Don Lancaster's

RESOURCE BIN

number ninety one

A collection of antenna resources.

Our usual reminder here that the *Resource Bin* is now a two-way column. You can get tech help, consultant referrals and off-the-wall networking on nearly any electronic, *tinaja questing*, personal publishing, money machine, or computer topic by calling me at (520) 428-4073 weekdays 8-5 Mountain Standard Time.

Be certain to frequently check out my new *Guru's Lair* web site you'll find at (where else?) *www.tinaja.com* This is the place you'll go for instant tech answers. Among the many files in our library, you will find complete reprint sets for all of the *Resource Bin* and other columns. Plus a brand new Research InfoPack Service.

You will get the best results if you have both *Netscape Communicator* and *Acrobat Reader 3.0* installed.

Some Antenna Resources

An *antenna* is any method of getting electromagnetic energy to go between guided and free space propagation. The guided end can be a waveguide, a transmission line, fiber optics, or any other type of "wire". The object of the game is to get as efficient a coupling between the media as possible.

There are many important ways to measure antenna performance. Your *gain* is how strong the intended signal appears compared against a standard antenna pattern such as a *dipole* or an *isotropic radiator*. The *bandwidth* is the range of operating frequencies over which the antenna is useful. Antennas usually have to get carefully *tuned* or *matched* to frequencies of interest.

The *pattern* of an antenna is a plot of its sensitivity in various directions. A tv satellite receiver demands a very narrow and a carefully aimed pattern, while a GPS nav antenna has to cover the entire sky. Television transmitters send most power horizontally, giving an *effective radiated power* typically five times higher than actual rf input.

An antenna pattern is intentionally created by the number and position of its elements. Patterns are also affected by the proximity to ground, to nearby reflectors, and to other conductors.

The *SWR*, or *Standing Wave Ratio* is a measure of how well the antenna does its job. On a transmitter, SWR is a comparison of your transmitted to reflected power. A SWR of one is ideal and has no reflections.

The *field strength* is the measure of how strong a received signal is. Often expressed as *microvolts* on the wire or *microvolts per meter* in free space. The *signal to noise ratio* is the measure of how strong the received signal will be compared to noise levels in the same effective bandwidth.

A minimum of 20 decibels of S/N is needed for quality FM reception. Data comm should need something around eleven decibels for decent error rates. By going to special *spread spectrum* or *phaselock* techniques, the signals may sometimes be extracted that are much weaker than the noise that happens to be present. Our GPS nav or planetary comm are two important examples.

Typical noise is either terrestral or atmospheric at lower frequencies and inherent *"ktb"* resistive noise at the higher ones. Your *noise figure* of an input stage is a measure of how much noise will get unavoidably added to an antenna's received signal. Noise figures do become quite important at VHF and microwave frequencies. But they're often of little concern at lower frequencies where interference from power lines, storms, and automotive ignition dominate.

NEXT MONTH: Don looks into some new PostScript adventures.

That *characteristic impedance* of an antenna is a measure of its equivalent electrical resistance at frequencies of interest. Most antennas are *matched* to an impedance of 50 or 72 Ohms.

Television twinlead is 300 Ohms, while the usual free space impedance is equal to 377 Ohms.

Usually, the much smaller *radiation resistance* has to be transformed to the desired impedance. Such matching can get done using tuning inductors and capacitors; with transmission line stubs; or else by a *balun* or other high frequency transformer.

The *directivity* of an antenna is the ratio of your gain in its front and rear directions. Most antennas have one or more deep *nulls* where little signal is sent or received. These can sometimes be chosen to reduce interference from other stations on the same frequency.

The *effective height* of an antenna is a comparison against any quarter wave vertical radiator. The *actual height* of any antenna is simply how far it sits above the ground. At VHF, a line of sight is always needed for your best comm, so the higher the better.

Let's look at a few more important antenna resources...

ARRL

Otherwise known as the *American Radio Relay League*, their superb *Radio Amateur's Handbook* is your essential starting point to pick up most antenna fundamentals.

Their website is *www.arrl.org*.

The ARRL also offers a number of antenna specific publications. Their most important of which is the *ARRL Antenna Book* and its companion CD.

Other pubs include...

ARRL Antenna Book & CD
Antenna Compendiums (5 vols)
Antenna Experimenter's Guide
Antenna Impedance Matching
Electronic Smith Chart Applications
HF Antenna Collection

HF Antennas for all Locations
MicroSmith V2.3 Simulator
ON4UN's Low Band DXing
Physical Design of Yagi Antennas
Practical Wire Antennas
Radio Amateur's Handbook
Transmission Line Transformers
Vertical Antenna Classics
Wire Antenna Classics
Your Guide to Propagation
Your Ham Antenna Companion

More details on these titles appears on their website. For easy browsing, use *www.tinaja.com/amlink01.html*

Other Antenna Books

That *Antennas* by John Kraus in the McGraw Hill E. E. series probably remains your single most important technical antenna reference. Another major publisher of antenna books is *Artech House.*

Here's my choice of useful antenna books from major publishers...

