Micropower Broadcasting - A Technical Primer

Many people still assume that an FM broadcast station consists of rooms full of equipment costing tens of thousands of dollars. The Micropower Broadcasting-Free Radio Movement has shown this to be untrue. Micropower broadcasting uses FM transmitters whose power output is in the range of 1/2 to 100-150 watts. Such transmitters have a physical size that is not much greater than that of your average brick. Combined with other equipment including inexpensive audio mixers, consumer audio gear, a power supply, filter and antenna, these transmitters enable any community to put its own voice on the air at an average cost of $1000-$1500. This is an affordable figure within the range of most communities.

All of the technical aspects of putting together a micropower broadcasting station are covered in the following material. It is important to note that the main argument the FCC uses against micropower broadcasting is its claim of interference with other broadcast services. Interference is a valid concern. By using equipment that is frequency stable and properly fitted with harmonic suppression filters, along with good operating procedures and standards, the FCC's argument can be effectively neutralized.

Further, the technical aspects of micropower broadcasting require some basic knowledge in the areas of electronics and broadcast practices. Hopefully, this primer will be able to convey some of this knowledge to you. If you are unsure of your abilities, try to find someone who has the technical experience to help you. Radio Shack sells some introductory books on electronics. The ARRL (Amateur Radio Relay League - www.arrl.org) handbook, published every year, is one of the best books available for radio theory. Although some of the content changes every year, the basic theory sections remain the same. Copies of past years handbooks are fairly easy to find at used book stores. There is a wealth of information available on the internet. Just enter "electronic tutorial" as a search term in Google or another search engine. As this movement grows, a network of people with the required technical skills will be formed to assist in the process of empowering every community with its own voice. If you are a person with engineering or technical experience, please contact Free Radio Berkeley to become part of this network.

FINDING A FREQUENCY

Before you can proceed any further, you must determine if there are any available frequencies in your area. Due to frequency congestion in the large urban metroplexes such as Chicago, Boston, LA, NYC, etc., this may be a bit difficult. You will need several items to do a frequency search: a listing of the all the FM radio stations within a 50-70 mile radius of your area; and a digitally tuned radio. Go to the FCC database to create the listing of stations in your area. Given the fluid nature of web sites, this Web link may change. You can go to the FCC home page (www.fcc.gov) to find the FM station database if the following link does not work.

FCC Database - http://www.fcc.gov/mmb/asd/fmq.html

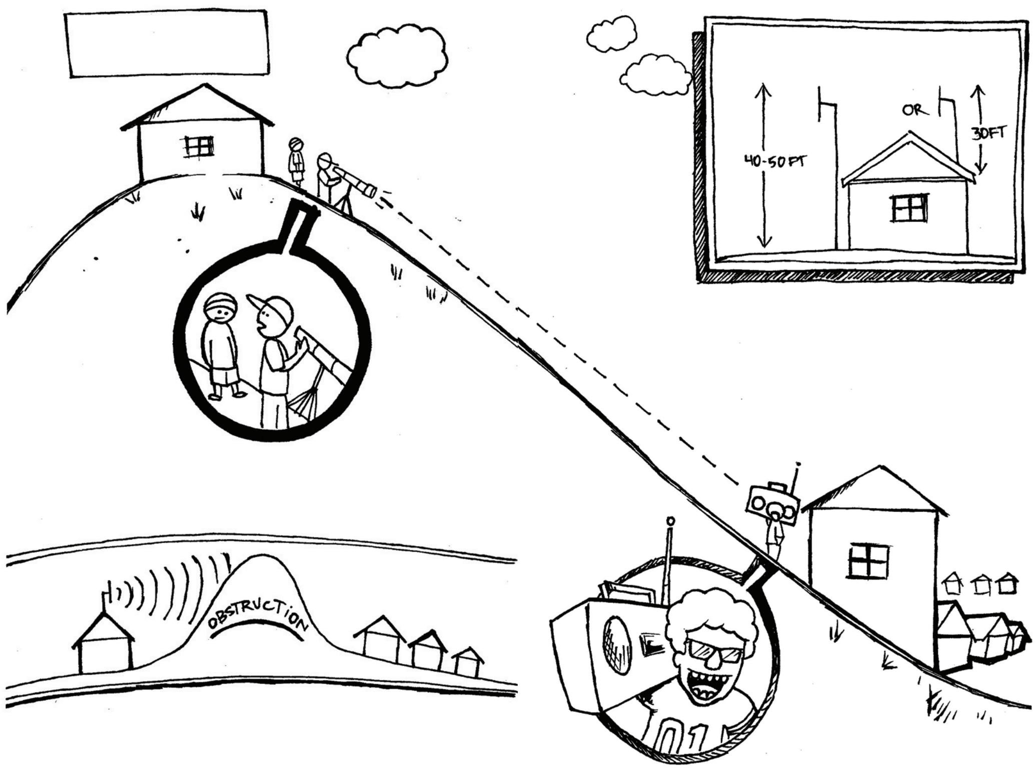
Channel separation is the biggest problem. FM broadcast frequencies are assigned a frequency channel 200 kilohertz wide. Good broadcasting practice requires that at least one channel of separation must exist on either side of the frequency you intend to use. In other words, if you have picked out 90.5 as a possible frequency, then 90.3 and 90.7 should be clear of any receivable signals. This is why a digital receiver is an important item for the frequency search.

Once you have a complete listing of all the FM radio stations, look for possible frequencies with the appropriate channel spacing. Depending on topography, distance and the output power of the other stations, certain "used" frequencies may in fact be open. The FCC database listing is very detailed. It will show the output power, antenna height, etc. Compile a list of the possible frequencies. Then, using a digital FM receiver with an external antenna, scan and check these frequencies. Do this from a number of locations and at varied times within the area you propose to cover. In most cases. weak, intermittent, or static-filled signals can be ignored and counted as either usable or providing the necessary channel separation. Hopefully, you will find at least one or two usable frequencies. If you live in a more rural area or some distance from a large urban area, finding a usable frequency should not be very difficult. 87.9 can be used as a frequency under two conditions. One, if there is not an existing station on 88.1, and, two, if there is not a TV Channel 6 being used in your area.

After compiling your list of possible frequencies, have your friends check them out on their receivers or radios as well. It is helpful to do this since a variety of different receivers will more accurately reflect the listening conditions in your area. After all of this, you should have a workable list of frequencies to use.

LOCATION OF STUDIO AND TRANSMITTER

Before you set up the station, find an adequate location. Since the antenna will be there as well, in most cases a site with adequate elevation is required. Ideally the top of a hill or a spot somewhere on the side of a hill overlooking the area of coverage is best. FM transmission is “line of sight.” The transmitting antenna and receiving antenna must be able to “see” each other. Therefore, any large obstructions will have a tendency to block the signal path. Keep this in mind when choosing your location. If your site is a one to three story building, a 30-foot push-up style mast attached and guyed to the roof or a TV antenna style tower bracketed to the side of the building will be needed to provide adequate height for the antenna. At the very least, you need to have the antenna at least 40-50 feet above the ground. In some areas a building permit may be needed to attach a mast or tower to a building. An increase of just 10 to 15 feet in antenna height can be more effective than an increase in transmitter power. When Free Radio Berkeley was broadcasting from the Berkeley hills, about 700-800 feet above average terrain, a 25-30 watt signal went a distance of 20-25 miles.



It is good practice to keep the transmitter some distance from the audio studio since the radio frequency emissions from the transmitter can get into the audio equipment, causing noise and hum. Your transmitter should be set up in another room, attic space, etc. as close to the antenna as possible. Keep the distance from the transmitter to antenna as short as possible. This will minimize signal loss in the coaxial cable feeding the antenna.

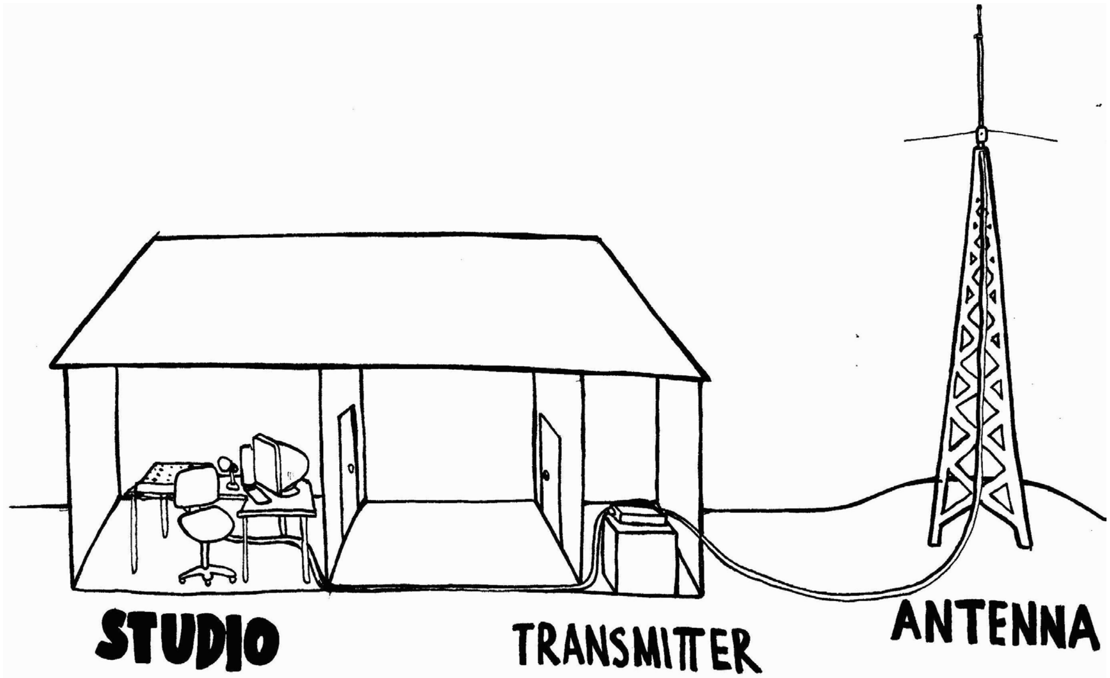
These are some of the basic issues regarding site selection. Landlords, room mates, leases etc. are your problem. If you are leasing a space, it is best to have an up-front conversation with your landlord, explaining that you are engaging in free speech activity, not felonious behavior despite what the FCC agents might say to the contrary if they make contact with him or her. More stations have been shut down by freaked out landlords than by FCC agents waving papers. A lease provides a reasonable firewall between your activities and the legal exposure of the property owner.

DRIVE BY RADIO

One option to consider is what has been termed “drive by radio”. If you are not sure whether you want to commit to a fixed studio location right off, then drive by radio might be the best solution for you. Basically, it entails the setting up of a portable broadcast operation at a public event or gathering of one sort or another. For a period of time, Free Radio Berkeley operated a weekend station at a local community flea market – it was called “Flea Radio Berkeley”. Our motto was “Creating the itch the FCC cannot scratch out.” Powered by a car battery, the station covered a radius of several miles with an output power of 6 watts. It was a perfect way to introduce micropower broadcasting to the community, enlist support, recruit new programmers, and give the community another way to express itself.

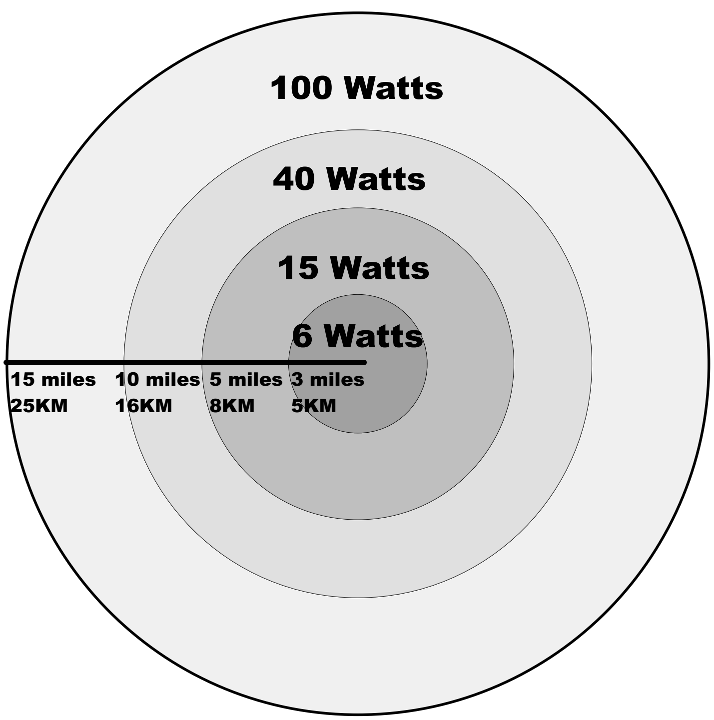
It is unlikely that the FCC will present a problem for this type of broadcasting, given previous experience. Equipment needed for this includes: a 6-20 watt transmitter; an antenna (a j pole or 5/8 ground plane antenna would work best); 25-50 feet of coaxial cable; a 70-100 ampere car battery or deep cycle marine battery; a small battery operated mixer; at least one microphone; a portable CD player; various audio and power cables; and a mast and stand to support the antenna. All the equipment should easily fit on a small table.

