MAY 1980

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- Yagi design 18
- ground systems 27
- phased array 44
- ZL-special 50
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  - Interface LOOP, RS232, MIL-188 and CMOS with no extra options to buy
  - Full RS232 Modem connector and full or half-duplex for computer use
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From time to time I am taken to task for editing a monthly Amateur Radio magazine that is “much too technical” and is written for radio engineers, not hams. I do not disagree with that premise in principle, only in degree — I feel strongly that most of our feature articles can be understood and applied by Amateurs who are interested in the technical aspects of radio: Amateurs who are still interested in the subtle details of designing their own circuits and building some of their own station accessories. Even with the great influx over the past couple of years of new Radio Amateurs who are primarily communicators with little technical knowledge, I believe the majority of licensed Amateurs still spend a large portion of their hobby time in their home workshops.

Subscribers who have been regular ham radio readers since I put together the first issue more than twelve years ago know that, from the beginning, ham radio has always placed the emphasis on radio theory and technique; operating news and views were left to others. Over the years we have tried to stay abreast of the state of the art, although at times this has been nearly impossible because of the great and rapid advances in developing technology. And, in general, when viewed in terms of the technology of the day, a better technical background is required now than it was ten years ago to understand a comparable level of circuit theory. The corollary, of course, is that what we consider to be unduly complex and difficult to understand in 1980 will likely seem relatively simple in 1990. This presents an interesting problem because as we continue to publish up-to-date radio circuits and projects, we run the danger of leaving a few dedicated readers behind. That is not our intent, and we shall make every effort to continue to appeal to as wide an audience as possible.

The microprocessor revolution has also greatly affected the technical content of ham radio, although not in the way you would expect; when most of the magazines jumped on the computer bandwagon, we continued to stress analog circuitry and presented only those computer topics that were closely related to radio communications. This has been highly popular, but many radio engineers and technicians who previously depended upon the industrial magazines for up-to-date design information became regular readers of ham radio; these are the same people who design the frequency-synthesized solid-state hf transceivers that are currently popular. Thus a dilemma: to publish up-to-date design articles that will ultimately improve the type of communications equipment we all have available, or continue to present decade-old technology to a 1980 world? Our answer has been a carefully chosen mix of established older techniques and complex new ones; when we stray too far one way or the other, we hear about it!

The continuing series on Yagi antenna design by W2PV which returns this month after a two-month hiatus is a good example of the type of article some readers feel is out of place; it explores antenna design and performance at a level normally reserved for engineering journals. If you’ve seen any engineering magazines lately, though, most of their articles are centered around microprocessor circuits; antenna articles are few and far between unless they’re for satellite earth terminals. Those editors are appealing to a completely different market, so W2PV’s Yagi series would be out of place — more important, it would not have been read by those people who are designing and building new high-gain antennas for the Amateur market. I feel we made the right decision when we accepted it for publication — it’s likely to have more impact on high performance high-frequency antenna design than anything published in the last 20 years.

Jim Fisk, W1HR
editor-in-chief
The Question we seem to get most often from our customers:

"WHEN IS ICOM COMING OUT WITH A HAND-HELD?"

**ICOM IC-2A SYNTHESIZED 2 METER HAND-HELD**

**FEATURES YOU'VE WANTED**

- 800 T/R Channels.
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**THE ANSWER IS: NOW!**

All 800 channels of it!
Hallicrafters story

Dear HR:

"The Hallicrafters Story" did not end with World War II! Several years later, in Korea, the BC-610 transmitters — tired old rigs that they were — still carried the brunt of our radio communications during the early days of the Korean conflict. We of the Military Advisory Group in Korea inherited several BC-610s and a few SCR-399 rigs when the American Army of occupation left in 1949. When the invasion of south Korea started on June 25, 1950, we fired off a SC-399 and established an emergency communications link with Tokyo.

When the Hahn river bridge was blown sky high two days later, one of our SCR-399 trucks was jammed in heavy traffic — on the north ramp of the bridge. On the south side of the river, I was operating another SCR-399 in contact with Tokyo. I heard the operator on the north side of the river and he was in contact with Tokyo, too (all on CW) but for some reason he couldn’t hear my signals! He was telling Tokyo that the bridge had blown up in his face, the traffic jam was so bad that he might have to destroy the radio, and there were enemy tanks wandering around the city of Seoul! Then he went off the air; I figured we could scratch one radio, but Sgt. Francisco was not giving up so easy!

A few hours later he was back on the air — reporting that he had gotten the truck and trailer of his SCR-399 across the river on a barge! Now he was out of gasoline and the enemy was lobbing mortars at him! We rushed a jeep up the river with a couple of jerry-cans of gas, and a bit later the truck I never expected to see again pulled into our camp!

A few nights later we made a crash retreat south; there was a report that enemy tanks had gotten behind us and cut the roads, so we drove down trails so narrow that we scraped brush on both sides of the road. I operated my BC-610 mobile in motion all that night, and a radioman in Yokohama kept contact with me straight through!

During the battle for Taegon the choke in the high-voltage supply of my BC-610 went down to ground. We replaced it with a resistor and went right back on the air — with a real pretty note and a few more watts of power! (A Korean mechanic rewound the choke for us and it was still working two years later.) The roads were so rough in Korea that wheel-bolts would sometimes crystalize and break off the trucks. Once a modulation transformer broke loose and wiped the whole audio deck clean — right down to reducing everything on the deck to dust! So what! We were operating all CW anyway, so we didn’t miss the audio deck in our BC-610.

One night there was some kind of blackout, and the whole high-frequency band was just a hiss — not a signal to be heard; of course, that was the night the big brass had an urgent message that just had to get through! We fired off both SCR-399 rigs, one with a horizontal antenna, the other vertical, and we adjusted the frequency of one about 800 hertz off the frequency of the other, then keyed them both together; what a God-awful signal that made, but we got the message through. The only message that got through from all Korea that night!

Our SCR-399s served all through the Pusan perimeter days, went north when the breakout came, and made the long retreat back down the peninsula when the Chinese clobbered us. By the time the cease-fire came, we had added another ten-thousand hours to those old war-weary rigs left over from World War II!

James Houldsworth, W1TVN
Pittsfield, Massachusetts

Dear HR:

I feel compelled to let you and Bill Orr know how much I enjoyed the "Hallicrafters Story" in the November 1979 issue. Bill Orr should be commended for yet another very fine article.

Marshall B. Turner, K0ADM
Parkville, Missouri

Talking digital readout

Dear HR:

I want to congratulate you on the fine article, "Talking Digital Readout for Amateur Transceivers," in the June, 1979, issue. Pete Tanner, N5EJ, built one for Jerry Thomas, KA5GBP, who is blind, and it works great with his TS-120S. You are to be commended for providing this assistance to handicapped Amateurs.

Sammy Neal, N5AF
Cleveland, Texas
Check these state-of-the-art specifications

- Power Capability: 2500 W PEP
- Frequency Range: Continuous 3.0 to 30 MHz
- Impedance Matching: 20 ohms to 300 ohms to 50 ohms resistive
- Direct Reading SWR Meter: 1 to infinity
- Direct Reading Power Meter: Two meter scales from 0 W to 250 W and 0 W to 2500 W; front panel switch selects FWD or Reflected Power. (Illuminated panel meters)
- Power meter displays RMS with continuous carrier and automatically displays PEAK when driven with SSB signal.
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- Tune-up time not affected by power level: can be as low as 1 W.
- A unique "Linear Disable" circuit automatically switches companion linear amplifier to standby within milliseconds whenever SWR exceeds a threshold preset on front panel, thus protecting the linear and antenna tuner from excessive SWR.
- Toroidal bridge coupler provided in separate enclosure, permitting it to be installed directly at the output of the transmitter for meaningful SWR measurements.
- Power requirements are 115/230 VAC 50-60 Hz, 10 W operating/5 W standby; or 13.5 VDC, 1 A operating/=.5 A standby.
- Antenna tuner packaged in cabinet 17" W x 5-1/4" H x 14" D (Rack mounting optional).

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More Details? CHECK — OFF Page 94
COMPLAINTS TO THE FCC ABOUT AMATEUR operations have tripled in the past year, and though the Amateur service is still considered to be probably the best in compliance of all the services administered by the Commission, this rapid increase signals a very alarming trend that shouldn’t be allowed to continue. The increase lies principally in two areas: net operations on the hf bands, and on repeaters. In both areas the problem is mainly one of jamming, willful and deliberate interference, an area that’s been widely publicized since Southern California Amateurs enlisted the aid of California Congressman James Corman last summer.

Pyranol is one well-known example of a chemical widely used as a high-voltage insulator until a ban was imposed on its use in the late 70s. There is No Danger so long as seals are intact, but exposure to liquid PCB seeping from a leaking capacitor could have grave health consequences for an Amateur or his family. Amateurs who suspect their oil-filled capacitors might contain PCB should check all seals carefully for leakage and Damaged Or Leaking PCB-Filled components should not be thrown in the garbage; it is illegal, in fact, to dispose of more than three pounds (one quart) of PCB except in a government-approved disposal site.

A NEW SIBERIAN-BASED "WOODPECKER" has now been confirmed, transmitting a slightly different pulse pattern than his three more western brothers, and apparently located in the Kamchatka Peninsula area. It definitely points up much further east than the central Siberian woodpecker that came on last fall. The European Woodpecker started a new transmission pattern in late March, with a 50-100 kHz wide signal and a 25-35 Hz pulse rate. It’s been spending long periods on the low end of 10 meters between 1200 and 1400 UTC, and points up from the same area as the Kamchatka Peninsula woodpecker.

A Woodpecker Noise-Blanker circuit will be presented in the June issue of HAM RADIO. Designed by DJ7YY for receivers with a 9-MHz i-f, the circuit is not widely known outside Europe, where it was originally published two years ago.

A POTENTIALLY DEADLY THREAT exists in many hamshacks due to the PCB, the potent cancer-causing chemical widely used as a high-voltage insulator until a ban was imposed on its use by the Environmental Protection Agency. Polychlorinated biphenyls have been widely used in the manufacture of capacitors and transformers since the early 1930s, and many Amateurs are currently using PCB-filled capacitors in their high-voltage supplies without being aware of the potential hazard.

There Is No Danger so long as seals are intact, but exposure to liquid PCB seeping from a leaking capacitor could have grave health consequences for an Amateur or his family. Amateurs who suspect their oil-filled capacitors might contain PCB should check all seals carefully for leakage and make sure the capacitors are run well below their ratings to avoid stress that should not be thrown in the garbage; it is illegal, in fact, to dispose of more than three pounds (one quart) of PCB except in a government-approved disposal site.

ART COLLINS, W0CXX, has been chosen to receive the Electronic Industries Association’s Medal of Honor. Art, who started Collins Radio in his Cedar Rapids basement in the early 1930s, now heads Arthur A. Collins Corp. in Dallas doing R&D work in the communications field. Congratulations!
new features, new performance + all 9 hf bands

NEW — ALL 9 HF BANDS. Full coverage from 160 through 10 Meters. Ready to go, with crystals supplied for seven bands (crystals for 18 and 24.5 MHz bands available when bands are ready for use).

ALL SOLID-STATE. From the pioneer.

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NEW 3-MODE, 2-RANGE OFFSET TUNING. Another TEN-TEC first... (1) Offset Receiver Tuning, (2) Offset Transmitter Tuning and (3) Offset Transceiver Tuning. None other has it. For complete flexibility, to meet all needs, fine tuning or DX. 2-ranges: ± 500 Hz or ± 1 kHz.

OPTIMIZED RECEIVER SENSITIVITY. For an ideal balance between dynamic range and sensitivity... from 2 µV on 160 to 0.3 µV on 10 Meters.

NEW OPTIMIZED BANDWIDTH. Seven response curves—four for SSB, three for CW. Standard i-f filter is an 8-pole 2.4 kHz crystal ladder type. Options include a 1.8 kHz 8-pole crystal ladder type, a 500 Hz 8-pole CW filter and a 200 Hz 8-pole CW filter. Switch an optional filter from the front panel to put it in series for up to 16 poles of filtering. And the standard CW active audio filter has 450 and 150 Hz bandwidths for added attenuation. New toggle switches select i-f and audio filtering. Selectivity for any situation.

BUILT-IN NOTCH FILTER. Variable null eliminates unwanted signals and carriers in a pass band from 200 Hz to 3.5 kHz with a notch depth of more than 50 dB.

NEW BUILT-IN NOISE BLANKER. Standard equipment. New 2-pole monolithic crystal filter handles big signals easily, makes impossible locations usable.

GREATER DYNAMIC RANGE. Better than 90 dB, typically. Reduces front-end overload and distortion. Plus a PIN diode switchable 18 dB attenuator on the RF gain control.

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DIGITAL READOUT. 6 shielded 0.43" LEDs with 5 in red, the 6th (100 Hz) in green.

SEPARATE RECEIVING ANTENNA CAPABILITY. Use with separate components, instant break-in, transverters, or transmitters.

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200 WATTS INPUT. On all bands, when used with 50 ohm load. Proven, conservatively rated design. Fully warranted for first year, pro-rata warranty for five extra years!

100% DUTY CYCLE. Full power hour after hour without fail. Ideal for RTTY, SSTV or any hard usage.

BUILT-IN VOX AND PTT. Smooth VOX with 3 front panel controls. And PTT control at both front and rear panel jacks.

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FRONT PANEL CONTROL OF LINEAR OR ANTENNA. Auxiliary break-in terminals on rear panel permit simultaneous control of external relays or circuits. Disregard to interface with new TEN-TEC solid-state/CW Linear.

AUTOMATIC SIDEBAND SELECTION. And you can reverse it with the mode switch.

SUPER AUDIO. A TEN-TEC trademark. Proper shaping plus low distortion.

IMPECCABLE SIGNAL. Clean. Easily exceeding FCC requirements, thanks to meticulous design, fine components, and conservative ratings.

