

Only example: TEXT and IMAGES

Understanding Antennas For The Non-Technical Ham

A Book By Jim Abercrombie, N4JA

(Jim Abercrombie n4ja@prtcnet.com)

Illustrations by Frank Wamsley, K4EFW

Edited by Judy Haynes, KC4NOR

Copyright July 2005. Second Edition

Edited for the web , N4UJW

Editors Note: This is a book length web article provided by the author FREE for all hams.

It is to be used only for personal non-profit educational use.

It is HUGE!

Bookmark this page for future reading or see more options for saving at bottom of page!

The original book contained 60 pages and illustrations.

They are all here!

Many of the antennas described here are in project form on this web site.



Here are some of the main topics in the book that you will learn more about.

Antenna systems, antennas, simple antenna formulas, basic antenna theory, feed-lines, matching units,

how antennas work, polarization of electromagnetic waves, frequency, the ionosphere and modes of propagation, Ground-Wave Propagation, Direct Wave or Line of Sight Propagation, Propagation by Refraction,

Skywave Propagation, Greyline Propagation, Long Path Propagation, ham bands propagation, antenna

myths, standing wave ratio, real antenna systems, Flat Top Dipole, Inverted-V Dipole, Dipole Shape

Variations, Calculating the Length of a Half-Wave Resonant Dipole, The Decibel, Resistances and

Reactance, Feeding Dipoles Efficiently,

Cause of Feed-Line Radiation, Baluns, Other types of dipoles, Shortened Loaded Dipole,

All Band Dipoles, Sloping Dipole, Folded Dipole, Double Bazooka Dipole, Broad-Banded Coax-Fed Fan

Dipole, Two-Element Collinear Dipole, Four-Element Collinear Dipole, Coax-Fed Dipoles Operated on

Odd Harmonic Frequencies, Three Half-wave Dipole, All Band Random Length Dipole, All Band

Center-Fed Random Length Dipole,

A Two-Band Fan Dipole, Trapped Dipole for 75 and 40 Meters, The Extended Double Zepp Dipole, The

G5RV Dipole, Off-Center Fed Dipoles, One wavelength Off-Center Fed Dipole, Carolina Windom,

Windom Dipole (Fritzel Type), End-Fed Antennas, End-Fed Zepp, Alternate Method of Feeding an End-

Fed Zepp, End-Fed Random Length Antenna, The Half-Sloper antenna, Vertical antennas, Ground

Mounted Trapped Verticals, Disadvantages of Using Quarter-Wave Verticals, Long and Short Verticals,

Unscientific Observations of Verticals, The Inverted-L Vertical , Vertical Mobile Antennas, HF mobile

antenna comparisons, One wave-length single loop antennas, Horizontally Oriented Loop, Vertically

Oriented Single Loop for 40 and 80 Meters,

Single-Element Vertical Delta Loop, Directional beam antennas, Monoband Yagi, Three-Element Yagi,

Page 1 of 74

file://C:\Program Files\Trellian\basicantennas.htm 7/17/2007

Trapped Multi-band Yagis, SteppIR Antenna, The Log-Periodic Array,

Directional Cubical Quad and Delta Loop Antennas, Single Band Cubical Quad, field-strength meter,

The Quagi, Gain vs front to back ratio, Feed lines, Antenna Safety,

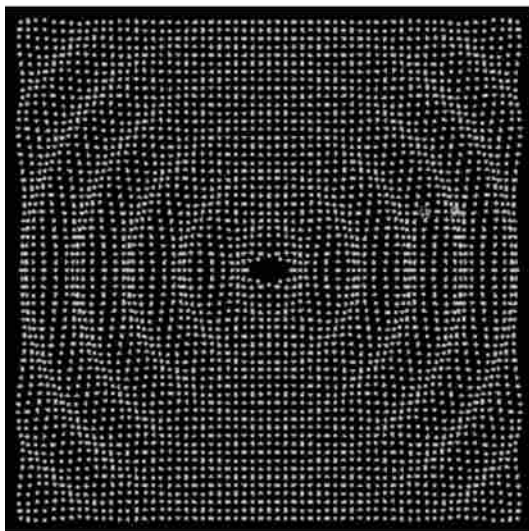
Erecting Antennas on Masts, Tower Safety, Quarter Wave Matching

Sections of 70-ohm Coax chart,

and much more!

The Book Starts Here!

Enjoy!



PREFACE

One reason for writing this book is to educate you so you can make an informed choice concerning the

best antenna for you. Another reason is to dispel the many antenna myths that circulate in the amateur

community. The third reason is a desire to teach basic antenna theory to the average ham. Therefore, to achieve that goal, you should read this book from cover to cover. It was written primarily for the newcomer and the non-technical old-timer.

This book is about common medium wave and high frequency (short wave) antennas, but the theory presented here relates to antennas of any frequency. It is in a condensed form and the antenna theory is explained so most hams can understand it. Realizing many hams are mathematically challenged, only simple mathematics procedures are used. If you can add, subtract, and divide using a calculator, you will not have trouble with this book.