AM Broadcast Station Antennas
Antenna Design: Practical Guide
Antenna Engineering Handbook
Antenna Theory, Analysis & Design
Antenna Theory and Design
Antenna Toolkit
Antennas
Antennas for Nonsinusoidal Waves
Arrl Antenna Book
Integrated Active Antennas
Limited Space Shortwave Antennas
Microstrip Antenna Design
Mobile Antenna Systems Handbook
Modern Antennas
Phased Array Antenna Handbook
Practical Antenna Handbook
Practical Wireless Comm Antennas
Radio Amateur Antenna Handbook
The Right Antenna
Treatise on Electricity & Magnetism
Yagi Antenna Design

Additional details on these titles at *www.tinaja.com/amlink01.html*

Antennax and Friends

This is a fee based web ezine found at *www.antennax.com* Cost for a year is $24, while $38 also gives you access to a 450 article backlist. They also have dozens of freebie sample files on their website. I am not a subscriber. You can form your own opinion as to the quality of their offerings.

Other web antenna resources are...

rec.radio.amateur.antennas
sci.electronics.design
sci.physics.electromag
uk.radio.amateur

IEEE Publications

The most important scholarly pubs on antennas usually arrive from the IEEE. Especially their *Antennas and Propagation* special interest group who publishes both their highly technical *transactions* and a informal *magazine.*

Their website is *www.ieee.org* More IEEE resources which might touch on antenna topics include *Broadcasting, Microwave Theory & Techniques,* and *Consumer Electronics.*

Many of these publications can be found in larger technical libraries. Or gotten through the *Dialog* or *INSPEC* commercial services.

More Mags

A lot of antenna info gets buried in non-antenna specific magazines. Such as these ham and popular titles...

73
Amateur Radio
Car Audio and Electronics
CB Radio
CQ
DX Listening Digest
DX Monitor
Electronics Now
Mobile Comp & Comm
Nuts & Volts
Popular Communications
Popular Electronics
QST
Radio & Communications
Wavelength
World Radio
W5YI Report

There are also these rf and microwave trade journals...

Applied Microwave and wireless
Electrotechnology
GPS world
ITS world
Microwave Journal
Microwave Product Digest
Microwaves and Optical Tech Ltrs
Microwaves & rf
Mobile Electronics Monitor
Mobile Electronics Retailer
Mobile Radio Technology
Mobile & Wireless Internet
Personal Technologies
Portable Design
Radio Science
RF Design
Telecomm & Radio Engineering
TWICE
Wireless Data News
Wireless Design & Devlopment
Wireless Technology International
Wireless Week

SOME USEFUL ANTENNA RESOURCES

AntenneX
PO Box 72022
Corpus Christi TX 78472
(361) 855-0250
www.antennex.com

Applied Mwave & Wireless
2245 Dillard Street
Tucker GA 30084
(770) 908-2320
www.noblepub.com

ARRL
225 Main St
Newington CT 06111
(203) 666-1541
www.arrl.org

Artech House
685 Canton St
Norwood MA 02062
(800) 225-9977
www.artech-house.com

Broadcasting & Cable
245 W 17th St
New York NY 10011
(212) 645-0067
www.broadcastingcable.com

Broadcast Engineering
9800 Metcalf Ave
Overland Park KS 66212
(913) 341-1300
www.broadcastengineering.com

CB Radio
76 N Broadway
Hicksville NY 11801
(516) 681-2922
www.electronicservicing.com

CQ VHF
76 N Broadway
Hicksville NY 11801
(516) 681-2922
www.electronicservicing.com

Denon
222 New Road
Parsippany NJ 07054
(201) 882-7449

Electronics Now
500-B Bi-County Blvd
Farmingdale NY 11735
(516) 293-3000
www.gernsback.com

Global Communications
6300 S Syracuse Way #650
Englewood CO 80111
(303) 220-0600
www.intertec.com

GPS World
859 Willamette St
Eugene OR 97440
(503) 343-1200
www.gpsworld.com

IEEE
445 Hoes Ln
Piscataway NJ 08855
(908) 981-0060
www.ieee.org

ITS World
859 Willamett St
Eugene OR 97401
(541)343-1200
www.gpsworld.com

Microwave Journal
685 Canton St
Norwood MA 02062
(781) 769-9750
www.artech-house.com

Microwave/Optical Ltrs
605 Third Ave
New York NY 10158
(212) 850-6088
www.wiley.com

Microwave Product Digest
34 Evergreen Pl
Tenafly NJ 07670
(201) 568-1101
www.mpdigest.com