Depending on your circumstances, you may be able to affix the antenna and mast to an existing structure or upright sign pole. Carry some extra hose clamps (3-5 inches in diameter) to enable this process. You can



use a three-foot antenna mast tripod bolted to cinder blocks, one under each leg mounting foot (use a masonary bit to drill out the holes to match the hole pattern on the feet). Another option, if you are handy with welding, is to weld a three-foot steel pipe whose inner diameter is slightly larger than that of the antenna mast to a steel plate about two x three feet in size. Weld the pipe perpendicular to the plate and drill and tap a hole at the top of the pipe to accommodate a large set-screw to hold the antenna mast in position. Drive your car or truck over the steel plate so one tire rests directly on the steel plate; this will securely anchor it. Drop your mast with antenna attached to the other end into the pipe and tighten down the set-screw to keep the mast from rotating. You can use about 15 feet of mast in this situation or more if you use a push up mast and guy wire.

Ideal Coverage Distances for Micropower Broadcasting Stations



These are ideal coverage distances. They assume: an antenna height of 60-70 feet; using an omni-directional Comet 5/8 ground plane antenna; and relatively flat terrain. Depending on broadcast antenna used, terrain, the type of FM receiver (whether it uses an outside antenna or not), and antenna height, your distance may vary. You are constrained by both the distance to the horizon which is a function of antenna height and the broadcast power level. A general guideline is that is takes 4 times the power to double the broadcast distance. Further, raising the antenna height by just 10-15 feet or 3-4 meters will, in many cases, be more effective than increasing broadcast power.

FM TRANSMITTERS

FM is an abbreviation for Frequency Modulation. Modulation is how information is imparted to a radio frequency signal. In the case of FM the audio signal modulates what is called the carrier frequency (which is the frequency of the broadcast signal) by causing it to shift up and down ever so slightly in response to the level of the audio signal. An FM radio receives this signal and extracts the audio information from the radio frequency carrier by a process called demodulation.

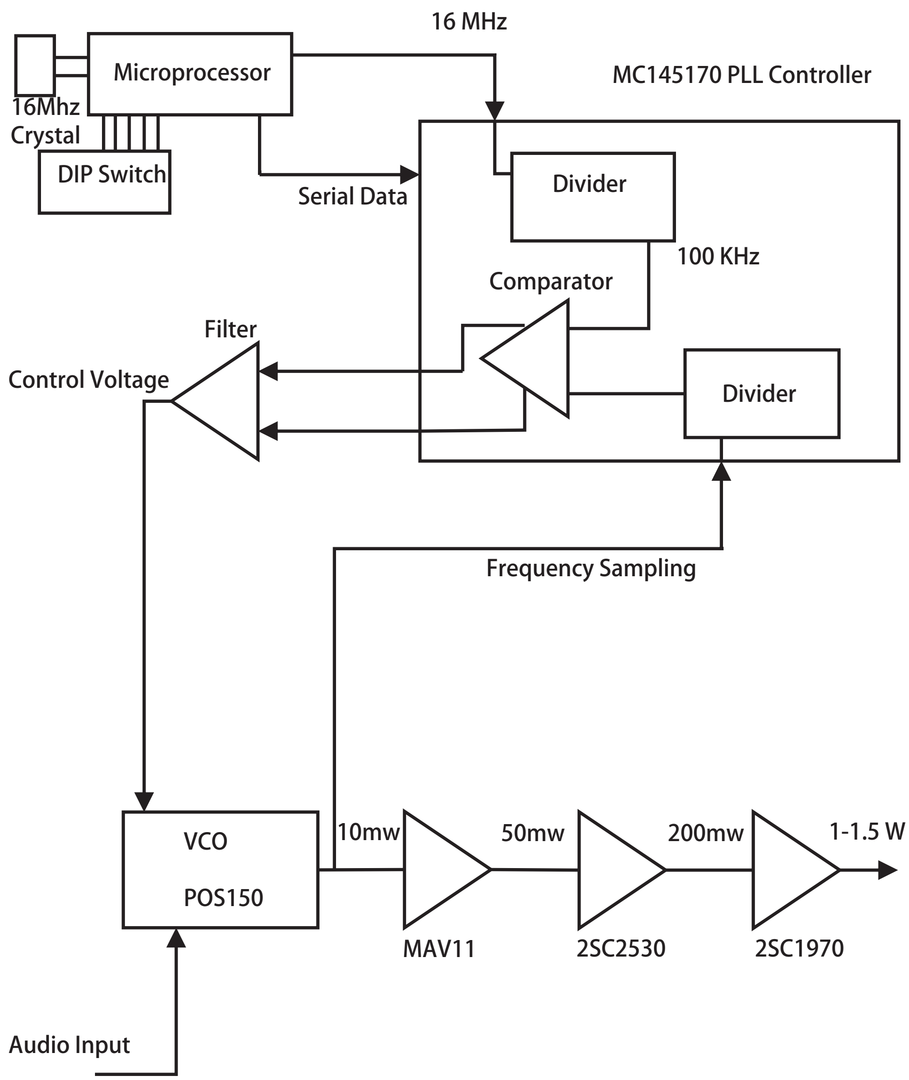
Modulation of the signal takes place within the FM broadcast transmitter. The transmitter consists of several different sections: the oscillator, phase locked loop, and gain stages. Generation of the broadcast carrier frequency is the responsibility of the oscillator section. Tuning (as distinct from modulation) or changing the frequency of the oscillator section is either done electronically or manually. For a practical radio station that will be operated for more than a few minutes, it is almost essential to have the tuning done under electronic control since free running or manually tuned oscillators will drift in frequency due to temperature and inherent design limitations. This is an important consideration in selecting a transmitter. Since one of the goals is to deprive the FCC of technical objections to micropower broadcasting, it is critical to have transmitters that stay on frequency and do not drift. This, of course, rules out using transmitters based on free running oscillators.

Frequency control brings us to the next section. Oscillator frequency drift is corrected by a circuit known as a phase lock loop (PLL) controller. In essence, it compares the output frequency of the oscillator to a reference frequency. When the frequency starts to drift it applies a correction voltage to the oscillator which is voltage tuned, keeping it locked to the desired frequency. In a PLL circuit the frequency is selected by setting a series of small switches either on or off according to the frequency setting chart that comes with the transmitter. In some cases, the switch array may be replaced by four dial-up switches that show a number for the FM frequency of transmission, i.e. 100.1 for 100.1 MHz. Even simpler, some units have a display like a digital radio with up and down buttons for changing frequency.

One part of the oscillator section, the voltage tuning circuit, serves a dual purpose. As described above, it allows the oscillator to be electronically tuned. In addition, it is the means by which the broadcast carrier frequency is modulated by an audio signal. When the audio signal is applied to this section the variations in the audio signal voltage will cause the frequency of the oscillator to shift up and down. Frequency shifts brought about by audio modulation are ignored by the PLL controller due to the inherent nature of the circuit design. It is important not to over modulate the transmitter by applying an audio signal whose level is too great. Many transmitters are equipped with an input level control which allows one to adjust the degree of modulation. Further control of the audio level is provided by a compressor/limiter which is discussed in the studio section.

As the modulation level increases, the amount of space occupied by the FM signal grows as well. It must be kept within a certain boundary or interference with adjacent FM broadcast channels will result. FCC regulations stipulate a maximum spread of plus or minus 75,000 cycles centered about the carrier frequency. Each FM channel is 200,000 cycles wide. Over modulation- the spreading of the broadcast signal beyond these boundaries- is known as splatter and must be avoided by controlling the modulation level. As a result, the signal will be distorted and interference with adjacent channels will take place.

Following the oscillator section are a series of gain stages which buffer and amplify the signal, bringing it to a sufficient strength for FM broadcast purposes. In most cases this will be 1/2 to 1 watt of output power. This level is sufficient for a broadcast radius of 1-2 miles depending on circumstances. For increased power, a separate amplifier or series of amplifiers is used to raise the power level even higher. Amplifiers are covered in the next part of this primer.



PLL Exciter Block Diagram

Transmitters are available in kit form from a number of different sources including Free Radio Berkeley, Progressive Concepts, Panaxis and Ramsey. Assembly requires a fair degree of technical skill and knowledge in most cases. Free Radio Berkeley offers an almost fully assembled 1/2 watt PLL transmitter kit requiring a minimal amount of assembly. Kits from Ramsey are debatable in terms of broadcast quality. An English firm, Veronica, makes some nice kits as well.

AMPLIFIERS

Although one-half to one watt may be perfectly adequate for very localized neighborhood radio coverage, higher power will be required to cover larger areas such as a town or a portion of a large urban area. In order to increase the output power of a low power FM exciter or transmitter, an amplifier or series of amplifiers are connected to the output of the transmitter. Amplifiers are also referred to as amps, and should not be confused with the unit of current also called amps.

Amplifiers are much simpler in design and construction than a transmitter. Most of the amplifiers used in micropower broadcasting employ only one active device, an RF power transistor, per stage of amplification. By convention most broadcast amplifiers have an input and output impedance of 50 ohms. This is similar to audio speakers having an impedance between 4 and 8 ohms. When an RF amplifier with a 50 ohm input impedance is attached to the 50 ohm output impedance of a transmitter, this matching of impedances assures a maximum flow of electrical energy or power between the two units.

A mismatch between any elements in the chain from transmitter to amplifier to filter to antenna will reduce the efficiency of the entire system and may result in damage if the difference is rather large. Imagine the results if a high-pressure water pipe four inches in diameter is forced to feed into a 1/2" water pipe with no decrease in the action of the pump feeding the four inch pipe. In an RF amplifier the RF power transistor will heat up and self-destruct under analogous conditions.

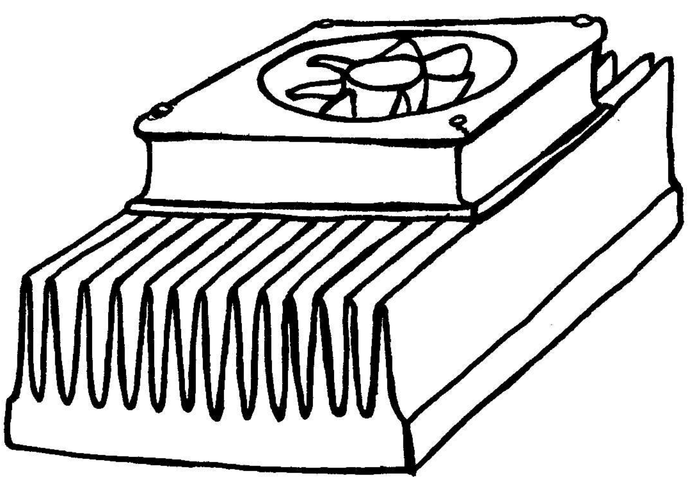
An RF power amplifier consists of an RF power transistor and a handful of passive components, usually capacitors and inductors which are connected in a particular topology that transforms the 50 ohm input and output impedances of the amplifier to the much lower input and output impedances of the RF power transistor. Detailed circuit theory of this interaction between the components is not covered in this primer.

Amplifiers can be categorized as either narrow band or broad band. Narrow band amplifiers are tuned to one specific frequency. Broad band amplifiers are able to work over a specified range of frequencies without tuning. Most of the amplifiers that have been used in micropower broadcasting are of the first type. A tunable amplifier can be a bit of a problem for those without much experience. In a typical tuned stage amplifier there will be two tuning capacitors in the input stage and two more in the output stage. If not correctly adjusted, the transistor can produce unwanted sideband spurs at other frequencies both within and outside of the FM band.

To make set up easier for the average micropower broadcaster, a broad band amplifier is preferable or one with a minimal amount of tuning stages. Several designs are available.

