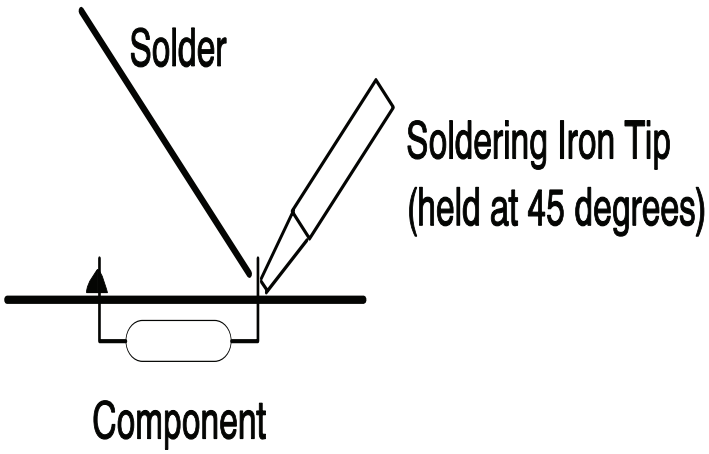
FRB No-Tune 1 Watt PLL Transmitter Kit

Tools required will be: Soldering iron 25 - 30 watts. Use a good qualtiy pencil style type with a plated tip not greater that 1/16" in size. Our preference is for Weller brand soldering irons. Do not use any soldering iron with a rating greater than 30 watts.

Electronic supply stores sell TV alignment tools which have a very small metal blade at the end of a plastic rod. This will be needed to adjust the fine frequency trimmer capacitor on the PLL. You will also need a small pair of diagonal cutters to trim the component leads after soldering. A pair of needle nose pliers will be very useful as well. It will be necessary to hold the circuit board steady while inserting the various components. A circuit board vise or "third hand" sold by Radio Shack and other stores will work quite well. If you don't want to buy one, you might want to cut a hole in a small cardboard box, just smaller than the board, so that the components leads can fit through, but the board is suspended. You can tape it down when soldering to keep it from moving.

When soldering, heat the area surrounding the hole that the lead goes through, and the lead, from one side at an angle of about 45 degrees. After heating for a short time, apply the solder from the other side of the lead and hole. Move the solder in a circle and pull up the soldering iron with a wiping action when the solder melts. This gives you the best connection between the lead and the board. The entire hole should be filled all around and have a conical appearance, sort of like a very small chocolate kiss. If you have trouble getting the solder to run, the temptation will be to melt the solder directly on the iron from one point. Instead, be sure to use thin solder. Lastly, snip off the excess lead tails less than 1/8 inch or as close to the tip of the cone as possible. **Important.** In R.F. construction, solder components as close to the board as possible, unless otherwise instructed, or the circuit will be prone to instability due to extra lead length adding spurious inductance and capacitance..



Begin assembly by orienting the circuit board to match the loading diagram The side with component markings should be facing up. Sort out the components by type and then by value. Check to make sure that all the components are in the kit and match the parts list.

A component lead bender is required to properly form the resistor leads. These can be found at most electronic supply stores. Or, find a piece of plastic or something that can be cut to 4/10ths of an inch wide to form the leads of the resistors. Bend the leads over it 90 degrees, so that they point down and push them through the appropriate holes in the board until the resistor is as close to the board as possible. Bend the leads 90 degrees (parallel with the circuit board and resting on it) and cut the leads to no more than 1/8 inch long. This insures that the component will not fall back out when you turn it is time to solder. All components leads are treated in this manner unless noted otherwise.

Take all the other resistors and insert them one by one into the circuit board, pulling the leads through so the resistor sits flush with the circuit board After all the resistors have been inserted into the circuit board at the proper places indicated, solder them into place after confirming proper placement according to the loading diagram.

Next go to the capacitors. Observe correct polarity on the electrolytic capacitors, they are polarized - one lead is negative and the other is positive. On the side of the capacitor will be either a plus (+) sign or a minus (-) to indicate polarity. That indicates the polarity of the lead directly underneath the marking, and the opposing lead will be either negative or positive depending on the marking. Orient and place according to the layout diagram. Note the color of the variable capacitor (trimmers). C48 is green. It sits next to C36-37. Install C48 with the flat side facing toward IC4.