HIGH STABILITY. Deviation is no more than 15 cycles per degree temperature change after warm-up.

HIGH ARTICULATION KEYING. 2½ msec rise and decay time for sharp, clean keying.

BUILT-IN SPEAKER. Built into the bottom of the cabinet shell. Compression-loaded for better quality and higher efficiency. External speaker connections on rear panel.

PLUG-IN CIRCUIT BOARDS. For easy removal if needed.

FUNCTIONAL STYLING. Dark front panel, convenient control groupings, "clamshell" cabinet, full shielding, and easier-to-use size: 5½"h x 14¼"w x 14½"d.

POWER. Operates on 12-14 VDC for mobile or storage battery use. For 117 VAC use, an external supply is required.

FULL ACCESSORY LINE. Model 217 500 Hz CW filter $55, Model 219 200 Hz CW filter $60, Model 218 1.8 kHz SSB filter $55, Model 243 Remote VFO $139, Model 255 Power Supply/Speaker $169, Model 280 Power Supply $139, Model 645 Dual Paddle Keyer $85, Model 670 Single Paddle Keyer $34 50, Model 234/214 Speech Processor & Condenser Microphone $163, Model 247 Antenna Tuner $69. All in matching color.

Model 546 OMNI-Series C ......... $1189

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A fresh idea!

Our new crop of tone equipment is the freshest thing growing in the encoder/decoder field today. All tones are instantly programmable by setting a dip switch; no counter is required. Frequency accuracy is an astonishing ±.1 Hz over all temperature extremes. Multiple tone frequency operation is a snap since the dip switch may be remoted. Our SS-32 encode only model is programmed for all 32 CTCSS tones or all test tones, touch-tones and burst-tones. And, of course, there's no need to mention our 1 day delivery and 1 year warranty.

TS-32 Encoder-Decoder
- Size: 1.25" x 2.0" x .40"
- High-pass tone filter included that may be muted
- Meets all new RS-220-A specifications
- Available in all 32 EIA standard CTCSS tones

SS-32 Encoder
- Size: .9" x 1.3" x .40"
- Available with either Group A or Group B tones

Frequencies Available:

<table>
<thead>
<tr>
<th>Group A</th>
<th>Group B</th>
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<tr>
<td>TEST-TONES:</td>
<td>TOUCH-TONES:</td>
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<tr>
<td>600</td>
<td>697</td>
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<td>1500</td>
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- Frequency accuracy, ±.1 Hz maximum - 40°C to +85°C
- Frequencies to 250 Hz available on special order
- Continuous tone

- Frequency accuracy, ± 1 Hz maximum - 40°C to +85°C
- Tone length approximately 300 ms. May be lengthened, shortened or eliminated by changing value of resistor

Wired and tested: TS-32 $59.95, SS-32 $29.95
three-element quad for 15-20 meters which uses circular elements

Development of a circular-element quad beam from conception to final result — the Dream Beam

This project started in the winter of 1977-78 when I became active after having been off the air for over 40 years. I wanted a good antenna for 15 and 20 meters, but my location precluded a big beam. This article describes a quad antenna using circular elements rather than the usual square element configuration. Advantages of using circular rather than square elements are described together with construction details for building your own antenna. Development of the idea is discussed, beginning with a single-element circular antenna for 15 meters. The final version, a three-element circular quad, has given a good account of itself.

The idea was inspired by a bicycle wheel. Structural rigidity for the circular quad elements is provided by “spokes” radiating from the element hubs to the elements. Another bonus: the circular loop has a 0.9 dB gain over a square or diamond.¹

May I now present the Dream Beam, its early development, model tests, construction, and performance.

early antennas

The first attempt was a very small model. The “bicycle” rim or tire (conductor) was made by springing a length of small-diameter stiff plastic tubing into a circle about two feet (0.6 meter) in diameter. The wheel hub was a 6-inch (153-mm) length of ¼-inch (6.5-mm) wood dowel with small plywood flanges on each end. Holes were drilled in the flanges all around, spaced at 45-degree intervals. Eight pairs of “spokes” were made from kite string connecting the “tire” in pairs to the holes in the hub flanges. Sure enough there was the wheel! It proved to be what I hoped for — very lightweight, surprisingly strong, resilient, simple, and a near perfect circle.

One-element circular quad loop for 15 meters. This work led to an attempt at a single-element, full-size antenna for 15 meters. The conductor for this antenna was 3/8-inch (9.5-mm) aluminum tubing lengths spliced together to a total length of about 46 feet (14 meters). This assembly was easily sprung into a circle, and the ends were attached to a feedpoint insulator that included an SO-239 coax connector. The hub was a 30-inch (765 mm) length of 1-inch (26-mm) PVC plastic pipe to which some end flanges had been fitted.

Eight pairs of spokes were used, which were made from 40-pound (18-kg) test monofilament nylon fish line. It did indeed look like a big bicycle wheel! It was about 15 feet (5 meters) in diameter, and I wondered if I could ever get it up into the vertical position. I gingerly picked it up by the hub and, to my pleasant surprise, found it quite stable and easy to handle. The whole element weighed only about 2½ pounds (1 kg) — so light that I could carry it up a ladder to the roof alone using one hand for myself and one for

By J. W. Kennicott, W4VO, 468 Colonial Drive, Lexington, Tennessee 38351

¹ By J. W. Kennicott, W4VO, 468 Colonial Drive, Lexington, Tennessee 38351
the antenna. The 15-meter antenna performed beautifully, and I used it for several months. It proved to my satisfaction that the construction principle was sound and would work.

**One-element circular quad loop for 15-20 meters.** A single-element 15 and 20 meter antenna was the next step. It was similar to the 15 meter version but quite a bit larger. About 70 feet (22 meters) of ½-inch (12.5-mm) aluminum tubing was sprung into a 22-foot (7-meter) diameter circle and connected with a similar feed point insulator. The hub was 4-foot-8-inch (1.4-meter) length of 1½-inch (38-mm) PVC pipe with flanges on each end. The number of spokes was increased to twelve pairs, and these were made from heavier 80 pound (36 kg) test monofilament nylon. The 15-meter element of no. 16 (1.3 mm) copper antenna wire was attached to the spokes in much the way a spider spins a web: rather than a true circle, it was a regular twelve-sided polygon. This antenna was a success and I worked much DX with it.

**two-element beam for 15-20 meters**

The two-element beam was a natural and easy development. Reflector elements were made just like the driven elements, except there were no feed-point insulators, of course. And did it work? I received excellent reports and many compliments on my signal from all over the world. I could usually contact any station I could hear. Europeans, ZLs, and VKs were worked with the greatest of ease and almost at will. It was a quiet receiving antenna and seemed to have excellent directional properties.

**three-element beam for 15-20 meters**

Then I began to think of installing a director. Would the antenna be further improved with a third element, a director? If so, could I get one up there? Yes, there might be a way, and I dreamed up the basics of the three-element version.

I was about to begin building when nagging doubts began to creep through my mind. The message said, “Look OM, you have a fine antenna now, but you really know very little about it. Do you know what the beamwidth is, what the pattern looks like, and whether you have the optimum reflector length and spacing? If you put up a director, what length will be optimum? What spacing will be optimum? What will the front-to-back ratio be? You really don’t know these things. Enlarging the beam will take a lot of time and much work. You may fall flat on your face!” I had to agree. I decided to postpone the director and embarked on a three-month period of model testing to find out where I was, where I wanted to go, and how I was going to get there.

**model tests**

In my backyard antenna range, a one-watt 2-meter carrier from a dipole illuminated the model antenna under test. Induced currents were observed and recorded and patterns plotted. After literally hundreds upon hundreds of patterns, I felt I had the answers to all the questions — plus much other valuable and interesting data.

One particularly interesting result concerns a very closely spaced two-element (driver and reflector) circular loop beam. If the reflector is made 1.018 times the length of the driven element and spaced at 0.065 wavelength, a very nice beam results. At 146 MHz this spacing is only about 5½ inches (140 mm). A beautiful 2-meter mobile beam antenna could be made using an aluminum loop driver. The reflector could be bracketed right to the driver with nonconducting material. You can’t add a director to this arrangement; it will not work that way.

The model tests of the two-element configuration showed that I had been lucky. My earlier guesses at reflector length and spacing were reasonably close to optimum.

The bulk of the work was with the three-element configuration. Director and reflector lengths were varied, and the effects of various spacings investigated. The goal was to zero in on the optimum antenna. This was eventually done and the *Dream Beam* was made to the following dimensions:
of quarter-wave matching sections of 75-ohm coax. In the three-element configuration the feed point impedance becomes much reduced. The impedance of the 20-meter driven element turned out to be about 20 ohms; the 15-meter element about 27 ohms. Excellent matches were made between the transmission lines and the antenna elements using matching stubs cut for these impedances.

circle versus rectangle

In general character there is much similarity between the Dream Beam and the familiar quad. Construction and configuration aside, there are some electrical differences. The resonant length of the circular configuration is somewhat less than that of the square or diamond. The resonant length of the circular loop is about $974/f$. The usual formula for the quad is $1005/f$. The parasitic element lengths are nearer to the length of the driven element in the case of circular loops. The director element is 1.3 per cent shorter; the reflector element is 1.7 per cent longer.

construction

To start at the bottom: A bearing and rotator are installed in the attic of my house. The installation is remarkably similar to the one described in detail by WØYBV. He and I were perhaps cutting holes through our roofs at about the same time! The lower part of the Y-base (fig. 2) is a piece of 1½-inch (38-mm) steel pipe. To the top were welded two U-shaped steel members from a junk pile. They were just the right size and the V-struts were attached to them with U-bolts.

The V-struts are 12-foot (4-meter) lengths of 2-inch (51-mm) aluminum tubing. They are connected to the two 1½-inch (38-mm) diameter boom halves with U-bolts using tie plates cut from 1/8-inch (3-mm) aluminum sheet. This assembly must be carefully laid out so everything is in good alignment.

The 20-meter elements are made from lengths of 3/4-inch (9-mm) type 6061-T6 aluminum tubing. This tubing was flattened to make it something like an elliptical section about 15/16 inch (24 mm) wide and ½ inch (12.5 mm) thick. For the joints between sections, solid aluminum inserts were used. These inserts, 3/8 x ½ x 3 inches (9.5 x 12.5 x 77 mm), were fixed and connected by using no. 6 (M3.5) stainless steel machine screws. Spoke attach eyes are 3/32 x 1 inch (25 x 25.5 mm) stainless steel cotter pins in holes in the plane of the loops at proper intervals. Points are bent sharply back around the outside of the elements. The feedpoint insulator for the 20-meter driver is placed at the bottom. The SO-239 fitting mounted underneath was potted in silicone to make it watertight.
fig. 2. Above, the *Dream Beam*. Although this antenna is similar to the quad, there are some electrical differences because the resonant length of this circular configuration is somewhat less than that of a square or diamond: for a circular loop, it’s about \( 974/f \), as opposed to \( 1006/f \) for the quad. Below, details of the boom/V-strut mounting bracket.
The hubs are 6-foot (1.8-meter) lengths of 1 1/2-inch (38-mm) schedule 40 PVC plastic pipe with spoke-attach flanges cemented on each end. Spoke-attach eyes are 1/8 x 1 inch (3 x 25.5 mm) stainless-steel cotter pins inserted in holes drilled through the flanges. Holes are parallel to the axis of the hub.

Nylon monofilament spokes in earlier antennas were not completely satisfactory. The Dream Beam elements have spokes of no. 20 (0.8 mm) stainless-steel wire. These are insulated, and nine pairs are spaced around at 40-degree intervals. Their lengths were calculated. They were made fairly accurately on a simple jig. This jig was a 12-foot (4-meter) length of 2 x 4 lumber with small finishing nails in it corresponding to the several points on the spokes. The element end of each pair of spokes is fitted with a 4-inch (102-mm) triangular insulator cut from a sheet of 1/4-inch (6.5-mm) Lucite. The insulator is attached by a 3/8-inch (19-mm) "key ring" to its spoke-attach eye. ("Key ring" is used for lack of knowing a better term. It consists of almost two turns of stiff, springy stainless wire and may be easily threaded onto and off of the attach eye. I got the key rings at a sailboat supply house, where they're called "cotter rings.")

In toward the hub another small plastic insulator is inserted in each spoke. These are 1/4 x 1/2 x 4 inches (6.5 x 6.5 x 102 mm) long. There is a hole in each end to which the spoke is attached, and a hole in the center. The hole in the center is the eye through which the 15 meter element of no. 16 (1.3 mm) copper antenna wire is threaded. These elements become nine-sided regular polygons. These insulators must be accurately located (a nail in the jig) so that neat polygons of the correct perimeter result. The hub ends of the spokes are simply fixed to their attach eyes on the hubs. The flanges and hubs serve as insulation here.

**handling**

The elements may be assembled where there's sufficient room handy to the antenna location. Simply put them together. No jig or other special tooling is needed. They end up, completed, lying on the ground.

Handling and transport of the assembled elements at first appeared to present a tricky and complicated challenge. However, it turned out to be ridiculously simple, easy, and safe. A carrier was made like a grossly elongated T. The "up-and-down" portion is a 12-foot (4-meter) length of 1 1/4-inch (32-mm) light steel tubing. At the top, a 4-foot (1-meter) piece of tubing is attached across. Two clips were made from a piece of PVC pipe (somewhat larger then the hubs). The clips were cut so they could be snapped on and off the hubs with ease; they were bolted to the top of the T.

