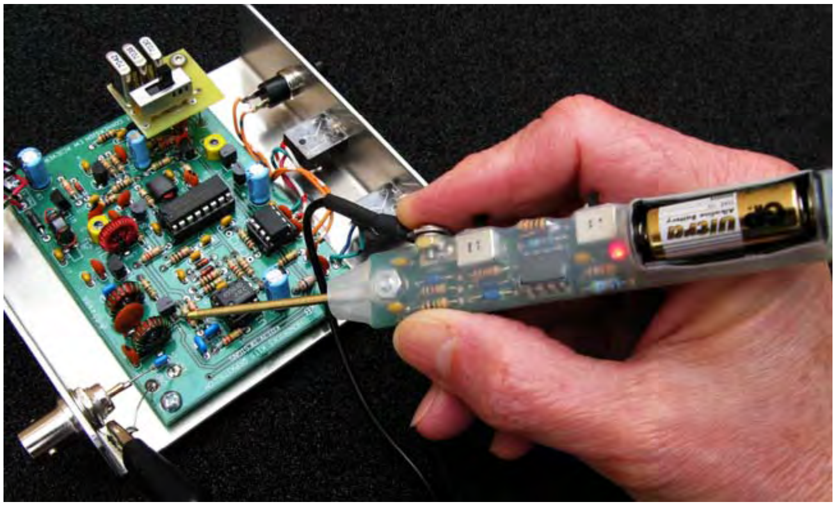
N2CX Accuprobe Plus Assembly Instructions



First off, check to see if the parts match the parts list.

Electrical components:

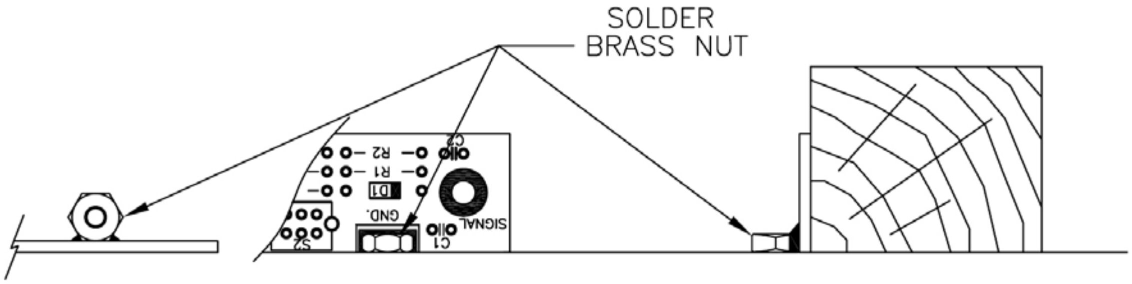
R1	1K, 1/4W, 5%, (BRN, BLK, RED, GLD)
R2	1M, 1/4W, 5%, (BRN, BLK, GRN, GLD)
R3	15K, 1/4W, 5%, (BRN, GRN, ORN, GLD)
R4	150K, 1/4W, 5%, (BRN, GRN, YEL, GLD)
R5	649K, 1/4W, 1%, (BLU, YEL, WHT,ORN, BRN)
R6	20.5K, 1/4W, 1%, (RED, BLK, GRN, RED, BRN)
R7	49.9K, 1/4W, 1%, (YEL, WHT, WHT, RED, BRN)
R8	6.8K, 1/4W, 5%, (BLU, GRY, RED, GLD)
C1, 2	.01uF marked (103)
C3	.1uF marked (104)
U1	LMC6482AIN, Op Amp, 8 PIN DIP
D1, 2	1N5711 diode
D3	Red LED
S1,2	DPDT Slide Switch
PCB	Printed circuit board

Mechanical components:

