NCJ

NATIONAL CONTEST JOURNAL

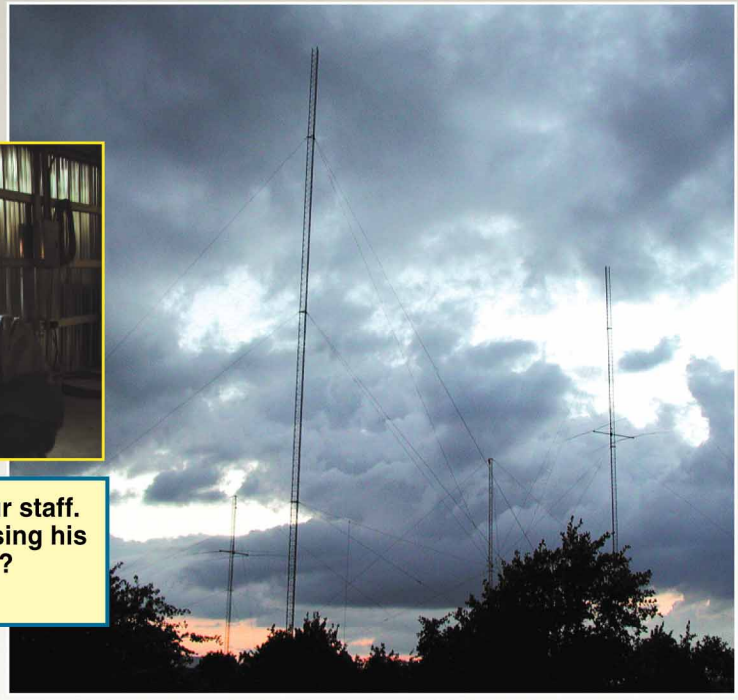
$4

November/December 2001

Volume 29 Number 6

- Getting It Right for the First Time—A Station Builder Confesses his Addiction
- Elmer's Still Alive—and Contesting
- Some Notes on Two-Element Horizontal Phased Arrays—Part 1
- *NCJ* Profiles: NØAX

Visit our Web Site: www.ncjweb.com



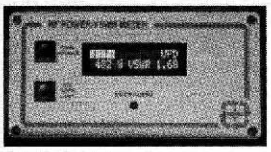
A mysterious new columnist has joined our staff. In this issue he kicks things off by confessing his addiction. Just who is this shadowy figure? Tune in next time and find out!

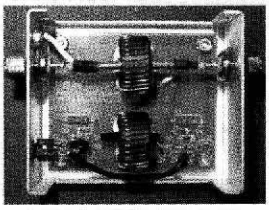
NCJ: The National Contest Journal
American Radio Relay League
225 Main Street • Newington, CT 06111-1494

RF Applications, Inc

- Vacuum Fluorescent Display
- 2,955 and 5000 Watt HF Version
- 300 Watt VHF Version
- 65 Element Bar graph—Better than a meter!
- Settable VSWR Alarm
- VSWR Alarm Relay Option
- RF Power Monitor Option
- Vanity Option (Callsign)
- Remote Sensor
- 12 VDC Operation
- Specifications Page

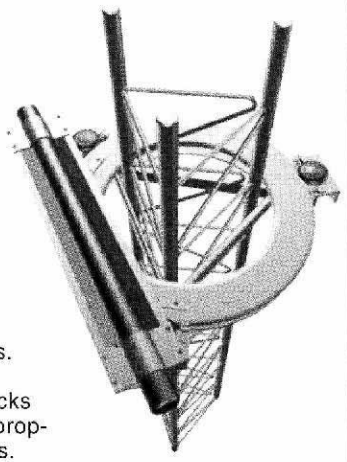
The VFD's display holds your peak PEP for about two seconds after you stop transmitting.





We use large ferrite cores that will not saturate at legal power levels. Shielding between the two cores is provided by a spot-welded plate on the cover of the sensor.

TIC RING RINGROTOR



The TIC Ringrotor offers ham operators the ability to have true "On the Tower" control of single or multiple antenna arrays for a full 360' of rotation-guaranteed!

Array Solutions is the authorized dealer for TIC Ringrotors. We work closely with TIC-General to make sure our stacks on your tower are integrated properly and turn without problems.

We have three models to chose from:

TIC 1022D Maximum Tower Face Width 18½ inches
Maximum Leg Diameter 1½ inches

TIC 1032D Maximum Tower Face Width 28 inches
Maximum Leg Diameter 1½ inches

TIC 1048D Maximium Tower Face Width 40 inches

All can be driven with the new and improved Digital Controller.

Contact Array Solutions to discuss your specific requirements.

CAL-AV LABS, INC.

http://www.cal-av.com

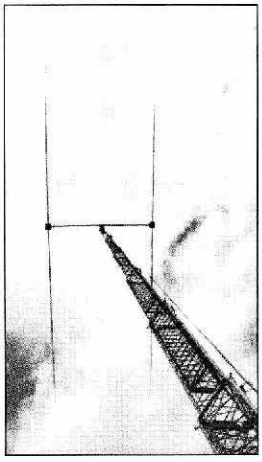
PERFORMANCE that well exceeds

Making a name for themselves with some very well-engineered, high-performance antenna products.

30 and 40 meter beams—2 full-size elements on a short boom that have performance that well exceeds a 2-element "shorty 40", and approaches a 3-element, full-size Yagi. Please see the patterns of these antennas at www.arraysolutions.com

30 and 40 meter rotary dipoles—full-size dipoles for higher performance than inverted Vs

Verticals VF series—1/4 wave, full-size verticals with heavy-duty bases



Contact Array Solutions to discuss your specific requirements.

RF switching, phasing and contesting products from

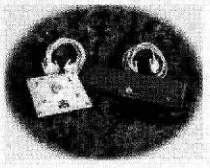
ARRAY SOLUTIONS

RATPAK—6 way remote antenna switch 5 kW continuous

Filters—Bandpass and BCB by W3NQN

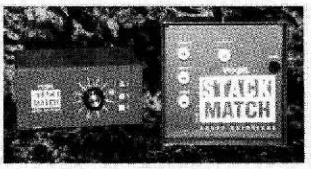
SCK—CW and Phone message keyer, and a lot more

SO2R Master—Finally a SO2R controller for high performance contesting



StackMaster—stack/phase up to 4 mono band antennas

StackMatch—the world's leader in stacking/phasing devices mono or Tribanders.



Towers and Accessories:
Full turnkey installations of your next tower

Antennas by
Cal-Av, Titanex, Bencher, Skyhawks, M2, Tennadyne

WX0B ARRAY SOLUTIONS

www.arraysolutions.com

Phone 972-203-2008 **FAX 972-203-8811**

Contesting products for the dedicated Contesters, DXing products for the deserving

WX0B ARRAY SOLUTIONS

CABLE X-PERTS, INC.

Connecting you to the World...™

November 2001 Featured Special

JAKE, suggests getting ready for the November Sweepstakes with 500 ft RG8X-Mini 95% Brd Black UV Resistant Jacket $69.95

For additional product details, please visit us on line at www.cablexperts.com

Shipping and handling applies to all products. Minimum order: $30.00 in product.
Prices subject to change without notice or obligation.
Sorry, No COD's. Illinois residents 8.25% sales tax added. This offer expires November 30, 2001

COAX (50 OHM"LOW LOSS")

	100FT/UP	500FT	1000FT
"FLEXIBLE" 9913 STRD BC CNTR FOIL + 95% BRAID 2.7dB@ 400MHz NC/DB/UV JKT	.60/FT	.58/FT	.56/FT
LMR 400 SOLID CCA CNTR FOIL + BRAID 2.7dB @ 450MHz WP/UV JKT	.64/FT	.62/FT	.60/FT
LMR 400 "ULTRA-FLEX" STRD BC CNTR FOIL + BRAID 3.1dB @ 450 MHz TPE JKT	.89/FT	.87/FT	.85/FT
LMR 600 (OD.590") SOLID CCA CNTR FOIL + BRAID 1.72dB @ 450 MHz WP/UV JK T	1.27/FT	1.25/FT	1.23/FT
LDF4-50A Andrew 1/2" Heliax® 1.51 db/1530 watts @450 MHz 450 MHz	2.38/FT	2.33/FT	2.25/FT

COAX (50 OHM "HF" GROUP)

	100FT/UP	500FT	1000FT
RG213/U STRD BC MIL-SPEC NC/DB/UV JACKET 1.2 dB/2500WATTS @ 30MHz	.40/FT	.38/FT	.36/FT
RG8/U STRD BC FOAM 95% BRAID UV RESISTANT JKT 0.9dB/1350WATTS @ 30MHz	.34/FT	.32/FT	.30/FT
RG8 MINI(X)95% BRAID UV RESISTANT JACKET 2.0dB/875 WATTS @ 30MHz	.18/FT	.16/FT	.14/FT
RG58A/U STRD CENTER 95% TC BRD UV RESISTANT JKT 2.6dB/350 WATTS @ 30MHz	.19/FT	.17/FT	.15/FT
RG223/U SOLID SC 2 95% BRD NC/DB/UV JKT 2.0 dB/600 WATTS @ 30 MHz	.69/FT	.62/FT	.56/FT
RG214/U STRD SC 2 95% BRD NC/DB/UV JKT 0.925 dB/2500WATTS @ 30MHz	.25FT/UP	1.75/FT.	
RG142/U SOLID SCCS 2-95% SILVER BRAIDS *Teflon®* JKT 8.2dB/1100WATTS @ 400MHz	.25FT/UP	1.75/FT.	

ROTOR & CONTROL CABLES

	100FT/UP	500FT	1000FT
5971 8/COND (2/18 6/22) BLK UV RES JKT. Recommended up to 125ft	.22/FT	.20/FT	.18/FT
1618 8/COND (2/16 6/18) BLK UV RES JKT. Recommended up to 200ft	.37/FT	.36/FT	.34/FT
1418 8/COND (2/14 6/18) BLK UV RES JKT. Recommended up to 300ft	.49/FT	.47/FT	.45/FT
1216 8/COND (2/12 6/16) BLK UV RES JKT. Recommended up to 500ft	.80/FT	.76/FT	.72/FT
1806 18GA STRD 6/COND PVC JACKET Recommended for Yaesu Rotors	.25/FT	.23/FT	.21/FT

ANTENNA & TOWER SUPPORT ROPE

	100FT	250FT	500FT	1000FT
3/32" DOUBLE BRAID *"POLYESTER"* 260# TEST WEATHERPROOF	7.95ea	15.95ea	25.95ea	44.95ea
1/8" DOUBLE BRAID *"POLYESTER"* 420# TEST WEATHERPROOF	10.95ea	20.95ea	35.95ea	63.95ea
3/16" DOUBLE BRAID *"POLYESTER"* 770# TEST WEATHERPROOF	15.95ea	30.95ea	50.95ea	90.95ea
5/16" DOUBLE BRAID *"POLYESTER"* 1790# TEST WEATHERPROOF	20.95ea	42.95ea	75.95ea	150.95ea

FLEXIBLE 2/COND RED/BLK DC POWER "ZIP" CORD

8GA (rated:40 amps)	50FT $24.50	100FT $44.50	250FT $107.50
10GA (rated:30 amps)	50FT $15.50	100FT $28.00	250FT $65.00
12GA (rated:20 amps)	50FT $10.50	100FT $19.00	250FT $42.50
14GA (rated:15 amps)	50FT $8.50	100FT $15.00	250FT $32.50

TINNED COPPER "FLAT" GROUNDING BRAID

1 INCH WIDE (equivalent to 7ga)	25FT $24.00	50FT $47.00	100FT $94.00
1/2 INCH WIDE (equivalent to 10ga)	25FT $14.00	50FT $27.00	100FT $53.00
1/2 INCH x 6FT Copper Plated Ground Rod w/clamp	$20.95/3 pk (sold in packages of 3 only)		

PL259

CONNECTORS

Made in USA

"N" Male

Both connectors fit 9913 types and LMR400 types MADE IN USA

PL 259 SILVER/*Teflon®*/GOLD TIP.....10PC $12.50.....25PC $27.50.....50PC $52.50....100PC $100.00
"N" (2PC) SILVER *Teflon®* /GOLD TIP...10PC $37.50.....25PC $87.50.....50PC $162.50..100PC $300.00

http://www.cablexperts.com

FAX: 847-520-3444 / TECH INFO: 847-520-3003

Se Habla Español

Ready-Made Coax Assemblies

with USA made Silver/Teflon® Gold Pin PL259 connectors.

FLEXIBLE 9913 strd BC cntr foil+95% braid 2.7dB 400MHz NC/DB/UV JKT. 200' $144.95 175' $126.95 150' $109.95 125' $93.95 100' $76.95 75' $60.95 50' $43.95 25' $26.95 15' $23.95 10' $20.95 6' $14.95 3' $13.95 1' $12.95

Available at Amateur Electronic Supply, Ham Radio Outlet & Ten-Tec

RG213/U strd BC Mil-Spec NC/BD/UV JKT. 1.2dB 2500 watts @ 30MHz. 200' $99.95 150' $77.95 125' $66.95 100' $55.95 75' $44.95 60' $38.95 50' $33.95 25' $22.95 15' $20.95 10' $18.95 6' $13.95 3' $11.95 1' $10.95

Available at Amateur Electronic Supply, Ham Radio Outlet & Ten-Tec

RG8/U strd BC foam 95% braid UV resistant JKT. 0.9dB 1350 watts @ 30MHz. 150' $71.95 125' $60.95 100' $49.95 75' $38.95 50' $27.95 25' $20.95 15' $18.95 10' $15.95 6' $13.95 3' $11.95 1' $10.95

Available at Amateur Electronic Supply, Ham Radio Outlet & Ten-Tec

RG8 MINI(X) strd BC foam 95% braid UV resistant JKT. 2.0dB/ 875watts@ 30 MHz. 150' $37.95 100' $29.95 75' $25.95 50' $22.95 25' $16.95 CLR JKT: 18' $14.95 12' $13.95 9' $12.95 6' $11.95 3' $10.95 1' $9.95 18' PL259-Mini UHF Fem & PL259. $23.95/ea.

Available at Amateur Electronic Supply, Ham Radio Outlet & Ten-Tec

With USA made Silver/Teflon®/Gold Pin male "N" connectors.

FLEXIBLE 9913 strd BC cntr foil+95% braid 2.7dB 400MHz NC/DB/ UV JKT. 150' $123.95 125' $104.95 100' $88.95 75' $73.95 50' $59.95 35' $49.95 25' $43.95 15' $35.95 10' $28.95 6' $18.95 3' $17.95 1' $16.95

Available at Amateur Electronic Supply, Ham Radio Outlet & Ten-Tec

With USA made Silver/Teflon®/Gold Pin PL259 to male "N"

FLEXIBLE 9913 strd BC cntr foil+95% braid 2.7dB 400MHz NC/DB/ UV JKT. 100' $80.95 75' $65.95 50' $48.95 25' $32.95 15' $29.95 10' $26.95 6' $16.95 3' $15.95 1' $14.95

Available at Amateur Electronic Supply, Ham Radio Outlet & Ten-Tec

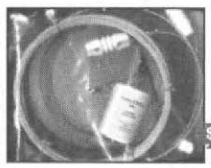
HT SOLUTION ASSEMBLIES

These jumpers will help improve the performance and life of your Hand Held Transceiver.
RG58A/U Group: 1ft R.A. SMA Male-SO239 (UHF Female) $16.95ea • 1ft R.A. SMA Male-"N" Female $15.95ea • 1ft R.A. SMA Male-BNC Female $15.95ea • 3ft R.A. SMA Male-PL259 $13.95ea **RG58/U Group:** 3ft R.A. BNC Male-SO239 (UHF Female) $15.95ea 3ft R.A. BNC Male-PL259 $14.95ea. **RG8X Mini Group:** 6ft PL259-BNC Male $10.95ea.

All connector terminations are soldered, Hi-Pot® tested @ 5kv for one minute, continuity checked, ultra violet resistant heat shrink tubing, and red protective caps, which can also be used as a boot.

Jake's Featured Products of the Month

G5RV Antenna
Work the HF bands (80-10 meters) inexpensively



$29.95

Coax Stripping Tool 8720ES
Quick and easy prep tool for coax, RG58/U, RG8X, RG213/U, 9913FX

$24.95

Please visit us on line at www.cablexperts.com

ORDERS ONLY:

800-828-3340

416 Diens Drive, Wheeling, IL 60090

Hours: M-F 9AM-5PM CST

Visit us on line at www.cablexperts.com for Discounts, Specials and our complete catalog

MasterCard VISA DISCOVER

Teflon® is a registered trademark of DuPont.

CABLE X-PERTS, INC.

The National Contest Journal
Volume 29 Number 6 Nov/Dec 2001

National Contest Journal (ISSN 0899-0131) is published bimonthly in January, March, May, July, September and November by the American Radio Relay League, 225 Main Street, Newington, CT 06111-1494. Yearly subscription rate is $20. Other rates are listed below. Periodicals postage paid at Hartford, CT and at additional mailing offices.
POSTMASTER: Send address changes to: National Contest Journal, 225 Main St, Newington, CT 06111-1494

Publisher
American Radio Relay League
225 Main Street, Newington, CT 06111
tel: 860-594-0200 • fax: 860-594-0259 (24-hr direct line)
Electronic Mail: *hq@arrl.org*
World Wide Web: *www.arrl.org/*

Editor
Dennis Motschenbacher, K7BV
4357 Appollonio Way, Carson City, NV 89704
editor@ncjweb.com

Assistant Editor
Carl Luetzelschwab, K9LA
1227 Pion Rd, Fort Wayne, IN 46845
assistanteditor@ncjweb.com

NCJ WWW Page
Bruce Horn, WA7BNM, Webmaster
www.ncjweb.com

ARRL Officers
President: Jim Haynie, W5JBP
Executive Vice President:
David Sumner, K1ZZ

Contributing Editors
Gary Sutcliffe, W9XT—Contest Tips, Tricks & Techniques
Paul Gentry, K9PG—*NCJ* Profiles
Jon Jones, N0JK—VHF-UHF Contesting!
Carl Luetzelschwab, K9LA—Propagation
Bill Feidt, NG3K—DX Contest Activity Announcements
Joe Staples, W5ASP—International Contests
Joe Pontek, K8JP—The Contest Traveler
Kenny Silverman, K2KW—Contest Expeditions
Wayne Matlock, K7WM—RTTY Contesting
Brian Kassel, K7RE—Contesting for Fun
Bruce Horn, WA7BNM—Contest Calendar
ARRL CAC Representative
Ned Stearns, AA7A
7038 E Aster Dr, Scottsdale, AZ 85254
aa7a@arrl.net
North American QSO Party, CW
Bob Selbrede, K6ZZ
6200 Natoma Ave, Mojave, CA 93501
cwnaqp@ncjweb.com
North American QSO Party, Phone
Bruce Horn, WA7BNM
4225 Farmdale Ave, Studio City, CA 91604
ssbnaqp@ncjweb.com
North American QSO Party, RTTY
Ron Stailey, K5DJ
504 Dove Haven Dr, Round Rock, TX 78664
rttynaqp@ncjweb.com
North American Sprint, CW
Boring Amateur Radio Club
15125 Bartell Rd, Boring, OR 97009
cwsprint@ncjweb.com
North American Sprint, Phone
Jim Stevens, K4MA
6609 Vardon Ct, Fuquay-Varina, NC 27526
ssbsprint@ncjweb.com
North American Sprint, RTTY
Wayne Matlock, K7WM
Rt 2, Box 102, Cibola, AZ 85328
rttysprint@ncjweb.com
Advertising Information Contact:
John Bee, N1GNV, ARRL; tel 860-594-0207;
fax 860-594-0259; *ads@arrl.org*

NCJ subscription orders, changes of address, and reports of missing or damaged copies should be addressed to ARRL, 225 Main St, Newington, CT 06111 and be marked ***NCJ* Circulation**. ARRL members are asked to include their membership control number or their *QST* mailing label.

Letters, articles, club newsletters and other editorial material should be submitted to *NCJ*,
4357 Appollonio Way, Carson City, NV 89704

The NA Sprint and NA QSO Parties are not sponsored by the ARRL.

Yearly Subscription rates: In the US $20; US by First Class Mail $28; Elsewhere by Surface Mail $32 (4-8 week delivery); Canada by Airmail $31; Elsewhere by Airmail $40

In order to insure prompt delivery, we ask that you periodically check the address information on your mailing label. If you find any inaccuracies, please contact the Circulation Department immediately. Thank you for your assistance.

TABLE OF CONTENTS

NCJ Advertising Index

Editorial

Dennis Motschenbacher, K7BV

This is the first issue of the *NCJ* to come out since the terrible events in New York City, Washington DC and Pennsylvania that have forever changed all of our lives. I have been searching for days for just the right words to begin this editorial, and somehow find a way to put Amateur Radio contesting in proper prospective in this new world that we are now finding ourselves in as we wake up each morning. But no words have come. So here now—at 4 AM—just a few short hours before I have to board a plane for a business trip to Brazil, I am forced to simply start typing and see what flows from within.

I am a strong proponent of the idea that the best thing that we as Americans can do now—for both themselves and our Nation—is exactly what I'm about to do. I'm going to move forward and put completing the task of meeting my everyday responsibilities ahead of the horror that I feel over the events of that Tuesday morning. I imagine that taking the time to turn through the pages of this issue of *NCJ* might be a small part of your effort to do so as well.

September 2001 NA SSB Sprint Canceled

Out of respect for the tens of thousands of lives that were so deeply affected by what occurred just a few days before its scheduled dates, this year's September North American SSB Sprint was canceled. This particular running will not be rescheduled, but we certainly look forward to hearing many familiar and hopefully some new voices during the upcoming February 2002 SSB Sprint.

The Winter Contest Season is Upon Us

The long awaited winter contest season has arrived, and there are still plenty of sunspots around to enhance our fun. I hope that you all reap the rich rewards of the many hours that you've spent making preparations for the upcoming competitions—*Good Luck and Have Fun!*

Cabrillo

Elsewhere in this issue, you'll find an update on the ARRL's progress with the implementation of a standardized electronic log submission format. See: "Logs and Robots and Cabrillo… *Oh My!*" by ARRL Contest Branch Manager Dan Henderson, N1ND. Dan provides us with a behind-the-scenes look at the role that Cabrillo is playing in improving the speed, accuracy and efficiency of the League's contest log processing procedures.

NCJ Assistant Editor

I am delighted to announce the appointment of Carl Luetzelschwab, K9LA, as Assistant Editor of the *NCJ*. Carl has been a long-time columnist for this magazine, and over the years his material has helped many of us greatly expand our understanding of radio propagation.

I created this new position—and put Carl in its driver seat—for a number of reasons. His primary responsibility will be the same as mine: keep the *NCJ* fresh and full of new and informative content. Carl is a real taskmaster, and that's a trait that I intend to take full advantage of as we chase down sources for feature articles and seek ideas for new columns.

Perhaps an even more important role for Carl will be that he'll be able to provide me with a second prospective on contesting—and on you, the people we serve. I am acutely aware of the dangers of running a one-man show, and I believe that the two of us—working as a team—will be better able to move forward with the ever ongoing evolution of this magazine.

His wife Vicky, AE9YL, has always supported Carl's love for DXing and contesting—as these are passions that they share. I'm hoping that we'll see an occasional article from her. There are far to few women that have discovered and embraced competitive radiosporting. I'm sure you'll agree that K9LA is one very fortunate OM!

New Columns and Columnists

I would say that the single most enjoyable aspect of my editor job is taking an idea—frequently one that's been provided by a loyal reader—and turning it into an ongoing flow of information—a regular column. The last few months have taken me down many paths as I've been seeking out qualified individuals who can grasp concepts and do what's necessary to develop them into columns. I am pleased to say that I have recently had a great deal of success in this endeavor—thanks entirely to the volunteer spirit that has always been the backbone of the *NCJ.*

One reader in particular, Ken Harker, WM5R, must be commended for his unselfish efforts to grow the usefulness of the *NCJ*. He is—in many ways—my "perfect reader," as he feels free to not only offer constructive criticisms of the magazine, but has also taken measures to personally help improve it by contributing articles and ideas. Two of his suggestions have been used to develop new columns that will be premiering soon. We all thank you, Ken.

Contesting on a Budget

Few of us are able to enjoy the contesting side of radiosporting with the benefit of an unlimited amount of money to feed our unquenchable desire for *More Toys*! Instead, we must find innovative ways to be competitive without the latest cutting-edge equipment and massive antenna farms. We may have to settle for compromises, but—then again—we may also be the ones getting the most satisfaction out of our occasional triumphs. No one can argue—we try harder!

Paul Schaffenberger, K5AF (formerly KB8N), is going to collect ideas and suggestions from near, far and abroad that will help those of us on a budget enjoy contesting just as much as those who are in a position to spread more "green" around the shack. Paul will introduce his new "Contesting on a Budget" column in our next issue. I am sure that he would love to start receiving input and ideas from you today—why not drop him a note? You can reach him by e-mail at **PaulKB8N@aol.com**.

NCJ Profiles

After several years of faithful dedication to the *NCJ*, Ward Silver, N0AX, is retiring his post on our staff in favor of other pursuits. I'm sure you agree that he has a done a fantastic job of delivering a nonstop flow of profiles on the folks behind those well-known call signs that we hear tearing up the bands on contest weekends. He has done a wonderful job of putting a face and personality on those call signs. We have all enjoyed the many things these profile subjects have shared with us through his column.

Paul Gentry, K9PG, has been writing a similar column for another contest-oriented magazine and has decided to join us and carry on where Ward has left off. Paul's decision to join the *NCJ* staff assures that we can all look forward to a seeing many new and entertaining profiles appearing in future issues.

Tom Taormina, K5RC—last issue's "Profiles" subject—turns the tables on Ward and "special guest stars" as this episode's "Profiler." Paul will assume the helm next time.

Contest DXpedition News

Steve Nace, KN5H, our "Contest DXpedition List" columnist, regrettably has to make more time available for work responsibilities (he's helping an emerging company through some challenging times). We thank him for the excellent work that he's done for us over the last year.

