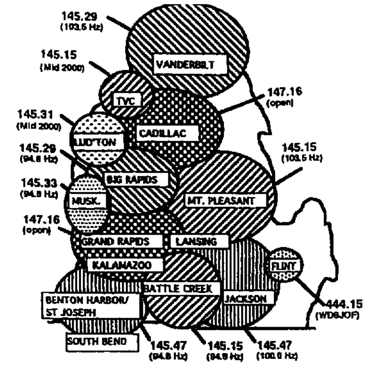
THE PURPLE CRYSTAL

Special Hamfest Edition June 2000

A BULLETIN OF THE INDEPENDENT REPEATER ASSOCIATION, INC.
562 92nd Street, S.E. -- Byron Center, MI 49315



THANK YOU!

The Independent Repeater Association, Inc. sincerely thanks you for attending the IRA Hamfestival. We hope that you and your friends had a great time and we hope that you found those great bargains you were looking for.

Each year, we have strived to make the Hamfestival the best in the State. If you enjoyed attending this year, tell your friends and make plans to come back next year. The camping, potluck dinner, swap-camaraderie, indoor facilities, outdoor trunk sales, the Michigan-Florida hams coffee-klatch, the prizes (the "John and Randy give-away show") and the annual VE exams make the IRA swap "one of the best they've ever attended" according to many attendees.

The reason we started calling it a Hamfestival is because it's usually held the same weekend as the Grand Rapids City Festival. Hundreds of thousands of visitors attend the downtown festival taking in the great ethnic food, music and entertainment all weekend. If you haven't stopped by the Grand Rapids Festival after the IRA swap, you are missing a big treat. Make a big weekend out of it and attend both.

We hope that you enjoy this Special Hamfest Edition of the Purple Crystal newsletter. The only way to receive a copy was at the IRA hamfest. We will not be mailing this issue out. It will be posted on the IRA web-site after the hamfest. This "fun issue" is our way of saying thanks for your support. We hope that you learn something about repeaters and antennas you did not know before.

Ham radio is a great hobby! Some hams say the IRA link repeater system is the best repeater in Michigan. You, as an attendee at the hamfest, helped make it that way because of your support (with donations and attending the hamfest). The financial requirements for running the link system and publishing the Purple Crystal exceeds $7,500 per year as documented in the last isue of the Purple Crystal. Your attendance at our hamfest helps with our financial needs. THANK YOU! From the Independent Repeater Association, Inc.

WHAT DO YOU LIKE BEST ABOUT HAM RADIO?

The opportunities for operating ham radio abound! With the recent license restructuring, many hams are upgrading and will be able to operate new frequencies and modes. New hams are entering the ranks because there is an inordinate amount of VE exams available. Equipment sales will probably hit new highs in 2000.

There are so many facets available for operating a ham radio station, it boggles the mind. It makes one wonder why people would even consider creating havoc on the bands (and on repeaters) when there is so much available to satisfy ones amateur radio ego.

There are SSB, AM,and FM voice modes to communicate anywhere in the world with. There are internet hookups, digipeaters, CW (high speed and low speed), satellite communications, even moon-bounce and amateur TV to test ones technical prowess and capabilities.

There are contests galore, with QSLing, awards, and achievements to reward ones dedication. Particpating in emergency services during disasters or severe weather conditions and handling message traffic all provide benefits far beyond just self satisfaction.

Operating from DX Countries unheard of, during Field Days, or just QRP in the backyard surprisingly is NOT experienced by many hams.

Reading the hundreds of books and the dozen ham magazines available and receiving the wonderful AES catalog twice a year can provide weeks of interesting reading and relaxation. Attending and participating in a "good hamfest" can yield new equipment, ideas and friends.

What do you like best about amateur radio? The IRA promotes good will and amateur service through its link repeater system covering most of lower Michigan. The examples given above can make excellent topics for many conversations on any bands or on a repeater. Why then do people on repeaters sometimes just "kerchunk and kerchunk" and not ID or talk?

THE VIEW FROM THE HILL........ ....ANOTHER GREAT SWAP!

Thank you all for attending the IRA swap this year.Thanks to people like you, the year 2000 IRA Hamfest was a great success.

What do I enjoy most about hamfests? By the very fact that you are reading this article in this Special Edition of the Purple Crystal (only available at the IRA hamfest) is evidence of your taking ham radio to a level beyond just the technical. The physical meeting of two ham's (an "eyeball") has long been a tradition at Hamfests all over the world. For me, it is the thing I probably enjoy most about the IRA Hamfest. Watching others do the same thing while selling or buying runs a close second.

What do I enjoy most about ham radio? Without a doubt, it is the large circle of friends that come with the hobby. I often find myself wondering what I would be doing besides the tower, equipment, and Purple Crystal parties, the ham radio coordinated lunches, hamfests, dinners out, Field Day, and many other things too numerous to mention. I have had my ham license since 1985 and can truly say that it has been a life changing experience.

The IRA continues to improve the reliability and performance of the link system. Your attendance at the swap helps us financially to continue with our goals. It is my sincere wish that all of you enjoy the swap to its fullest. If you meet one of the IRA Boardmembers, say hello and let them know your appreciation. It's the only compensation they receive.

Volunteer - The word permeates the fabric of ham radio! By design this is the only way things get done in our hobby. It takes dozens of people just to organize the IRA hamfest. Add another 3 or 4 more dozen to run it and you start to appreciate what an effort this is for a lot of people. If you can give some time and talent to the IRA, it would be greatly appreciated. Listen for your opportunity to help out. Abe, W8HVG is always looking for someone to share those 100's of miles he puts on every month improving the link system.

The view from the hill is better than ever thanks to those who volunteer. If you can spare some time (even today), check with an IRA Boardmember to see just where you can help. With that, I wish all of you a really GREAT summer and enjoy the IRA link system.