The small surface mount capacitors are supplied already soldered to the board.

Now, to the inductors. Start with the wide band rf chokes (L1-L5), insert with one lead straight down and bend the lead over to go into the designated hole. L6 has a small gray/beige body, a bit smaller than the resistor. Solder with one lead on the surface pad of the MAV11 and the other through the hole in the board at the juncture of R6 and C7. L7-10 are supplied already soldered to the board. L11 is a short piece of wire with a ferrite bead on it, solder to the areas indicated.

Installation of semiconductors - integrated circuits, transistors and diodes. Observe correct orientation of the ICs, the dot and/or notch should be facing in the direction indicated on the loading diagram. Install and insert the 18 pin socket for IC4, PIC16F628. Install and insert the 8 pin socket for IC2, LF351/TL071. Insert 12 volt regulator IC5, bend the leads 90 degrees down to match the hole pattern. Insert 5 volt regulator 78L05 IC3, observe correct orientation of the flat side, facing toward the edge of the board. Place IC6, MAV11, as indicated on the placement diagram, gently push each lead down and solder. Insert IC7, do not push all the way down, **leave about 1/16" between the POS150 and the surface of the board**. Observe correct orientaion, pin with blue dot goes to top left. Insert 2SC2053 Q1, observe correct orientation, flat side facing toward outside edge of the circuit board. The body of Q1 should be about 1/4" above the top surface of the board. Form the leads of 2SC1970 Q2 so they match the hole pattern on the circuit board. The leads will be bent down 90 degrees so Q2 will lie on its back against the heat sink that sits flat on the board surfaces. Install Q2 after applying heat sink compound to its back side. Secure Q2 and the heat sink to the circuit board with a 4-40 nut and screw. Then solder its leads. Insert D1-D5, observe correct orientation. Position with black bands matching diagram. Solder all these components, diodes, transistors and ICs very carefully - do not apply heat for very long to each pin, just long enough to get a good shiny joint without excess solder.

Install the 8 position dip switch, orient with postion #1 at top and solder carefully.

The last component to install is the 16 MHz crystal. Solder very carefully and do not apply heat very long.

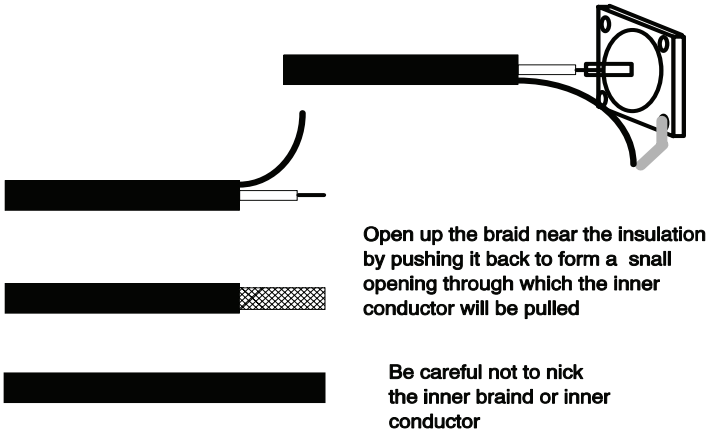
Pick out the coaxial cable from the wires provided, it will be marked in most cases with the legend RG174 and should be black in color. The coaxial cable consists of an outer insulator covering a wire braid which surrounds another insulated inner conductor. Strip the outer insulation back about one inch and pull the inner wire through the braided section by taking a small pointed tool to open up a hole in the braid near the outer insulation through which the inner conductor is pulled using needle nose pliers. Be gentle. do not cut the braid or crush or nick the inner conductor in this process Strip the inner conductor back about 1/4 inch or less. Twist it tight and tin the end. Insert it from the top through the hole marked RF out. Solder it to the pad where it pokes through on the bottom of the circuit board. Twist the outer braid so that is tight and there are not any stray pieces sticking out. The braid should be bent outwards so it is about 90 degrees to the inner conductor. Tin the end of the braid and insert, keeping the braid at 90 degrees to the inner conductor, through the point marked ground (next to RF out) and solder it to the pad.

