The LARC Repeater

A publication of the
Livonia Amateur Radio Club

Volume 1 Number 8 April 2008

PRESIDENT'S CORNER:

Opening Day at Tiger Stadium, let's see if the rain holds out so that we don't get rained out. So far the Tiger's are leading 3-0 in the 5th inning, let's see if we can hold Kansas City Royals from getting any runs. We didn't, need I say more.

I am so glad to say that **John Mathey K8AZT** stepped up, and will chair Field Day this year. I am sure that, we all will do our part to make this year's Field Day a GREAT TIME for all and help out where we can. We do need operator's, and this is where all the members come in. I would like to see everyone from the LARC, out at Field Day for at least two hours to operate. John will have sign up sheets at the May meeting, for those wanting to work and what time.

We will be with the Ford Tin Lizzy Club again this year, there will be plenty to do for set-up, so we will need to see club members out there helping out in whatever they can do. We have tents and stations to set-up, and antennas to hook up. Set-up starts at 10:00 a.m. and, I am sure like in past years the Ford Club will have coffee and bagels with cream cheese. Orange juice and Muffins, along with other stuff to munch on. Let's hope for nice weather, no rain, about 80 degrees with a nice breeze.

We do have a speaker this month, and if you were at our SWAP you might have stopped by and talked with him. The speaker is **Dale Williams WA8EFK Michigan Section Manager ARRL**, and if you have any questions for him you will be able to ask them after his talk.

Welcome New Members:
Robert WX8YZ, Lynette KC8NAH, Richard K6VEM, John KB8QQU

TECHNICAL SECTION:

Antenna Newcomers and the Language of Antennas

L. B. Cebik, W4RNL

The antenna forums and discussion lists often have occasion to answer inquiries from individuals who are relative newcomers to the study of antennas. As well, many other newcomers "lurk" in the background, reading the stream of questions, notes, and replies, but rarely sending a message.

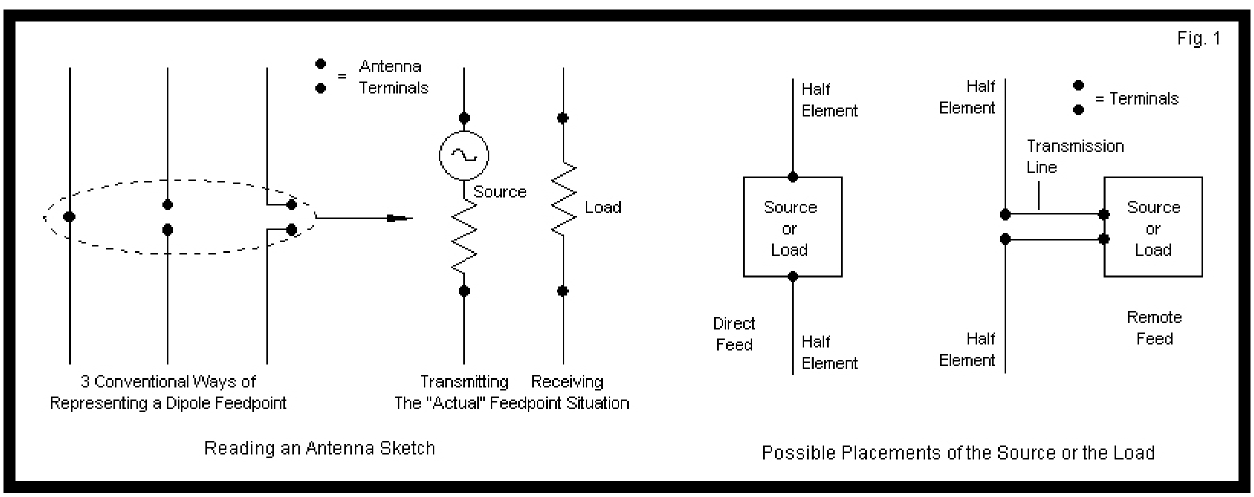
Antenna newcomers deserve a hearty welcome, but also some understanding. Most are not EE students using the various information sources as an adjunct to "Antennas 101." Rather, they are individuals who already have embarked on life's journey through work in other areas. They may have become interested in RF communications and now find that antennas are interesting if only because they seem the most mysterious part of the path between the key, computer, or mike on one side and the speaker, headphones, or computer on the other side. The curbs at the edge of the road that signals must cross are the antennas. Still others may already be involved in electronics, but have now been re-assigned to work with antennas--and they cannot remember a word of what happened in "Antennas 101." I have had the good fortune to meet these and many other types of individuals who are relatively new to antennas.

One of the oldest and worst postures that experienced antenna workers (teachers, engineers, 50-year hams, etc.) can take is the attitude of superiority that says, "I have made it this far. It is up to you to catch up." Rather, we should all be amazed at what the newcomer has to learn just to get started. Let's make a short list of what it takes just to get going in this fascinating arena. We can divide the areas of "getting-started information" into 3 general categories. Our list is strictly practical.

1. Basic conventions and concepts related to antenna representation;
2. Some basic concepts applicable to antenna operation; and
3. Some basic concepts of antenna performance in numerical and graphical form.

