the perforation. Be carefully, the part you are not holding in your hand will shoot away when you make the cut. You may wish to smooth the jagged edges of the PCB with a file or some sandpaper.

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.

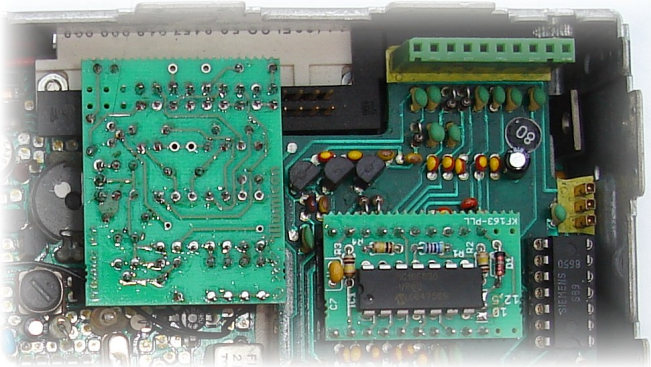
Start by soldering the channel spacing jumper. Place a blob of solder over 2 pads to select either 10 or 12.5 kHz channel spacing (indicated on the board).The 32 channel variety of the kit contains a microcontroller (IC1) that is preprogrammed with 32 frequencies in a 12.5 kHz raster, but you may choose to re-program the PLL controller with frequencies in a 10 kHz raster.

Next, mount all resistors and both diodes. D1 and D2 both are in a small glass DO34 package, and at times the printing on these can be hard to read. It is important that you do not mix up these two types. D1 is slightly bigger than D2. If needed use a magnifying glass and a bright light to identify each 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.

Connector strip P2 needs special attention. First it needs to be cut in 2 equal halves, resulting in 2 strips with 10 contacts each. Use sharp cutting pliers, or an X-acto knife to make a clean cut. **IMPORTANT:** These 2 strips are the only parts that are mounted from the soldering side of the PCB, i.e. these are soldered at the component of the board. Before soldering take care of 2 things. **IMPORTANT:** The pins in the strips are thicker on one end than the other end. The thick end goes in the PCB and is soldered. Also take care that the pins are soldered in straight. If the pins are fixated pointing inwards or outward, the circuit board may not fit properly in the EPROM socket in the KF163. The easiest way to make certain pins are straight is by placing them in the EPROM socket before soldering the 4 outer pins. Do not push the pins all the way in the EPROM socket, but just sit in in the cups. This is enough to align the pins before fixating them in place.

After mounting all components and separating the board along the perforation, both modules can be inserted in the KF163. See the picture below for orientation of the modules.

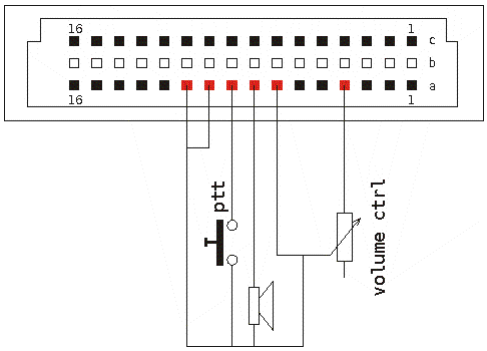


KF163 alignment

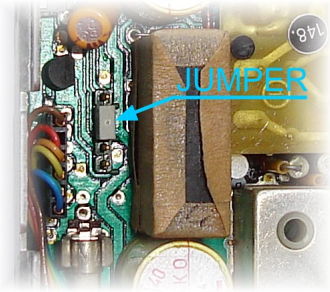
To (re-)align a KF163 to the 2m radio band you need to following tools

1. speaker,
2. PTT switch,
3. 50Ω dummy load,
4. trimmer that properly fits in the KF163's ferrite cores,
5. multimeter,
6. low-power (portable) transmitter, or better a RF signal generator.