Take one of the hookup wires provided, strip and tin one end and solder one lead to the spot marked 13.5 volts near the optional voltage regulator on the layout diagram.. Take another length of hookup wire, strip and tin it one end, and solder it to the same spot. Take one of these leads and route it to the other 13.5 volt pad. Cut excess length off. Strip and tin the end and solder it to the 13.5 volt pad on the underside of the board. Take another piece of hookup wire, strip and tin (tinning means heating the bare end of the wire with the soldering iron and applying a little bit of solder to the bare wire)the end, and solder to the ground point nearest to the 13.5 volt point from underneath the board. Take the twisted pair of hookup wire, strip and tin the ends, solder one lead to the point marked audio in and the other to the point next to it marked ground. Note which color goes where.

Now, check your work carefully, look for any solder bridges between pins or leads. Use a voltmeter or DVM with a contituity test, this will help quite a bit. All the solder joints should be nice and shiny without excessive solder.

Your board is now ready for preliminary testing. Strip and tin the other end of the RG174 coax. Attach one of the ground lugs provided in the kit to the SO239 RF connector (large item with threads on one side attached to flat square flange with 4 mounting holes) with a 4-40 bolt and nut. Solder the inner conductor of the coax to the pin in the center of the SO239 connector and the braid of the coax to the solder lug attached to the SO239 connector. This will be a temporary hookup.

Use a short jumper of coax cable either RG58 or RG8X with PL259 plugs at both ends and connect the SO239 connector from the transmitter to the SO239 input connector of your power meter. Take another 1-2 ft coax jumper as described above and connect the output connector of the power meter to the input connector of a dummy load (see diagram for details on construction of a



low power dummy load or use our 15-20 watt dummy load kit). A frequency counter should be used as well, put the probe of the frequency counter near the SO239 connector to which the transmitter is connected. The PDC 356 frequency counters we supply can be placed in line with the use of coax jumper or a wire can be solder to the center conductor of an RCA plug which the counter accepts and used as a probe.

The coax jumper cables, frequency counter, power/SWR meter and dummy load can be purchased at many radio, TV and amateur radio supply stores. Be sure the dummy load, frequency counter and power/SWR meter are specified for the VHF frequency range, not CB freqeuncy range.

Now that everything is properly set-up it is time to apply power and check the transmitter for proper operation. Use a power supply that put out a voltage of 13.5 volts. Connect the 13.5 volt lead coming from the board to the positive terminal (usually red) of the power supply and connect the ground lead from the board to the negative or ground terminal (usually black) of the power supply. Make sure the leads are connected properly before applying power. **NEVER RUN THE TRANSMITTER WITHOUT A LOAD, DOING OTHERWISE WILL LIKELY DAMAGE OR DESTROY THE OUTPUT TRANSISTOR**. Make sure the transmitter board is sitting on a non-conductive surface and that are no stray pieces of bare wire, solder, metal, etc. underneath it.

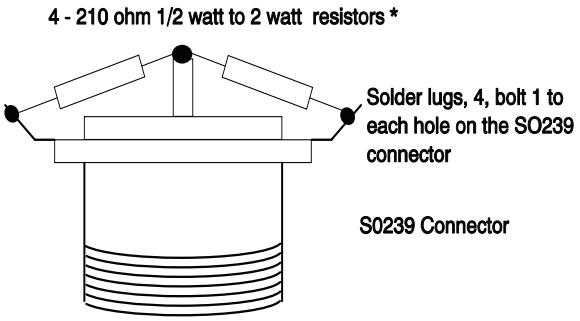
Turn on the power supply, you should see some sort of movement of the power meter which should be set to the most sensitive range. Check Q2, if it becomes extremely hot, turn off power immediately. Do the same if any other components become hot. The LED lock indicator on the board should be glowing. Turn off the power supply. Look for shorts caused by solder bridges or improperly placed components if any components become hot.

