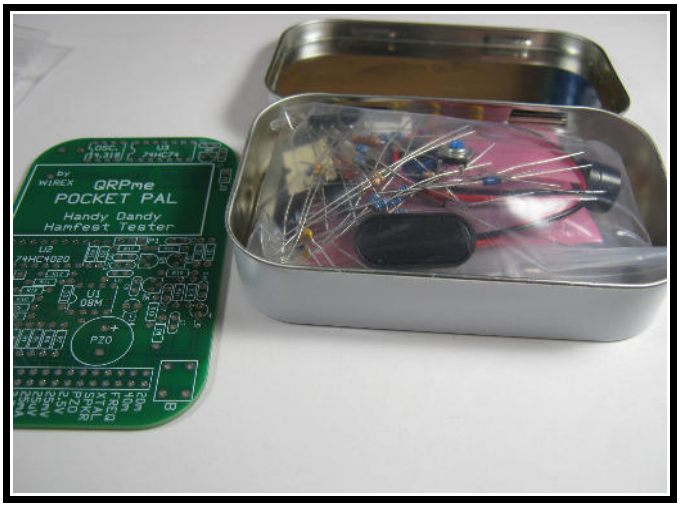
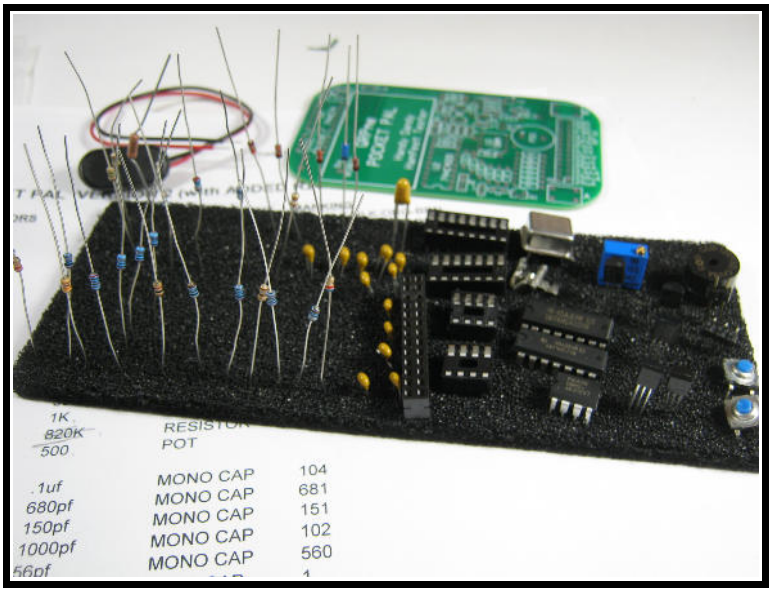
QRPme's
Pocket PAL][
version 2
Builder's Guide

December 11, 2017
by
W1REX

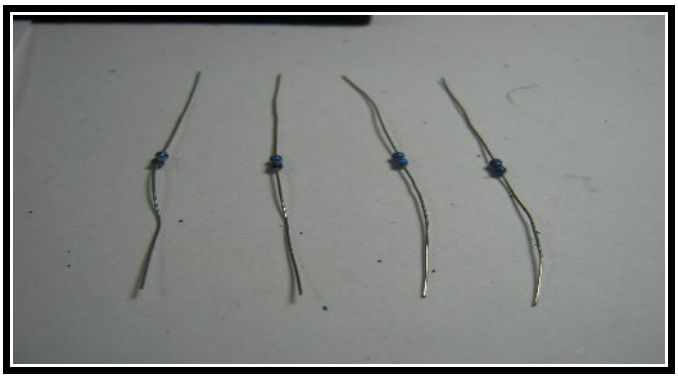


Board, Parts & Tin



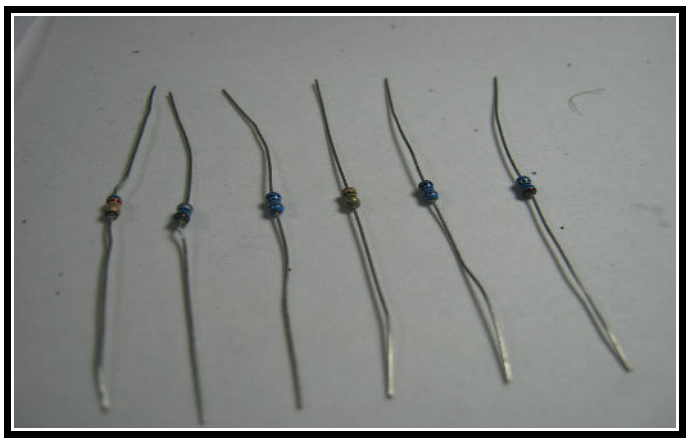
Organized & Ready to build!

You should sort and organize the parts for easy assembly later and to insure that all the parts were included in the kit. Here the caps are organized by increasing pf from front to back. The resistors are sorted right to left and then down to the back in ascending resistance. Sorting AND organizing the parts ONCE will make your build go MUCH faster....



Select resistors R1, R2, R3 & R4.

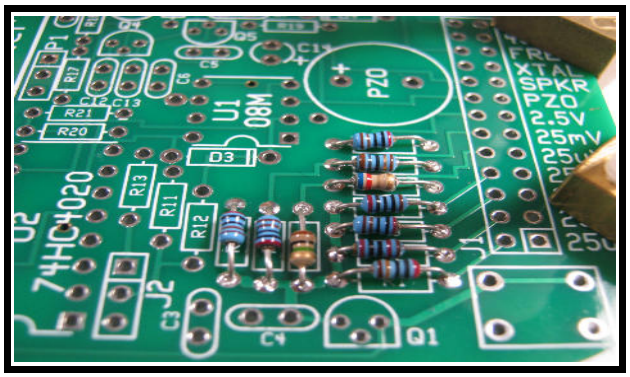
R1 = 200K ohm resistor marked (RED-BRN-YEL) or (RED-BLK-BLK-ORG-BRN)
R2 = 20K ohm resistor marked (RED-BRN-ORG) or (RED-BLK-BLK-RED-BRN)
R3 = 2K ohm resistor marked (RED-BRN-RED) or (RED-BLK-BLK-BLK-BRN-BRN)
R4 = 200 ohm resistor marked (RED-BRN-BRN) or (RED-BLK-BLK-BLK-BRN)
The Pocket PAL resistors are tiny 1/8 watt parts and many of them are close tolerance so they are marked with MANY tiny color bands. I prefer to double check the values with a DMM when I organize them AND before I solder them onto the board. There should be an electronics adage: Measure twice and solder once!
Install them in their respective positions. Use only the minimal amount of solder to complete the soldering of each pad. The pads are pretty small so too much solder could easily 'bridge' to an unwanted spot.