We have been very fortunate to have Bill Feidt, NG3K, step in and take on the job of providing us with up-to-date listings on DXpeditions that are planned for contest weekends. Our goal with this column has always been to try to help prevent two or more parties from arriving on some rare rock in the middle of some ocean only to find another group already there bracing themselves for the start of a contest. We're confident that this listing, now retitled "DX Contest Activity Announcements," will continue to do just that.

Our Cover—A Mystery Columnist Makes His Debut

A mystery columnist makes his debut in this issue of the *NCJ*. Read his article—titled "Getting It Right for the First Time—A Station Builder Confesses His Addiction" and see if you can guess the identity of this well-known addition to our columnist staff.

Above I introduced a column devoted to contesting on a budget. Just because the majority of us have to contest on a budget does not mean we do not love to visit those stations that seem to be beacons on the band—with impressive signals and contest results to match.

Many of these stations have had a role in producing the technology that we all use today—even in our modest stations. In future issues, our mystery columnist is going to fill you in on the details of some of these stations, introduce you to their builders and fill you in on any innovations that they may have contributed to our hobby. I suspect that we shall see the writer of this column emerge from the shadows soon… ■

Some Notes on Two-Element Horizontal Phased Arrays—Part 1: The Limits of Performance

L. B. Cebik, W4RNL
1434 High Mesa Drive
Knoxville, TN 37938-4443
cebik@cebik.com

The directional 2-element horizontal phased array achieved notoriety in the 1950s with builder claims that one or another variation on the basic design outperformed 3- and even 4-element Yagis. Although we now know that the appearance of high performance owed much to Yagi deficiencies of the period, horizontal phased arrays have retained much of their mid-century aura of magic. Since magic and an understanding of antennas are mutually exclusive, perhaps we should begin again.

The notes in this series will begin with some basic modeling data that tends to set limits to the performance expectations that we may logically have of 2-element phased arrays. In the second part, we shall explore the degree to which the geometry of the parasitic array can capture the potential of phased element performance. Part 3 will examine one of the two classic methods of array phasing: the ZL-Special with its single phase line. In Part 4, we shall look at two different ways of phasing a pair of elements using element-matching techniques, one by R. Baumgartner, HB9CV, the other by Eric Gustafson, N7CL. Throughout we shall try to integrate specific design strategies into an overall picture of the performance of which 2-element phased arrays are capable.

A Few Preliminaries

The idea of a 2-element phased array contains an ambiguity. At the most general level, the notion can refer to the relative phasing of the elements in any 2-element array. Under this heading, we may include arrays with a single driven element as well as two driven elements. The perspective offered by this most general idea of a phased array will be useful in seeing where some antennas fit into a larger picture.

Alternatively, the concept of a 2-element phased array often refers specifically to an "all-driven" antenna, that is, to an array in which both elements receive power directly from the source. The key question that immediately arises within this view of phased arrays is how we may get energy to the individual elements in the correct magnitude and phase to effect a desired set of performance characteristics. The most common means is via a "phasing line" composed of a length or lengths of transmission line. Indeed, this means of conveying energy from the array source to the individual elements has been the basis of numerous misconceptions about how phased arrays operate.

The phasing-line system of energy transfer, of course, is quite unnecessary. As Brian Egan, ZL1LE, demonstrated with a 15-meter phased array in the 1990s, one may create a phasing network of lumped components and then use separate lines to each element so long as they preserve the relative values of current magnitude and phase created by the network.

The key to understanding 2-element horizontal phased arrays is the fact—stressed by Roy Lewallen, W7EL, in many writings—that the relative current magnitude and phase angle between the two elements determines the operating characteristics of the antenna. In the early days of phased-array popularity, most builders thought in terms of the impedance transformation along a transmission line linking the elements. However, the impedance along a mismatched line does not track with the current magnitude and phase transformations along the line. Impedance values repeat on a lossless line twice for each wavelength of line. However, current magnitude and phased values appear only once per wavelength.

From this misunderstanding others emerged. Although the most popular line lengths interconnecting elements were in the vicinity of $^1/_8$ λ, most folks thought in terms of a 135° phase shift. However, with or without a half twist in the short line, the current can only make an approximate 45° phase shift. (The number is a crude marker, since we have already noted that the current phase may change more or less than 45° in a line that is 45° long.) If a straight line yields a 45° phase shift in current, then a line with a half twist yields a –45° phase shift. Antenna patterns may be identical to those produced by feeding the elements 135° out of phase, but the current behavior and the consequences for evaluating means of obtaining the correct phasing of the elements will depend upon the –45° perspective. Because we shall be looking at close-spaced element systems, we shall adopt this orientation throughout these notes.

A further constraint upon our understanding of 2-element horizontal arrays has been the magic associated with $^1/_8$-λ spacing. In fact, no particular spacing between elements holds any theoretically superior place in the scheme of 2-element arrays. We shall discover that in some respects, almost any spacing will do, although specific spacings between elements can result in arrays that are easier to implement.

A Modeling Project

In a number of past articles, I have presented a partial portrait of phased array performance potentials, for example, in my series on log-cell Yagis (see "The Monoband Log-Cell Yagi Revisited" Parts 1 through 4, *NCJ* Jan/Feb 2000 through Jul/Aug 2000). In the remainder of this first set of notes, I want to expand our appreciation of phased array performance parameters, although space will not allow an absolutely complete account.

Figure 1 presents the basic parts of a 2-element phased array as we shall model it in *NEC-4*. We shall assign to each element a current source, specifying both the magnitude and phase angle. By convention, the designated forward element will have a current magnitude of 1.0 and a phase angle of 0.0°. The designated rear element will then be assigned the values of current magnitude and phase that yield a desired performance limit. Since we are working with directional arrays with a single main forward lobe, the forward element will always be the element in the direction of that lobe. Assigning separate values of current magnitude and phase angle to each element is an analog of what we accomplish with a phasing network. Such networks cannot yield perfp.!ance that exceeds the limits of separate sources

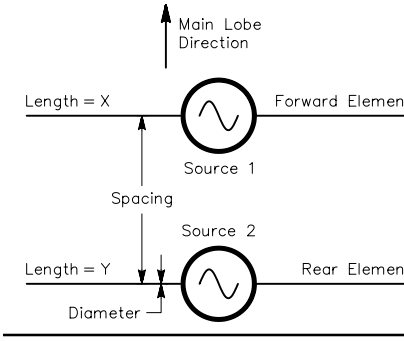


Figure 1—The basic parts and structural variables of a 2-element horizontal phased array.

for each element, no matter the ingenuity of the system.

For the notes in this section, we shall reduce the total number of variables to a manageable number. We shall vary the spacing between elements systematically. We shall also examine some variations in element length, using both equal-length and unequal-length elements in the study. However, these results will change if we alter the diameter of the elements. For convenience, we shall employ 10-meter (28.5-MHz) elements made from 0.5-inch diameter aluminum. These elements give us a reasonably realistic model that scales easily to other amateur bands. With a fixed element diameter, we shall not explore variations that result from selecting other diameter materials.

When exploring sources with a relative phase angle between 0 and –90°, we must simulate the line half twist by setting up the model elements in opposite directions. That is, if the forward elements extend from a – value to a + value, then the rear element extends from a + value to a – value. Adhering to this modeling scheme keeps the instantaneous current directions correct.

The basic element for our exploration is a resonant dipole of the specified material. In a *NEC-4* model, such a dipole is 197.6 inches long or about 0.4771-λ long at 28.5 MHz. (The 1/2-inch diameter element is 0.001207-λ across.) The subject dipole has a resonant impedance of 72.1 + *j*0.5 Ω. Now we are finally ready to examine a 2-element phased array.

Maximum Front-to-Back Ratio Configurations

The basic model consisted of two self-resonant dipoles of the type just described set at various distances apart. The spacing ranged from 0.05-λ to 0.2-λ in 0.025-λ increments. This range covers—with some interesting but practically useless excess—the element spacing used in virtually all recorded directional phased array construction.

In addition to using equal-length self-resonant elements, I also made up pairs that are 10% shorter and 10% longer than the basic model. The short elements are 177.84 inches long (0.4294-λ), while the long elements are 217.36 inches long (0.5249-λ). As we shall see, resonance is not a requisite for a phased pair of elements. (We shall look at unequal-length elements soon.)

The first exercise attempted to arrive at the rear element relative current magnitude and phase angle necessary to achieve a maximum 180° front-to-back ratio. Although the pursuit of a perfect null can go on indefinitely, it proved fairly easy to obtain a rear null greater than 60 dB lower than the forward lobe maximum value. Since the maximum null is a very narrow-bandwidth phenomenon, –60 dB seemed deep enough to show general trends when we set 2-element phased arrays for a maximum front-to-back ratio.

Figure 2 shows typical patterns for the narrowest element spacing and the widest element spacing used. Although only one set of patterns appears in the figure, the general properties apply to all three of the subject models. As element spacing increases beyond 0.1-λ, gain drops off. More notable are the rear lobes. The deep null occurs within a rearward lobe, leaving angled side lobes. The lobes are weakest at the most narrow spacing levels and increase with wide spacing. To some degree, then, aiming at the maximum 180° front-to-back ratio may be practically misdirected, although it serves to set operational limits for the 2-element array.

Table 1 provides full data for the short, resonant and long element pairs. As we

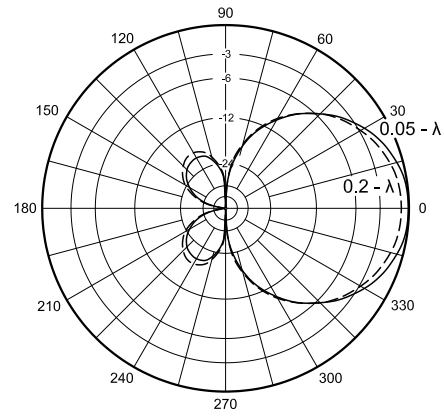


Figure 2—Comparative free-space azimuth patterns of a 2-element horizontal phased array configured for maximum 180° front-to-back ratio with close-spaced and wide-spaced elements.

Table 1
Performance and operating conditions of 3 equal-length element 2-element phased arrays in a maximum 180° front-to-back ratio configuration.

Model SHT-E Element Length (Front and Rear): 0.2147-λ
Frequency: 28.5 MHz Diameter: 0.001207-λ (0.5-inch)

Space (λ)	*Gain (dBi)*	*Front-to-Back Ratio (dB)*	*Z1 (Rear) (R +/–jX Ω)*	*Z2 (Forward) (R +/–jX Ω)*	*Rear I Magnitude*	*Rear I Phase*
0.05	6.41	65.58	3.9 – *j*110.3	3.2 – *j*78.8	1.024	–17.4
0.075	6.42	66.13	7.9 – *j*117.1	7.5 – *j*71.8	1.035	–26.4
0.1	6.36	73.68	11.9 – *j*120.7	14.7 – *j*64.0	1.045	–35.6
0.125	6.25	61.40	15.7 – *j*122.8	24.4 – *j*57.6	1.051	–44.9
0.15	6.11	65.41	19.1 – *j*123.8	35.7 – *j*53.7	1.056	–54.3
0.175	5.92	68.86	22.3 – *j*124.3	47.7 – *j*53.0	1.057	–63.8
0.2	5.69	65.46	25.7 – *j*124.2	59.1 – *j*55.8	1.057	–73.2

Model RES-E Element Length (Front and Rear): 0.2386-λ
Frequency: 28.5 MHz Diameter: 0.001207-λ (0.5-inch)

Space (λ)	*Gain (dBi)*	*Front-to-Back Ratio (dB)*	*Z1 (Rear) (R +/–jX Ω)*	*Z2 (Forward) (R +/–jX Ω)*	*Rear I Magnitude*	*Rear I Phase*
0.05	6.50	63.70	10.7 – *j*35.5	–1.6 + *j*7.0	1.033	–17.0
0.075	6.50	88.97	15.9 – *j*37.5	4.6 + *j*24.2	1.049	–26.0
0.1	6.44	60.36	20.7 – *j*38.4	15.3 + *j*39.4	1.063	–35.2
0.125	6.33	64.42	25.1 – *j*38.8	29.8 + *j*51.2	1.074	–44.7
0.15	6.18	66.73	–29.1 – *j*38.6	46.8 + *j*58.2	1.080	–54.3
0.175	5.99	61.47	32.8 – *j*38.2	64.6 + *j*60.1	1.083	–64.0
0.2	5.76	63.34	36.0 – *j*37.6	81.3 + *j*56.7	1.080	–73.6

Model LNG-E Element Length (Front and Rear): 0.2624-λ
Frequency: 28.5 MHz Diameter: 0.001207-λ (0.5-inch)

Space (λ)	*Gain (dBi)*	*Front-to-Back Ratio (dB)*	*Z1 (Rear) (R +/–jX Ω)*	*Z2 (Forward) (R +/–jX Ω)*	*Rear I Magnitude*	*Rear I Phase*
0.05	6.59	66.90	18.9 + *j*39.0	–7.3 + *j*95.5	1.045	–16.6
0.075	6.59	74.73	25.9 + *j*41.8	1.0 + *j*125.3	1.067	–25.5
0.1	6.52	63.87	32.0 + *j*43.8	16.4 + *j*150.6	1.087	–34.9
0.125	6.41	65.07	37.4 + *j*45.5	37.7 + *j*169.4	1.101	–44.5
0.15	6.26	66.57	42.3 + *j*47.0	62.8 + *j*180.7	1.110	–54.4
0.175	6.08	72.84	46.7 + *j*48.6	88.8 + *j*183.6	1.113	–64.3
0.2	5.85	67.24	50.7 + *j*50.0	113.3 + *j*178.5	1.110	–74.3

Note: All gain values are for free-space. Rear current (I) magnitude and phase values are relative to forward element values of 1.0 and 0.0°. Model RES-E uses elements of equal length to an independent resonant dipole at the test frequency. Models SHT-E and LNG-E use elements that are 10% shorter and 10% longer, respectively.

might expect, the maximum gain for any spacing is partly dependent upon the element lengths. Consistent among the three test models is the occurrence of maximum gain at the closest spacing levels: 0.05- and 0.075-λ. Thereafter, gain decreases steadily. The front-to-back values are simply for the record to verify that the model obtained the requisite depth of rear null.

At a spacing of 0.125-λ, a popular element separation for 2-element Yagis and phased arrays, the forward gain of the maximum-null phased arrays do not differ significantly from the gain of a well-designed Yagi. In the maximum front-to-back configuration, then, the phased array's claim to fame is only its rearward null and not its gain.

Of primary interest to us are the rear element relative values of current magnitude and phase angle necessary to yield the deep null. **Figure 3** graphically portrays the data of Table 1. Of immediate notice is that the change in element lengths between models has almost no effect on the requisite phase angles. The graphs of the three lines overlap and proceed in a virtually linear curve from about –17° at 0.05-λ spacing to about –73° at 0.2-λ spacing. Equally notable is the fact that we may obtain a rearward null for any spacing in this range.

What does change with the length of the elements is the relative current magnitude required on the rear element. The longer the element pair, the higher the required value of relative rear element current to achieve. The differentials for 10% changes in element length are between 2% and 3%.

Not all element spacings will be easy to implement with standard means of element phasing. The tabulated data shows negative resistance values in some entries for very close-spaced elements. These values are correct and simply mean that the mutual coupling between elements is providing more energy to the affected element than the source itself.

A Test of Equal vs Unequal Element Lengths

There are three possible element arrangements for a 2-element horizontal phased array. As we have just examined, both elements may be equal in length. However, **Figure 4** shows two more configurations. The forward element may be shorter than the rear element, and the forward element may be longer than the rear element. Our familiarity with the requirements for parasitic beams makes one of the arrangements natural and the other almost unthinkable.

Nevertheless, both types of unequal-length element arrays are fully functional in a phased array. All that we need to do is provide the two elements with the correct relative current magnitudes and phase angles. **Table 2** provides the complete modeling data on the test runs. The equal-length model is the same as used for the earlier runs. Each of the unequal-length arrays has one element that is the same as our original self-resonant dipole and a second element that is 5% longer: 207.48 inches or 0.5010-λ. As the table shows, there is no significant difference in the maximum forward free-space gain. Once more, at the closest element spacing modeled, a negative resistive component on the forward element is possible.

Figure 5 shows the relative current magnitude on the rear element, along with the relative phase angle. As with the three equal-element-length arrays, the phase angles required to achieve a 180° front-to-back ratio in excess of 60 dB overlap with considerable precision. The differences are almost solely in the realm of the required relative current magnitude for the rear element.

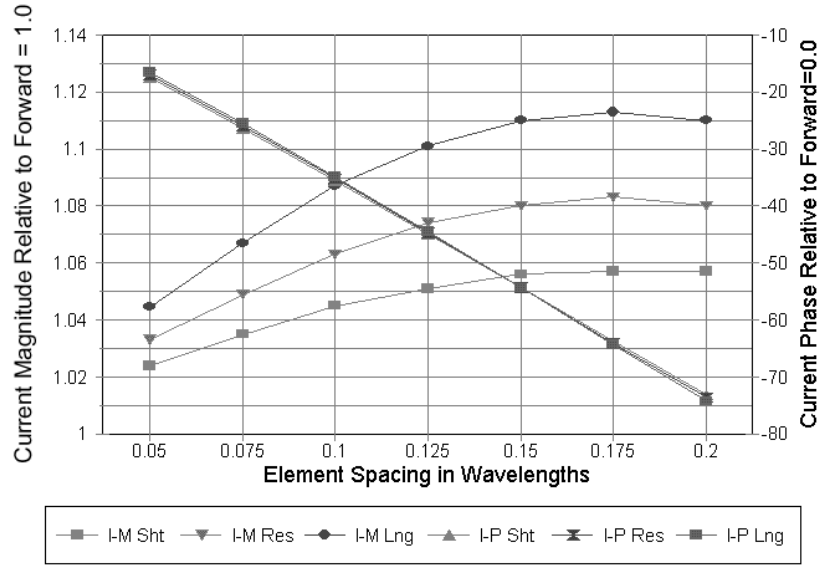


Figure 3—The rear element relative current magnitude and phase angle for short, resonant and long element lengths in arrays having equal-length forward and rear elements, and set for maximum front-to-back ratio. "I-M" means rear element relative current magnitude. "I-P" means rear element relative current phase. "Sht" refers to model SHT-E; "Res" refers to model RES-E; and "Lng" refers to model LNG-E. See Table 1 for model specifications.

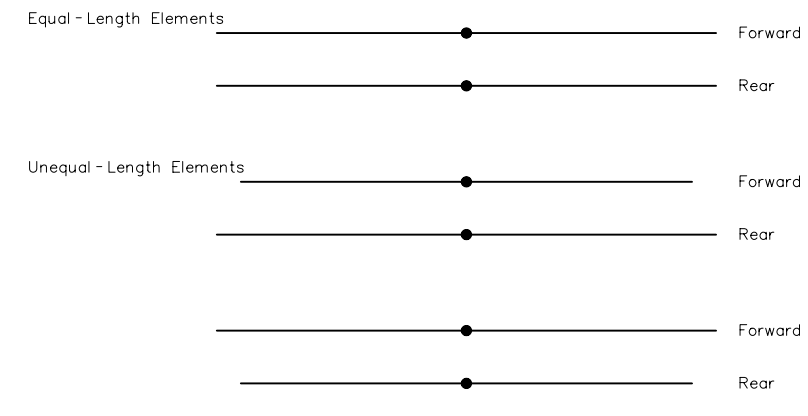


Figure 4—Three options for element length relationships between the forward and rear elements of a 2-element phased array.

Table 2
Performance and operating conditions of two unequal-length element 2-element phased arrays in a maximum 180° front-to-back ratio configuration.

Model RES-UF Element Length: Front: 0.2505-λ; Rear: 0.2386-λ
Frequency: 28.5 MHz Diameter: 0.001207-λ (0.5-inch)

Space (λ)	*Gain (dBi)*	*Front-to-Back Ratio (dB)*	*Z1 (Rear) (R +/–jX Ω)*	*Z2 (Forward) (R +/–jX Ω)*	*Rear I Magnitude*	*Rear I Phase*
0.05	6.52	62.19	12.1 – *j*38.7	–3.6 + *j*53.5	1.114	–16.9
0.075	6.52	69.26	17.3 – *j*39.5	3.5 + *j*75.7	1.139	–25.9
0.1	6.45	63.68	22.0 – *j*39.7	16.4 + *j*95.2	1.160	–35.3
0.125	6.34	65.22	26.2 – *j*39.5	34.0 + *j*109.8	1.175	–44.9
0.15	6.20	63.14	30.1 – *j*39.0	54.6 + *j*118.6	1.185	–54.6
0.175	6.02	67.19	33.5 – *j*38.4	76.1 + *j*120.6	1.186	–64.4
0.2	5.79	68.90	36.6 – *j*37.6	96.3 + *j*116.4	1.184	–74.2

Model RES-UR Element Length: Front: 0.2386-λ; Rear: 0.2505-λ
Frequency: 28.5 MHz Diameter: 0.001207-λ (0.5-inch)

Space (λ)	*Gain (dBi)*	*Front-to-Back Ratio (dB)*	*Z1 (Rear) (R +/–jX Ω)*	*Z2 (Forward) (R +/–jX Ω)*	*Rear I Magnitude*	*Rear I Phase*
0.05	6.52	63.77	13.3 + *j*4.5	–2.4 + *j*3.7	0.962	–16.9
0.075	6.52	61.79	19.3 + *j*3.7	3.7 + *j*22.1	0.974	–25.9
0.1	6.45	67.19	24.8 + *j*3.6	14.5 + *j*38.0	0.985	–35.1
0.125	6.35	62.79	29.7 + *j*3.7	29.2 + *j*50.1	0.992	–44.5
0.15	6.20	65.18	34.2 + *j*4.2	46.2 + *j*57.4	0.997	–54.1
0.175	6.01	65.28	38.4 + *j*4.9	64.0 + *j*59.3	0.998	–63.7
0.2	5.78	63.36	42.1 + *j*5.9	80.8 + *j*56.3	0.998	–73.3

For comparative data on Model RES-E, see Table 1.

Note: All gain values are for free-space. Rear current (I) magnitude and phase values are relative to forward element values of 1.0 and 0.0°. Model RES-E uses elements of equal length to an independent resonant dipole at the test frequency. Models RES-UF and RES-UR use elements that are 5% longer than those in RES-E at the forward and at the rear elements, respectively.

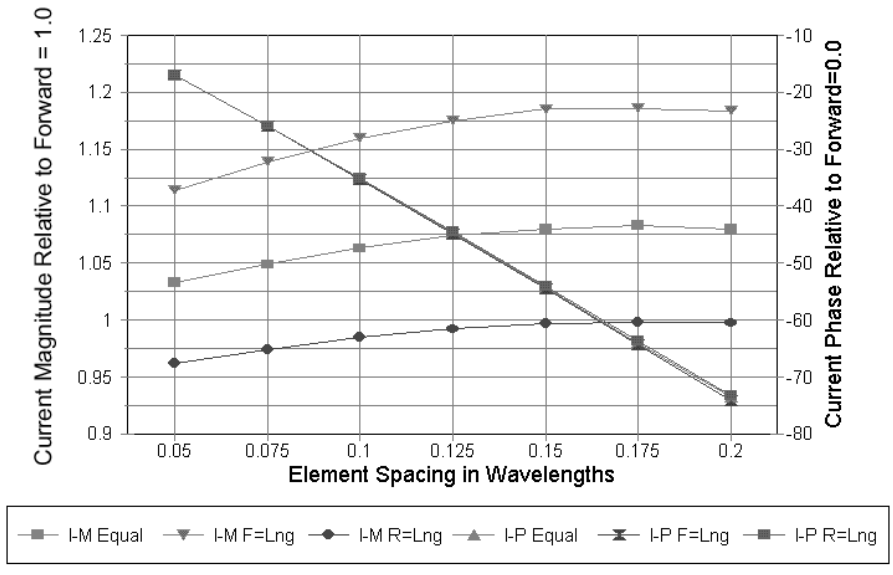


Figure 5—The rear element relative current magnitude and phase angle for various element-length relationships in 2-element horizontal phased arrays that are set for maximum front-to-back ratio. "Equal" refers to model RES-E; "F=Lng" refers to model RES-UF; and "R=Lng" refers to model RES-UR, according to whether the elements are equal in length, the forward element is 5% longer, or the rear element is 5% longer. See Table 2 for the specifications of models RES-UF and RES-UR.

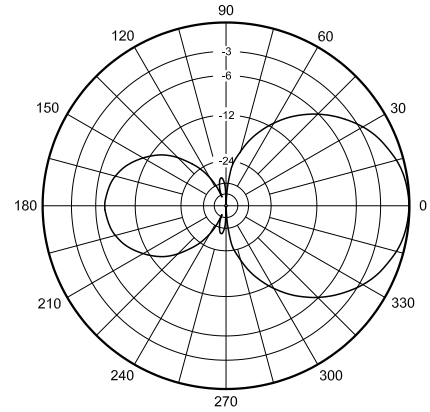


Figure 6—A typical free-space azimuth pattern for a 2-element phased array for 28.5 MHz set for maximum forward gain. The element spacing is 0.125-λ.

In this figure and in Figure 3, you will note a slight decrease in the rear element current magnitude at the maximum spacing used (0.2-λ). The reversal of direction in current magnitude is consistent for all models in the series, both the ones used here and others in my collection.

These models cannot guarantee that any particular element arrangement will provide an adequate basis for a practical array. However, when experimenting with phased arrays and various phasing schemes, it pays not to overlook the potential of a longer forward element.

Maximum Gain Configurations

The maximum front-to-back ratio configuration of a phased array represents one limit of performance, one marked by moderate gain and a deep rearward null. We may also set the relative current magnitudes and phase angles to achieve maximum forward gain, letting the front-to-back ratio become whatever it will be. In general, the conditions for maximum forward gain in a 2-element horizontal phased array do not favor high front-to-back ratios. **Figure 6** shows a typical maximum gain pattern, with a front-to-back ratio well below 10 dB.

For the five models that we previously examined, **Table 3** provides the necessary data. Maximum gain does not occur at the very closest spacing tested, but appears in the 0.75- to 0.1-λ region of element spacing. Front-to-back ratios show a steady decrease with increasing element spacing. The maximum gain phenomenon has a wider bandwidth than the maximum front-to-back null. Therefore, each registered data set comprises a centered set of

values in the middle of the range of phase angles and the range of current magnitudes that yield the highest gain. Over this region, the front-to-back ratio may change by as much as 2 dB, and the table shows only the center value.

