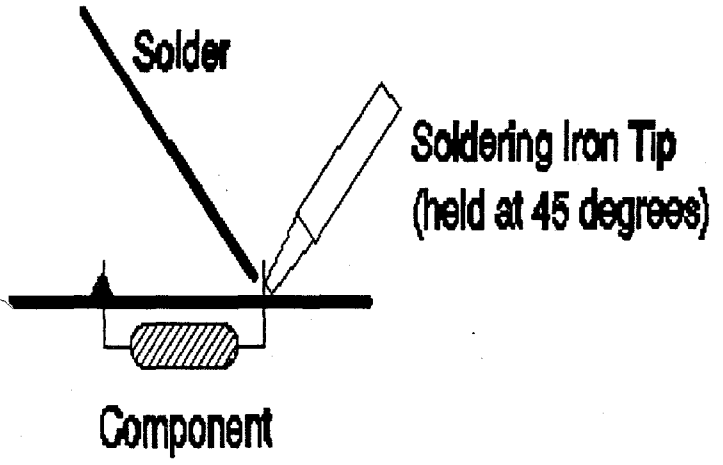
FRB 1/2 Watt PLL Transmitter Kit

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.

Various TV/radio supply stores and Radio Shack sell a cheap color TV alignment kit that has plastic screwdrivers and tools, perfect for adjusting the transmitter when it is done, because they must be plastic. You will also need a small pair of diagonal cutters to trim the component leads after soldering. A pair of needle nose pliers will also 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. Note: if you ordered the partially assembled PLL kit, you will have just a few parts to solder. 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. Separate out R17, and R13, these will be fitted with a ferrite bead over one lead of each resistor. Find a piece of plastic or something that is 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. Kink the leads when the component is down all the way so that they won't fall back out when you turn it over to solder. R17 and R13 get a little ferrite bead (black cylinder with hole through it.) on one lead, snug up against the resistor body.

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. R26 is a variable resistor known as a potentiometer (commonly called "pots") will be prepared later. 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, the shorter one, is negative and the other is positive marked with a + on the board. Place according to the layout diagram. Note the color of the variable capacitors (trimmers). C15 & C6 are green and C24 & C45 are either orange or yellow.

Now, to the inductors. L1, L2 and L3 are the wide band rf chokes, insert with both leads straight down into the designated holes. L5, L6 and are the wire coils, they should be about 3/16" above the surface of the board. The leads on L5 may need to be scraped for soldering. L8 & L9 are lumpy looking blue components. L4 is the adjustable coil and is yellow in color. L6's position on the board has changed and is not at the spot marked on the board. See the loading diagram for proper positioning. Where L6 is marked on the circuit board, insert a wire jumper and leave

1/8"-3/16" clearance between the jumper and the board.

Installation of semiconductors - integrated circuits, transistors and diode. 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 28 pin socket for IC1. Install and insert the 8 pin socket for IC3. Insert IC2 directly into the board, no socket - observe correct orientation, notch or dot on left pointing toward C1. Insert IC4, bend the leads 90 degrees down to match the hole pattern. Insert IC6, observe correct orientation of the flat side, facing toward IC4. Insert IC5, observe correct orientation of the flat side, facing toward the center of the board. Insert Q1 and Q2, observer correct orientation, flat side facing toward edge of board. The bodies of Q1 & Q2 should be about 1/4" above the top surface of the board Insert Q3, observe orientation of tab, toward R18. Do not make Q3 flush with the board, the bottom of Q3 should be about 1/4" above the top surface. Insert D1, observe correct orientation, flat side facing in toward center of board. 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. When soldering Q1 & Q2 alternate soldering between Q1 & Q2 to prevent overheating.

Install the 10 position dip switch, solder carefully.

The last component to install is the 5.12 MHz crystal. Solder very carefully and do not apply heat very long. DO NOT CUT THE LEADS WITH REGULAR CUTTERS, USE SCISSORS. SHEAR ONLY

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 indicated hole on the layout sheet. **NOTE:** the spot indicated on the circuit board printed legend has changed. 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 nearest Q3 underneath the board. 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 near C28. Cut excess length off. Strip and tin the end and solder it to the 13.5 volt pad c 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 Q3 (next 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.