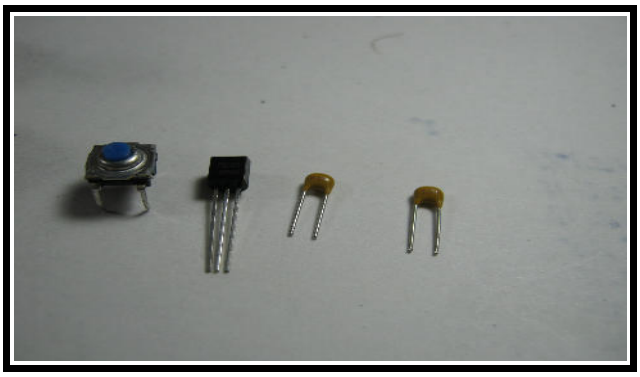
Select resistors R5, R6, R7, R8, R9 & R10.

R5 = 6.2 ohm resistor marked (BLU-RED-GLD-GLD)
R6 = 10 ohm resistor marked (BRN-BLK-BLK-GLD)
R7 = 2K ohm resistor marked (RED-BLK-BLK-BLK-BRN-BRN)
R8 = 1M ohm resistor marked (BRN-BLK-GRN) or 1004F
R9 = 2K ohm resistor marked (RED-BLK-BLK-BLK-BRN-BRN)

R10 = 2K ohm resistor marked (RED-BLK-BLK-BLK-BRN-BRN)
Install in their respective positions.



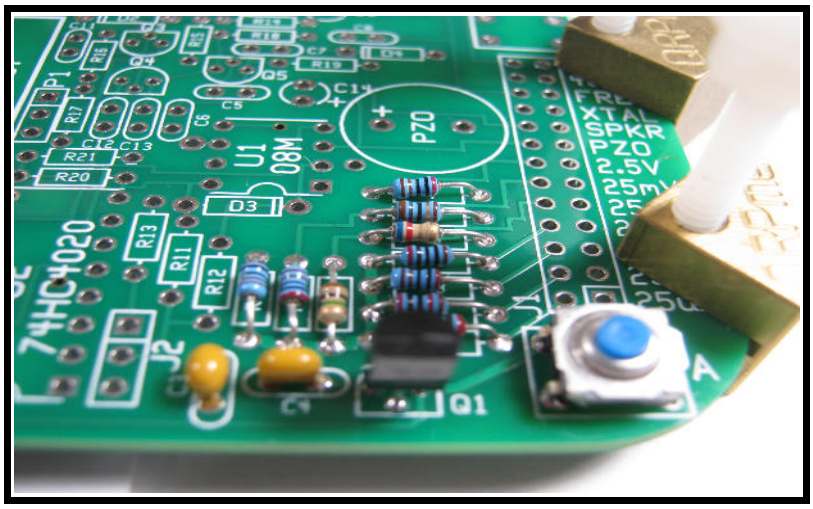
First batch of resistors installed.



Select a tactile switch, LM78L05 and two .1uf (104) caps.

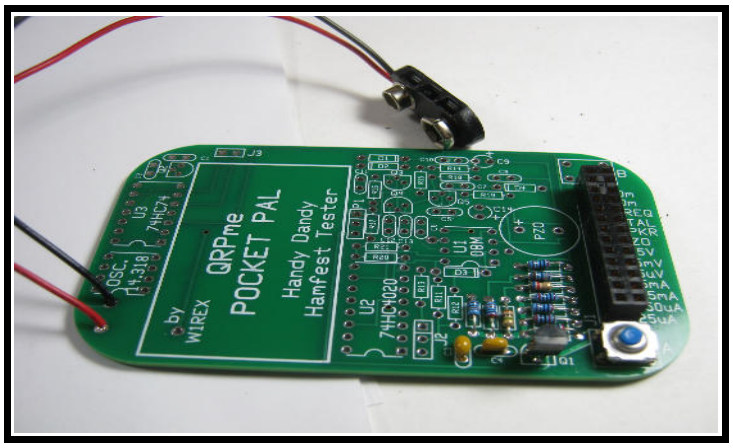
A = Tactile switch
Q1 = LM78L05 voltage regulator
C3 = .1uf capacitor (marked 104)
C4 = .1uf capacitor (marked 104)

Caution: When installing the tact switch, it is NOT square! I found it easiest to take the slight kinks out of the legs with my needle nose pliers before attempting to install them onto the board. You will find that the switch doesn't quite fit the holes one way (the WRONG way) and will easily fit in the holes in the pad when oriented the RIGHT way.



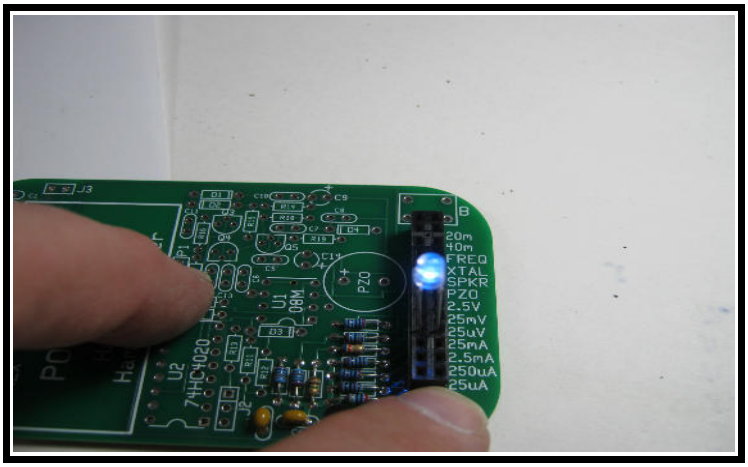
So far so good!

Notice my little BRASS SET holders being used in the assembly of the Pocket PAL....