Figure 7 graphs the current magnitude and phase angle data for the three equal-element-length models. Once more the phase angle curves form an overlapping trio. Irregularities in the current magnitude curves arise from the simple averaging and centering procedure used to produce the curves. However, the general trend is both clear and consistent with the maximum front-to-back curves: the longer the elements, the higher the required relative current magnitude level on the rear element to achieve the desired performance curve.

The maximum gain curves represent the highest gain level that we may achieve with two elements of the sizes in the models. In general, the highest gain levels coincide with those for a quite short boom 3-element Yagi or a 2-element quad, both of which are designed for adequate 10-meter band coverage. The Yagi boom length would be about 8 feet for this gain level, with 12-foot boom 3-element Yagis capable of 8 dBi free-space gain across the first MHz of 10 meters. However, the phased-array data, taken at a single frequency, do not necessarily hold over an equivalent operating bandwidth.

Conclusions and Compromise

The exercise that we have presented is at most a demonstration of phased array properties and not a proof of them. What it shows is two sets of limits between which most horizontal phased arrays operate. In general, designers either consciously select or discover through experimentation phasing arrangements that yield acceptable performance with respect to gain, front-to-back ratio, and operating bandwidth.

Table 4 gives us a partial view of what happens to the performance characteristics of a 2-element array as we drift away from the conditions that yield maximum front-to-back ratio. Varying the rear element relative current magnitude alone (with a fixed relative current phase angle) by about ± 10% shows a gradual decline in gain and a more rapid decrease in front-to-back ratio whether the current magnitude goes too high or too low. However, as we fix the current magnitude on the rear element and vary the phase angle, we obtain a different progression. The front-to-back ratio decreases on both sides of the optimal values. In contrast, the

Table 3
Performance and operating conditions of five 2-element phased arrays in a maximum-gain configuration.

Model SHT-E Element Length (Front and Rear): 0.2147-λ
Frequency: 28.5 MHz Diameter: 0.001207-λ (0.5-inch)

Space (λ)	*Gain (dBi)*	*Front-to-Back Ratio (dB)*	*Z1 (Rear) (R +/–jX Ω)*	*Z2 (Forward) (R +/–jX Ω)*	*Rear I Magnitude*	*Rear I Phase*
0.05	7.10	8.57	1.8 – *j*102.1	1.5 – *j*87.4	1.010	–8.0
0.075	7.23	7.57	3.5 – *j*104.5	3.2 – *j*85.1	1.015	–11.0
0.1	7.24	7.42	5.4 – *j*105.0	6.2 – *j*80.1	1.020	–14.8
0.125	7.21	7.01	7.0 – *j*103.8	10.5 – *j*75.5	1.020	–18.0
0.15	7.15	6.67	8.8 – *j*101.9	15.5 – *j*70.4	1.025	–21.3
0.175	7.06	6.33	10.6 – *j*99.7	21.4 – *j*66.5	1.025	–24.5
0.2	6.96	5.95	12.6 – *j*97.2	27.7 – *j*63.4	1.030	–27.5

Model RES-E Element Length (Front and Rear): 0.2386-λ
Frequency: 28.5 MHz Diameter: 0.001207-λ (0.5-inch)

Space (λ)	*Gain (dBi)*	*Front-to-Back Ratio (dB)*	*Z1 (Rear) (R +/–jX Ω)*	*Z2 (Forward) (R +/–jX Ω)*	*Rear I Magnitude*	*Rear I Phase*
0.05	7.19	8.17	4.9 – *j*24.6	–0.7 – *j*5.7	1.015	–7.5
0.075	7.31	7.72	7.0 – *j*21.8	2.0 + *j*5.1	1.020	–11.0
0.1	7.31	7.38	9.5 – *j*18.1	6.2 + *j*15.9	1.030	–14.5
0.125	7.28	7.08	11.8 – *j*14.2	12.3 + *j*25.5	1.038	–18.0
0.15	7.21	6.75	13.7 – *j*10.2	20.3 + *j*33.7	1.035	–21.5
0.175	7.13	6.46	16.1 – *j*6.3	28.9 + *j*40.6	1.040	–25.0
0.2	7.02	5.97	18.3 – *j*1.7	37.9 + *j*45.1	1.040	–27.8

Model LNG-E Element Length (Front and Rear): 0.2624-λ
Frequency: 28.5 MHz Diameter: 0.001207-λ (0.5-inch)

Space (λ)	*Gain (dBi)*	*Front-to-Back Ratio (dB)*	*Z1 (Rear) (R +/–jX Ω)*	*Z2 (Forward) (R +/–jX Ω)*	*Rear I Magnitude*	*Rear I Phase*
0.05	7.28	8.48	9.3 + *j*52.5	–3.8 + *j*78 0	1.025	–7.5
0.075	7.39	7.71	11.8 + *j*62.1	0.3 + *j*98.1	1.030	–10.8
0.1	7.39	7.47	14.5 + *j*69.9	7.0 + *j*116.4	1.035	–14.5
0.125	7.35	7.11	17.5 + *j*77.5	15.6 + *j*132.1	1.045	–18.0
0.15	7.29	6.77	20.3 + *j*84.5	26.6 + *j*145.2	1.050	–21.5
0.175	7.20	6.43	23.4 + *j*91.1	39.2 + *j*155.7	1.055	–25.0
0.2	7.10	6.03	26.1 + *j*97.6	53.0 + *j*162.6	1.050	–28.3

Model RES-UF Element Length: Front: 0.2505-λ; Rear: 0.2386-λ
Frequency: 28.5 MHz Diameter: 0.001207-λ (0.5-inch)

Space (λ)	*Gain (dBi)*	*Front-to-Back Ratio (dB)*	*Z1 (Rear) (R +/–jX Ω)*	*Z2 (Forward) (R +/–jX Ω)*	*Rear I Magnitude*	*Rear I Phase*
0.05	7.21	8.19	5.2 – *j*28.3	–1.1 + *j*38.7	1.085	–7.5
0.075	7.33	7.74	7.6 – *j*24.2	1.7 + *j*53.1	1.100	–11.0
0.1	7.33	7.36	9.7 – *j*19.8	7.1 + *j*66.5	1.110	–14.5
0.125	7.30	7.04	11.9 – *j*15.3	14.3 + *j*78.6	1.120	–18.0
0.15	7.23	6.70	13.7 – *j*11.0	23.7 + *j*88.6	1.120	–21.5
0.175	7.15	6.40	16.0 – *j*6.7	34.1 + *j*96.9	1.125	–25.0
0.2	7.04	6.02	18.5 – *j*2.4	45.1 + *j*102.8	1.130	–28.3

Model RES-UR Element Length: Front: 0.2386-λ; Rear: 0.2505-λ
Frequency: 28.5 MHz Diameter: 0.001207-λ (0.5-inch)

Space (λ)	*Gain (dBi)*	*Front-to-Back Ratio (dB)*	*Z1 (Rear) (R +/–jX Ω)*	*Z2 (Forward) (R +/–jX Ω)*	*Rear I Magnitude*	*Rear I Phase*
0.05	7.21	8.60	6.6 + *j*16.5	–1.4 – *j*8.8	0.950	–7.8
0.075	7.33	7.80	8.8 + *j*21.8	1.5 + *j*2.8	0.950	–11.0
0.1	7.33	7.44	11.5 + *j*27.0	5.9 + *j*14.2	0.955	–14.5
0.125	7.30	7.13	14.1 + *j*32.2	12.0 + *j*24.4	0.960	–18.0
0.15	7.23	6.82	16.9 + *j*37.3	19.6 + *j*33.3	0.965	–21.5
0.175	7.15	6.36	19.0 + *j*42.6	28.5 + *j*39.7	0.960	–24.5
0.2	7.04	6.01	21.7 + *j*47.6	37.9 + *j*44.7	0.960	–27.8

Note: All gain values are for free-space. Rear current (I) magnitude and phase values are relative to forward element values of 1.0 and 0.0°. Model RES-E uses elements of equal length to an independent resonant dipole at the test frequency. Models SHT-E and LNG-E uses elements that are 10% shorter and 10% longer, respectively. Models RES-UF and RES-UR use elements that are 5% longer than those in RES-E at the forward and at the rear elements, respectively.

change in phase angle shows a single low-to-high progression in the ±2° variation in the example.

The table shows clearly that the operating bandwidth for a set of conditions varies directly with the spacing between elements. The cost of obtaining the wider operating bandwidth is, of course, a decrease in the forward gain. However, the rate of gain decrease itself increases with spacings above about 0.125-λ. Indeed, one of the sensible reasons for selecting an element spacing in the 0.1- to 0.15-λ region is that we acquire reasonable operating bandwidth while maintaining higher gain levels.

Designers of phased arrays rarely survey the potentials for practical beams by extending the systematic model variation exemplified by Table 4. There are too many variables involved in the design work for one to fix upon a set of relative current magnitudes and phase angles and then design means for obtaining them. Instead, they tend to discover configurations that meet our usual amateur standards for what counts as a "good" beam. **Figure 8** shows a typical and desirable phased array pattern for an array using equal length (self-resonant) elements and spaced

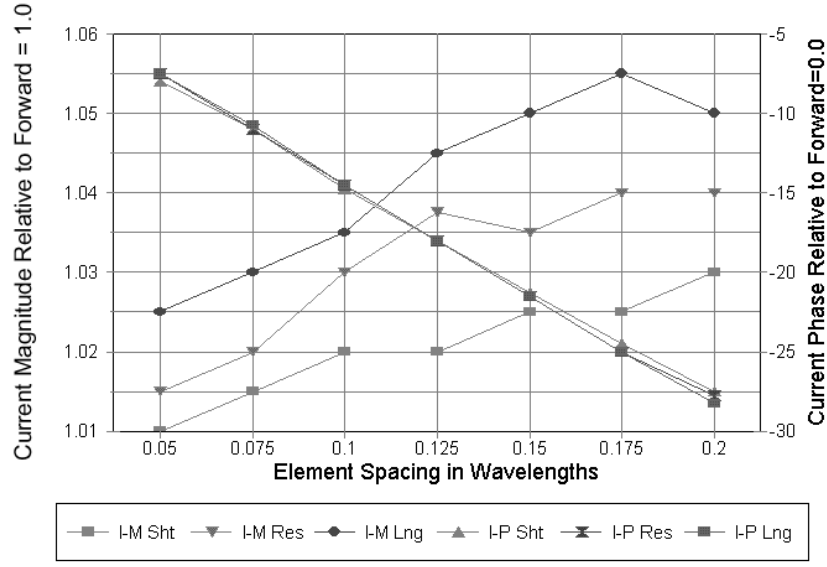


Figure 7—The rear element relative current magnitude and phase angle for short, resonant and long element lengths in arrays having equal-length forward and rear elements, and are set for maximum forward gain. "I-M" means rear element relative current magnitude. "I-P" means rear element relative current phase. "Sht" refers to model SHT-E; "Res" refers to model RES-E; and "Lng" refers to model LNG-E. See Table 3 for model specifications.

Table 4
Performance shifts in model RES-E at 0.05, 0.125 and 0.2-λ element spacing with a constant rear element relative phase angle and a variable relative current magnitude and with a constant rear element current magnitude and a variable relative current phase angle.

Model RES-E
3 Element Spacings
Element Spacing: 0.05-λ
1. Rear Element Relative Current Phase Angle: –17.0°

Rear I Magnitude	*Gain (dBi)*	*Front-to-Back Ratio (dB)*	*Z1 (Rear) (R +/– jX Ω)*	*Z2 (Forward) (R +/– jX Ω)*
0.933	6.34	15.23	3.7 – *j*38.9	5.9 + *j*6.1
0.983	6.47	21.48	7.4 – *j*37.0	2.2 + *j*6.6
1.033	6.50	63.70	10.7 – *j*35.3	–1.6 + *j*7.0
1.183	6.42	21.95	13.7 – *j*33.8	–5.3 + *j*7.5
1.133	6.28	16.30	16.4 – *j*32.4	–9.0 + *j*7.9

2. Rear Element Relative Current Magnitude: 1.033

Rear I Magnitude	*Gain (dBi)*	*Front-to-Back Ratio (dB)*	*Z1 (Rear) (R +/- jX Ω)*	*Z2 (Forward) (R +/– jX Ω)*
–13.0	6.88	17.45	8.5 – *j*30.7	–2.0 + *j*1.6
–15.0	6.69	23.97	9.6 – *j*33.1	–1.8 + *j*4.3
–17.0	6.50	63.70	10.7 – *j*35.3	–1.6 + *j*7.0
–19.0	6.30	25.07	11.9 – *j*37.6	–1.2 + *j*9.7
–21.0	6.11	19.47	13.2 – *j*39.8	–0.7 + *j*12.4

Element Spacing: 0.125-l
1. Rear Element Relative Current Phase Angle: –44.7°

Rear I Magnitude	*Gain (dBi)*	*Front-to-Back Ratio (dB)*	*Z1 (Rear) (R +/– jX Ω)*	*Z2 (Forward) (R +/– jX Ω)*
0.974	6.31	23.22	20.3 – *j*42.5	33.8 + *j*46.2
1.024	6.33	29.53	22.8 – *j*40.5	31.8 + *j*48.7
1.074	6.33	64.42	25.1 – *j*38.8	29.8 + *j*51.2
1.124	6.31	29.77	27.2 – *j*37.1	27.9 + *j*53.7
1.174	6.28	24.03	29.1 – *j*35.7	25.9 + *j*56.2

2. Rear Element Relative Current Magnitude: 1.074

Rear I Magnitude	*Gain (dbi)*	*Front-to-Back Ratio (dB)*	*Z1 (Rear) (R +/– jX Ω)*	*Z2 (Forward) (R +/– jX Ω)*
–40.7	6.52	25.75	22.7 – *j*35.4	26.2 + *j*48.1
–42.7	6.42	31.85	23.9 – *j*37.1	28.0 + *j*49.7
–44.7	6.33	64.42	25.1 – *j*38.8	29.8 + *j*51.2
–46.7	6.23	32.45	26.4 – 40.4	31.7 + *j*52.7
–48.7	6.14	26.50	27.8 – *j*41.9	33.7 + *j*54.0

Element Spacing: 0.2-λ
1. Rear Element Relative Current Phase Angle: –73.6°

Rear I Magnitude	*Gain (dBi)*	*Front-to-Back Ratio (dB)*	*Z1 (Rear) (R +/– jX Ω)*	*Z2 (Forward) (R +/– jX Ω)*
0.980	5.76	26.01	32.5 – *j*41.3	80.3 + *j*51.3
1.030	5.76	32.36	34.3 – *j*39.4	80.8 + *j*54.0
1.080	5.76	63.34	36.0 – *j*37.6	81.3 + *j*56.7
1.130	5.76	32.38	37.5 – *j*36.0	81.8 + *j*59.3
1.180	5.75	26.68	38.9 – *j*34.5	82.3 + *j*62.0

2. Rear Element Relative Current Magnitude: 1.080

Rear I Magnitude	*Gain (dBi)*	*Front-to-Back Ratio (dB)*	*Z1 (Rear) (R +/– jX Ω)*	*Z2 (Forward) (R +/– jX Ω)*
–69.6	5.92	28.63	33.6 – *j*35.1	77.3 + *j*57.3
–71.6	5.84	34.61	34.8 – *j*36.4	79.3 + *j*57.0
–73.6	5.76	63.34	36.0 – *j*37.6	81.3 + *j*56.7
–75.6	5.69	35.05	37.3 – *j*38.8	83.3 + *j*56.3
–77.6	5.61	28.98	38.7 – *j*39.9	85.3 + *j*55.8

Note: Total rear element relative current magnitude shift: ± 10%; total rear element relative current phase angle shift: ± 2°

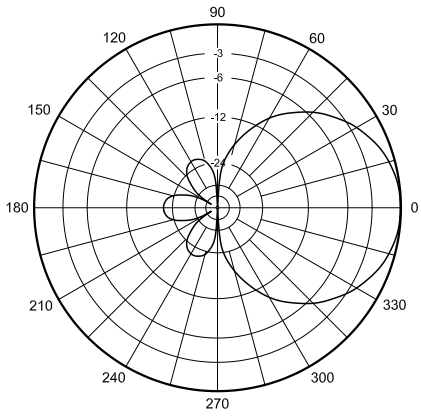


Figure 8—Typical "desirable" free-space azimuth pattern for a 2-element horizontal phased array for 28.5 MHz set for acceptable amateur operation. The element spacing is 0.125-λ.

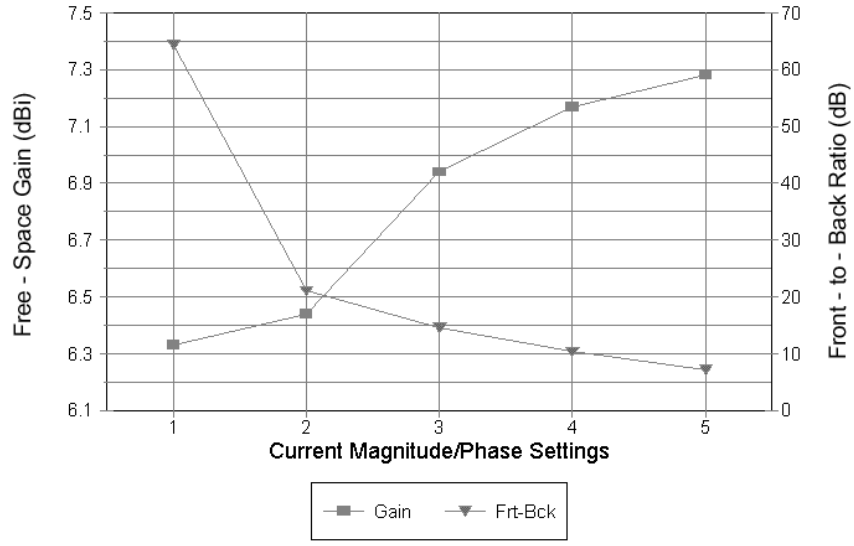


Figure 9—Free-space gain and front-to-back ratio of 2-element horizontal phased arrays at compromise settings of rear element relative current magnitude and phase angles between the limits of maximum forward gain settings and maximum front-to-back ratio settings. See Table 5 for details of the compromise settings.

0.125-λ. Gain does not appear on the pattern, but the triple rear lobe everywhere exceeds –20 dB relative to the forward lobe.

There is no single set of values for relative current magnitude and relative phase angle that will yield patterns of this sort. **Table 5** lists data for a set of compromise values developed simply by taking proportional parts of the differentials between the magnitude and phase angle values for the two extreme or limiting cases. **Figure 9** graphs the free-space gain and front-to-back ratio. The setting numbers correspond to the combinations shown in the table.

As noted earlier, the very high 180° front-to-back ratio decreases quickly, so that a phase angle of –38° on the rear element with a 1% decrease in current magnitude results in a front-to-back ratio just over 20 dB. However, in this increment, gain only rises by about 0.1-dB, with the steeper gain increase curve appearing between settings 2 and 3. As a result, one must accept a front-to-back ratio of less than 20 dB to achieve gain levels higher than 6.5 dBi.

The strategy used for these models can well be altered with possibly different results. We have sampled only two of many strategies in the effort to find a satisfactory set of operating conditions, and we have not explored the question of operating bandwidth—the frequency range over which the performance characteristics sustain themselves at acceptable levels. One reason for this void in our discussion is that the means by which we effect the current magnitudes and phase angles on each element play a significant role in setting the operating bandwidth. The exploration of such means is yet to come. We can only note at this stage that the number of variables involved in phased array design is high enough to preclude anything like a complete treatment.

So far, we have only scratched the surface of horizontal array understanding. The exercise has set performance limits. The data in Tables 1 and 2, however, are more than interesting numbers: they provide insight into the conditions that yield individual element impedances in paired combinations. The pattern of impedances will take on considerable importance in Parts 3 and 4 of this series.

As well, we have identified some of the factors affecting operating bandwidth, such as element spacing and where we set the rear element relative current magnitude and phase angle between the maximum gain and the maximum front-to-back values. Of course, we have not mentioned a third significant factor that affects operating bandwidth, namely, the diameter of the elements that we use. However, element diameter as a fraction of a wavelength will play a role in operating bandwidth, especially as one examines wire and tubular implementations of 2-element phased arrays.

So far, we have not explored how close we may come to a nearly perfect array with the ordinary design means available to us. One of those ordinary means that we usually overlook is antenna geometry. We shall explore the nature and limitations of that design route in the next episode. ■

Table 5
Performance shifts as the relative rear element current magnitude and phase angles are shifted in proportional steps between maximum front-to-back ratio and maximum gain settings.

Model RES-E
0.125-λ Element Spacing Stepped Between Front-to-Back and Gain Settings

Setting No.	*Rear I Magnitude*	*Rear I Phase*	*Gain (dBi)*	*Front-to-Back Ratio (dB)*	*Z1 (Rear) (R +/– jX Ω)*	*Z2 (Forward) (R +/– jX Ω)*
1	1.074	–44.7	6.33	64.42	25.1 – *j*38.8	29.8 + *j*51.2
2	1.065	–38.0	6.64	21.05	20.8 – *j*33.3	24.2 + *j*45.5
3	1.056	–31.4	6.94	14.53	17.1 – *j*27.4	19.5 + *j*39.3
4	1.047	–24.7	7.17	10.32	14.1 – *j*21.0	15.4 + *j*32.6
5	1.038	–18.0	7.28	7.08	11.8 – *j*14.2	12.3 + *j*25.5

Elmer's Still Alive... and Contesting

Bill Denton, W5SB, and
OJ Quarles, K1OJ

Robin and Glenna Shaw sent us these comments after they participated in a "Rookie" contest operation that we sponsored for the February 2001 10-10 International Phone Contest.

"About 12 years ago my wife Glenna and I decided to try our hand at sailing. One afternoon we were at marine supply store shopping for some parts for a small catamaran we were rebuilding. After talking to us for awhile, the storeowner discovered that we were just learning to sail. He imparted this bit of wisdom: 'The best way to learn to sail is to compete.' I remember thinking *yeah, right!* We're just out there to have a nice relaxing sail. The long and short of it? We soon started racing.

"We joined a local multi-hull sailing club. There we met lots of willing 'Elmers' who helped us both on and off of the racecourse. And 'ya know what? That storeowner was right! Instead of just wandering back and forth on the easiest tack, we soon learned all points of sail. We were able to sail with more confidence, we made new friends and we just plain had more fun!

"We decided to apply the same principle to Amateur Radio. Last year, we became interested in becoming hams. We figured that ham radio would be a great way to supplement our communications when we were out cruising. Using contesting to improve our proficiency seemed to make perfect sense. But where would we start?

"We listened in on a couple of contests—it seemed pretty intimidating. Then one night we were participating in the Northwest Amateur Radio Society (NARS) 2-meter net and found out that Bill, W5SB, and OJ, K1OJ, were organizing a 'rookie' contest operation for the February 2001 10-10 International Phone Contest. I sent an e-mail to Bill and let him know that we were interested in joining the team.

"Bright and early on the morning of the contest, we set out on our pilgrimage to ham radio 'Mecca'—W5SB's shack. When we arrived, OJ, Bill and several others were already deep in the contest fray. We sat around and listened for awhile. Could we do this?

"'Want to give it a try?' OJ asked. 'No, I think I'll just observe a bit longer' I said, but Glenna was ready to give it a go. She jumped right in and soon had a pileup of stations going. It seemed as if the other participants were eager to make contact with that lovely voice that was signing the Dit Dit Contest Club call sign, K5OJ. After Glenna made it look so easy (and wanting to protect my manly pride), I grabbed a headset and joined in myself.

"Sure, we made a few mistakes... I thought everyone had been snake bit when I mistakenly called QRZ on another station's frequency. We learned a lot, had a lot of fun and met some great new friends.

"Making HF contacts was new to us since, at the time, we were both Technician class operators. It was great to have someone to set us on the proper course. Since the 10-10 contest, Glenna and I have participated in the CQ WW Phone Contest. We are still learning, and still making a few mistakes, but—perhaps most importantly—we are still having fun!

"Participate in contests, help others participate in contests. It's a fast and easy way for newcomers to become better operators, and everyone has fun in the process. Thanks again to W5SB, K1OJ and all of the others!"

—Glenna and Robin Shaw, KD5LYA and KD5LYB

Matt, KD5LOA, and Mitch, W5MQS, test their mettle.

Perhaps due in part to license restructuring, our radio club, the Northwest Amateur Radio Society (NARS) of Houston, has recently enjoyed an influx of new members. Most of these are of the Technician variety. For many years a large percentage of the NARS membership was Extra and Advanced class operators. We are very proud of that fact.

One day back in January, OJ and I were talking about what we could do to get these newly licensed hams interested in upgrading and how we could best introduce them to HF operation. We kicked around a few ideas, but it was the thought of getting them involved in contesting that really struck our fancy. Since both of us especially enjoy that aspect of our hobby, contesting would obviously be our preferred venue for exposing our rookies to the wonders of HF.

OJ, K1OJ, logs as his son, Travis, takes a turn at the mike.

Rookie contester Jerry, KB5VGD, and OJ team up.

Robin, KD5LYB, gets in the groove as his wife Glenna, KD5LYA, proudly looks on. Mitch, W5MQS, serves as Elmer/logger.

Robin learns a sobering lesson; YLs are pileup magnets! Greg, W5IDX, types yet another contact into the log.

The wheels were in motion. What contest should we choose? Where would we operate from? How would we get the word out?

Selecting the Right Contest and Host Station

We looked over the contest calendar and quickly agreed that the North American QSO Party, the CQ WW 160-Meter Contest or the North American Sprint might be just a little too competitive for our greenhorns. Then we spotted the Winter 10-10 International Phone QSO Party. That particular event seemed like just what we were looking for.

Neither of us had previously been very active in the 10-10 activities, but over the years I've heard many operators on 10 meters exchanging 10-10 numbers. They always sounded very cordial and friendly. This is exactly what we wanted our rookies to experience. So the 10-10 contest it was.

