

A POPULAR GUIDE TO...

BUILDING FM BROADCAST STATION

A COMMUNITY

Written & illustrated
By T.J. Enrile



Dude we should start
our own radio station.
...We really could.

Yeah right! Maybe someday
when I'm a millionaire.

I'd love to have a station, but...

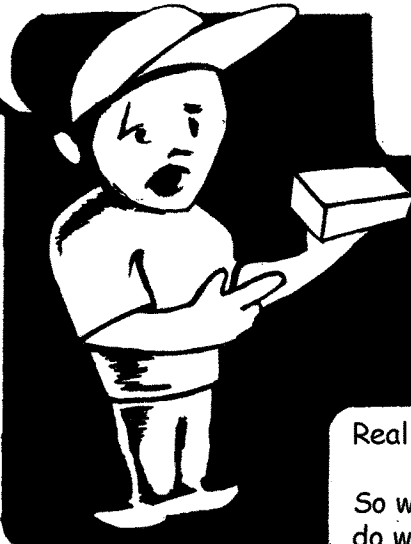
Don't you need
a huge building?

With rooms
full of expensive
equipment?





No, I don't have hundreds of thousands of dollars, but...



we actually don't need all that stuff. Because we are gonna build a micro-power broadcast station. Our equipment will be smaller and very affordable our transmitter will be about the size of a brick. So with that and a few other components our studio could be the size of a closet and only cost about \$1000- \$1500.

Really? Wow.

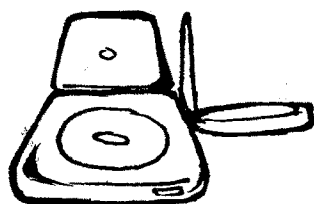
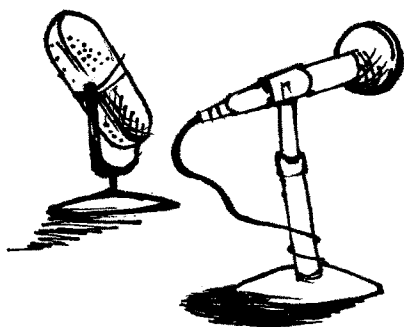
So what equipment do we need?



WHAT IS NEEDED

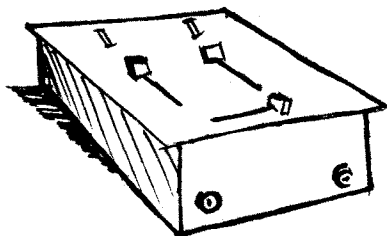
A

microphone(s)

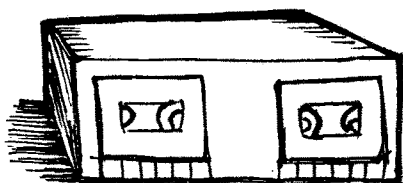


CD players

an audio mixer



tape deck(s)



TO CREATE RADIO STATION?

limiter/compressor



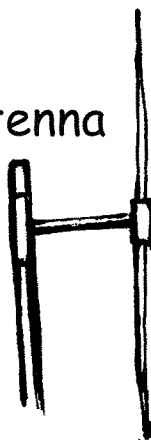
transmitter



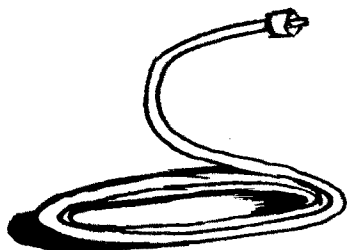
power supply

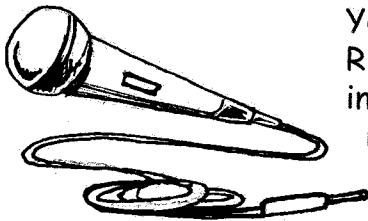


antenna

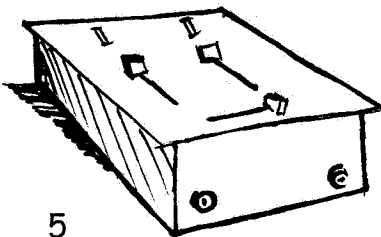


coaxial cable

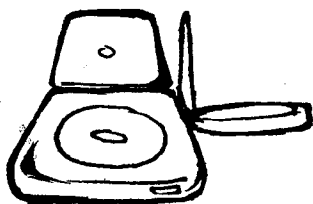




You know what a **microphone** is Right? You plug them in and talk into them. You can use a low impedance one for broadcasting, but most any one will work .



a **mixer** is what you plug all your microphones, cd players, and audio stuff into, then it mixes it into one output. use a mixer that fits your needs.



CD players and Tape decks can be your average higher quality consumer audio gear. Day in and day out use 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.



A **limiter/compressor** is required to prevent over modulation of the FM signal. Over modulation will cause spurious emissions and interference with other signals plus sound very distorted. It is extremely important to prevent this.

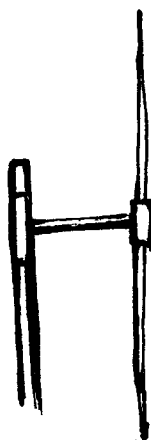


A **transmitter** is the peice of equiptment that turns your audio signal into a FM broadcast signal. Again, try to find one that suits your needs.