Broad band designs are not as common due to the degree of design experience required to create a functional unit. It seems a number of kit providers are content not to optimize and improve their amplifier designs. Free Radio Berkeley is now offering amplifiers that are either no tune or minimal tune designs in several different ranges of power. Certain broad band designs may be too wide in their range of frequency coverage and will amplify the harmonics equally well. For FM broadcast purposes the width of frequency coverage should be for only the FM band, about 20-25 Megahertz wide.

Selecting the right amount of power is important since you should only use enough power to cover the desired area. Unfortunately there is not an easy answer to the question of how much area a certain amount of power will cover. Antenna height is very critical, five watts at 50 feet will not go as far as five watts at 500 feet. Assuming you do not have a 10 story building or a convenient 500 foot hill to site your antenna and transmitter on, experience in urban environments has yielded the following rough guidelines. With an antenna approximately 50 feet above the ground, one-half to one watt will yield an effective range of one to three miles; five to six watts will cover out to about one to five miles. Ten to 15 watts will cover up to eight miles. Twenty to 24 watts will cover up to 10-12 miles and 30-40 watts will cover up to 15 miles. Coverage will vary depending on terrain, obstructions, type of antenna, etc. If your antenna is very high above average terrain, you will be able to go much further than the figures given above. Quality of the radios receiving your signal will be a determining factor as well. Since the power levels are rather low in comparison to other stations, an external antenna on the receiver is highly suggested, especially an outdoor one.



It is very important to provide adequate cooling for RF amplifiers. This means using a properly sized heat sink and an external cooling fan. Heat sinks have heat dissipating fins which must be placed in an upward pointing direction. Overheating will cause premature failure of the transistor. A cooling fan, usually a four to five inch square box fan, will offer extra insurance. It should be placed so that the air flows over the fins of the heat sink.

Under no circumstances should an amplifier/transmitter be operated without a proper load attached to the output. Failure to do so can destroy the output transistor. When testing and tuning, a dummy load is used to present a load of 50 ohms to the transmitter/amplifier. It is very bad practice to tune a unit with an antenna attached. Use a dummy load of proper wattage rating to match the transmitter output wattage.

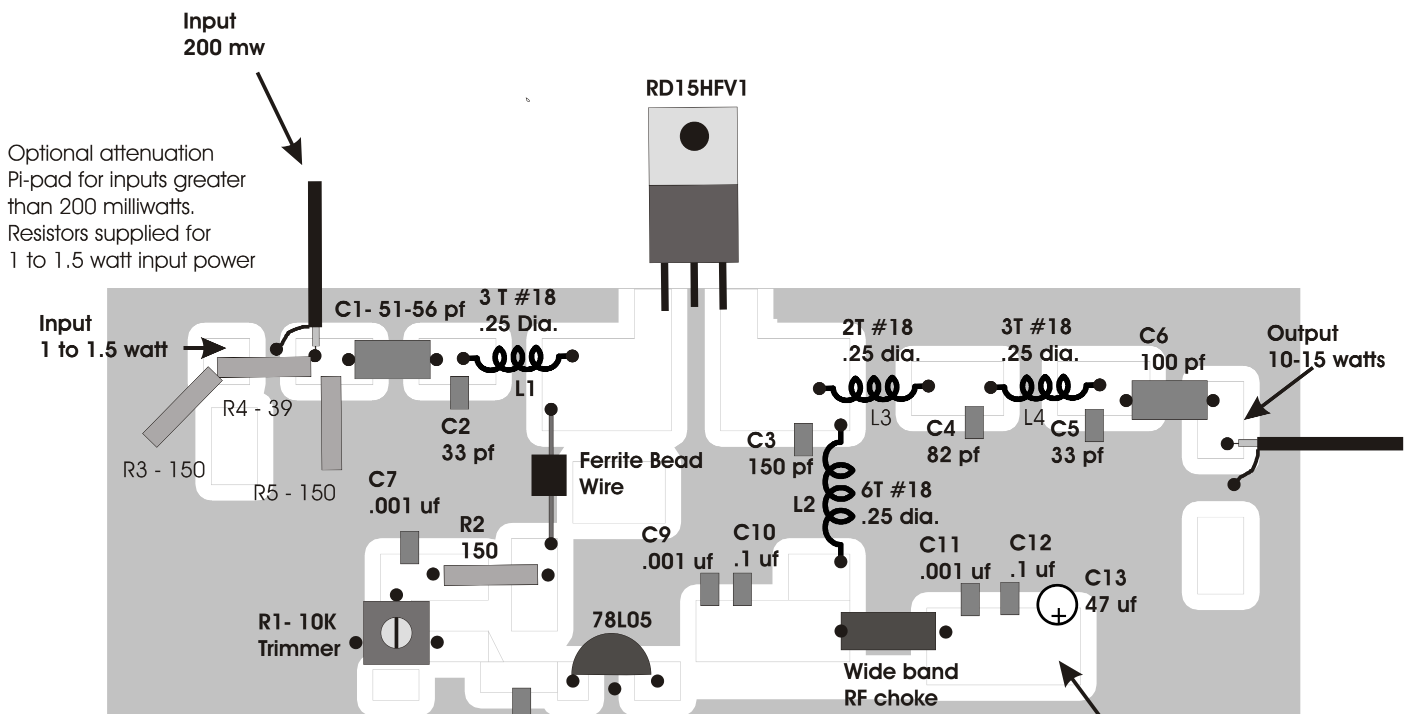
An output filter must be used between the transmitter/amplifier and the antenna. More on this in the filter section.

Heavy gauge (12-16 AWG) insulated stranded wire is used to connect the amplifier to the power supply. Observe correct polarity when making the connection. Reversing the polarity will result in catastrophic failure of the transmitter. Red is positive and black is negative or ground.

CONSTRUCTING FM RF AMPLIFIERS

RF Amplifiers are somewhat easy to build provided certain guidelines are followed. Component leads must be kept as short as possible. The transistor is soldered in last after it has been bolted down to the heat sink with a thin coating of heat sink thermal compound between the mounting area of the transistor and the heat sink.

Several amplifier designs are presented. The 15 watt amplifier does not necessarily need a pre-made printed circuit board although either full kits or just the circuit boards can be ordered from Free Radio Berkeley. Cut a piece of doubled-sided (copper foil on both sides) fiber glass (G-10 or equivalent) circuit board to the dimensions given in the construction diagram. Then cut out smaller pieces of circuit board for the individual mounting pads as show in the diagram. Try to cut them to about the same dimensions of the pads on the diagram. The pads are glued down on the larger board, duplicating the layout in the diagram.

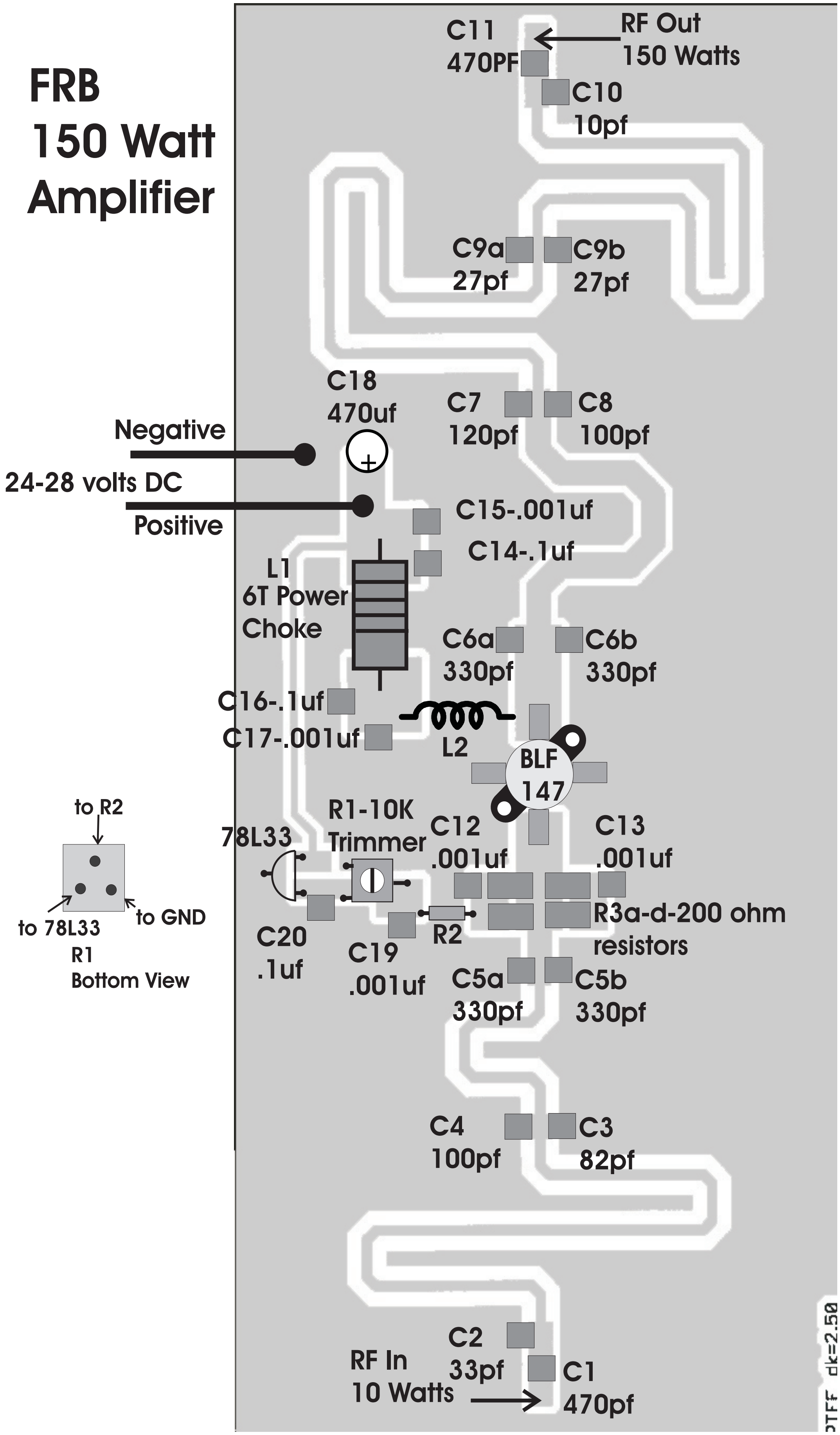


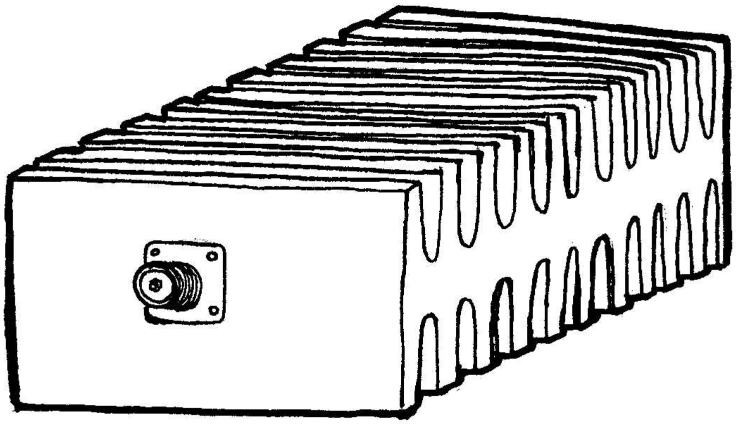
Free Radio Berkeley
15 Watt FM FET Amplifier
8-3-2007

The first amplifier is a 15 watt no-tune, broad band design. It is very easy to build and use. This amplifier requires 100 to 200 milliwatts of drive power and operates at 13.8 volts DC. Output power is adjustable, the bias voltage trimmer R1 controls this.