BASIC CONVENTIONS AND CONCEPTS RELATED TO ANTENNA REPRESENTATION

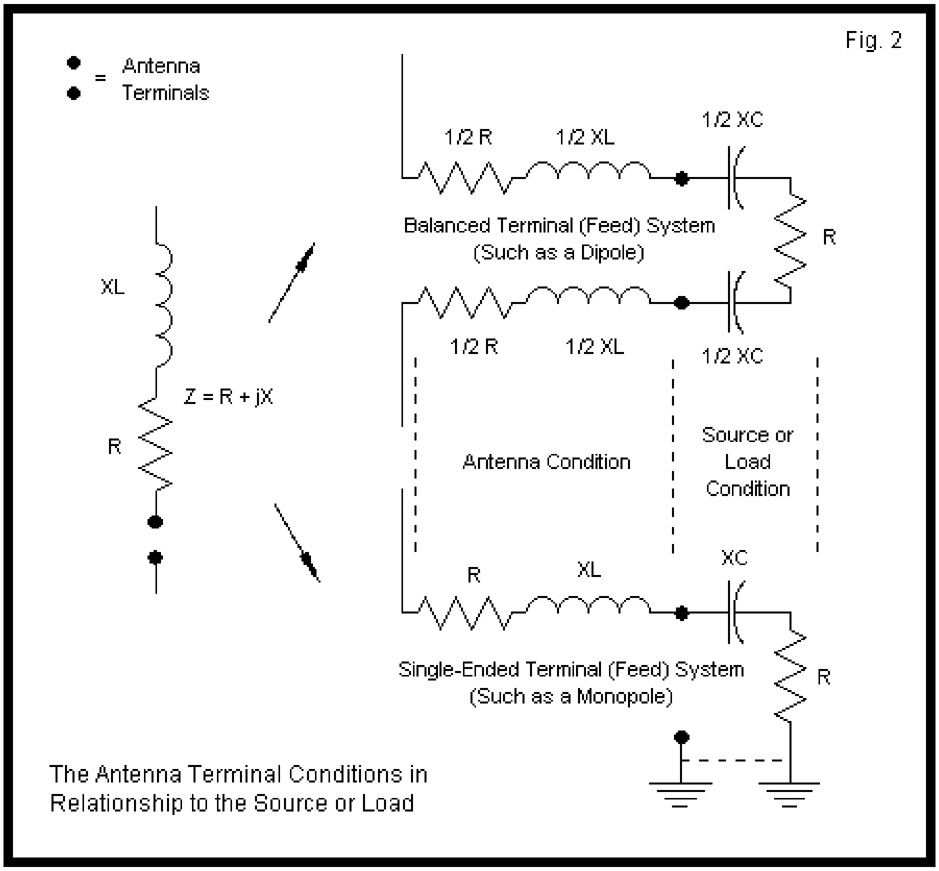
More experienced antenna workers typically sketch antennas incompletely and casually. For example, the 3 forms of dipole sketching on the left in **FIG. 1** have all appeared in these pages. The straight lines are obviously the antenna wire or tubing parts. But what about the center section--the so-called feedpoint?



Somehow, because no one ever comes right out and says so, the newcomer must realize that the 3 sketches of the same antenna are highly presumptive about the feedpoint. First, we have the transmitting convention: most antenna parts go by names based on the antenna's use as a transmitting transducer, one that transforms RF (AC) energy into ever-expanding electromagnetic fields. Hence, we call the terminals the feed point to indicate that we are supplied with energy from a source (which always has a series resistance or impedance). We forget to footnote the name with the fact that the antenna works the other way around as well, intercepting electromagnetic fields and converting that energy into RF electrical energy. The device using that energy forms a load resistance or impedance for the antenna as a source.

We also generally fail to mention to newcomers that we have at least 2 ways to handle the antenna's source and its load. We can place the transmitter and/or the receiver directly at the antenna terminals, or we can remotely site the source and/or the load and use a transmission line to connect the two. Of course, the moment we mention a transmission line, we are into one of the mysteries of antennas that takes a longer time to bring into the light. Since we are just getting started in the area of antennas, we can simply think about the sloping antenna that we throw up during amateur field operations, or the collapsible whip on the FM receiver (or 2-m transceiver), to imagine how we may connect the source or the load directly to the antenna.

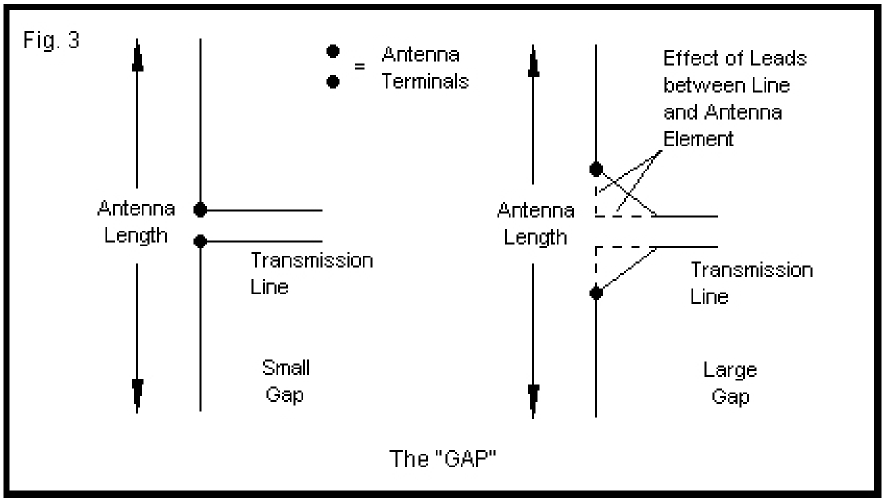
We also presume that newcomers can automatically and correctly read our conventional representation of the antenna's terminal impedance, whether resonant, inductively reactive, or capacitively reactive. The left part of **FIG. 2** shows how we conventionally draw the situation for an antenna with an inductively reactive terminal impedance.