A **power supply** supplies the transmitter with the proper amount of DC input voltage. That is done by transforming a wall socket's AC current into DC.

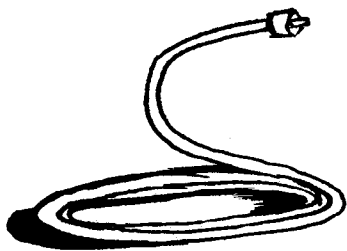
You can also use a 12 volt lead acid battery. Or even a car's cigarette lighter socket. ,(with a proper understanding of the car's electrical system, of course) check with an auto mechanic if you are unsure.



An **antenna's** purpose is to radiate the FM broadcast signal from the transmitter to surrounding FM radio receivers. In order to do this the antenna must first be tuned to the frequency being transmitted. You will need a SWR meter to tune it, but we will get to that later. Secondly the antenna must be sited and oriented properly.

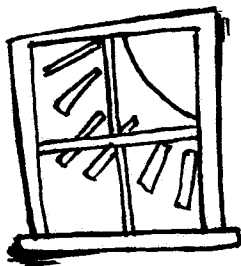


A **Coaxial Cable** is a special type of wiring that has an inner conductor surrounded by an insulating plastic sheath which is covered by a braid of copper wire that is then covered by a plastic jacket. They are like the ones that are used to hook up cable to your TV set. But those are 75 ohm, since we are using ours for radio frequency we will need to use **50 ohm** cable.



I'm gonna be like,... today's weather is - wait, let me look out my window... It's good!

I can't wait.



yeah, me neither. let's find a location



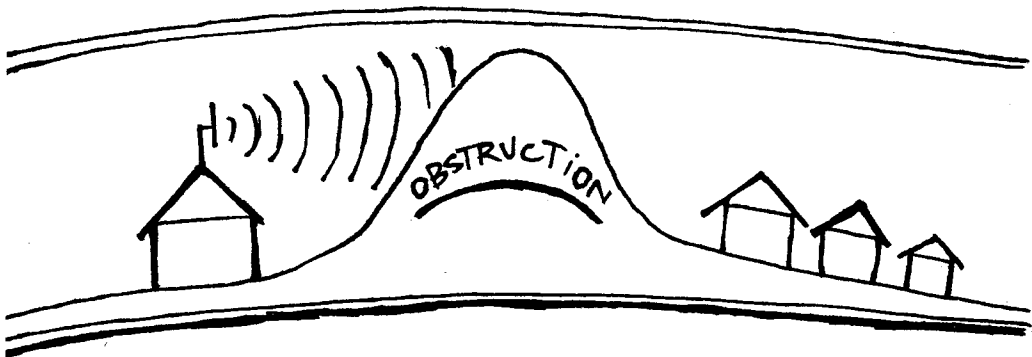
Finding a location for the antenna...



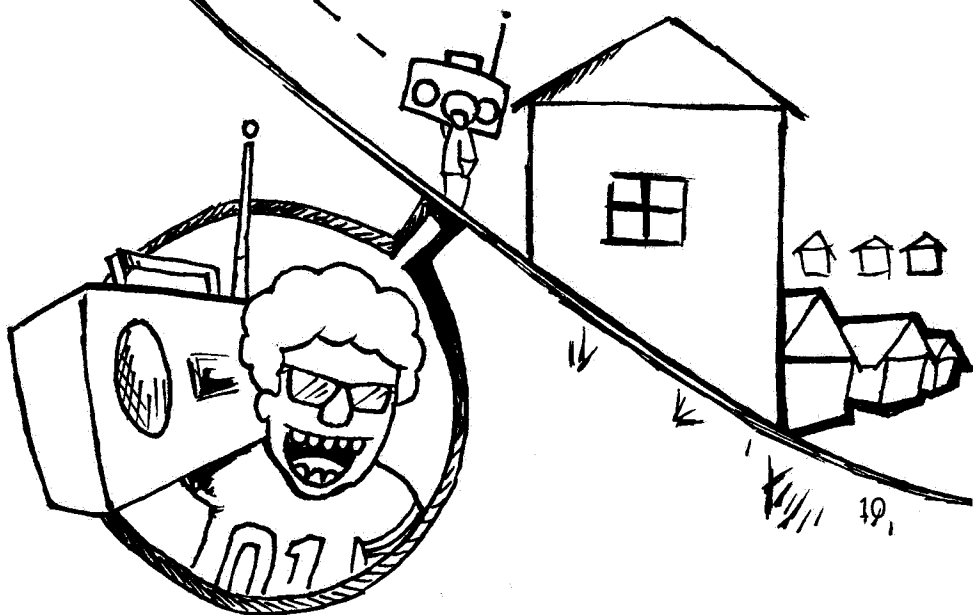
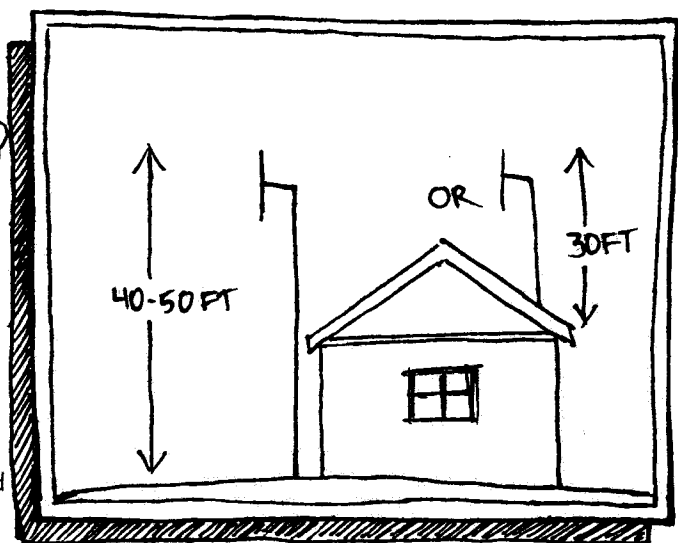
The top or side of a hill overlooking the area of coverage is best.