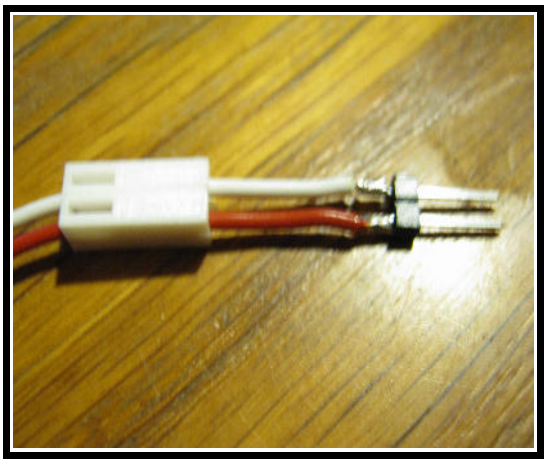
Ready for the first test!

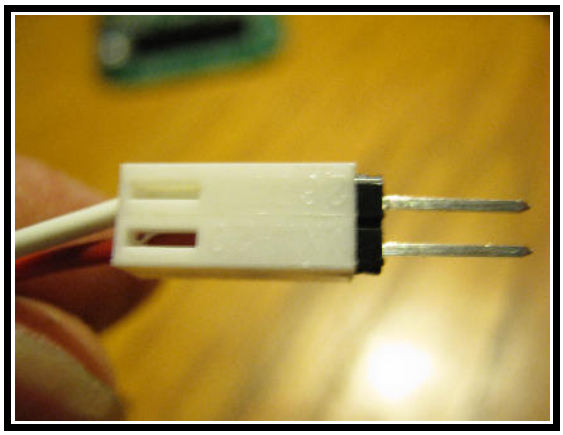
Now solder in the 2x13x.1" header connector and 9 volt battery snap. The + lead goes into the lower pad while the – lead goes into the upper pad where you can see small 'rays' from the pad to the ground plane.

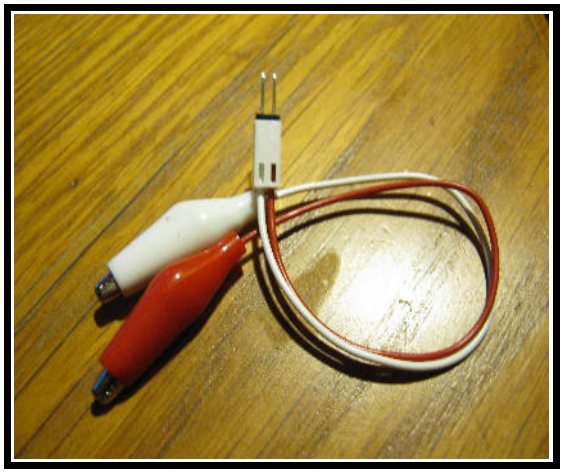


Let their be light!

Install a 9 volt battery in order make a preliminary test. Insert an LED into one of the first 4 pairs of sockets located at the bottom end of the header socket and press and HOLD the A side tactile switch. The socket pairs are labeled 25uA, 250uA, 2.5mA and 25mA. A 'regular' LED will be pretty dim in the 25uA position and increase in brightness when moved up the line to the 25mA slot. SUPER bright LEDs will still have a decent brightness level at the 25uA position. The prime use for the 25uA to 2.5V test positions were for testing meters at a hamfest. I am a sucker for a good meter and sellers usually don't know what the meter movement is.....unless it is marked on the box!
Remember that the tactile switches are momentary action so the Pocket PAL will be on only as long as you press the A or B switch.
Remove the battery before continuing your build.

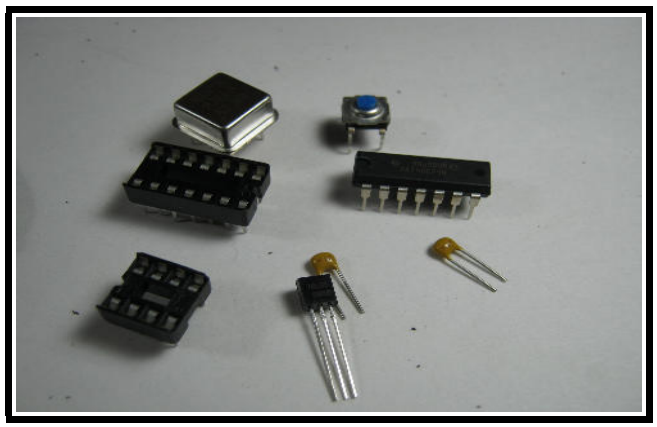






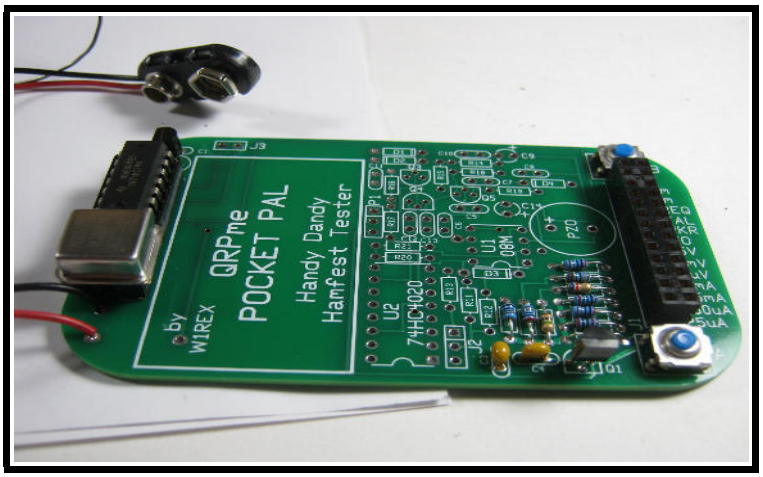
Turn a pair of alligator test leads into a test probe.

Use the 2 pin Molex connector shell, 2 pin header and a ½ pair of generic alligator test clips to make a Pocket PAL test probe. Some things like LEDs and crystals can be plugged directly into their corresponding test positions. Other items like meters require a test probe.



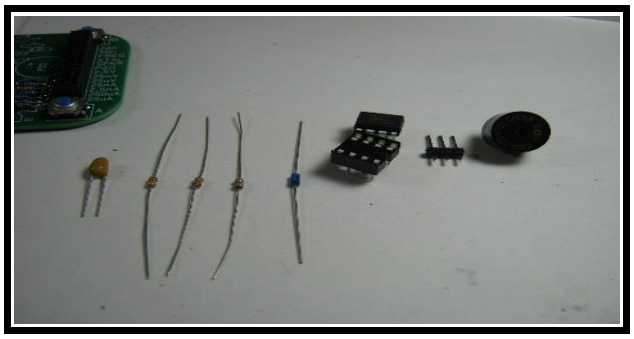
Components for the 20m & 40m test oscillator.

