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Understanding Antennas For The Non-Technical Ham

A Book By Jim Abercrombie, N4JA

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It is HUGE!

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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,

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

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 elses. 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 doesnt 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

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

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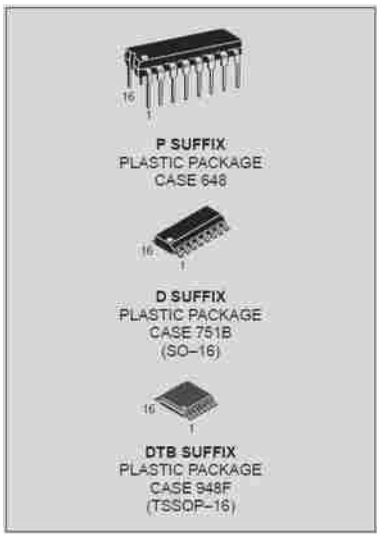

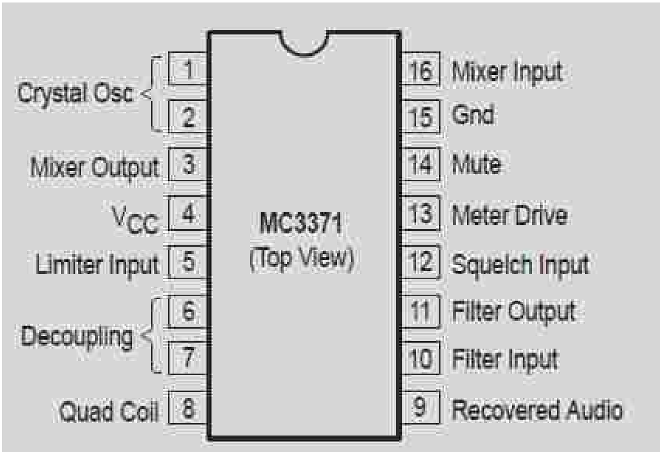

A straight wire that has an AC current flowing through it also has a magnetic field surrounding it. But it
is a weaker field than is produced by a coil. The magnetic field from the wire radiates out into space and
becomes weaker with distance. The radiating magnetic field from a wire is known as "electromagnetic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

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