First we need to hook up the KF163. Connect the speaker, PTT switch and potentiometer for volume control to the KF163's front connector.

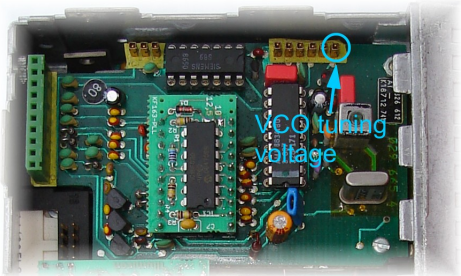


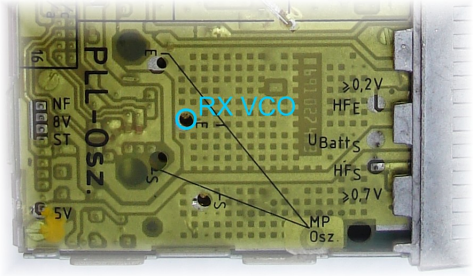
Remove the tone-lock module and remove one of the jumpers on that module and place it on the pin header in the KF163 as shown on the picture below.



Next insert the PLL Ctrl module in the EPROM socket.

Power up the KF163. The receiver should tune to 144.8 MHz if only the VCO were to be tuned within the PLL synthesizer control range. This is probably not the case unless the unit has been tuned to the 2m band before. Measure the VCO control voltage on the measuring point indicated by the circle in the picture below. Trim RX-VCO until the VCO control voltage is about 4V (+/- 0.2V).

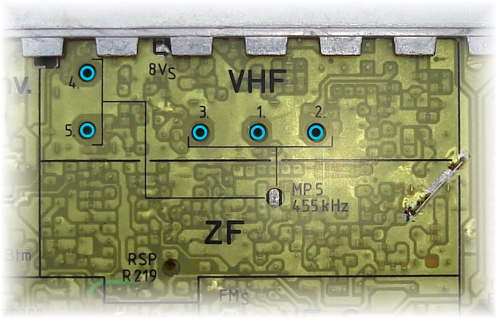




Insert a piece of wire (about 50 cm) in the antenna socket of the KF163. Take a 2nd transmitter (e.g. a low-power hand-held transceiver), connect a 50Ω dummy load, tune it to 144.8 Mhz and turn on it's transmitter. You should now hear the carrier on the KF163 receiver. Alternatively connect a RF signal generator with appropriate attenuators and 1000Hz modulation, +/- 1.5 kHz deviation, to the KF163.

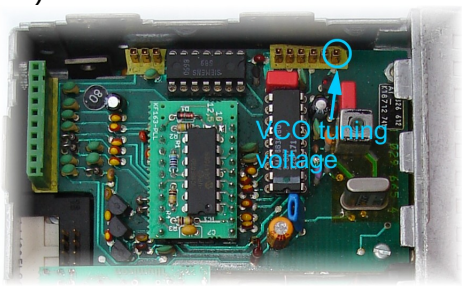
Now place the transmitter at some distance until the signal becomes noisy and is barely detectable. The coils that need to be trimmed are marked with numbers 1, 2, 3, 4 and 5 on the yellow overlay (see picture). Start alignment by trimming in the order 1—2—3—4—5. Increase the distance of the signal source (the 2nd transmitter) if the signal gets too strong. If you do not feel

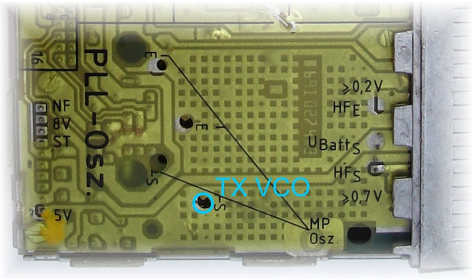
comfortable tuning by ear, or if you have an oscilloscope or RF milli-voltmeter, then connect it to measuring point no. 5 (MP5) and tune to max. signal. If the RF voltage on MP5 gets above 60mV then reduce the RF input signal (i.e. increase distance of the 2nd transmitter). Repeat the sequence in the order 4—5—3—1—2.