The right side of the figure redraws the terminal situation for a balanced dipole antenna and for a single-ended monopole termination. Many newcomers only much later realize that the dipole drawing is as legitimate a representation as the monopole sketch. For the dipole, we can show half the resistance and half the reactance on each of the two balanced terminals, since the antenna terminals are in series with the source or the load. If one of the two terminals connects to ground, then we may use the single-ended form. The sketches also show the way we handle reactance at the antenna terminals in the most usual cases. We compensate with an equal reactance of the opposite type. However, if we must also transform the resistive component to effect a match, then we enter another set of mysteries called networks (or more casually, antenna tuners). This arena is also one that takes time to master.

A perennial question that arises from antenna newcomers--especially those trying to build an antenna based upon an article they have read--is the gap between the terminals.

How big or small should the gap be? Do we add the gap size to the antenna element length or is it included in the length? **FIG. 3** illustrates the problem and part of the solution.

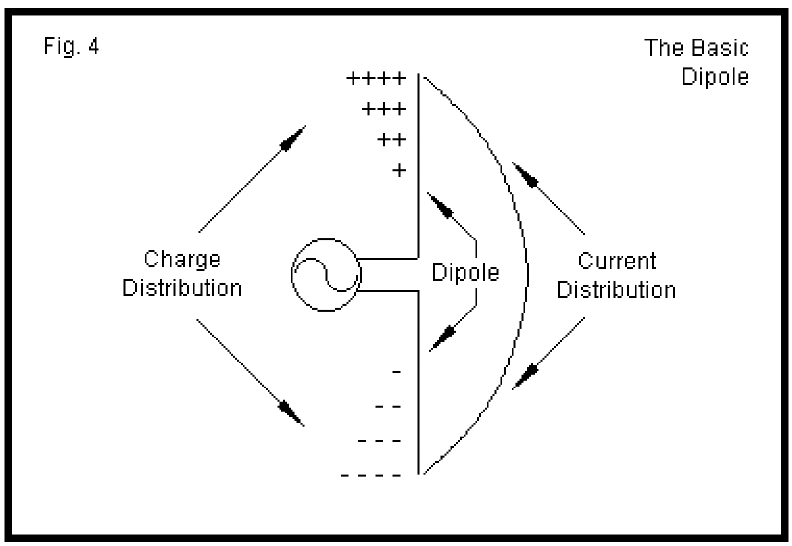


Except under direct interrogation, no one tells the newcomer that the smallest gap should be just wide enough to keep the half-elements from shorting together. But wider gaps will do, with due attention to frequency. On 80 meters, a foot-wide gap is fine, but at VHF, we want the smallest practical gap--perhaps as wide as the spacing of the conductors of the transmission line connected to the terminals. At lower frequencies, where the gap is wider than the transmission-line conductor spacing, the leads from the line to the terminals of the element become part of the element. There are limits to gap size at any frequency, but generally, the size of the gap has no effect on the element length from tip-to-tip.

These sample quandaries reflect the types of questions that newcomers often have (and are almost as often afraid to ask) about the casual and conventional ways in which we sketch antennas. There are others, but we should look at a few ideas involving basic antenna operation.

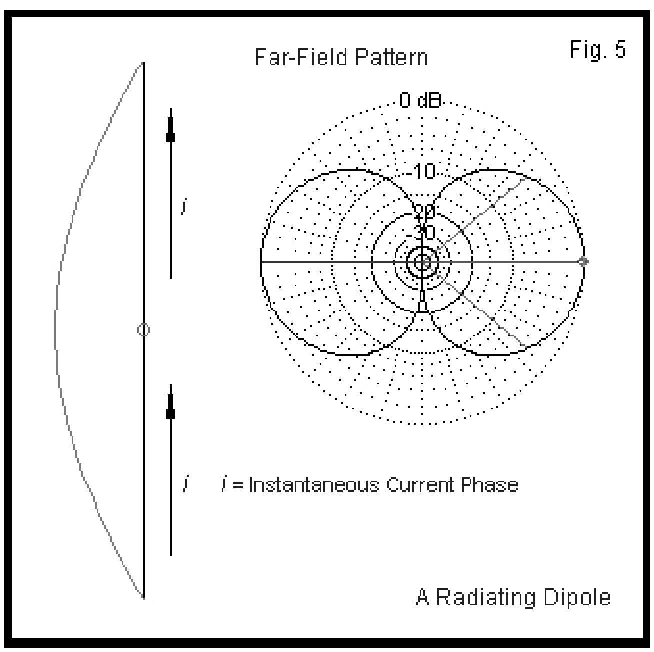
Some basic concepts applicable to antenna operation