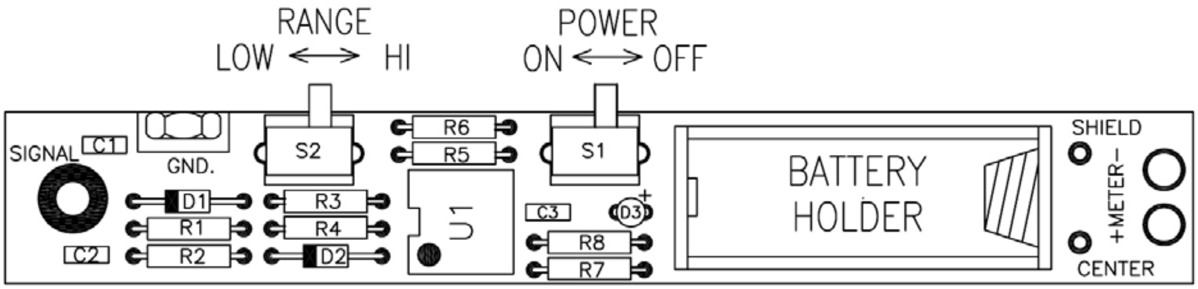
N size battery holder
Size 23A alkaline battery
4-40 brass nut
4-40 steel nut
2 ea. #4 internal tooth lock washers
2 ea. 4-40 x 1/4" L. pan head screws
2 ea. 14-16ga., #4 ring terminals
3/32" dia. x 2" brass rod
3/16" x 2" L. black heat shrink tubing
3/4" dia. x 5" L. clear heat shrink tubing
Small Tyrap
2' RG-174 coax
Red banana plug
Black banana plug
Alligator clip and lead

Read all the instruction before assembling the N2CX Accuprobe Plus

The first item to assemble will be soldering the 4-40 brass nut to the GND. pad on the pcb.



o Solder the nut, flush to the side of the board. Use something square to position the board up against, I used a small piece of wood, and lie the nut down 90 degrees to the board. This will be the alligator lead connection point used later. Do not get any solder inside the threads of the nut.



All components are soldered on the silk screened side of the board. Solder all the resistors in place, following the above guide and the silk screened locations. Bend the leads 90° and lay the resistors down flat, there are no vertically mounted resistors. Trim all leads after soldering. If you have any doubt as to the correct value, double check them with your VOM. R5, 6, 7 are 1% resistors, so they have 5 color bands.

Install and solder all the resistors:

o R1, 8 - 1K, 5%, (BRN, BLK, RED, GLD)

o R2 - 1M, 5%, (BRN, BLK, GRN, GLD)

o R3 - 15K, 5%, (BRN, GRN, ORN, GLD)

o R4 - 150K, 5%, (BRN, GRN, YEL, GLD)

o R5 - 649K, 1%, (BLU, YEL, WHT,ORN, BRN)

o R6 - 20.5K, 1%, (RED, BLK, GRN, RED, BRN)

o R7 - 49.9K, 1%, (YEL, WHT, WHT, RED, BRN)

o R8 - 6.8K, 1/4W, 5%, (BLU, GRY, RED, GLD)

Install and solder all the capacitors:

o C1, 2 - .01uF marked (103)

- C3 - .1uF marked (104)

- Solder D1,2 1N5711 to the circuit board. Note the banded end of the diode must match the silk screened band legend on the surface of the pcb.

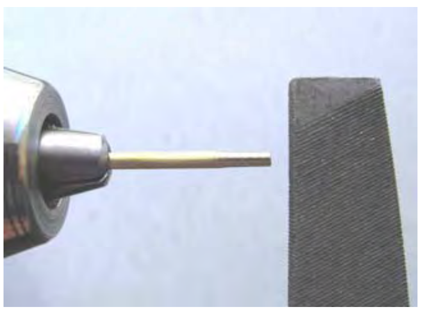
- Solder U1, the LMC6482AIN Op Amp Integrated Circuit, onto the board. Be careful to insert all the pins into the holes, it is easy to fold one underneath. Note the dot, designating pin 1, and insert it in the end with the silk screened notch in the outline.

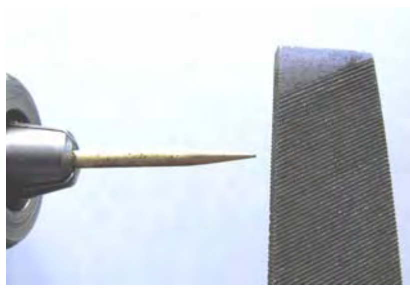
- Solder D3, the red LED to the designated place on the board. The long lead is positive, and must go into the "+" hole on the silk screened legend.