Simply clip the carrier onto the hub, pick up the element, and lift it to the vertical position. Super-human strength and balance are not needed; after all, an element weighs only about 9 pounds (4 kg). I must admit to being a little frightened when I tried it for the first time. The 22-foot (7-meter) "wheel" looks gigantic when towering over your head! The purpose of the carrier, of course, is for transporting the element and slipping it onto the boom. The hub ID is about 3/32 inch (2.5 mm) greater than the 1 1/2-inch (38-mm) boom, so it may be slipped on and off readily. When the hub is on the boom, give the carrier a downward jerk. The clips open and the carrier is separated. Elements went up and on, and off and down, many times during development for changes, adjustments, and pruning. Not the slightest difficulty was ever encountered.

**assembly**

Assembly of the entire array is really not so complex as it may at first seem. It was quite fun — a great satisfaction to see it up there, in place and "flying." I'm not exactly a spring chicken and don't claim the vision, balance, and agility of 30 or more years ago. The whole antenna was, however, assembled from the parts on the ground to their places in the rooftop array in about four hours. This work was done entirely alone with no assistance whatsoever.

Fig. 2 shows the various parts in relative positions. The key to the assembly of the structure is 20-foot (6-meter) length of 3/32-inch (2.5-mm) stainless-steel flexible cable. This is obtainable at most marine hardware dealers, particularly those handling sailboats and supplies. It is permanently attached to the inside of the left V-strut and boom half, securing it to the Y-frame with U-bolts.

1. Position the steel Y-frame in the bearing and rotator.
2. Run a 25-foot (8-meter) messenger of stout cord or fish line through the eyebolt in the left tie plate (used later for the reflector preventer cord). Erect the left V-strut and boom half, securing it to the Y-frame with U-bolts.
3. Run a 25-foot (8-meter) messenger through the hub of the driven element. Bring the driven element into position, ready to slip onto the left boom half. Connect the flexible cable to this messenger and pull it through the hub of the driven element so it comes out on the right. Slip the driven element onto the left boom half.
4. Drill a 3/8-inch (9.5-mm) hole in the bottom of the right boom half near where it is attached to the V-
strut. Run a 25-foot (8-meter) messenger (for the flexible cable) through this hole so that it comes out from this boom half on the left.

5. Run a 25-foot (8-meter) messenger through the eyebolt in the right tie plate (used later for the director preventer cord). Connect the flexible cable to its messenger. Pull the flexible cable into the right boom half so that it comes out through the 3/8-inch (9.5-mm) hole. Slip the right boom half into the driven-element hub and secure this V-strut to the Y-frame with U-bolts.

6. Pull the flexible cable tight and fasten it securely to the Y-frame. The structure is now erected. The hub of the driven element acts as a sleeve connecting the boom halves. The flexible cable holds them tightly together inside the hub.

7. Slip on the reflector element. Connect the preventer cord (1/8-inch or 3-mm high-grade nylon parachute cord) to its messenger and pull it through the eyebolt in the tie plate, securing it to the Y-frame. This preventer cord simply restrains the element from sliding off the boom.

8. Slip the director element on in the same manner as the reflector.

disadvantages

The only disadvantage of this array is in the sheer size of the element assemblies. Once it's put together in your yard or patio, the only possible thing you can do with them is put them up where they belong. They are too large to ship by any means. They won’t fit in your garage or basement, so they can’t be stored away — unless you happen to have a vacant airplane hangar! They could be disassembled for shipping or storing, but not nearly so readily as with other beams.

serviceability

Only high-grade corrosion resistant materials were used. The PVC hubs were painted with polyurethane to avoid deterioration by sunlight. The antenna has satisfactorily survived two rather severe winter ings. Being somewhat resilient, the elements swing and sway in a gusty wind, but the array has withstood quite a number of very high winds in thunderstorms. As the array is mounted just above the rooftop, it’s centered only about 30 feet (9 meters) above the ground. Some protection occurs from numerous tall trees in the area. I can’t say how the array would do atop an 80-foot (24-meter) tower. The exposed area of each loop is 3 square feet (0.3 square meters). Further experience may show up weaknesses not anticipated.

How the feedpoint insulator is made and connected to the 20-meter driven element. The triangular-shaped insulator is between the circular conductor and the wire spokes. Portions of the Y-frame are visible, and the lower end of the V-strut can be seen.

performance

Evaluation of antenna performance is both difficult and perilous. The difficulty lies in the large number of uncontrollable variables, which render numerical comparisons very questionable. The peril is in one’s ability to enforce strict self-discipline and maintain a truly objective viewpoint. It’s easy and tempting to overrate something which is your own baby, your own creation.

In the past year every opportunity for evaluation and comparison has been seized; this process is still going on. Reports and results have been extremely encouraging, and I become more pleased and confident as the hard evidence comes in day by day and week by week. Much of the time I get reports such as: “You are very, very strong;” You have the strongest signal on the band;” and, “Your signal is 15 to 20 dB over S9.” Some of the reports have been so good as to be not believable. I can’t remember when another station couldn’t read me if I could read him. Being picked out the first time in DX pileups has become fairly common. Though many long months in coming, the Dream Beam is now a reality.

reference

Yagi antenna design: performance of multi-element simplistic beams

A Yagi antenna can be characterized by one or more driver elements and a number of parasite elements, all supported on a boom.

For each element we must specify $X$ and $Y$ coordinates, a length ($LE$), a radius ($RO$), all measured in terms of (central) wavelength, and in the case of each driver, the excitation potential ($V$) or current ($I$) and its phase referred to some time standard.\(^1\)

It is instantly apparent that with all of these variables an exhaustive investigation into all possible configurations is impractical! Instead I shall begin with an initial consideration of “simple” or simplistic Yagi antennas and will subsequently discuss a variety of departures from this simplistic design. I will define this (simple) class of Yagi antennas as those involving a single driven element with one or more parasitic elements. No more than one “reflector” will exist, and all “directors,” if any, will be uniform, i.e., they will have identical lengths and diameters. Moreover, all elements will be uniformly spaced along the boom. Additionally, the antenna will be in free space; we shall initially investigate only free-space performance properties.

These restrictions may seem at first sight to be quite severe, but I hasten to remark that free-space performance will relate to actual performance over ground or earth (to be discussed in a later article) and the simplistic Yagi antenna, as defined above, can, in many instances, provide performance levels fully as good as those from more sophisticated designs. Furthermore, we can learn a great deal about Yagi antenna performance from studying these simple designs and, as we shall see, will develop useful conceptual ideas about Yagi behavior and ideas for “best” design.

Throughout this investigation of simplistic antennas I will choose element dimensions (radii) characteristic of “normal” 14 MHz construction ($RO = 0.000526 \lambda$). The results can be translated to any other element dimension by proper scaling calculations; scaling rules will be given later.

two-element beams

I shall begin with a 2-element Yagi beam involving one parasite which can act either as a “reflector” (for frequencies above its resonance) or as a “director.” For such a beam there are only two fundamental variables: The physical separation of the two elements along the boom and the physical length of the parasite! The exact length of the driven element is of little consequence as far as gain and pattern are concerned; it does, however, affect driving-point impedance (especially reactance) which is considered later. Since we shall be interested first in a frequency swept plot of the gain and $F/B$ properties, the physical length of the parasite can be fixed; as we increase the frequency from well below to well above the parasite free-space resonant frequency we can observe the properties of the beam first where the parasite behaves as a director and secondly as a parasitic reflector.

The computation methodology I shall use is that given explicitly in an earlier article.\(^1\) In all cases of the 2-element beam I have used a cylindrical length, $LE = 0.48167 \lambda_o$, and a radius, $RO = 0.0005260 \lambda_o$ for both parasite and driver; this makes each element’s isolated free-space resonant frequency, $FR$, equal to unity on the normalized frequency, $F$, scale, where $F = f/f_o = 1$. The frequency itself is varied in steps

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By James L. Lawson, W2PV, 2532 Troy Road, Schenectady, New York 12309
from about 90 per cent ($F = 0.9$) to 110 per cent ($F = 1.10$) of the central frequency ($F = 1.0$); these steps were made sufficiently small to fully show the behavior of the beam. Element separation, $S$, measured in wavelengths at the central frequency, $f_0$, is varied from 0.025 to 0.5, again in steps sufficiently small to bring out essential behavior.

Fig. 1 shows the frequency swept gain of the 2-element Yagi antenna for several element spacings, $S$, where the parasitic element acts as a reflector! Each curve represents a particular spacing, $S$, appropriately keyed in the legend. Fig. 2 is a similar frequency swept plot of the front-to-back ratio, $F/B$, for the same series of element separations, $S$. Figs. 3 and 4, in the same format, show the gain and $F/B$ where the parasitic acts like a director, i.e., where the gain is positive in the direction of driver towards parasite!

Examination of these performance plots, together with additional information on computed driver input impedance, reveals a number of interesting facets of the behavior of 2-element Yagi beams. First I show in fig. 5 a plot of the gain at central frequency ($F = 1$) only as a function of element spacing, $S$. This is similar but not identical with a plot shown on page 147 of the *ARRL Antenna Book*; it is possible that the differences, particularly at small spacings, are due to greater precision in the new calculations. In any case, I believe the implications of this plot may be somewhat misleading!

You can easily see that the maximum gain(s) obtainable at the "best" frequency(s) in figs. 1 to 4 look somewhat different! These are shown in figs. 6
and 7, where for reference the curve for \( F = 1.0 \) is also shown. You can see that the obtainable gain does not depend greatly on whether the parasite is a reflector or a director as implied in fig. 5; moreover, the largest gain is obtained at very small spacings! This is a result which is not intuitive. Figs. 6 and 7 can be compared with the early analysis by Brown, and there appears to be good agreement. However, the result shown on page 146 of the ARRL Antenna Book which cites Brown's analysis is somewhat different. The fall off in maximum gain for low spacings shown by the ARRL reference does not appear to agree with Brown nor does it substantiate the calculations I have made (figs. 6 and 7).

If you examine the maximum gain(s) shown in figs. 1 and 3 for best frequency and corresponding (driver) driving-point impedance, you obtain the values shown in table 1. A plot of \( R \) is shown in fig. 8 which can be compared with a similar diagram shown on page 147 of the ARRL Antenna Book; except for low values of \( S \), agreement is fairly satisfactory.

You can see from table 1 and fig. 8 that element spacing affects (driver) driving-point resistance, and, therefore, circuit loaded \( Q (Q_L) \) over a very large range! This factor, as well as the gain curves shown in figs. 1 and 3 set a practical limit to the achievable gain over a desirable bandwidth, e.g., perhaps 4 per cent in \( F \). Moreover, the higher values of (radiation) loaded \( Q \) will, in practice, cause circuit resistive losses to be large and therefore the antenna efficiency to be low! Thus, in practice, really short booms are not very desirable; one must choose between efficiency and bandwidth on the one hand, and gain and \( F/B \) ratio on the other!

Long booms, however, also appear undesirable because gain really falls off (primarily due to reduced excitation of the parasite). Furthermore, for booms longer than \( 0.3X \) a new phenomenon can be seen from a detailed computational analysis (not shown here). The front lobe of radiation begins to "dimple" in the forward direction, resulting in a pattern where the gain maximum occurs at an elevation angle other than zero with respect to the boom direction. (The gain shown in figs. 1 to 4, however, is just the energy flux in the direction of the boom referenced to
an isotropic radiator.) This pattern effect was predicted by Brown\textsuperscript{3} and shown in Kraus, page 294.\textsuperscript{4}

Note that the 2-element Yagi gives respectable performance in gain for a wide range of element separations! However, the \( F/B \) figures are not especially impressive; moreover best \( F/B \) does not occur at the same frequency as best gain! Thus, in designing a 2-element Yagi beam a practical compromise is necessary. If you wish to obtain good gain with at least a fair \( F/B \) ratio over a bandwidth of say 4 per cent, you can determine by inspection of figs. 1 through 4 and table 1 that a 2-element beam should have a boom length of perhaps 0.15 wavelength. For such a boom the gain is essentially independent of whether the parasite is a reflector or a director; moreover, the \( F/B \) is about equivalent for either situation.

To move the peak of the gain curve(s) in figs. 1 to 4 to center frequency, the parasite length is adjusted commensurately; to reduce central frequency (driver) reactance, the driver length is adjusted.

These characteristics of 2-element beams are shown in figs. 9 and 10 with a frequency-swept plot of each design. Note that each of these figures show gain, \( F/B \), \( R \) and \( X \) of the driver. They illustrate the kind of design compromises which must be made. They also show the frequency-swept behavior of the main performance parameters.

The "best" central frequency is a matter of choice and is a compromise between gain and \( F/B \) ratio; it is adjusted by the length of the parasite. The (driver) driving point resistance and reactance vary significantly with frequency! Note that you cannot generally specify "a" resistance except at a single frequency such as the central design frequency; also note that

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Table 1. Maximum gain and feed-point impedance of a 2-element Yagi at various element spacings.
fig. 11. Gain and front-to-back (F/B) ratio for three-element Yagi beams with varying boom lengths, and changing reflector and director lengths (see table 3 for complete data). Boom lengths from 0.1λ₀ to 0.4λ₀. See next page for boom lengths from 0.5λ₀ to 0.7λ₀.

...
more than two elements

I will now turn to an analysis of simplistic Yagi antennas having more than one parasite. In all cases there will be only one reflector and all directors will have identical lengths. All elements are uniformly spaced along the boom. I shall display for clarity only the essential frequency-swept gain and frequency-swept $F/B$ behaviors; the driving point impedances, all of which were computed, are of secondary interest at this point. For these Yagi antennas there are a number of parameters which should be systematically explored. Table 2 shows these parameters and the range over which each has been varied. To display results in a consistent way I have chosen for each frequency-swept plot a fixed number of elements and a fixed overall boom length, $\lambda_B$, measured in wavelengths at the central frequency. On each plot there are six numbered curves; each number designates a particular parasite “tuning” combination; these combinations are shown in Table 3. The lengths and free space resonant frequencies of parasites are shown for each numbered combination.