Install IC1and IC4 into their respective sockets. Do not use excessive force and be careful that all the leads go into the sockets and none bend under. Observe correct orientation of the ICs, the dot and/or notch should be facing in the direction indicated on the loading diagram. Go to the frequency setting chart and select your operating frequency. Set the dip switch according to the chart by sliding or pushing the switches to either an off or on condition. The switch setting represent a binary number which corresponds to the frequency of choice. **"0"** represents a switch closure or **on** while **"1"** represents a switch open or **off**. Check your settings, it is easy to get them reversed.

Turn the transmitter on. If you are lucky the transmitter should lock to frequency, the LED should be not glowing if this is the case. You should see a power reading of 1 watt or so. With the correct frequency displayed on the frequency counter adjust the green trimmer capacitor next to IC4 to bring the frequency as close as possible to having all zeros from the second digit to the right of the decimal point (assuming your counter is set to display Mhz) i.e. 88.1 should read 88.10000. It will only take minute turns of the trimmer to do this. According to FCC regs the frequency tolerance should be +/- 2000 cycles.

All of the above set-up procedures assume that the transmitter came up without any problems. If you are careful about your work, this should be the case. If it does not , go back and check your work. Be sure that voltage is present at the two 13.5 volt points on the board. On the far right pin of IC4 you should see 12 volts. Be certain that all components are inserted correctly, especially Q1, Q2, , IC1. IC4. It is really a rather simple circuit, an RF oscillator controlled by the PLL followed by a buffer and

LOW POWER DUMMY LOAD



Use a mating connector, a dual male PL259 (Radio Shack #278-192 or equivalent) to connect this directly to the transmitter output S0239

*If 2 watt resistors are used, this load can be used with transmitters with an ouput power of 5-6 watts maximum.

amplifier. Check the dipswitch settings. It is a common error to have two of the switch lines shorted together with a solder bridge.

The following assumes that you are going to place the transmitter in a box as a stand-alone unit.

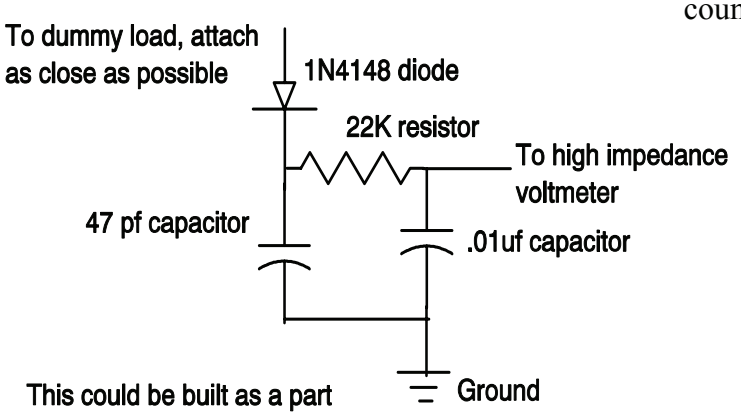
You are now ready to install the board in the box! Get the 4 round spacers along with 4 nuts and 4 bolts. Locate the four mounting holes in the chassis that match those of the transmitter board. Attach the spacers with the 4 bolts which will enter from the outside of the chassis. Tighten down loosely. Place the board down so the threaded portions of the spacers are beneath the circuit board mounting holes, push down gently until full contact is made with the hexagonal body of the spacers. Attach with 4-40 nuts and tighten. Now tighten up the screws holding the spacers to the chassis. (Round spacers forget this). If you have round spacers insert the longer 4-40 bolts from the outside of the chassis and lay it flat so the bolts stick up-right. Drop the spacers over them, place the board over the bolts and push down gently. Attach with 4-40 nuts. In both cases the board should be oriented with the RF out end facing toward where the SO239 connector will be.