First things first—we'd need a 10-10 number. I didn't have one. OJ had one under his K1OJ call sign, but we wanted to use the Dit Dit Contest Club call sign. We needed to get a number assigned to K5OJ. I sent an e-mail off to Mike Davidson, N5MT, of the local 10-10 chapter here in Houston, to find out how we could get a number—and get one quickly. We didn't have much time before the contest.

Mike explained that we needed to collect ten 10-10 numbers by contacting 10-10 members on the air. We would then need to send a log sheet of those contacts along with our membership fee, address and contact information to 10-10 International. (A membership form with the proper log sheet is available on the organization's Web site: **www.ten-ten.org**.)

That was easy enough. The folks at 10-10 International promptly processed our application and we received our 10-10 number for K5OJ a short time later. The next part was not so diplomatic. Where would we hold the operation? Since OJ had two votes—one as K1OJ and one as K5OJ—he outvoted me two to one. I immediately suspected some hanging chads, but after a lengthy investigation I eventually conceded. Our contest effort would be mounted from my station.

Greg, W5IDX, compares notes with Jamie, KC5WFF, on the fine points of operating an FT-1000MP.

Spreading the Word

How would we get the word out? NARS has a very active 2-meter repeater, a club reflector and a newsletter. (And better yet, an extensive grapevine system.) We employed all four methods. We started receiving responses immediately. Eighteen people contacted us wanting to come by and operate, including some seasoned veteran contesters that offered to give us a hand. This was going to be a fun event!

Contesting Basics

The rules were simple: Put on the headset, call someone and give them our 10-10 number. Say "thank you" and move on. One of the more experienced operators would do the logging on *TR* and help the newcomers learn the exchange. Each rookie operator could operate as much or as little as they desired.

The first impulse for most of the beginners was to make a few contacts and then ask if anyone else wanted to try. Before we knew it, they were operating longer and longer and began showing an increasing reluctance to give up the chair.

The look on their faces when they would throw out our call and someone would respond was priceless.

Rookie: "He heard me! He's in *Maine*."

Elmer : "Give him your name and 10-10 number."

Rookie: "My name is Suzie."

Elmer : "No! No! Tell him your name is Dit."

Rookie: "My name is *what* ? Dit?" (We used Dit for all contacts.)

Unsuspecting Victim: "This is W1QQQ. Please copy thirty-seven dollars and twenty-nine cents—and repeat your name."

Rookie: "Huh???"

As the day progressed, the rookies quickly became more polished. They relaxed and really started having fun. We Elmers enjoyed seeing how comfortable they all became as their operating skills improved. One particularly memorable quote was "Wow! This really *is* better than two meters".

Most of these new operators had never seen or talked on an HF radio before entering my shack. I have a fairly modest multi-2 operation with an FT-1000D and an FT-1000MP and all of the usual antenna switching devices, computers and other stuff necessary for competitive contesting. I also have a 115-foot tower

with three tribanders and a quad on a smaller tower. I had to make absolutely certain that these new folks didn't think they had to have all this equipment to get on the air.

I think they all enjoyed participating as a contest team. Hopefully some of them will be back.

The Payoff

We think our rookie contester program was a tremendous success. The rookies agree. Glenna and Robin have since upgraded—Robin to Extra and Glenna to General. They operated CQ WW from their shack and are planning a mini DXpedition to the Caymans.

Another of our contesting rookies, Jerry, KB5VGD, was first licensed way back in 1976. He told me that he was very "radio timid" when it came to things like contesting. He said that he always wanted to operate at Field Day but was just too intimidated by the fast pace. After graduating from our rookie training program he was heard to say, "After all of these years, I now have the confidence and I am finally going to jump in there and operate at Field Day."

Margaret, K5MSQ (K1OJ's XYL), also joined in on the fun. Although she has had little previous HF on-air experience, she has chauffeured OJ around Texas for several years as he operated the Texas QSO Party mobile. Last year she drove about 900 miles through 37 counties as OJ and I operated a multi-2 mobile in TQP. She is ready to go again.

Another rookie operator was Travis, OJ's 14-year-old son. Hopefully a license is in his future.

Memories of Past Sessions

Several years ago I did a multi-3 for the Texas QSO party from my station. We designated the number three station as "Novice/Tech"—similar to Field Day. We had several Novice and Technician operators. These guys really had a blast. For many of them, it was their first time on HF.

During that contest, one of the rookies called me over to the operating position and said, "This guy won't give me his county." I put on the headsets and listened. I asked the rookie operator, "Do you know where he is?" "No" he replied. "He's in *Japan*." I said. "You mean I am actually talking to someone in Japan!" That was a priceless moment.

Now It's Your Turn

I think that every contest station owner should open his door to a rookie operator every once in a while. I try to introduce a new operator as often as I can. Perhaps the new guy or gal will get the contest bug and go off and build their own station—and start the process all over again.

Gregg, W5IDX, came on the ham radio scene just a couple years ago. He has helped elevate my score in the NAQP SSB and other contests. Gregg was also part of this year's XA5T ARRL DX SSB team that's currently in second place. This just goes to show how quickly these newcomers can learn the ropes.

There are a lot of nice contest stations in this part of Texas. Almost all of the owners say the same thing: It is really hard to get enough operators to staff a multi for a 48-hour contest. Perhaps we should concentrate more on training new operators?

Closing Credits

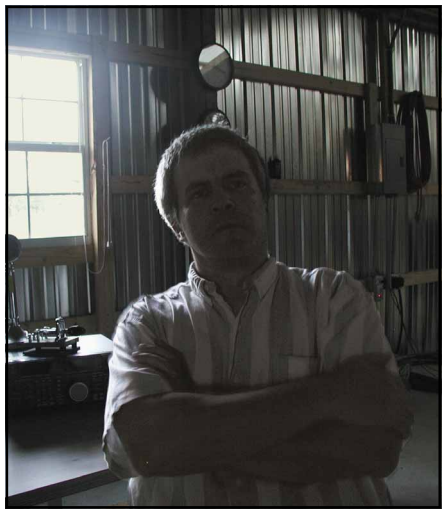
We want to thank 10-10 International for their help in getting our number quickly, and we want to pass along special thanks to all of the 10-10 members that were courteous, polite and patient with our rookies on the air.

The rookies in attendance were Jamie, KC5WFF; Margaret, K5MSQ; Mitch, W5MQS; Glenna, KD5LYA; Robin, KD5LYB; Matt, KD5LOA; Jerry, KB5VGD; and Travis. The old timers: Gregg, W5IDX; Bill, W5SB; Al, KD5CML; Steve, N5EN; Danny, WA5OJE; Bruce, N1LN; Laurie, N1YXU; George, W5GFP; Bill, K5ZTY; and OJ, K1OJ. A very special thanks goes to my XYL—Marian, KB5SGV—who graciously acted as hostess for this event.

For more information on the Northwest Amateur Radio Society visit **www.w5nc.org**, *and for the Dit Dit Contest Club, see* **www.ditdit.com**. ■

Getting It Right for the First Time —A Station Builder Confesses His Addiction

(Author's identity withheld by request)



It all started when I was a kid—this insatiable curiosity with radio. When my parents would visit friends, I used to sneak off and snoop around the house until I located the Big Console Radio. I would caress the smooth, cold cabinet, eyeballing the tuning dial intently to find out if it had shortwave bands, and if it did, *how many*...

You could tune in the world with nothing but a 3-foot wire for an antenna, covertly borrowed from the turntable. I was addicted to the BBC's English folksongs and the hauntingly minor tower bells Radio Nederlands would repeat over and over to warm up its transmitters. Radio Moscow gave me my first dose of propaganda at a tender young age. The sweet noise of 6-kilocycle wide atmospheric static was as music to me.

It was bound to happen: One day I tuned across ham radio operators talking. By seventh grade I was licensed. I joined the local radio club. They took me out for Field Day. I was a goner. In 24 hours I went from a handkey-pounding novice of a puny 11 WPM to a Vibroplex-slapping pro of over 20 WPM—as long as all I had to copy was a call sign and an exchange. Limitless youth allowed my skills to "exponentiate." Down I went to the FCC and got my *Advanced*.

One night in the cold of winter, in the basement, focused intently on the HW-16 I built myself, I found a traffic net. The clouds parted, the angels sang, the trumpets sounded and I was empowered with all ham operators' birthright—*public service*. And my code speed soared. I was becoming complete.

The old guys on the net took note, too. They flattered my impressionable little kid self by asking me to help with the region. Me, playing with the big boys. It wasn't long before I was appointed an Official Relay Station. You think *that* certificate didn't look good on my wall?

But the best thing that ever happened to me was being recognized by some of the other guys as potentially having The

Out in the boneyard there is enough aluminum to keep busy for some time.

You can never have enough of these. These are modified for stoutness.

Though relics, these old PCs should tackle the rigors of *TRIlog* handily.

Inside the shack, I've got just enough finished to get through the contest season.

I've been a Kenwood man since the dawning of transceiver QSK.

Right Stuff, and getting invited out for a real, "take no prisoners" Field Day. We're talking hundred-foot supports, Yagis and quads down to 40 meters. (I didn't even think you were *allowed* to have a quad on 40 meters.)

As all teenage males of my day came to be certain, bigger is almost always better. It certainly held true for radio antennas.

Hanging out with this bunch, I learned that other truism of life—that "politically incorrect" fact—that when there's emergency traffic to move, nobody moves it faster or with greater accuracy than contest operators—that *contesters are ham radio's greatest asset*—and that I was a true-blue member of ham radio's elite, punching it out quarterly with all of the other appointees in the famous CD Parties.

I found myself operating from stations I could never even have dreamed of—acres of real estate, bazillions of towers and antennas, plenty of watts. Operating consoles that looked like the shelves of a ham radio superstore. Racks of amplifiers. And there, down at the end, was a chair with my name on it: Second operator on 160 meters. My eyes lit up like the tubes in the 75A4 sitting on the table. I had *arrived*.

Not only that, I was under wings. These were guys who would sneak behind the console with headphones to listen to me operate. The quality of their operation was something they were proud to uphold, and accuracy was of utmost importance. These were guys who would detune the amp, or switch in the wrong antenna, and see how long it took for "the new guy" to notice, hoping to separate the wheat from the chaff. (I knew a couple guys who didn't get asked back.) By passing all these tests, I earned acceptance and respect.

I said to myself, "*one day I want to build a station for myself*" and I started collecting parts.

I spent once a month for about 5 years at that station, learning the ropes of tower work and antenna design, station layout, repairs, modifications. Back home, I impressed the locals with my tower savvy and became the chief engineer of a big club station and grew it to many times its original size. Members of clubs would call me and ask if I could help at antenna parties. Everywhere I looked I would see towers and antennas that I raised for other hams. I would keep the leftover parts.

I started watching the skyline with an eye for abandoned towers. A few phone calls, a little elbow grease, and I slowly added tower section after tower section to my pile. Sometimes it would be an old ham tower—then I might land some old beams, too.

True to my upbringing, I realized that I was lacking one important thing to make myself complete—I had not earned my Extra. As a young adult I dedicated 4 weeks of evenings to study and took it and passed it. Trivial. Done. History. Never again would I have to consult a band plan (you 160 guys relax—I didn't mean *that*).

At age 25 I was invited on my first DXpedition. Up until then I thought I had seen it all. At 28 I made the top 10 in Sweepstakes (if you have to ask which mode, you have not been paying attention). Three years later I made the world top 5 in the CQ Worldwide, single op high power. I even came in 3rd in the Sprint once. *Once*.

I had accomplished a lot of things, but I had *never* built my own contest station. The boneyard continued to grow.

In the other part of my life, I had committed the grave error of marrying the wrong person for the wrong reasons the first time. (I know this is unusual among contest operators.) After piles of self-analysis books, I learned that CW was not the only foreign language I had to know—women came from another planet, and to make it worse when they spoke it only *sounded* like English. My mistake. I made it worse by inventing my own rules as I went along—something that would never fly in the contest community. She kicked me out the day I got home from the CQ Worldwide, but it was not radio's fault. It was *my* fault. Contesting stopped short and went underground for almost a decade. Almost without thinking I continued to collect radios, towers, rotators, antennas and tools, knowing that *some day I would build the station of my dreams*. I was addicted.

Before I went under, I had figured out something very important. I had figured out how to build the ultimate domestic contest station. See, in the early 80s, I was computer modeling when computer modeling wasn't cool. I figured out almost two decades ago that 99% of my competitors' station designs were not optimal.

And, luckily for me, this appears to still be the case. There have been strides, yes, but there are still basic ideas which are far from understood by the majority... but that's all I'm going to say about it.

Always one to try and learn from mistakes, I think I am now married to the right person for the right reasons. She has stood firm on things like credit cards and time with the family (a great case for "tough love"). Originally I squirmed and balked—but when I finally obeyed her commands I found the most remarkable thing happened. She gave in. (Maybe it was pointing out all the $40,000 Bass boats, or perhaps it was my allusions to taking up exciting hobbies like mountain climbing or parachuting.) With a new lease on my ham radio life, I hope to finally realize the dream of my lifetime.

I'm not foolish enough to think I will become the next Sweepstakes superstar. I am less youthful than I was, out of shape, and I have never been the sharpest knife in the drawer. If I do well from my new station, it will be because of luck and superior hardware. If I don't do well, I'll bring in someone who can. If they don't do well at least it will have been fun to learn the answer. I am a station builder at last, finally bringing my dream to reality. That has got to count for *something*! And I am WAY addicted… ■

Logs and Robots and Cabrillo ...*Oh My!*

Dan Henderson, N1ND
ARRL Contest Branch Manager

In the fall of 1999, the ARRL officially adopted a standardized format for electronic log submission. To some contesters, the transition to the Cabrillo file format has been relatively painless, like a picnic with the Lollipop Kids from the Wizard of Oz. For others, it has been as traumatic as the encounter with Dorothy's house was to the Wicked Witch of the East. But what has the introduction of Cabrillo done for ARRL contesting since its implementation, and where do we now stand—nearly two years along on our journey towards the Emerald City?

Once Upon a Time...

In the pre-Cabrillo days, every contest entry that arrived at the ARRL Contest Branch—whether electronic or paper—had to be processed by hand. Entries sent in via e-mail or diskette were manually saved to the appropriate electronic storage location, a paper copy of the summary sheet was printed out and filed, and eventually all of the necessary information was manually typed into the databases.

For a smaller contest (such as the 10 GHz and Up Contest), once all of the logs were in, we could complete this process in just two or three working days. Larger contests (such as the International DX CW Contest) required up to four weeks just to print and save the electronic files and an additional three or four weeks to complete the data entry. After all of the log information—paper and electronic—was entered, the database was sent off to the log-checking teams.

Over the busiest portion of the contest season—November through early March—we typically receive over 12,000 entries for our various contest events. During this time, the Contest Branch is also performing other tasks. These tasks include writing contest-related material for *QST*, handling queries, and preparing and shipping certificates and awards. The sheer volume of contest entries meant that it might be three or four months after a log submission deadline before the Contest Branch staff could schedule the time to process the entries for a particular event.

It was quite apparent that we needed to bring our log processing and contest results reporting into the 21st Century.

The Yellow Brick Road

Our initial goal seemed simple enough: we would begin by automating the process of sorting electronic logs into our databases. This would immediately reduce the amount of time—*and money*—spent on processing contest entries. The development of a standardized log file format would be the first step.

Our ultimate goal was to eventually develop the system to the point where it could automatically extract summary information and queue the log for the checking process. Hand sorting and data entry of thousands of summary reports for the various contests is not only time consuming and expensive, but also provides an opportunity for human error to creep in. A system that could automatically perform all of the steps involved in processing electronic entries would significantly improve accuracy and efficiency, and lead to considerable additional cost savings.

A "standard" electronic log file format was the key. At that time, there were around a dozen sources of contest logging software. If the electronic logs that were generated by these various software packages could all be output in a single standard format, an automated system—or "robot" as we've come to know it—could then be used to process them. Yes, software could have been written that would allow the robot to recognize and process a wide range of electronic log submission formats, but the cost of developing such a program would be prohibitive. After consultation with the major players in the contest logging software industry, the Cabrillo format was eventually agreed upon.

The Recent Past

The use of Cabrillo began in earnest during the 2000/2001 contest season. At that time, all electronic logs were automatically forwarded to a dedicated contest back-up server. When an e-mail arrived there, an acknowledgment message—including a receipt number—was automatically sent back to the original sender.

No automatic processing of the logs was being performed during our first stage of implementation, however. Stage one was devoted to working out the details of the receiving and receipting routines. The logs were queued for the robot to process at a later time. While this was our first step towards reducing the manpower required throughout the process, it also revealed some additional problems. If we had already fully committed to an automated data entry system, errors might not have been detected, or might have remained hidden until later in the process when there was less time to correct them. Means of detecting errors electronically are being developed.

The "Man" Behind the Curtain

The theory behind automated processing of a Cabrillo formatted file is simple. The robot software reads each line and searches for a key word that identifies what that particular line contains. For example, the robot sees a line with the key word "CONTEST:" (the colon is necessary) and uses the information that immediately follows it to determine the contest, it spots the key word "CALL:" and uses that to identify the call sign used during the operation, etc. This is the first and strongest advantage of Cabrillo: the ability to sort electronic logs by contest and extract all of the required summary sheet information into the proper contest database—Call, Operators, Category, Section, Club, etc.

If I Only Had a Brain

The information that the electronic log submitter supplies in the Cabrillo file's header is the real lynchpin. As is the case with all computer software, the principle of GIGO (garbage in—garbage out) applies. The vast majority of Cabrillo logs that we are receiving contain accurate header information. But what happens when an electronic log has an incomplete or inaccurate header?

While processing logs for the 2001 ARRL International DX Contest, we encountered the following submitted information in various Cabrillo headers:

Category: Single Operator Portable Rookie
Category: School Club Multi-limited
Category: Triband with Wires
Category: Single Assisted Low Power QRP Portable
Category:
Category: Single
Club: Yes
Section: PA

And from just *one* entry came *all* (yes, *all six lines*) of the following:

Category: Single Operator All Band
Category: Single Band 10
Category: Low Power
Category: Triband with wires
Category: School Club
Category: Checklog

You get the idea. The biggest problem we have come up against so far is that some entries include wrong, incomplete or unnecessary information. None of the examples above are valid category information for any ARRL-sponsored contest.

The entry categories that are valid for

each contest are included in the contest rules, published both in the contest announcement in *QST* and on the ARRL Contest Branch Web site (**www.arrl.org/contests**). Some logging programs, however, may allow you to select invalid categories for a particular contest. They may not limit your choices only to those that apply. It's best not to assume that the choices that your logging program offers are correct.

Many of the commercially available logging programs have addressed this in recent releases. If you are using an older version of a program, make certain that the information that shows up in the Cabrillo header is valid for the contest.

Flying Monkey (Wrenches)

If information in the header is invalid, the log will be flagged for manual inspection. Some types of header errors are fairly easy for us to manually correct. For example, when someone notes a state instead of a section, (such as "PA" instead of the section—EPA or WPA) we are usually able to determine the correct answer. If someone claims both All Band and Single Band, an exam-ination of the log will allow us to resolve that problem. If possible, the Contest Branch staff attempts to contact entrants who have problem logs and request clarification.

Remember that some contests use the US state or Canadian province as the required *exchange* information. Most of our contest *results*, however, are reported and awards determined by ARRL section—not state. When the Cabrillo header is calling for the ARRL Section, if you are operating from a state that contains multiple sections (California, Florida, Texas, Washington, Massachusetts, New York, New Jersey or Pennsylvania) *do not* input your state.

At times—just as we would with a paper log submission—we will resort to "default" information (see section 4.11 of the "General Rules for All ARRL Contests"). If someone claims Single Operator but does not indicate a power level, they are defaulted to High Power. Of course, after the results are in print we invariably receive at least one call or e-mail from someone who forgot to include that information in their submission. They typically say something along the lines of "I couldn't have participated as 'High Power,' I don't even *own* an amplifier." If someone claims Single Assisted in a contest where there is no such category (such as the ARRL 10-Meter Contest) they will be defaulted to the Multi-operator category. Those correspondences always begin with "You put me in the wrong category." Situations such as these can be easily avoided—simply take the time to make certain that the information in your submission is both complete and accurate.

When we receive your Cabrillo file, it should already include all of the information we need to process your log. The robot does not take into account any additional attachments that it receives along with the Cabrillo file. Electronic submissions do not require dupe sheets. Old style summary sheets are also not needed—the log-checking software calculates QSO, multiplier and score totals. All of the information that's needed to process an entry—including guest op or multiple operator calls, club names, soapbox comments, etc—is accommodated within the single Cabrillo file.

One suggestion that was directed to us is that we should continue to manually open every file we receive and double check that the information contained within appears to be correct. Another we received said that we should still require the old summary sheets and we should manually compare them against the Cabrillo file header. Doing either would defeat the purpose of this project. We can not check extraneous files to see if the information contained corresponds with that in the Cabrillo file. Please do not send any additional file attachments along with your electronic entry, only the Cabrillo file should be submitted.

Our use of an automated system does mean that some errors that might have been caught early during our old manual processing procedure might not be detected. Ongoing software development is addressing these concerns. The automated system has, however, eliminated those errors that might have been inadvertently introduced during manual data entry.

It is important that you verify the information in your electronic file before you send it in. If a participant's Cabrillo header is correct, the basic reporting error rate can be near zero.

One of our log-checking teams recently reported that they received over 50 different types/styles of files for the contest on which they were working. These included *CT*, *NA* and *TR* Cabrillo files, *Word* documents and *Excel* spreadsheets and user-defined files and formats. For an electronic file to be interpreted by the robot, it must be able to "understand" what it is reading. Normal output files from such programs as *Microsoft Word*, *Excel* or even a *CTLog.bin* file contain computer code that allows the program that created it to read, understand and format its contents for display or output. These control codes can not be interpreted by the robot, and make these files unusable. This is why a Cabrillo log file is in an ASCII readable format, and uniform in what it contains.

We're Here to See the Wizard

When an e-mailed entry is received at the contest-specific e-mail address (**SSCW@arrl.org** for the CW Sweepstakes, for example), a copy of it is immediately stored on the ARRL server and a duplicate copy is sent to the contest robot. When it arrives at the contest robot, an automated receipt is returned to you. The reply includes a receipt number, and you should definitely keep a record of this in case a problem arises. At this point, the robot does not begin to process the entry immediately; it only acknowledges its receipt. If the call sign that's associated with the entry does not appear in the subject line of the e-mail, the entry is returned to the sender, along with a request for resubmission with the call sign included in the subject line.

When the log-checking team is ready to process the logs for a particular contest, the robot again swings into action. It archives a copy of the complete e-mail as received, including attachments. This archive allows the Contest Branch and log-checking team to view the message as received. We require that the call sign appears in the subject line of the e-mail so that we can find it in the archive if we run into any problems with the submitted log.

The robot next deals with the contents of the e-mail. Without going into too much detail, the robot opens the message and tries to determine if it is a Cabrillo-formatted file. If it is, the entry is saved directly as is to the server. If the log is not in the required format, it gets routed into a special area so that it can be handled manually. In the future, the robot will be able to generate an e-mail message back to the submitter informing him that the log does not fit the required format. The message will also provide suggestions on how to put the log in the proper format.

A frequently asked question is "I have an older version of a program that won't generate a Cabrillo file, so now what do I do?" The best and easiest solution is to upgrade your software to a newer version that incorporates Cabrillo. Licensed registered users of all currently marketed contest logging programs shouldn't have any problem getting their hands on an update. Another option is to use one of the log conversion programs that are available. These will require that you import into the conversion program one of the old style output files and then follow the instructions to properly mark the old file for updating by the converter. These work, but they do require the user to have an active involvement with the program, so you need patience to use them.

Somewhere Over the Rainbow

As our electronic log submission processing procedures are further developed, more and more of the information that can be extracted from the logs will be available earlier, and some of this will very likely be added to the data that is already appearing on our "Logs Received" Web pages

(www.arrl.org/contests/claimed/). These posting can serve to alert individual contest participants of problems in their log file format or information they've sent in. Anyone submitting an electronic Cabrillo log file should inspect the information posted on the Logs Received page. If they spot any inaccuracies, they should let us know immediately. To get a feel for how this works, have a look at the Logs Received page for Field Day 2001 (www.arrl.org/contests/claimed/repRYIYjv.html).

Have a Heart

One of the directives from the ARRL Board of Directors in regards to this project was that we be as flexible as possible while working towards full implementation. Thanks to the hard work of several volunteers and the log-checking team, many non-compliant logs that we have received have been included in the results. This has required hundreds of hours on the part of the entire log checking team to try and assist participants as they work towards getting the Cabrillo output files in place. As we progress further along on this project, we will continue to try and work out any difficulties with individual submissions. Errors that occur due to logs that are non-compliant, however, may ultimately lead to the entry being ineligible for inclusion in the competition for an event.

As with any change, people ask "what's in it for me?" The tangible benefits of Cabrillo seem far off for the average contester. However, the number of errors occurring from human data entry has significantly declined. Most errors we are currently seeing evolve from errors in the log file provided by the participant.

We are already seeing a decrease in the time it takes to get the logs initially processed and onto the Logs Received page. As this project is further developed, participants will be able to verify more information from their entry on the Web site. We hope to eventually reach the point where information from entries that arrive in the correct format and free of errors will show up on the Logs Received page in the next daily update.

Data from paper logs will still take some time to show up on the Logs Received page. As less time needs to be devoted to manually processing electronic logs, the Contest Branch staff will be able to input the information from paper submissions in a more timely manner.

If you have questions about how the changes are occurring or how the system works in more detail, please feel free to contact me at 860-594-0232 or n1nd@arrl.org. And, thanks for your patience and cooperation as we continue to move towards full implementation.

The Emerald City wasn't built in a day, and no Wizard of Oz can exercise his magic and bring this project instantly to completion. But with the support of the contest community, we can continue our journey down the Yellow Brick Road on our quest to deliver the most accurate and complete contest reporting. ■

NCJ Reviews: Array Solutions SO2R Master Two-Radio Control Interface

John Unger, W4AU

As is the case with many other contesters, over the last couple of years I've been experimenting with operating in the single-operator, two-radio (SO2R) mode. I've always had a backup rig of one sort or another set up in my shack and I've put them to good use to check for activity on other bands when things slowed down during a contest. It seemed like a natural step to try and wire up a "real" SO2R setup—particularly since I run *TRLog*. This software includes sophisticated capabilities for operating in this mode.