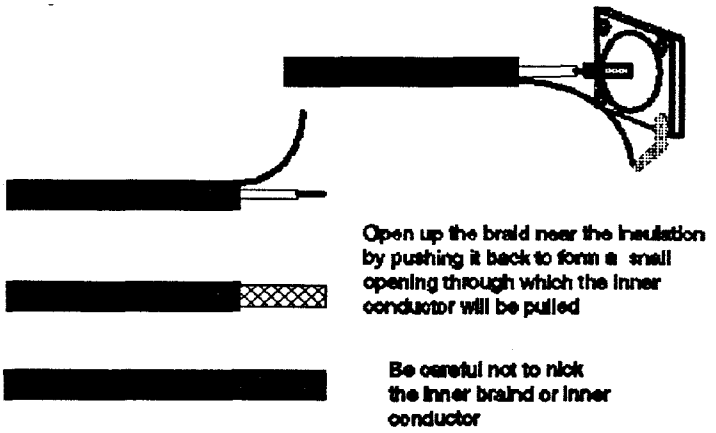
Now, check your work carefully, look for any solder bridges between pins or leads. Use a voltmeter or DVM with a continuity test, this will help quite a bit. All the solder joints should be nice and shiny without excessive solder.

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 o. 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 250 frequency counters we supply can be placed in line with the use of coax jumper or a wire can be soldered 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 frequency 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 is rated for a voltage of 13.. volts DC. 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.

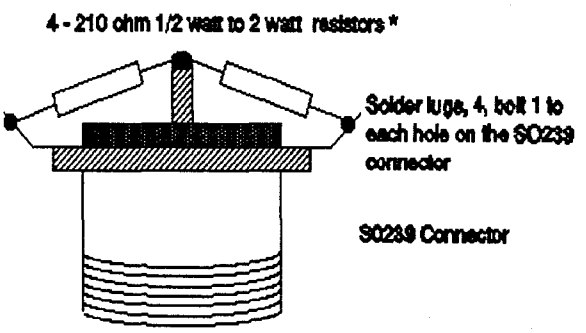
Turn on the power supply, you should see some sort of movement of the power meter which should be set to the most sensitive range. Check Q3, if it becomes extremely hot, turn off power immediately. Do the same if any other components become hot. If the tuning slug of L4 is down most of the way the frequency counter should read in the 80 MHz range. Adjust C24 and C25 for maximum power, you should see between 1/2 watt and 3/4 of a watt output. At this point you have a free running transmitter without any frequency control since IC1 and IC3 are not in the circuit. Adjust the tuning slug (L3) with a tiny flat blade plastic screwdriver (be careful, the ferrite slug is brittle), the frequency counter should show the frequency changing. Now adjust C15 a little bit one way or the other, the frequency should shift quite a bit either way. Adjust both C15 and L4 to bring the transmitter close to the frequency you wish to broadcast on. Adjust C24 and C25 for maximum power at that frequency. During this time the LED lock indicator on the board should be glowing. Turn off the power supply and leave everything hooked up.

Install IC1 and IC3 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 may need to adjust C15 slightly to achieve frequency lock. Hook the positive lead of a voltmeter to the test point marked TP1 on the board and is to the left of R8, a 100K resistor, and the ground lead to a convenient point on the board. Adjust C15 and L4 to bring the voltage at this point to the value specified on the chart for the frequency range you are operating in. You might have to slightly adjust C24 and C25 for maximum power.

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 pass the first test as a free running transmitter, 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. At the end of R15 nearest IC6 you should read 8-9 volts. Be certain that all components are inserted correctly, especially Q1, Q2, Q3, D1, IC2. It is really a rather simple circuit, an RF oscillator controlled by the PLL followed by a buffer and amplifier. If it passed the free running stage but does not lock or locks to the wrong frequency, check your dipswitch settings. It is a common error to have two of the switch lines shorted together with a solder bridge. Probe for voltage at the juncture of R1 and R4. While adjusting C15 or L4, you should see a changing voltage at this point. If it stays at 4-5 volts, the PLL circuit is not functioning. Check proper orientation on IC2 and proper insertion of IC1. If the voltage fluctuates but the circuit does not lock, check between R1 and the output of IC3 for proper placement of

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 SO239

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

components and good solder connections.

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.