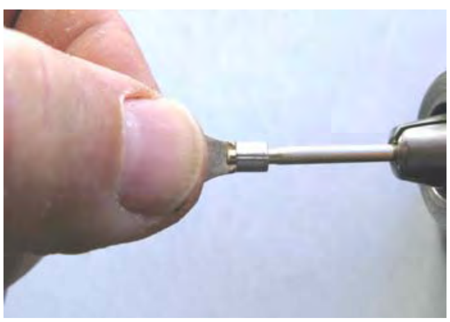
- Solder the POWER switch S1, and RANGE switch S2, to the designated places on the board. The operating levers go to the outside of the board.

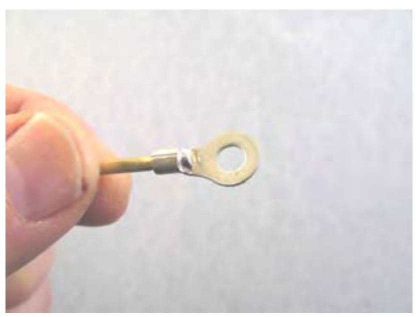
- Solder the battery holder, where marked on the board. Be sure to observe the correct alignment. The spring end, (-),of the holder towards the end of the board.

- Slide the plastic boot back from the alligator clip and solder the lead to the clip. Sometimes these are crimped only, and can lose conductivity. Replace the boot. Cut the 3/16" dia. x 2" L. heat shrink tubing in half and place one piece over the loose end of the alligator clip lead. Solder the lead assembly to one of the #4 ring terminals, and shrink the tubing to the transition from the ring terminal to the lead. Color may vary from picture. Set it aside for later assembly.