FM transmission is "line of sight" meaning, the transmitting antenna and receiving antenna must be able to "see" each other.

So, if there are any large obstructions it might block the signal path. We should keep that in mind.

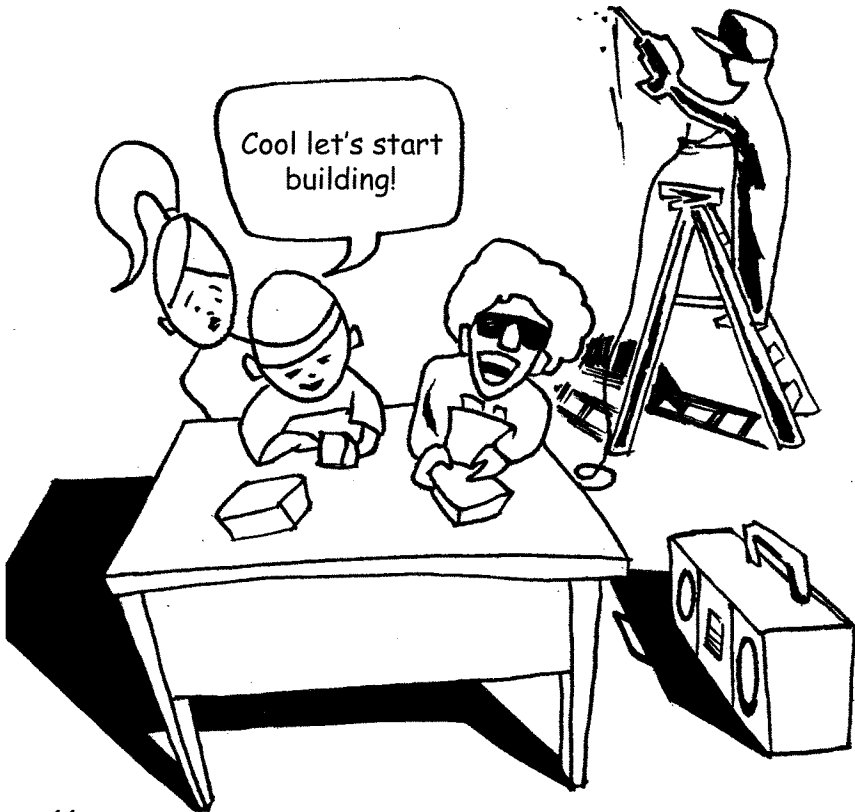
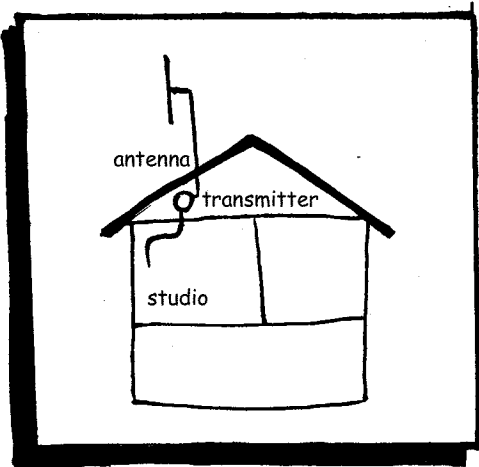


If your site is a 1-3 story building, a 30 foot push up style mast attached and guyed to the roof or a TV antenna style tower bracketed to the side of the building will be needed to provide adequate height to the antenna. You need to have the antenna at least 40-50 feet above the ground.

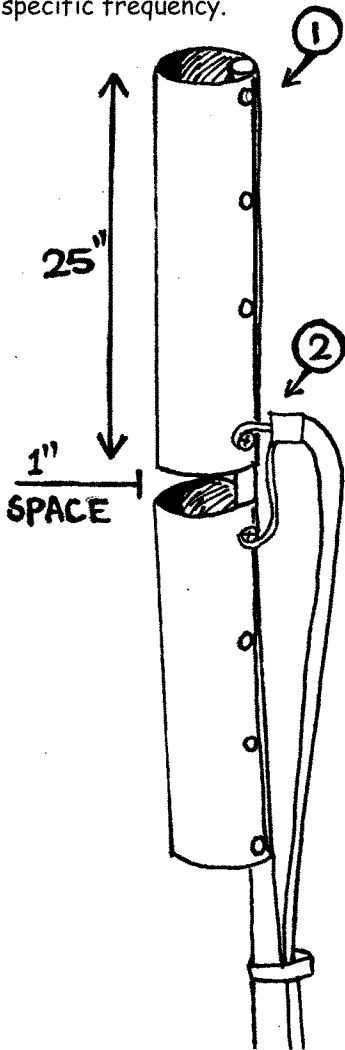


One more thing... it's good to keep the transmitter far away from the audio equipment, perhaps in another room or attic space since radio frequency emissions from the transmitter can get into the audio equipment and cause noise and hum.

the transmitter should be far away from the audio equipment, but as short a distance to the antenna as possible to avoid signal loss in the coaxial cable that feeds the antenna.