If needed you can adjust the squelch setting with R219.

Last thing to do is tune the TX VCO. Connect a 50 Ω dummy load to the KF163 antenna connector. Close the PTT switch and measure the VCO control voltage on the measuring point indicated by the circle in the picture below. Trim TX-VCO until the VCO control voltage is about 4V (+/- 0.2V).





That's it, you're done! The KF163 as available from museum “Jan Corver” do not need further alignment.

Software

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

- Firmware
- Configuration software

Aprstracker 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.

Aprstracker 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. Connect the serial-data-in, serial-data-out, and ground on the KF163 front side connector to a sub-D female connector. Make the following connections:

- KF163 pin c4 to sub-D pin 2
- KF163 pin c5 to sub-D pin 3
- KF163 pin c9 to sub-D pin 5

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

KF163 PLL Firmware

The firmware for the KF163 PLL module comes in 2 varieties, KF163PLL8 and KF163PLL32.

KF163PLL8 is a variety intended for APRS usage. It is available via www.jancorver.org. KF163PLL8 is preprogrammed with 8 APRS VHF channels. Channel selection inputs are read at power-up and cannot be changed during operation. Also the 8 memory channels are not user-programmable.

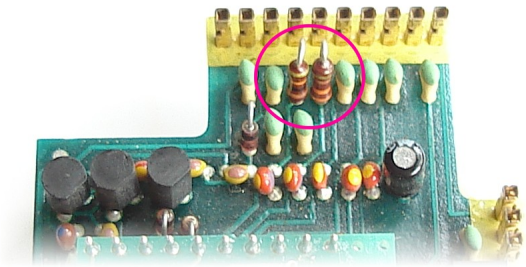
KF163PLL32 is the variety with 32 user-programmable memory channels. It is available via www.ezkits.eu. This variety has 5 address input lines to select up to 32 different frequencies.

KF163 PLL Configuration Software

The KF163PLL32 variety contains a microcontroller (IC1) that is preprogrammed with 32 frequencies in a 12.5 kHz raster, but you may choose to re-program the PLL controller with frequencies in a 10 or 12.5 kHz raster. The only restriction is that all 32 memory channels use the same raster.

To communicate with a PC the KF162PLL32 uses 2 of its address lines as a serial interface. During the first second after powering up the KF163, the KF163PLL32 polls if it is connected to a PC that is running the KF163PLL Configuration utility. If it is not, then it resumes normal operation after one second and all address lines function as inputs for channel selection.

Before you make serial connections to a PC, you need to make some modifications on the VFO module. Replace 2 diodes with a 10k and a 330Ω resistor. (see photo)