A 150 watt amplifier design is shown next. Like the 15 watt amplifier, the output power can be varied from about 1-2 watts to full power with a bias control. This amplifier requires 8-10 watts of drive power at 24 volts

FRB 150 Watt Amplifier





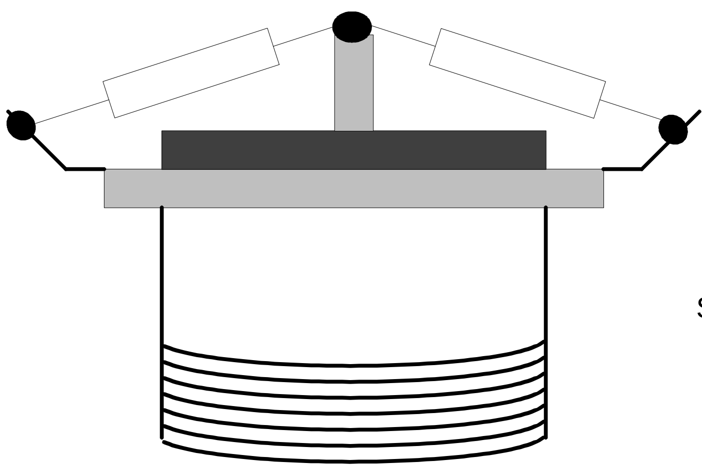
DC for 150 watts of output power. The 15 watt amplifier can be used to drive the 150 watt amplifier provided the input power does not exceed 10 watts.

DUMMY LOADS

To properly tune and set up an RF amplifier, a dummy load is needed since it is not good practice to use an antenna for such purposes. A dummy load simulates an ideal RF load of 50 ohms. The first design can be built for power range of 1-10 watts. A second design can be scaled for 25-100 watts depending on how many resistors are used.

LOW POWER DUMMY LOAD 2-10 WATTS

4 - 210 ohm 1/2 watt to 2 watt resistors *



Solder lugs, 4, bolt 1 to each hole on the SO239 connector

S0239 Bulkhead Connector

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

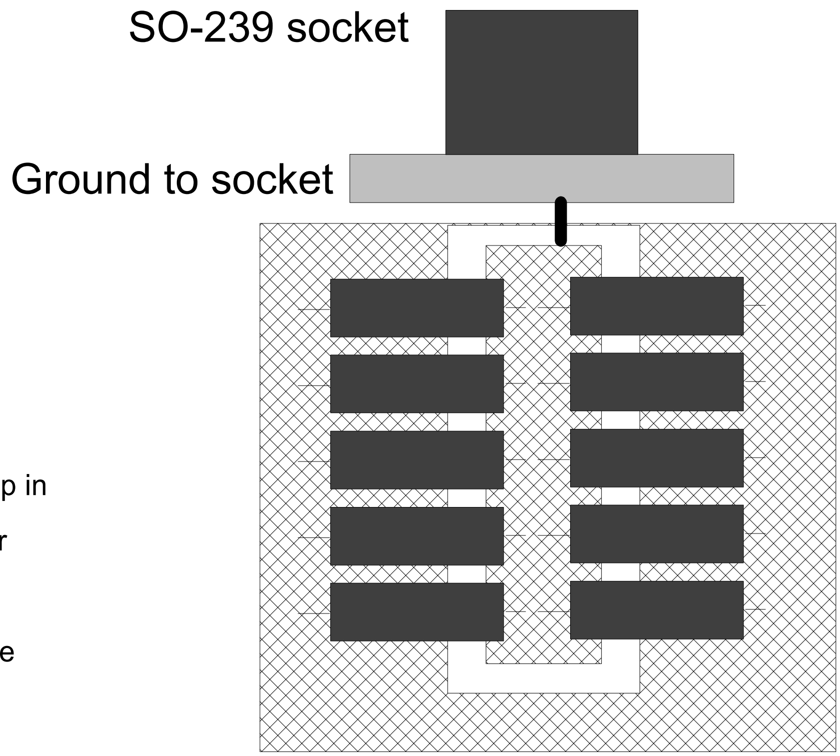
*If 2 watt resistors are used, this load can be used with transmitters with an ouput power of 5-6 watts maximum. To increase power capacity to 10 watts use 8 410 ohm 2 watt resistors, 2 at each corner. Use either carbon film or carbon composition resistors only. Do not use wirewound resistors

50 Ohm 20 Watt Dummy Load Design

Use for tuning and testing transmiiters & amplifiers. Do not operate either without a load, damage will result. This design can be used with the 30 watt amplifiers for a short period of time, do not let the resistors overheat

10 - 510 ohm carbon compostion or film, 2 watt resistors. Solder one end to the isolated strip and the other end to the ground portion of the circuit board.

Isolate a 3/4 to 1 inch wide strip in the middle of a piece of copper circuit board material, use a dremel tool or sharp xacto knife to cut away the copper



Mount resistors 1/4 " above the board

Attaching the SO239 socket to the board. Bolt the two ground lugs to the SO239 socket with 4-40 nuts and bolts. Attach to the side with the solder pin on it. Be sure the lugs are on opposite to each other, not diagonal. They should point straight down when held above the circuit board. Bend the solder lugs up at a 90 degree angle, the bend point should be flush with the edge of the SO239. Solder the lugs to the ground side of the circuit board, straddling the center strip, Use a piece of jumper wire to conect from the center pin to the center strip of the circuit board.

POWER SUPPLIES

Most of the transmitters and amplifiers used in micro broadcasting require an input voltage of 12 to 14 volts DC. Higher power amplifiers (above 40 watts) require 24-28 volts DC. In a fixed location, the voltage is provided by a power supply which transforms the house voltage of 110 volts AC to the proper DC voltage.

Power supplies are not only measured in terms of their voltage but current as well. A higher power amplifier is going to require a greater amount of input power as compared to a lower power amplifier. Output current is measured and specified as amps. A power supply is selected on the basis of its continuous current output which should be higher than the actual requirements of the amplifier. Power supplies operated at their fully rated output will have a tendency to overheat under continuous operation. An amplifier which requires 8 amps will need a power supply with a 10 to 12 amp continuos capacity. In most cases the following ratings are suggested for transmitters requiring 13.8 volts.

1-5 Watt Transmitter	1 Amp
10-15 Watt Transmitter	3 Amps
40 Watt Transmitter	6 Amps

Any power supply you use must have a regulated voltage output along with protection circuitry. Some reasonably priced brands include Pyramid, Triplite and Astron. There are two types of power supplies, linear and switching. Linear power supplies use a large and heavy power supply transformer. Switching supplies use a much smaller and lighter transformer. A 12 amp linear supply can weigh 15 lbs., whereas, an equivalent switcher weighs two to three 3 pounds. Switchers are rated by both voltage and wattage. Due to their higher efficiency, they do not need to be over rated as much as a linear type. One very reliable manufacturer of switching power supplies is Meanwell, which is distributed by Jameco, RSI Power, and Mouser. Do not use any of the wall transformer type of power supplies. Such units are not adequate for this application. Higher power transmitters require power supplies with an output voltage of 28 volts. A 75 watt transmitter will require a power supply with a current rating of 6-8 amps and 28 volts.

For mobile applications, voltage can be fed from the cigarette lighter socket of a car with the correct plug and heavy gauge wiring. This may not work well in some newer vehicles which are reported to have some sort of current limit protection on the lighter socket. Check with an auto mechanic about this if you are in doubt. Electrical systems on newer vehicles are rather sensitive and can be damaged if not properly understood.

Another problem with mobile operation is battery drain. A 20-40 watt transmitter running for 4-5 hours can deplete the battery to the point where the vehicle may not start. It is better to have a separate battery running parallel to the charging system with an isolator. Isolators are available from recreational vehicle accessory suppliers. Use a high capacity, deep discharge type of battery.

Lead acid batteries are not very benign. Acid can leak and spill on people, clothing and equipment. It is best to keep the battery in a plastic battery box. Vapors from the battery are explosive in confined areas. Keep this in mind for mobile vehicle operations. You might consider using a gel cell type of battery. It is sealed and can not leak. These are a bit pricey but have far fewer problems. A good quality gel charger must be used to ensure battery longevity.

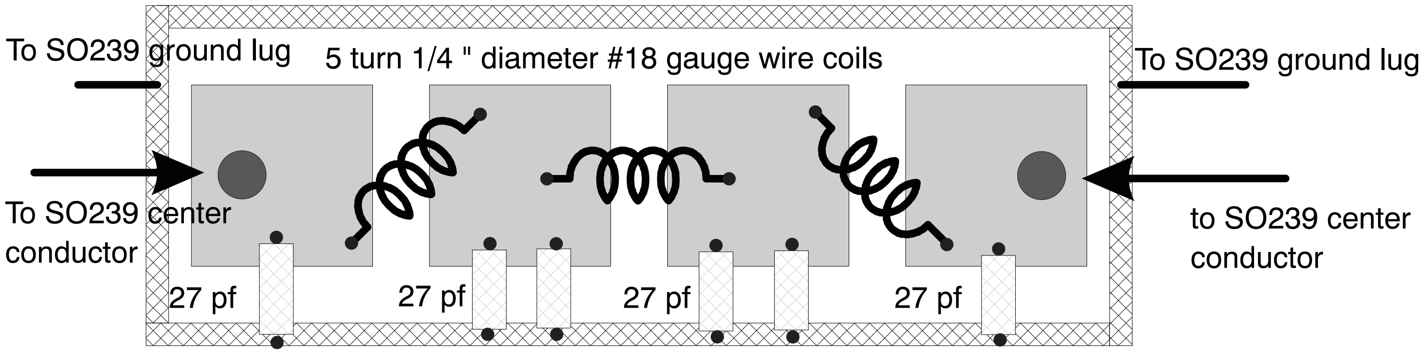
Smaller gel cell batteries work really well for setting up a low power (6 watts or less) transmitter on a street corner as a public demonstration of micropower radio. Transmitters can be set up at demonstrations and rallies so motorists can tune their radios to the frequency which is displayed on large banners near the streets and listen in on what is happening. This has worked very well. Use your imagination to show how micropower broadcasting can be brought into the community.

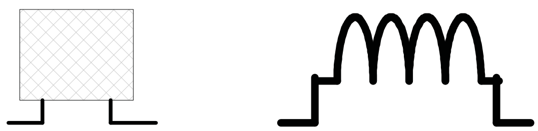
FILTERS

Although it is simple in design and construction, a filter is one of the most important elements in broadcasting. No matter what, a proper filter must be used between the transmitter and antenna. Use of a filter will help deprive the FCC of one of its main arguments against micropower broadcasting - interference with other broadcast services.

A proper filter reduces or eliminates harmonics from your broadcast signal. Harmonics are produced by the transmitter and are multiples of the fundamental frequency you are tuned for. For example, if you broadcast at 104.1, you may produce a harmonic at 208.2, and (less likely) 312.6 and so on. Most filter designs are of the low pass type. Frequencies below a certain frequency pass through unaffected. As the frequency increases, the filter begins to attenuate any frequency that is higher than the set point. The degree of attenuation increases with the frequency. By the time the frequency of the first harmonic is reached, it will be severely attenuated. This is

7 ELEMENT LOW PASS FILTER



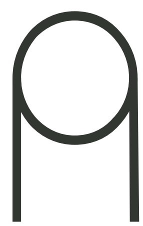


1.) Form the leads on the capacitors as shown above and solder from the pad to the outside ground area.

2.) Be sure that the turns on the coil are separated by a distance equal to the diameter of the wire and that the enamel coating is scraped from the portion of the coil lead that is to be soldered to the pad.

3.) Form the leads on the coil as shown above.

4.) Solder the coils in place as shown above.



Wind on 1/4 " diameter form such as a drill bit. On one end the lead is on the right and on the other end it is on the left.