Now, again, starting from the back of the box. Screw the SO. 239 to the back of the box with the short 4-40 bolts and hex nuts. Pull the coaxial cable to the SO 239 connector and cut the R.F. wire so that it lays neatly in the box and does not have excessive length or does not drape across the circuit board. Leave about an extra 1 1/2 inch in the cable for attachment to the SO239. Prepare the coaxial cable as described above. Strip the outer jacket off to a distance of about 1 inch and strip the insulation off the inner conductor back 1/4 inch. Solder the inner conductor of the coaxial cable to the solder cup terminal in the middle of the SO239 connector and the RF. ground shield to the little solder lug, which goes under one of the nuts holding the SO239 to the chassis in order to ground it.

Next, install the banana jacks on the back of the box. Take the two twisted pair leads that go to the 12 volt and ground pads on the board, shorten the lengths so they lay nicely in the box without excessive length. Strip the ends about 1/4 " and solder the 12 volt wires to the red one and the ground leads to the black one. Be certain that the leads are connected properly, a reversal of leads will destroy the device. Solder a .01 uf capacitor and a 10 uf capacitor from the red jack to the black one, keep the leads short and slip a bit of insulating tubing (supplied) over the leads prior to soldering.

Mount the variable resistor on the front of the box from the inside of the box with the shaft facing outwards. There is a metal tab on the body of the variable resistor, cut this off flush. Now install the 1/4" RCA. jack in the middle hole in the box's front. with the outer lead tab facing toward the variable resistor. Connect a short lead of wire from the ground terminal of the RCA connector to the left terminal (looking from the rear of the variable resistor) of the 10K variable resistor R?, solder the RCA end. Take the ground lead of the twisted wire pair from the audio input pads of the PLL transmitter, strip 1/4" and solder to the left terminal of the variable resistor along with the ground lead going to the RCA connector.. Solder the audio input wire to the center terminal of the variable resistor after stripping 1/4" of insulation. Solder a short piece of wire from the center terminal of the RCA jack to the right terminal of the variable resistor.

This should complete the hookup of the transmitter to the chassis. Repeat the tests (dummy load, frequency counter. etc.) above to check for proper operation. Open



This could be built as a part of the dummy load shown in a previous diagram, keep lead lengths as short as possible

Volts	Power
2V	80mw
3V	180mw
4V	320mw
5V	500mw
6V	720mw
7V	980mw

Power output equals voltage squared divided by 50 (presuming you have a 50-52 ohm dummy load)

up the variable resistor about 3/4 of a turn, rotate all the way clockwise first and then turn back 1/4 or so. Tune an FM radio to the frequency chosen, a digital tuner works best. Turn the transmitter on, you should hear silence with very little hum if any. Run a line level audio source to the input of the transmitter, you should hear whatever your source material is.. If you do not hear anything, check your connections. Set the input level control at point where a line level signal input produces a signal on your receiver with a volume slightly less that of comparable stations. This will help prevent over modulating (a limiter is needed to fully prevent this) the transmitter.

If you ordered the 6 watt amplifier with this unit, it will be mounted in the same chassis to one side of the PLL board. The output of the PLL transmitter will go to the input of the 6 watt amplifier instead of the SO239 connector which will be connected instead to the output of the 6 watt amplifier. Voltage connections will be the same with the voltage and ground leads from the 6 watt amplifier connected to the same banana sockets.

If your ordered the PLL with a 15 watt amp, or above along with a brick enclosure, the arrangement is somewhat different. The PLL board mounts on a flat aluminum plate (supplied with the brick enclosure). The audio input section is on another plate which forms one end of the brick, connections are the same. You might need longer pieces of hookup wire for the PLL voltage and ground leads which will be soldered to the banana sockets on the other end plate of the brick. Enough slack is needed to allow sliding the plate back for tuning the amplifier board which rests against the bottom of the brick.