So back in early 1998, I built a parallel port computer interface from a schematic that—if I remember correctly—was developed by Tree, N6TR. I wired this in with a very simple headphone switching box that I had previously homebrewed.

Since that time, these two boxes have come out of the closet for most of the contests I've participated in. Using them has helped me improve my SO2R operating techniques. As with most homebrew projects, though, I have been continuously fiddling around and adding "features." The system finally reached the point where the ever-increasing maze of jumpers and cables started to drive me crazy. It became obvious that I should rebuild the thing from scratch, but I kept putting off that daunting task.

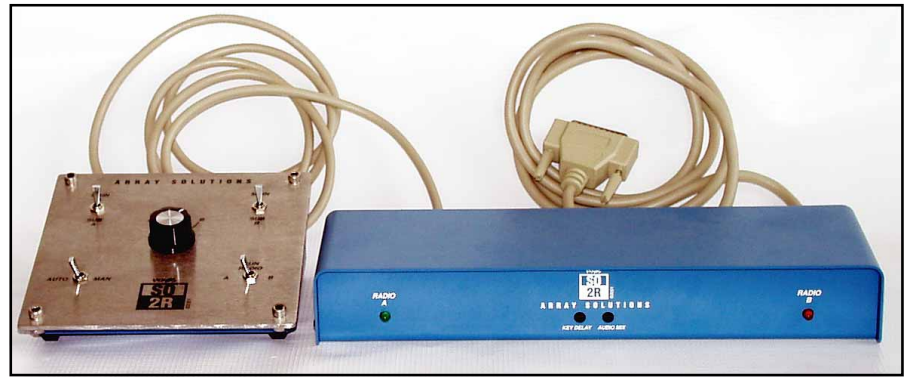


Figure 1—The two components that make up the SO2R Master.

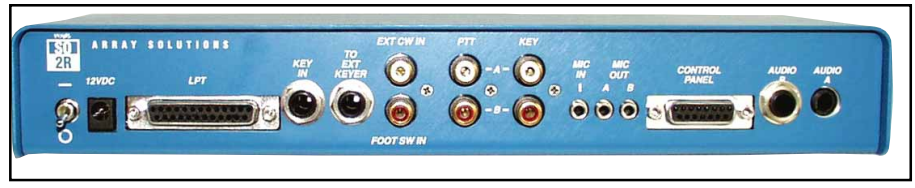


Figure 2—The rear panel of the input/output box.

Array Solutions to the Rescue!

Then I saw an announcement for the Array Solutions SO2R Master Controller interface. When I read the description of the Master's capabilities, a number of features—several of which I had intended to eventually integrate into my own homebrew system—caught my eye.

First was the ability to mute the Run radio's sidetone when the software was calling CQ or sending the exchange and have the S&P radio's audio come up in both ears during that time. Another was the ability to leave the system connected to my radios and computer and to use a single set of headphones, paddles and microphone with either radio, even when I wasn't running the contesting software.

I ordered one when the first batch of units became available. When the package from Array Solutions arrived, it contained two boxes (see **Figure 1**), cables to connect them to each other and a PC, and a six-page instruction manual.

One of the boxes is a long, thin, blue input/output box with two LEDs on the front and 16 connectors on the rear (see **Figure 2**). This box is designed so that it can be positioned somewhere out of the way. The second box is a stylish, retro-looking control console with a sloped, brushed stainless steel face. There's a large three-position rotary switch in the center that's surrounded by four toggle switches. A 1/4-inch stereo headphone jack is located on the left side of the enclosure.

The console is intended to sit close at hand near your keyboard or paddles and connects to the I/O box via a single cable. The slick appearance and ergonomics of the control box shows the benefit of having access to a professional industrial engineer's expertise. Company owner Jay Terleski's (WX0B) brother, Tim, assisted with its design.

Of course, being the curious type, I just had to take the cover off of the I/O box and see what it looked like inside. I was impressed with the well laid out, uncluttered circuit board that's almost entirely populated with discreet components (the circuit employs one IC). Schematic diagrams for both boxes are provided. The manual, by the way, can be downloaded from Array Solutions' Web site.

Wirin' It Up

The most time consuming chore involved with getting this system up and running was making up the cables to connect all of my station hardware to the I/O box. Minimum wiring requirements for a CW setup are power (12 V dc at 300 mA), cables from the box to the key jacks on your rigs, a cable to your paddle, a cable from your keyer (if you want to use the SO2R without contesting software running on your computer) and cables from the box to the headphone connectors on each rig.

All of the connectors you'll need are pretty much standard items. You shouldn't have any problems finding them at your local electronics store, but I'll fill you in on a couple of potential snags. First, the microphone connections are made to the I/O box via three 1/8-inch mono jacks that are positioned in a row. One is used for mike input and the other two feed mike audio out to the rigs. The smallest 1/8-inch mono plugs that RadioShack offered had shell diameters that were a bit too large for the three plugs to fit along side each other in the closely spaced jacks. I ended up having to remove a bit of plastic from them so that they'd fit side-by-side.

Second, be sure to get the proper coaxial power plug for the 12-V dc power jack. The required plug has a 5.5-mm outside diameter is set up for a 2.1-mm

pin diameter. (Digikey's part number for the proper plug is CP-004-ND.)

When I purchased the unit, Array Solutions had not yet begun offering optional cable sets. A cabling package that includes two pre-made six-foot long cables for Yaesu, Kenwood or ICOM transceivers (mix and match—your choice) are now available, and this includes a dc power cord. A "generic" cable set—designed to plug into Heil headset adapters—is also offered.

Workin' It

I've given the SO2R Master a good workout in a couple of contests: the Virginia QSO Party and the WPX CW Contest. The system performed without a glitch or hiccup during both outings.

I won't try to list all of the features offered by the SO2R Master—you can read about them yourself on the Array Solutions Web site. Suffice it to say that this unit takes full advantage of all of the SO2R potential available in the *TRLog*, *NA*, *CT* and *Writelog* contest logging programs (and other programs that adhere to the same LPT standard). It even adds a few "extras."

One example of an extra is the ability to mix more or less audio from each radio for when you're listening to both radios at the same time. Another is being able to listen to a radio's sub receiver in one ear and the main receiver in the other ear, if you have a transceiver with dual receivers.

Yet another is the ability to inhibit the automatic audio switching circuit when you're using your paddles (this is the function of the IC mentioned earlier). This allows you to hear your sidetone when you are sending CW manually.

Tweakin' It

I get the impression that the SO2R Master has been designed so that modifications can easily be made, if necessary. For example, the I/O module circuit board has five jumpers that allow you change some of the operation of the system, and the manual (which is constantly being updated on the Array Solutions Web site) includes some modification ideas that have been provided by users.

Other than the integrity of the cases and the overall design of the circuits, there are no special measures taken to reduce RF interference. I have had absolutely no problems with RF getting into the SO2R Master while running my Alpha full bore using resonant antennas. (I should mention that this was not always the case with my homebrew SO2R system.) There are provisions, however, to make it easy to deal with any RF that might try to make its way in through the mike lines. The circuit board includes holes (jumpered in stock units) that are laid out to accept a Panasonic ELK-AH103EB filter. (This part has recently been superceded by the Panasonic ELK-TT103EA.—*Ed.*) You could alternatively install your own inductor, capacitor and/or ferrite bead filter in the same spot.

Non-Contest Operation

A big advantage of the Master over my homebrew unit is the ability to use it in "manual" mode when I want to operate without firing up my contest software. In this mode you can switch your mike/paddle/keyer/headphone between the two rigs quickly and easily. In fact, when I'm sitting down in the evening now and listening around the bands, I'll routinely have one rig on my 40-meter antenna and the other on the tribander so I can switch to whichever rig I want to transmit on instantly.

Rationalizin' It

The price of the SO2R Master is $275. The optional cable sets sell for $85 (standard) or $75 (generic). This may seem like a significant chunk of change, but after I gave some consideration to the time and effort that I put into building my homebrew units, the price tags suddenly didn't seem quite so steep. And with the Master, I have an SO2R controller system that can do everything I want—and more. I love to build and always seem to have at least one or two homebrew ham projects on my bench, but I haven't regretted for one minute spending my hard-earned cash on the SO2R Master.

The SO2R Master control interface is available directly from Array Solutions and also through Geo Distributing (**www.qth.com/tr**), an outfit that carries a wide selection of *TRLog*-related software and hardware accessories.

Manufacturer: Array Solutions, 350 Gloria Rd, Sunnyvale, TX 75182; 972-203-2008, fax: 972-203-8811; **wx0b@arraysolutions.com**; **www.arraysolutions.com**.

NCJ Profiles—The Doctor of Trivia —Ward Silver, N0AX

Tom Taormina, K5RC
K5RC@aol.com

I'm not sure who invented the concept of "turnabout is fair play," but K7BV recently announced to me that, since N0AX did his last profile on me, I had to do Ward's. I don't entirely follow the logic, but here we are.

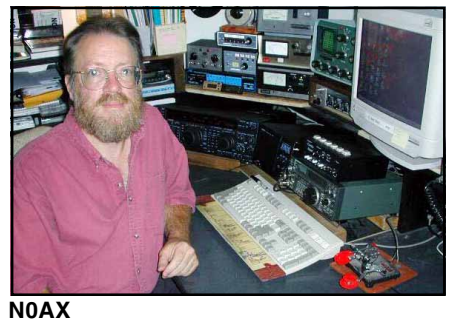
One of my great joys in contesting is my friendship with many of the "colorful" characters in our midst (and in our past). As I was preparing for this assignment, it occurred to me that Washington State must be a breeding ground or gathering spot for these colorful characters, such as K7SS, K7LXC, W7RM, K7JA. Several months ago, the entire Silver family paid us a visit, and this served to confirm to me Ward's membership in that elite society and, in that context, I am honored to be his "Profiles" biographer.

Beginning at the beginning, Ward's story starts thusly: "My first exposure to non-broadcast radio was the big, old Magnavox console radio my family had when I was a kid. It had those funny bands marked 'Aircraft,' 'Police' and 'Short Wave.' Of course, it had no antenna to speak of, so I never heard anything other than the local St Louis AM broadcast stations—and boy, did the Cardinals and Jack Buck sound good on that 15-inch speaker. Occasionally, I heard a loud humming and buzzing coming out of the thing and imagined that maybe it was the sound of an airplane, but to my 8- or 9-year-old mind, there wasn't much of interest in there other than the glowing tubes.

"A couple of years later, I stumbled across a copy of *QST* in our local library—a truly life-changing bit of serendipity. By the way, this would be a great project for ARRL clubs—donate *QST*s to public and school libraries. There are thousands and thousands of kids out there just trolling the stacks every afternoon. Anyway, I was instantly fascinated. I gulped up all the antenna and design articles; the W1CJD cartoons were terrific, McCoy and DeMaw were just coming into their prime, and I was sure that this was something I wanted to be a part of.

"Only problem was I didn't know anybody that had a license or that knew anything about Morse code. The chances of my figuring all of this out on my own were nil—so it remained a fantasy. I engaged in 'cargo-cult' ham radio—collecting various parts, reading magazines and taking apart TV sets. I still have plate caps, power resistors, sockets and my first soldering (or rather, de-soldering) gun from those junior high days. *QST*, however, continued to hold my interest, and I started to read through the contest results, 'How's DX' and even 'Section News.' With persistence, I eventually found my Elmer in the person of WN0DYV (now KJ7PC).

"I passed the Novice exam in January of 1972, but didn't have my license by the Novice Roundup, so I lent 'DYV all six of my



N0AX

crystals—*and he won!* A short time later, the Little Print Shop informed me of my new call (WN0GQP—how did I ever become a CW guy with that call?) and a week after that, I had the actual FCC document. My first QSO, from 'DYV's house, was with WB5FXC. I soon convinced my mom to let me buy an HW-16 kit. My dad was a real hard sell on ham radio, but he eventually conceded and let me run some RG-58 up through the attic to a 40-meter dipole all of 15 feet off the ground.

"In high school, I was pretty much obsessed with ham radio and computer programming. The 'computer' was an ASR-33 in the math department. We had a 300-baud dial-up connection to some Big Iron in downtown St Louis. The computer was supposed to be for the teachers, but once us geeks found out about it, I don't think we ever let them get near it again. So it was computers at school and ham radio at home. I didn't realize it at the time, but this is probably about as close to heaven as it ever gets for a techie.

"By the end of high school, we had a club (WB0DQI); I had hosted Field Day in my backyard twice, operated in numerous contests, and was ready for Big Time Radio at college. I attended a serious engineering school—the University of Missouri at Rolla, previously known as the Missouri School of Mines. W0UN had graduated from there fifteen years before. There was a very active radio club, W0EEE. Most of the members had flunked out of school, so the station had achieved a certain amount of notoriety with the administration of the Electric Engineering department.

"The club station was housed in the oldest building on campus (circa 1870) and it had a 60-foot tower perched on its roof. Bats would fly out of the roof access hatch during our trips up to the tower. There was a really swell modern (and air-conditioned) shack located in the basement. It was easy for a ham to find the station—we had an absolutely huge dipole strung between the campus power plant's smokestack and a 1930s-vintage building. The wire was stretched com-pletely across the main quadrangle. It was very, very cool, indeed.

"I think I basically lived in that shack for my first few years on campus. It was fully equipped with the latest SB-301/401/220/610 combination, a Mosely CL-36 at 100 feet, various wires for 40 and 80, back issues of magazines galore, cheap soda pop (we had a 10-cent machine that somehow avoided being updated to the 50-cent rate for years) and was in close proximity to the burger joints. Why on earth would an electrical engineering student go anywhere else? I think one year I spent 600 hours just contesting—not counting the time I spent typing the logs, QSLing and just hanging out. We phone-patched for traveling professors' wives, handled messages for starving students and ran radio chess matches with Purdue, University of Illinois and University of Wisconsin. We bet cases of beer on Sweepstakes scores with our archrivals at Kansas State, W0QQQ. Life was good.

"I learned a huge amount about real-world stations and operating. The upperclassmen mentored me through my various rough stages—WA0ACF, WB9FSL, WA0RAD were great older friends. The younger group included N1EUZ, K4OQ, WB0SDK, AK0M, K4MA, WB9BVV and others. Just to keep active, we even invented a drinking game that we titled 'Ham Radio Indian' to play on non-contesting weekends (I'm sure you understand).

"There was really nobody around to guide us—K4VX was a few years in the future. So we just got on and tried to beat some of the other Show-Me State Big Guns like K0SGJ, N0SS and K0RWL. N0XX—Bill Sattler—was active from W0ZLN at the main University of Missouri campus, and we competed with him in the CW Sweepstakes. We had a good location, 24-hour access, and were eating up electrical engineering like ambrosia. All this had to come to an end eventually though, and sadly, I received my degree and it was time to go.

"I moved to the West Coast (Vashon Island, near Seattle) in 1983, was blessed with the twins in 1984, and was only occasionally active until we moved to our present home in 1988. During this period, my big contesting effort was Field Day with the Boeing Club at a beach here on Vashon Island, and of course, SS CW. My XYL, Nancy, found contesting amusing during the early years, especially due to my occasional requests for 'spoon feeding.' This was still pretty much wanna-be contesting as a Little (and sporadic) Pistol.

"Finding my current QTH turned out to ignite a renaissance in ham radio for me. Perched on the upper part of an east-facing slope above a salt-water harbor, there could hardly be a better location for a low-power Northwesterner. A few months after moving in, I put up a 2-ele-ment bamboo quad—the

first rotating antenna I've ever owned—on a mighty 35-foot 2 × 4 mast. But located between two ravines, it was electrically much higher. I started working real DX and generating some much larger contest scores.

"I suppose it was only a matter of finding a good location where modest antennas could provide some success. I wonder how many other hams are out there in a similar position—they've had some fun over the years dinking around and making some QSOs, but haven't been exposed to what a good location can do.

"As the boys got a little older, it became possible for me to be more active. I was able to do a lot more operating and contesting than ever before—just ask Nancy! This exposed me to the local DXers and contesters. The Western Washington DX Club has a long and storied history and some really motivated and excellent contesters. K7SS, W7WA, WA0RJY, K7ST, K7LXC, N7LOX, N7WA, N7TT, W7TSQ, K7QQ and many others keep the flame burning brightly up here through the long winter between sunspot cycles. I have been operating regularly at the W7RM mega-station during multi-ops, helping Rush bring the Zone 3 CQ WW CW record back to the Northwest.

"My current lash-up has not changed all that much in recent years. The 'ExH Ranch' sports two towers—a 55-foot crankup with a 2-element quad and a 50-foot HDBX topped with a 40-2CD, a 30-meter dipole, a C-3 and two 80-meter half-slopers. My 160-meter antenna is an inverted-L that has allowed me to work all continents with 100-W. I also have a motley selection of 160-meter listening antennas that do their best to help me hear through the grumbles of the six high-power AM broadcast stations that share my island. I've collected the QSLs for DXCC Honor Roll sans amplifier and have managed 290 QRP entities, and am gunning for 300. 5BDXCC-QRP is almost quixotic from Washington State, but the 80-meter grail may be attainable with perseverance and luck over the next few years.

"Inside the shack are an FT-1000MP, an IC-735 and an assortment of gadgetry and switches that supports a fairly nimble SO2R setup. I don't own an amplifier... yet, although I might get serious about 160 again as the current cycle bottoms out. By relocating one of the radios I can put together a functional multi-two setup that allows me, my boys and some of their friends to do fun multi-operator efforts for NAQP, SS, WPX or WW."

By day, Ward is a Datacomm Systems Engineer for a company that makes cardiac defibrillators. His fervent wish is that none of us ever have to use his product. He and Nancy have been married for 19 years and they have twin sons—Webster, KD7FYX, and Lowell, KD7DQO. At 16 years old, the boys are bundles of energy and incredibly inquisitive. I think I got a sense from them of what Ward must have been like in high school. I think it's a good thing there is only one Ward, however.

Aside from his love of QRP contesting (his only visible character flaw), Ward's membership in the "colorful character" club is a result of his diverse collection of interests within contesting.

"The list of my current amateur activities includes:

• Northwestern Division CAC Representative and resident pot-stirrer.

• WRTC—I am a member of the WRTC Steering Committee. My biggest focus here is the methods that are used for operator selection. I published a first stab at operator rating a few years ago and would like to take some of those lessons learned to put the US team selections on a more solid footing. Having some kind of metric to evaluate performance is not only a convenient way to identify top performers nationally, but is a powerful tool for personal growth, as well.

• 'Advanced Internet-Radio Hybridization'—While participation is growing, contesting has not changed much strategically since the introduction of multi-multi stations in the sixties—get on, be loud, call CQ. SO2R is basically an advancement of the single-operator skill set, but is not a significant qualitative change. The integration of the capabilities of real-time, high-bandwidth, worldwide networking with HF contesting could create some truly unique and exciting new avenues for technological adventure. I'd like to see experimental categories in major contests to encourage and publicize new and exciting ideas.

• Travel and DXpeditioning—I've taken a hard look at my station and its capabilities with an eye towards going to 'the next level.' Frankly, it would cost a lot of money to make the improvements that would be necessary for me to challenge some of the other big stations out there.

"My intentions, instead, are to spend those dollars traveling. I'll be part of the HC8N crew this Thanksgiving, and I've signed on with the Caribbean Contesting Consortium (PJ2T) and am hoping to get my first shift behind the radio on Curacao during the 2002 ARRL CW. This is a mighty big world and I'd like to see what it sounds like from 'out there'—including DXpeditioning. I'm not getting any younger and, while I can still hear, think and type, I'd like to be one of those guys standing around the water cooler on a pile of broken coral and shells."

That brings us to the reason for the title of this profile, Ward's talent for trivia. I asked him how this interest evolved. "I've always had a knack for remembering a lot of facts, even when little. That's just my thing, I guess—I read voraciously and seem to hang on to a lot of it. Somebody came up with the idea of having a little fun at a WWDXC Christmas party, and that spawned the first quiz. People seemed to like it, so I submitted it to Chod Harris at *DX Magazine*. It got a good response, so I wrote up a couple more and then found that I'd apparently tapped into something my brain has a lot of. Once you get the hang of it, you start building up lists of question topics, and then words over time. Aside from the trivia quizzes that have appeared in *QST*, there are now two volumes of Yagi tests and one of vertical comparisons resulting from my work with K7LXC. Collaborations with Bob Brown, NM7M, led to two volumes of a Top-Band Compendium benefiting the Western Washington DX Club. I am about to branch off and try my hand at some 'real writing' and have the ham radio community to thank for being a great and supportive peer group. It's important to have had the opportunity to test my wings, get some self-confidence, and work out some of the mechanics. Look for my byline on *QST*'s 'Contest Corral' and as a technical editor."

My final question to Ward was "what keeps you contesting?" "Funny question—it's a difficult thing to answer. A little sequence of goals has pulled me ever farther in the sport. The first time I made the Top Ten box in the CW Sweepstakes was really mind-blowing, and has led to serious efforts to make a top score nationally in certain contests. I realize that 'winning'—as in getting the highest score—is pretty much out of my reach in any contest except the Sprints, and possibly the CW SS, at least from this QTH. However, there are lots of minor accomplishments to be had in almost any contest, if you're willing to look. Record opportunities abound: Improving multiplier or QSO totals, beating my competition, yearning to take one of N5TJ's records, that sort of thing. I also organize teams and micro-contests in this area, and that also keeps interest high, particularly during the poor propagation years." ■

Contest Tips, Tricks & Techniques

Gary Sutcliffe, W9XT
w9xt@qth.com

Station Layout—Part 3


W9XT

This is the third and final installment in our series on station layout. In case you missed them, Part 1 touched on some of the theory behind how equipment layout affects efficiency. Part 2 covered general layout, layout for SO2R operation, antenna control considerations and human factors.

Cable Routing

One common problem in the shack is dealing with all of the cables. These can quickly turn into a real rat's nest. A great starting point for keeping things in order is to label every cable on both ends. A labeling kit can be a good investment. W4PA goes one step further. In addition to labeling the cables, Scott also wraps a piece of colored tape on each end to help keep things straight.

The operating desk at GW4BLE uses a commercially available cable management system. It is designed for dealing with phone and computer cables in the office environment, but Steve says it works equally well in the shack. It is essentially a tray that fastens to the back of the desk. Cables lie loose in the tray. Steve used to tie wrap all of his cables to keep them in order, but that proved to be a pain when he needed to rework something. The tray system makes changes easy.

Steve says that even though he has all of the cables running right next to each other, he has not experienced any RFI problems. He attributes this in part to the fact that he only buys the highest quality cables and connectors.

You can purchase trays for routing cables from industrial electrical supply companies. Mail order companies specializing in computer supplies, especially networking equipment, are another source.

Tie wraps are often used to make tidy bundles of cables. Common zip ties must be cut for removal, which is a pain. Office supply stores offer hook and loop type wraps. These can be opened up and re-closed as many times as necessary when changes are made.

K9AY has a 12-inch utility shelf under the rear of the main console. This holds the rat's nest of cables. Holes that are bored in the tabletop behind the radios provide routes to the shelf.

Keeping the table away from the wall can help when snaking cables around. K3PP positioned his about 3 feet from the wall. Glenn says that it may not utilize the shack space as well as other methods—and might not look as nice—but it does make repositioning equipment and changing connections a breeze.

K4TMC has given up on trying to control the cable mess. Henry's comment is "this is an operating shack, not a model shack!"

W9YS passes on a neat trick for grabbing cables in hard-to-reach locations. Mike makes a fish hook out of a coat hanger.

N4ZR gave a talk at the 2001 Dayton Hamvention titled "Why do they call it wireless?" In case you missed Pete's talk, you can view the Power Point presentation that he used at **www.pvrc.org/dayton_2001.htm**. It is well worth checking out if you are looking for some additional ideas.

Odds & Ends

Building a station that is efficient for both single op and multi-op efforts is difficult, notes K9SD. Sam's operating desk is 22 feet long. This design was due mainly to the shape of the available space. While it is convenient to spread the equipment out linearly for a multi-op contest facility, he thinks an L- or U-shaped console is a much better configuration for the single op station.

K9UQN recently swapped his desk mike for a Heil headset. Bob Heil told him that his score would go up 30% in his first contest. Don says that Bob's estimate was almost dead on. The hands-free operation—along with the freed up desk space—was a big advantage.

Positioning computer monitors presents a special challenge. You want them in a good location since you will be spending a lot of time looking at them. Larger monitors are easier on the eyes but take up more space. I currently have a 15-inch monitor in my shack. It is getting close to 10 years old, and it's getting a bit difficult to read—a situation that's not helped by my middle-aged eyesight. It is time to buy a new one. I am trying to decide if the enhanced readability of a 17-inch monitor is worth the extra shelf space it will require.

K9AY has an interesting future plan for his computer monitor. Gary currently uses a 17-inch CRT-type monitor. Once the price on them drops enough, he plans to purchase a thin profile LCD monitor and mount it on a movable arm. This will let him easily adjust its position as he shifts his attention from one radio to another.

WA3SES thinks raising the front of the rig up at an angle is a big help, as the displays are pointed up more towards your eyes than your chest. Ed uses a piece of 2×4 lumber to prop up his rig. He says that you could probably find something more attractive to use, but his solution was inexpensive!

PY2NY says that his current shack layout is the result of a lot of experimenting. Vitor's one wish would be for his cables and coax to enter the shack from underground, but that's not possible.

Several operators—including K8JP, K9UQN and N4ZR—mention the benefit of keeping a wattmeter right in your line of sight. The idea is that you will notice a drop in power right away, as opposed to eventually realizing there's something wrong after wondering why your rate has been so low for the last hour. Those dual-meter watt meter/SWR bridges are an even better choice for this purpose. A drop in power may result from equipment problems in the shack or your antenna system, but the SWR meter can also alert you if you are—for example—accidentally trying to transmit an 80-meter signal into your 10-meter antenna.

Good engineering practice dictates that you should isolate low signal level cables, power cables and high signal level cables from each other. KJ9C has an interesting idea for keeping RF out of the computer and minimizing computer noise in the radio. In his shack, all of the RF-related stuff is located to the left side of the center of the operating position, and all of the computer-related stuff is located to the right.