The curves of Fig. 11 show the results for 3-element beams as boom lengths, $\lambda_B$, are varied from 0.100 to 0.700 wavelengths. It is apparent from an inspection of these plots that the performance is superior to that of the 2-element beams; this is especially true in the $F/B$ ratio. As you increase boom length the maximum gain increases (unlike that for 2-element beams); the $F/B$ increases spectacularly, then decreases again. For this class of Yagi antennas there seems to be a best boom length; we shall see this kind of result for all of the simplistic Yagis and the physical explanation will soon be apparent!

Note that the chief parameter controlling the bandwidth over which gain remains high is the (resonant)
fig. 12. Gain and front-to-back (F/B) ratio for four-element Yagi beams with varying boom lengths, and changing reflector and director lengths (see table 3 for complete data). Boom lengths from 0.1λ₀ to 0.5λ₀. See next page for boom lengths from 0.6λ₀ to 1.0λ₀.

frequency separation of reflector and director; this observation will also prove to be generally true for all simplistic Yagi antennas! The bandwidth of the F/B performance (when the F/B is very high) is small; this is due to the critical nature of low back radiation.

Back radiation is very low only when there is vectorial cancellation of field in the back direction; this comes about only where element complex currents...
Gain and front-to-back (F/B) ratio for four-element Yagi beams; boom lengths from 0.6λ₀ to 1.0λ₀.

are accidentally favorable for such cancellation. When this happens very small changes in those currents, e.g., by shifting frequency slightly, will destroy the favorable vectorical cancellation. This general result is inherent in all Yagi antennas; if the F/B is exceptionally high it will be so only over a very narrow frequency band!

Similar results for 4-element simplistic beams are shown in fig. 12; results for 5-, 6-, and 7-elements, although not plotted here, show increasing complex-
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summary

Simplistic Yagis with two, three, and four elements with boom lengths to 1.0λ have been systematically explored, and it has been shown that the gain function is generally not flat and the F/B ratio varies greatly from one example to another. Next month I will continue this discussion with a series of graphs which show gain and front-to-back ratio for 6-element Yagis with boom lengths up 1.5λ. I will also compare the performance characteristics of Yagis with up to seven elements and present interesting new data on the subject of front-to-back ratio.

references


ham radio

**DON'T LAUGH, YOU SHOULD SEE THE FRONT TO BACK RATIO!**
notes on ground systems

How to provide an effective ground system for your station and how to measure ground-system resistance

A good ground system makes as good a contact as possible with the earth. A large surface area, as well as depth to moist earth, is essential. Several ground rods of large-diameter copper (at least 5/8 inch or 16 mm) will meet these requirements if driven in 6 to 8 feet (1.8-2.5 meters).

In this article I discuss the delta-Y ground-rod configuration, which is efficient and far superior to a single ground rod, utility ground system, or water pipe. Also discussed is a straightforward method of measuring net resistance of the ground system.

system considerations

If desired, three rods may be used in a delta arrangement without too much increase in the net ground resistance. The delta or Y configuration isn’t mandatory but does provide a convenient way of measuring the net ground resistance and thereby a means of determining the quality of the ground system.

An ac voltage is employed to measure the resistance to avoid dc electrochemical effects such as battery action and polarization. If available, an ac megohmmeter could be used to measure the resistance between the respective ground rods.

The ground rods should be copper or copper-clad steel and 6-8 feet (1.8-2.5 meters) long. Ground rods using 3/8-inch (9.5-mm) copper clad steel are generally available. Five-eighths inch (16-mm) copper tubing would be better but in some soils it may be very

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Delta configuration of ground rods for measuring the net resistance of the system to ground. Ground rods are designated \( R_1, R_2, \) and \( R_3; R_{12}, R_{23}, \) and \( R_{31} \) are the ground resistances between the designated rods.

difficult to drive. Aluminum should be avoided, and galvanized steel is not very satisfactory.

Do not use the electric utility ground bus, as the common impedance will introduce the noise and interference on that ground wire. Water pipes are not very satisfactory for a variety of reasons. Many times, if copper plumbing is used in the house, the copper pipe extends only about 10 feet (3 meters), and from there on plastic pipe is used. With galvanized pipe, the resistance of the coupling joints as well as the surface resistance may be quite high. The fact that the pipe is full of water does not contribute to its effectiveness as a ground.

The antenna tower or mast should not be connected to the station ground because of the hazard of lightning; furthermore, never ground the tower down through the concrete foundation; a lightning strike would probably shatter the concrete. All ground leads from the equipment to the ground bus should be as short as possible. One-half inch (12.5-mm) or wider copper braid, tinned at each end and drilled for strapping to the ground terminal, makes a satisfactory and flexible connection.

The connecting wires should be as large as possible: no. 10 or no. 8 (2.6 or 3.3 mm) copper to keep resistance and reactance as low as possible. Two wires in parallel are equivalent to three sizes larger; hence, two no. 10 (2.6 mm) wires would be equivalent to a single no. 7 (3.7 mm) wire. The dc resistance of no. 7 (3.7 mm) copper wire is 0.5 ohm per 1000 feet (305 meters), so for connecting lengths less than 10 feet (3 meters) the dc resistance would be about 0.005 ohm. Because of skin effect, the rf resistance will be higher; at 14 MHz it would be about 0.35 ohm.

Avoid connecting lengths that are a half-wavelength or multiples thereof at the operating frequency, because they would act like a half-wavelength antenna. Also avoid quarter wavelengths, as they present a very high impedance at the resonant frequency.

Do not let a bare ground wire to the equipment touch any metal, as the intermittent contact will introduce serious noise.

### resistance measurements

The following procedure may be used to determine the net resistance of the delta-Y configuration to ground (see fig. 1). In the following example, the delta sides are 9 feet (2.7 meters).

Using an isolation transformer, Variac, ac voltmeter, and ac ammeter as shown in fig. 2, determine the resistances between each pair of ground rods. Use the Variac to adjust the voltage until 1 ampere is obtained. Then the value of the voltage will be equal to the resistance in ohms. Determine \( R_A, R_B, R_C, R_D, R_E, \) and \( R_F \) in this manner.

Calculate \( R_1 \):

\[
R_1 = \frac{1}{2} \left( R_A + R_C - R_B \right) \tag{1}
\]

which is one half of the sum of the two adjacent legs of the delta minus the opposite leg.

Likewise calculate:

\[
R_2 = \frac{1}{2} \left( R_A + R_B - R_C \right) \tag{2}
\]

\[
R_3 = \frac{1}{2} \left( R_B + R_C - R_A \right) \tag{3}
\]

\[
R_4 = \frac{1}{2} \left( R_D + R_E - R_A \right) \tag{4}
\]
\( R_1, R_2, R_3, \) and \( R_4 \) should be essentially the same, and if so, the net resistance of the configuration to ground will be

\[
R = \frac{R_1}{4}
\]  

(5)

If the values of \( R_1, R_2, R_3, \) and \( R_4 \) are significantly different, calculate the net resistance of the four in parallel. The value of the individual rod-resistance-to-ground is about 10 to 20 ohms and depends on the type of soil, moisture content, depth, and rod size.

\[
R_X = \frac{R_1 R_2}{R_1 + R_2} \quad R_Y = \frac{R_3 R_4}{R_3 + R_4} \quad R = \frac{R_X R_Y}{R_X + R_Y}
\]  

(6)

The net resistance of the connected rods should be less than 5 ohms. The rods are connected as shown in fig. 3.

calculating wire inductance

The self-inductance of a single wire may be calculated by the following formula (National Bureau of Standards Circular No. 74):

\[
L = 0.002 \times (2.303 \log \frac{d}{\varphi} - 1) \ \mu H
\]  

(7)

Example:

\( \varphi = 9 \) feet (274 cm)
\( d = \text{no. 7 AWG} = 0.14 \) inch (0.36 cm)\(^2 \)

\[
L = 0.002 \times 274 \times (2.303 \log \frac{0.14}{0.36} - 1)
\]

\( = 4 \ \mu H \)

At 4 MHz, \( X_L = 2 \pi \times 4 \times 4 = 100 \) ohms

Contrast this with the reactance of a 25-foot (8-meter) length of no. 16 (1.3-mm) ground wire, which would be over 200 ohms. The length and size of the wire are the determining elements of the resulting inductance, so it's readily seen that the length must be as short as possible and the wire size as large as possible.

The procedure used in determining the ground resistance is covered on page 257 of the Government Printing Office publication DCAC 330-175-1 addendum 1.

references


bibliography


ham radio
dual quad array
for two meters

Design and construction of a quad array that challenges a Yagi-Uda with the same number of elements

Several months of work on two meters with quad antennas of various designs and configurations have resulted in an improved design using all-metal construction. The driven elements are of the closed-loop type, employing an improved feed method that provides ease of adjustment and an excellent match to the feed system.

This construction method offers several advantages, both mechanical and electrical, over the usual insulated-spreader type of quad layout. The all-metal structure will withstand severe environmental conditions such as high wind or ice loading. It also presents a grounded system for electrical charges that may be induced by a severe electrical storm.

description

The dual quad array consists of two 4-element quads mounted on a common cross boom spaced approximately 5/8 wavelength apart. The quads are connected by 3/4-wavelength phasing sections of RG-58/U foam-filled coax. (More on this later.)

Basically, a quad antenna is a one-wavelength conductor that may take the form of a square, diamond, or round loop. Regardless of configuration, the quad antenna’s electrical characteristics remain essentially the same. In this article I refer to it as a quad loop.

The two halfwave dipoles diagrammed in fig. 1A show the formation of a quad loop. They have two low-impedance points, so they may be mounted to a metal support without affecting their electrical characteristics. The voltage curve along a halfwave dipole shows maximum voltage at the ends, with the center at zero potential (low impedance), this being points A and B of the dipoles.

If the dipoles are spaced 1/4 wavelength apart and their ends folded over at the 1/8-wavelength points and joined together, a cubical quad is formed (fig. 1B).
fig. 1. Principles of a quad antenna. Two halfwave dipoles form a quad loop, (A). A cubical quad is formed by folding the ends at the 1/8-wavelength points, (B). Mounting points A and B are at zero rf potential. Polarization depends upon feedpoint: vertical when fed from side, horizontal when fed at top or bottom.

1B). Points A and B remain at zero rf potential so long as the feedpoint is at either A or B.

feedpoint considerations

The feedpoint to a quad loop determines the voltage and current distribution around the loop as well as the polarization of the emitted wave front.

The quad loop looks and performs like two halfwave dipoles connected back-to-back. If the quad loop is fed at either side, maximum current flow occurs in the vertical sides; hence it's vertically polarized. If fed at either the top or bottom, the voltage and current nodes are shifted around the loop by 90 degrees and the quad becomes horizontally polarized.

loop configuration

Circular loops are used in the dual quad array described here. They are easily formed and perform slightly better than the other configurations at the higher frequencies. (High-frequency currents don't like sharp bends or abrupt changes, and the circular configuration offers a more uniform transition from the low-to-high impedance points around the loop.)

The circumference of the driven loops can be determined by a simple equation. Circumference of the loop is:

\[
C = \frac{12,060}{f} \text{inches} \quad (1)
\]

where \(C\) is the loop circumference in inches. For centimeters, the numerator in eq. 1 is replaced by 30.624. The driven loops were cut to 82 inches (208 cm), which is near the center of the 2-meter band. The reflector is 2 inches (51 mm) longer, and the directors progressively 2 inches (51 mm) shorter. Spacing is 16 inches (406 mm) on the reflector and 12 inches (305 mm) on the directors.

matching system

Common practice is to open the loop at the desired feedpoint and attach a 50-ohm feedline. This practice gives an acceptable match, but it has been found that a more desirable method is to leave the loop closed and feed it with a modified gamma match as shown in fig. 2. This method makes for an easy adjustment of SWR and gives an excellent match to the phasing harness. The gamma rods are 8 inch (203 mm) lengths of 1/4-inch (6.5-mm) copper tubing. The gamma capacitor is a miniature Johnson variable. A cap with 15-20 pF maximum capacitance is sufficient. The capacitor is mounted in a plastic tube and sealed for weather protection. [I used 1 inch (22.5 mm) diameter plastic pill boxes in the original construction.]

construction

Construction of the array is quite simple. Hand tools will be adequate for the job. Most of the materials are off-the-shelf items obtainable in any hardware store.

The main framework (fig. 3) is constructed of thinwall 1/2-inch (12.5-mm) electrical conduit. Pipe straps, as used for mounting 1/2-inch (12.5-mm) tubing, are used throughout the assembly for mounting the loops and securing the 1/2-inch (12.5-mm) conduit to the mounting points.

The loops (fig. 4) are constructed of no. 8 (3.3-mm) aluminum wire sold as TV ground wire. Two strands of this wire are used in each loop. The strands are tightly twisted together to form a semi-rigid conductor.

1. Clamp the two ends of the wire in a bench vise and chuck the other ends into an electric drill motor. Keep the wires evenly spaced by applying a little pressure.

2. Turn on the drill motor and the wires will be tightly and evenly twisted together.

3. Cut the wires about 6 inches (152-mm) longer
than the desired loop, as they will be shortened by the twisting action.

4. Hand form them into a loop that will be rigid when mounted to a metal cross member.

The insulated mounting rings to which the gamma rods are attached are cut from 1/4-inch (6.5-mm) plexiglass or phenolic. Use a 1 x 3/4 inch (25.4 x 19 mm) hole saw.

1. Drill the centers to slip over the 1/2-inch (12.5-mm) conduit cross member.

2. Flatten the copper tubing gamma rod ends in a bench vise and drill for mounting to the insulating rings. A half-circle strap connects the ends of the gamma rods together; this may be made of copper or thin aluminum.