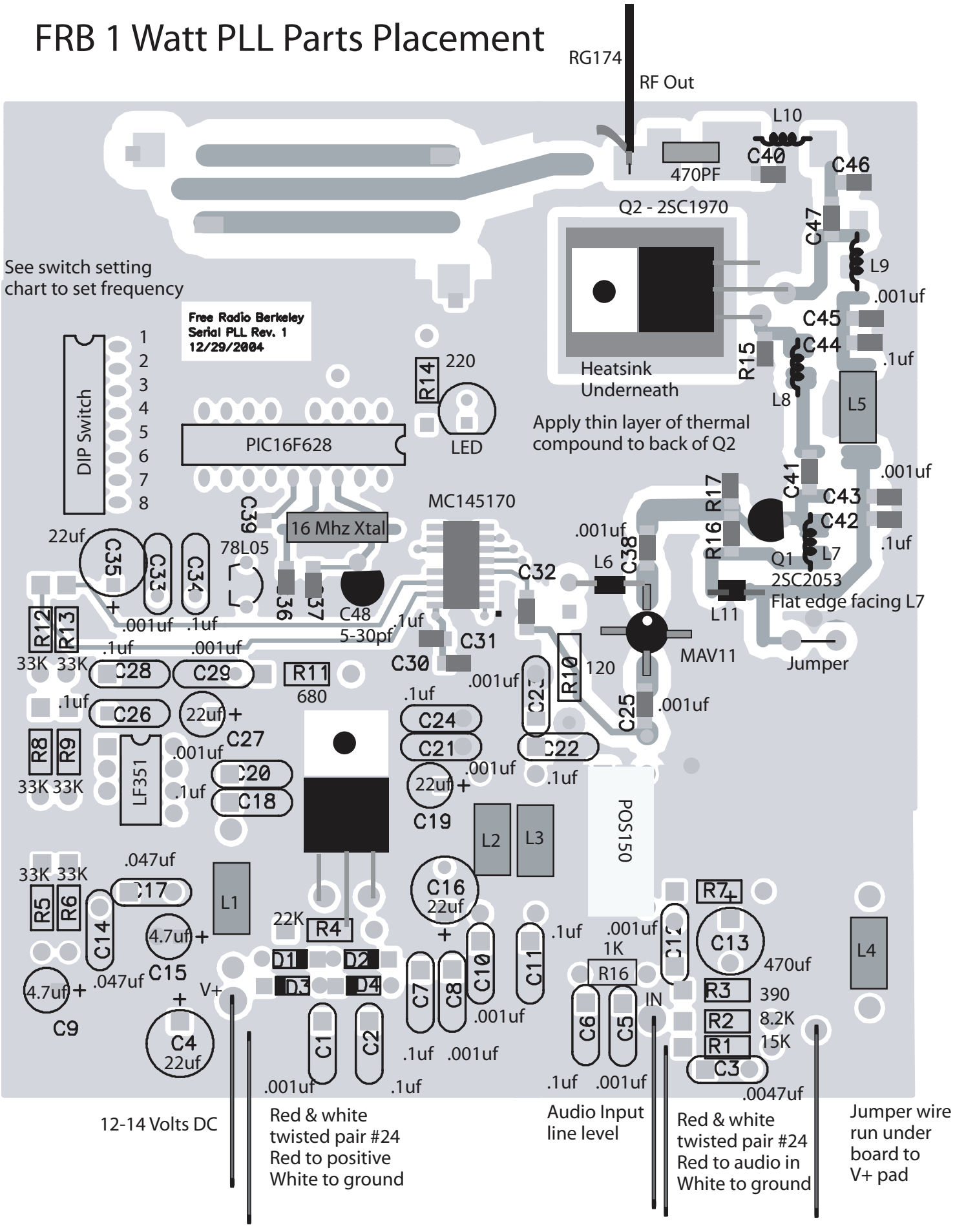
It is very important to observe some basic broadcast engineering practices. Select a frequency that is not occupied by any other broadcaster. That frequency should have one channel of separation to either side in relation to other stations. In other words, if your are at 88.5, for example, 88.3 and 88.7 should be clear of broadcast stations. Use a good tuner and check the FM band from a number of different locations in the area. Check on both car and home tuners, use digital tuners. If you hear a weak signal, check the location, If you are outside the primary coverage area (30-50 miles) and have obstructions such as a hill between your area and the signal source, it will most likely be OK to use - double check though.