73,de Tom, KA8YSM
President, IRA

THE IRA............FYI

The Independent Repeater Association, Inc., is a tax exempt non-profit corporation registered in the state of Michigan and is responsible for managing the technical and financial aspects of its repeater systems. It has 501C3 status with the IRS. It is not a club and there are no dues. Operating expenses are covered by donations, which are tax deductable, and fund raising activities such as the yearly sponsored Grand Rapids Hamfestival at the Hudsonville Fairgrounds.

The Association operates and maintains a network of 2-meter repeaters covering western Michigan from the Indiana border to the upper peninsula. Everyone is welcome to use and enjoy the link repeater system.

The Vision of the IRA with the link repeater system is to provide:

- Dependable communications
- Opportunity for service
- Technical assistance forum
- Occasion to support
- Spread ham radio goodwill

As a result of elections held in December 1999, the IRA Board of Directors for 2000 are as follows. On the executive board are: Tom Werkema KA8YSM, President; John Knoper KC8KK, Vice-President; Randy Chelette N8KQX, Secretary; and Jeff Ansley N8NII, Treasurer. Ray Abraczinskas, W8HVG, is the Trustee and Purple Crystal Editor. IRA Directors are John Rittenhouse WB8VOJ, Steve Stutzman WB8NCD, Rick Dykstra KD8CP, Randy Hofmeyer N8DAN, and Bob McClymont K8DOG.

IRA Board business meetings are held at 7:30 P.M. on the second Thursday of the month at Russ' Restaurant on Division Avenue in Cutlerville, Michigan. You are welcome to attend and make suggestions.

Listen on the link repeater system for the Amateur Newsline Report every Monday evening at 8 P.M. The link system is there for everyone to use and enjoy whether it's across town or across the State but please use common sense and be considerate of those listening. We'd like to see the link system being used 24 hours a day with new hams meeting new hams all over the State. That is what it's for!

If you would like to receive the Purple Crystal, write to the address at the top. The IRA website is www.iserv.net/~w8hvg. Check it out!

Signal Propagation from Repeaters in Michigan – A Treatise by W8HVG

Why can certain repeaters from certain areas be consistently heard further than other repeaters (operating in the same area)? How can repeaters be heard behind hills? Why does a repeater sometimes come in "full-quieting" while others are not even heard? Why does a repeater sometimes "interfere" with another on the same frequency at certain locations? How can a repeater not be heard in an area 30 to 50 miles away yet be heard "full-quieting" 60 to 150 miles away? These are interesting questions, especially in Michigan where all of the above examples can and typically do occur.

Five Basic Influences

The reasons why the above examples occur with VHF and UHF repeaters are directly related to five basic influences. They are: 1) radiated power, 2) antenna height(s), 3) gain patterns (directivity), 4) propagation effects (terrain/meteorological), and 5) receiver sensitivity. Changes in any one (or combinations) of the above five basic influences can and do have a significant impact on repeater signal propagation. There are other things such as antenna polarization and ambient noise effects but they generally "drop out" of consideration by optimizing the antenna polarization and minimizing the ambient noise into a fixed set of conditions. NOTE: Voice repeater antennas are most always vertically polarized. However, ambient noise can vary sometimes, affecting receiver sensitivity.

Unique Propagation State

Michigan is a unique VHF-UHF propagation State because it's surrounded by the Great Lakes and coupled with the "merging and changing weather effects" that occur caused by cold air from the north, warm dry air from the west, and warm moist air from the south, there is a "changing VHF and UHF propagation condition" continuously occurring. Also, the sun affects signal propagation as it traverses across because as the sun gets higher it burns off the enhancing medium and VHF-UHF signal propagation gets poorer. That's why distant repeaters or stations tend to drop out, get noisy or not be heard after 8 A.M. or 9 A.M. until the sun goes down.

The unique propagation in Michigan is one of the reasons why the Michigan Area Repeater Council promoted and agreed with surrounding states to coordinate repeaters on a 120-mile distance basis many years ago. But still, repeater signals can easily propagate more than 120 miles in Michigan and often times do.

Radiated Power – Maximize!

Let's talk about each of the five basic influences. First, every ham knows that the greater the radiated power is, generally the stronger the signal will be. It is not true with repeaters however, because when your signal is "full quieting" in a FM receiver, having more signal (more power) serves no purpose.

How one gets increased radiated power depends on many things, starting with the transmitter (power amplifier), duplexer losses, connectors and coax feed-line losses and the antenna (gain or loss). Note that the antenna gain is influenced by how the antenna is mounted on the tower and by surrounding metallic objects. Most hams don't consider these effects on their repeater antenna gain/pattern nor attempt to measure or analyze it. (Antenna patterns and antenna gain is discussed later).

Most amateur repeaters in Michigan typically run 10 to 50 watts output. There are some repeaters probably running 100 to 300 watts for a particular reason, i.e., to achieve "hand-held coverage" (or just because they have the equipment to do so). Even though the FCC rules say to only run enough power as necessary to communicate, some hams must think they need to run very high power. The truth is that a signal received that is "full quieting" won't get any better by running more power. There needs to be a balance between receive and transmit capability.

Antenna Height

Given that one has "efficiently maximized" the repeater power to the antenna, the height of the antenna is the next significant factor in repeater signal propagation. Generally, "the higher the better" is always true but there can be a point of diminishing returns when the antenna is too high for the antenna gain pattern. This is caused by the antenna's vertical pattern, which is compressed or squashed into a narrow beam (for gain). The VHF-UHF signal transmitted by such an extremely high antenna (with a narrow vertical beam width) can skip over receivers located within a few miles but be heard very well a 100 miles away. Conversely, due to antenna reciprocity, a ham using an HT locally may be noisy or not be able to get into such a repeater.