3. Drill the center of the strap for a 6-32 (M3/5) screw, which secures a solder lug at this point.

This solder lug is the feedpoint and connects to the inner conductor of the phasing harness. The coax braid is being attached directly to the cross boom and secured by another screw and solder lug.

phasing harness

The phasing consists of two equal lengths of RG-59/U coax cut to an electrical 3/4 wavelength and terminated in the center to an SO-239 connector to which the main 50-ohm feedline connects. Because of the coax velocity factor, the actual length will be shortened by this factor. Unfortunately, the propagation velocity will vary between cables of different coax brands.

Foam-filled cable comes out to be near 47 inches (119 cm) for 3/4 wavelength at 2 meters, while the solid type comes out near 36 inches (91 cm).

The recommended method of determining the electrical length is to cut a length of cable slightly longer than the estimated length required. Short one end with a small pickup loop and couple this loop to a grid-dip oscillator. Carefully trim off the free end until you get a dip near the center of the 2-meter band.

tuneup

Each quad section is tuned separately.

1. Connect a 50-ohm feedline from the transmitter to the solder lug feedpoint. (The coax shield is grounded directly to the cross boom.)

2. Set the shorting strap that connects the lower gamma rod to the radiator four inches (102 mm) below the feed point. This dimension may be adjusted if unity SWR is not obtained by adjusting the gamma capacitor.

3. Insert an SWR meter into the line, preferably near the antenna where it may be easily observed.

4. Apply power to antenna at a frequency near the
center of the 2-meter band. Use reduced power to prevent interference.

5. Note meter reading. With an insulated tool, adjust the gamma capacitor until a reading of near unity SWR is obtained. Use the same procedure for the other quad.

6. Now connect the phasing harness and main feedline. A slight adjustment of the gamma capacitor will again bring the SWR reading to near unity.

You must, of course, observe the usual precautions of having the antenna on the clear while making these adjustments. Height above ground doesn’t affect the quad as much as the Yagi for

distant stations you’ve been unable to work.

**in retrospect**

Those familiar with the Swiss quad have no doubt noted that it’s also an all-metal design, with closed loops and a modified gamma match. The Swiss quad has been popular in Europe for several years and is now making an appearance in this country. It’s a very good antenna, but I must add that the dual quad array shown here has out-performed it at my location.

Over the years, there’s been much controversy concerning the relative merits of the quad versus the Yagi. My only comment is this: Compare this dual quad array with your favorite Yagi, with a compara- number of elements, using on-the-air tests with a distant station. I think you’ll find that on-the-air tests don’t always agree with gain measurements made on an antenna range under controlled conditions.

This quad array has a low takeoff angle of radiation and will work quite well at low heights above ground. It’s very tolerant of variations in dimensions and very easy to match. Directivity is very sharp; a variation of a few degrees can mean the difference between an S1 and an S9 signal. If you wish to use the array for horizontal polarization, rotate the array 90 degrees so that the quads are stacked one above the other.

**references**


**bibliography**

automatic
VSWR and power meter

Design and construction
of an instrument
that indicates
rf power and VSWR
simultaneously

One of the most common station accessories used by the Amateur Radio operator is the VSWR meter, which determines the voltage standing wave ratio between transmitter and antenna. VSWR is a measure of the quality of the system match, or may be looked at as a measure of system efficiency. Many articles have been written stating that a high VSWR doesn’t usually seriously degrade transmission-line performance. Also the articles have correctly stated that reduction in radiation efficiency caused by antenna nonresonance is barely noticeable.

Now that most Amateurs are convinced that their 80-meter dipole will work from 3.5-4 MHz even though the VSWR may be high at either end, they’re faced with the VSWR limitation of their transceiver. To solve this problem, a transmatch or antenna tuner is placed between transmission line and transmitter.

In light of the previous comments, it’s not as important to use a VSWR meter to monitor the transmission line VSWR as it is to monitor the VSWR between transmitter and antenna tuner.

The antenna tuner introduces more knobs to be adjusted during tune up and can cause some delay in tune up because of interaction between loading adjustments. Also, because of the moderate Q involved in the tuner, you can easily encounter VSWRs from infinity to 1:1 while adjusting the tuner. Thus, it’s usually desirable to do initial tuning at low power and final tuning at full power. The wide range of power and VSWR encountered during tuner operation makes use of the conventional VSWR meter difficult, because the REF or CAL point changes, which causes inaccurate VSWR readings. This is where an automatic meter can greatly speed up the tuning procedure, because the VSWR-meter readings are accurate and independent of power level down to some minimum power level.

automatic VSWR meter

The automatic VSWR meter described in this article is unique, versatile, and easy to use. The basic circuit design is covered by U.S. Patent 4,110,685. It’s battery operated and has an automatic ON/OFF feature for extended battery life. Two meters that display power and VSWR simultaneously give a greater feel for how well the transmitter is operating on a continuous monitoring basis. Also, the two-meter display of power and VSWR as independent

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34  may 1980
parameters greatly speeds up antenna loading adjustments and gives greater confidence that the transmitter is operating properly without any switching, reference setting, or mental calculations.

**how it works**

As in all VSWR meters (fig. 1), an in-line directional coupler senses and develops a voltage proportional to the forward and reflected voltage on the transmission line. The directional coupler in this instrument also has a diode compensation network to provide additional linear range at low levels. It also senses when rf is present to saturate a transistor, which is used to turn the instrument on.

The signal from the directional coupler that senses rf power is fed to a circuit that uses transistors to turn the supply voltages of +16 and -9 volts to the analog computing circuits ON or OFF.

The directional-coupler dc outputs are connected to fet input buffer amplifiers to provide a high-impedance load to the directional coupler outputs and low impedance outputs for the logarithmic amplifier and wattmeter.

Dc outputs $V_F$ and $V_R$ are linearized to provide outputs that can be used directly. Thus $V_F$ can be used to drive a wattmeter. Power is displayed in watts on a scale constructed by using the formula

$$P = \frac{V_F^2}{R}$$

(1)

Since dc output voltages $V_F$ and $V_R$ are developed by peak-detecting diodes, the wattmeter scale displays two decades of power range; i.e., the 250-watt full-scale meter displays power from 2-250 watts. This can be seen in the photo of the meters. A peak detector whose output is calibrated to read volts rms or power can have errors if the signal has large harmonic content; thus the peak detector gives accurate results.

The logarithmic amplifier develops a voltage at the output with a relationship proportional to the logarithm of the input voltage. At the log amp outputs are two voltages that are the logarithm of $V_F$ and $V_R$. An expression called return loss, which is used by the telecommunications and instrument industry, is defined as follows:

$$\text{return loss} = 20 \log \frac{1}{\rho} = 20 \log \frac{V_F}{V_R}$$

(2)

where $\rho$ = reflection coefficient

By mathematical equality, eq. 2 can also be expressed as

$$\text{return loss} = 20 \left( \log V_F - \log V_R \right)$$

(3)

It can now be seen that if we take the difference of the two voltages, log $V_F$ and log $V_R$, the result will be a voltage proportional to the return loss in dB:

$$E_{RL} = \log V_F - \log V_R$$

(4)

Return loss is related to VSWR by

$$RL_{dB} = 20 \log \left( \frac{VSWR + 1}{VSWR - 1} \right)$$

(5)

By scaling construction the meter can be made to display VSWR (see the VSWR-meter photo). Voltage $E_{RL}$ is the difference between voltages log $V_F$ and log $V_R$, which is always present from the log amps. Thus VSWR is automatically and continuously displayed with no need to set a reference and operate a switch.

![fig. 1. Automatic VSWR/power meter block diagram.](image-url)
VSWR-meter scale

One of the things you’ll notice when you look at the VSWR meter scale (photo) is that it’s “backwards.” With this meter you peak the VSWR meter as well as the wattmeter for best loading.

Having $VSWR = \infty$ at the left-hand end of the meter is explained by the way VSWR is computed. Note table 1, in which the three parameters, reflection coefficient, VSWR, and return loss, are tabulated.

From this table you can see that when $VSWR = \infty$, return loss = 0 dB; and conversely, when $VSWR = 1$, return loss = $\infty$ dB. In this instrument return loss is computed so the display of $VSWR = \infty$ is no problem, because the subtraction of two equal voltages is easily made electronically. However, there’s a problem in the display of $VSWR = 1$, because this value is equal to infinite return loss. Obviously, a display of zero to infinite return loss in dB is impossible. As a result, a practical limit must be selected, so I’ve chosen to limit return loss to 25 dB, or a VSWR of 1.12.

This limit was chosen for practicality. A VSWR of 1.12 represents an efficiency of 99.7 per cent of the available power being delivered to the load. Ivory Soap long ago convinced the consumer that 99.44 per cent pure soap was good enough, and I feel that 99.7 per cent of my transmitter power delivered to my antenna is good enough.

With the VSWR scale is a scale called LOAD EFFICIENCY in per cent. This scale greatly enhances your feel for system efficiency. (There’s always the question, Just what does VSWR mean and how much should I have?) The scale is also a constant reminder that there’s a reasonable limit to how low you must keep the VSWR. Another practical reason for the limit in the displayed VSWR is that a directional coupler with isolation good enough to measure low VSWR numbers of high return-loss numbers is difficult to construct.

directional coupler

The directional coupler is of conventional design and works on the principle described by Bruene, however the design of this directional coupler for specific applications wasn’t covered. I’ve developed some simple formulas that can be used in predicting, to a good approximation, the values needed to
obtain the desired operation. Reference 1 covers the theory of operation and some considerations for the directional coupler design. I urge you to review this fine article. The basic circuit is shown in fig. 2 and is used to develop the formulas.

**Bridge balance.** The basic principles of the directional coupler is that, at bridge balance, the voltage presented to reflected diode detector $CR_R$ is zero and the voltage presented to forward diode detector $CR_F$ is $E_D$. The diode-detector voltage output is determined by two voltages proportional to the magnitude and phase of transmission-line voltage $E_V$ and current $I_i$. The voltage proportional to transmission line current $I_i$ is made to appear in phase with $I_i$ on the reflected diode detector by the center-tapped resistor load for the current-to-voltage transformer.

At bridge balance, and with a reference resistive load, $E_D = E_D/2$ is in phase on the reflected side and $-180$ degrees out of phase on the forward side. With these conditions the forward diode detector voltage is $E_D + E_D/2 = E_D$ and the reflected diode detector voltage is $E_D - E_D/2 = 0$.

When a load other than the resistive reference value is present, the bridge will not be balanced, and the voltages presented to the diode detectors will be determined by both magnitude and phase of the voltages $E_D$ and $E_D/2$. The amount of unbalance is detected in the diode detectors. Their dc outputs result in the outputs, voltage forward $V_F$ and voltage reflected $V_R$, from which the ratio of these two voltages determines the VSWR.

There's no unique solution that will completely design the coupler. Table 2 lists the main parameters and guidelines to design this type of directional coupler. From the previous paragraph note that, at bridge balance, $E_D = E_D/2$ and also that the voltage presented to the diode is $E_D$. Since voltage $E_D$ across the diode is a parameter to keep track of, I’ve found it convenient to develop my formula using $E_D$.

**Current transformer.** Now for the expression to use for the current transformer. Assume the conditions for a valid transformer are met. Then $E_D = E_i \cdot N$, since the primary in this case has only one turn. Also $E_i = R_I I_i$; $I_i = \sqrt{P/R_L}$; and $R = R_I N^2$. Putting all this together, the expression to work with for design is

$$E_D = \frac{R}{N} \sqrt{P/R_L}$$

(6)

From this expression we see that, at a given power level, $E_D$ is increased with increasing values of $R$ and decreased with increasing number of turns.

For the above expression to be true, current-transformer action is assumed. To obtain this, the inductive reactance of the transformer secondary must be $\geq 5 \cdot R$ at the lowest frequency of interest.

To compute the inductance of a toroid inductor, the expression $L = N^2 \cdot LT/NT^2$ is used. $LT/NT$ is the $A_L$ or inductance index of the toroid. If $A_L$ is expressed in inductance per unit turn, the inductance of a toroid is the number of turns squared times $A_L$ or $L = N^2 A_L$. After calculating the toroid inductance, the reactance at the lowest frequency of interest can be determined by

$$X_L = 2\pi f L$$

(7)

As for $E_D$, the value of $R$ and $N$ also determines the directional coupler insertion resistance. Insertion resistance is equal to $R$ divided by $N^2$; $R_I = R/N^2$. Insertion loss can also be expressed in dB for a 50-ohm system:

$$dB_I = 20 \log \left( \frac{100 + R_I}{100} \right)$$

(8)

The current transformer load, $R$, will have power

---

**Table 2. Design guidelines.**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diode voltage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diode threshold voltage</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>Insertion resistance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Value of C1 for loading transmission line</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>Number of turns on toroid core</td>
<td>$X_i \geq 5 \cdot R$ at lowest frequency of interest</td>
<td>$X_i \geq 5 \cdot R$ at highest frequency of interest</td>
</tr>
<tr>
<td>Value of C2</td>
<td>$C_2 \geq 25 \cdot C_D$</td>
<td>$C_D = \text{diode capacitance}$</td>
</tr>
</tbody>
</table>
applied during operation, and the power in \( R \) can be calculated by

\[
P_R = \frac{E_D^2}{R} \tag{9}
\]

The voltage at the other side of the diode is determined by capacitive divider \( C1 \) and \( C2 \). Voltage-divider output \( E_O \) is equal to \( E_L \) times \( C1 \) divided by \( (C1 + C2) \). If we let \( E_v = \sqrt{P \cdot R_L} \) and \( E_O = E_D / 2 = \frac{R}{2N} \sqrt{P / R_L} \)

(condition for bridge balance) and solve for \( C2 \), we obtain

\[
C2 = \left[ C1 \frac{2R_1N}{R} - 1 \right] \tag{10}
\]

This expression is convenient because it’s in terms of the two parameters usually adjusted to obtain the desired performance.