Next, use a filter. This is very important to prevent interference with other communications services. The first harmonic from an FM transmitter falls right into the VHF TV band (channels 6-12). Use the 7 element filter with transmitters 15 watts and under. Use the 9 element filter for those above that power. We have designs for other types of filters as well. The filter should be in a separate shielded metal enclosure, available as part of the filter kits from FRB. It is inserted in line with coax jumper cables between the transmitter and antenna. If you can find a friend with a spectrum analyzer, have them check the output of your transmitter for harmonics and such.

Over modulation can cause spurious emissions that interfere with adjacent channels. To prevent this use an audio limiter between the mixer and the transmitter. This can be purchased either from FRB or any well stocked pro-audio shop. Cost will range from $125 to $400.

By taking these measures we can deprive the FCC of their technical objections against micro power free radio. Do it right the first time and you will likely avoid scrutiny for sometime since the FCC usually becomes aware of a micro power operation from complaints.

FRB 1 Watt PLL Parts Placement



Serial PLL Version 1 Parts List

Part number	Quantity	Description
C1, C5, C8, C10, C12, C20-21, C23, C26, C29, C33	11	.001uf capacitor, marked 102
C2, C6-7, C11, C18, C22, C24, C28, C34	9	.1uf capacitor, marked 104
C25, C30, C38, C43, C45	5	.001uf capacitor, SMT1206
C31, C39, C42, C44	4	.1uf capacitor, SMT1206
C3	1	.0047 capacitor, marked 472
C4, C16, C19, C27, C35	5	22uf electrolytic capacitor
C9, C15	2	4.7uf electrolytic capacitor
C13	1	470uf electrolytic capacitor
C14, C17	2	.047uf capacitor, marked 473
C36, C40-41, C46	4	22pf capacitor, SMT 1206
C47	1	100pf capacitor, SMT1206
C48	1	5-30pf green trimmer capacitor
C49	1	470pf ceramic cap, marked 471
D1-D4	4	1N914 diode
D5	1	LED diode
IC1	1	LF351/TL071 op amp
IC2	1	MC145170 serial PLL
IC3	1	78L05 voltage regulator
IC4	1	PIC16F628, programmed CPU
IC5	1	7812 voltage regulator
IC6	1	MAV11 amplifier
IC7	1	POS150 VCO
L1-L5	5	Wide band RF choke
L6	1	1uh choke, small brown or green body
L7,L10	2	Coil 4 turns, #22 1/8” dia.
L8	1	Coil 2 turns, #22 1/8” dia.
L9	1	Coil 5 turns, #22 1/8” dia.
Q1	1	2SC2053 Transistor
Q2	1	2SC1971 Transistor
L11	1	Ferrite bead on wire
R1	1	Resistor, 15K - brown, green, orange
R2	1	Resistor, 8.2K - gray, red, red
R3	1	Resistor, 390 - orange, white, brown
R4	1	Resistor, 22K - red, red, orange
R5-6, R8-9, R12-13	6	Resistor, 33K - orange, orange, orange
R7	1	Resistor, 360 – orange, blue, brown
R10	1	Resistor, 120 - brown, red, brown
R11	1	Resistor, 680 - blue, gray, brown
R14	1	Resistor, 220 - red, red, brown
R15	1	Resistor, 470 - 1206SMT
R16	1	Resistor, 33K - 1206SMT
R17	1	Resistor, 1K - 1206SMT
R18	1	Resistor, 1K – brown, black, red
X1	1	16 MHz crystal SMT

Other items:
1 - 8 pin IC socket, 1 – 18 pin IC socket, 1 – TO220 heat sink for Q2, 1 – 8 position dip switch, 1 – ¼” #4 bolt, 5 #4 nuts, 4 – ½” #4 bolts, 4 ¼” spacers, 1 - 10” length of #24 twisted pair, 1 – 5” length of #24 twisted pair, 1 – 10” length of RG174 coaxial cable, 1 – packet of thermal compound, 1 – red banana socket, 1 – red banana plug, 1 – black banana socket, 1 – black banana plug, 1 – SO239 socket, D mount, 1 – 10K potentiometer with washer and nut, 1 – RCA socket