Gain Patterns and Directivity

Repeater antenna gain patterns or directivity-effects are probably the most significant influence and the least paid attention to in constructing an amateur repeater. All antennas have a radiation pattern in the horizontal and vertical plane, which can vary with frequency. It's somewhat hard to predict them and it's also hard to measure them (accurately), especially if the antenna is side mounted on a tower. The antenna spacing and location relative to the tower face, tower legs and other antennas all affect the antenna pattern. "Lobing" can and usually occurs. Some antenna manufacturers provide radiation patterns for their antennas for different tower mounting configurations but the plots are not always accurate because they are integrated plots.

If the antenna is on top of a high-rise building such as a hospital, bank or apartment building, there usually is other antennas or metallic objects nearby which can affect the antenna radiation pattern. Also, rain and ice effects can alter the radiation pattern further. Even reflections from airplanes flying near the repeater can significantly affect the signal by reflecting it albeit usually only for a few moments. It's not impossible to have these pattern affects produce another 3 to 6 db gain (or loss) added to your repeater antenna pattern thereby doubling or quadrupling (or reducing) the radiated power in certain directions. All hams should know that antenna gain is directivity. It's like love and marriage. You can't have one without the other!

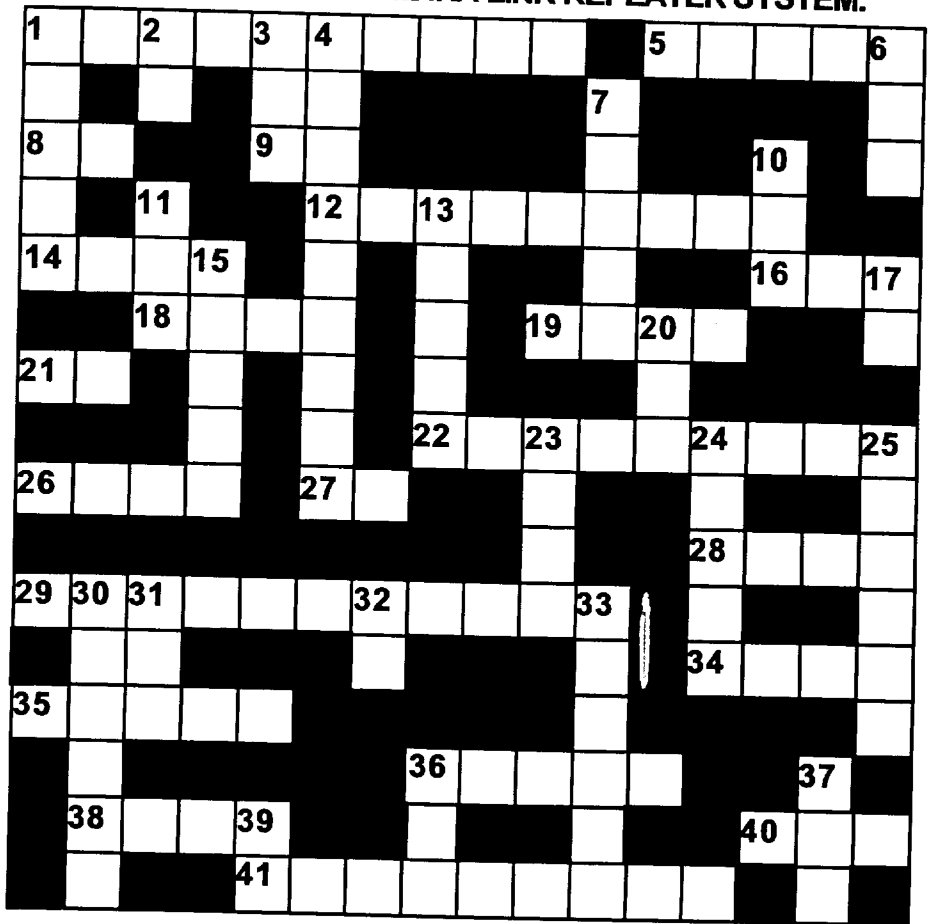
Propagation Effects

Propagation effects influenced by the terrain and/or meteorological conditions definitely occur in Michigan. Resulting from glacial moraines, Michigan has hills, ridges, gentle slopes and flat land varying from 750' to 1500' altitude. Signals can appear strong behind hills due to the "knife-edge effect." This is where the tops of hills and mountains can bend the signal down behind them because the radio wave is slowed down (bent) and essentially scattered as it strikes the top of the hills and mountains. Terrain boundary propagation effects can contribute to signals being received behind hills, on higher sloping terrain or across the lake. Michigan has this type of terrain, however the author believes that meteorological conditions play the greater role in VHF-UHF signal propagation (based upon 34 years of repeater operation observations in central Michigan). The bands tend to be "hotter" longer than not, with some exceptional band openings occurring usually from spring through fall in the evenings and mornings. Even during mid-winter when the weather can warm up for a few days, band openings occur to surrounding states and beyond. (Remember the earlier comment about coordinating repeaters at 120 miles distance?)

Receiver Sensitivity

There is no question that radios today are more sensitive than radios of several years ago. Solid-state devices today have lower noise-levels (and higher gain). Sometimes a ham just by changing his VHF or UHF radio or adding a receiver pre amp will hear repeaters he never heard before. The results can be so startling that he may think it's a new repeater or the repeater owner increased the repeater power considerably. Improvements can occur in many different ways! There are many things that affect how, when, and where you hear a repeater (or two). It's hoped that this summary explanation of the five major influences of repeater signal propagation will help you better understand why it can occur, especially here in Michigan. - W8HVG

TAKE THIS NEW HAM EXAM. GET 40 OR MORE RIGHT - YOU'RE EXTRA CLASS. GET 35 OR MORE - YOU'RE ADVANCED CLASS. GET 30 OR MORE - YOU'RE GENERAL CLASS. GET 25 OR MORE - YOU'RE A TECHNICAN. LESS THAN 25 YOU BETTER LISTEN MORE TO THE IRA LINK REPEATER SYSTEM.