Here's how you can make a simple "no-tune dipole antenna" out of some things you can find at any hardware store. It doesn't require any tuning because it works over the entire band instead of at a specific frequency.



You need:

6" diameter vent pipe



**an 8 ft. length
1.5" or 2"
diameter PVC**



**and some
Screws**



1. You need two 25" lengths of the 6" vent pipe. Then put the PVC through one of the vent pipes and secure the vent pipe to the PVC with screws along the length. Leave the screw closest to the one inch space slightly unscrewed so it's head can be used as a coaxial cable connection. It's a good idea to drill some pilot holes for the screws first.

repeat this with the second vent pipe and leave a one inch space between them.

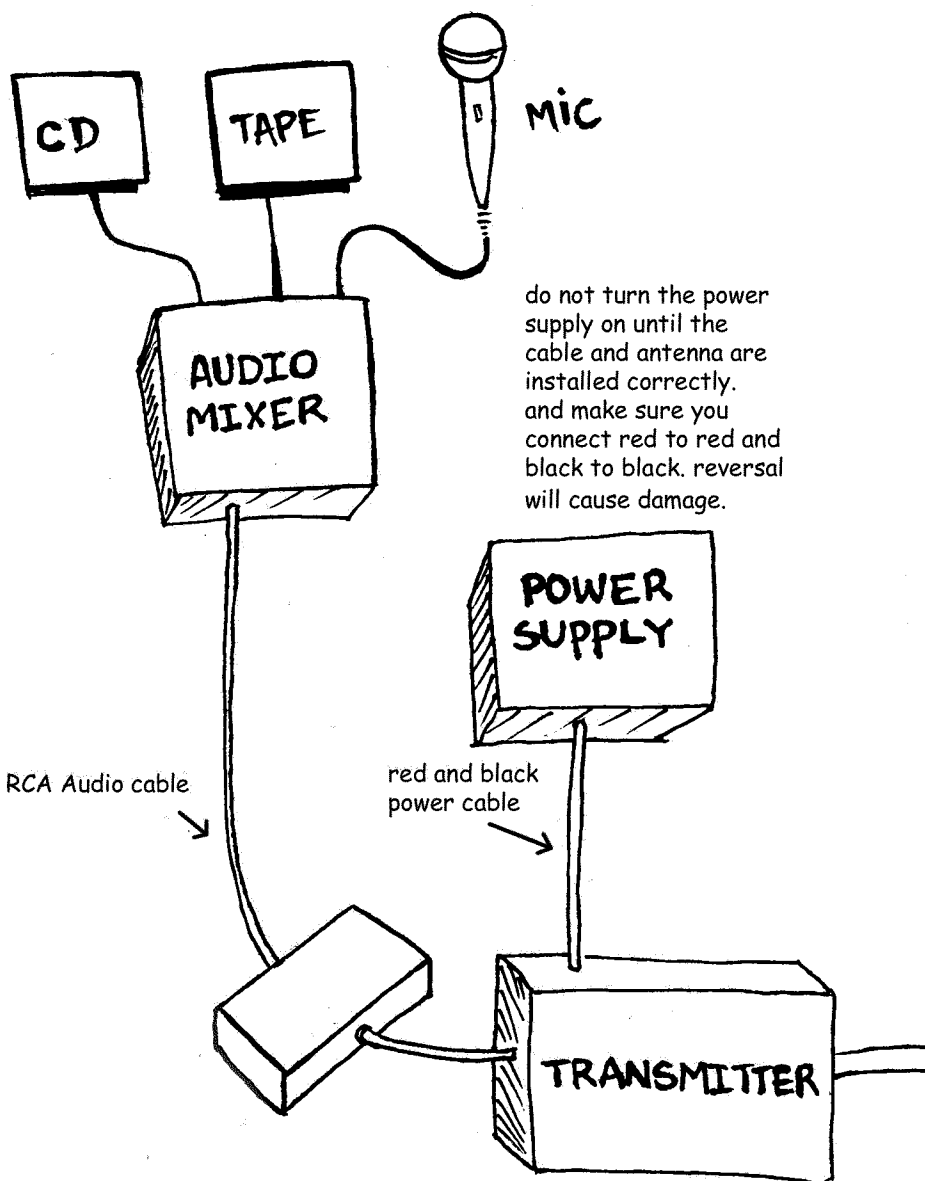
2. Cut piece of coax cable about 3 or 4 inches long and strip it off so that you're left with a 3 or 4 inch piece of the inner conductor wire. Set that aside.