If a newcomer asks how a dipole really operates, some respondents will send the individual to a basic college text for a "review" of Maxwell's Laws, Poynting Vectors, and the entire theoretical foundations of antenna theory. (At least an equal number of others will either admit that they do not know or provide a smoke screen of odds and ends to cover up that fact.) What we often forget is that the newcomer--if not in an EE class--may simply be looking for a reasonably accurate way to visualize the operation in order to develop some rational expectations of antennas and some foundation for understanding what appears in mid-level articles and handbooks. Something as simple as the sketch in **Fig. 4**, adapted from many texts, may do the basic job. It may also leave room for the individual to move at personal speed both back to the fundamentals and forward to the construction project.



When the question-and-answer session is informal, we can stress only a few points and still get across the basic ideas. First, the concentration of charges is an instantaneous phenomenon, with polarity shifts in tune with the operating frequency. However, the concentration tells us why the ends of a wire antenna can be dangerous to anyone touching them during a transmission. Second, the current curve is a standing wave. If the antenna is a dipole, then the peak current occurs at the center of the element, right at the terminals. Third, the sketch omits the source's series resistance, which we assume is matched to the impedance of the dipole at its terminals, however long the dipole might be. Fourth, a true dipole can never be longer than 1/2-wavelength electrically, since if it grows longer, then current peaks occur on either side of the center point and not at the center. (This is a good time to remind the newcomer about how antenna terminology is often thrown about casually, so that we often name as a "dipole" almost any center-fed antenna.) Finally, we can enter into a discussion of the relationship between the center-fed wire's length and the terminal impedance conditions.

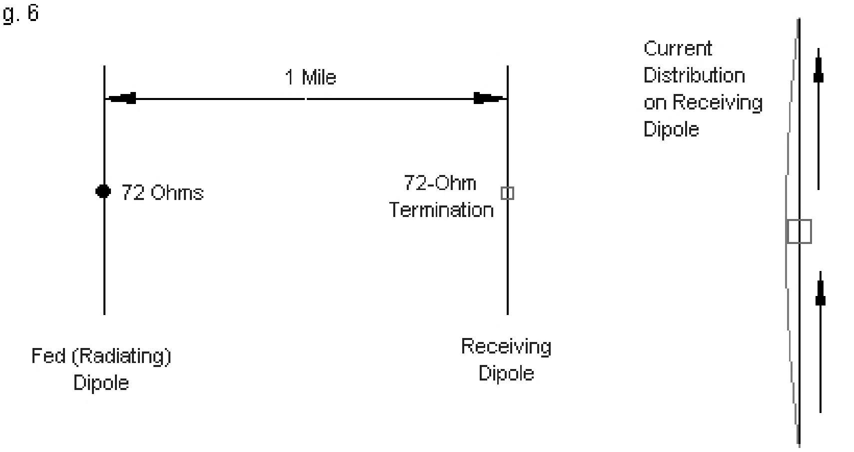
There is much more that we can reasonably say without ever introducing an equation, and it may all be helpful in developing reasonable expectations about antennas. Equations are also good, but only if the student is ready for them. However, we can also illustrate what we say. A well-wrought experiment is ideal, but usually the questions arise when we are not close to our materials and test equipment. However, if we have some modeling software, we can show the student what he or she needs to see. The materials in **Fig. 5** show especially the current magnitude and phase of the current standing wave on a resonant half-wavelength dipole when it is transmitting or radiating.



The particular set of diagrams happens to come from EZNEC. Other software may represent current in a similar way or the software may use a color coding to represent the maximum and minimum levels. Either technique can be equally effective in answering basic question, so long as the individual understands the conventions of the representation.

The transmitting situation of the current on a dipole is fairly easy to represent, since the model is simple. This one happens to be in free space, so everything is very nicely symmetrical about the antenna terminals. Actually, we can also represent the current situation on a receiving antenna with fair ease. Simply start with the transmitting antenna. Then create an identical dipole about a mile away. Do not forget to provide the receiving antenna with a load that is equal to its resonant impedance. After you run the model, examine the currents on the receiving antenna. You likely will see a current magnitude and phase angle curve like the one in **Fig. 6**.

Fig. 6



Current Distribution on an Terminated Receiving Dipole in Free Space

You can actually go into a good bit of detail here based on the modeling data. For example, if you look at the current calculation tables, you will find that the ratio of current magnitude between the tips and the center of both antennas is the same. This may also be a good time to open the question of aligned and cross polarization between linear antennas. All you have to do is change the axis along which you create either the transmitting or the receiving antenna. (Actually, the demonstration is most effective when you conduct it both ways.)