5.) Use a metal box with a little clearance at either end. The filter board will mount on top of the the SO239 connectors. Place the board on the chassis and mark the center pin hole positions. Center punch the hole positions with a center punch or a sharp nail and hammer to keep the drill bit from walking. Use a 5/8" (16mm) drill for the SO239 mounting holes

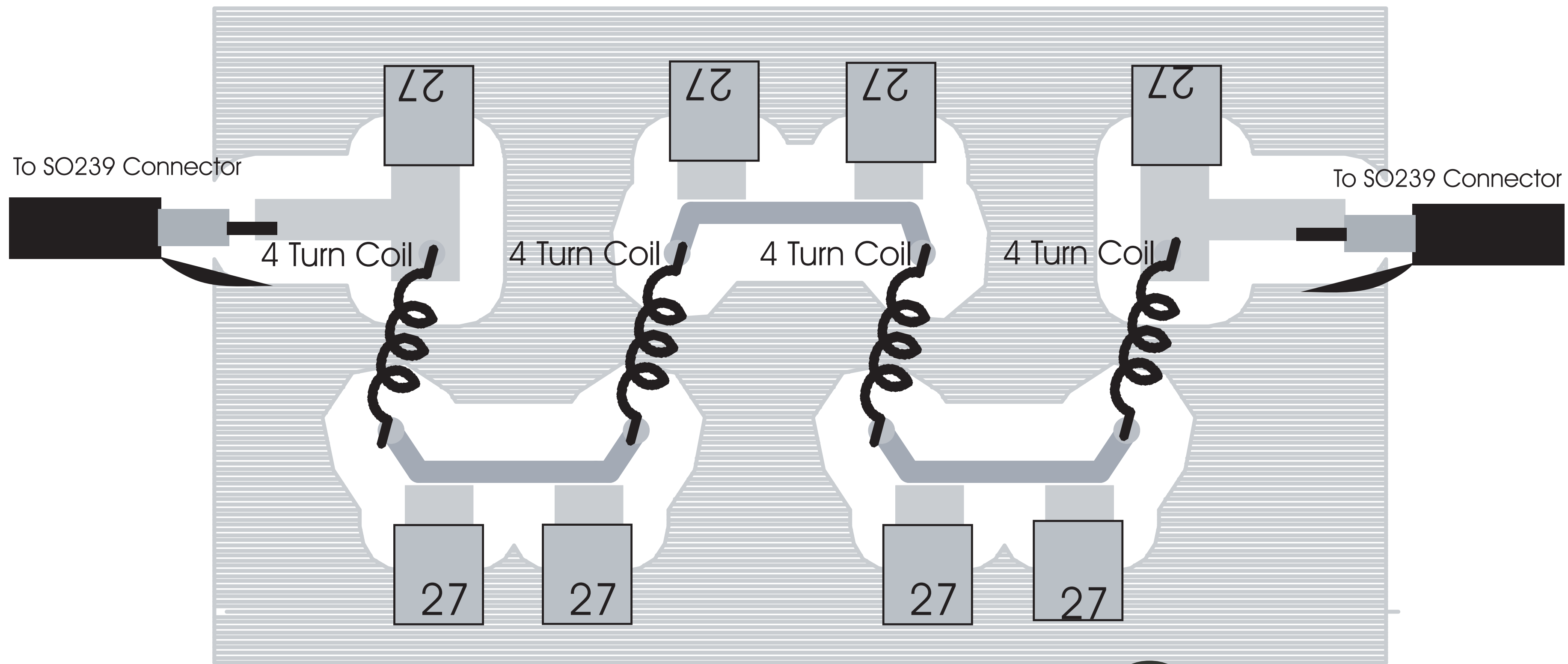
6.) Mount the SO239 connectors. Insert the connectors into their holes, place the ground ring on first followed by the lock washer and nut from the opposite side. Position the grounding ring tab so it will not be under the circuit board. Tighten securely. Bend the tab on the grounding ring vertical

7.) Place the filter board down onto the SO239 connectors with the center pins inserted into the holes on the circuit board. Very thoroughly solder the center pins to the circuit board pads, a fair amount of heat will be required

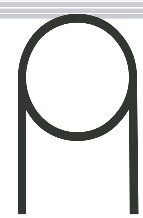
8.) Solder a piece of bus wire from the ground lug of the SO239 connector to the ground side of the filter board on each end. Place cover on box.

Parts list

L1, L2. L3 - #18 bus wire, 1/4" diameter, 5 turns	C1-C6 - 27 pf capacitors
2 - SO239 connectors	Short piece of #18 bus wire



9 Element Filter



Form leads as shown

Coils are #14 enamel
Inner coils are11/32" diameter
Outer coils are 5/16" diameter

Scrape the insulation from the leads on each coil
Mount the coils approximately 1/8" above the board

Solder the capacitors in first, keep the leads as short aspossible
Tin the pad with a puddle of solder and position the capacitor by heating the pad and putting the cap into position
Then, solder the other lead to the ground area
Place the coils in position and solder them from the top side of the board, cut the leads flush on the bottom
Mount in a suitable enclosure and use short pieces of coaxial cable to connect from the filter board to the SO239 connectors,
Center conductor of the coax to the pad, shield to ground side
Then connect the coax to the SO239 connectors, center conductor to SO239 pin, shield to ground lug
Alternatively, the PCB may be mounted directly to the SO239 connectors. Use the PCB as a template for the placement of the connectors on a panel. Or, the output side may be connected directly and a coax feed from the amplifier to the filter input side

Either side can be used as the input or output, it is symmetrical.

very important since the first harmonic from an FM transmitter falls in the high VHF TV band. Failure to reduce this harmonic will cause interference to neighboring TV sets.

You do not want to generate complaints from folks who engage in the odious habit of watching TV. Noble sentiments, such as telling them to smash their TV if they have a problem, will not suffice. Use a filter. Complaints increase the possibility of the FCC showing up at your door.

Harmonics further up the radio spectrum can cause interference to other mobile and emergency radio services. Not desirable either.

Transmitters with output power ratings of less than 25 watts will need at least a 7pole design. Higher power units will need a 9 pole design. Increasing the number of poles increases the degree of attenuation. Representative designs are shown. If you build one of these put it in a metal, well-shielded enclosure.

Not really related to filters, but an important side issue is the use of FM frequencies at the bottom and top ends of the band. Do not use 87.9 to 88.3 or so if there is a channel 6 TV frequency being used in your local area. Television sets have notoriously poor selectivity and your signal might end up coming in on the sound carrier of the TV if channel 6 is being used. At the top end of the band, do not go any higher than 106 MHz if the transmitter is near an airport. In fact, do everything possible not be too close - at least several miles and away from the flight path(s). Even though interference possibilities are minimal, there is not any point in taking chances since the FCC has claimed airplanes will fall from the sky if micropower broadcasting is given free reign. (Corner cutting corporate airline maintenance polices most likely pose a greater danger to public safety than micropower broadcasting, however.)

Filters are reasonably easy to construct. As noted above in the amplifer design section, cut a double sided piece of circuit board to the proper dimensions and cut out smaller pieces for the pads to which the components are soldered.

ANTENNAS

An antenna's primary purpose is to radiate the FM broadcast signal from the transmitter to surrounding FM radio receivers. In order to do this several conditions must be met. First, the antenna must be tuned to the frequency being transmitted. Secondly, it must be sited and oriented properly.

At FM frequencies the radio waves travel in a straight line until an obstacle is met. This is known as line of sight transmission. If the receiving antenna and transmitting antenna can "see" each other and the path distance is not too great to attenuate the signal, then the broadcast signal can be received. Radio signal strength is based on the inverse square law. Double the distance and the signal strength will be one-quarter of what it was.

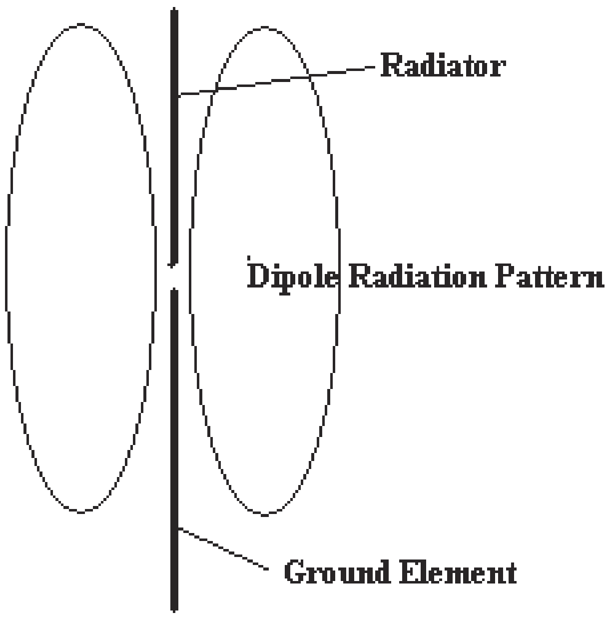
Since FM broadcast transmissions are line of sight, the height of the antenna is very important. Increasing the height is more effective than doubling or tripling the power. Due to the curvature of the earth, the higher the antenna, the greater the distance to the horizon. Increased height will place the antenna above obstructions which otherwise would block the signal. Your antenna should be at least 40-50 feet above the ground. Count yourself lucky if you can site the antenna on a hill or a ten story building.

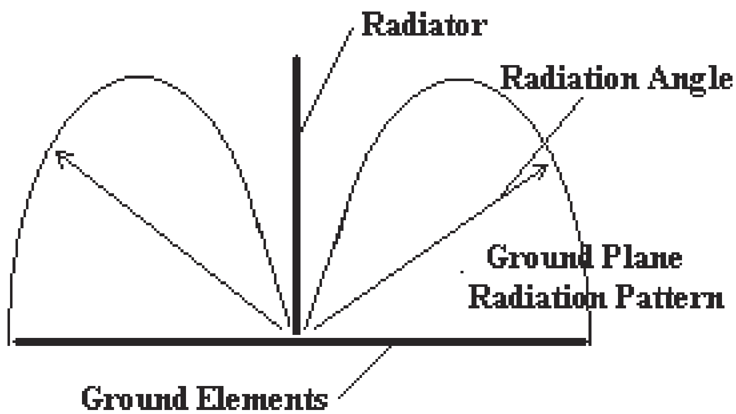
An antenna is rough tuned by adjusting the length of the radiating element(s). Many antenna designs are based on or derived from what is called a dipole, two radiating elements whose length is roughly equivalent to one-quarter of the wavelength of the desired frequency of transmission. Wavelength in inches is determined by dividing 11811 by the frequency in megahertz. The result is either divided by four or multiplied by .25 to yield the one-quarter wavelength. A correction factor of .9 to .95, depending on the diameter of the element, is multiplied times the one-quarter wavelength resulting in the approximate length of each element. A table of element lengths is provided in the appendix of this primer.

Fine tuning the antenna requires the use of an SWR power meter. SWR is an abbreviation for standing wave ratio, the ratio between power going into the antenna and the power being reflected back by the antenna. A properly tuned antenna is going to reflect very little power back. Correct use of an SWR meter is described a bit further down in this section. If you can afford $100, get a dual needle meter. It shows both reflected and forward power at the same time. A good brand is Daiwa.

A dipole with tuning stubs is one of the easiest antennas to make and tune. Two dipoles can be combined on a 10 foot mast if they are spaced three-quarter of a wavelength from center to center with the elements vertical and fed with a phasing harness. A phasing harness consists of two 1.25 wavelength pieces of 75 ohm coaxial cable (RG11) cut to a length that is the product of the 1.25 wavelength times the velocity factor (supplied by the manufacturer) of the cable. A PL259 plug is attached to the end of each cable. These are connected to a 259 T adapter with the center socket being the connection for the feed cable coming from the transmitter. The other ends go respectively to each dipole. Such an arrangement will increase the power going into the antenna by a factor of 2.

Besides the dipole, a number of other antenna designs are employed in micropower broadcasting. Each one has a characteristic pattern of coverage. Antennas can be broken down into two basic types – omni-directional and directional. Under most circumstances the omni is the antenna of choice for micropower broadcasting. Polarization is another aspect to consider but does not play that big of a role in most cases. Antennas can be vertical, horizontal or circular in polarization. Most micro broadcast antennas are vertically polarized. In theory a vertically oriented receiving antenna will receive better if the transmitting antenna is vertically oriented as well. Obstructions in the receiving environment will have a tendency to bounce the signal around so that the signal will be not be exactly vertically polarized when it hits the receiving antenna, particularly in a car that is moving. Commercial broadcasters employ circular polarization, yielding both vertical and horizontal components to the signal. It is said that this is best for car radios. This may be true, given the dependence of commercial broadcasters on "drive time" as a peak listening period.

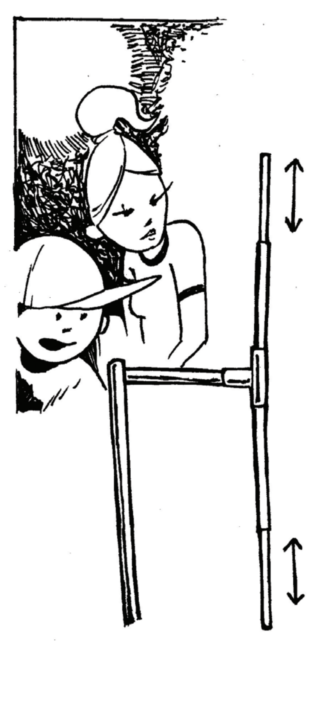




A single radiating element vertically oriented will have a rather high angle of radiation where a good portion of the signal is going up to the sky at angle of around 35 degrees or more. When you combine two vertical elements such as two dipoles you reduce the angle of radiation to a point where the signal is more concentrated in the horizontal plane. This is what accounts for the apparent doubling of radiated power when you use two dipoles phased together. Power output from the antenna or antenna array is known as effective radiated power (ERP) and is usually equal to or greater than the input power.