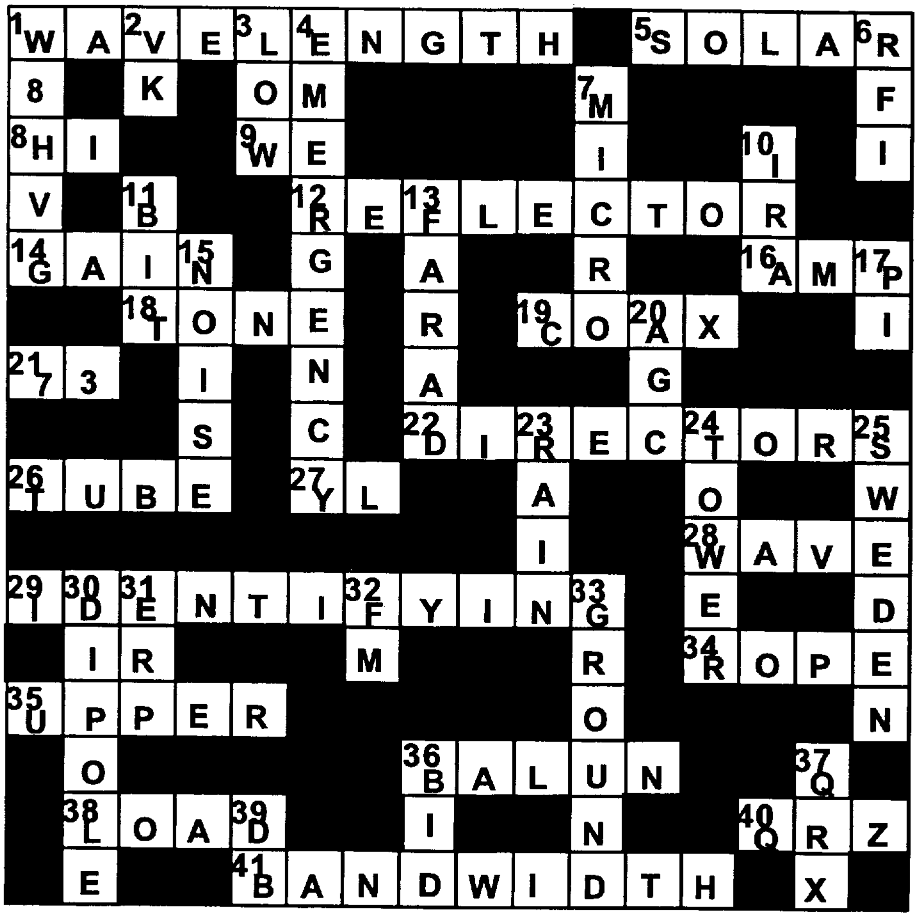
Across

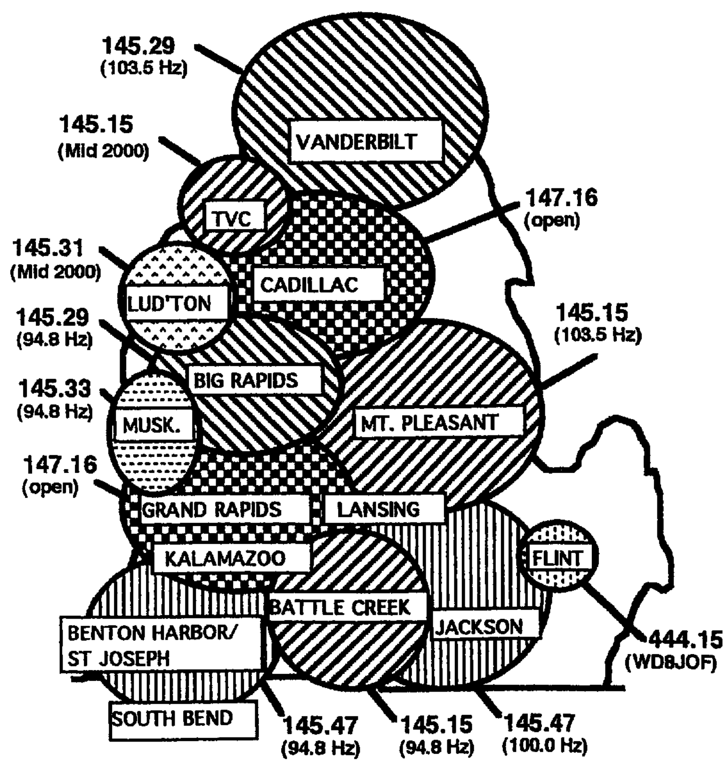
1	One RF cycle length
5	Type of flux affecting radio signals
8	Greeting
9	Us
12	Rear element of beam
14	Antenna beam concentration
16	Ham's afterburner
18	Repeater courtesy __
19	Concentric feedline
21	Best Regards (number)
22	Front elements of a beam
26	Ham "bottle"
27	Young Lady
28	A Sine ____
29	Saying your call
34	Pull the antenna up with ___
35	Sideband above
36	Balanced-Unbalanced device
38	A good dummy
40	Who's calling?
41	What B.W. stands for

Down

1	Call on the "link system"
2	Australian prefix
3	Reduced power
4	"Break, Break"
6	Radio Frequency Interference
7	Ten to the minus-six
10	Independent Rptr Association
11	Computer word element
13	Unit of capacitance
15	Unwanted interference
17	3.1416
20	Automatic Gain Control
23	Produces static
24	Holds antennas up
25	SM prefix is ___
30	Halfwave antenna
31	Effective Radiated Power
32	Frequency Modulation
33	A good RF one is hard to get
36	Do on e-Bay
37	Standby
39	Logarithmic power ratio

HOW DID YOU DO? HERE ARE THE ANSWERS TO THE NEW HAM EXAM PUZZLE AND A MAP OF THE IRA LINK SYSTEM IN CASE YOU HAVE TO LISTEN MORE.