U3 = 14 pin socket and then the 74HC74
OSC 14.318 = 8 pin socket & then the oscillator can. The little dot on the can is pin1
B = tactile switch
Q2 = LM78L05 voltage regulator
C1 = .1uf capacitor (marked 104)
C2 = .1uf capacitor (marked 104)
You might find it easier to install the 74HC74 before the OSC 14.318 can as the spacing is tight. You are installing them into sockets so the order of insertion is quite easy to change....



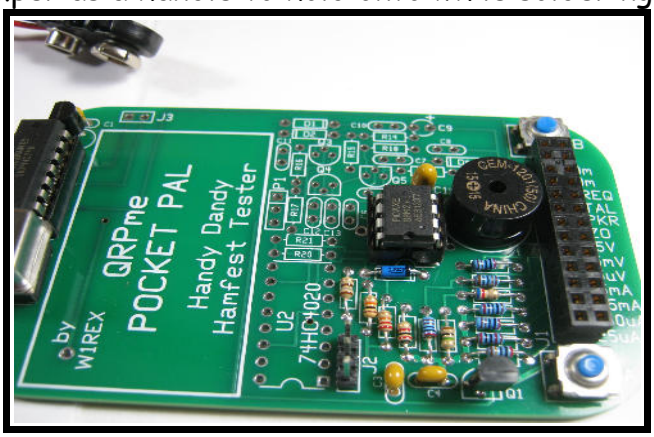
Ready to test an RF receiver.

Install the 9 volt battery again. Pressing the B side switch powers up the 14.318Mhz oscillator can and frequency divider circuit. You can hear the oscillator directly in a nearby receiver or make a direct connection to a circuit under test using the 20m & 40m test positions on the header socket.



And now the BRAINS of the Pocket PAL kit!

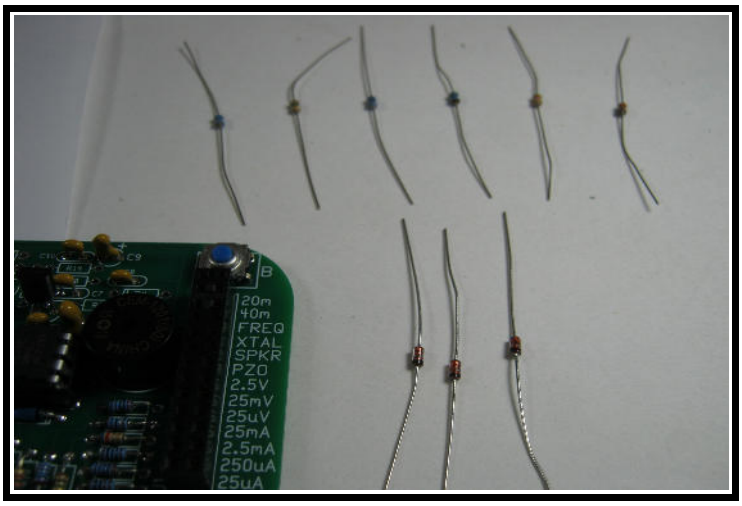
C14 = 10uf electrolytic tantalum capacitor
R11 = 10K ohm resistor marked (BRN-BLK-ORG)
R12 = 22K ohm resistor marked (RED-RED-ORG)
R13 = 180 ohm resistor marked (BRN-GRY-BRN)
D3 = 1N6263 diode
U1 08M = 8 pin DIP socket & then Picaxe 08M microcontroller
PZO = Piezo speaker
J2 = 1x3x.1" male Molex style header connector
All the parts are straightforward to install except the Molex header connector. It is pretty easy to burn your fingertips trying to hold onto the connector while soldering it. I use a 2 pin Molex jumper as a handle to hold onto while soldering.



Ready to try the Picaxe?

The A side tactile switch turns on the voltage and current circuit testing sockets AND the microcontroller. The micro should be pre-programmed and awaiting action! Pressing and holding the A switch will cause the Picaxe to come to life and output the hello message "72 PAL" in Morse code on the piezo sounder.... If the Picaxe has no program, then you need to make a download cable, download and install the editor software from Revolution Education and then download the Pocket PAL from QRPme. The Pocket PAL is designed to be a neat hamfest parts tester AND to be a nice learning tool for BASIC

programming. The microcontroller inside the PAL is very easy to program. It was designed specifically to be THE educational computer in UK school systems.

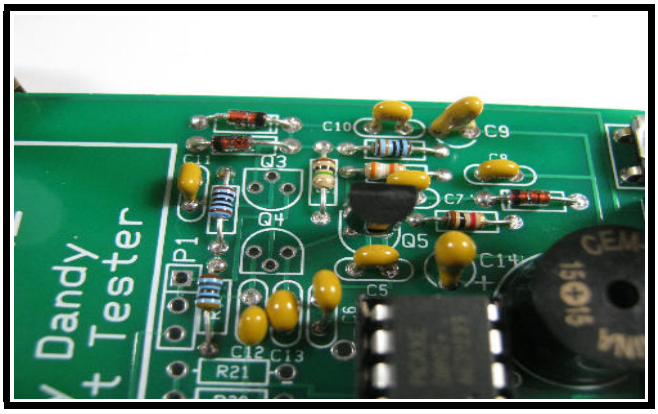


Resistors and diodes for the oscillator section.