In summary, here are the expressions needed to solve for the values of the components for a directional coupler:

- \( N = \frac{R}{E_D} \sqrt{P / R_L} \) (turns)
- \( L = N^2 \cdot A_L \) (inductance per unit turn)
- \( R_I = R / N^2 \) (ohms)
- \( P_R = \frac{E_D^2}{R} \) (watts)
- \( C2 = C1 \left[ \frac{2R_1N}{R} - 1 \right] \)

**Design example.** To gain a feel for using the formulas, let’s work out the values used for the directional coupler in this article. (See the basic circuit, fig. 2.) In this case I’m operating the diodes in a peak-detecting mode, so I’ll select the diode voltage to be 10 volts rms when the maximum power of 250 watts is applied through the directional coupler. Also I’ll select \( R \) to be 50 ohms and the frequency range to be 1.8-30 MHz. These initial design parameters will allow the component values to be calculated.

The number of turns, \( N \), for the toroid is

\[
N = \frac{R}{E_D} \sqrt{P / R_L}
\]

\[
= \frac{50 \text{ ohms}}{10 \text{ volts}} \sqrt{250 \text{ watts}} \left( \frac{50 \text{ ohms}}{50 \text{ ohms}} \right) = 11.18 \text{ turns}
\]

Since we can’t wind fractional \( A_L \) turns, the number of turns are rounded off to 11, which will be used in the following calculation.

Now we check to see if the number of turns is okay for inductance. Calculate \( L = N^2 \cdot A_L \), where \( A_L = 2.1 \mu H \) per turn for the Ferroxcube toroid core number 266T125 (fig. 3) and we find \( L = 11^2 \cdot 2.1 = 234 \mu H \). At 1.8 MHz, the inductive reactance is 2872 ohms. The inductive reactance is easily greater than 5 times 50 ohms, which is okay. Empirically, by winding the toroid core, we find the length of wire to be 18 cm. The maximum length of wire is approximately

\[
1 = \frac{300}{20f} \text{ in meters or } 1 = \frac{1500}{30} = 50 \text{ cm}, \text{ which means my 18-cm length of wire is okay.}
\]

The insertion resistance is \( R_I = R / N^2 = \frac{50}{11^2} = 0.4 \text{ ohm,} \) and the power in the resistors at full scale is

\[
P_R = \frac{E_D^2}{R} = \frac{102}{50} = 2 \text{ watts,} \text{ or } 1 \text{ watt per resistor.} \]

The values obtained are acceptable. A 25-ohm, 1-watt resistor is a practical value, and an insertion resistance of 0.4 ohm, which translates to a 0.04-dB loss, is reasonable. If, during this step, the power in the resistor is too high or insertion loss is unacceptable, you’d adjust either \( R \) or \( N \) or both and try again until an acceptable answer is obtained.

Capacitor values are determined by first selecting the value of \( C1 \), which should have an impedance of approximately 10 \( \cdot \) \( Z_0 \) or 500 ohms at 30 MHz. The maximum value of capacitance is 10 pF. Since there are two \( C1 \)s, each \( C1 \) has a maximum-value of 5 pF. To obtain some margin, I’ve selected 3.3 pF for \( C1 \).

From this selection of \( C1 \), \( C2 \) can be calculated by:

\[
C2 = C1 \left[ \frac{2R_1N}{R} - 1 \right]
\]

\[
= 3.3 \{22-1\} = 69 \text{ pF}
\]

The diode capacitance is about 2 pF maximum; therefore \( C2 \) should be greater than 2 \( \cdot \) 25 or 50 pF. We must adjust the bridge so that \( E_O = E_D / 2 \) for balance, so either \( C1 \) or \( C2 \) is made adjustable.

In summary, we find that for a 250-watt, 1.8-30 MHz directional coupler, the following values will work: \( R / 2 = 25 \text{ ohms; } 11 \text{ turns on the toroid core; } C1 = 3.3 \text{ pF, and } C2 = 69 \text{ pF.} \) I’ve verified that the preceding values will give the desired performance. The calculated values are ideal, and in practice the results will be slightly different. However, I’ve found from building a number of different types of directional couplers that the calculated and measured values are always quite close in agreement.

Dc output voltages \( V_F \) and \( V_R \) are taken from the junction of \( C1 \) and \( C2 \) (fig. 2). The resistor value or impedance must be high enough not to load \( C2 \), which means the load impedance should be approxi-
Construction. The construction can be noted in the photo of the inside of the directional coupler. The mately 20 times or greater than \( C_2 \) reactance at the lowest frequency of interest.

In this directional coupler design a diode compensation network uses the base-emitter junction of a transistor to extend the low-end range of the diode detector. Note the circuit in fig. 3. The compensation works by the variable attenuator formed by \( R_4, R_2, \) and \( Q_1 \). When the dc voltage from the diode detector is high, the current in \( R_2 \) is high, thus causing \( Q_1 \) base-emitter junction to conduct and look like a low-impedance for \( R_2 \) to ground. Since \( R_2 \) is grounded, the detector voltage is attenuated by the ratio of \( R_4 \) to \( R_2 \). When the dc voltage from the diode detector is low, the current in \( R_2 \) is low, causing \( Q_1 \) base-emitter junction impedance to increase due to less current in \( R_4 \), which, in turn, decreases detector-voltage attenuation to the \( V_F \) output. Note also that \( Q_1 \), which compensates for \( V_F \), has its collector brought out so that, when enough signal is present, \( Q_1 \) collector saturates and turns on the power to the instrument through the ON/OFF circuit.

Calibration. The composition circuit is calibrated by applying a known 3 volts rms at some midrange frequency, say 7 MHz, and adjusting \( R_4 \) \((R_{11})\) for an output of 3 volts dc at \( V_F \) \((V_R)\) with a 10-megohm voltmeter. Disconnect the anode of \( CR_1 \) \((CR_2)\) from \( R_6 \) \((R_9)\) and \( L_1 \) for this adjustment. Calibration of the bridge for balance is straightforward. Adjust \( C_7 \) for minimum voltage at \( V_R \) when connected in the normal manner. Reverse transmitter and load for adjusting \( C_4 \) for minimum voltage at \( V_F \). The use of a known good 50-ohm load is a must for proper calibration.

Because it’s not easy to determine the sense of the toroid output, it may be necessary to reverse connection to the toroid to get voltages \( V_F \) and \( V_R \) at the proper side. I usually find a small amount of interaction in adjustments, so I repeat the procedure to be sure the directional coupler is calibrated accurately.

directional coupler was constructed in a die-cast aluminum box, Bud no. CU-124. Feedthrough capacitors were used to bring out the dc signal voltages. The layout of the PC board isn’t especially critical; however, a compact symmetrical pattern usually works best.

power on-off circuit

Power for the automatic VSWR meter comes from three standard 9-volt batteries. Two are connected in series to provide \(+18\) volts and the other provides \(-9\) volts to the analog circuits. The circuit is in fig. 4. When \( R_3 \) is grounded by the saturated collector of \( Q_1 \) in the directional coupler, the Darlington transistor pair \( Q_1, Q_2 \) is turned on so that the \(+18\) volts is supplied to the analog circuits through \( CR_1 \), which is a power-on indicator LED (amber).

When the positive supply goes on, current flows through \( R_4 \), which turns on \( Q_3 \), which in turn turns on \( Q_4 \). This connects the \(-9\) volt battery to the analog circuits. The ON/OFF switch is connected so that when it’s in the open or OFF position, the instrument will not come ON even though rf power may be present in the directional coupler. The purpose for this is to allow for longer battery life because it’s usually not necessary to monitor power and VSWR.
after tune up and may also be distracting to see meters going up and down during normal CW or phone operation.

Expected battery life is about thirty-six hours for continuous operation. However, with the OFF switch and normal transmit-receive duty cycle, the expected life should be at least a year for the average Amateur. Battery operation is very desirable for ease of installation and use of the VSWR meter, especially for tuning mobile antennas.

A connection from the power ON/OFF circuit also goes to the CHECK switch, which turns on the power so that analog circuit calibration can be checked from time to time and also allows a measure of battery condition from the wattmeter. (This will be covered in more detail in the description of the check-switch circuit.)

**analog circuits**

The analog circuits (fig. 5) receive the dc signals from the directional coupler and, when power is applied, process the dc signals to be applied to the wattmeter and VSWR meter. The two dc signals from the directional coupler, $V_F$ and $V_R$, are sent to the buffer amplifiers, which are connected in a unity-gain configuration. The output of the $V_F$ buffer amplifier $U_2$ is connected to the input of $V_F$ logarithm amplifier $U_5$ and also the wattmeter. The output of the $V_R$ buffer amplifier, $U_1$, is connected to the input of the $V_R$ logarithmic amplifier, $U_3$. Logarithmic amplifiers $U_3$ and $U_5$ are of a basic configuration using a grounded-base transistor for the feedback diode. Note in the circuit that the feedback diodes, $U_4$ are a matched transistor pair (National Semiconductors LM394BH).

In this application it’s very important that the temperature and logging characteristics match, so that the difference in voltage between the two logarithmic amplifiers doesn’t vary as a function of temperature and other environmental factors. The absolute voltage of each logarithmic amplifier will change, but that’s not an important factor because the meter amplifier, $U_6$, is connected to reject the common-mode voltage from the logarithmic amplifiers; thus only their voltage difference is measured. Also note in the diagram that diodes $CR_1$ and $CR_2$ are connected to prevent possible reverse voltage on the base-emitter junctions of $U_4$ from becoming too large.

The output voltages of the logarithmic amplifiers are called $LV_F$ and $LV_R$; their voltage difference results in a new voltage, $E_{RL}$, which is proportional to return loss in dB. Meter amplifier $U_6$ is connected as a difference-voltage amplifier. The VSWR meter is connected in series with feedback resistors $R_{17}$ and $R_{18}$. In this configuration, the current in the meter is determined by the value of $R_{15} + R_{14}$ and $E_{RL}$. $R_{15}$ is adjustable, so that the scale factor, or calibration, of the VSWR meter can be set.

Diode $CR_3$ in the feedback circuit of $U_6$ limits the forward and reverse current through the meter to protect the meter from damage when VSWRs greater than 1.12 are measured. The reverse-voltage protection is necessary during initial calibration of the unit when a reverse polarity signal can easily be present.

Also note that the inputs to the meter amplifier are not referenced to ground, thus providing common-mode voltage rejection. The operational-amplifier inputs will never be more than plus or minus one diode drop from ground.

The analog board is an analog computer that computes return loss and, by scale construction on the meter, displays VSWR. Because most all operational amplifiers have offset currents and voltages, each operational amplifier has an offset voltage adjustment so that these errors can be compensated for proper operation. A voltage divider network consisting of $R_{19}$, $R_{20}$, and $R_{21}$ provides an accurate voltage ratio for calibration and check.

**check-switch function**

The check switch serves a very useful function. It
allows instrument calibration and operation to be verified at regular intervals. The calibration is verified by the voltage ratio from resistor divider \( R_{20} \) and \( R_{21} \), fig. 5. The voltage ratio in this case is 0.091, which is equal to reflection coefficient \( \rho \). A \( \rho \) of 0.091 is equal to a VSWR of 1.2:1. During normal operation \( V_F \) and \( V_R \) inputs come from the directional coupler, but when the check switch is put in the CHECK position, \( V_F \) and \( V_R \) inputs are connected to the known voltage ratio corresponding to a VSWR of 1.2:1. This known voltage ratio is used to calibrate the instrument.

The \( V_F \) Cal voltage is a measure of the battery voltage. As such it appears on the wattmeter in watts. Accuracy isn’t excellent, because the wattmeter calibration affects the actual V-to-watts reading; however, it’s an excellent first-order reading of the battery voltage. On this 250-watt scale, a low battery voltage reading is approximately at 40 watts.

**construction notes**

Construction of this instrument requires no special techniques to achieve success. A wiring diagram appears in fig. 6. Construction isn’t detailed because anyone experienced in construction should be able to meet the parts and fabrication requirements.

One area of concern is shielding. The analog board and power ON/OFF board have high impedances, so care must be taken to make sure these boards are not exposed to rf. Except for external rf pickup, there are no critical layout areas inside the instrument. The shielded directional coupler is essential so that it may be located inside the instrument (see fig. 3).

The meters used are readily available from Radio Shack, part 22-052. I made a three-to-one scale of the meter face, then had it photographically reduced to fit on the scale. The scale photograph was then attached to the Radio Shack meter scale by double-sided tape. I removed the original scale from the meter, attached the new scale to it, and then replaced the scale, securing it with the two mounting screws.

Six 1-per cent metal film resistors are called out for the analog board. Availability may be a problem, so here are some possible alternatives with expected performance changes. \( R_4 \) and \( R_8 \) must be a matched pair for logarithmic tracking. Thus the actual value is not critical, and they could be carbon film resistors if they are matched to 1 per cent. \( R_{14} \) and \( R_{12} \) are metal film resistors only to minimize temperature influence and could be carbon film.

\( R_{20} \) and \( R_{21} \) must be selected to be within 1 per cent of the absolute value, because these two resistors determine the basic accuracy of instrument calibration. I encourage the builder to find 1 per cent

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**fig. 5. Analog circuit schematic.**

U1, 2, 3, 5 = TL081ACP  
U4 = LM394BH  
U6 = µA741  
CR1, 2, 4, 5 = 1N4005  
CR3 = 6.2V zener  
Resistors = 1 per cent are 1/8 W  
metal film others are 5 per cent 1/4 W carbon composition
metal film resistors if at all possible. If carbon film resistors are used in any of the 1-per cent metal-film resistor slots, some performance degradation will occur as a function of temperature.

U's 3 and 5 must be in sockets to allow for adjusting the offset trim pots for the operational amplifiers. Also test points for $V_R$, $V_F$, $L_{VR}$, and $L_{VF}$ will allow for easy testing and calibration of the analog board.