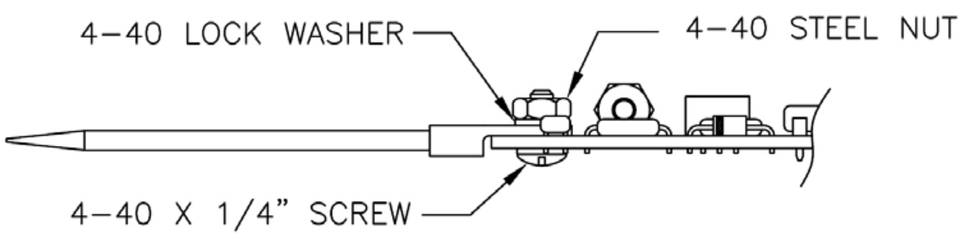


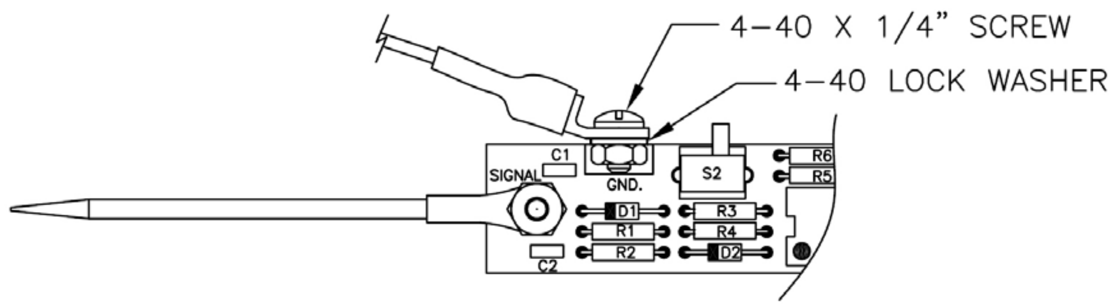




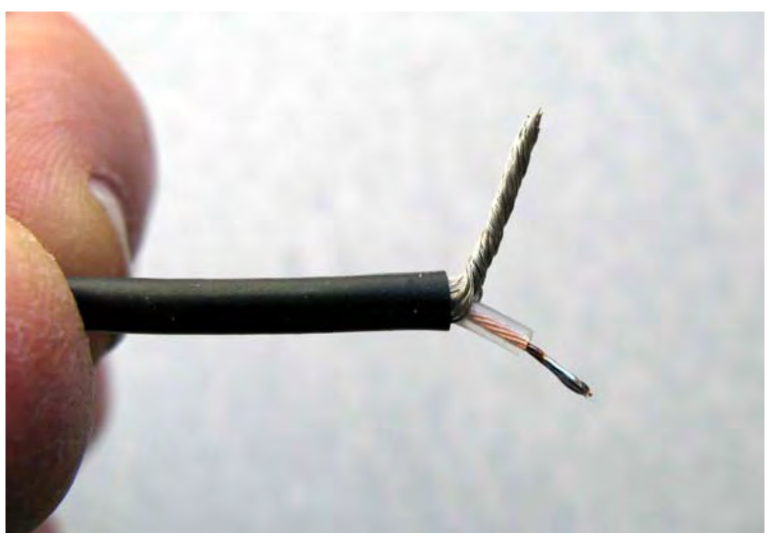


- File a contact point on one end of the 2" long, 3/32" brass rod as shown. File down the other end of the brass rod to accept the other #4 ring terminal, and solder it in place. An electric drill makes it easy, but you can do it by hand as well.

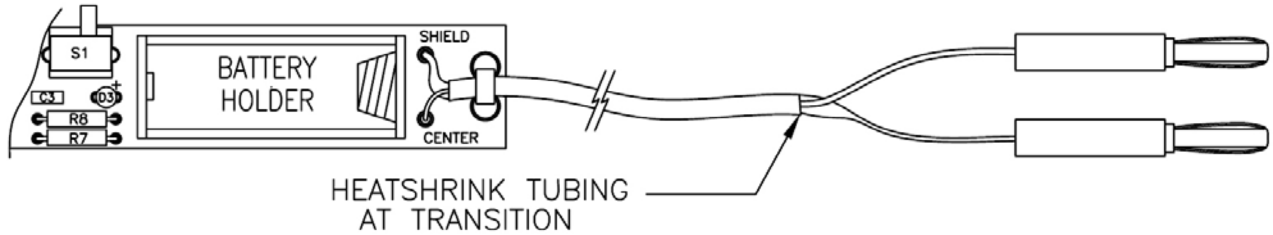




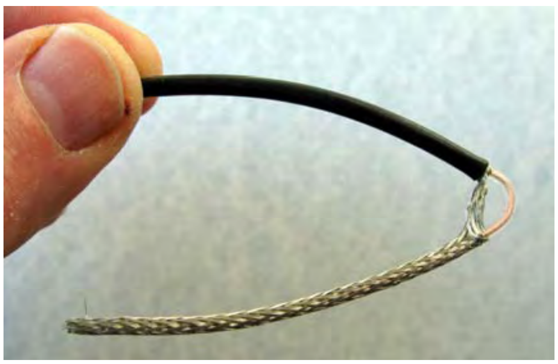
- Secure the contact point and ring terminal assembly to the signal pad of the pcb using the 4-40 x 1/4" pan head screw, lock washer, and steel nut in the order shown. The screw head should be on the bottom of the pcb, then the board, ring terminal, lock washer, and finally the steel nut. Tighten the nut securely, checking that the ring terminal does not touch either of the leads of C1 or C2. Temporarily attach the alligator clip assembly to the brass nut. It will be required for testing, but will be removed for final packaging.