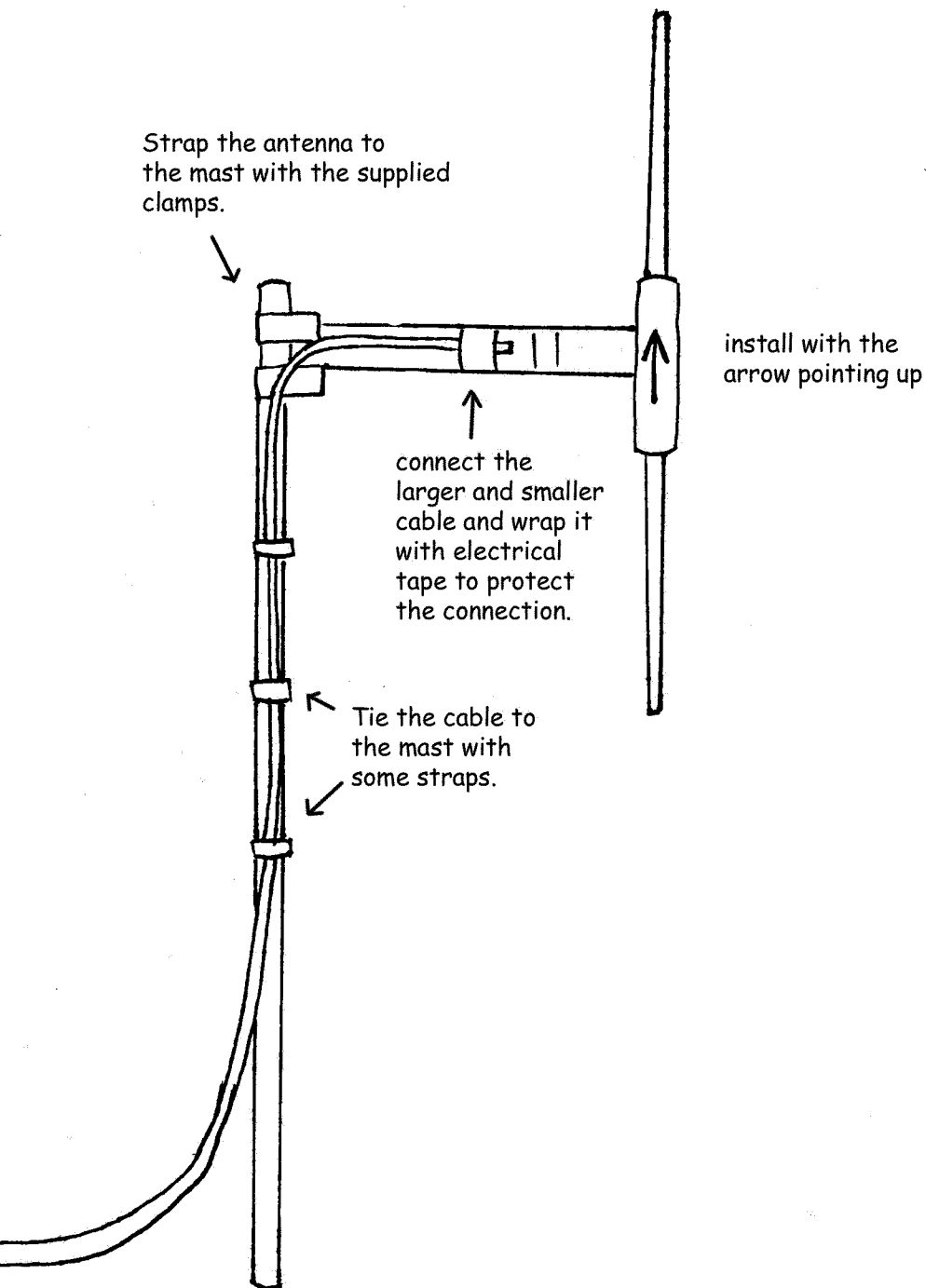
Next prepare the end of your coax cable by first, stripping it to expose about two inches of the conductor.

Secondly strip off the outer plastic jacket to expose about a half inch of the copper braid. Then Take the 3 or 4 inch piece of conductor that you saved from before and wrap one end of it around the copper braid. now you have you two conductors, one that is connected to the copper braid and another that is the original conductor. Use some electrical tape to get the cable covered again and to insulate both conductors from touching each other.

Then, to connect this modified cable to the antenna, wrap the original conductor around the connection screw in the top vent pipe and the copper braid conductor around the screw in the bottom vent pipe.

the Layout...



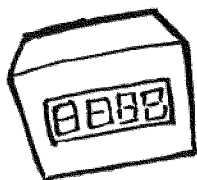


(remember not to sharply bend the coax cable)

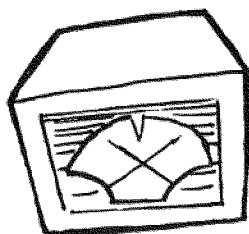
These are some other accessories you will need for the tuning and testing of the transmitter and limiter compressor.



Always use a **dummy load** when testing and tuning transmitters and amplifiers. A dummy load is a non-inductive resistive load which simulates an ideal antenna impedance of 50 ohms. Never use an antenna for testing and tuning transmitters.