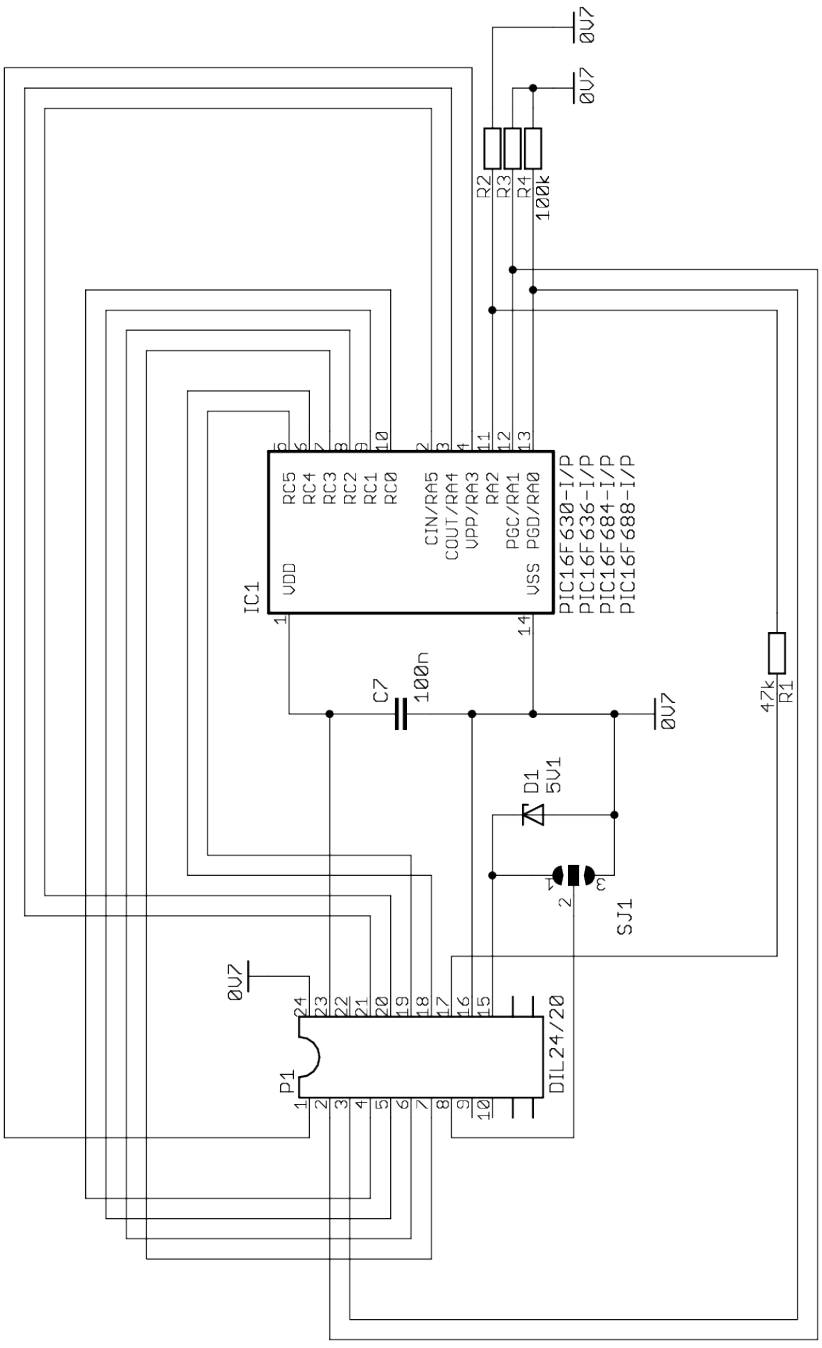
To reconfigure the memory channels of the PLL connect the PLL-serial-data-in, PLL-serial-data-out, and ground on the KF163 front side connector to a sub-D female connector. Make the following connections:

- KF163 pin a12 to sub-D pin 2
- KF163 pin a13 to sub-D pin 3
- KF163 pin a11 to sub-D pin 5

Important: Do not connect the PLL to a PC's serial port without making the modifications as indicated on the photo above first. If you ignore this warning, and connect without these 2 resistors in place, you will permanently damage the PIC-microcontroller IC1.

Boot the PC from the bootable CDROM. After initialization, the Apprstracker config utility starts. Quit the Aprstracker config utility with Ctrl-C. Then start the PLL config utility by typing `setmem` followed by Enter.