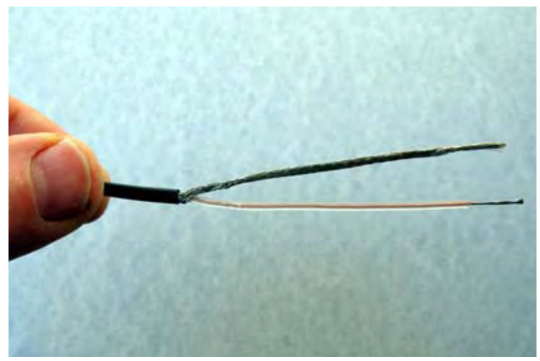


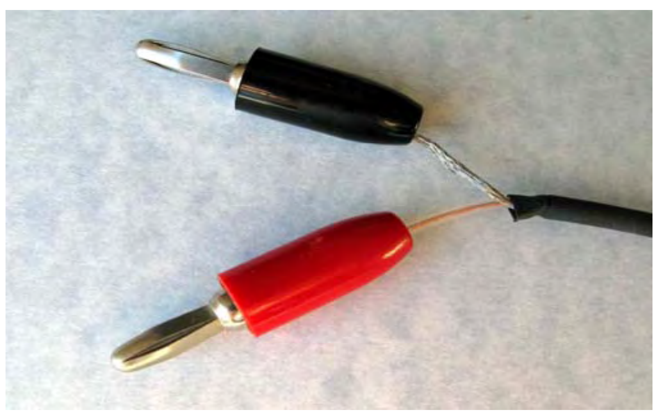
- Strip and prepare as shown, 1/2" off one end of the RG-174 coax cable.



- Solder the center conductor to the pad marked CENTER, and the shield to the pad marked SHIELD. Secure the coax to the pcb using the cable tie supplied







- Finally, strip 3 1/2" and prepare as shown the end of the RG-174. Pass the center conductor through the side of the braided shield, as shown. Slide the remaining piece of shrink tubing over the end before attaching the banana plugs. Attach the center conductor of the coax to the RED plug and the shield to the BLACK plug, and shrink the remaining piece of tubing at the transition.

- Insert the 12V, A23 battery, with the negative side towards the rear of the board. You are ready for testing.

Joe – N2CX has written the testing, troubleshooting, and usage procedures.

Checkout:

Before connecting a battery for the first time, ensure that RANGE switch is in the “LO” position. Connect the output leads to a DMM, observing correct polarity. The red plug is positive and the back one is negative.

Set the DMM to read DC voltage on a range of 10 volts or so. Now set power on. The DMM should read about 10 mV or less. If it reads much higher than this check connections and ensure that IC U1 is oriented correctly.

To check operation, you will need a low-level RF source. The best way to check operation is with a calibrated RF signal generator. Simply load the output of the generator with its rated load resistance and connect the probe across the resistor. DC readings on the DMM should be the RMS value of the signal generator output.

Lacking a calibrated signal generator you can use an oscillator in a receiver. Clip the input ground lead to a ground point in the receiver close to the oscillator components and touch the input probe to the output of the oscillator. You should get a reading in the 10’s of millivolts to several volts depending on the oscillator output level. If you have a circuit where the RF levels are specified you can verify that the readings agree. Otherwise all you will get is a relative indication. If your signal generator output is variable but not calibrated you can set it using an oscilloscope. Set the output to 1.4V p-p and the RMS value will be 0.224 V. Verify that the Accuprobe indicates 0.224V.

The N2CX Accuprobe’s HIGH range can be checked using an HF QRP transmitter. Be sure to set switch to the HIGH position. Set the transmitter to output a known level in the QRP range and assure that it is terminated in a 50 ohm load. Now clip the Accuprobe Plus ground lead to a convenient ground point and touch the input probe to the center conductor of the transmitter output connector. The DC reading on the DMM will be 1/10 the RMS value of the transmitter output voltage. At 1 watt this will be 707 mV, ranging up to 1.58 mV for a 5 watt transmitter.

Troubleshooting Tips

As usual, check for bad solder joints, correct component placement, diode, and U1 orientation.

If the LED does not light, check to insure the battery is secure and is in the correct direction. If that seems OK, then check the LED, it may be in backwards or open.

Final Assembly:

Do not proceed until you have tested and verified all is assembled and operating correctly.