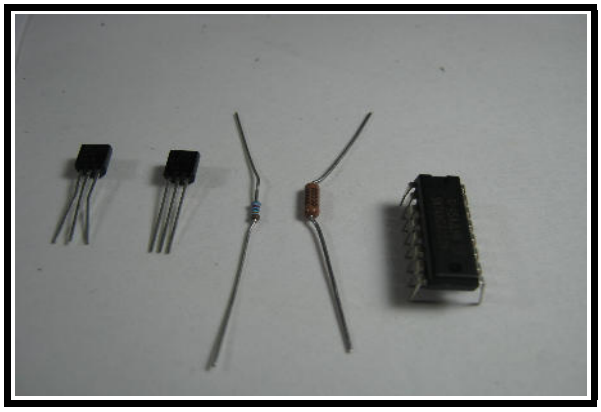
R14 = 100K ohm resistor marked (BRN-BLK-YEL)
R15 = 1M ohm resistor marked (BRN-BLK-GRN) or 1004F
R16 = 100 ohm resistor marked (BRN-BLK-BRN) or (BRN-BLK-BLK-BLK-BRN)
R17 = 300 ohm resistor marked (ORG-BLK-BLK-BLK-BRN)
R18 = 39K ohm resistor marked (ORG-WHT-ORG)
R19 = 1K ohm resistor marked (BRN-BLK-RED)
D1 = 1N4148 Pay attention to the polarity marking on the diodes when installing them.
D2 = 1N4148
D4 = 1N4148

Now move on to the remaining oscillator parts.....

Q5 = PN2222 transistor
C13 = .1uf capacitor (104)
U2 = 16 pin DIP socket
C5 = 680pf capacitor marked (681)
C6 = 150pf capacitor marked (151)
C7 = 1000pf capacitor marked (102)
C8 = 56pf capacitor marked (560)
C9 = 1uf electrolytic tantalum capacitor
C10 = 56 pf capacitor marked (560)
C11 = 470pf capacitor marked (471)
C12 = 1000pf capacitor marked (102)

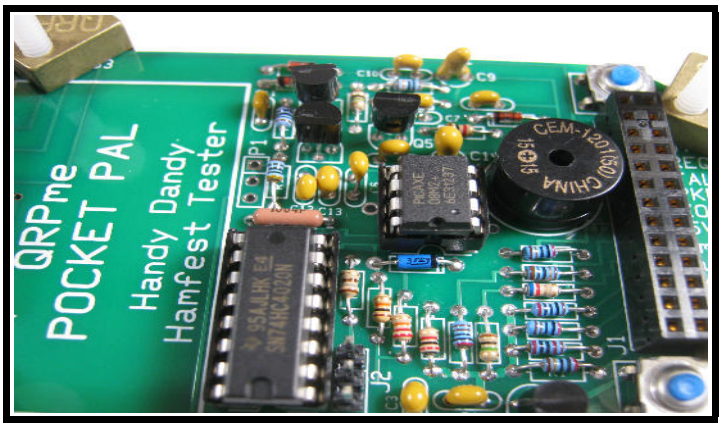


Caps, Diodes & Resistors....

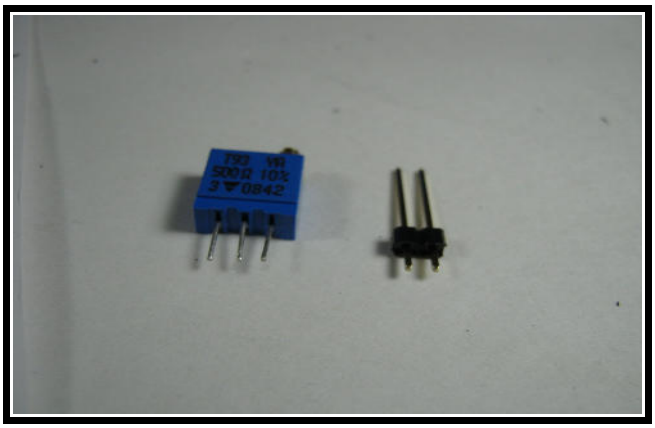


5 EASY pieces...

Q3 = MPF102 transistor
Q4 = 2N4403 transistor
R20 =820K ohm resistor marked (GRY-RED-BLK-ORG-BRN)
R21 = 1M ohm resistor marked (BRN-BLK-GRN) or 1004F
U2 = SN74HC4020 counter IC



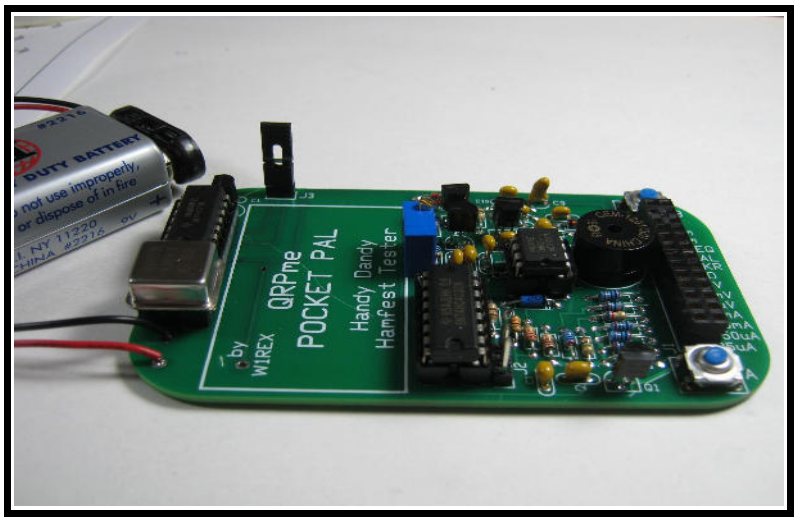
ONLY 2 parts remaining now...



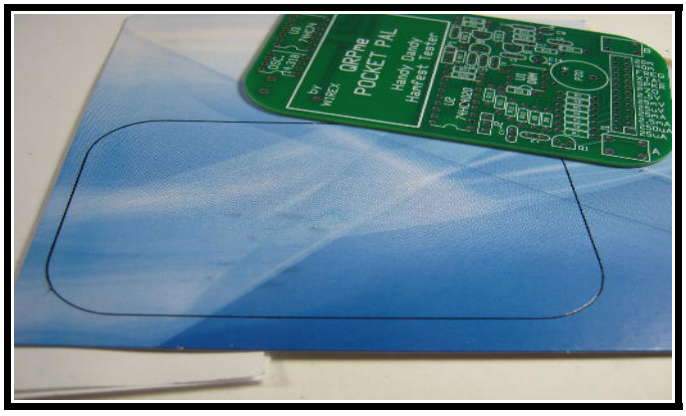
The final 2 parts!

P1 = 500 ohm trimmer potentiometer
J3 = 1x2x.1" male Molex header

The adjustment screw for the pot is of course UP, but I've been told by a beta builder that the preferred orientation is to have the screw to the rear of the pcb.
When the J3 jumper is installed, the 40m output signal will be approximately 5 volts peak to peak. Removing the jumper will cause the 40m output to drop to 2.5 volts peak to peak.