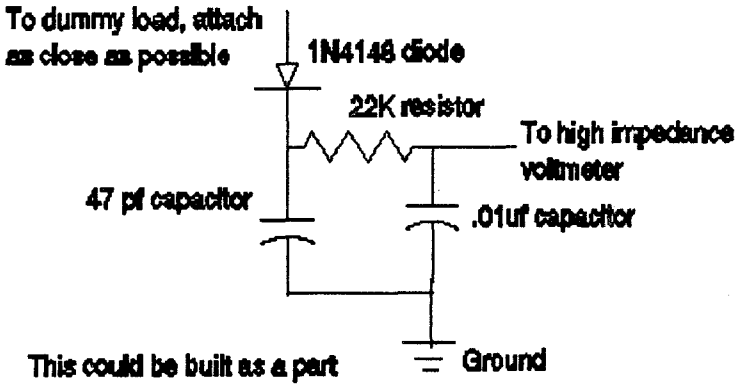
Now, again, starting from the back of the box. Screw the SO239 to the back of the box with the short 4-40 bolts and hex nuts. Pull the coaxial cable to the SO 239 connector and cut the RF wire so that it lays neatly in the box and does not have excessive length or does not drape across the circuit board. Leave about an extra 1 1/2 inch of 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 inch and solder the 12 volt wires to the red one and the ground leads to the black one. Be certain th 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 R26, 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 transmi ter to the chassis. Repeat the tests (dummy load, frequency counter, etc.) above to check for proper operation. Open up the variable resistor about 1/8 of a turn, rotate all the way clockwise first and then turn back 1/8 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. We have found that the 1/8 point is best for most audio sources and 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 g to the input of the 6 wa amplifier instead of the SO239 connector which will



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)

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, 20-24 watt amp or 30-40 watt amp 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.

APPENDIX

Indentifying components

Capacitors

There are several marking standards for capacitors. Typical markings are shown as follows:

These are all .1 microfarads but can be marked three ways:

.1 104 100n (nanofarad)

These are all .001 microfarads but can be marked three ways

.001 102 1n (nanofarad)

In most cases capacitors specified in picofarads will just have two numbers on the body of the capacitor.

22 means 22 picrofarads.

Mica capacitors are marked in a similar but somewhat different fashion.

220 means 22 picofarads and 221 means 220 picofarads

The rightmost number indicates the number of zeroes following the first two numbers

Electolytic capacitors usually have the value in microfarads marked on the body of the capacitor along with the voltage rating. Observe correct polarity which is marked on the body as well.

Resistors

Resistors use colored bands to indicate value. A gold or silver band will be on the right with three bands of color to its left. The first two bands (working from left to right) are the value followed by the multiplier.

Black	0
Brown	1
Red	2
Orange	3
Yellow	4
Green	5
Blue	6
Violet	7
Gray	8
White	9

For example, the following is a 22K ohm (22,000 ohms - K means thousand) 5 % (tolerance, means value can vary plus or minus percent) resistor.

red red orange gold

The last color band indicates the number of trailing zeroes, orange is three. Color hues can vary from manufacturer to manufacturer, use a DVM (digital volt meter) when in doubt.

Circuit description

Essentially the 1/2 watt PLL transmitter/exciter is a combination of two circuits - a 1/2 watt transmitter consisting of Q1, Q2 and Q3, and a phase locked loop frequency controller consisting of IC1, IC2 and IC3.

Q1 and its associated components (C20, C44, R9. C15, L4, C14, D1 and L9) form the FM oscillator and modulator circuit with an output of about 10 or milliwatts. Following this is a buffer/amplifier consisting of Q2, C18, R13, R14, and L5. Q2 increases the signal level from Q1 to a level sufficient to drive Q3 to an output power of 1/2 to 1 watt.

Q1 also serves as the FM modulator section. An audio voltage applied to variable capacitance diode D1 through L9 changes the oscillator frequency to produce an FM (frequency modulation) signal. A DC (direct current voltage) from the PLL controller section applied through R8 constantly tunes the oscillator ensuring frequency stability.

Q3 provides the final output power of 1/2 to 1 watt. A matching network consisting of C24, L6 and C45 convert the impedance of Q1 to a nominal output impedance of 50 ohms, the standard for most RF transmitters of this type.