K3PP mentions a problem that affects just about every ham: clutter in the shack. In preparation for the beginning of each major contest, Glenn performs a major clean up. He puts all of the things that seem to collect in the shack into a box and moves it to a different room. (Glenn notes, however, that a lot of those items are lost forever after that!)

Dave, W9LYA, passed on a neat little trick that allows him to adjust his manual antenna tuner without causing a lot of QRM. Dave has a two-position antenna switch that toggles between his rig and an MFJ-259 antenna analyzer. When he changes bands he flips the switch to the analyzer position and uses that to fine-

tune the antenna tuner.

KH6SQ operates a ham-oriented bed and breakfast in Hawaii. Terry says that several well-known contesters have been guests there, and they often rearrange the existing equipment to suit their own preferences (which is just fine with Terry).

This wraps up our three-part look at station layout. I hope that you have enjoyed it and have picked up a trick or two. In Part 1, I mentioned that my own shack was—about 10 years ago—carefully designed around the gear I had on hand. Over the years though, much of the equipment has been upgraded and several new pieces have been added. The current shack layout really just evolved over time. There was no grand master plan.

Before the start of the fall contest season I intend to completely tear down my station and reassemble it. Better cable routing and careful relocation of the most often accessed equipment are my primary goals. Other changes under consideration include more flexible and efficient antenna control.

A big thanks goes out to AA4NU, GW4BLE, G3BUO, KH6SQ, KJ9C, K3PP, K4TMC, K4XS, K4WI, K8JP, K9AY, K9SD, K9UQN, N4ZR, N0KE, PY2NY, WA3FET, WA3SES, W3DQ, W4PA, W9LYA and W9YS for sending in their comments on station layout.

Topic for January-February 2002 (deadline November 10th)

Reducing Interference in Multi-Op and SO2R Stations.

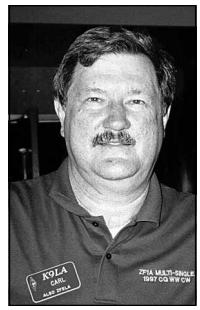
What kind of inter-station interference problems have you experienced and solved in your multi-op or SO2R station? What types of filters or other special equipment have you used? What antenna combinations have you found worked best at reducing interference between stations? Packet assisted contesters: have you had problems between your packet and HF stations?

Send in your ideas on these subjects or suggestions for future topics. You can use the following routes: Mail—3310 Bonnie Lane, Slinger, WI 53086. Internet —**w9xt@qth.com**. Please be sure to get them to me by the deadline. ■

Propagation

Carl Luetzelschwab, K9LA
k9la@gte.net

The Importance of "Ground"—Part 1



K9LA

One of the QSLs that I received for a February YK9A DXpedition that I participated in was from a DL2. He included a short note saying that he used to listen to AM broadcast station WOWO back in the '60s when he was a BCL (broadcast listener).

WOWO is a 1190 kHz AM radio station here in Ft Wayne. Back then it was one of the elite Clear Channel AM stations in the US. The antenna system was a directional array that put nulls to the southwest (to protect a Mexican station and a station in Dallas) and to the west-northwest (for a station in Portland, OR). This resulted in WOWO's signal being best on headings from north through southeast.

Back in those days Bob Sievers, W9JFT, was one of the DJs. During the winter months WOWO would occasionally receive reception reports from overseas listeners. Most were from Europe (like the DL2), but one notable report was from a listener in India. W9 to VU on 1.19 MHz—now that's some good DX, even when you take into consideration the amount of power WOWO ran (50,000 W carrier).

One of the critical parameters that helped WOWO's signal travel to Europe and beyond was the station's "ground." WOWO's engineers had selected the location for its antenna after an exhaustive search for a site with the best ground conductivity in the area west of Ft Wayne. Their effort in this endeavor highlights the importance of ground.

There is more than one geographic location, however, where ground quality is important to our contesting (and DXing) efforts. The ground that WOWO's engineers chose—and improved by adding buried radials—was the ground right under their antenna and extending out many wavelengths. This ground plays a critical role in the efficiency of an antenna system and the strength of the antenna pattern at low elevation angles—those angles generally considered best for long distance communications (there are exceptions to this, as discussed in my November/December 1999 "Propagation" column).

The other important ground locations are likely to be hundreds or thousands of miles away. These are the spots where, in a multi-hop propagation mode, our RF strikes the surface of the Earth and reflects back up to the ionosphere for another hop. The quality of ground at these distant locations determines how many dB are lost in each ground reflection.

The quality of ground varies considerably over the surface of the Earth. We have good dirt, we have average dirt, we have poor dirt, we have rock in mountainous areas (diffraction, rather than reflection, might be occurring there), we have fresh water, we have salt water, we have sand and we have ice in the Polar Regions. I probably left some out, but the ones I've listed more than likely cover most of the variations.

Each type of ground affects the reflection loss of our RF differently. The frequency of the wave, the polarization of the wave and the angle of incidence with respect to the surface also come into play. **Figure 1** is a collection of plots that show the reflection loss for salt water, average ground, poor ground, and the polar ice cap for horizontal and vertical polarization on 160 and 10 meters versus the angle of incidence (0 degrees is grazing incidence, 90 degrees is normal incidence). The plots are arranged in descending order of ground quality. The top two plots (the left for horizontal polarization, the right for vertical polarization) are for the best ground (salt water). The bottom two plots (again the one on the left is for horizontal polarization and the one on the right is

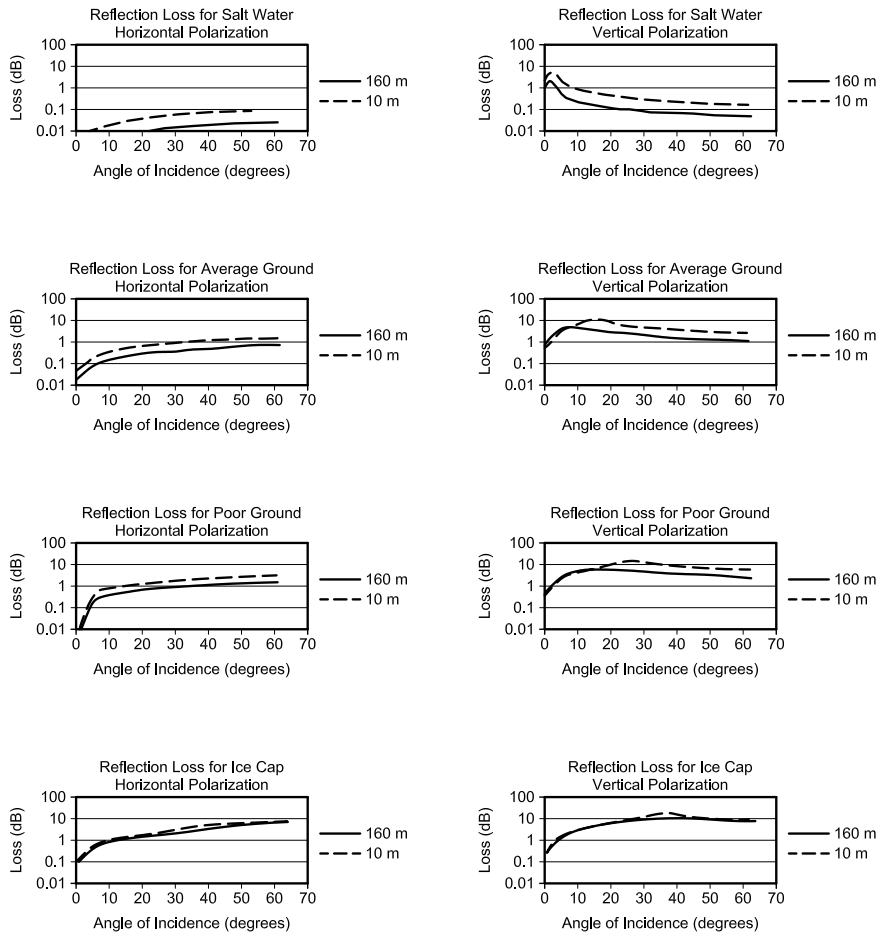


Figure 1—Reflection loss of 10- and 160-meter horizontally and vertically polarized signals over a range of incident angles for four types of ground quality.

for vertical polarization) are for the worst ground (polar ice cap).

Those eight plots are kind of busy, but if you stare at them long enough you'll see some trends emerging:

1) There is more reflection loss as the quality of the ground gets worse.

2) Ten meters suffers more reflection loss than 160, except for the worst ground condition where they're pretty much identical.

3) Vertical polarization exhibits a peak in reflection loss that occurs at progressively higher angles as the quality of the ground gets worse. The angle of maximum reflection loss is called the pseudo-Brewster angle, which is named after the same phenomenon in optics.

4) The reflection loss for both polarizations for a given ground condition is equal at 90 degrees (normal incidence), and this can be seen by visually extrapolating the plots out to 90 degrees. Not so evident from these plots (especially the good ground plots where the pseudo-Brewster angle is low) is the fact that the reflection loss for both polarizations for a given ground condition is also equal at 0 degrees (grazing incidence).

Next time, we'll take a practical look at what all this means. ■

VHF-UHF Contesting!

Jon K. Jones, N0JK
n0jk@hotmail.com

WSJT in VHF Contests

This summer the "WSJT" weak-signal mode for meteor scatter appeared. It quickly became very popular. Thousands of 6- and 2-meter QSOs have already been made via this mode. In the weeks leading up to the 2001 September ARRL VHF QSO Party, there was a lively debate on the VHF Contest Reflector: Could the new mode be used for contest QSOs? Was it allowed under the current rules? Is it "ethical" to make QSOs using WSJT for contest credit?

Just What is WSJT?

WSJT is a software package developed by Joe Taylor, K1JT. WSJT stands for: "Weak Signal Communications, by K1JT." The mode itself is designated "FSK441." It is similar to High Speed CW in that it uses a high data rate to communicate using meteor scatter. It is not CW, however; it's four-tone frequency-shift keying at 441 baud. The benefit of WSJT is that it allows scatter DX QSOs to occur under "dead band" conditions—it does not rely on meteor showers, sporadic E or tropo propa-gation. The typical range is from 500 to 1400 miles. K1JT notes "Most hams who have tried WSJT have found it fun and easy to use. It is a big step beyond High Speed CW, and a vast step beyond SSB for meteor scatter work."

WSJT allows operators to take advantage of "under-dense" meteor burns. These are frequent, but the signals are very weak and the burn duration is short. This is what's behind the "pings" you hear on SSB. WSJT allows you to use these under-dense burns to carry high speed data (147 characters per second). DSP performed by PC sound card software is used to decode these extremely weak signals. You can find more detailed information on the new mode at the WSJT Web page: **pulsar.princeton.edu/~joe/K1JT**.

Why the Debate?

One reason stems from a property of the software. K1JT notes in his "announce.txt" that "WSJT does not require any proficiency with Morse code." The signals are decoded and displayed as text on a computer monitor. A number of VHF operators believe that the human ear should be used for detection of signals. N6TR observed, "The day might be coming where technology could replace the human ear with enough performance to make the human detection method noncompetitive... I, for one, would not welcome that day, as I think it would remove most of the fun and make the contest results less dependent on operator skill, but rather on how well you can program your DSP. I feel the basic thing that makes ham radio interesting compared to just sending e-mail is putting on your headphones and listening."

Quite a few ops—myself included—prefer to hear the signals through the phones. We consider that part of the rush of operating VHF meteor scatter. After hearing many minutes of noise, a signal rises up to clear copy and you make the contact. But then again, there are HF contests—such as the RTTY Roundup—that are decidedly "digital." The operator doesn't decode RTTY by ear.

One unique aspect of most VHF contests is that all modes are allowed. In a typical VHF contest, contacts are being made using AM, FM, SSB, CW, PSK31, SSTV, EME, RTTY and HSCW. Why should WSJT/FSK441 not be allowed?

An argument for using WSJT is that it gives the "little pistols" and "black holers" a chance to be competitive in the contests. Arliss, W7XU, provides us with a "black hole contest station" perspective: "The only way my station (competing as a limited multi-op) sitting here in South Dakota can compete in the VHF contests is by running up relatively large grid square totals. During a typical June contest, roughly 15 percent of the stations we work on 2 meters are within 200 miles. We just don't have the population base to make a lot of QSOs on the VHF bands, so we try for grids. So late at night and during the early morning hours someone is up running schedules on 2-meter HSCW (and WSJT in the future). If we can't run meteor scatter, our 2-meter station might as well shut down at midnight and not bother to get back on until 8 AM Sunday. For us, HSCW and WSJT increase the activity level, and are primarily late-night activities. They don't cut into daytime activity levels."

As for the little pistol, I completed a few 1000-mile 6-meter WSJT QSOs in 15 to 20 minutes running 50 W to an attic dipole under "dead band" conditions. The mode is amazing, it gives my simple station the same VHF DX capability on 6-meter scatter as a big gun running a kW on SSB feeding stacked Yagis. Seen from this perspective, WSJT could be a real boost to overall contest activity. With more hams living under antenna restrictions, WSJT gives anyone a shot at working some "real DX" on 6 and 2 meters—even if the bands are "dead."

What is the ARRL's position on all of this? Dan Henderson, N1ND, posted the following: "Nothing in our rules prohibits any specific mode or modes in the VHF/UHF contests. We allow all modes in VHF/UHF contests. There is nothing in the rules which prohibits the use of a decoding-type device. The one limitation is that any QSO claimed for contest credit must be completed during the contest. Both parties in a QSO must send and acknowledge the required contest exchange during the contest period. Taping or similar means of storing information for decoding after the contest period would not be permissible."

There are no restrictions on the use of WSJT in the ARRL VHF contests. I suspect that the big gun stations will use it, or they will end up being less competitive. Little pistol home stations may find that if the bands are dead, WSJT can make a dull contest interesting and fun. Rovers may want to consider using WSJT as well, as it can certainly be set up on a laptop.

Some Final Thoughts on WSJT

WSJT is a fun mode to play with, and being CC&R antenna restricted at home, WSJT offers me increased opportunities for VHF DX. I should be one of its biggest fans. Somehow, though, WSJT leaves a hollow feeling.

I was recently leafing through my 2-meter QSL card collection. Looking at the cards reminded me of the many hours that I've spent patiently listening to the band noise, and the joy of catching rare 2-meter Es openings as S9 signals from a thousand miles away suddenly popped up. I remember feeling as if I could practically smell DX in the air in the moments before a 2-meter tropo opening to the Gulf Coast, and I can almost still hear the characteristic broad hiss of the CW signals during the aurora contacts that I made.

These experiences are even more special when they occur during a contest. I recall watching WA0TKJ run Florida stations on 2-meter Es from WB0DRL during the June 1987 VHF Contest, personally working W2SZ/1 on 70-cm tropo in that same contest, seeing AA7A in Arizona pin my meter on 2-meter Es during the June '96 contest and logging him running 10 W, and savoring the all-day/all-night tropo opening to 8 and 9 land during the 1993 September VHF QSO Party. This is the stuff VHF contest memories are made of. I'll bet it's like the feeling that a surfer gets when he catches that rare perfect wave. All of the hours (years) of listening to band noise pays off when you encounter these types of openings. You can't work that kind of stuff every day on 2 meters. Or can you?

WSJT comes along, and now you can. Have hard work, skill, experience, patience, hours of listening to noise, station building and luck now been replaced by a software program, a sound

card, a "RIGblaster" and skeds made in an Internet "pingjockey" chat room? Fifteen years from now will I be waxing nostalgic about my WSJT contest QSOs?

The 2001 ARRL UHF Contest

There were some decent tropo openings during this year's UHF contest. Mike, K0AZ, in EM37 made numerous QSOs into Ohio and Michigan on 432 MHz. I operated Sunday morning QRP portable from EM18 and found loud signals from W7XU in South Dakota, K2DRH in Iowa, W5ZN in Arkansas and K0AZ in Missouri. I heard K9KL in EN64 (almost 700 miles distant) but wasn't able to complete a QSO. K1DS reported a 13k score operating rover. The UHF Contest is a good opportunity to test gear and antennas in preparation for the September ARRL VHF QSO Parties.

EME Contesting for Beginners

The 2001 ARRL EME (Earth-Moon-Earth) Contest will be held on the weekends of October 13th and 14th and November 10th and 11th. The object of this contest is "Two-way communications via the Earth-Moon-Earth path on any authorized amateur frequency above 50 MHz."

Many VHF operators believe that only "big gun" stations can participate in EME contests. While being a big gun helps, thanks to the existence of some really big EME stations, like W5UN, even relatively modest stations can complete EME QSOs. This is one type of contest where making even one contact makes you "a winner." Here are some suggestions that may help you make the ultimate long path contact.

Two meters is probably the easiest band for you to attempt your first EME contest contact. Dave Blaschke, W5UN, has used a 480-element phased Yagi array that—due to its very high gain—provides single and two Yagi stations an opportunity to work him on 2-meter EME (see "MBA, The Mighty Big Antenna" in *QST*, Sep 2000 for more information on Dave's EME array). Several other stations—such as KB8RQ, W7GJ and some Europeans—also have very large Yagi arrays. Due to the extremely weak signals, most EME work (particularly for those employing a "minimum station") will be on CW. The big guns can and occasionally do make EME SSB QSOs amongst each other.

What are the minimum station requirements to work a big gun on 2-meter EME? A single 3.2- or 4.2-λ long Yagi and 160 W will give you a reasonable shot. Dave has worked lessor stations, but says that those contacts were very marginal. He states that "If your 2-meter station outputs 100 W or more to a good 16-element Yagi antenna, and your receiver front end has reasonably low noise, you may be able to work me via 2-meter moon bounce." More power helps. If you are running a kW to two Yagis for terrestrial work you should have no difficulty completing some EME QSOs.

If you are using your tropo station for

Johanna Preston, W5JLP (president of the University of Texas Amateur Radio Club), and Gary Raney, KM5TY, operating the club station, N5XU, during the 2001 ARRL September VHF QSO Party. Johanna is a senior in chemical engineering and Gary is a sophomore in economics.

EME, your best chance for contacts will occur during moonrise and moonset. The rise and set times can be found in an almanac or in your local newspaper. The azimuth can be derived from various sources on the Internet, or you can even just use visual aiming. There is about 20 to 30 minutes of usable time at rise or set for making EME QSOs. As the moon rises you may hear Europeans as well as W5UN, KB8RQ and others calling CQ.

Pileups often occur as stations call the big guns trying for an EME contest QSO. Moonset may be an easier time to get through to them as many stations shut down after the "European Window" (the time of shared visibility of the moon between Europe and North America) closes. Some years ago I heard W5UN quite loud at moonset during an EME contest calling CQ after CQ with no takers. One call with 160 W and a Junior Boomer Yagi and he was in my log.

Almost all 2-meter EME activity takes place in the lowest 100 kHz of the band. Many EME stations have an established frequency. W5UN uses 144.041 MHz. Often you can get a good idea of who you are listening to by what frequency they are on.

Once you have made a few EME contest QSOs, you may have your interest piqued and want to make more. The number of contacts you can make via EME is very dependent on your antenna gain and power. Building up a four-Yagi array that can be steered in azimuth and elevation and running a kW will open a whole new layer of potential EME contacts. This station can be purchased "off the shelf." From four Yagis, some choose to advance to 8, 16, 32, or more. Then it's often on to new bands—432 MHz and 1296 MHz are the next most popular. EME on these bands requires more technical proficiency, but is certainly within the reach of a persistent ham.

EME can be used in the upcoming ARRL January VHF Sweepstakes—January 19th through 21st, 2002. Some of the big contest multi-ops and W5UN may be active at moonrise and set. Depending on EME conditions during the contest weekend (EME conditions vary with the location of the moon against the stars and its distance from earth) some stations may make as many as 20 EME contest QSOs. It is a little tougher to complete EME contacts during the VHF Sweepstakes, as you must exchange and confirm grid squares. EME may be a way for you to pick up some additional contest QSOs and new grid squares. It may be worthwhile to check the low end of 2 meters during moonrise and moonset.

A good variety of links to EME resources are available through **www.links2go.com/topic/EME**.

W5UN's Web site has a lot of useful information on basic station requirements, an online "ERP Calculator" for evaluating your station, and a good "EME Operating Primer." Dave even has a fully functioning and useful moon tracking program that you can try free of charge: *Moonbrat*. Visit his Web site at **web.wt.net/~w5un/**.

Hope to hear your signals off the moon! ■

Contesting For Fun

Brian Kassel, K7RE
bkassel@dancris.com

The Magic Homebrew Elixir

Contest-oriented folks like us tend to have a reputation for being a rather fussy lot. We always seem to be striving for perfection in so many ways when it comes to operating. And there are, indeed, many challenges to be reckoned with in the contest operating arena. Trying to increase rate is often cited as one. Collecting all of the sections in the ARRL Sweepstakes is another. The list can be quite lengthy, and is limited only by one's personal abilities and urge to succeed.

Homebrewed Rig + Contesting = Fun

There is one challenge, though, that may not seem as obvious—especially in the context of contemporary Amateur Radio contesting. I'm talking about the art and challenge of building or homebrewing some—or even all—of one's contesting equipment.

But why in the world would anyone even consider such a notion? Well, for one thing, there are a few contests that award bonus points or multipliers for those using a home-built radio. Generally, the rules of these contests allow the equipment to be built from scratch or kits. Beyond just the points though, there is an indescribable satisfaction one experiences when operating a contest with a rig (or even a small accessory) that was crafted with his or her own two hands.

Kits—Not Just that Greasy Kid's Stuff Like Your Dad Used to Use.

Certainly one couldn't possibly build a rig that would be anywhere near as good as those available in today's commercial amateur marketplace, right? Nope, DEAD WRONG! Just a couple of years ago a kit radio appeared on the market that is, by anyone's standard, a world class transceiver. I'm specifically talking about the Elecraft K2. I encourage you to have a look at the company's Web site: **www.elecraft.com**.

Elecraft's site provides links to PDF copies of the Mar 2000 *QST* K2 Product Review and the ARRL Lab's K2 Expanded Test-Result Report. Compare some of this rig's features and basic receiver performance numbers with ANY other transceiver—including some of the top-of-the-line radios. You will be surprised; I guarantee it. Although the K2 currently only produces QRP-range power output, a self-contained 100-W amplifier option is in the works, and should be available soon.

Remember Heathkit? If you've been a ham for more than 15 years or so, I'd lay odds that you've built and owned at least one of their products. Ever since they ceased producing kits, many—including myself—have yearned for some outfit to step in and take their place. The Heath manuals and kit instructions were, in their day, THE standard to judge any other kit offering against. Their customer support is equally legendary.

Well, hold on to your toupees, folks, the well written manuals and level of customer support that Heath was famous for have perhaps met their match. Elecraft has already earned a similar reputation in the few short years that they've been around. Now, I don't expect you to take my word for it. (Hey, *I* wouldn't even take my word for it.) Check it out for yourselves. Visit their Web site, download a PDF version of one of their manuals, and/or ask some of their customers.

I Want My Radio *My* Way

There are additional advantages to rolling one's own rig. How about customization? The shape and various parameters of receive filters can be an amazingly personal thing to individual operators. The K2 allows one to set up each of its four filter positions for the CW and SSB modes using a simple software and firmware approach. One can spend any number of hours tinkering around with these filter parameters. No physical adjustment of trimmer capacitors or inductors is required; they are set up using menu parameters. Even the clinically diagnosed retentive will be filled with joy over the almost infinite filter possibilities.

You Can Have My Key When You Pry It From My Cold Clenched Hands...

Some folks are CW diehards, and may take pride in the fact that they don't even *own* a microphone. Why should these hams pay extra for a mode that they will never use? Why, indeed? SSB is an option on the K2. If you don't have any use for it, you don't have to pay for it. Adding or removing the option is quite painless. The additional SSB circuitry is built on a plug-in board.

Oh Give Me a Home Where My Radio Roams

I really enjoy portable contest operation. Talk about pure fun!

There just isn't a field-oriented contest or event that I don't enjoy participating in. If one REALLY wants to be sure to have fun, to me, minimizing the hassles pretty much guarantees that the rest will fall into place.

As with any operating configuration, one quickly develops a list of do's and don'ts for portable operation. One obvious don't is don't take any more boxes and stuff that you really need. The K2 is indeed self-contained. Standard features include a built-in CW keyer with message memories. An internal battery pack is available as an option. With that installed, you could just throw up an antenna, plug in the key, paddle, or mike (and maybe a set of nice comfortable headphones) and you're ready to go. Great fun, and minimum hassle.

Hey, I Can Do That!

One of the real hassles in contest operation is failure of a key piece of equipment. Oh sure, you can always send your stuff in for repair, but this puts you at the mercy of the repair facility. Some are good, some aren't. Lots of today's radios use very special or custom parts, available only from certain—or even unique—suppliers. Then take into consideration the trend towards surface-mounted components. These things are tough to see, much less test and replace. And let's not forget good old Murphy's Law, a corollary of which is that if something fails, it WILL fail at the worst possible time—like usually one hour before the contest begins.

Well, if one actually is the builder of said rig, and if the rig uses those slightly out of vogue through-hole components, one can probably not only fix that rig, but also do it in a reasonable amount of time. Another challenge is met and conquered! (We ARE talking about challenges here, right?)

Me Too, Daddy, Me Too, Me Too

Looking for an even more compact rig? Consider the little brother to the K2, namely the K1. (Pretty clever choice of model numbers, huh?)

The K1 doesn't exhibit the same crunch proof, contest grade performance

as its big brother, but of course it is quite a bit less expensive. Unless you plan to participate in a close-in multi-op type of operating environment, the K1 will likely fill the majority of your out-of-doors contest operating needs.

Did I mention how just plain cute this little rig is? It is a CW-only radio, and only covers two bands at a time. Optional 2-band "filter modules" are available that allow you to easily change the coverage to alternative bands. But I'll warn you, playing with the K1 can be VERY detrimental to a lousy or negative mood. It's the perfect remedy for a "bad day at the salt mines."

The Bigger They Are...