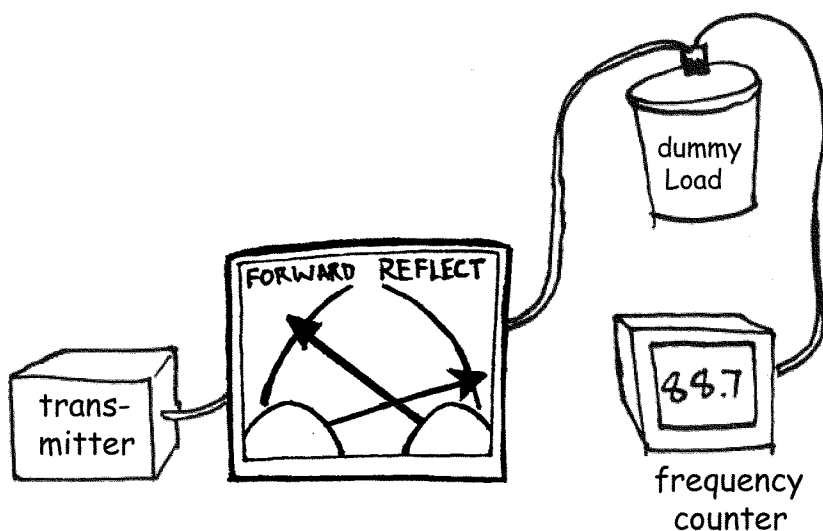


To accurately maintain your operating frequency a **digital frequency counter** is highly recommended.



an **SWR/power meter** is essential to the proper tuning and setting up of transmitters and antennas. An antenna has to be fine tuned so that it accepts the full power of the transmitter and reflects the lowest amount possible back, that ratio of forward power to reflected power is known as the standing wave ratio (SWR). The various stages of both transmitters and amplifiers have adjustable capacitors which are used to tune the unit to the frequency of operation. A power meter allows you to see the effect of these adjustments on the power level and to set everything at optimum level.

How to test your transmitter



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.

You can test your transmitter by connecting it to an SWR power meter, a dummy load and a frequency counter as shown.

Since the dummy load simulates an ideal antenna the SWR meter should show little or no reflected power and the forward shows how much power is being put out by the transmitter. The frequency counter will display your desired operating frequency.

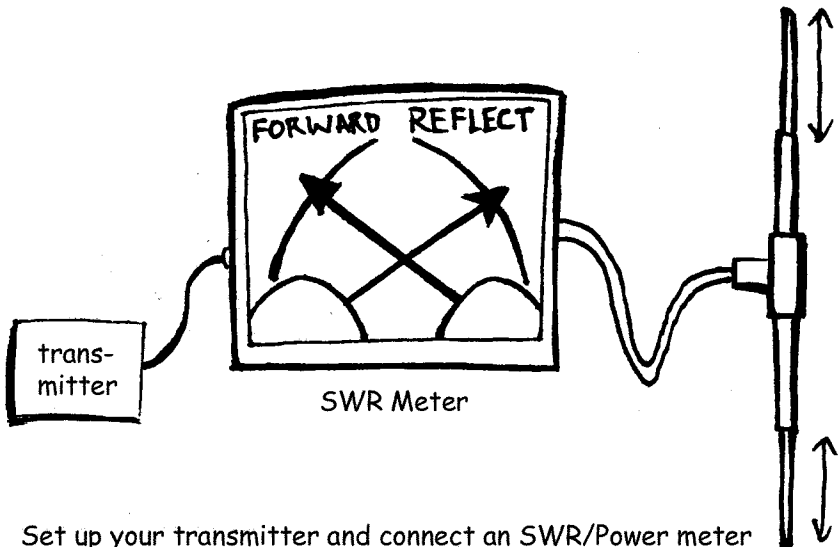


rough tune the
antenna first

"It's time for a
little bit of
math! Don't
worry it's just
a tiny bit, I
swear."

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 $1/4$ 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 4 or multiplied by .25 to yield the $1/4$ wavelength. A correction factor of .9 to .95, depending on the diameter of the element, is multiplied times the $1/4$ wavelength resulting in the approximate length of each element.

and then, fine tune
the antenna

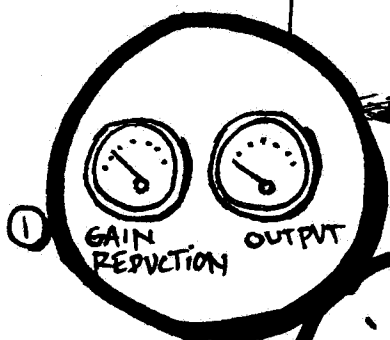
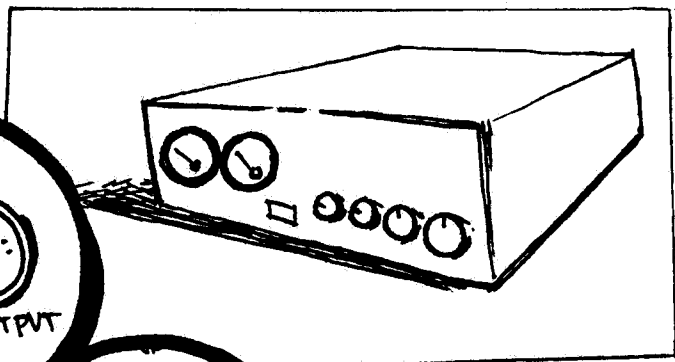