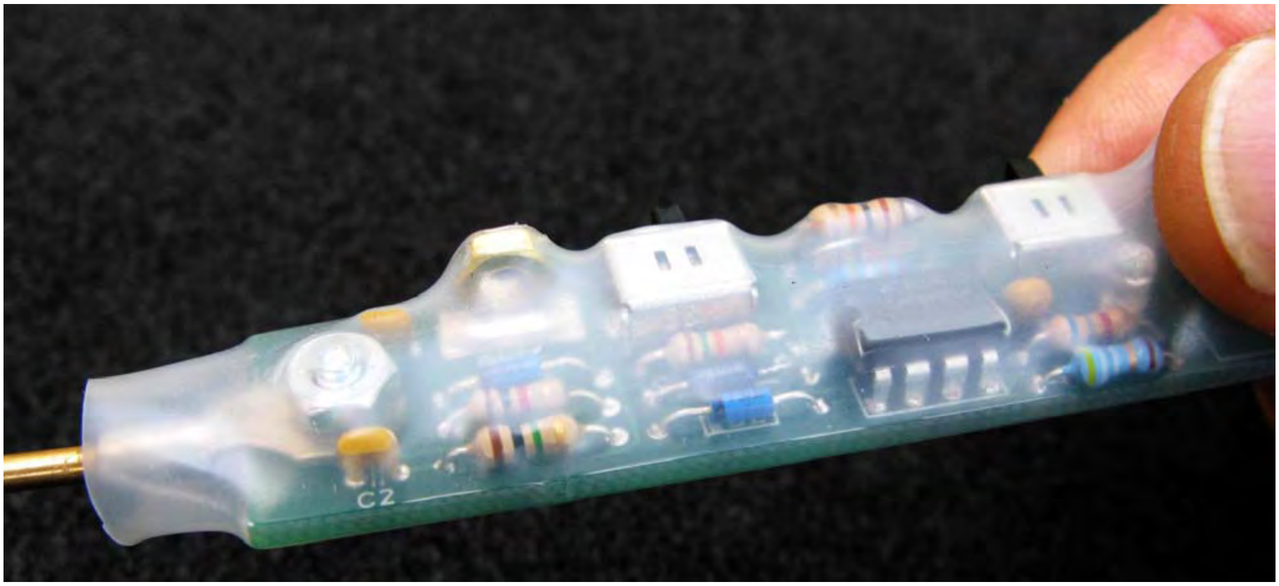
The probe assembly is encapsulated in the 3/4” diameter clear heat shrink tubing. All the operating access to the switches, cable, alligator clip, and battery will be provided for. The shrink tubing is a one time shot, so make sure you are completed and tested before this final operation. Make a final check that all components are trimmed on the bottom of the pcb, and remove the alligator clip assembly used in testing. It will be re-attached later.

- Slide the complete assembly into the shrink wrap, battery end first. Center it into the piece provided. It gets a little tight after going over the top of the potentiometer shaft and past the mode switch. Take your time, it will fit.

Using an appropriate heat source, eg. heat gun, or one of the small craft hot air sources for doing embossed cards, start to shrink the tubing. Take your time. **Some heat guns are extremely hot, and can strip paint, so be careful, go slowly.** I prefer the craft hot air gun, it does a gradual shrink, and it's difficult to damage components.

This picture shows what it looks like about 50% through the process. At this point you want to stop

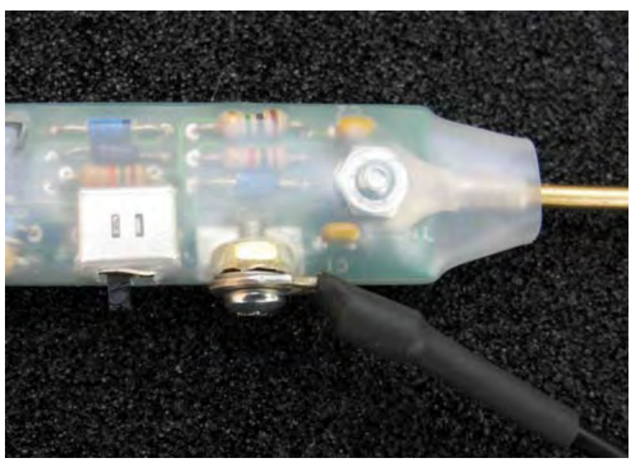
- Use an Xacto knife, and trim around as shown. This picture shows after the trimming. This will provide for a nice finished look when complete.