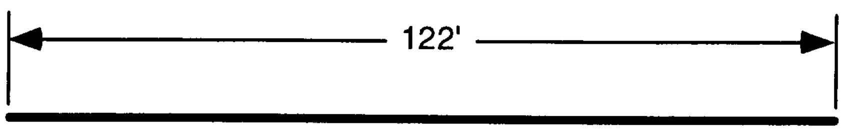
IRA LINK SYSTEM COVERAGE MAP

Some Facets Worth Knowing About Antennas

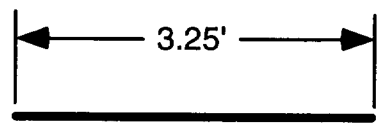
By Ray Abraczinskas, W8HVG

For discussion purposes, a dipole antenna is the simplest form of antenna. It can be used singly, mounted horizontal or vertical, and/or combined into arrays with other dipoles, or with parasitic elements such as director(s) and/or reflector(s) in order to achieve directivity (gain or nulls). These arrays are called beams, Yagis, collinear, phased arrays, Sterba curtains, etc.

A dipole antenna is a half-wavelength long resonant antenna. The physical length (in feet) of a half-wavelength resonant antenna (a dipole) is determined by dividing 468 by the frequency in MHz. Therefore, the physical length of a dipole antenna for 3.835 MHz is 122 feet long. A dipole for 144 MHz would be 3.25' long. (Two examples picked for a nice resultant number). However, it needs to be said here that the "final physical length" for a dipole will be affected by things like the proximity to ground and surrounding objects (such as trees and buildings), the diameter of the antenna, and the dielectric material surrounding the antenna. Affects of a few percent are typical. The physical length of a dipole antenna becomes shorter the higher the frequency.



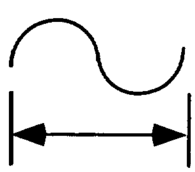
A dipole antenna for 3.835 MHz would be 122' long. (Length in feet equals 468 divided by frequency in MHz)



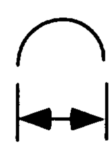
A dipole antenna for 144 MHz would be 3.25' long.

A dipole antenna can have a feed-line connected to it anywhere along its length from the center (center-fed) out to the ends (end-fed). The feedline can be a single wire, twin-lead, ladder-line or coaxial cable. Each has their advantages and disadvantages depending on the situation. Now let's look at how current and voltage is distributed along a dipole antenna.

Since a frequency is alternating current (and voltage), they are represented by a sine wave for one wavelength as shown below. A half-wavelength is half of a sine wave as shown.

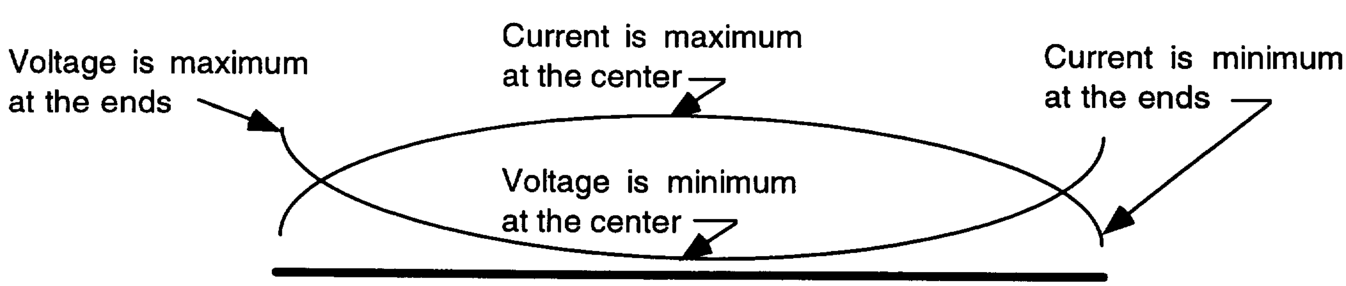


One wavelength



Half-wavelength

Current flowing on a half-wave antenna is maximum at the center and minimum (zero) at the ends (because there is no more conductor). It would resemble the half-wavelength sine wave shown above. Current and voltage distribution on a dipole is shown below.



Dipole antenna current and voltage distribution.

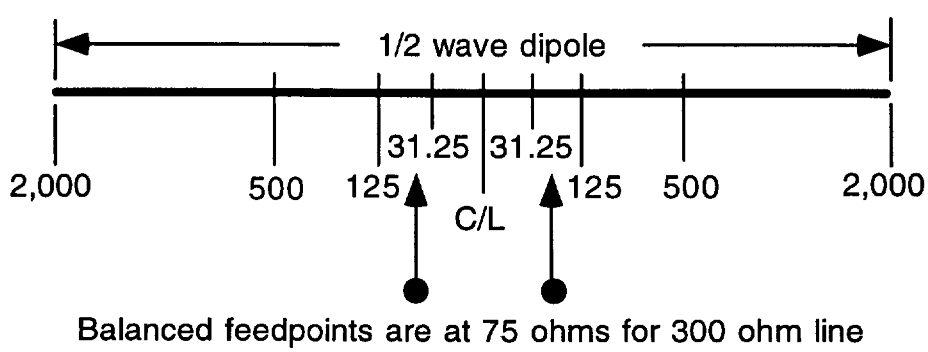
Let's discuss the impedance of a dipole antenna. Understanding impedance is very important for matching the feedline to the antenna and achieving the best match and lowest SWR (Standing Wave Ratio). However, the lowest SWR does not necessarily mean that the antenna is radiating the best signal (because a dummy-load has a low SWR). More information on this later.

The impedance of a dipole (or any antenna) is made up of the radiation resistance and reactance terms. Radiation resistance is a fictive term describing a resistance that would dissipate all the RF energy applied to it. The reactance term indicates a too-long dipole when positive and a too-short dipole when negative. At resonance the reactance term is ideally zero but it will change as you change frequency. How rapidly it changes affects bandwidth.