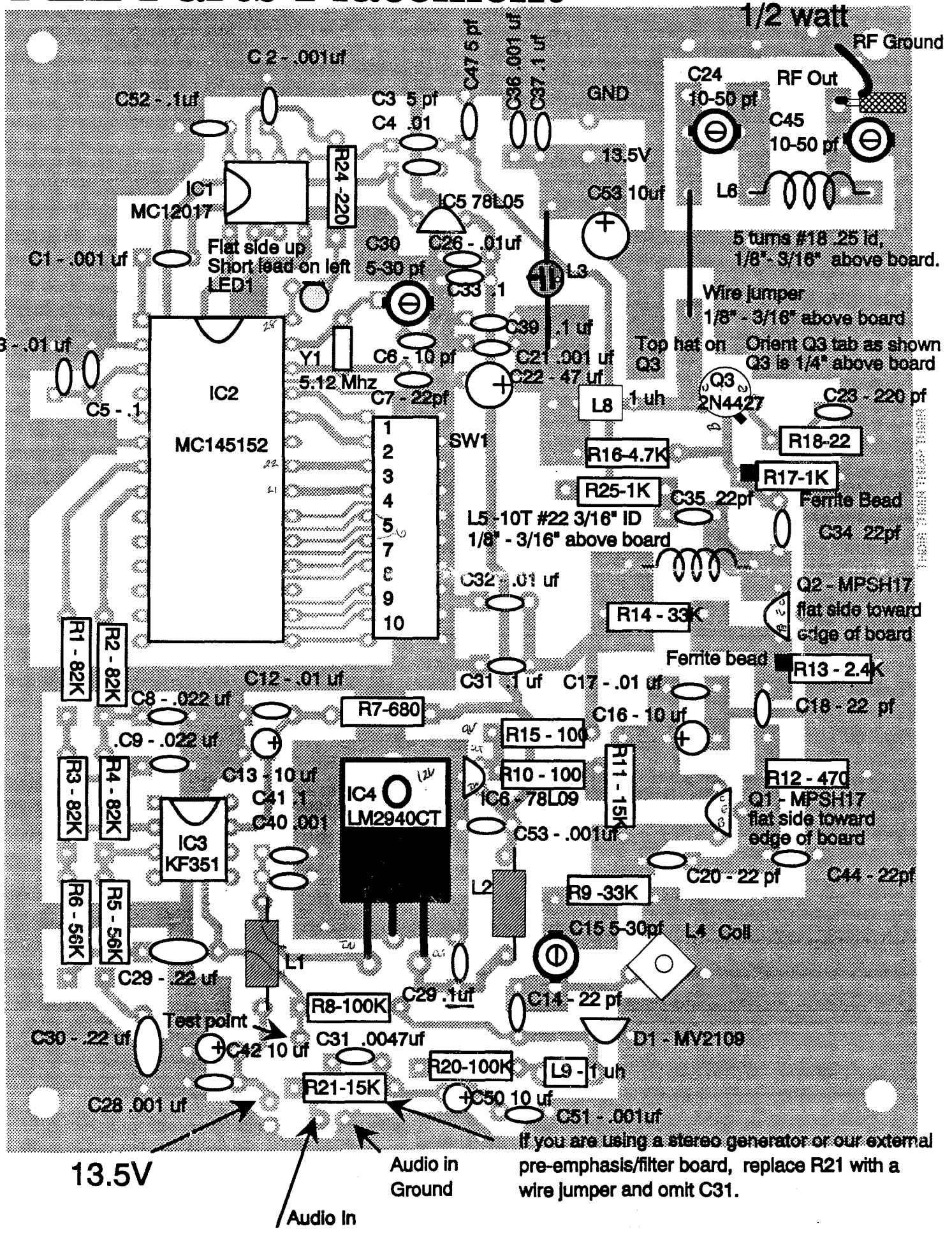
A sampled frequency is taken from R15 and C35 and applied to the PLL section. This signal goes to IC1 which is a frequency divider which reduces the signal to an acceptable frequency range for IC2. Comparing the incoming signal from IC1 to a reference frequency of 5.12 MHz generated by crystal Y1 and a digital division ratio programmed by 10 position dip switch SW1, IC2 generates an error signal which is filtered by IC3 and applied to D1 to control the frequency. Each time the signal drifts one way or the other, IC2 generates an error voltage to bring it back to the frequency programmed by SW1. When the PLL is functioning or "locked" LED1 will go out. An unlocked condition is indicated by LED1 being on.