Microwaves & RF
611 Rt #46 West
Hasbrouck Heights NJ 07604
(201) 393-6060
www.penton.com

Mobile & Wireless Internet
52 Foundling Ct
London, WC1N 1AN UK
44 (0) 171 837 0815
www.t-media.com

Mobile Computing & Comm
6420 Wilshire Blvd
Los Angeles CA 90048
(310) 589-3100
www.mobilecomputing.com

Mobile Electronics Monitor
2500 Wilson Blvd
Arlington VA 22201
(703) 907-7646
www.cemacity.org

Mobile Electronics Retailer
21061 S Western Ave
Torrance CA 90501
(310) 533-2400
www.mermag.com

Mobile Radio Technology
PO Box 12901
Overland Park KS 66212
(913) 341-1300
www.intertec.com

Personal Technologies
175 Fifth Ave
New York NY 10010
(800) 777-4643
www.springer-ny.com

Popular Communications
76 N Broadway
Hicksville NY 11801
(516) 618-2922
www.electronicservicing.com

Popular Electronics
500-B Bi-County Blvd
Farmingdale NY 11735
(516) 293-3000
www.gernsback.com

Portable Design
1421 S Sheridan Rd
Tulsa OK 74112
(918) 835-3161
www.portabledesign.com

QST
225 Main St
Newington CT 06111
(203) 666-1541
www.arrl.org

Radio Science
2000 Florida Ave NW
Washington DC 20009
(800) 966-2481
www.agu.org

Radio World
5827 Columbia Pk #310
Falls Church VA 22041
(703) 998-7600
www.imaspub.com/rw.html

RF Design
5660 Greenwood Plz Blvd #350
Englewood CO 80111
(303) 793-0448
www.rfdesign.com

Synergetics
Box 809
Thatcher AZ 85552
(520) 428-4073
www.tinaja.com

Telecom & Radio Engineering
79 Madison Ave
New York NY 10016
(212) 725-1999
www.begellhouse.com

Television Broadcast
460 Park Ave 9th Fl
New York NY 11510
(212) 378-0400
www.tvbroadcast.com

TV Technology
5827 Columbia Pike #310
Falls Church VA 22041
(703) 998-7600
www.imaspub.com

TWICE
245 West 17th St
New York NY 10011
(212) 337-7003
www.twice.com

W5YI Reports
PO Box 565101
Dallas TX 75356

www.w5yi.org

What's New In Radio Comm
PO Box 289, Wahroonga
NSW AUSTRALIA 2076
61 2 9487 2700
www.westwick-farrow.com.au

Wireless Data News
1201 Seven Locks Rd
Potomac MD 20854
(301) 340-2100
www.phillips.com

Wireless Design & Dev
301 Gibraltar Dr
Morris Plains NJ 07950
(201) 292-5100
www.wirelessdesignmag.com

Wireless Satellite/Bdcst
214 Harvard Ave
Boston MA 02134
(617) 232-3111
www.igigroup.com

Wireless Technology Intl
6300 S Syracuse Way #650
Englewood CO 80111
(303) 793-0448
www.intertec.com

Wireless Week
600 S Cherry St #400
Denver CO 80222
(303) 393-7449

WorldRadio
2120 28th
Sacramento CA 95818
(916) 457-3655

Or these broadcast magazines...

Broadcast Engineering
Broadcasting and Cable
College Broadcaster
Global Communications
Radio World
Radio and Comm Technology
TV Technology
Television Broadcast
Wireless satellite & Broadcasting

"Miracle" Antennas

Maxwell's laws of electromagnetic behavior are well known and have been extensively explored. They get tested and retested in countless ways day in and day out. You can read all about them in any field theory book. My favorite remains the ancient *Fields and Waves in Modern Radio* by Ramo and Whinnery. Or you can actually read Maxwell himself in his readily available old *Treatiste on Electricity and Magnetism* replica volumes. But be forwarned that (A) all the partial diff math is hairy, and (B) his primitive notation makes it much worse.

These laws lead us to conclude that efficient antennas have to be around a quarter wavelength or so in size and that highly directional ones should be much larger. One crucial paper here

is Wheeler's *Fundamental Limitations upon Small Antennas* in the *Proceedings of the IRE* #35, pages 1497-1484.

As any conventional antenna gets smaller, the efficiency and radiation resistance both drop dramatically, the matching gets horrendously difficult, and the differences between your free space theory and the real world all get real ugly. Real quick like.

Yeah, the time is certainly ripe for antenna breakthroughs. By all of our newly discovered methods to analyze complex electromagnetics. By being newly able to more tightly integrate antennas with active electronics. By the expanded use of *interferometer*, holographic, and other large element array concepts.