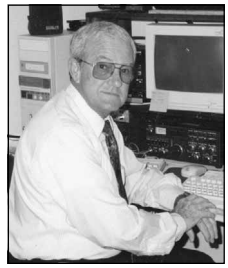
I'm aware of at least one very well known contester who loves his K1 all to pieces, so to speak. He's even been known to take the little beastie with him on mini-DXpeditions, and will sit it right next to his big contest radio and amplifier. I can also tell you—from personal experience—that it's quite a chore to get him to put down the paddle and move on to some of the more germane chores around the contest station. Even when one does succeed in getting him to relinquish his key, he just grins from ear to ear, and keeps repeating "But it's just SOOOO cute." A grown kid and his toys... But hey, can any of us really throw stones here?

I've got my toys, and I'm sure you do too. The difference is that some of us KNOW who built their radio.

73, Brian, K7RE ■

RTTY Contesting

Wayne Matlock, K7WM
k7wm@i10net.com


K7WM

By the time you have this issue in hand, the summer doldrums will be over and winter will be upon many of us. It's been an interesting summer in the world of RTTY. A couple of new FSK/AFSK modes came on line and generated all kinds of comments, interest and experimentation.

First on the scene was the MFSK16 mode, whose proponents set up camp smack dab in the middle of the RTTY DX calling frequencies. This really produced lots of comments, mostly negative.

The sound of the mode is quite unusual. I had to do some investigating to ascertain just what kind of signal it was and how in the world to decode it. Usage has declined and there is more or less peace on that portion of the band once again. I feel that the lack of DXpeditions this summer kept the potential for interference problems to a minimum.

Then another RTTY mode was introduced, RTTY23. A sponsoring group ran a test to see how it would be accepted and if it was practical. The comments flew back and forth for awhile. As of this date, we have yet to hear any reports on the information that they gathered.

All in all—and trying to keep everything in perspective—this is what keeps ham radio interesting and progressive. Someone is always looking for a "different" way to communicate.

I remember back when SSB appeared on the scene and us ole AM fellas were pretty vocal about not being caught dead making them Donald Duck sounds on the air and gracing them with our call signs. My, how time changes things...

A new PC sound card RTTY program became available—*MMTTY*—and has found enthusiastic acceptance. Several of the more popular software/contesting programs have already incorporated *MMTTY* into their packages. *MMTTY* is a *Windows* RTTY program that was developed by Makoto Mori, JE3HHT. Visit his Web site **www.qsl.net/mmhamsoft/** for more information.

Nayyy...

A well-known ham that publishes a RTTY newsletter brought up the SO2R controversy again as he had received several letters on the subject from his readers. As of the last edition of the newsletter published, he says that as far as he is concerned—due to lack of interest and no rules changes—the topic is closed. Kinda like beating a dead horse.

The RTTY World Ranking List

Waldemar, DK3VN, has a "RTTY World Ranking List" posted on his Web site, **www.qsl.net/dk3vn**. Along with the list, Waldemar has laid out the rules that he is using to compile the list, and has solicited comments and suggestions for improvements. Check out his Web site and you'll see that he has put a lot of serious effort into this project and, in turn, has generated a lot of interest and comments from RTTY operators around the world.

A list of the 17 RTTY DX contests whose official results are used in the determination of the list standings is shown on the site. All you need to do to have a chance to get on or change your standing on the list is simply submit your logs to the individual contest sponsors. Not sending in a log—even if you operated for fun or only for a short period of time—could be likened to racing a 100-mile hare and hound motorcycle race and then pulling off the track 50 yards from the finish line. (I don't know about you, but I always wanted to finish that sucker after 99+ miles of getting beat to death.)

NAQP Plaques

If you would like to sponsor a plaque for any of the NAQP contests, please drop a line to the appropriate Contest Manager. They will be extremely grateful. If you have already committed to sponsoring a plaque and feel you cannot continue to do so, please notify the Contest Manager immediately so that a new sponsor can be located.

To all contesters who send in logs, please be sure that your correct address is on the log/summary sheet. Nothing is more frustrating to a Contest Manager than to mail a plaque or certificate out and have it come back due to an incorrect address. Mailing plaques and certificates is not cheap. Plaques are about $3 each for stateside addresses and certificates are 70 cents each for stateside and $1.75 for DX.

The *NCJ* NAQP RTTY Contest was an outstanding success this year. Propagation did not do us in like last year. Participation was at an all-time high and team competition was great. The "Big Dogs" team got off the porch and were really howling again. There has been a rumor that some serious attempts to chase them back up the steps and quiet them down, en masse and/or individually, is going to occur before next year. This may be just a vicious rumor, so don't place too much credibility on it.

SCC RTTY Championships

The Slovenia Contest Club's SCC RTTY Championships was a great success. Propagation on 10 meters here on the West Coast was strange at best, but the remainder of the bands were in excellent shape.

I ran into some trouble on 80 meters though. I was asked to move there at about 0500Z. I flipped the antenna switch, turned the amp to standby (thank goodness), hit the TX button on the TS-850S and the SWR went off the scale! I rechecked all of my settings and they all looked good. It was time for some head scratching. I tried everything, but I could not get the SWR down. I eventually moved back to 40 meters.

The next morning I took a walk out to the tower to try to figure out what had gone wrong. I immediately noticed that the coax on my 80-meter bazooka was disconnected from my tower antenna relay box! The prior morning I was out checking the 10-meter monobander and—while reaching under the relay box—had inadvertently unscrewed the 80-meter antenna connection instead. In my hurry to get the 10-meter antenna checked before the temperature reached 110 degrees and it was too hot to climb the tower, I had forgotten to reconnect the feedline... Sometimes the dragon wins. I hung my head in shame. I sure could have used those 80-meter mults.

A Quick Glance in the Rearview Mirror

I am approaching the 2-year mark as the RTTY Contesting columnist. Looking back over that time we've had excellent guest columnists who have given us views of RTTY contesting from Africa, the Caribbean, the East Indies and Guernsey. Wish I could have been there with them.

There have also been outstanding guest columnists who have written on SO2R RTTY contesting, strategy and time management for contesting and contesting from some of the more exotic stateside contest locations. To all of these guest columnists, I extend my heartfelt thanks for sharing their experiences with us. If *you* have a RTTY contesting story to tell or one to share, please drop me a line. Your input is more than welcome.

That's it for this issue, 73 to all and hope to work you in the contests.

Wayne, K7WM, in Lonesome Cibola... ■

Contest Expeditions

Kenny Silverman, K2KW
k2kw@prodigy.net


K2KW

I'm writing this column just a few days after the horrific tragedy of the terrorist attacks against the World Trade Center and the Pentagon. It is difficult to comprehend what happened and why. The small things that we often complain about in ham radio seem so trivial now. My heart goes out to those who have been impacted by this horrendous act. This is an event that will forever be etched in our memories.

Life must go on, but our world has changed. Those of us who travel on DXpeditions will be faced with increased domestic airport security and restrictions. At this time of writing, airlines are barely starting to fly again and the security processes that we will have to go through at airports are still uncertain. Below are examples of some of the ways that the changes in air travel will impact our DXpeditions. The new Federal Aviation Administration (FAA) regulations are not being released directly to the public for security reasons, so there may be changes or errors in these guidelines. When the time approaches for travel on your next DXpedition, please thoroughly investigate the rules that are in force at that time.

It has always been illegal to carry anything with aerosol, flammable items, sparklers, poison and such onto passenger jets. Traveling hams have, however, always been able to take along a valuable tool: their knives (up to 4-inch blades), Swiss Army knives, or Leatherman-type tools. When flights resume, knives and cutting instruments of any size—made of metal, plastic or any other material—may no longer be allowed in the cabin of commercial planes (though they will be okay in checked luggage). These items also cannot be used or sold in any part of airport terminals, including restaurants and concession stands. Essentially, the new rule means that airport diners will be left with forks and spoons, or possibly chopsticks, but no cutlery. It is unclear if this ruling on knives is temporary.

The new rules will tighten security but also increase the time to check baggage, enter airline terminals and board planes. Curbside check-in will be eliminated. Jetliners will be searched by security officers before passengers board. Passenger planes will very likely no longer carry cargo or mail, to reduce the risks of bombs. Unattended cars will be towed if they are parked within 300 feet of a terminal. The Sky Marshals program, which places plain-clothed armed agents on selected flights, will be revived and strengthened. A thorough search and security check will be done before passengers are allowed to board aircraft.

As mentioned, curbside check-in will be discontinued. All passengers must go to the ticket counters to check in (if they have luggage). E-ticket travel has been suspended, as you must have a physical ticket to pass through security. Off-airport check-in at hotels, car rental locations and other venues has also been halted. Boarding areas are for passengers only. Only ticketed passengers will be allowed to proceed past airport security to catch their flights. If you only have hand-carry luggage and you have a physical ticket, you may check in at the gate. Since only ticketed passengers can get past security, it's no longer possible to meet anyone at the gate.

There will be more physical checks on passengers. Airport security screeners will be required to meet higher standards, and the contractors who supply the security personnel will be required to report to the FAA. Look for more professional ground security crews as well.

Baggage matching, already a common practice in Europe and the Middle East, is likely to be implemented domestically. Baggage matching is a process where all checked luggage is typically lined up on the tarmac outside the plane. Each passenger must then identify their luggage as they are boarding the plane, and only then will the luggage be loaded.

There have been rumors that carry-on items will be restricted. This does not appear to be an FAA ruling, but a decision that will be made by either the airport or airline. Apparently SEATAC in Seattle has banned all carry-on luggage, up to and including women's purses. It is unclear how the rest of us who travel with laptop computers, cameras, CD players or similar items will be affected.

There are very likely additional security measures that will affect us as we travel, but complete information is not yet available. Again, when you travel, check the current rules in force. Plan ahead, be safe, and allow at least 3 hours before departing on a domestic flight. Don't expect to arrive 25 minutes before a flight and be able to make it—those days are behind us. Even short flights will essentially be an all-day event. Be patient, as these security measures are intended to ensure your safety.

New QTH News

The following are some tidbits that will help contest expeditioners find their perfect contest location. For additional information, see my Web site, **www.dxholiday.com**.

• Contesters will delight that Ranko's (YT6A) QTH is now available for rent! He has a potent station with multiple towers and huge antennas.

• "The Contest Registry," a column that appeared in the recently discontinued *CQ Contest* magazine, will still be available on my Web site. The registry is intended to link up new contesters with contest Elmers around the world (though many of these Elmers will welcome any contester who wishes to operate from their location).

• For those of you who are searching for 3-point contest locations, Cape Verde Islands (D4) has started issuing 6-month temporary visitor's licenses.

• It is now possible for visitors to obtain South Korean (HL) licenses.

• The Syrian Technical Institute of Radio invites you to visit their Web site at **www.qsl.net/tir/Home.htm** and is allowing operation from their club station.

Visit my Web site for updates on available QTHs in 8P, J3, SM, V3, VP2M, VP5, ZF, VE, HI, 4U1VIC, FK, P4, DU, EA8, YJ, SV9, PJ2, 9M2, 5B, K, E4 and YU.

The contest season is upon us. Most of the big Rent-a-QTHs have already been booked, but cancellations do occur. Some of the smaller locations may still be available for last-minute reservations, so make some calls! Take care, and travel safely. 73, Kenny, K2KW ■

DX Contest Activity Announcements

Bill Feidt, NG3K
Bill@ng3k.com

This issue heralds a changing of the guard, as I take on the reins of the "Contest Dxpedition List." The first order of business is to extend our heartfelt thanks to Steve Nace, KN5H, who has conducted this column over the past year.

Some of you may know me from my Web pages. I've maintained Web listings of announced operations for the major contests since 1996. I've been a ham since 1957 and my Amateur Radio interests include both contesting and DXing. I envisage this column as a natural extension of the work that I'm already doing on the Web.

In this issue, the focus is on the CQ WW contests. More detailed and fully up-to-date information may always be found on my Web site: **www.ng3k.com**. URLs that take you directly to the pages for each contest are shown at the bottom of each listing.

Of course, listings such as these depend on information provided by you, the peripatetic contester. Please be sure to share your travel plans with your colleagues by completing the on-line form at **www.ng3k.com/Contest/consub.html** or by e-mailing them to **Bill@ng3k.com**.

I'll be especially interested to hear about your intentions for the 2002 ARRL DX contests.

Thanks in advance and I look forward to working with you all.

73, Bill, NG3K

CQ WW DX Contest, SSB (October 27-28, 2001)

Call	*DXCC Entity*	*Category*	*Operator(s)*
4U1VIC	Austria	M/S	OE5OHO and friends
4X0J	Israel	SO/SB 40M	4X4FJ
6Y6L	Jamaica	M/M	AC8G, WA8LOW, W8ILC, N7YX N6HR, K8QOE
7S2E	Sweden	SOAB	SM2DMU
8P2K?	Barbados	M/?	KH6WZ, NI7T, 8P6SH
9M6A	East Malaysia	SOAB (A)	DL2OBF
A50A	Bhutan	M/M	US and A5 team
C6A	Bahamas	M/?	W5OXA/C6AKO, W5UE/C6ARB, N5PA, K5NY, KK5EW
D44TC	Cape Verde Is	M/S	I4UFH, IK4UPB, IK2NCJ, IK2JUB, IK2SGC, IV3TAN, CT1DVV, CT1ESV, SM0JHF
E20HHK	Thailand	SO LP	E20HHK
E4/OE1GZA	Palestine	SOAB	OE1GZA
ES9C	Estonia	M/M	10 ES ops and guests ops
FG5BG	Guadeloupe	M/S	Sarajevo Contest Group members: T93M, T94WW, T93Y
FM5GU	Martinique	M/S	IV3BTY, IV3JVJ, IV3TDM, FM5DN, FM5GU, FM5WD
FY5KE	French Guiana	M/S	F1HAR, F5HRY, F5MZN, F5OIH F6HLC, FY5FU, FY5FU
GD6IA	Isle of Man	M/S	K1EU, K1JB and YCCC members
GH4BJC/p	Jersey	?	G0WFH
GZ7V	Scotland	M/M	GM3WOJ, GM4YXI
HC8N	Galapagos Is	M/S	N5KO
HR3J	Honduras	M/S	JA6WFM, JM6EBU, JM6UAA
HS4BPQ	Thailand	SOSB 15M	HS4BPQ
HS5AYO	Thailand	SO?B LP	HS4AYO
HS0AC	Thailand	M/?	JF6DEA, HS1CKC, HS6NDK, E21EIC
IQ8A	Italy	SOAB	IK8NWK
IG9A	Italy	M/M	Marconi Contest Club
IH9P	Italy	M/M	IT9BLB and Pantelleria International Team
IS0A	Sardinia	M/M	IS0GRB, IS0MYN, IS0WBT, IS0VSU, IS0XDA, IS0SEL, IS0HHA, IS0XSE, IS0HFE
J49Z	Crete	M/S	IK8UND, IK8HCG
J75J	Dominica	M/S	W4WX/J75WX, N2WB/J79WB, KR4DA/J79DA, W1LR/J79LR, W9AAZ/J79AA
JW5E	Svalbard	M/S	JW5NM, LA7FD and others
LX5A	Luxembourg	M/S	LX1AQ, DK2OY, LX1RQ, LX1ER
LZ8T	Bulgaria	SOSB 160M	LZ2CJ
NH7A	Hawaii	SOAB	NH7A
OE75CWL	Austria	SOAB	OE5CWL
OG6NIO	Finland	SOAB (A)	OH6NIO
OM7M	Slovak Republic	M/S	OK2BFN, OM3PA, OM3PC, OM5RM, OM5RW, OM5ZW
P40A	Aruba	SOSB 20M	KK9A
PJ2Z	Neth Antilles	M/S	K8NZ, WC4E, N8VW, W0CG, KU8E
SW2A	Greece	SOSB 10M	SV2AEL
TI2/SM4DHF	Costa Rica	SOSB ?	SM4DHF
TI5X	Costa Rica	SOAB QRP	N0KE
V47KP	St Kitts Nevis	SOAB	W2OX
VB2V	Canada	M/M	VE3BY, NB1B, VE3SRE, VE3DBF, VA3KO, VA3RMF, VE3OFT, VA3RD, VE3BIX, VE3KJS, VE3HAE, VA3TSG, VE3AGC, VA3FIN
VE2IM	Canada	SOAB HP	VA3UZ
VE9US	Canada	M/M	W2EN, NO2R
VK8HZ	Australia	SOAB	VK2CZ
VP2E	Anguilla	M/M	KC5EA, K5MR, K5AB, K4UEE, N5HGB, N5AU, N5QQ, W5WW, N0AT, DL6LAU, JA3USA
VP5T	Turks and Caicos	M/M	N2VW, K2WB, WA2VYA
VY2ZMM	Canada	SOSB 160M	K1ZM
XP1AB	Greenland	M/M	OX3LG and others
ZK1CG	North Cook Is	M/M	Western Washington DX Club
ZW5B	Brazil	SOAB	N6TJ

See also: **www.ng3k.com/Misc/cqs2001.html**.

ARRL Sweepstakes (CW) (November 3-5, 2001)

Call	*DXCC Entity*	*Category*	*Operator(s)*
WP2Z	Virgin Is	SO HP	K9TM

CQ WW DX Contest, CW (November 24-25, 2001)

Call	*DXCC Entity*	*Category*	*Operator(s)*
7S2E	Sweden	SOAB	SM2DMU
8P9Z	Barbados	SOAB	K4BAI
A61AJ	United Arab Em	M/M	Slovenia Contest Club
D44TC	Cape Verde Is	SOAB	Marconi Contest Club
C56/DL5XAT	Gambia	M/S	DL5XAT, DF4XX
CN2JS	Morocco	SOAB	F6BEE
GM7V	Scotland	M/M	GM3WOJ+
HC8N	Galapagos	M/M	K5KO, K6AW, KM3T, N0AX, N0JK, K1KI, K1TO, K9NW+
NH0S	Mariana Is	M/S	JQ1UKK, JF2SKV, JK2VOC, JG3VEI, JE6MYI
OG6NIO	Finland	SOAB	OH6NIO
PJ2T	Neth Antilles	M/S	W0CG, KP2L, K6LA, K4WA
TI5X	Costa Rica	SOAB/QRP	N0KE
V26K	Antigua	SOAB/LP	AA3B
V47KP	St Kitts & Nevis	SOAB	W2OX
VP5G	Turks & Caicos Is	SOAB	K3TEJ
VY2ZMM	Canada	SOSB/160	K1ZM
WP2Z	Virgin Islands	SOSB/15	K7BV
ZD8Z	Ascension Is	SOSB/10	N6TJ

See also: www.ng3k.com/Misc/cqc2001.html.

ARRL 160-Meter Contest (December 7-9, 2001)

Call	*DXCC Entity*	*Category*	*Operator(s)*
ZF2AH	Cayman Is	SOHP	W6VNR

See also: www.ng3k.com/Contest/othcon.html.

ARRL 10-Meter Contest (December 15-16, 2001)

Call	*DXCC Entity*	*Category*	*Operator(s)*
FG/K6LA	Guadeloupe	SOHP Mixed	K6LA
V31JP	Belize	SOHP	K8JP
ZF2AH	Cayman Is	SOHP	W6VNR
ZF2NT	Cayman Is	SOHP CW	N6NT

See also: www.ng3k.com/Contest/othcon.html.

ARRL DX Contest, CW (February 16-17, 2002)

Call	*DXCC Entity*	*Category*	*Operator(s)*
PJ7/ND5S	Sint Maarten	SOAB/LP	ND5S, ND5S
V31JP	Belize	SOAB	K8JP
V47KP	St Kitts & Nevis	SOAB	W2OX

See also: www.ng3k.com/Misc/adxc2002.html.

ARRL DX Contest, SSB (March 2-3, 2002)

Call	*DXCC Entity*	*Category*	*Operator(s)*
PJ7B	Sint Maarten	SOAB	W8EB
V31JP	Belize	SOAB	K8JP
V47KP	St Kitts & Nevis	SOAB	W2OX
ZF2AH	Cayman Is	SOAB/HP	W6VNR

See also: www.ng3k.com/Misc/adxs2002.html.

CQ WPX Contest, SSB (March 30-31, 2002)

Call	*DXCC Entity*	*Category*	*Operator(s)*
J6DX	St Lucia	M/S	SWODXA
ZF2AH	Cayman Is	SOAB HP	W6VNR

See also: www.ng3k.com/Misc/wpxs2002.html.

For more detailed and up-to-date information, such as QSL routes, CQ Zone numbers and any planned operation outside of the contest period, please visit the URLs given at the end of each contest's listing.

Contest Calendar

Compiled by Bruce Horn, WA7BNM
bhorn@hornucopia.com

Here's the list of major contests to help you plan your contesting activity through February 2002. The Web version of this calendar is updated more frequently and lists contests for the next 12 months. It can be found at **www.hornucopia.com/contestcal/**.

Please note that the Tennessee QSO Party, which was originally cancelled due to the tragic events of September 11th, has been rescheduled for December 2nd.

As usual, please notify me of any corrections or additions to this calendar. I can be contacted at my callbook address or via e-mail at **bhorn@hornucopia.com**. Good luck and have fun!

November 2001

IPA Contest, CW	0600Z-1000Z and 1400Z-1800Z, Nov 3
Ukrainian DX Contest	1200Z, Nov 3 to 1200Z, Nov 4
ARRL Sweepstakes Contest, CW	2100Z, Nov 3 to 0300Z, Nov 5
ARCI Running of the QRP Bulls	2100Z, Nov 3 to 0300Z, Nov 5
IPA Contest, SSB	0600Z-1000Z and 1400Z-1800Z, Nov 4
High Speed Club CW Contest	0900Z-1100Z and 1500Z-1700Z, Nov 4
Japan Int. DX Contest, Phone	2300Z, Nov 9 to 2300Z, Nov 11
Anatolian ATA PSK31 Contest	0000Z-2400Z, Nov 10
WAE DX Contest, RTTY	0000Z, Nov 10 to 2359Z, Nov 11
ARRL International EME Competition	0000Z, Nov 10 to 2359Z, Nov 11
OK/OM DX Contest, CW	1200Z, Nov 10 to 1200Z, Nov 11
CQ Western Electric Contest	1600Z, Nov 10 to 0500Z, Nov 12
LZ DX Contest, CW	1200Z, Nov 17 to 1200Z, Nov 18
IARU Region 1 160m Contest, CW	1400Z, Nov 17 to 0800Z, Nov 18
Carnavales de Tenerife Contest	1600Z, Nov 17 to 1600Z, Nov 18
LI/NJ-QRP Doghouse Operation Sprint	1700Z-2100Z, Nov 17
ARRL Sweepstakes Contest, SSB	2100Z, Nov 17 to 0300Z, Nov 19
RSGB 1.8 MHz Contest, CW	2100Z, Nov 17 to 0100Z, Nov 18
CQ Worldwide DX Contest, CW	0000Z, Nov 24 to 2400Z, Nov 25

December 2001

TARA RTTY Sprint	1800Z, Dec 1 to 0200Z, Dec 2
Tennessee QSO Party	1800Z, Dec 2 to 0100Z, Dec 3
QRP ARCI Holiday Spirits Sprint	2000Z-2400Z, Dec 2
ARRL 160-Meter Contest	2200Z, Dec 7 to 1600Z, Dec 9
ARRL 10-Meter Contest	0000Z, Dec 15 to 2400Z, Dec 16
OK DX RTTY Contest	0000Z-2400Z, Dec 15
28 MHz SWL Contest	0000Z, Dec 15 to 2400Z, Dec 16
Croatian CW Contest	1400Z, Dec 15 to 1400Z, Dec 16
AGB Party Contest	2100Z-2300Z, Dec 21
DARC Christmas Contest	0830Z-1059Z, Dec 26
RAC Winter Contest	0000Z-2400Z, Dec 29
Stew Perry Topband Challenge	1500Z, Dec 29 to 1500Z, Dec 30

January 2002

AGB NYSB Contest	0000Z-0100Z, Jan 1
SARTG New Year RTTY Contest	0800Z-1100Z, Jan 1
AGCW QRP Winter Contest	1500Z, Jan 5 to 1500Z, Jan 6
ARRL RTTY Roundup	1800Z, Jan 5 to 2400Z, Jan 6
Japan Int. DX Contest, 160-40m	2200Z, Jan 11 to 2200Z, Jan 13
Midwinter Contest, CW	1400Z-2000Z, Jan 12
North American QSO Party, CW	1800Z, Jan 12 to 0600Z, Jan 13
NRAU-Baltic Contest, CW	0530Z-0730Z, Jan 13
NRAU-Baltic Contest, SSB	0800Z-1000Z, Jan 13
Midwinter Contest, Phone	0800Z-1400Z, Jan 13
DARC 10-Meter Contest	0900Z-1059Z, Jan 13
LZ Open Contest, CW	1200Z-2000Z, Jan 19
MI QRP January CW Contest	1200Z, Jan 19 to 2359Z, Jan 20
North American QSO Party, SSB	1800Z, Jan 19 to 0600Z, Jan 20
ARRL January VHF Sweepstakes	1900Z, Jan 19 to 0400Z, Jan 21
CQ 160-Meter Contest, CW	2200Z, Jan 25 to 1600Z, Jan 27
REF Contest, CW	0600Z, Jan 26 to 1800Z, Jan 27
BARTG RTTY Sprint	1200Z, Jan 26 to 1200Z, Jan 27
UBA DX Contest, SSB	1300Z, Jan 26 to 1300Z, Jan 27
Kansas QSO Party	1800Z, Jan 26 to 1800Z, Jan 27

February 2002

Vermont QSO Party	0000Z, Feb 2 to 2400Z, Feb 3
New Hampshire QSO Party	0000Z, Feb 2 to 2400Z, Feb 3
10-10 Inter Winter Contest, SSB	0001Z, Feb 2 to 2400Z, Feb 3
Minnesota QSO Party	1400Z-2400Z, Feb 3
YL-OM Contest, CW	1400Z, Feb 2 to 0200Z, Feb 4
Delaware QSO Party	1700Z, Feb 2 to 0500Z, Feb 3 and 1300Z, Feb 3 to 0100Z, Feb 4
Mexico RTTY International Contest	1800Z, Feb 2 to 2400Z, Feb 3
North American Sprint, Phone	0000Z-0400Z, Feb 3
CQ/RJ WW RTTY WPX Contest	0000Z, Feb 9 to 2400Z, Feb 10
Asia-Pacific Sprint, CW	1100Z-1300Z, Feb 9
Dutch PACC Contest	1200Z, Feb 9 to 1200Z, Feb 10
YL-OM Contest, SSB	1400Z, Feb 9 to 0200Z, Feb 11
FISTS Winter Sprint	1700Z-2100Z, Feb 9
RSGB 1.8 MHz Contest, CW	2100Z, Feb 9 to 0100Z, Feb 10
North American Sprint, CW	0000Z-0400Z, Feb 10
QRP ARCI Winter Fireside SSB Sprint	2000Z-2400Z, Feb 10
ARRL Inter. DX Contest, CW	0000Z, Feb 16 to 2400Z, Feb 17
CQ 160-Meter Contest, SSB	2200Z, Feb 22 to 1600Z, Feb 24
REF Contest, SSB	0600Z, Feb 23 to 1800Z, Feb 24
North Carolina QSO Party	1200Z-2359Z, Feb 23 and 1200Z-2359Z, Feb 24
UBA DX Contest, CW	1300Z, Feb 23 to 1300Z, Feb 24
RSGB 7 MHz DX Contest, CW	1500Z, Feb 23 to 0900Z, Feb 24
High Speed Club CW Contest	0900Z-1100Z and 1500Z-1700Z, Feb 24

CD-ROM Collections

NEW 5-year set: 1995-1999
- IMPROVED viewer (works with all sets!)
- BETTER Search & Browse
- SUPERIOR image quality!