Several vertical element antenna designs have a lower angle of radiation even though they only use one element. These are the J-Pole and the Slim Jim designs. Having a signal pattern that is more compressed into the horizontal plane makes the Slim Jim ideal for urban environments. Both can be easily constructed from 1/2" copper pipe and fittings. Plans are available from FRB directly or the FRB web site: www.freeradio.org.

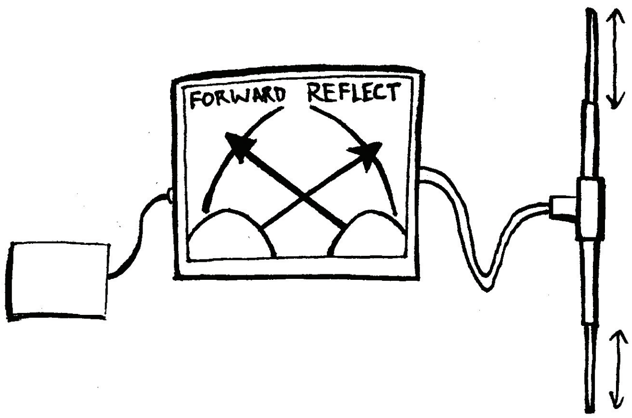
Another class of antennas are the 1/4 and 5/8 wave ground plane antennas. A commercially manufactured 5/8 ground plane for FM broadcast purposes is available for around $100. It is an ideal antenna for those want an easy to tune and assemble antenna. Set up time is less than 15 minutes.



Directional antennas are not usually required for micropower broadcasting. If the area you wish to cover lies in one particular direction, you might consider the use of such an antenna. An easy way to do this is to put a reflecting screen 1/4 of a wavelength behind a vertical dipole. The screen will need to be bit taller than the total length of the elements and about 3 feet wide. This will yield a nice directional pattern with a fair amount of power gain. Your pattern will be about 90 degrees wide. Another type of directional antenna is the yagi, a basic dipole as the radiating element but additional elements as reflectors and directors. A yagi can be a bit difficult to build for those not well versed in antenna design and construction. Your best choice is a dipole with a reflector.

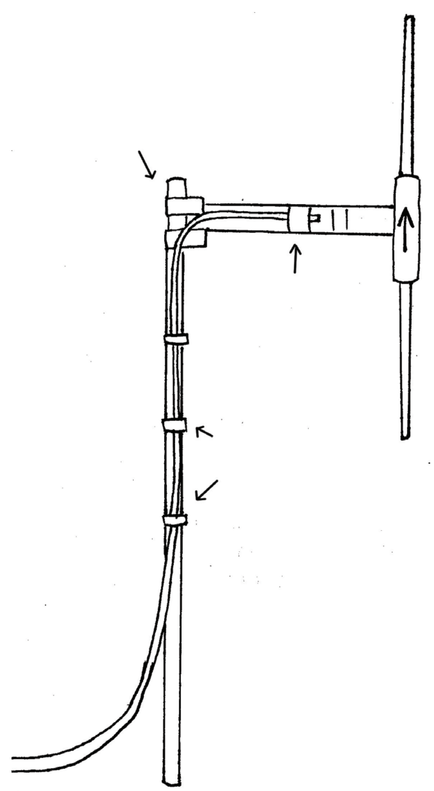
For those who wish for a practical design that can be built and put to use, the following is a basic dipole antenna which can be constructed from common hardware store items. It uses 1/2 inch copper water pipe and fittings along with aluminum tubing. A half-inch plastic threaded T is used with a copper 1/2 inch threaded to 1/2 inch slip adapters at all three points. An aluminum tube 9/16 of inch or so in diameter will fit into this slip adapter and is attached with two #6 self tapping sheet metal screws. This tubing is 20 inches long. Another piece of aluminum tubing 15 inches long with a diameter small enough to slip inside the other tubing is used as the adjustable tuning element. Four slots 90 degrees apart and 1 1/2 inches long are cut into in one end of the larger tubing. A small diameter hose clamp is slipped over that end. With the smaller tubing inserted inside the hose clamp is tightened to hold it in place. This is repeated for the second element. A copper half inch thread to slip adapter is soldered to one end of a 36 inch piece of 1/2 inchcopper tubing which is the support arm for the dipole. A copper T is soldered to the other end. Then, two 3 inch pieces of 1/2 inch copper tubing are soldered to the T fitting. This allows easy clamping to a mast. A solder lug is attached to each element using one of the self tapping screws holding the elements to the slip fittings. Your coaxial cable will be attached to these solder lugs. Center conductor to one, braid or shield to the other. You can get a little fancier and make an aluminum bracket to hold an SO239 socket and attach this to the T connector.

Once you have it all put together as shown in the diagram, it is time to tune it. Adjust the element lengths to the 1/4 wave length you arrived at with the above formula. Tighten the clamps so the tuning stubs can barely slide back and forth. Mark each stub where it enters the larger tubing. Using either hose clamps or U clamps attach the antenna to the end of a mast piece 10 feet long. The element to which the braid or shield of the coax is attached must be pointing down Support the mast so that it stands straight up with the antenna at the top. It is best to do this outside.



Set up your transmitter and connect an SWR/Power meter between the transmitter and the antenna. Adjust your meter to read SWR according to the directions that came with it. SWR is the ratio of power coming from the transmitter and the power reflected back from the antenna. A properly tuned antenna will reflect very little power back, resulting in a very low SWR ratio. Too much reflected power can damage the transmitter.

Turn on the transmitter and observe the SWR or amount of reflected power. Shut the transmitter off if the level is very high and check your connections. Rough tuning the antenna by measurements should have brought the readings down to a fairly low level. Turn off the transmitter and adjust each tubing stub up or down about 1/4 of an inch. Turn the transmitter back on and note the readings. If the reflected power and SWR ratio went lower you went the right direction in either increasing or decreasing the length of the stubs. Turn off the transmitter and continue another 1/4 inch in the same direction or the opposite direction if the SWR ratio and reflected power increased. Turn the transmitter on again. If the reading is lower, continue to go in the same direction in 1/4 inch increments, being sure to turn off the transmitter to make the adjustments. Continue to do this cycle until you have reached the lowest possible reading. At some point the readings will start to increase again. Stop there.



You can do this with two dipoles as mentioned earlier in this section. Each dipole is tuned by itself and then both are connected with a phasing harness when mounted to the mast section.

A dipole antenna has a power gain of 1. There are several designs which will provide a power gain of approximately 2-3. The first design is 5/8 Ground Plane antenna.

5/8 Ground Plane Antenna

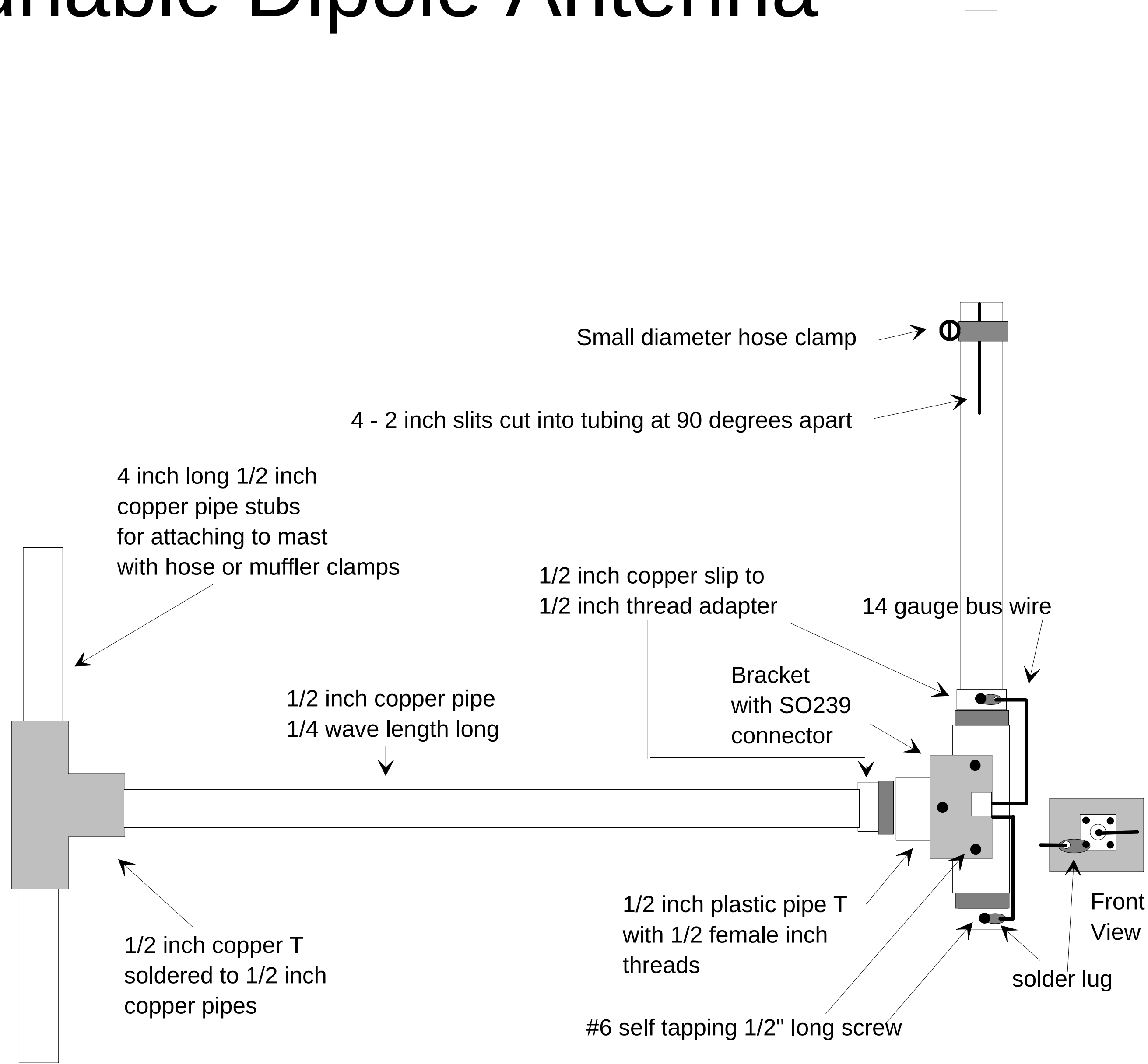
The next design is a J Pole antenna. It is one of the easiest to construct provided you know how to solder copper pipe with a propane torch.

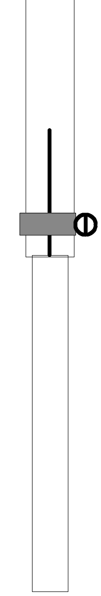
J Pole Antenna

CONNECTORS AND CABLE

Radio frequency cables are referred to as “coax” as a generic term. It is short for coaxial. A coaxial cable consists of an inner conductor inside an insulating core.