From this point, you can go in many directions. Usually, you will have to lead the newcomer to the right questions to ask. For example, what happens to the current along the wire if we make the wire longer, longer yet, and exceptionally long? Is there any regularity not only to the current curves but also to the development of lobes? (Here you may be in for a long session on the operation of a multi-band center-fed antenna, perhaps an 80-meter dipole operated on 10 meters, for example.) Are there ways to control the current phase along a center-fed wire that is very long? Suddenly you are working with collinear arrays. Why must the antenna be center-fed? How do lobes develop if we feed the wire at its end when it is multiple wavelengths long. Finally (for the moment), here is the best question: how is a vertical monopole like a dipole and how is it different?

One well-placed question leads to others. Education of newcomers lies in the questions, not just the answers. To further the process, every answer should lead to the next question(s).

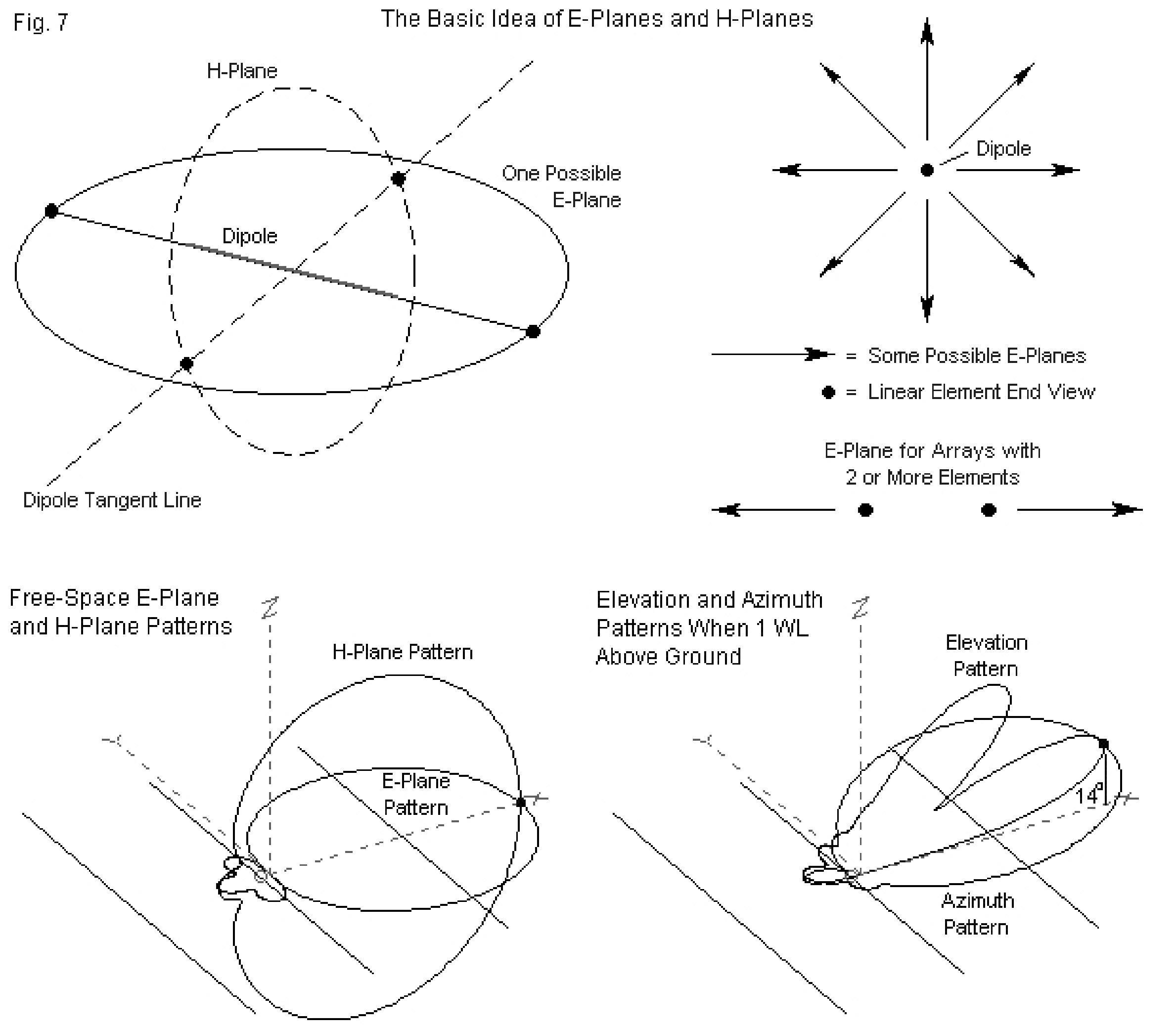
Some basic concepts of antenna performance in numerical and graphical form

Although we might have continued the questions that arose from the simple dipole demonstration, we cannot forget that our goal is to orient the newcomer to read with understanding. The dipole discussion has already led us to look at antenna patterns and use terms like "polarization." These terms are part of a third cluster of ideas that a newcomer must naturalize: the conventions and concepts used to represent antenna performance.

Today, we tend to use graphical representations of antenna performance as much or more than numerical reports. Nevertheless, both rest upon measuring or calculating the far-field radiation pattern produced by the antenna (among other things). In turn, these patterns rest on some fundamental ideas that relate the antenna to its environment.