QST View

NEW 1995-1999 set!

The perfect way to enjoy past issues of *QST*! Each CD-ROM set includes all the ads, articles, columns and covers—scanned to provide black-and-white images that can be viewed on your computer screen or printed. Every Page!

Features:

Search for articles by title and author.

Select specific year and issue.

Browse individual articles or columns.

QST View CD-ROM sets

Years	Order No.
1915-29	#7008
1930-39	#6710
1940-49	#6648
1950-59	#6435
1960-64	#6443
1965-69	#6451
1970-74	#5781
1975-79	#5773
1980-84	#5765
1985-89	#5757
1990-94	#5749
1995-99	#8497

$39.95* PER SET

Requires Microsoft *Windows*.

SAVE over $80 when you order the entire ***QST* View Collection.** Includes all 12 CD-ROM sets!
QSTV ~~$479.40~~ **Only $399**

Call our toll-free number, 1-888-277-5289, to order or to find a dealer near you!

ARRL Periodicals on CD-ROM

An entire year of ARRL journals on CD-ROM!

Each CD includes: QST The official membership journal of ARRL

NCJ National Contest Journal

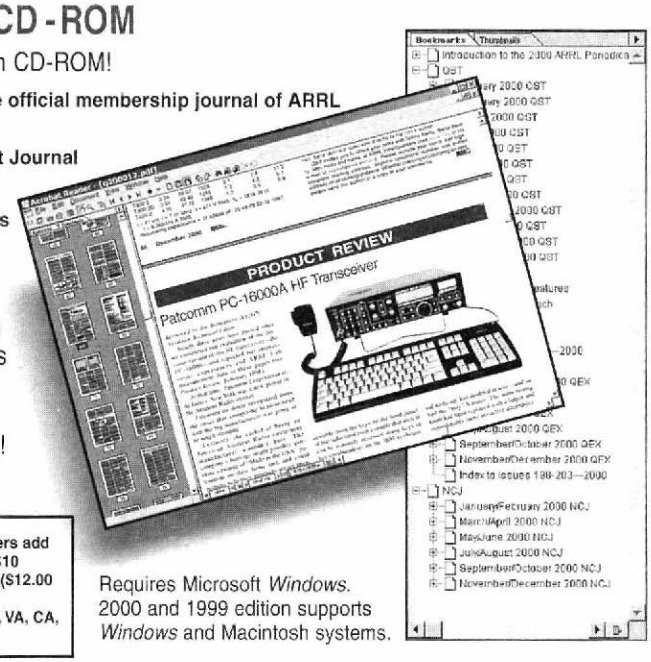
QEX Forum for Communications Experimenters

Features:

Search the full text of every article by entering titles, call signs, names—almost any word.

See every word, photo, drawing and table—including color images!

Print what you see.



Requires Microsoft *Windows*. 2000 and 1999 edition supports *Windows* and Macintosh systems.

ARRL Periodicals CD-ROM sets:

Year	Order No.
2000	#8209
1999	#7881
1998	#7377
1997	#6729
1996	#6109
1995	#5579

JUST $19.95* PER SET!

***Shipping & Handling** charges apply: US orders add $5 for one CD, plus $1 for each additional CD ($10 max). International orders add $2.00 to US rate ($12.00 max).
Sales Tax is required for orders shipped to CT, VA, CA, and Canada.

QEX and NCJ Collection CD-ROMs

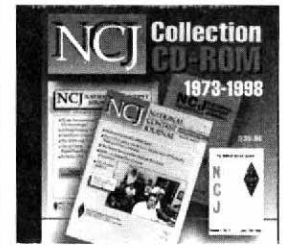
Back issues from these journals have been scanned to provide black-and-white images that can be read on your computer screen or printed. All the articles, ads, columns and covers are included. Search—Select—Browse—it's all there!

The QEX Collection CD-ROM.
For Communications Experimenters! Includes all *QEX* issues from 1981 through 1998.

The NCJ Collection CD-ROM.
Contests, scores and more! Includes all *NCJ* issues from 1973 through 1998.

System Requirements: Pentium or equivalent IBM-compatible PC, and Microsoft *Windows*.

QEX Collection CD-ROM
#7660 ..... $39.95*



NCJ Collection CD-ROM
#7733 ..... $39.95*

ARRL *The national association for AMATEUR RADIO*
www.arrl.org/shop

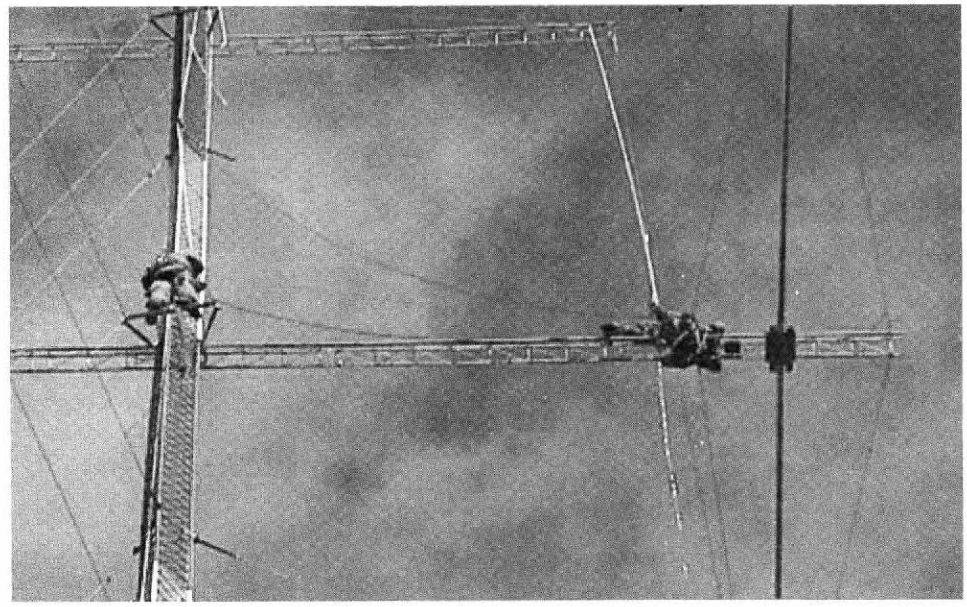
225 Main Street, Newington, CT 06111-1494 tel: 860-594-0355 fax: 860-594-0303

In the US call our toll-free number **1-888-277-5289** 8 AM-8 PM Eastern time Mon.-Fri.

XX Towers, Inc.

We provide complete installation and maintenance of tower/communication systems for ham and commercial applications.

- ❖ Fully insured
- ❖ Recommended by M^2, HRO, US Towers and many others.
- ❖ Factory authorized ROHN dealer.
- ❖ We travel anywhere



CT9 - The Ultimate Contest Software

Available exclusively from XX Towers, Inc.

CT™ has been the recognized leader in contest software since 1985. No other program is as easy to use or contains as many helpful features. With CT, you can operate an entire contest without ever touching a pencil or paper. Key features include logging, duping, scoring, PacketCluster® interface, MS and MM networking, QSL labels, radio control for nearly all popular transceivers, Multiplier lists, rate information and log stats.

Ordering Information:

⇒ CT Version 9 (for 386/486/Pentium computers only) $79.95
⇒ Upgrade from CT 8 to CT 9 $44.95
⇒ **Shipping:** $5.00 US, $6.00 Canada, $10.00 DX

Disk Size: **CT 9** is available only in 3.5" HD format (1.44MB)

MasterCard/Visa accepted; checks must be in US$ and drawn on a US bank, payable to *K1EA Software*

XX Towers, Inc. 814 Hurricane Hill Road, Mason, NH 03048
CT order line (603) 878-4600, Tower Phone: (603) 878-1102, Fax: (603) 878-4200

www.xxtowers.com

Force 12

Antennas & Towers

10 Years of Leadership

>10,000 Amateur HF Antennas Shipped

Performance talks – BUY the best and forget the rest!

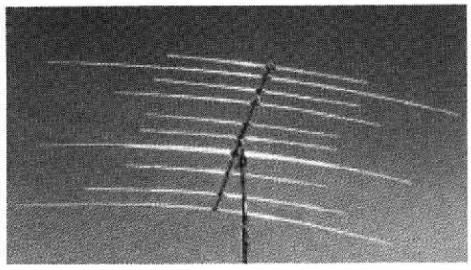
>100,000 Web Site Accesses for Information

People want to know information they can depend on.

Force 12 is the leader in HF antenna design and production. Our products have revolutionized HF antennas. Besides developing new electrical designs, we evaluated, designed and selected the best mechanical techniques.

Force 12 is the originator of high-efficiency, MULTI-MONOBAND™ antennas utilizing:

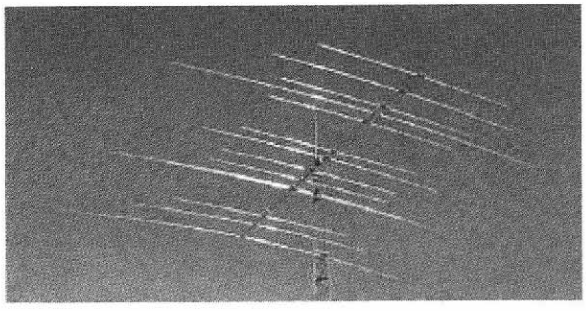
- TrueSpec©: only company with accurate specs since day #1
- Multi-band Antennas (Yagis & Verticals) with NO traps
- Patented Multi-Band feed systems
- EasyOn™ 2-plate antenna mounts
- Strong, tapered, low profile elements
- Pre-mounted element to boom brackets
- Pre-assembled and bundled elements
- "Plug and Play" on most designs
- Riveted Construction is the most effective and is a Force 12 signature: **"If its riveted, it's a Force 12!"**



C-19XR for 20-15-10

Powerhouse in a Small Size

19' boom with: 3 ele on 20, 3 ele on 15 and 5 ele on 10
Single coax feedline, 9.1 sqft windload, 58 pounds
100 mph standard rating and 120 mph optional
UPS shippable and 4' packaging available; 5KW.



C-31XR for 20-15-10

The 20-15-10 Leader

31' boom with: wide spaced 3 element on 20 mtrs
4 elements wide spaced on 15 mtrs & 7 elements on 10
Single coax feedline, **OR** separate feedlines
10.7 sqft windload, 82 pounds
100 mph standard rating and 120 mph optional
UPS shippable; 5KW

Want more?? The *C-49XR* is the answer!

Check our web site at www.force12inc.com for more details.

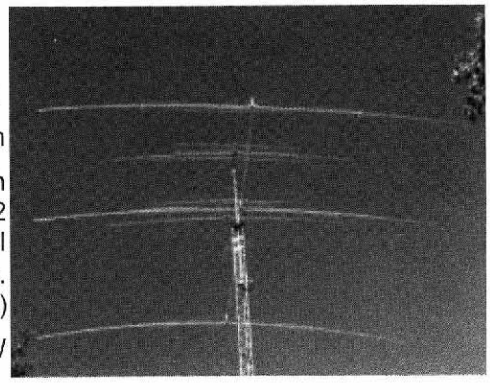
MAGNUM 340N

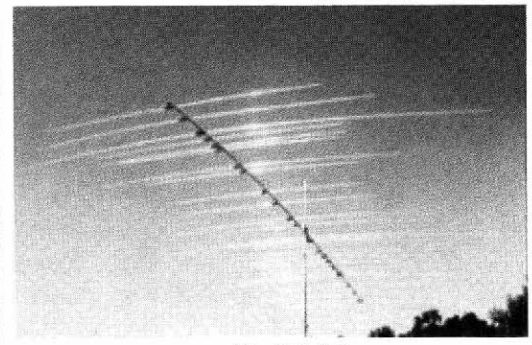
Latest Technology
3 element 40 mtr Yagi

85% Full Size, 36' boom

Can be mounted within a few feet of Force 12 antennas, such as all XR and C-series. (Shown 7' below C-3)

100 mph and 5KW





C-49XR

Equivalent to 6el20, 6el15, >8el10

Force 12 ⇒ Anything Else is Just an Antenna!

Complete line of HF and VHF Antennas, Amateur and Commercial
Available direct, through all 12 Ham Radio Outlet stores, Texas Towers and Dealers Worldwide

For FREE brochure - down-loadable, viewed on line, via mail, product info, tech tips: www.QTH.com/force12
For expanded product info, T-shirts, Debugging an Antenna, Antenna Specs and more: www.force12inc.com
E-mail to: force12e@lightlink.com Join the Force 12 Reflector – see the QTH.com Web Site

Force 12, Inc. PO Box 1349 Paso Robles, CA 93447
Order Line 1.800.248.1985 Tech Line 1.805.227.1680 FAX 1.805.227.1684

SAVE BIG ON ANTENNAS, TOWERS & CABLE

TELESCOPING ALUMINUM TUBING

DRAWN 6063-T832

.375	$.70/ft
.500"	$.80/ft
.625"	$.90/ft
.750"	$1.00/ft
.875"	$1.10/ft
1.000"	$1.20/ft
1.125"	$1.35/ft
1.250"	$1.55/ft
1.375"	$1.75/ft
1.500"	$1.95/ft
1.625"	$2.25/ft
1.750"	$2.50/ft
1.875"	$2.75/ft
2.000"	$3.00/ft
2.125"	$3.50/ft

In 6' or 12' lengths, 6' lengths ship UPS. Call for 3/16"& 1/4" rod, bar stock, and extruded tubing.

BENCHER / BUTTERNUT

Skyhawk, Triband Beam	$1129
HF2V, 2 Band Vertical	$219
HF5B, 5 Band Minibeam	$429
HF6VX, 6 Band Vertical	$299
HF9VX, 9 Band Vertical	$349
A1712, 12/17m Kit	$54
CPK, Counterpoise Kit	$129
RMKII, Roof Mount Kit	$159
STRII, Roof Radial Kit	$125
TBR160S, 160m Kit	$119

More Bencher/Butternut–call

COMET ANTENNAS

GP15, 6m/2m/70cm Vertical	$149
GP6, 2m/70cm Vertical	$139
GP9, 2m/70cm Vertical	$179
B10NMO, 2m/70cm Mobile	$36
B20NMO, 2m/70cm Mobile	$49
SBB2NMO, 2m/70cm Mobile	$39
SBB5NMO, 2m/70cm Mobile	$49
SBB7NMO, 2m/70cm Mobile	$75
Z750, 2m/70cm Mobile	$55
Z780, 2m/70cm Mobile	$69

Much more Comet in stock–call

DIAMOND ANTENNAS

D130J/DPGH62	$79/139
F22A/F23A	$89/119
NR72BNMO/NR73BNMO	$39/54
NR770HBNMO/NR770RA	$55/49
X200A/X3200A	$129/210
X500HNA/700HNA	$229/369
X510MA/510NA	$189/189
X50A/V2000A	$99/149
CR627B/SG2000HD	$99/79
SG7500NMO/SG7900A	$75/112

More Diamond antennas in stock

GAP ANTENNAS

Challenger DX	$289
Challenger Counterpoise	$29
Challenger Guy Kit	$19
Eagle DX	$299
Titan DX	$329
Eagle/Titan Guy Kit	$29
Voyager DX	$409
Voyager Counterpoise	$49
Voyager Guy Kit	$45
Quicktilt Mount	$75

Please Call for Delivery Information

CUSHCRAFT ANTENNAS

X7/X740	$679/229
XM240	$719
R6000/R8	$319/469
A50-3S/5S/6S	$95/159/259
AR2/ARX2B	$49/69
AR270/AR270B	$85/99
ARX270N/ARX-450B	$219/65
13B2/17B2	$139/249
26B2	$389
A270-6S/A270-10S	$75/99

Please call for more Cushcraft items

M2 VHF/UHF ANTENNAS

144–148 MHz

2M4/2M7/2M9	$89/109/119
2M12/2M5WL	$149/189
2M5-440XP, 2m/70cm	$159

420–450 MHz

440-470-5W/420-450-11	$129/89
432-9WL/432-13WL	$169/219
440-18/440-21ATV	$119/139

Satellite Antennas

2MCP14/2MCP22	$169/219
436CP30/436CP42UG	$219/259

M2 ANTENNAS

50–54 MHz

6M5X/6M7JHV	$199/239
6M2WLC/6M2.5WLC	$419/449

10/12/15/17/20m HF

10M4DX, 4 Element 10m	$379
12M4DX, 4 Element 12m	$379
15M4DX, 4 Element 15m	$419
17M3DX, 3 Element 17m	$379
20M4DX, 4 Element 20m	$499

More M2 models in stock–please call

MFJ ANTENNAS

259B, Antenna Analyzer	$219
269, Antenna Analyzer	$299
941E, 300W Antenna Tuner	$109
945E, 300W Antenna Tuner	$99
949E, 300W Antenna Tuner	$139
969, 300W Antenna Tuner	$169
986, 3kW Antenna Tuner	$289
989C, 3 kW Antenna Tuner	$309
1796, 40/20/15/10/6/2m Vert.	$189
1798, 80–2m Vertical	$249

Big MFJ inventory–please call

LAKEVIEW HAMSTICKS

9106	6m	9115	15m	9130	30m
9110	10m	9117	17m	9140	40m
9112	12m	9120	20m	9175	75m

All handle 600W, 7' approximate length, 2:1 typical VSWR ... $24.95

HUSTLER ANTENNAS

4BTV/5BTV/6BTV	$149/189/209
G6-270R, 2m/70cm Vertical	$169
G6-144B/G7-144B	$129/179

Hustler Resonators in stock–call

FORCE 12–MULTIBAND

C3	10/12/15/17/20m, 7 el	$599
C3E	10/12/15/17/20m, 8 el	$649
C3S	10/12/15/17/20m, 6 el	$539
C3SS	10/12/15/17/20m, 6 el	$559
C4	10/12/15/17/20/40m, 8 el	$759
C4S	10/12/15/17/20/40m, 7 el	$679
C4SXL	10/12/15/17/20/40m, 8 el	$979
C4XL	10/12/15/17/20/40m, 9 el	$1119
C19XR	10/15/20m, 11 el	$959
C31XR	10/15/20m, 14 el	$1299

Please call for more Force 12 items

ROHN TOWER

25G/45G/55G	$89/189/239
AS25G/AS455G	$39/89
GA25GD/45/55	$68/89/115
GAR30/GAS604	$35/24
SB25G/45/55	$39/89/109
TB3/TB4	$85/99
HBX32/HBX40	$349/439
HBX48/HBX56	$589/699
HDBX40/HDBX48	$549/699
BXB5/6/7-8	$39/49/59/59

Please call for more Rohn prices

GLEN MARTIN ENGINEERING

Hazer Elevators for 25G

H2, Aluminum Hazer, 12 sq ft	$359
H3, Aluminum Hazer, 8 sq ft	$269
H4, HD Steel Hazer, 16 sq ft	$339

Aluminum Roof Towers

RT424, 4 Foot, 6 sq ft	$159
RT832, 8 Foot, 8 sq ft	$229
RT936, 9 Foot, 18 sq ft	$389
RT1832, 17 Foot, 12 sq ft	$499

Please call for Glen Martin info

COAX CABLE

RG-213/U, (#8267 Equiv.)	$.36/ft
RG-8X, Mini RG-8 Foam	$.19/ft
RG-213/U Jumpers	Please Call
RG-8X Jumpers	Please Call

Please call for more coax/connectors

TIMES MICROWAVE LMR® COAX

LMR-400	$.59/ft
LMR-400 Ultraflex	$.89/ft
LMR-600	$1.19/ft
LMR600 Ultraflex	$1.95/ft

ANTENNA ROTATORS

M2 OR-2800PDC	$1099
Yaesu G-450A	$249
Yaesu G-800SA/DXA	$329/409
Yaesu G-1000DXA	$499
Yaesu G-2800SDX	$1089
Yaesu G-550/G-5500	$299/599

ROTATOR CABLE

R61 (#20)/R62 (#18)	$.28/32
R81/R82	$.25/.39
R83/R84	$.52/.85

TRYLON "TITAN" TOWERS

SELF-SUPPORTING STEEL TOWERS

T200-64	64', 15 square feet	$1099
T200-72	72', 15 square feet	$1299
T200-80	80', 15 square feet	$1499
T200-88	88', 15 square feet	$1769
T200-96	96', 15 square feet	$2049
T300-88	88', 22 square feet	$1989
T400-80	80', 34 square feet	$1939
T500-72	72', 45 square feet	$1879
T600-64	64', 60 square feet	$1799

Many more Trylon towers in stock!

US TOWER

MA40/MA550	$849/1399
MA770/MA850	$2359/3729
TMM433SS/HD	$1139/1379
TMM541SS	$1499
TX438/TX455	$1069/1599
TX472/TX489	$2649/4599
HDX538/HDX555	$1379/2399
HDX572MDPL	$6329

Please call for help selecting a US Tower for your needs. Shipped factory direct to save you money!

UNIVERSAL ALUMINUM TOWERS

4-40'/50'/60'	$519/739/1049
7-50'/60'/70'	$939/1369/1789
9-40'/50'/60'	$729/1049/1469
12-30'/40'	$559/869
15-40'/50'	$969/1399
23-30'/40'	$869/1289
35-30'/40'	$979/1509

Bold in part number shows wind-load capacity. Please call for more Universal models. All are shipped factory direct to save you money!

TOWER HARDWARE

3/8"EE / EJ Turnbuckle	$11/12
1/2"x9"EE / EJ Turnbuckle	$16/17
1/2"x12"EE / EJ Turnbuckle	$18/19
3/16" / 1/4" Preformed Grips	$5/6

Please call for more hardware items

HIGH CARBON STEEL MASTS

5 FTx .12" / .18"	$45/75
10 FT x .12" / 10 FT x .18"	$75/125
15 FT x .12" / 15 FT x .18"	$105/175
20 FT x .12" / 20 FT x .18"	$135/225
10 FT x .25" / 20 FT x .25"	$175/335

PHILYSTRAN GUY CABLE

HPTG1200I	$.45/ft
HPTG2100I	$.59/ft
PLP2738 Big Grip (2100)	$6.00
HPTG4000I	$.89/ft
PLP2739 Big Grip (4000)	$8.50
HPTG6700I	$1.29/ft
PLP2755 Big Grip (6700)	$12.00
HPTG11200	$1.69/ft
PLP2558 Big Grip (11200)	$18.00

Please call for more info or help selecting the Phillystran size you need.

WEEKDAY HOURS:
9 AM–5 PM CST

SATURDAY HOURS:
9 AM–12 NOON CST

CREDIT CARDS:
M/C, VISA, DISCOVER

TEXAS TOWERS

A Division of Texas RF Distributors, Inc. • 1108 Summit Avenue, Suite #4 • Plano, TX 75074

(800) 272-3467

LOCAL CALLS:
(972) 422-7306

EMAIL ADDRESS:
sales@texastowers.com

INTERNET ADDRESS:
www.texastowers.com

Pulling Signals Out Of The Air Just Got Easier.

The New IC-756PROII

This new HF/50 MHz all mode transceiver has the familiar look and feel of the '756PRO - but with the improvements and features that you requested most. Including selectable IF filter shape characteristics - sharp or soft shapes independently selectable for SSB and CW, improved 3rd IMD characteristics - making a dramatic improvement in receiver performance, one touch digital voice recorder playback - selectable even while displaying the bandscope, and much more. The 'PROII uses not only our latest digital technology, but also benefits from our superior experience in analog technology. To find out more about the 'PROII, see your authorized ICOM dealer today, visit www.icomamerica.com, or call our literature hotline at 425-450-6088.

IC-756PROII. The best just got better.

HF/6M • 100W • All Mode • Enhanced Rx • Dual Watch • 32 Bit IF-DSP • Independently Selectable IF Filter Shapes For SSB & CW • Variable Level Noise Blanker • Auto & Manual Notch Filter • Twin Passband Tuning • Improved 5" TFT Color Display • CW Memory Keyer • VOX • Auto Antenna Tuner • SSB/CW Synchronous Tuning • External Control For Voice Memory & Memory Keyer • Adjustable RIT Clear • 1/4 Tuning Steps In Digital Mode

IC-756PROII Features
- Improved Third Order Intercept Point
- Improved Sensitivity Without Preamp
- Selectable IF Filter Shape
- Improved Noise Reduction
- Adjustable Level Noise Blanker
- Improved Bandscope Noise Floor
- Improved Audio Fidelity
- Enhanced Backlighting - better for dark rooms
- Enhanced 5" TFT Color Display

Digital User Features
- Digital & Voice modes store filter settings independently
- Compression no longer allowed in Digital Modes
- 1/4 Tuning Steps in Digital Mode
- Improved low-level volume control

Contester Features
- Fast, adjustable RIT clear
- SSB/CW "synchronous tuning"
- External control of Digital Voice Recorder Playback & Memory Keyer, selectable even while displaying the bandscope

The 'PROII has the familiar look and feel of the '756PRO - but with the improvements and features that you requested most!

Find out more

www.icomamerica.com

ICOM®