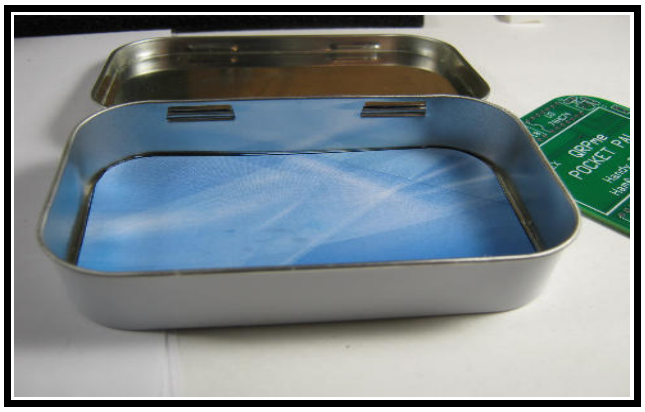
A finished Pocket PAL!



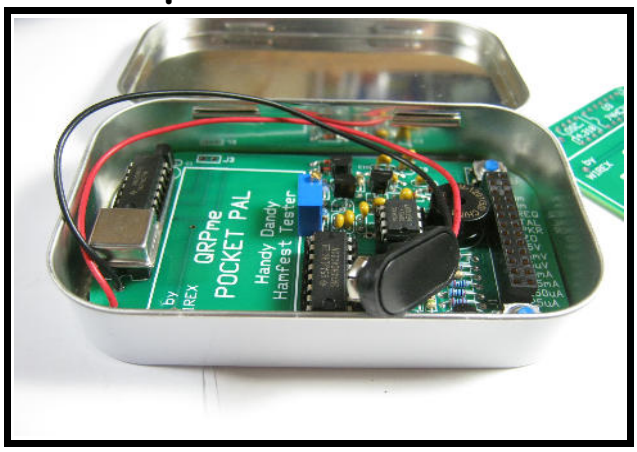
Making an insulator...

Use a piece of <u>not too heavy</u> cardboard as an insulator between the assembled Pocket PAL board and the bottom of the mint tin so the parts pins won't short to the bottom of the tin. Trace out the pcb outline on a scrap piece of cardboard and cut it out. Too thick of an insulator and the cover won't close properly because the battery sticks up too high.

A FREE meter to the FIRST person who can tell me what my piece of cardboard is from!



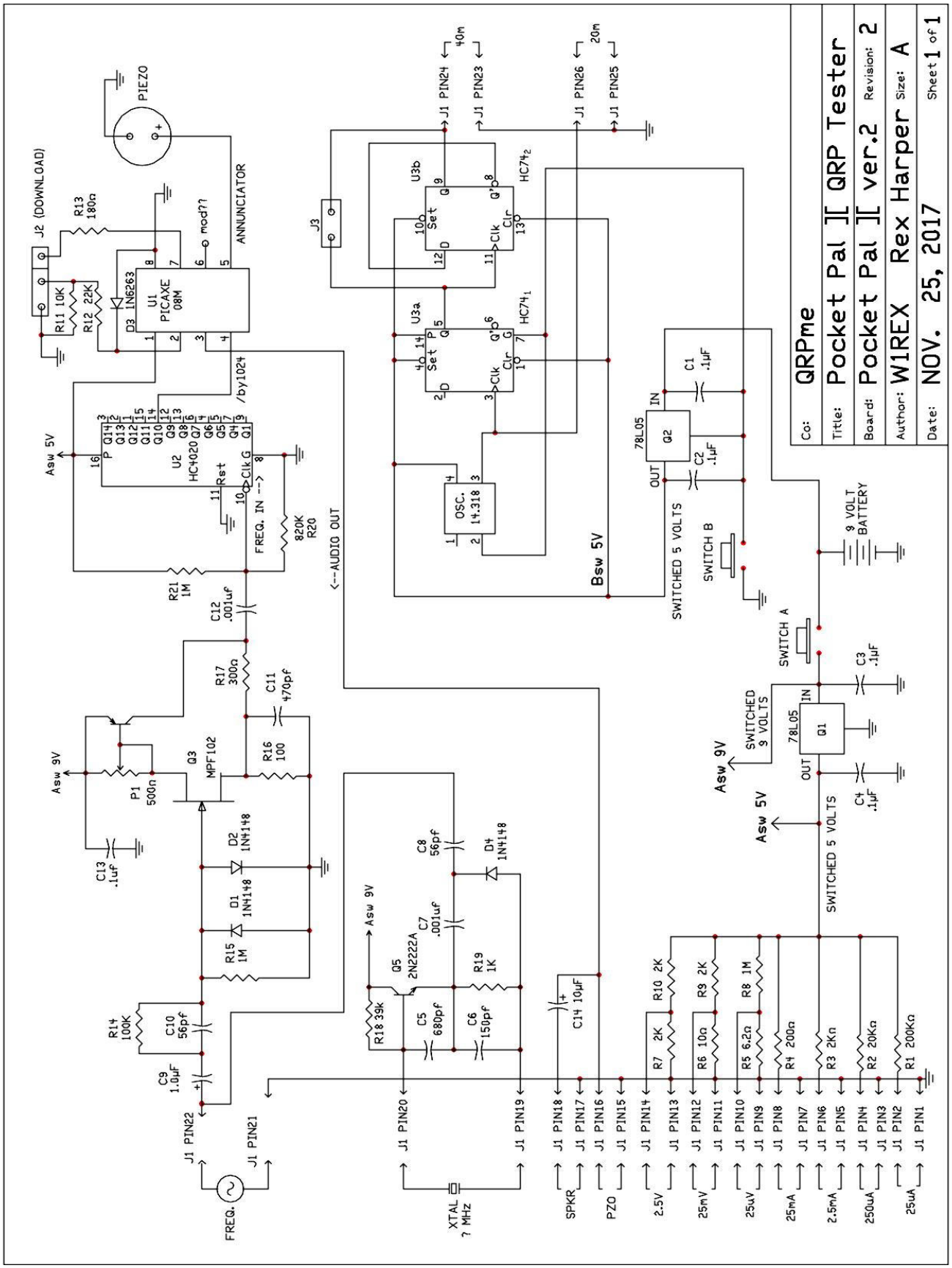
Drop it into the tin...



…followed by the assembled Pocket PAL...