A few principles in here are based on conclusions drawn from the Laws of Physics. Everything else in this book can be found scattered through The A.R.R.L. Antenna Book and nothing in here contradicts what is written there.

I. WHY ALL THE FUSS ABOUT ANTENNAS

Definition: An antenna is a piece of metal, a conductor of electricity, to which you connect the radio. It radiates your signal and receives the signals you want to hear.

Definition: An antenna system consists of the antenna, the feed-line, and any matching unit. Most

antennas are made of copper or aluminum, while most mobile antennas are made of stainless steel. A feed-line consists of two conductors that carry the signal to and from the radio and to and from the

antenna. A matching unit can be an antenna tuner, a series matching section, or one of several different kinds of matching circuits at the feed-point.

Does the type of antenna make much difference? Here is an example:



Once in 1959 two of us were involved in testing two antennas on 15 meters. The late R. Lynn Kalmbach, W4IW, using one antenna received a 30-dB better signal report on his antenna from a station in England than we did on our antenna. (Decibel or dB will be explained later). Thirty dB means his signal appeared that he was running 1000 times more transmitter power than we were. At that time, we didnt live that far apart so we couldnt blame it on propagation. We both were running about equal power. Both antennas were at

Page 2 of 74

file://C:\Program Files\Trellian\basicantennas.htm 7/17/2007

50 feet. The comparison proved that a good antenna could make a difference. Lynn used a home-built G4 ZU mini-beam; we were using a 15-meter 2-element Mosely Mini-Beam, which had short loaded elements. Evidently, it had a lot of loss.

Another example: Today we hear people breaking in to our ragchews with signals almost level with the

noise. Why is that? The reason is they are using the wrong antennas. Their signals are twenty to thirty decibels below everyone else's. They are making contacts, but just barely. The first question our group asks, "What kind of antenna are you using?" Experienced amateurs know the antenna can make all the difference. The guy with the poor signal sometimes will blame his bad signal report on band conditions or his lack of a linear amplifier. He is just sticking his head in the sand.

What we are trying to prove is next to your radio, the most important part of your station is the antenna.

Many years ago, an old-timer said, "For every dollar you spend on a radio, you should spend two dollars on your antenna." That is also true today. You can do more to improve your signal strength with antennas than you can ever do by increasing your power. Having the ability to make contacts on a particular antenna doesn't mean it works well! Any antenna will make contacts, but your signals will be stronger on some antennas than on others. In addition, some antennas hear better than others.

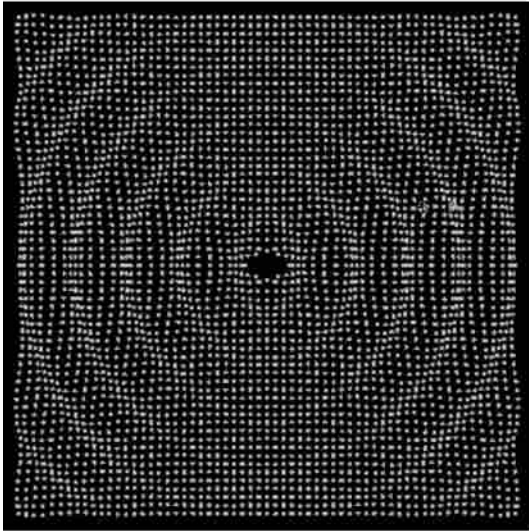


II. HOW ANTENNAS WORK.

First of all to work properly the antenna system must be matched to the transmitter. That is, all modern

transmitters have an output impedance of 50 ohms. Antenna systems range in impedance of a few ohms to several thousand ohms. There are several ways to match them: pruning the length of the antenna, using an antenna tuner, matching the antenna with a length of transmission line called a matching section, or the use one of several matching systems at the antenna feed-point. Antenna matching is beyond the scope of the material found in this book and it is suggested you consult a more comprehensive antenna manual. Simple half-wave dipoles eliminate the need for a matching system because a resonant half-wave dipole has an impedance near 50-ohms. You must understand electromagnetism to understand how antennas work. If you attach the two poles of a direct current (DC) voltage source to the two ends of a coil of wire, current will flow through the coil of wire and it will become magnetized. The magnetized coil is known as an electromagnet. Its magnetism will extend out to infinity becoming weaker with distance. Remove the voltage and the magnetic field collapses back into the coil. If an alternating current (AC) is connected to the coil, the magnetism moves out and collapses into the coil in step with the frequency of the alternating current source. The north and south poles of the electromagnet reverse on each half-cycle of the AC voltage. If voltage and current can cause a coil to become magnetized, the reverse is true: A magnetic field can produce a voltage and a current in a coil. This is known as Faradays Principle of Magnetic Induction. A voltage will be produced at the ends of the coil of wire as you move any permanent magnet close to and

parallel to the coil. The difference in this case is the magnet must be kept moving. Move the magnet in one direction, and current will flow in one direction. Reverse the direction the magnet is moving and the current will flow in the opposite direction. Moving the magnet back and forth produces alternating