Set up your transmitter and connect an SWR/Power meter between the transmitter and the antenna. Adjust your meter to read SWR according to the directions that came with it. SWR is the ratio of power coming from the transmitter and the power reflected back from the antenna. A properly tuned antenna will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

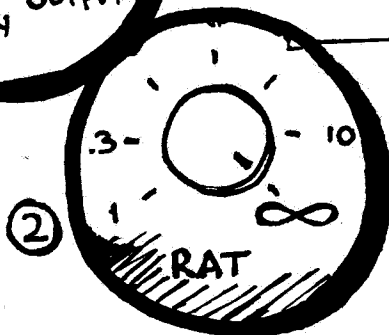
Turn on the transmitter and observe the SWR or amount of reflected power. Shut the transmitter off if the level is very high and check your connections. Rough tuning the antenna by measurements should have brought the readings down to a fairly low level. Turn off the transmitter and adjust each tubing 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 have hit the sweet spot.

setting up the limiter/compressor

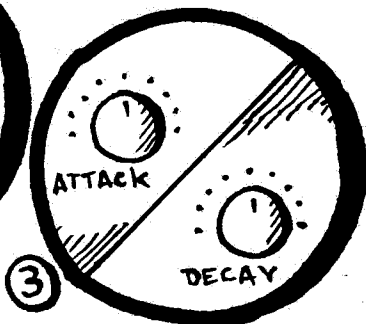
Like we said before the limiter/compressor is very important because it prevents signal slatter and distortion. To properly set up the mixer, limiter/compressor and transmitter start with a steady audio source. (a test tone CD or signal generator plugged into the board.) then You adjust the input level and master output level controls so that the meters are reading zero. Master levels should be at mid position. Audio output goes from the mixer to the limiter/compressor and from there the to the transmitter. **Do not turn the transmitter on yet.**



Indicators show gain reduction is being applied and output level.

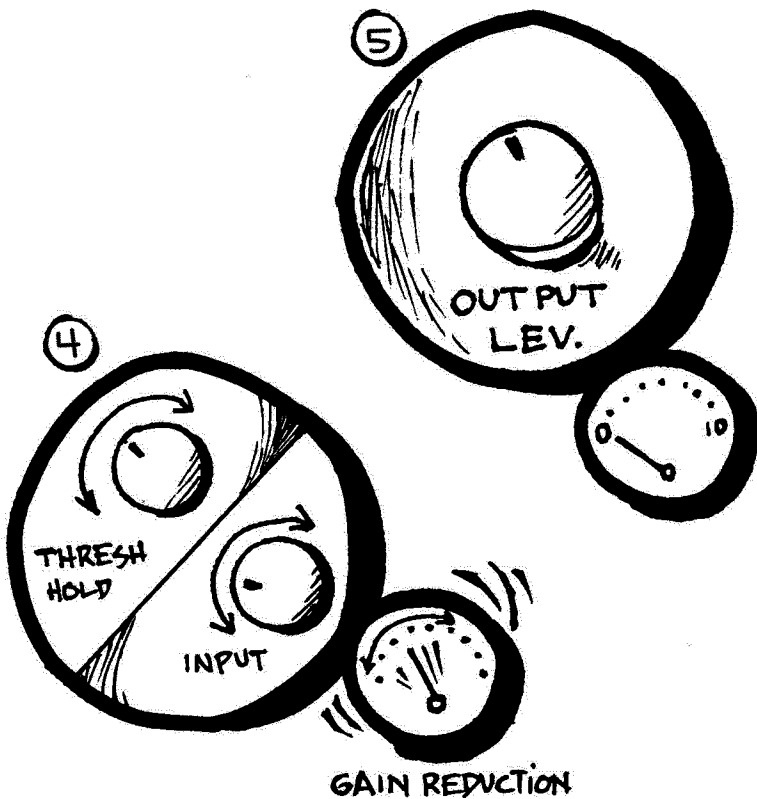


Set the radio control to the infinity setting. This engages the hard limit function.



set the attack and decay at mid position

Adjust the output level so
the output indicator shows
zero output level



Adjust the threshold and input
level so that the gain reduction
indicator shows activity

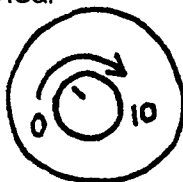
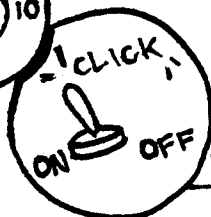
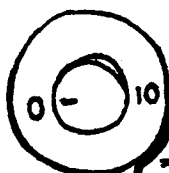
Wait up! Just one more thing before you turn on the transmitter.

- ① make sure the input on the limiter/compressor is turned all the way down to zero.



Now go ahead and turn on the transmitter.