Works 5MHz below the FM radio band (in the spectrum assigned to TV channel 6)
Frequency selectable in 100kHz increments, 83.0MHz-108.0MHz
(Note: TV channel 6 is 82-88MHz, FM band is 88-108MHz.)
Note: TV channel 6 sound carrier is 87.75MHz

DIP switch setting:

The top five values are diagnostic modes:
FF: Sweep from 83.0MHz to 108.5MHz at 5MHz/second
FE: Sweep from 83.0MHz to 108.5MHz at 500kHz/second
FD: Set PLL to 100MHz and transmit 1kHz square wave test tone
FC: Set PLL to 100MHz and transmit 100Hz square wave test tone
FB: Toggle between 88.0MHz and 108MHz at a .1Hz rate
The remaining 250 values set the PLL frequency in 100kHz increments. Examples:
FA - 108.0MHz
AA - 100.0MHz
32 - 88.0MHz
00 - 83.0MHz

DIP switch: | 12.8MHz | 6.4MHz | 3.2MHz | 1.6MHz || .8MHz | .4Mhz | .2MHz | .1MHz |

Table #1:

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
F0	107.0	107.1	107.2	107.3	107.4	107.5	107.6	107.7	107.8	107.9	108.0	TOGGL	100Hz	1kHz	SLOW	FAST
E0	105.4	105.5	105.6	105.7	105.8	105.9	106.0	106.1	106.2	106.3	106.4	106.5	106.6	106.7	106.8	106.9
D0	103.8	103.9	104.0	104.1	104.2	104.3	104.4	104.5	104.6	104.7	104.8	104.9	105.0	105.1	105.2	105.3
C0	102.2	102.3	102.4	102.5	102.6	102.7	102.8	102.9	103.0	103.1	103.2	103.3	103.4	103.5	103.6	103.7
B0	100.6	100.7	100.8	100.9	101.0	101.1	101.2	101.3	101.4	101.5	101.6	101.7	101.8	101.9	102.0	102.1
A0	99.0	99.1	99.2	99.3	99.4	99.5	99.6	99.7	99.8	99.9	100.0	100.1	100.2	100.3	100.4	100.5
90	97.4	97.5	97.6	97.7	97.8	97.9	98.0	98.1	98.2	98.3	98.4	98.5	98.6	98.7	98.8	98.9
80	95.8	95.9	96.0	96.1	96.2	96.3	96.4	96.5	96.6	96.7	96.8	96.9	97.0	97.1	97.2	97.3
70	94.2	94.3	94.4	94.5	94.6	94.7	94.8	94.9	95.0	95.1	95.2	95.3	95.4	95.5	95.6	95.7
60	92.6	92.7	92.8	92.9	93.0	93.1	93.2	93.3	93.4	93.5	93.6	93.7	93.8	93.9	94.0	94.1
50	91.0	91.1	91.2	91.3	91.4	91.5	91.6	91.7	91.8	91.9	92.0	92.1	92.2	92.3	92.4	92.5
40	89.4	89.5	89.6	89.7	89.8	89.9	90.0	90.1	90.2	90.3	90.4	90.5	90.6	90.7	90.8	90.9
30	87.8	87.9	88.0	88.1	88.2	88.3	88.4	88.5	88.6	88.7	88.8	88.9	89.0	89.1	89.2	89.3
20	86.2	86.3	86.4	86.5	86.6	86.7	86.8	86.9	87.0	87.1	87.2	87.3	87.4	87.5	87.6	87.7
10	84.6	84.7	84.8	84.9	85.0	85.1	85.2	85.3	85.4	85.5	85.6	85.7	85.8	85.9	86.0	86.1
00	83.0	83.1	83.2	83.3	83.4	83.5	83.6	83.7	83.8	83.9	84.0	84.1	84.2	84.3	84.4	84.5

Hex-Binary conversion

F=1111	7=0111
E=1110	6=0110
D=1101	5=0101
C=1100	4=0100
B=1011	3=0011
A=1010	2=0010
9=1001	1=0001
8=1000	0=0000

The resulting binary number is read from right to left. O = switch on and 1 = switch off. Switch position 1 is the first 0 or 1 on the right and switch position 8 is the last 0 or 1 on the left.