Tunable Dipole Antenna





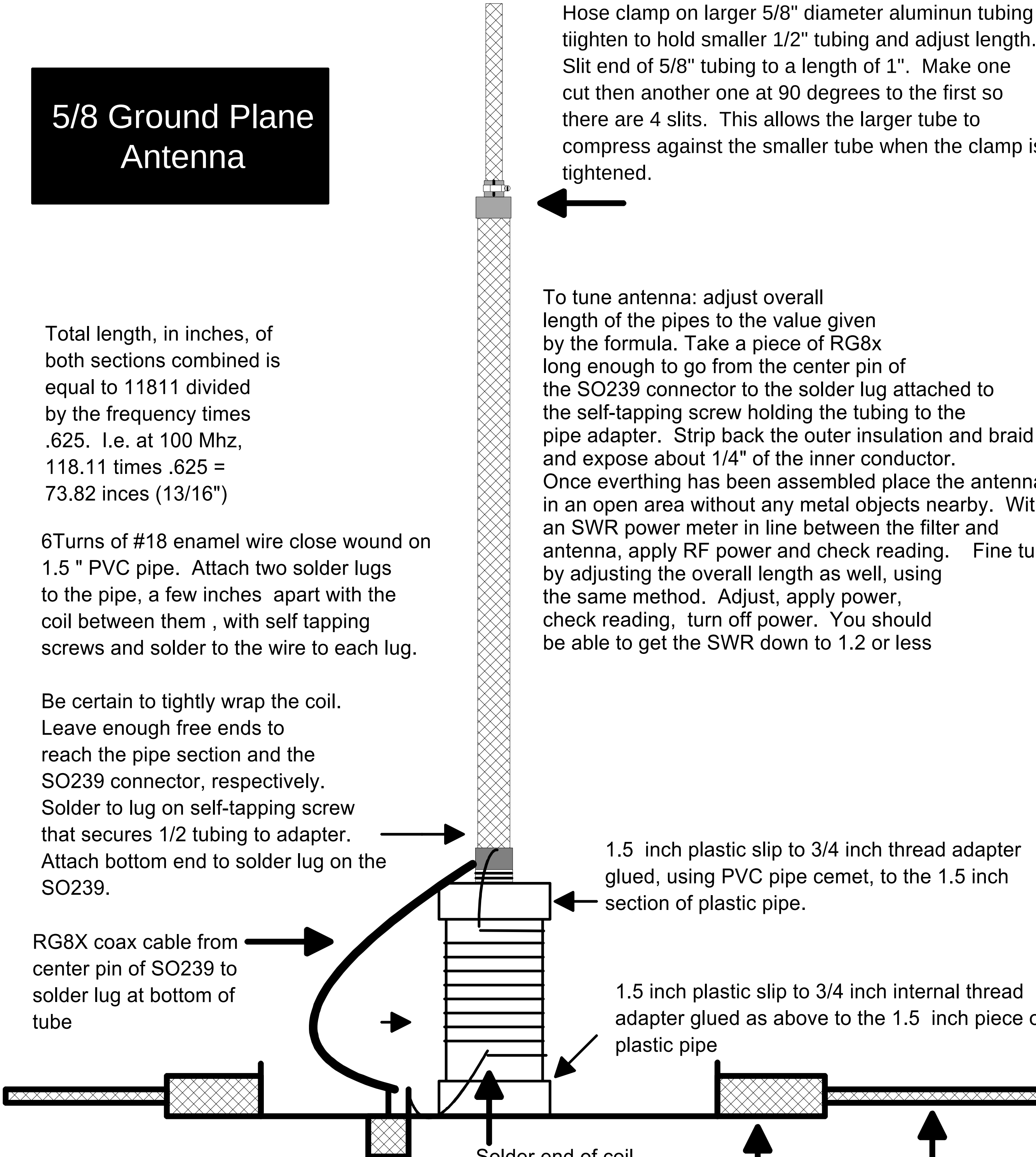
1.) Solder all copper pieces before attaching to the 1/2 inch plastic T

2.) The aluminum tubing is attached to the copper fitting with 2 self tapping #6 screws, 1/2 inch long. One on each side

3.) The antenna element to which the ground side of the SO239 is attached always points downward

4.) Tune the antenna by adjusting the length of the adjustable elements
Length in inches is equal to 2952 divided by frequency in MHz

5/8 Ground Plane Antenna



J-POLE ANTENNA

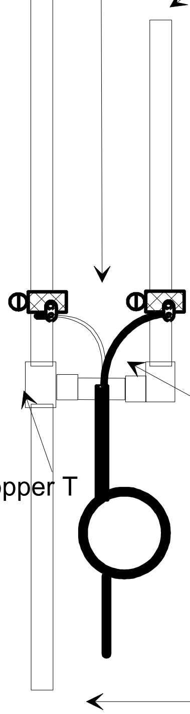
1/2" copper pipe
3/4 wave element
Length, in feet 705/Frequency in Mhz, i.e. 104.1

Made from 1/2 " copper pipe & elbow fittings soldered together. Use propane torch and copper pipe solder. Cut copper pieces according to the formulas given. Press fit all connections after polishing and applying flux to all pipe ends and lay flat on an even surface to solder. Hang the end over your workbench to solder it. Be sure it is flat & parallel prior to soldering.

Tap point for coaxial cableconnection is between 11/2to 3 inches from the bottom. The cable shield is attached to C and the center conductor is attached to A. A VHF power meter with an SWR scale is needed for optimum tuning which is accomplished by moving the tap points up or down and checking the meter for lowest SWR. Position the antenna in the middle of the room supported by a box or something not metallic. Turn on the transmitter, take a reading and note it. Turn off transmitter and move the tap points 1/2" up or down. If the reading is lower keeping repeating 1/4" movements in the same direction (reverse direction if reading is higher) until the lowest reading is obtained.
To mount the antenna attach the bottom 2 foot stub to your mast with either hose or muffler clamps

1/2" copper pipe
1/4 wave element
Length =234/frequency in Mhz, i.e. 104.1

Solder the inner coax lead and the shield braid to the solder lugs provided. Center conductor goet to the 3/4 piece and the shield goes to the 1/4 piece. Undo the clamps and slip around the copper pipes and slide the solder lugs under the clamps as shown. Tighten to the point where the clamps will slide. The clamps are moved up and down to find the best matching points for the antenna. When that point is determined drill into the copper pipe with an 1/8" bit. Attach the solder lugs with #6 self-tapping screws, hex head. Attach a PL259 plug to the other end of the coax cable. This is then attached to your main feed coax with a barrel connector. Seal all joints with coax seal.



1/2 " copper elbow

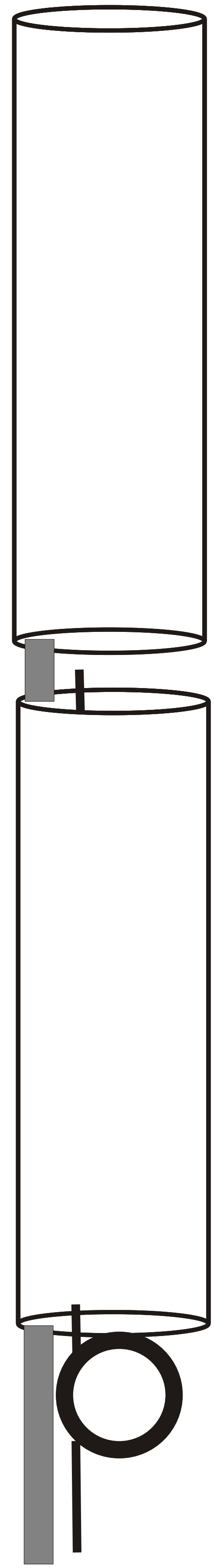
1/2" copper T

Distance between elements in feet = 22/frequency in Mhz, i.e. 104.1

Use RG8 Coax. After attaching one end to the antenna, make a 5 turn, 5 inch diameter coil with the coax, leaving 1-2 feet for the end to which the PL259 connector is soldered.

2 Ft. 1/2" copper pipe, clamp to your mast

FM Wideband Vent Pipe Dipole Antenna

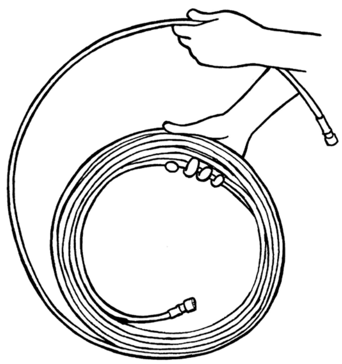


This is surrounded on the outside by a metal braid or foil, called the shield. This shield is in turn covered by an insulating jacket of plastic material. Coaxial cables are specified in terms of impedance which for most micropower broadcasting purposes is 50 ohms except for dipole phasing harnesses.

In the 50 ohm category, there are a number of choices when selecting coaxial cable. The most important characteristic of coax is its level of signal attenuation. This depends on the length of the cable and its particular frequency response. RG58 coaxial cable has a high degree of attenuation and should only be used for short connections. RG8X or mini 8 works well for lengths under 50 feet and is suited for portable and mobile set ups since it is rather flexible. RG8 and its higher performance cousins such as 213 and Belden 9913 are the best for fixed installations. Belden 9913 has the lowest loss for any given length as compared to other variations of RG8. In fact, it has a loss figure at 100 MHz that compares well with commercial broadcast hard-line coax. It is rather stiff cable and must be installed correctly.

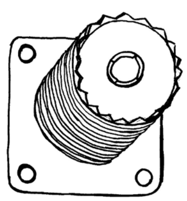
Coaxial cables do not take rough treatment very well, especially 9913. They must be carefully rolled up by hand, not wrapped between palm of hand and elbow like a rope. Kinks are to be avoided at all costs. When routing a cable keep the bends from being sharp and keep it away from circumstances where it can be pinched or slammed.

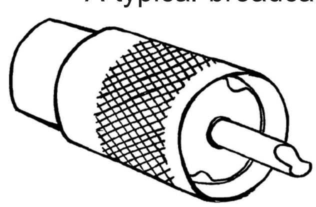
Three types of connectors are in general use - BNC, PL259 and N. Most micropower broadcasting equipment uses PL259 and its mating socket known as the SO239. Any connector will introduce some small degree of signal loss. N connectors are used where high performance and reliability are of most importance.



STUDIO SET UP

A typical broadcast studio consists of an audio mixer (DJ style works best), one or more CD players, one or more cassette tape decks, a turntable or two, several microphones, and a compressor/limiter. Optional items can include a cart machine and a phone patch.





Reasonable quality mixers start at $200 and go up in price from there. DJ styles are best since they have a large number of inputs available and support turntables without the need of external phono preamps. Any mixer you select should have least two or more microphone input channels. These should be low impedance inputs. Other features to look for include high visibility VU (level) meters, slide faders for each channel, switchable inputs for each channel, stereo or mono selection for the output signal, and at least one or more auxiliary outputs for an air check tape deck and studio monitors. Behringer is one manufacturer of good quality mixers and other audio equipment. Their DJ1000 mixer is a good choice, costing less than $200.

CD players and tape decks can be your average high quality consumer audio gear. Day in and day out usage will eventually take their toll so pay for the extra warranty period when it is offered. When one wears out in 6 months or so, just take it back under warranty for either repair or replacement.

DJ style turntables are the best choice for playing vinyl. Cheaper units just will not stand up to the wear and tear of daily usage. Select a heavy-duty stylus as well.

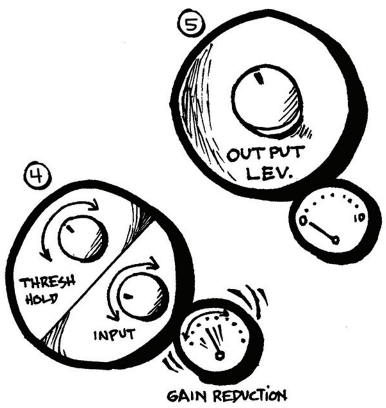
Microphones should be good quality vocal types. They can be either directional or omni-directional. Directional microphones will pick up less ambient noise but need to be on axis with the person's mouth for best pick up. Since some folks do not pay attention to where the microphone is in relation to their mouth, an omnidirectional might be considered a better choice. A distance of about four inches should be maintained between the microphone and mouth. Place a wind screen foam piece over each microphone. Some microphones have built-in shock and vibration isolation to keep bumps to the microphone from being audible. It is a good idea to use some sort of isolated holder for the DJ microphone. An old swing arm lamp can be adapted to hold a microphone.

For programmers who do a lot of reading of material on the air, a headphone microphone is something to consider since it will maintain a uniform distance from mouth to microphone no matter where the head moves to. One drawback is that they tend to be a bit fragile in rough hands.

Headphones are essential for monitoring and curing up program material. You can either opt for high quality rugged units that are a bit costly or plan on replacing an inexpensive set every few months.

A limiter/compressor is an essential part of the audio chain. It is used to keep the audio signal from exceeding a preset level. Without this the transmitter will be overmodulated, resulting in signal splatter and distortion. Signal splatter will cause interference with adjacent stations and distortion will send your listeners elsewhere.

Common to most limiter/compressors are a set of controls - input level, output level, ratio, threshold, attack and decay. To properly set up the mixer, limiter/compressor and transmitter, you start with a steady audio source (a signal generator plugged into the board or a test tone CD, tape or record). You adjust the input level and master output level controls so that the meters are reading zero dB. Master level should be at mid position. Audio output goes from the mixer to the limiter/compressor and from there to the transmitter. Do not turn the transmitter on at this time.



Most limiter/compressors have indicator lights or meters to show how much gain reduction is being applied and the output level. Set the ratio control to the infinity setting; this enables hard limit function. Attack and decay can be set around mid position. Adjust the threshold and the input level until the gain reduction shows activity. Adjust the output level so that the indicator lights or meters show a 0 dB output level.