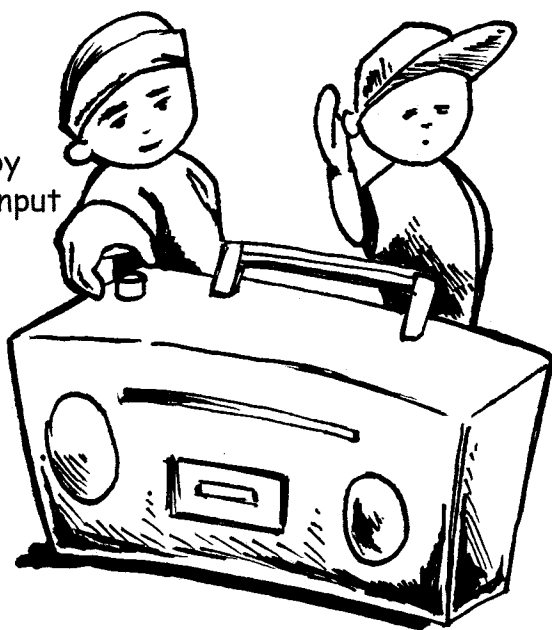
- ② Now, on a good quality radio that is set to your station, slowly turn up the input level on the limiter /compressor until you hear your test tone.



Hey, we're on the air!

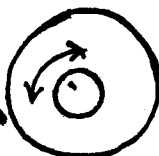
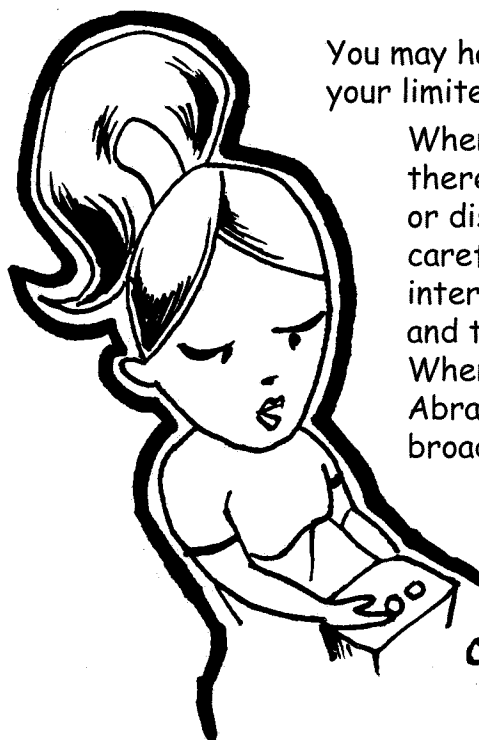


- ③ Compare your signal to other stations. And by adjusting the input level



You may have to fine tune your limiter compressor

When everything is set correctly there shouldn't be any splatters or distortions. So listen very carefully for hot audio. Some interplay between the output and threshold should fix it. When everything sounds good, Abracadabra! you're ready to broadcast!



OUTPUT

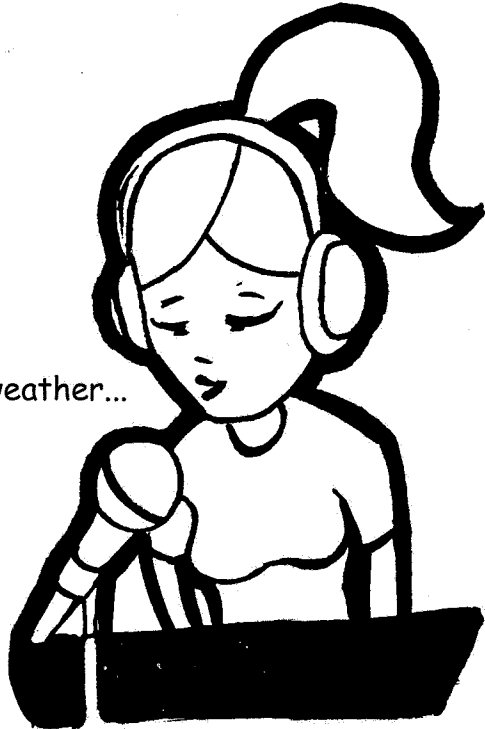


THRESH
HOLD

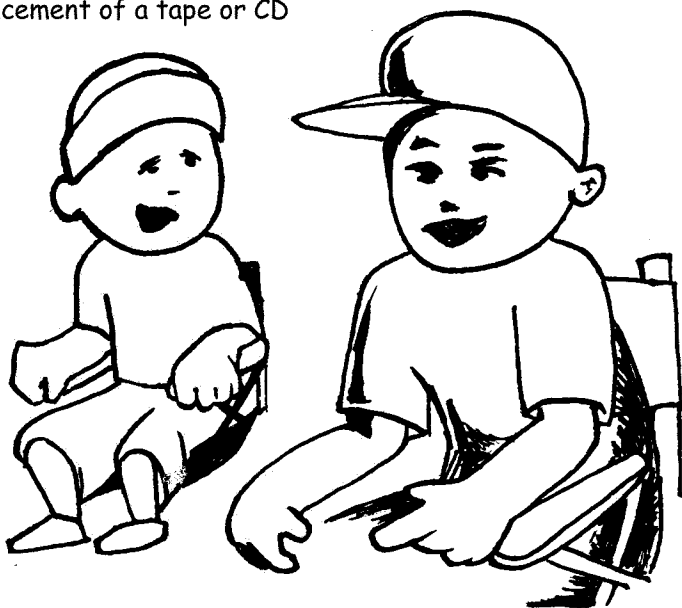


Before you commit to your first broadcast it would be advisable to have an attorney available who is sympathetic to the cause. Even if they may not be familiar with this aspect of the law, there are plenty of briefs and other materials that will bring an attorney up to speed.

...And today's weather...



"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?"