Schematic



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Document Number: SCH/PBA10102

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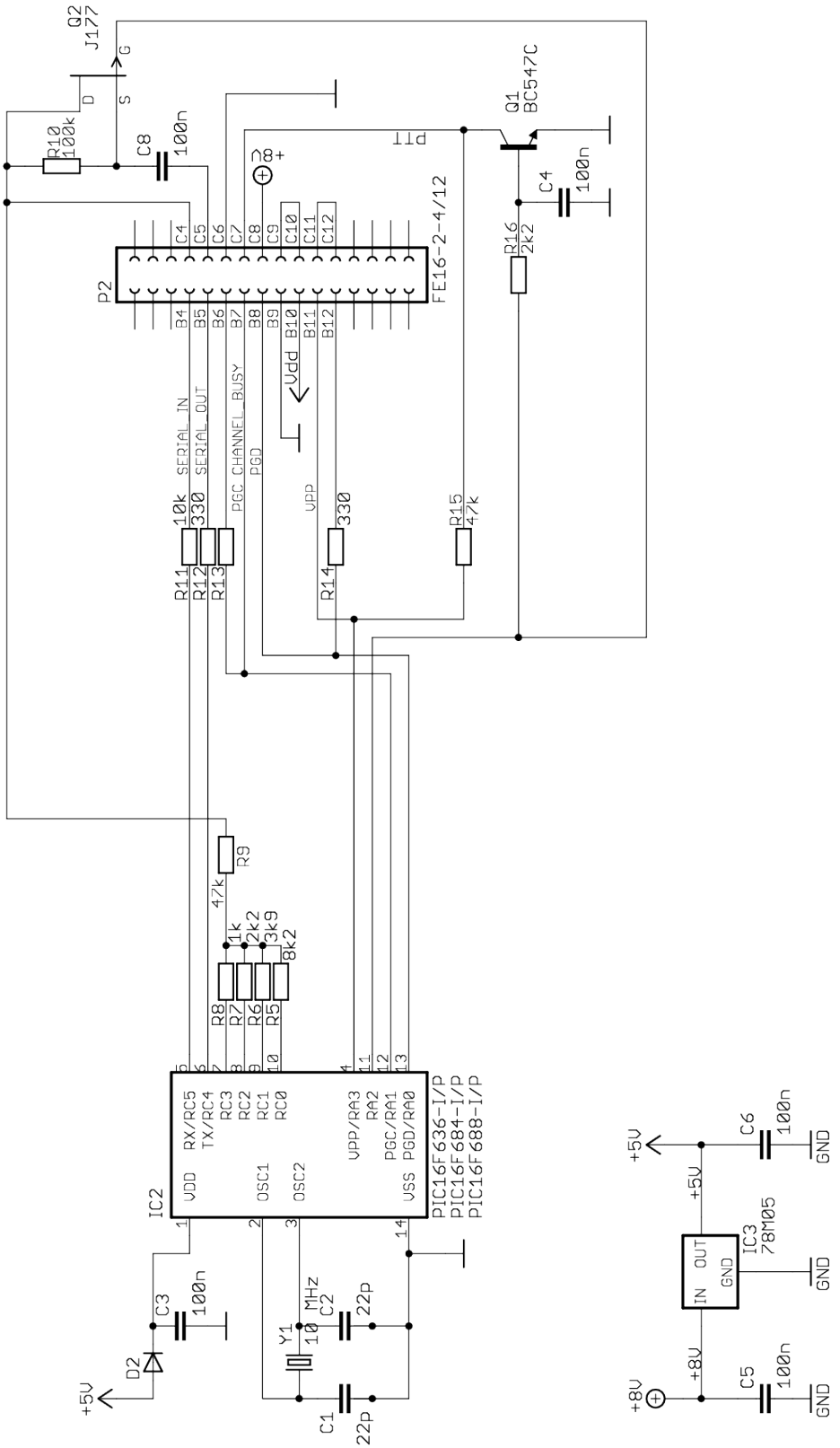
Date: 2007-02-04 19:21:44