One important thing to remember (and understand) is that the impedance of a dipole antenna is lowest in the center (minimum) and highest at the ends (maximum). In free-space (in the air and away from objects), a dipole's impedance at the center has been determined to be about 66 to 75 ohms balanced . Typically, the impedance at the ends of a dipole is in the thousands of ohms (1,000 to 2,000 ohms). The final value of impedance is dependent upon conductor size, height above ground and the effects of surrounding objects. The shape of the antenna also has an effect, i.e., is it linear, folded, bent, zigzagged, in a "V", etc? Some of these effects will be discussed later.

How do you determine the feedpoint impedance of a resonant antenna? There is a way you can guess and approximate it based on the center and end point information given above. Hugh Wells; W6WTU wrote an interesting article in 73 magazine, August 1998 issue, about applying transformer impedance theory to a dipole antenna. Transformer theory says that the impedance will vary as a function of the square root of the turns ratio. This means that one-fourth of the impedance will be found at the center tap of a coil whose impedance is low (zero) at the bottom and high (thousands of ohms) at the other end.

Applying transformer theory to an antenna means that the impedance in any center segment will be 1/4th of the high-end impedance (of that segment). So if our dipole has an end impedance of 2,000 ohms, midway out from the center of the dipole to the end the impedance will be 500 ohms. Midway out to that point the impedance will be 125 ohms, and midway out to that point, the impedance will be 31.25 ohms. Somewhere between these two points would be close to matching with 52-ohm coax, right? These would be "unbalanced" feedpoint impedance's because they are referenced to the center of the dipole. For "balanced feedpoints", connect the feedline an equi-distance across the centerline, C/L. The connection points would correspond to 1/4 the balanced feedline's characteristic impedance, i.e., 75 ohms for 300 ohm twin lead.



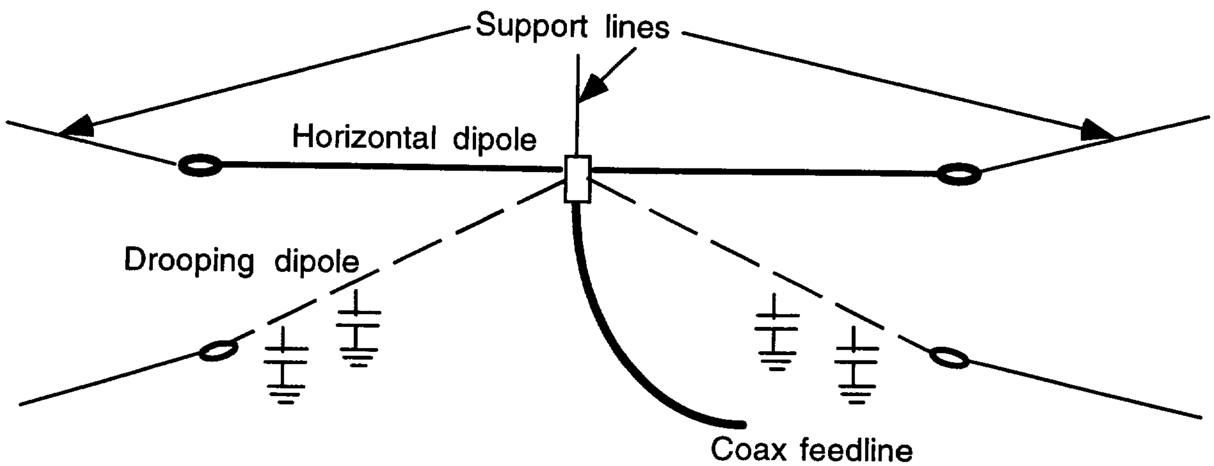
Theoretical impedance distribution along a half-wave dipole with balanced feedpoints.

Now to give you some more general information about the impedance of an antenna because it's important to understand it when connecting your feedline.

After determining the physical dimensions for a dipole based on the operating frequency, the material is cut and constructed into a dipole antenna. Checking it on the ground and putting it up in its final configuration will have different results. Further adjustment (trimming) is usually required. Raising or lowering the height of a horizontal (or vertical) dipole will change the voltage and current ratio on the dipole thereby changing the radiation resistance and reactance (feedpoint impedance). This can be observed with a SWR analyzer (made by MFJ Enterprises, Inc.). It is an extremely handy instrument to build and install antennas with.

Once the dipole is elevated, changing the in-line relationship of each half of a horizontal dipole will affect the radiation resistance and reactance thereby changing the feedpoint impedance. Generally, when mounted near the ground, a horizontal dipole will appear to have capacitive reactance until it is raised more that a half-wavelength above ground. Typically, a low-frequency horizontal dipole will have the "best-match" to a coax feedline around ½ wavelength above "good ground."

The apex angle in an "inverted-vee" or drooping antenna will also affect the feedpoint impedance. Typically, the impedance goes lower with the apex angle decreasing from 180 degrees through 90 degrees. Then it starts to become a very low radiation resistance with a high reactance. Having the ends of an inverted vee close to ground will produce a capacitive loading affect that raises the resonant frequency making the dipole antenna appear too long. This is why an "inverted-vee" or drooping antenna for 75-meters generally requires slightly less wire than the formula indicates.



A horizontal dipole will always perform better than a drooping dipole but a drooping dipole offers some ease of installation advantages.

For VHF and higher frequencies, due to the short wavelengths, the height effect on antenna impedance gives way to a "surrounding object effects" which may alter the antenna's directivity. Mounting a VHF antenna above a tower in the clear away from surrounding objects will minimize the effect. However when mounted on the side of a tower, the tower legs, tower face and any guy-wires will influence the dipole feedpoint impedance and also the directivity.