**calibration**

Calibration of the instrument is in two parts, rf and dc. The directional coupler can be calibrated before installation in the instrument; the procedure was covered in the discussion on the directional coupler. Refer to fig. 5 for the following procedure:

1. With U3 and 5 removed from their sockets, ground the $V_O$ output of the directional coupler and turn on the instrument. The amber LED pilot light should glow, indicating power is being drawn by the analog board.

2. Connect test points $L_{VR}$ and $L_{VF}$ together with a jumper lead.

3. Adjust $R_{16}$, $U_6$ offset adjust for "∞" on the VSWR meter (normal meter zero).

4. Disconnect jumper from test points $L_{VR}$ and $L_{VF}$. Connect voltmeter to $V_R$ and adjust $R_3$, $U_1$ offset adjust for zero volts ($< ±5$ mV).

5. Connect voltmeter to $V_F$ and adjust $R_7$, $U_2$ offset adjust, for zero volts ($< ±5$ mV).

6. Turn off instrument and install U3 and 5.

7. Connect voltmeter to test point $L_{VR}$ and ground. Turn instrument on and adjust $R_{11}$ for approximately $-0.30$ volts. Then adjust $R_{10}$ for "∞" on VSWR meter. There will be some interaction, so repeat adjustments of $R_{11}$ and $R_{10}$ until voltage test point $L_{VR}$ is $-0.30$ volts and VSWR meter is "∞".

8. Set check switch to 1.20 VSWR, check position, and adjust $R_{16}$ for a VSWR reading of 1.20.

9. Return check switch to NORMAL or OFF position and note that voltage at test point $L_{VR}$ is still about $-0.30$ volt. With no inputs to the analog board from the directional coupler, the voltage at test points $L_{VR}$ and $L_{VF}$ will drift around due to the extreme low currents into the logarithmic amplifiers. This is normal. When the dc signals from the directional coupler are present the logarithmic amplifier outputs will be stable.

10. Turn instrument off and disconnect voltmeter and jumper wire that grounded $V_O$ from directional coupler.

11. Connect input side (TRANSMITTER) of directional coupler to transmitter and output (ANTENNA) side of directional coupler to a good wattmeter and dummy load. With an applied rf power of between 100-250 watts, adjust $R_{13}$ so that the instrument wattmeter reads the same as the external wattmeter. Calibration frequency isn't critical, but I usually use the 40-meter band as a midrange frequency.

**performance**

Wattmeter accuracy is primarily determined by the design and construction of the directional coupler. In this instrument, the wattmeter accuracy is $±5$ per cent reading $+1$ per cent full scale between 1.8 and 30 MHz. The VSWR measurement accuracy is difficult to specify, because several factors affect the measurement. For VSWR greater than 2, the direc-

---

fig. 6. Wiring diagram.
directional coupler open-short ratio dominates the VSWR error.

This directional coupler measures an open-short ratio of 0.6 dB, which translates to an error of 7.5 percent at a VSWR of 6. A complete discussion of the open-short ratio can be found in an instruction book for the ANZAC Model RB-3 standing-wave-ratio bridge, dated March, 1966. For VSWR less than 2, directional-coupler isolation is a dominant factor with the detector diode operating-voltage level.

The isolation of this directional coupler is about 30 dB. The analog circuit dynamic range exceeds that of the detector diodes and isn’t a factor in VSWR accuracy. As with any diode detector, a minimum level of ac signal is required before any dc current will flow. Also since the diodes are in the peak detecting mode, there’s a minimum level of ac signal where the diode dc current will be accurate with respect to the ac signal peak value. Therefore, a minimum amount of signal is necessary to obtain accurate readings.

In this instrument, the minimum forward power required to obtain an accurate ±10 percent VSWR at various VSWR numbers is:

1. 2.5 watts for VSWR = 2.0.
2. 5 watts for VSWR = 1.5.
3. 25 watts for VSWR = 1.2.
4. 35 watts for VSWR = 1.12.

You may ask what it means if the VSWR meter reads more than 1.2 with 25 watts input. It means that the VSWR is better than 1.2 but the actual value isn’t known. To put it another way, at any power level a minimum VSWR number is accurate, and any lower number is optimistic. This minimum power for an accurate VSWR number is characteristic of all directional couplers using diode detectors; however, it’s usually not specified nor mentioned as a limitation in VSWR measurement.

Performance is more than adequate for quick and accurate measurements of a typical transmitter power output and how well it is matched to the load.

VSWR measurement

Numerous articles correctly state that VSWR in a transmission line is not an important parameter to keep low in value, and that only upper-limit numbers are of concern based on transmission line loss and other factors. So why is there still concern about VSWR?

One aspect of the measurement sometimes overlooked is that a reference impedance is involved. The VSWR measurement is only valid for the reference impedance for which it has been designed, in this case 50 ohms. Common practice is to define system performance with reference to a system impedance. Also common practice for Amateurs is to use a 50-ohm dummy load for tune-up. In doing so, the 50-ohm reference is established, and if all other measurements are relative to this 50-ohm reference, the results will be valid. If VSWR measurements are made in which the reference impedance is other than that of the instrument, the results will not be valid, and a correction must be made.

I feel that until a readily available means of measuring power transfer independent of impedance is available, the VSWR meter will continue to be a valid means of determining system performance. Plate-current meters on most transceivers allow a first-order means for measuring power transfer. Careful use of these meters can provide successful results. But I’ve never been quite as satisfied with this method as with the use of the external power and VSWR meter, using a transmatch to couple the antenna and a 50-ohm dummy load for reference.

conclusion

This article has several objectives. One is to give complete details on how my automatic VSWR meter design works so that others can understand its operation and use. Another is to provide design equations and show their use in the design of a commonly used directional coupler. Finally, it was desired to provide construction details for duplication of the instrument.

This automatic VSWR/power meter is a project I’ve been working on for more than two years. I’d like to thank fellow Amateurs who’ve encouraged me and given valuable advice. With their help I’ve developed what I believe is a very useful station accessory.

references


bibliography

Some interesting test results using phased colinear elements based on the “ZL Special”

Since the construction of the ZL beam\(^2\), I’ve been intrigued by the possibility of producing another noticeable improvement in antenna performance. After reviewing the literature, several options seemed available. First, one could duplicate the antenna and stack it over the present assembly. Secondly, one could stack the antenna in a side-by-side arrangement. Both arrangements should produce a 3-dB change in antenna performance. However, the cost of construction would be enormous, as would the cost of strengthening the support structure.

These options were discarded for economic reasons, and I continued to search the literature. After some thought, the following question came to mind: Why not extend the lengths of the ZL elements into full-size, half-wave elements and feed it as if it were a ZL Special?\(^1,2\) The following report gives the results of the experiment.

**description**

Fig. 1 shows the basic construction. Nine half-wave elements were constructed consisting of four driven half-wavelength elements \(E_B, E_A\), collinear reflector \(R\), and collinear director \(D_1\). Yagi director \(D_2\), 1/2 wavelength long and spaced 1/4 wavelength from \(D_1\), was also constructed. Two phasing stubs were connected to points \(A, B\). This basic configuration was alternately fed at these points for the tests (figs. 2 and 3). The parasitic elements were tuned and relative field-strength patterns were obtained as shown.

Reversing the A-B feed changed the action of

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fig. 1. The basic construction used in the experiments with the phased array.

fig. 2. Response when feed point A was used, which produced the best results.

phased elements to such an extent that the action of the parasitic reflector element was overwhelmed, which in fig. 3 had been tuned for maximum radiation in direction R.

tests
The test using feed point A (fig. 2) produced the best results. A 15-meter model was made, and performance was good. However, it didn’t “feel right.” Subsequently, a model was made for 10 meters and operated by a friend, who reported results not much better than those obtained from a regular Yagi. Again, the literature was searched and I discovered that element $E_A$ must have opposite polarity with respect to element $E_B$.

Once more the literature was reviewed, and a new question arose: Is there a way to connect the elements so that when a wave is emitted from $E_B$, it will coincide simultaneously with a wave emitted from $E_A$ when $E_A$ and $E_B$ are $1/8$ wavelength apart? The literature suggested that a $5/8$-wavelength piece of coax, fed at the $1/8$-wavelength point, would pro-
fig. 3. Reversing the A-B feed point changed the pattern dramatically, because the parasitic reflector element was overwhelmed.

fig. 4. Adding a phasing harness between feedpoints B and A resulted in a large increase in response.
vide the correct phasing, so that waves emitted from $E_B$ would coincide with those emitted from $E_A$ and remain coincident with direction $R$. I added a 4:1 coaxial balun on each end of the phasing harness to maintain balance and permit polarity reversal (fig. 4).

Before installing the phasing harness I made a relative field strength reading using the arrangement in fig. 2. I then connected the phasing harness as in fig. 4. To my astonishment, the phasing harness produced a 1 - 1-1/2 S-unit increase in relative field strength, or an estimated 5-7 dB improvement in antenna gain. I tweaked the parasitic elements, and the pattern of fig. 4 was obtained. The length of reflector $R$ is what would be expected in a normal Yagi. Directors $D_1$ and $D_2$ are shorter than the calculated value and are somewhat critical in adjustment.

On-the-air tests of the arrangement in fig. 4 suggested noticeable improvements — F/B was around 40 dB; F/S was 60 dB or more. Forward gain over a dipole, as suggested by the pattern, indicated 15 dB. Antenna bandwidth is approximately 500 kHz on 10 meters. The pattern is clean except for two small lobes off the back (when operated at ground level).

future experiments

Plans now are to modify a 20-meter beam by installing four halfwave elements in phase with parasitic elements and to explore the possibility of operating the parasitic directors as phased couplets, as shown in proposed test arrangement of fig. 5. Also, there seems to be no reason why the arrangement of fig. 4 can't be applied to quad antennas with the same results.

fig. 5. Future plans for four halfwave elements in phase with parasitic directors operating as phased couplets. Beam-widths shown at the half-power points.

acknowledgments

I wish to thank Dennis Timm and my daughter Lynnette, who helped with various measurements and adjustments during the antenna experiment. Also thanks to my wife, Shirley, who typed the manuscript.

references


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Hampered by real-estate restrictions or a grouchy landlord? Try this full-size rotatable array that fits into an average room.

To an Amateur, a huge antenna array high in the sky is beautiful. But more and more of us must live where outside antennas are frowned upon or forbidden. We’re then faced with two choices: forego hf operation or use some sort of indoor antenna. I find the first choice unbearable. As for the second, antenna manufacturers, antenna handbooks, and Amateur-magazine articles offer little except loaded dipoles, loaded verticals, or random wires zigzagging like crazed snakes. Fortunately, there’s no need to struggle with such inefficient antennas. Antenna theory applies equally well whether an antenna is located indoors or high on a mountain peak.

I live on the second (top) floor of a wood-frame, brick veneer apartment building. I operate from my bedroom using a full-size, rotatable, two-element, 10-meter, indoor ZL Special beam.¹ Just about anyone with a few simple hand tools and about $15 for materials can duplicate my antenna in a few hours.

why a ZL Special?
The ZL Special¹ is an all-driven array consisting of two unequal-length folded dipole elements spaced at 0.125 wavelength and fed 135 degrees out of phase. The array is unidirectional and has about 6 dBi forward gain and a good front-to-back ratio. The ZL Special is an old design and not currently in vogue. I suspect that its mechanical complexity, when constructed from aluminum tubing for outdoor use, and the fact that it’s a single-band device have detracted from its popularity. My experimentation with it and several other antennas has uncovered a number of very good reasons for making the ZL Special the antenna of choice for indoor use.

The usual ways to squeeze an antenna with a 5-meter (16.5-foot) span into a 3.7 x 3.7 meter (12 x 12 foot) room, are a) to use loading devices, or b) bend the elements to fit the available space. Within reason, the ends of folded dipole elements may be bent without appreciable loss.

All antennas are adversely affected by unwanted coupling to nearby objects. Indoor antennas are generally close to house wiring, heating ducts, and other objects, and tend to couple energy to them. This problem is manifested by resonance shifts, drastic VSWR changes, and reduced gain and directivity. All-driven arrays, particularly those with folded dipole elements such as the ZL Special, are less troubled by unwanted coupling than are parasitic arrays. Quads are too large, even when reduced in size by loading, to be used indoors.

The ZL Special is a low-Q, hence wideband-response, array which is fairly tolerant of element length and spacing. Array impedance is about 70 ohms, compared with about 20 ohms for a parasitic Yagi. The ZL Special can be fed with 75-ohm coax using a simple sleeve-type bazooka balun.

A variation of the ZL array uses 0.375-wavelength elements, which reduces the antenna span by 25 per cent.

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fig. 1. The ZL Special all-driven array is usually made of aluminum tubing and is cumbersome (left). Use TV twinlead with the ends bent to fit your available space, and you have the indoor ZL Special (right). The twinlead version has a phasing line shorter than the space between elements, and the rear element must be bowed forward slightly to connect the phasing line.

cent (described later). Spacing can be reduced to 0.1 wavelength. A 15-meter shortened ZL Special is about the same size as a standard 10-meter version and has only slightly less gain. A similarly reduced 20-meter array will fit a large 5.5 x 5.5 meter (18 x 18 foot) room or attic.

Attempts to use more than two elements, or to build multiband arrays indoors, are likely to be rewarded with less-than-hoped-for gain or with an array that performs poorly on several bands. I prefer one good antenna for my favorite band. I use temporary indoor dipoles for the other bands.

which design?

Dimensions for ZL Specials are many and varied. Element length depends on the type of construction. The vertical portions of the indoor ZL Special may act as capacitance hats and reduce the element length. These are dimensions I found to give the best results for a 10-meter array:

- **director length** = \( \frac{135}{f} \) meters (\( \frac{444}{f} \) feet)
- **reflector length** = \( \frac{144}{f} \) meters (\( \frac{472}{f} \) feet)
- **spacing** = \( \frac{37.2}{f} \) meters (\( \frac{121}{f} \) feet)
- **phasing line** = spacing \( \times 0.82 \) (velocity factor)

where \( f \) is frequency (MHz).