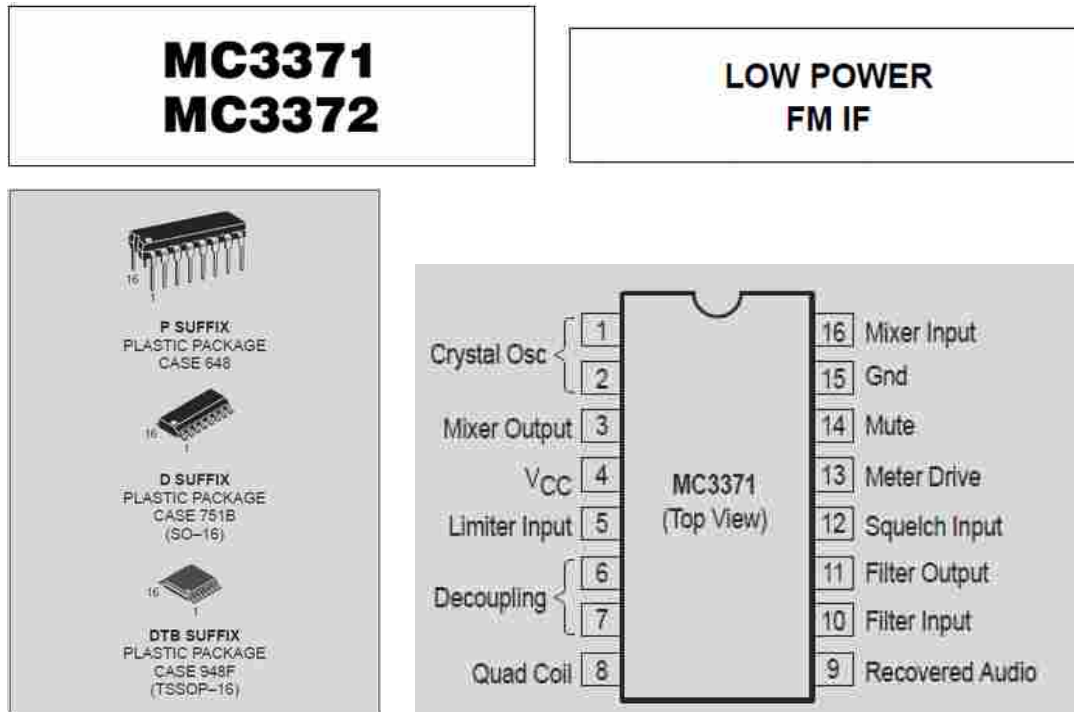


current. An AC generator spins a coil of wire between the two poles of a magnetic field. It doesn't matter which one is moving. The coil or the magnet can be moving. Any moving magnetic field can induce current in another coil. It doesn't have to be a piece of metal we call a magnet. Imagine a moving magnetic field produced by AC circulating in and out of a coil. If that moving magnetic field passes through a second nearby coil, it will induce an alternating current in the second coil. A transformer uses this method to work. Transformers have a continuous iron core running from the inside of one coil through the inside of the second coil to confine the magnetism inside the iron core. This makes the transformer

nearly 100% efficient since only a little of the magnetic energy escapes.

Page 3 of 74

file://C:\Program Files\Trellian\basicantennas.htm 7/17/2007



A straight wire that has an AC current flowing through it also has a magnetic field surrounding it. But it is a weaker field than is produced by a coil. The magnetic field from the wire radiates out into space and becomes weaker with distance. The radiating magnetic field from a wire is known as "electromagnetic radiation" and a radio wave is one type of it. The wire that radiates becomes the transmitting antenna.

Some distance away, a second wire in the path of these waves has current induced into it by the passing electromagnetic waves. This second wire will be the receiving antenna. The voltage in the receiving antenna is many times weaker than the voltage in the transmitting antenna. It may be as weak as onemillionth of a volt or less and still be useful. The receiving antenna feeds that voltage to the amplifiers in

the receiver front-end where it is amplified many thousands or millions of times. The dipole antenna is made of a wire broken in the center and where broken, each half of the wire connects to an insulator that divides the wire in two. Two wires from the voltage source, which is the transmitter, are connected across the insulator. On one side of the dipole, the current in the form of moving electrons flows first from the voltage source toward one end of the dipole. At the end, it reflects toward the voltage source. The same thing occurs on the other half of the wire on the other half cycle of alternating current. An antenna that is the right length for the current to reach the far end of the wire just as the polarity changes is said to be resonant. Because electricity travels at 95% the speed of light in a wire, the number of times the polarity changes in one second (frequency) determines how long the wire has to be in order to be resonant.

III. POLARIZATION OF ELECTROMAGNETIC WAVES



Electromagnetic waves travel away from the wire in horizontal, vertical, slanted, or circular waves. If the antenna wire runs horizontal or parallel to the earth, the radiation will be horizontally polarized. A

wire or conductor that runs at right angles to the earth produces vertical radiation.
A slanted wire has
components of both horizontal and vertical radiation. Crossed wires connected by
proper phasing lines
that shift the phase from one wire to the other wire by 90 degrees will produce
circular polarization.

@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@@