Other Antenna Facets

There are many other "facets" associated with antennas such as Radiation Efficiency, Bandwidth, Q-Factor, Polarization, Phasing, Gain, Front-to-Back Ratio, Directivity, and Matching (connecting different types of feedlines to them). Here are some simplified explanations of these facets. You can learn a lot more about them in various antenna books from the ARRL or by talking about them on the air with your friends.

Radiation Efficiency

The radiation efficiency of an antenna is given by dividing the radiation resistance by the sum of the radiation resistance and the loss resistance (ohms). Now you can see why it is extremely important to keep the radiation resistance high and make the loss resistance very low. The losses in a dipole are caused by 1) DC resistance of the dipole material, 2) Dielectric losses of the insulators, and 3) Ground losses (which usually absorb power unless a good ground plane is established).

Bandwidth

The bandwidth of a resonant antenna is usually measured by observing the SWR. The effects on the SWR are usually caused by the reactance changing when the frequency is changed. There are some simple ways to alter these changes. One way is to use a conductor with a large diameter relative to its length or make the dipole in a "wire cage" or "bow tie" configuration. This will increase the antenna diameter and bandwidth. Another way is to use "compensating elements" at the feedpoint. Building a dipole from a half-wavelength coax with the shield split and fed in the middle (called a "double-bazooka") is one form of such an antenna. Another antenna that generally has a wider bandwidth is a "folded dipole." The ultimate way to increase the apparent bandwidth is to use an automatic antenna coupler at the antenna.

Q-Factor

The Q factor of an antenna is a measure of its SWR bandwidth. Antennas are equivalent to inductive-capacitive-resistive circuits and so they have reactance. Q factor is directly proportional to the difference in reactance on two frequencies close to the frequency of analysis, and inversely proportional with the radiation resistance and relative frequency change. Therefore, low frequency antennas usually have lower bandwidth than higher frequency antennas.

Polarization

Because of their physical mounting (and feed methods), antennas are either vertically or horizontally polarized, although circular polarization is also possible. The polarization is determined by the position of the radiating element with respect to earth. A radiator parallel to the earth radiates horizontal polarization. An antenna perpendicular to the earth radiates vertical polarization. During line-of-sight communications (VHF and above), it's important that the transmitter and receiver use antennas with the same polarization for maximum signals. With HF propagation via the ionosphere however (called a sky wave), it's not essential that both antennas have the same polarization. This is because the sky wave is bent and twisted as it is refracted through the atmosphere. Polarization of the sky wave signal continuously changes. Therefore, the main consideration for a good DX antenna is a low angle of radiation, which can be achieved either with a horizontal beam or a vertical antenna. One further facet worth mentioning is that horizontally polarized antennas generally have a lower noise pickup than vertical antennas have. A horizontal full wave loop HF antenna is an excellent low-noise antenna.

Phasing

By controlling the currents (phase angles) in antenna elements, increased gain or changes in directivity result. A.M. broadcast stations sometimes have to change their direction pattern at night to keep from interfering with other station(s) on the same frequency. They do this by changing the phasing of the currents in multiple vertical antennas. Antennas with elements fed in-phase usually combine their energy broadside to the array. Antennas with elements fed out-of-phase usually combine their energy in the plane of the array. Equal length feedlines are a simple way to feed antennas in-phase but proper impedance transformations must also be adhered to.

Gain

The gain of an antenna is a measure of its ability to concentrate radiated energy in a given direction and is expressed in decibels (dB). The gain tells how much better a particular antenna is than a reference antenna, therefore it is a ratio. The reference antenna can be an isotropic radiator (an imaginary antenna that radiates equally well in all directions). The gain factor would be expressed in dBi. The reference antenna can be a dipole and the gain factor would then be expressed as dBd. A dipole antenna has a gain of 2.15 dBi because it has a donut shaped pattern for directivity. If placed above perfect conducting ground, a dipole could have as much as 8.15 dBi gain into the hemisphere above the antenna. It must always be understood what the reference is when speaking about antenna gain in dB. Also, antenna gain always means that there is directivity, i.e., the radiated energy is concentrated in some direction.

Front-To-Back Ratio

Front-to-back ratio (F/B) is a measure in dB (just like gain) indicating an antenna's ability to radiate a minimum of energy in the back direction, i.e., at 180 degrees from the main lobe. Consequently, it's also an indication of not being able to hear signals from that direction. The free-space F/B is always measured at a zero-degree wave angle. The F/B is one indication of discriminating against signals in one direction. But it's somewhat meaningless because unwanted signals can come from many directions. Also, the F/B can vary as a function of the vertical angle.

Directivity

Directivity is a term used to describe the angular direction an antenna radiates in (or receives from). It is usually expressed as an angle in degrees about the horizontal axis and vertical axis. It is an important facet especially for receiving antennas in their ability to null out interference from certain directions and to change directions very rapidly.