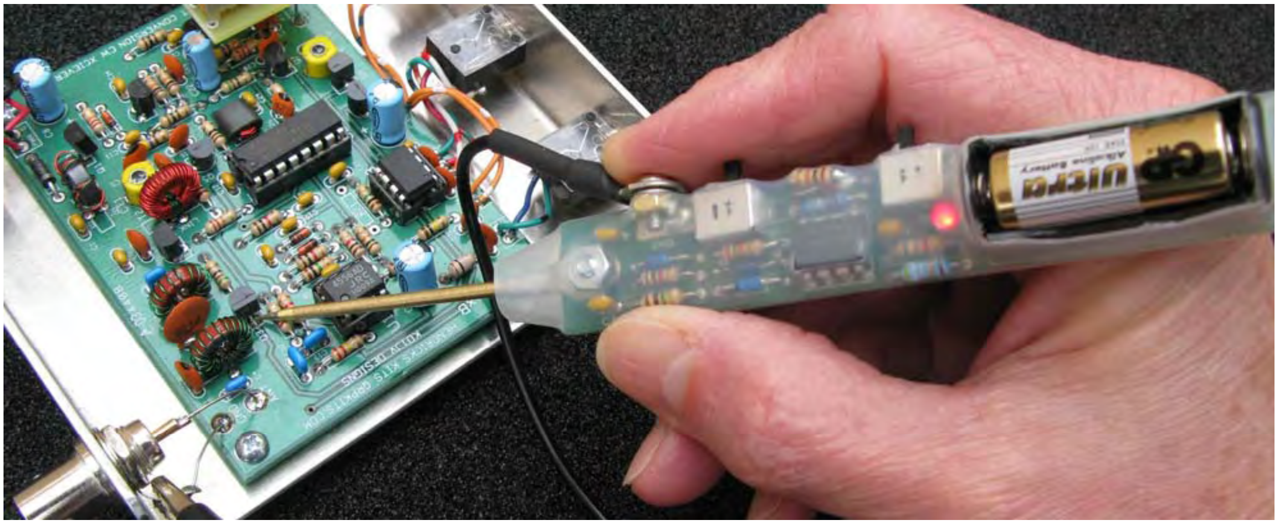
- Finish shrinking the tubing until it pulls down to touch the surface of the components and the bottom of the pcb. Be careful around the battery holder, it is especially sensitive to overheating. You are just looking to insulate and protect the components and pcb! Do not overheat.

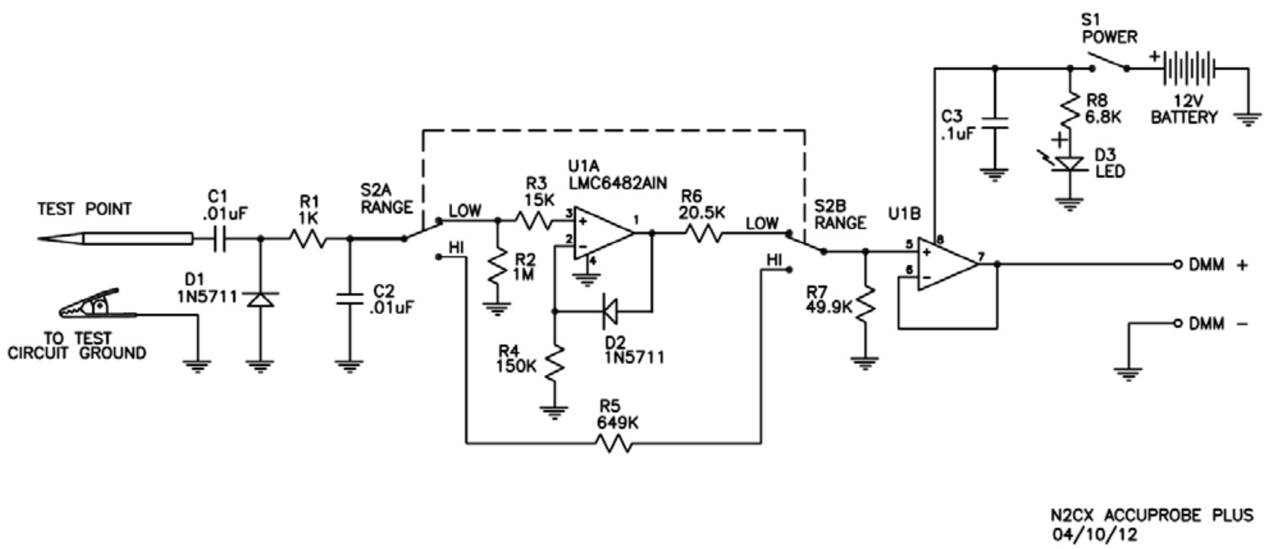
- After the shrink tubing has cooled, use a razor knife to carefully trim around the switches, so they have full travel. Carefully trim the access to the battery compartment, alligator clip connection point, and around the probe end as needed.