The most fundamental environment for an antenna is free-space, a limitless region in all possible directions with no up or down, since it lacks any references to make sense of these notions. Hence, we must use the antenna itself as a reference. Antennas with linear elements are handy in this regard, because we can distinguish an E-plane and an H-plane, as shown at the top left in **Fig. 7**.

Fig. 7



Radiation Patterns to Determine Forward Gain for a 3-Element Long-Boom Yagi
Free Space and 1 Wavelength Above Ground

The E-plane is the plane of the antenna's electric field--the one of greatest importance to the far field--which occurs in a plane parallel to the axis of the element. As shown at the top right, a simple dipole has an indefinitely large number of possible E-planes. However, we tend to use the one that parallels the E-plane of flat multi-element arrays. The antenna's H-plane occurs at right angles to the element in alignment with the magnetic field. At the lower left in Fig. 7 is the E-plane and the H-plane far-field radiation pattern for a typical 3-element Yagi. We may note that the two fields touch at the forward-most point of the pattern and again at the rear-most point. We should also note that the E-plane and the H-plane patterns have different shapes.

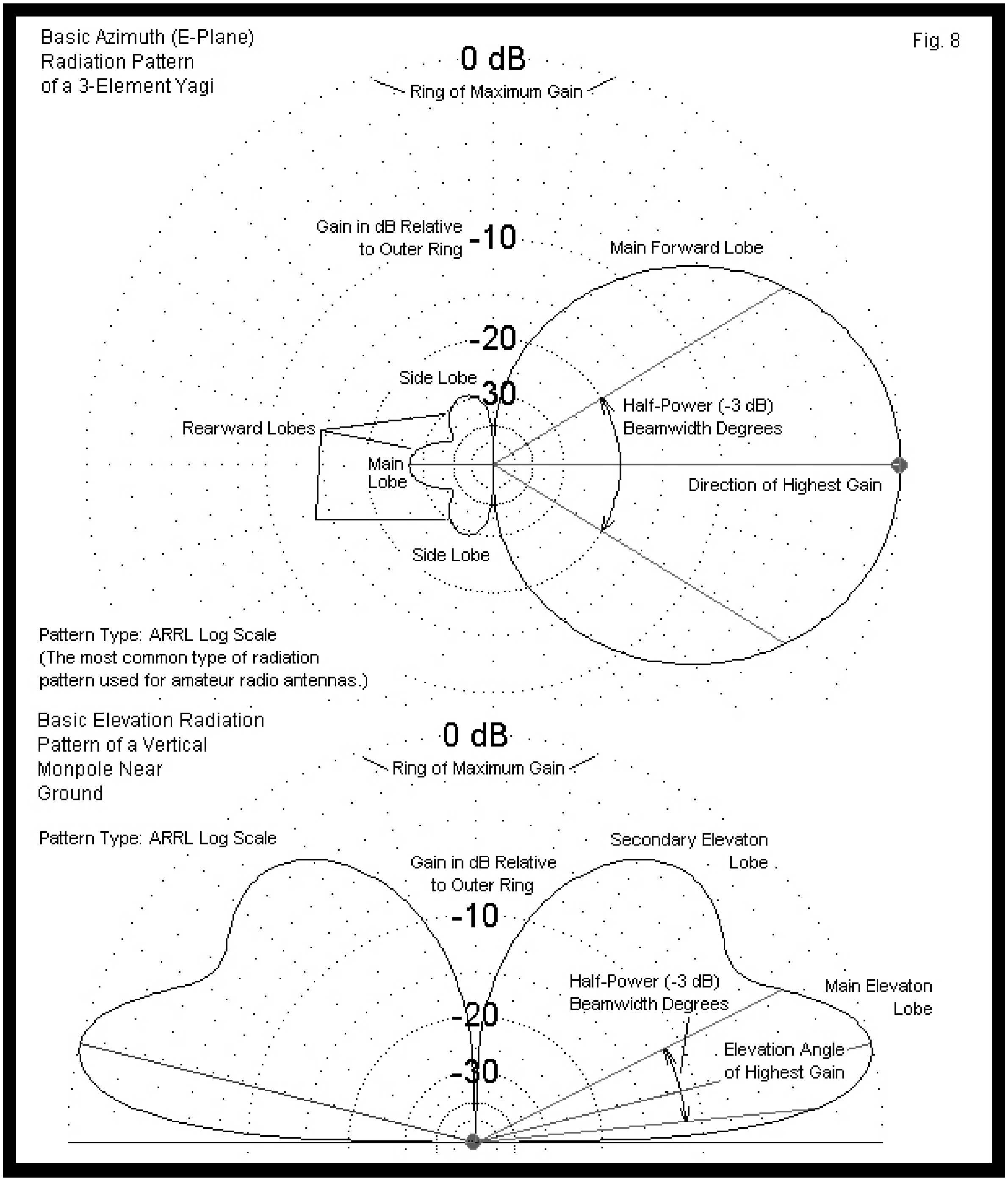
When we place the antenna over ground, say 1 wavelength above ground, our orientation changes. Now the ground and the pattern behavior together determine how we handle the performance representation. Instead of an H-plane pattern, we have an elevation pattern. Note the formation of elevation lobes and nulls that derive from the combining of the direct or incident waves from the antenna and from the ground reflections that may add or subtract from the incident waves. We call the elevation angle above the horizon where the radiation is strongest or the gain is the highest the take-off (TO) angle. In this case, the angle is 14 degrees.