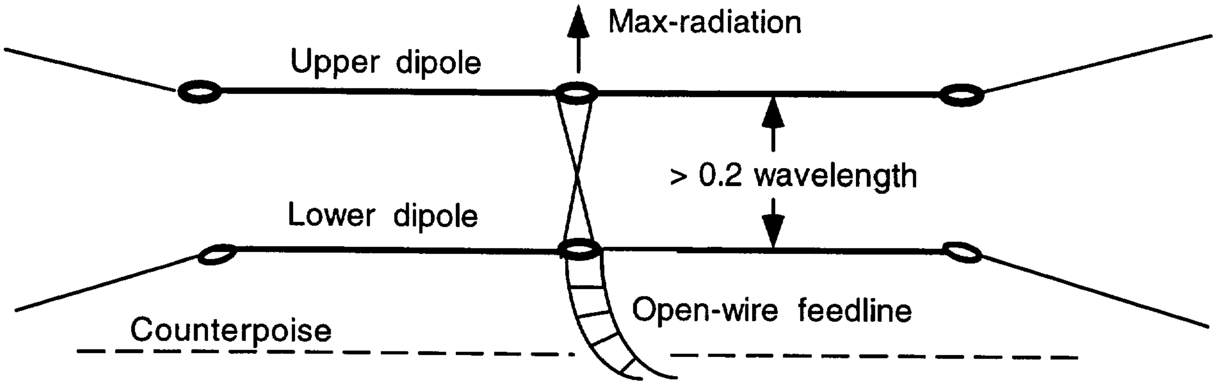
Matching

Matching is the function of providing the correct impedance match between an antenna and the characteristic impedance of its feedline for the maximum transfer of energy with minimum losses. Any mismatch here results in standing waves. The term Standing Wave Ratio (SWR) is indicative of mismatches between the feedline and the antenna. Making the SWR 1:1 only reduces the effects of feedline losses (and makes the transmitter happy). Minimizing the SWR to 1:1 DOES NOT indicate how well an antenna is radiating, only the radiation efficiency indicates that. Therefore, a 1:1 SWR is NOT an indication of a necessarily good antenna.

Finally

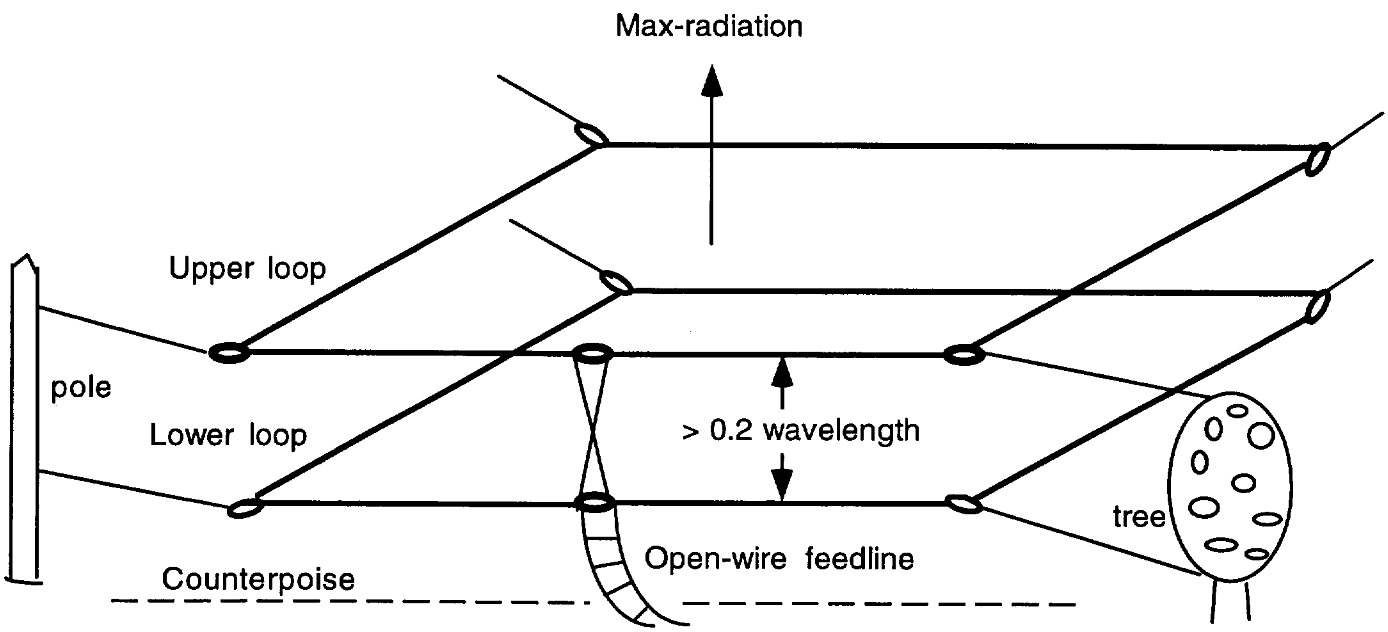
Antennas are the most important part of any ham station and they are the most fun of any equipment to build today. Have you tried building a miniaturized amateur transceiver lately? Antennas offer the most 'bang for the buck' in ham radio because antennas that work well typically do not cost much to make (in contrast to buying an expensive power amplifier). Increasing power from 100 watts to 400 watts is a 6-dB gain and may cost hundreds of dollars if you buy an amplifier. However it is not hard to achieve 6-dB gain with certain types of antennas, which only cost a few dollars to make, i.e., beams, phased arrays, etc. Additionally, look carefully at the advantages of utilizing "open wire feedlines" instead of expensive coaxial cable. The reduced losses over coax cable can also be considered a gain.

For 75M and 40M, an antenna that has high-angle radiation will definitely improve your signal. That means having a good ground plane or reflector element under your dipole. Shown below is such an antenna.



This dipole array will have excellent high-angle radiation improving your signal on the 75M and 40M bands (500 to 1000 mile region).

If more space is available, a full wavelength loop antenna also makes an excellent high angle radiation antenna with the added advantage of being low-noise on receive. It does not have to be erected in a symmetrically square configuration. It can have bends, zigzags or even be an oval and it will still work well. By making the dipoles in the above antenna into loops, it increases gain in the vertical direction thereby increasing signal strength in the region out to 500 to 1000 miles. This antenna is similar to a quad antenna, only it's configured to shoot the signal up vertically not horizontally. Again, having a good counterpoise under the antenna will further enhance the gain by reducing the ground losses.



This double horizonal full wave loop array will have higher gain high-angle radiation improving your signal on the 75M and 40M bands (500 to 1000 mile region). The loops can be mounted on poles, trees, towers, etc., and do not need to be symmetrical. The formula for calculating the length of wire in one loop (in feet) is 1005 divided by the frequency in MHz.

Study and discuss the advantages and disadvantages of different antennas and feedlines with your ham friends. Learn all that you can! The facets of antennas make an interesting QSO on any band! ..W8HVG