Turn the level input on the transmitter all the way down and power up the transmitter. Monitor the signal on good quality radio. Slowly turn the level control until you can hear the test tone. Compare the signal level to that of other stations. Your level should be slightly less since most other operations are using quite a bit of audio processing on their signal. You may have to make fine adjustments to the limiter/compressor to get things exactly right.

When everything is set up correctly, any audio signals that exceed 0 dB on the board will be kept at that level by the compressor/limiter. You will need to listen carefully to the signal to make sure when a "hot" audio source exceeds this, that the transmitted signal keeps an even level and does not distort or splatter. There will be some interplay between the output level and the threshold setting. Nor do you want a signal that is too low in level either since that will produce a weak sounding broadcast.

A very important consideration is to keep as much distance between the studio gear and the transmitter as possible. RF (radio frequency signals) will find their way into audio equipment and produce a hum or other types of noise. You can separate the two areas by using a low impedance cable between the limiter/compressor and the transmitter. This can be a long microphone cable with XLR connectors or a made up shielded 2 conductor cable with XLR connectors. You can have about 150 feet of cable, maximum. A high impedance to low impedance transformer will be needed at one end or both depending on whether the limiter/compressor and transmitter have low or high impedance connections. These transformers usually have an XLR female connector on the low impedance side and a 1/4" phone plug on the high impedance side. If your transmitter has an RCA style input, you will need the proper adapter to go from 1/4" phone plug to RCA plug.

Your studio should be arranged to provide easy access to all controls and equipment with plenty of table space. An L or horseshoe shape works well for the studio bench. An open area within the sight line of the operator should be provided so there will be a place for extra microphones and guests.

DIGITAL & INTERNET AUDIO

Digital and internet technologies offer a lot to micropower broadcasters. The micropower community was an early adopter of MP3 digital audio. Dissatisfied with the hassles and problems of duplicating and sending out audio tapes, a web site was created for the exchange of radio programs in digital audio format. Anyone could create a program, digitize it and upload it to the site. Likewise, anyone wishing to broadcast a program could download it from the site. That site is www.radio4all.net. Quoting from their site:

> "The A-Infos Radio Project was formed in 1996 by grassroots broadcasters, free radio journalists and cyber-activists to provide ourselves with the means to share our radio programs via the Internet. To our knowledge, the A-Infos Radio Project was the first grassroots media project of it's kind on the internet. Our goal is to support and expand the movement for democratic communications worldwide. We exist to be an alternative to the corporate and government media which do not serve struggles for liberty, justice and peace, nor enable the free expression of creativity. The archived material is available to anyone who wants it free of charge."
>
> "We welcome submissions from all stations and independent producers in the service of these goals. All material is donated by its producers who are solely responsible for its content."

This open publishing model has been incorporated into the structure of the independent media sites (www.indymedia.org). Radio4all has several thousand radio programs archived with more being posted daily. Another good resource for programming is http.radio.indymedia.org. Additionally, this is good resource site for broadcasting in general. You can find a variety of useful links here. With the advent of the Independent Media Centers, streaming radio stations covering global protests and events are a great resource for micropower broadcasting. No longer do we have to rely on corporate media networks for shoddy coverage of world events. These web stations provide live, on-the-ground coverage of events as they happen. Links for these are found on the IMC radio page. Many of the individual Independent Media Center sites are a good source of programming material. You can search by type of media – audio, video, etc. For stations producing their own news programs, the IMC sites are a good source. Indymedia.org is the main hub site.

To take advantage of these resources you need a computer system connected to the internet, a cable or DSL connection is best. In addition, a sound card or built-in audio capacity is needed. Cast off low end PC computers with a 233 Mhz or greater processor will handle the audio requirements without any problem. A large hard drive (40mb or greater) will be needed to store your audio files. Audio from the computer can be fed directly into the mixing board. Most computer analog audio output connectors are 1/8" stereo jacks. An audio cable with a 1/8" stereo plug on one end is plugged into the computer audio line out jack; the other end is terminated with two RCA type plugs, left and right. Plug the RCA connectors into an input channel on the mixer. Such a configuration will allow you to send audio directly into the mixer.

On the software side of things, an MP3 player such as Winamp is needed to play either a webcast MP3 stream or a downloaded MP3 file. There are other audio stream formats such Real Audio and Microsoft Media. Within the micropower and IMC community there is somewhat of a consensus to support and use software that is either open source and/or non proprietary. Some streams are only available in Real Audio format. Their media player is required to play the audio stream. If possible, try to find an earlier version of Real Audio, such as version 8. With a good mix of MP3 audio and music files any community station will be able to provide a wide variety of programming. Radio production software (look on the web site - http://www.hitsquad.com/smm/) will allow the station to run unattended for those times when a programmer is not available. Other software such as Sonicart (http://www.hitsquad.com/smm/programs/Sonicart/) emulates a multi rack cart player. Audio files can be set up and played when needed. Hitsquad is a good source of audio software, but enable your browser (Mozilla is good for this) to suppress pop-up windows when you use this site. This site is brutal otherwise. Other good sites are mp3.com and download.com.

Your computer can also be used to record and produce audio files. There are dozens of software programs called rippers which will digitally record MP3 files from an audio CD placed in the computer's CD drive. This is very useful when you want to preserve the station's CD collection and still make the music available. CD discs developing legs is a common problem at all stations. An auxillary line out from an audio mixer can be connected to audio input jack on the computer for digital recording and editing purposes. This will allow you to use a digital audio editor to record and produce radio programs on your computer. Several good editors include Audacity (free - http://audacity.sourceforge.net/) and Cool Edit 2000 (inexpensive - http://www.syntrillium.com/). A number of good digital audio tutorials can be found on the Cool Edit site - http://support.syntrillium.com/cooledit/tutorials.html.

Digital streaming software can be used to stream your station to the web. It can also be used to separate your studio from the transmitter. If the FCC obtains a seizure warrant, they can take everything associated with the broadcast station. By setting up your primary operation as an internet only broadcast station, you are not liable if some other group or individual in the community decides to hook up a transmitter to the audio feed coming from a computer picking up your stream. Transmitters and antennas are easier to replace than an entire studio of gear. If the FCC issues a warning letter to whoever is hosting a transmitter, it becomes the FCC's tough luck if it shuts down and someone else unrelated goes on the air with the web stream. The legal clock starts all over again. They just end up chasing a transmitter around the community. Check the IMC radio site mentioned above for information on streaming software. MP3 streaming software is the best choice since it is open source in most cases.

FINAL WORD

Although it seems like there is a lot to deal with in setting up a micropower station, it can be broken down into three areas- studio, transmitter and antenna. It should not be difficult to find someone with studio set-up experience to help with the project. Transmitters, particularly their construction and tuning, should be left to an experienced person. If such a person is not available, there are a number of people who will assemble, test and tune your transmitter for whatever fee they have set. Stick to a commercial, easy to tune antenna such as the Comet if your skills are minimal. These can be purchased pre-tuned for an additional fee from. It is best to put most of the energy into organizing and setting up the station.

Experience has shown that once the technical operation is in place and running, it will require very little in the way of intervention except for routine maintenance (cleaning tape heads, dusting, etc.) and occasional replacement of a tape or CD player.

What requires most attention and "maintenance" is the human element, however. More time will be spent on this than any equipment. As a survival strategy it is best to involve as much of the community as possible in the radio station. The more diverse and greater number of voices, the better. It is much easier for the FCC to shut down a "one-man band" operation than something serving an entire community. Our focus is on empowering communities with their own collective voice, not creating vanity stations. Why imitate commercial radio ?

Before you commit to your first broadcast, it is advisable to have an attorney available who is sympathetic to the cause. Even though they may not be familiar with this aspect of the law, there is a legal web site which offers all of the material used in the Free Radio Berkeley case and other cases. There are enough briefs and other materials available to bring an attorney up to speed. That web address is:
http://www.nlgcdc.org/briefs.html.

The National Lawyers Guild Center for Democratic Communications, www.nlgcdc.org, is doing a lot of the legal work on micropower broadcasting. A central clearing house web site for the micropower movement is www.radio4all.org. Free Radio Berkeley's website is www.freeradio.org.

The following is a brief legal guide produced a few years ago by the NLGCDC:

WHAT TO DO WHEN THE FCC KNOCKS ON YOUR DOOR
Produced by the Committee on Democratic Communications -- A National
Committee of the National Lawyers Guild

NOTE: The following discussion assumes that you are not a licensed broadcaster.

Q) If FCC agents knock on my door and say they want to talk with me, do I have to answer their questions?

A: No. You have a right to say that you want a lawyer present when and if you speak with them, and that if they will give you their names, you will be back in touch with them. Unless you have been licensed to broadcast, the FCC has no right to "inspect" your home.

Q) If they say they have a right to enter my house without a warrant to see if I have broadcasting equipment, do I have to let them in?

A: No. Under Section 303(n) of Title 47 U.S.C., the FCC has a right to inspect any transmitting devices that must be licensed under the Act. Nonetheless, they must have permission to enter your home, or some other basis for entering beyond their mere supervisorial powers. With proper notice, they do have a right to inspect your communications devices. If they have given you notice of a pending investigation, contact a lawyer immediately.

Q) If they have evidence that I am "illegally" broadcasting from my home, can they enter anyway, even without a warrant or without my permission?

A: They will have to go to court to obtain a warrant to enter your home. But, if they have probable cause to believe you are currently engaging in illegal activities of any sort, they, with the assistance of the local police, can enter your home without a warrant to prevent those activities from continuing. Basically, they need either a warrant, or probable cause to believe a crime is going on at the time they are entering your home.

Q) If I do not cooperate with their investigation, and they threaten to arrest me, or have me arrested, should I cooperate with them?

A: If they have a legal basis for arresting you, it is very likely that they will prosecute you regardless of what you say. Therefore, what you say will only assist them in making a stronger case against you. Do not speak to them without a lawyer there.

Q) If they have an arrest or a search warrant, should I let them in my house?

A: Yes. Give them your name and address, and tell them that you want to have your lawyer contacted immediately before you answer any more questions. If you are arrested, you have a right to make several telephone calls within three hours of booking.

Q) Other than an FCC fine for engaging in illegal transmissions, what other risks do I take in engaging in micro-radio broadcasts?

A: Section 501 of the Act provides that violations of the Act can result in the imposition of a $10,000 fine or by imprisonment for a term not exceeding one year, or both. A second conviction results in a potentially longer sentence. If you are prosecuted under this section of the Act, and you are indigent (unable to hire an attorney), the court will have to appoint one for you.

Q) Are there any other penalties that can be imposed upon me for "illegal broadcasts?"

A: Under Section 510 of the Act, the FCC can attempt to have your communicating equipment seized and forfeited for violation of the requirements set forth in the Act. Once again, if they attempt to do this, you will be given notice of action against you, and have an opportunity to appear in court to fight the FCC's proposed action. Realize, though, that they will try to keep your equipment and any other property they can justify retaining until the proceedings are completed. You have a right to seek return of your property from the court at any time.

Q) If the FCC agents ask me if I knew I was engaged in illegal activities, should I deny any knowledge of FCC laws or any illegal activities?

A: No. You will have plenty of time to answer their accusations after you have spoken with an attorney. It is a separate crime to lie to law enforcement officials about material facts. Remain silent.

Q) If I am considering broadcasting over micro-radio, is there anything I can do ahead of time to minimize the liklelihood of prosecution?

A: Yes. Speak with an attorney before you are approached by law enforcement to discuss the different aspects of FCC law. Arrange ahead of time for someone to represent you when and if the situation arises, so that you will already have prepared a strategy of defense.

Q) What can I do if the FCC agents try to harass me by going to my landlord, or some other source to apply pressure on me?

A: So long as there is no proof that you have violated the law, you cannot be prosecuted or evicted. If there is evidence of misconduct, you might have to defend yourself in court. Depending upon what the FCC said or did, you might be able to raise a defense involving selective prosecution or other equivalent argument. If the conduct of the agents is clearly harassment, rather than a proper investigation, you can file a complaint with the F.C.C. or possibly a civil action against them.

Q) If I want to legally pursue FCC licensing for a new FM station, what should I do?

A: It isn't the purpose of this Q and A sheet to advocate or discourage non-licensed broadcast operations. A person cited by the FCC for illegal broadcasting will find it virtually impossible to later obtain permission to get a license.