The pattern that circles the antenna is the azimuth pattern. The pattern corresponds in this case to the E-plane pattern of the free-space situation. Since the plane of the elements is horizontal relative to ground, and since all of the elements are linear, we can also say that the antenna is horizontally polarized. However, if we had set up the antenna with the elements vertical with respect to ground, we would take the azimuth pattern that corresponds to the H-plane pattern of the free-space situation. As well, the antenna is now vertically polarized.

We do not take the azimuth pattern at the level of the horizon. Instead, we normally take the pattern at a higher angle, most usually the TO elevation angle, although we may use other elevation angles as the need arises. The azimuth pattern actually forms a conical section from the origin of the system with a 14-degree angle. With such low angles, transferring that conical section to a flat graph causes negligible distortion, but at very high angles, the distortion may be considerable.

The more complex the patterns, the more parts we have to consider, and every part has two aspects: a name and some associated numbers. The top section of **Fig. 8** shows some of the parts of the typical azimuth pattern. This pattern is laid out on a circular grid. The angular notations are clear. The pattern strength numbers of the various rings may be less clear initially. This pattern uses a logarithmic ring scale. Other patterns may use a linear scale. Proponents of linear scales believe that they show pattern detail more realistically, but they do require that the user determine a minimum gain value for the innermost ring. In contrast, the log scale is uniform from one application to another.

The pattern is also normalized. To normalize a pattern, we set the gain of the outer ring to the maximum gain of the antenna. All other parts of the pattern show how much weaker the gain is relative to maximum gain. To find out the maximum gain, we must consult the numerical data. For our pattern, the maximum gain is about 12 dBi. A dB is 10 times the common log of the ratio of any two powers in the same units. We generally record gain vales in dB relative to some standard antenna, either real or theoretical. The most common standard today is the gain in decibels above an isotropic source, that is, one that radiates equally well in free space in every possible direction. A few decades ago, most amateur antenna articles showed the gain in dBd, the gain over a free-space dipole. By definition, a free-space ideal dipole has a gain of 2.15 dBi. So the two measures are supposedly interchangeable. The use of dBi prevents confusion over whether a gain recorded in dBd is the gain of a free-space dipole or the gain of a real test dipole in the same position as the antenna being considered. When we encounter a gain in dB with no reference, we know that some comparison is being made, perhaps between two antennas. (If the gain value in "bare" dB appears in an advertisement, then we know to be suspicious.)



Every lobe of interest in a radiation pattern has a beamwidth. We are generally interested in the main forward lobe of directional antennas, although other lobes may interest us for special reasons. We conventionally define the beamwidth in degrees between points on the pattern that show half the power of the point of maximum gain. Half the power means -3 dB. For a maximum gain of 12 dBi, the beamwidth is the angle between points on the lobe where the gain is 9 dBi. Note that I have been referring to the main forward lobe and not simply to the forward lobe. Although this pattern has only one forward lobe, many antennas have secondary lobes in the generally forward direction.

The rear quadrants are especially interesting. The present antenna shows 3 rearward lobes; other antennas may shows from 1 to very many lobes. We call the ratio of power gains in the forward direction and the rear direction the front-to-back ratio. However, there are numerous ways to obtain the ratio and multiple names for some ways. If we take a bearing 180 degrees opposite the bearing of the strongest forward gain, then we have the 180-degree front-to-back ratio. In some cases, the 180-degree direction does not show the strongest rearward lobe. We can also compare the gain of the forward lobe with the strongest rearward lobe and arrive at a worst-case front-to-back ratio (which some call the front-to-rear ratio). More commonly, the front-to-rear ratio averages all of the gain values in the rearward quadrants and compares that value with the forward gain. (But some call this value an average front-to-back value.) The lesson is to obtain not only the numbers, but also the foundation for those numbers before reaching any conclusions about antenna performance.

The elevation pattern, shown at the bottom of **Fig. 8**, also uses a log ring scale and it also has parts. Here, I have changed the antenna to a vertical dipole with its center point (or terminals) 1/4-wavelength above ground. The elevation patterns shows a stronger lower lobe with a TO angle. This lobe has a vertical beamwidth that rests on the same half-power points that we used to obtain the azimuth pattern beamwidth. The vertical beamwidth gives us an idea of over what range of propagation angles the antenna may be effective.

Compare the elevation pattern in this figure for a vertical dipole with the outline of the elevation pattern for the horizontal Yagi in **Fig. 7**. Although horizontal antennas produce distinct lobes and nulls based mostly on the height of the antenna above ground, vertical antenna below a few wavelengths above ground are less orderly in the development of secondary elevation lobes. The higher-angle lobe of the vertical dipole has only a shallow null between it and the lower main lobe. In some cases, the two lobes may merge and obscure just where the null should be.