Pocket ready Pocket PAL

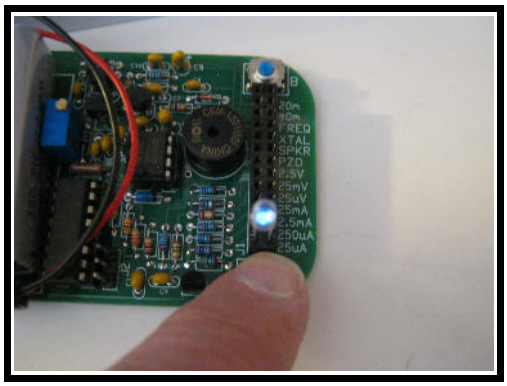
Attach a 9 volt battery to the snap, nestle it inside and you are now ready to find some neat parts at your next hamfest!

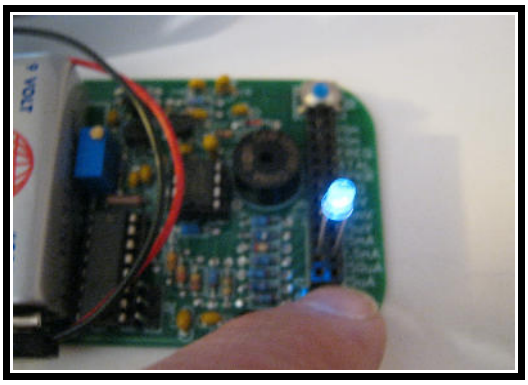

Co: QRPme
Title: Pocket Pal][QRP Tester
Board: Pocket Pal][ver.2 Revision: 2
Author: W1REX Rex Harper Size: A
Date: NOV. 25, 2017 Sheet 1 of 1
P1EZO
J2 (DOWNLOAD)
ANNUNCIATOR
U1 PICAXE 08M
U2 HC4020
U3a HC74
U3b HC74
OSC. 14.318
78L05
9 VOLT BATTERY
SWITCH A
SWITCH B
SWITCHED 5 VOLTS
SWITCHED 9 VOLTS
Asw 5V
Asw 9V
Bsw 5V
<--AUDIO OUT
FREQ. IN -->
/by1024
Q3 MPF102
Q5 2N2222A
D1 1N4148
D2 1N4148
D4 1N4148
FREQ.
XTAL ? MHz
SPKR
PZO
2.5V
25mV
25uV
25mA
2.5mA
250uA
25uA

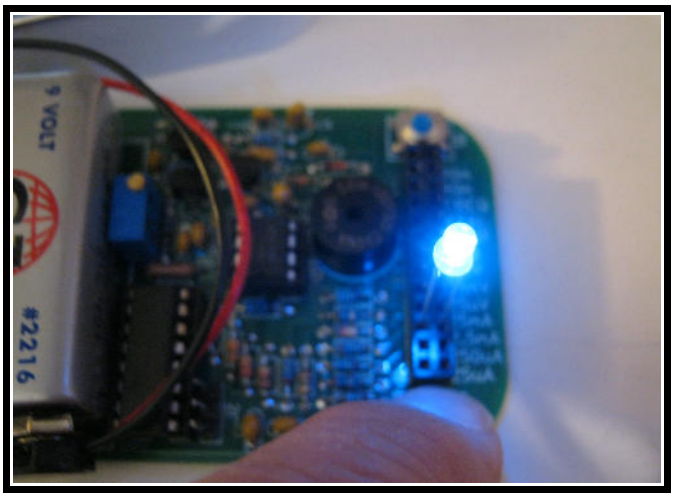
Pocket PAL][Schematic

OK! Now what the heck does it test, you might ask?

The A and B tact(ile) switches are momentary switches so you have to HOLD them down to power up the Pocket PAL. The A side powers up the current & voltage outputs and the Picaxe for FREQ, XTAL, SPKR & PZO testing. The B switch powers up the 20m & 40m oscillator outputs.



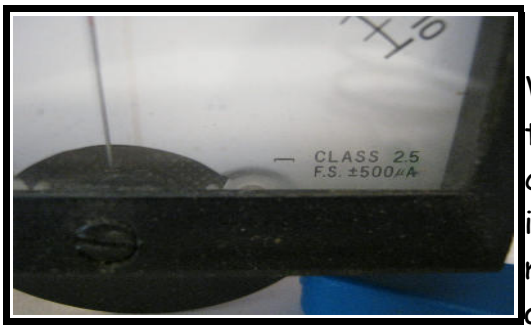




Use the 25uA, 250uA, 2.5mA & 25mA positions to test LEDs

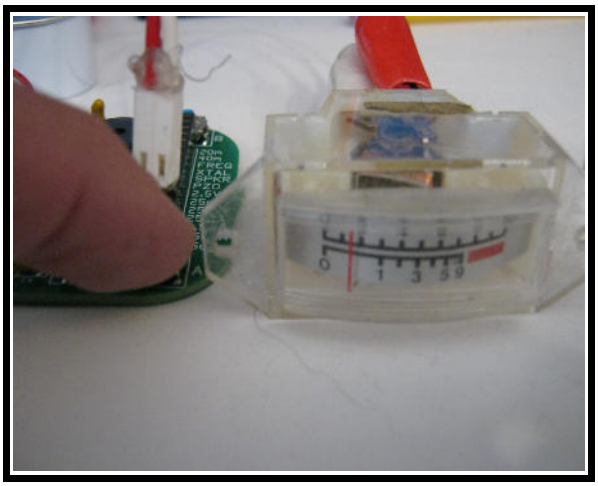
A regular LED will illuminate only faintly in the 25uA position, dull in the 250uA position and won't develop any real brightness until at least the 2.5mA test. A SUPER bright LED, like the blue one shown in the above pictures has noticeable lumens at the lowest 25uA position and will actually shock your eye when tested at the 25mA position.

When testing LEDs, the cathode or SHORT lead, should be inserted into the right hand socket of the test pair as that is the grounded side of the socket.