Voltage regulator IC4 provides the first stage of voltage regulation for both the oscillator and PLL sections. Individual regulation for the oscillator section is provided by IC6 and IC5 for the PLL. By having two stages of regulation AC ripple (which is heard as a cycle hum) from the power supply is kept out of the oscillator section due to the filtering and regulation provided by IC4 and IC6. It is important to note that IC4 is a low voltage dropout regulator, it must have at least 13 volts input to function properly.

L1, L2, and L3 and the capacitors which go from the voltage leads to ground provide filtering of the voltage on the circuit board and also keep RF currents from going back to the power supply.

That is a basic summary of the functional aspects of the PLL transmitter.

PLL Parts Placement



PLL Transmitter Parts List

C1, C2, C21, C28, C36, C40, C51, C53 - .001 uf (marked 102 or 1N)	(8)
C3, C47 - 5 pf	(2)
C4, C12, C17, C26, C32, C43 - .01 uf (marked 103 or .01 or 10N)	(6)
C6 - 10 pf (marked 10)	(1)
C7, C14, C18, C20, C34, C35, C44 - 22 or 24 pf (marked 22 or 24)	(7)
C8, C9 - .022 uf (marked .022 or 203 or 223) green color	(2)
C12, C16, C42, C50, C53 - 10 uf (marked 10) blue cylinder eletrolytic, observe polarity	(5)
C5, C13, C31, C33, C37, C39, C41, C52 - .1 uf (marked 104 or .1)	(8)
C22 - 47 uf electrolytic	(1)
C15, C30 - 5-30 pf trimmer (green)	(2)
C23 - 220 pf (marked 220 or 221)	(1)
C24, C45 - 10-50 pf trimmer capacitors (orange)	(2)
C29, C30 - .22 uf (marked .22) green color or blue marked 224	(2)
C31 - .0047 (marked 472)	(1)

D1 - MV2109 variable capacitance tuning diode, observe correct orentation

IC1 - MC12017 prescaler	(1)
IC2 - MC145152 PLL frequency synthesizer	(1)
IC3 - LF351 FET opamp	(1)
IC4 - LM2940CT voltage regulator	(1)
IC5 - 78L05 voltage regulator	(1)
IC6 - 78L09 voltage regulator	(1)

L1, L2, L3 - wideband RF chokes	(3)
L4 - variable tuning coil, yellow	(1)
L5 - 10 turns #22, 3/16 internal diameter,	(1)
L6 - 5 turns #18, 1/4" (.25) internal diameter	(1)
L8. L9 - 1 uh inductor, lumpy blue item	(2)

LED1 - Light emitting diode, red	(1)
Q1, Q2 - MPSH17 observer correct orientation	(2)
Q3 - 2N4427, observe correct orientation of tab	(1)

R1,R2, R3, R4 - 82K	(grey, red, orange)	(4)
R7 - 680	(blue, grey brown)	(1)
R5, R6 - 56K	(green, blue, orange)	(2)
R8,R20 - 100K	(brown, black, yellow)	(1)
R26 - 10K potentiometer		(1)
R9, R14 - 33K	(orange, orange, orange)	(2)
R10, R15 - 100	(brown, black, brown)	(2)
R11, 21 - 15K	(brown, green, orange)	(2)
R12 - 470	(yellow, purple, brown)	(1)
R13 - 2.4K	(red, yellow, red)	(1)
R17, R25 - 1K	(brown, black, red)	(2)
R16 - 4.7K	(yellow, purple, red)	(1)
R18 - 22	(red, red, black)	(1)
R24 - 220	(red, red, brown)	(1)

SW1 - 10 position dip switch

Y1 - 5.12 Mhz crystal

Other items: 8 pin dip socket, 28 pin dip socket, 4 standoffs, 8 4-40 nuts, 4 -1/4" 4-40 bolts, 4 - 1/2" 4-40 bolts, SO239 socket, banana plugs (R & B) and sockets (R&B), hookup wire, RG174 coaxial cable, RCA phono jack, top hat heat sink, grounding lugs (2) and 4 ferrite beads.