Sheet: 1/2

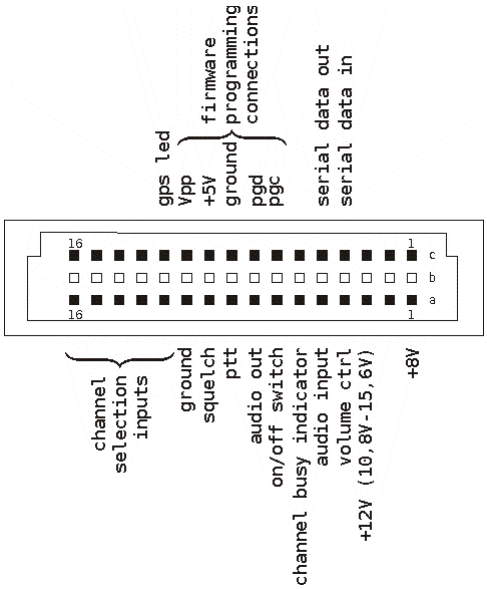
This circuit is an alternative for the CDP18U42 EPROM for usage in the Bosch KF163

Solder Jumper SJ1:
1-2: 10 kHz channel spacing
2-3: 12.5 kHz channel spacing



Connections

The KF163 front connector pin assignments are as follows;



All connections are relative to ground. Inputs for channel selection, squelch, ptt and on/off switch can be left open (floating) when unused. Otherwise simply connect inputs lines to ground. Volume control is a variable resistor connected to ground.

The channel busy input for the tracker is on pin c7. For channel free/busy detection to work, you have to connect pin a6 to pin c7 on the connector.

Serial data in/out are used to connect a GPS receiver and also used for connection with a PC to configure the tracker. See aprstracker documentation for configuration directions.

The PLL channel controller comes in two varieties, KF163PLL8 and KF163PLL32.

KF163PLL8 is a variety intended for APRS usage. It is available via www.jancorver.org. KF163PLL8 is preprogrammed with 8 APRS VHF channels. Channel selection inputs are read at power-up and cannot be changed during operation. Also the 8 memory channels are not user-programmable.

The following APRS frequencies can be selected;

10 kHz channel spacing
a12-a16 open: 144.800 MHz a16 grounded: 144.640 MHz a15 grounded: 144.930 MHz a14 grounded: 144.350 MHz a13 grounded: 144.390 MHz a12 grounded: 144.990 MHz

12.5 kHz channel spacing
a16 & a15 grounded: 145.175 MHz a16 & a14 grounded: 144.575 MHz

KF163PLL32 is the variety with 32 user-programmable memory channels. It is available via www.ezkits.eu.

This variety has 5 address input lines to select up to 32 different frequencies. The kit contains a microcontroller (IC1) that is preprogrammed with 32 frequencies in a 12.5 kHz raster, but you may choose to re-program the PLL controller with frequencies in a 10 kHz raster. The following frequencies are preprogrammed in IC1.

Connector pin					Address	Frequency (MHz)
a12	a13	a14	a15	a16		
X	X	X	X	X	0	145.200
X	X	X	X		1	145.225
X	X	X		X	2	145.250
X	X	X			3	145.275
X	X		X	X	4	145.300
X	X		X		5	145.325
X	X			X	6	145.350
X	X				7	145.375
	X	X	X	X	8	145.400
	X	X	X		9	145.425
	X	X		X	10	145.450
	X	X			11	145.475
	X		X	X	12	145.500
	X		X		13	145.525
	X			X	14	145.550
	X				15	145.575
X		X	X	X	16	145.000 - 145.600
X		X	X		17	145.0125 - 145.6125
X		X		X	18	145.025 - 145.625
X		X			19	145.0375 - 145.6375
X			X	X	20	145.050 - 145.650
X			X		21	145.0635 - 145.6625
X				X	22	145.075 - 145.675
X					23	145.0875 - 145.6875
		X	X	X	24	145.100 - 145.700
		X	X		25	145.1125 - 145.7125
		X		X	26	145.125 - 145.725
		X			27	145.1375 - 145.7375
			X	X	28	145.150 - 145.750
			X		29	145.1625 - 145.7625
				X	30	145.175 - 145.775
					31	144.800

Note that address bits 3 and 4 are swapped on the KF163 connector.