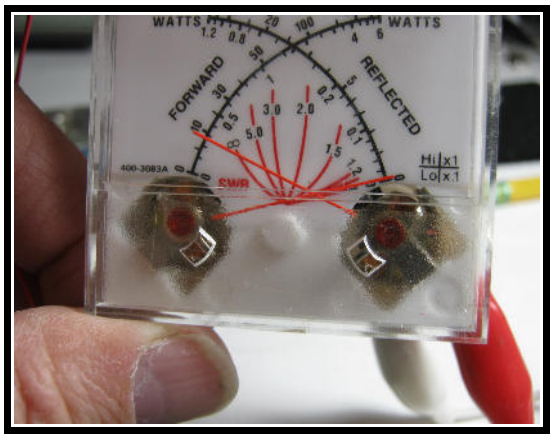
A QUALITY METER

When looking at a quality meter, you will usually find the actual full scale (FS) rating of the meter. In the case of the meter on the left, +/- 500uA. Meters of interest to QRPers are usually CHEAPer and have no markings....like the one below which was salvaged from an old CB radio carcus.



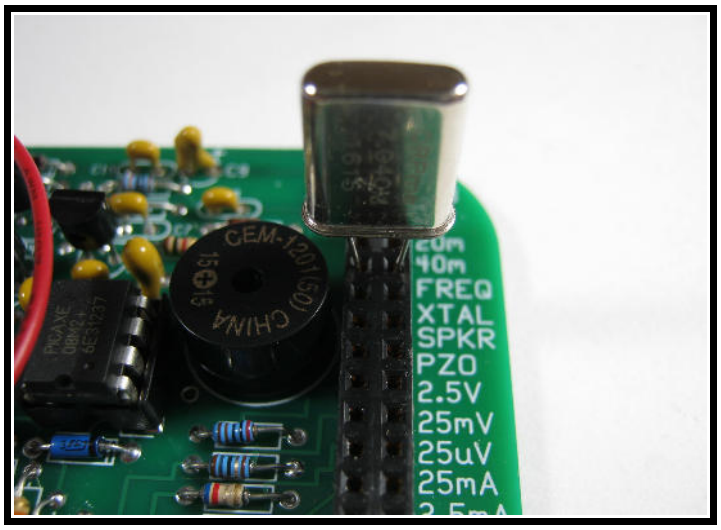
The 25uA & 250uA positions to check a QRPworthy meter...

The original design purpose for the bottom 7 test positions was to test ammeters and voltmeters. The above two images shows a typical hamfest meter find undergoing 25uA and 250uA tests. Notice the needle just moved in the left image and at full scale in the right image.



Checking the forward half of a COOL meter!

Injecting 25uA into the forward meter...moved the needle to the 10W/.3W mark.



Testing a crystal in the FREQ slot.

Inserting an HF crystal in the XTAL socket pair will cause the Picaxe to measure the crystal frequency and then announce it in Kilocycles using Morse Code. Only the whole digits are announced so a 7.0475 Mhz crystal will be announced as 7047 in Morse. The trimmer pot P1 needs to be adjusted (with NO crystal installed) after assembly to insure proper frequency counting. Holding down the A switch, adjust the pot until the junction point between R17 (300 ohms) and C12 (1000pf) measures about 2.5 volts.

You can measure the frequency of an external oscillator circuit by inserting the test leads into the FREQ position and connecting them to appropriate test points, signal & ground, of the external oscillator.

Piezo speakers can be tested at the PZO test points. The Picaxe micro generates an audio step sweep signal or ascending and then descending tones at the PZO pins. A SMALL QRPworthy speaker or headphones can be tested at the SPKR test pins.

The 40m & 20m test points can be used to send the 40m & 20m oscillator signals to an external circuit or say to a frequency counter under consideration of purchase. The 40m and 20m oscillator signals will also overload the front end of most receivers nearby for checking their front ends to see if they work. That is without even a direct connection to the receiver! The 14.318Mhz oscillator is used in NTSC video circuits and widely available....also meaning cheap! It is in the 20m ham band and when divided by 2 becomes 7.159Mhz which is also a valid 40m amateur signal....so both will typically be received by general coverage amateur radio receivers. I once had a source for 14.060 oscillator cans

which made the 14.060/7.030 equipped PAL even more QRP friendly. Alas, my source for those oscillator cans dried up long ago.

The complete test program in the Picaxe micro is open source and can be easily modified by inquisitive users who want it to operate differently. The program is written in Picaxe BASIC which is very easy to understand and program. Even a 5th grader can usually write Picaxe code with a little reading and practice.... Take a look at the program and see if YOU can make sense of it. It's pretty simple.

The Program Editor is available from the Revolution Education organization in the UK. It is available for free download. I use the smallest of Picaxe microcontrollers, Picaxe 08M2, in the Pocket PAL. It is an amazing little micro and a lot of FUN to work with.

http://www.rev-ed.co.uk/

To reprogram the Picaxe micro in the Pocket PAL, you need to either buy or build a programming cable.

http://www.picaxestore.com/index.php/en_gb/picaxe/picaxe-download-cables.html

The Picaxe manuals detail building your own cables which appeals to most QRPers. I have built many downloading cables over the years that I've worked with Picaxe micros but I also have bought a couple of AXE027 cables from REV-ED to use on my laptops. I have included a 3 pin Molex connector shell and terminals in the kit for making a downloading cable from a unused 9 pin serial cable but you need an older computer with a legacy serial port to use a home brewed programming cable. I keep an older desktop computer around for all my old programming needs....

Instructions are included in another document in the links section:

Making a Picaxe Downloading Cable.pdf

Here is how the Pocket PAL works.

Press and HOLD the A switch to turn on the Picaxe micro....
The Picaxe microcontroller STARTS....AND all the current and voltage test points become active.

It performs a frequency pulse count which takes a full second. If you only want to use the I & V test points, just use short presses of the A switch so the Picaxe can't complete a 1 second pulse count and procede to the frequency announcement stage.....

If the frequency count is greater than ZERO, the PAL will announce the frequency in Morse Code, pause, and then STARTS again...

If the frequency count is ZERO, the PAL assumes that no frequency measurement is being attempted so it continues to the following audio test mode.

The Picaxe issues a "72 PAL" welcome message and then a small pause.

A series of audio tones stepping up and then down in pitch are announced by the on board piezo speaker.

The same series of tones are then generated at the PZO and SPKR test points.

The length of each tone is increased by 1 unit

The tone pattern is repeated.

The tone cycle is repeated until the A switch is released....

Press and HOLD the B switch to power up the 14.318 oscillator can....
The Picaxe micro does not get powered up by the B switch...

The 14.318Mhz oscillator signal is sent to the 20m output test points pair.

The 7.159Mhz (14.318/2) signal is sent to the 40m output test points pair.

That's it!