Chart of Dipswitch Settings for the 1/2 watt PLL transmitter

Freq	Sw 1 (A4)	2 (A3)	3 (A2)	4 (A1)	5 (A0)	6 (N0)	7 (N1)	8 (N2)	9 (N3)	10 (N4)
88.1	1	0	1	0	1	0	0	1	0	0
88.3	1	1	1	1	1	0	0	1	0	0
88.5	0	1	0	0	0	1	0	1	0	0
88.7	1	0	0	1	0	1	0	1	0	0
88.9	1	1	1	0	0	1	0	1	0	0
89.1	0	0	1	1	1	1	0	1	0	0
89.3	1	0	0	0	1	1	0	1	0	0
89.5	1	1	0	1	1	1	0	1	0	0
89.7	0	0	1	0	0	0	1	1	0	0
89.9	0	1	1	1	0	0	1	1	0	0
90.1	1	1	0	0	0	0	1	1	0	0
90.3	0	0	0	1	1	0	1	1	0	0
90.5	0	1	1	0	1	0	1	1	0	0
90.7	1	0	1	1	1	0	1	1	0	0
90.9	0	0	0	0	0	1	1	1	0	0
91.1	0	1	0	1	0	1	1	1	0	0
91.3	1	0	1	0	0	1	1	1	0	0
91.5	1	1	1	1	0	1	1	1	0	0
91.7	0	1	0	0	1	1	1	1	0	0
91.9	1	0	0	1	1	1	1	1	0	0
92.1	1	1	1	0	1	1	1	1	0	0
92.3	0	0	1	1	0	0	0	0	1	0
92.5	1	0	0	0	0	0	0	0	1	0
92.7	1	1	0	1	0	0	0	0	1	0
92.9	0	0	1	0	1	0	0	0	1	0
93.1	0	1	1	1	1	0	0	0	1	0
93.3	1	1	0	0	1	0	0	0	1	0
93.5	0	0	0	1	0	1	0	0	1	0
93.7	0	1	1	0	0	1	0	0	1	0
93.9	1	0	1	1	0	1	0	0	1	0
94.1	0	0	0	0	1	1	0	0	1	0
94.3	0	1	0	1	1	1	0	0	1	0
94.5	1	0	1	0	1	1	0	0	1	0
94.7	1	1	1	1	1	1	0	0	1	0
94.9	0	1	0	0	0	0	1	0	1	0
95.1	1	0	0	1	0	0	1	0	1	0
95.3	1	1	1	0	0	0	1	0	1	0
95.5	0	0	1	1	1	0	1	0	1	0
95.7	1	0	0	0	1	0	1	0	1	0
95.9	1	1	0	1	1	0	1	0	1	0
96.1	0	0	1	0	0	1	1	0	1	0
96.3	0	1	1	1	0	1	1	0	1	0
96.5	1	1	0	0	0	1	1	0	1	0
96.7	0	0	0	1	1	1	1	0	1	0
96.9	0	1	1	0	1	1	1	0	1	0
97.1	1	0	1	1	1	1	1	0	1	0
97.3	0	0	0	0	0	0	0	1	1	0
97.5	0	1	0	1	0	0	0	1	1	0
97.7	1	0	1	0	0	0	0	1	1	0
97.9	1	1	1	1	0	0	0	1	1	0
98.1	0	1	0	0	1	0	0	1	1	0
98.3	1	0	0	1	1	0	0	1	1	0
98.5	1	1	1	0	1	0	0	1	1	0
98.7	0	0	1	1	0	1	0	1	1	0
98.9	1	0	0	0	0	1	0	1	1	0
99.1	1	1	0	1	0	1	0	1	1	0
99.3	0	0	1	0	1	1	0	1	1	0
99.5	0	1	1	1	1	1	0	1	1	0
99.7	1	1	0	0	1	1	0	1	1	0
99.9	0	0	0	1	0	0	1	1	1	0
100.1	0	1	1	0	0	0	1	1	1	0
100.3	1	0	1	1	0	0	1	1	1	0
100.5	0	0	0	0	1	0	1	1	1	0
100.7	0	1	0	1	1	0	1	1	1	0
100.9	1	0	1	0	1	0	1	1	1	0
101.1	1	1	1	1	1	0	1	1	1	0
101.3	0	1	0	0	0	1	1	1	1	0
101.5	1	0	0	1	0	1	1	1	1	0
101.7	1	1	1	0	0	1	1	1	1	0
101.9	0	0	1	1	1	1	1	1	1	0
102.1	1	0	0	0	1	1	1	1	1	0
102.3	1	1	0	1	1	1	1	1	1	0
102.5	0	0	1	0	0	0	0	0	0	1
102.7	0	1	1	1	0	0	0	0	0	1
102.9	1	1	0	0	0	0	0	0	0	1
103.1	0	0	0	1	1	0	0	0	0	1
103.3	0	1	1	0	1	0	0	0	0	1
103.5	1	0	1	1	1	0	0	0	0	1
103.7	0	0	0	0	0	1	0	0	0	1
103.9	0	1	0	1	0	1	0	0	0	1
104.1	1	0	1	0	0	1	0	0	0	1
104.3	1	1	1	1	0	1	0	0	0	1
104.5	0	1	0	0	1	1	0	0	0	1
104.7	1	0	0	1	1	1	0	0	0	1
104.9	1	1	1	0	1	1	0	0	0	1
105.1	0	0	1	1	0	0	1	0	0	1
105.3	1	0	0	0	0	0	1	0	0	1
105.5	1	1	0	1	0	0	1	0	0	1
105.7	0	0	1	0	1	0	1	0	0	1
105.9	0	1	1	1	1	0	1	0	0	1
106.1	1	1	0	0	1	0	1	0	0	1
106.3	0	0	0	1	0	1	1	0	0	1
106.5	0	1	1	0	0	1	1	0	0	1
106.7	1	0	1	1	0	1	1	0	0	1
106.9	0	0	0	0	1	1	1	0	0	1
107.1	0	1	0	1	1	1	1	0	0	1
107.3	1	0	1	0	1	1	1	0	0	1
107.5	1	1	1	1	1	1	1	0	0	1
107.7	0	1	0	0	0	0	0	1	0	1
107.9	1	0	0	1	0	0	0	1	0	1