By new *spread spectrum* comm that gives you much lower signal to noise ratios. And by those incredible new pulse radio schemes that we looked at in *www.tinaja.com/glib/muse137.pdf*

One new antenna approach I have been wanting to explore are ultra low frequency broadband arrays for cave finding and surface mapping. Pulse radio plus interferometry might make this newly possible.

The "miracle" antenna claims seem to be coming out of the woodwork. Everything from trucker's foil wound fluorescent lamps for defeating police radar down to way overpriced small capacitors which "convert your house wiring into a giant antenna".

The latter of which fails to pick up on the fact that the line borne noise nearly always goes up much faster than the signal does.

At least in any uncontrolled design.

Let's briefly look at three ongoing "miracle antennas" that may not end up being all they seem…

CFA Crossed Field Antenna– This is supposedly a rather small antenna particularly suited for hams and am broadcast transmitters. It purportedly applies a quadrature drive near field math trick to get far field results. In its decade long history, it seems to me to have been thoroughly discredited. But remains controversial to this day. The NAB even seems to have gotten sucked in on this fiasco.

CTHA Contrawound Torodial Helical Antenna– This one is another quite small antenna that is kinda hula-hoop shaped. Having two windings that go around in opposite directions. While their theory looks fairly good, there seems to be big time pattern and real world matching problems.

Fractal Antennas– These can be any self-similar or repeating element sets, but tend to apply *Serpinski* triangles, *Koch* curves, and other fancy 2-D or 3-D fractal math patterns. Modest size and pattern improvements over more traditional designs do actually appear possible. But hype abounds.

I've sure gotten a lot of email from highly vocal ham CFA proponents. They genuinely believe they are on to something. But if I replace the words " CFA antenna" and "field strength" with "carburetor" and "more miles per gallon", I always seem to end up with classic "looks like a duck - quacks like a duck" urban lore pseudoscience. I'd give more believability to *one* decent math paper and any *one* professional antenna range pattern measurement than I would to hundreds of stories about a QSL in Lower Tobonga.

Even a rusty bedspring will radiate.

What discourages me the most is the utter lack of any commercial CFA interest in an old concept. Other than its few early proponents

There is one "miracle" antenna that sure works well, though. And it has been around for years and years. And that is to hang a big old resonant loop near an AM receiver for long distance night reception.

It turns out the properties of any antenna can be greatly improved by carefully placing a resonator near it. At higher frequencies, these are called *directors* when they'll go in front and *reflectors* if they go behind your main antenna. At any rate, just get a three foot vertical wooden or plastic form and wind several dozen turns of wire around it. Then resonate it with a stock 365 pf variable capacitor. Put it within a foot or two of your radio and tune it for its maximum pickup. There will be an axis null, so you may have to rotate it as well.

More details on miracle antennas in *www.tinaja.com/glib/muse138.pdf*

And lots more on pseudoscience in *www.tinaja.com/pseudo01.html*

FM DX

I live fairly deep in a valley in a rather remote area, so it is a challenge to pick up decent FM stations. After a lot of experimentng, I ended up with a boosted and high roof mounted 10 element *Yagi* array combined with a better grade *Dinon* receiver that you can reduce the IF bandwidth on.

Favorite 120 mile distant stations such as KDKB in Phoenix or KXCI in Nogales Junction come in just fine.

Note that a "booster" cannot boost what is not there. Yes, they can make signals stronger, but they'll only make the signal to noise ratio worse.

Boosters also create fake signals by aliasing strong local stations. And do have an annoying habit of blowing up during lightning season.

More details on distant FM DX in *www.tinaja.com/glib/hack86.pdf* A great list of FM stations is up on the web at *wmbr.mit.edu/stations/locate.html* You use this fine service for trip planning or DX logging. You might even make a glove compartment book out of the places you are likely to travel often.

For More Info

Additional antenna info is found in *www.tinaja.com/glib/muse138.pdf* You can find details on most any antenna (or other) mag by using the OXBRDG button on my *www.tinaja.com* website or else by using *www.mediafinder.com* Similarly, antenna sites are quickly found by using my HOTBOT, ALTA, or INFER buttons.

Use the THOMAS button for names and addresses of manufacturers, or that new QUEST button for most any semiconductor data sheet or ap note. Or try that DEJA button to see who is posting what to the newsgroups.

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Other products and services appear in my nearby *Synergetics* ad. ✦

Microcomputer pioneer and guru Don Lancaster is the author of 35 books and countless tech articles. Don maintains his no-charge US tech helpline found at (520) 428-4073, besides offering all of his own books, reprints, and consulting services. Don also offers free catalogs of his unique products and electronic bargains. The best calling times are 8-5 weekdays, MST.

Don is the webmaster of his Guru's Lair found at http://www.tinaja.com

Full reprints and preprints of all Don's columns and ongoing tech support appear here. You can reach Don at Synergetics, Box 809, Thatcher, AZ 85552. Or send any messages to don@tinaja.com