Although I shall not add them here, we may graph almost any data about antenna performance on rectangular graphs. Even the pattern data is apt for such treatment. More usually, we find rectangular graphs that show important performance information over a spread of frequencies or a "sweep." We might graph over the selected frequencies such data as the maximum forward gain, the TO angle, the front-to-back ratio, the strength of any forward sidelobes, the feedpoint impedance, or the SWR relative to a standard, such as 50 Ohms.

Conclusion

These brief notes only scratch the surface of the basic concepts and conventions that the newcomer to antennas must eventually master to appreciate fully the great mass of literature that is available. Nothing here is at all complete or adequate. I have only said enough to indicate the importance of some of the ideas, terms, conventions, and representations. I have not presented any kind of cohesive treatise. Still, we can note that nomenclature and conventions interweave with substantive antenna operation basics, so that to learn one is to learn the other. Learning to talk rightly is one step toward learning to talk sensibly.

Indeed, when I look even at this truncated list of terms and conventions applicable to antennas, I am somewhat surprised that any newcomer does master them. But they do! The learning curve is longer or shorter, depending upon the help available and the impediments to learning that abound in some quarters. Readers of amateur journals and participants in the discussions have access to expert assistance, even for basic matters. Remember that all of the expert assistance available from the experienced antenna workers comes from folks who once upon a time were also newcomers. At one time or another, we have all had the same basic questions to ask--and have hesitated to ask them, lest we look ignorant. However, there is only one bad question, and that is the one that goes unasked.

Antennas are less a problem than they are a challenge. For many the challenge is fascinating, an endless field of things to be learned. In a sense, we are all newcomers to what has yet to be discovered.

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BUDGET BASEMENT:

I make personalized address labels, simple business cards or QSL cards. There are 30 address labels to a sheet, 10 business cards to a sheet or 4 QSL cards to a sheet. The charge is $1.00 a sheet (mix or match) with a 3 sheet minimum ($3.00). I have many graphics to choose from. **Contact Doris (KD8DXJ) at 734-941-5043 or** Dorimae492@yahoo.com **for more information**.

WEB SITES OF INTEREST:

Local Hams in your Neighborhood
http://www.vanityhg.com/maps/enterzip.html

National Weather Service Detroit
http://www.orh.noaa.gov/dtx

Logging Programs
http://www.n3fjp.com

R A D A R
http://www.qsl.net/wr8dar

Antennas
http://www.pi4cc.nl/link/bc.htm
http://www.cebik.com/radio.html

Contests And DX
http://cpcug.org/user/wfeidt/

International Call Look-Up
http://www.book.com/cgi-bin/do_hamcallexe

Mega ConverterWeb Page
http://www.megaconverter.com/mega2

Aurora Activity Map
http://sec.noaa.gov/pmap

Here is a list of repeater frequencies charts, coast to coast for those of you that will be traveling buy car this year. http://www.geocities.com/usrepeaters/

AREA EXAMS & SWAPS:

Milford Amateur Radio Club
Saturday April 19, 2008
8:00 a.m. to 1:00 p.m.
Milford High School
2380 Milford Rd
Highland, MI
Talk-in 145.49 (67 Hz LP) 146.52 back-up
Tickets $6.00 at door

Livonia ARC Exam Session
April 26, 2007, 1:00 to 3:00 PM
Livonia Police Department (*EOC Room*)
Five Mile Road & Farmington Road
Walk-ins only allowed as supplies last
Pre-register with Bruno Walczak
at (734) 464-8928

Chelsea Radio Swap
June 1, 2008   Talk-in 145.450 (PL100)
Chelsea Fair Grounds
20501 Old US 12 Hwy

Garden City Amateur Radio Club
Swap In The Park
Sunday June 8, 2008
8:00 a.m. to 2:00 p.m.
Cherry Hill and Merriman Roads
Main Picnic Pavilion
Table 10.00 or sell from your trunk for Free
Talk-in 146.860 100 PL

Monroe Hamfest
June 15, 2008
Monroe Coounty Fair Grounds
Gerstacker Bldg
6905 Eastman Ave
Talk-in 147.00 (PL 103.5)

Meeting Rooms for this year

April 28, 2008 Room A
May 19, 2008 Room A****
June 23, 2008 Room A
No Meetings July and August but the Board Does Meet. Hot Dog and Corn Roast In August.
September 22, 2008 Room B
October 27, 2008 Room A
November 24, 2008 Room A
December there is no meeting, that is because of our LARC Christmas Party.

****** The meeting is one week earlier than usual; January is early because of the Library's Book Sale. May is earlier, because of Memorial Day. Please make a note of these meeting rooms.**

ARRL Elections

My Name is John D Meyers, NB4K and I was Kentucky Section Manager for 3 terms of six years. Now it is time for me to set my sights on the Great Lakes Division Vice-Director Chair this summer. You will be getting ballots sometime in the week of Sept 23rd to Oct 1st. I would appreciate your vote as I plan on applying myself to the position as I did the Kentucky Section Manager position. I will be vocal in standing up for Michigan on the division level. I will attend as many club meetings and hamfests that the Director and I can arrange and I will always make my phone available to you.

Any help you could give me would be greatly appreciated. Thanks for allowing me to come to you through your club newsletter.
73

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