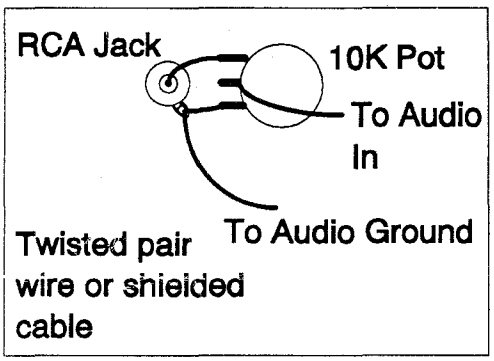
0 = 'ON' or switch closed (0V) up
1 = 'OFF' or switch open (5V) down

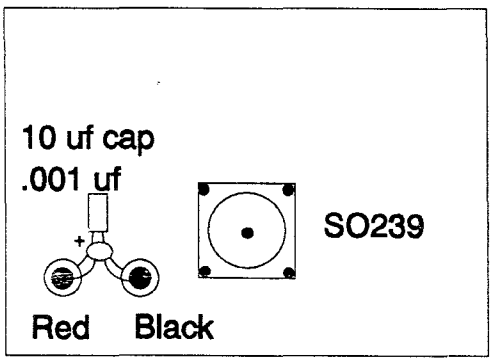
For best tuning range the following voltages should be present at Test Point 1 for the frequency ranges below. Adjust L4 (the yellow coil) & C15 to set the voltage.

88-92MHz	Set TP1 to 4V
92-96MHz	Set TP1 to 3.5V
96-100MHz	Set TP1 to 3V
100-104MHz	Set TP1 to 2.5V
104-108MHz	Set TP1 to 2V

Chassis Wiring for the PLL 1/2 watt transmitter

This diagram applies to the 1/2 watt PLL 1/2 watt transmitter when used either by itself or with a companion amplifier. When used alone the PLL RF output will go directly to the SO239 socket. If used with another amplifier, the RF output of the PLL will go the input of the companion ampifier whose output will then go to the SO239 socket.





Follow the wiring diagram for the audio input. Two leads will go to the PLL board, audio in and ground. These can be either twisted pair or shielded 2 conductor cable.

When soldering the capacitors between the banana sockets be sure to observe correct polarity of the electrolytic capacitor (10uf), negative lead to black (ground). At least one pair of voltage leads will be soldered to the banana sockets, positive voltage and ground. If a companion amplifier is being used, a second set of voltage leads will go to it as well. At least 18 gauge wire should be used for the companion amplifier and 22 gauge for the PLL leads.