- Attach the alligator lead assembly with the remaining 4-40 x 1/4" pan head screw, and lock washer. The proper order is, 4-40 screw, ring terminal, internal tooth lock washer, attached to the brass nut. Do not over tighten or you will break the brass nut off the pcb.



o Install the battery, and you are ready for use. The 12v battery was selected for it's small size. It is an inexpensive, readily available battery, used in devices like garage door openers, etc. The assembly only draws a few mA, but still do not leave the power switch on, when not taking measurements.



Theory of Operation

The Accuprobe is an RF detector with compensation circuitry that extends accurate readings well below common RF detector probes. Reference to the attached schematic diagram shows that it begins with a common AC-coupled half-wave detector formed by input capacitor C1, Schottky diode D1, resistor R1 and filter capacitor C2. At RF input levels of several volts or more, the DC across C2 is approximately the peak value of the input signals. However the inherent diode non-linearity causes the DC voltage to be less than the peak voltage at low levels and quite small (only millivolts) when the input RF is below 100 mV.

For low input levels (the LOW range) is used. Resistor R2 serves as a load for the half-wave detector. DC from the detector is fed to operational amplifier U1a through R3. R3 may appear unnecessary since its resistance is so low that it has negligible effect, however it prevents damage to U1 from input voltages higher than the specified range.

Diode D2 provides feedback to the U1a's inverting input to compensate for low-signal detector non-linearity. The amount of feedback applied is adjusted by resistor R4. This compensation scheme is the brainchild of John Grebenkemper, KI6WX who used it in SWR bridges. W7EL later applied the same technique in QRP SWR bridges. Their material has appeared in the ARRL Handbook and QST.

U1a's output is the corrected peak value of the input RF voltage. It is fed through a voltage divider formed by R6 and R7 which convert it to the input's RMS value. Again U1b is a unity gain buffer that feeds a DMM.

For higher voltage levels (the HIGH range) is used. Resistors R5 and R7 form a voltage divider to convert the peak DC voltage to the corresponding RMS DC value of the RF input and reduces the voltage by 10:1. Operational amplifier U1b is a unity-gain buffer that feeds the resulting DC level to an external DMM and prevents loading of the detector by the DMM. The 10:1 voltage reduction is needed so that DC fed to U1b is less than its 9-volt power supply. This results in DC readings on the HIGH range that are 1/10 the RF RMS input voltage.

Operating power is supplied by a 12-volt alkaline battery. Capacitor C3 serves as a power supply bypass for U1 to prevent instability.

Usage:

The N2CX Accuprobe Plus is useful for measuring RF signals with predictable results from 100 kHz to at least 30 MHz at levels ranging from 10's of millivolts up to 35 V rms. It provides minimal circuit loading so that it can be used for signal tracing in oscillator and mixer circuits as well as multistage QRP transmitters. Several suggested applications are:

- Amplifier input and output voltages to determine gain
- Filter input and output voltages to determine loss.
- Measurement of resonant circuit or filter circuits across a frequency band to check bandwidth or Q.
- RF power levels across a dummy load from microwatts to beyond QRP. Note that a very accurate 50 ohm dummy load is needed to retain accuracy.
- Attenuator calibration by accurate loss measurements.
- Signal generator output calibration

Credits:

The N2CX Accuprobe Plus project was conceived and promoted by Doug, KI6DS who also provided necessary prodding and encouragement. Printed circuit layout was carried out by Ken, WA4MNT. Circuit design and checkout was performed by Joe, N2CX. Technical questions on the N2CX Accuprobe Plus can be directed to him at n2cx@verizon.net