Using a design frequency of 28.7 MHz gives a director length of 4.7 meters (15.5 feet), reflector length of 5 meters (16.5 feet), spacing of 1.3 meters (4.3 feet), and a phasing line of 1.1 meters (3.6 feet).

With no weather problems to contend with, the indoor ZL (fig. 1) uses lightweight wood for the boom and element supports. An earlier version used PVC pipe, which performed as well as the wood version, except that the PVC is flexible and it flopped when rotated and struck the walls and ceiling.

construction

Select unwarped, knot-free, pine 1 x 2 lumber and redwood furring strips. Cut to size (fig. 2) and give the wood pieces two coats of paint. (I chose to match the color of the walls and ceiling.) Hardware is steel angle brackets and mending (reinforcement) plates, which are inexpensive and available at any hardware store. The boom is attached to the TV mast with a U bolt.

I found it easier to build and make the initial beam assembly on a flat surface (living room floor), then reassemble it at the operating site. If you use machine screws to attach the hardware, you can assemble or disassemble the array in about ten minutes. (Quick disassembly avoids questions about the "clothesline" by guests — or the landlord!)

The idea is to have as much of the elements oriented horizontally as possible, so the framework dimensions are flexible. Figure on at least 7.5 cm (3 inches) wall-to-crossmember clearance. The boom length controls the spacing and should not be changed. The vertical end pieces can be reduced to as little as 30 cm (1 foot) to increase headroom, but the element length may have to be increased.

I built a simple, sturdy base from two 31 x 62 cm
fig. 2. Crossmember construction. Two identical crossmembers are required. Pine 1 x 2 lumber and redwood furring strips provide a lightweight but strong structure. When the elements are in place, the structure is braced by the top guy wires and doesn’t sag or flop around when rotated.

(1 x 2 foot) pieces of particle board (fig. 3). One board is flat on the floor and the other is vertical. A pair of TV mast clamps hold bearings (PVC pipe couplings) to allow mast rotation. A PVC pipe cap or an empty mayonnaise jar will serve as a bottom bearing. The base is steadied by clamping it to a solid object or by setting a couple of concrete blocks on the horizontal board.

The elements are made from heavy-duty, foam-filled TV twinlead. The elements are looped around the vertical end pieces (taped in place) and strung across the top with wire or twine. Elements and top wires form a box at each end of the array. At moderate power, no additional insulation is required. PCB material with the foil removed makes excellent insulators. I used WA6TKT’s method of bowing the reflector forward to fit the phasing line length.³

feeding the array

The feedline RG-59/U should be a multiple of 0.5 wavelength. A simple bazooka (sleeve balun) is formed by slipping a 0.25 wavelength piece of shield braid, removed from RG-8/U or RG-11/U, over the antenna end of the feedline, fig. 4. The braid is soldered to the feedline shield at the 0.25-wavelength point, and no other connection is made to the braid. Wrap the braid with vinyl tape. The bazooka length is 2.6 meters (8.5 feet) for 10-meter operation.

performance

Performance data for my indoor ZL Special antenna appear in figs. 5 and 6. Gain, front-to-back ratio, and VSWR (fig. 5) are for a direction not affected by unwanted coupling. Proper performance of duplicate antennas is indicated by a VSWR minimum at the
fig. 3. A simple but sturdy base for the indoor array is made from two pieces of particle board or similar material and standard TV mast brackets. Total cost of the base is about $6.00 exclusive of the mayonnaise-jar bottom bearing.

design frequency (approximately 28.7 MHz). The front-to-back ratio is a function of phasing-line length, while gain is related to element spacing. Exhaustive pruning is probably not worth the effort once the array is working satisfactorily.

Fig. 6 shows VSWR variations of my array as it’s rotated. The variation is caused by coupling to metallic objects in the room. A parasitic array (an early attempt) had a peak VSWR of 6:1 in the direction of the air-conditioning duct. Metal objects more than 0.25 wavelength distant don’t cause resonance shifts or VSWR variations.

The difficulties of accurate measurement inherent to high-frequency arrays are compounded when the array is indoors. Repeated measurements using various techniques indicate a forward gain of about 6 dBd and a front-to-back ratio of 15-18 dB. The pattern is a cardioid and has a deep rear notch. VSWR is low over the entire 10-meter band and causes no problem for solid-state finals. I’ve checked the observed beam headings of hundreds of stations against a great-circle chart and found no significant errors. The only real difference between an indoor array and one outdoors is that the indoor array can be rotated in seconds rather than minutes.
fig. 5. Indoor ZL Special performance data. The data are for a direction not affected by unwanted coupling. Design center is 28.7 MHz.

another version

A shortened version of the antenna is shown in fig. 7. It’s a bit more complex, but the elements are 25 per cent shorter than in the design described above. It may be spaced 0.1 wavelength to decrease boom length but with some sacrifice in gain.

Element lengths are determined by the data given previously, multiplied by a factor of 0.75. For example, the director length for a design frequency of 28.7 MHz would be:

$$\text{director length} = \frac{135}{28.7} \times 0.75$$

$$= 3.5 \text{ meters (11.5 feet)}$$

The element ends may be bent up and around as shown in fig. 1B. My measurements of this shortened ZL Special were: gain approximately 5 dBd; front-to-back ratio about 12 dB.

concluding remarks

The indoor ZL Special is far and away the best indoor antenna I was able to construct in two years of trying. With the indoor ZL, stateside contacts are 3 to 4 S-units better than my next best indoor antenna, phased groundplane verticals. During a recent 48-hour contest period, I worked 21 different countries on all continents using a barefoot Ten-Tec Argonaut, 3 watts PEP output!

I hope nobody is naive enough to think that the performance of an antenna can be improved by placing it indoors; but neither should it be believed that indoor antennas cannot work. The multitude of variables make it impossible to predict how well an indoor array will perform at your location, but the indoor ZL Special is sure worth a try.

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- Tilt bail assembly: 3.95

More Details? CHECK—OFF Page 94
Here's how one Amateur erected a three-band quad antenna on a modest-size residential lot.

Let me begin by saying that there are a few time-honored maxims about Amateur antennas. First, the result will be in direct proportion to the amount of time, effort, and money expended. Second, there's no such thing as too high or too big. Third, if the antenna stays up through the winter, it's not big enough!

With this philosophy in mind, I decided to build a big quad antenna with four elements on the Amateur 15- and 20-meter bands and seven elements on the 10-meter band, all on an 8.5-meter (28-foot) boom. The entire array was to be installed in a modest California backyard on a tilt-over tower.

The following is a photo essay on the project. I hope it will inspire others with a small yard to bite the bullet and put up a big antenna.

big quad — small yard

background

Last year I acquired a 21-meter (70-foot) guyed crank-up tower. With my mast it would allow the antenna boom to be nearly 23 meters (75 feet) up. Also it looked strong enough to handle something much larger than my old cubical quad on a 2.7-meter (9-foot) boom. I brooded, plotted, and schemed all winter, which, in southern California, is marked by windstorms up to 112 km (70 miles) per hour for a four-month period. I'd built a four-element quad for 15 and 20 meters the previous year and it worked great, but the place where the two boom lengths were joined together was weak and bent in the wind; thus the end of the four-element quad.

For six years I've been constructing and erecting quads in my back yard. And for six years, trees and bushes have been growing, cutting down the available space. Even so, I decided to build a quad with four elements on 15 and 20 meters and seven elements on 10 meters — all on an 8.5-meter (28-foot) boom.

This arrangement would give 0.13-wavelength spacing on 10 and 20 meters and 0.20-wavelength spacing on 15 meters. My experience indicated that these were acceptable spacings for the bandwidth and gain I was seeking. The antenna for each band would be fed directly through a gamma match, and all three coax cables would be run down to the station. I decided to use two reflector elements on 10 meters. (This should improve the front-to-back ratio

By George McCarthy, W6SUN, 2739 North Atherwood Avenue, Simi, California 93065
fig. 1. View from author's patio roof showing the work area.

fig. 2. Method of assembling quad spreaders and elements.

fig. 3. Tower tilted over with mast and rotator installed and quad spreaders all over the place.

fig. 4. A length of PVC pipe, bolted to the mast with a muffler clamp. Ten-meter director wire is taped to the other end.

fig. 5. The "big quad — small yard" secret. Tower is raised and array is turned around.

fig. 6. Assembly of the other end of the antenna. Driven element is in place; the 10-meter reflector is next. The second reflector is installed last.
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<table>
<thead>
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<th>MODEL</th>
<th>BANDS</th>
<th>LENGTH</th>
<th>PRICE WITH HI-Q BALUN</th>
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**Putting it up**

The photos pretty much tell the story of how I managed to erect such a monster in a small area. I'll now relate some of the sidelights of the job.

I did all the work myself with one exception: the tower must be pulled over by someone else until gravity takes over and I can let it down with a winch. My thanks to Bob, W6TSH, and Joe, W6UL, who came over to help with this task.

A boat winch is the secret of my solo performance. The aircraft cable from the winch runs over the peak of the roof to the tower. That's right — I use the peak of the house as a gin pole! I figure that if anything goes it'll be the house. I raise and lower the tower from this position, which entails a lot of stopping and running around to make sure the wire isn't hung up on something.

From long experience, I no longer rely on predrilled holes in the fiberglass spreaders — they wear with wire movement. I stuck screwdrivers into the lawn to keep the spreader arms from distorting the perfect square. Then I ran the wires around the screwdrivers, moving the screwdrivers until I had a nice, tight loop that wouldn't pull the spreaders. I then taped the wire to the spreaders with PVC tape and applied PVC cement to keep the tape secure.

The short boom section connected to the boom-to-mast adapter is 1.4 meters (4-1/2 feet) long. It has a 4.8-mm (3/16-inch) wall, which I turned down slightly for a distance of 152 mm (6 inches) at each end. The aluminum booms, which are 3.7 meters (12 feet) long and 51 cm (2 inches) OD, with 1.7-mm (0.065-inch) wall thickness, were slipped over the ends and bolted.

**Final comments**

Putting up an array of this size in a small working area requires a lot of patience and the desire to succeed. My residential lot is only 20 meters (66 feet) wide by 31 meters (100 feet) long. Anyone who has attempted such a task will tell you that quad wires actually look for something in which to get tangled. Also, no matter how carefully you walk across a lawn full of strung spreaders you'll inevitably trip on some of the wires. Finally, my roof is made of thick shingles. No self-respecting wire would dare pass one up without trying to slide underneath.

I'm now in the process of tuning this monster, so I have no final words on performance. But it had better be great! Once tuned up, it'll be elevated to 22.3 meters (73 feet), where I hope to terrorize the ham bands — at least until the first big windstorm.

---

**Ham Radio**

May 1980
earth anchors
for guyed towers

Design data for earth anchors and how to make a deadman anchor for your tower guys

Often the design of a guyed tower fails to include the anchor design. This article describes construction and implementation of guy anchors.

holding power

The holding power of an anchor depends on anchor size and its depth in the ground. The weight of the earth above the anchor provides the holding force. Standard practice is to figure the holding force of earth in a cone shape above the anchor with a slope of 30 degrees relative to the vertical, as shown in fig. 1.

Note that, if the actual anchor were cone shaped, the total cone size would depend on depth, \( D \). The cone volume, \( V \), is:

\[
V = \frac{1}{3} \pi R^2 D
\]

Radius, \( R \), is proportional to depth, \( D \), where

\[
R = D \tan 30 \text{ degrees} = D(0.577)
\]

Therefore:

\[
V = \frac{1}{3} \pi (0.577D)^2 D = 0.35D^3
\]

If the weight, \( W \), of earth is assumed to be 100 pounds/foot\(^3\) (45 kg/0.3 meter\(^3\)), and the holding force, \( F = VW \), then \( F = 35D^3 \). Holding force versus anchor depth is shown in fig. 2.

If you use 1/4-inch (6.5-mm) diameter steel cable for guy wire, the breaking strength is 5480 pounds (2488 kg). An anchor for this cable buried 5-1/2 feet (1.7 meters) would be appropriate.

<table>
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<tr>
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<td>35 (16)</td>
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<td>5 (1.5)</td>
<td>4375 (1986)</td>
</tr>
<tr>
<td>6 (1.8)</td>
<td>7560 (3432)</td>
</tr>
</tbody>
</table>

By Ted Hart, W5QJR, Box 334, Melbourne, Florida 32901
deadman anchors

Screw anchors, available from lumber yards and marine-supply houses, have been used for antenna

fig. 1. The holding power of an anchor depends on anchor size and depth in the ground. Weight of earth above the anchor provides the holding force. Standard practice for such anchors is to figure the holding force of the earth in a cone with a slope of 30 degrees.

guys but they're expensive. So I decided to make a deadman anchor from concrete. Here's how to do it:

1. Make a loop of your guy wire and tie it with a cable clamp.
2. Pass two pieces of concrete reinforcing rod, 5 inches (128 mm) long through the loop and tie the rods at right angles. Use heavy wire to make the connection.
3. Use a container, such as a plastic pail, to pot the assembly in concrete.

Holes for the deadman anchors can be made with a post-hole digger. Make sure the dirt is moist. Tamp

fig. 2. A plot of holding force as a function of depth for anchors buried in earth.

the dirt and wait a few days for the earth to settle. You'll have to tighten the guy wires several times during the first few days after installation while the cable aligns itself through the earth.

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KLAL RADIO Inc.
8400 N. Pioneer Parkway, Peoria, IL 61614
Phone 309-691-4840
Tim Daily, Amateur Equipment Sales Manager

We have a complete stock of Cushcraft antennas — too many to mention in detail, so ask about our 2-meter line of verticals and beams for special low, low prices.

Digitrex Electronics

PA-19 Wideband Preampifier

-2 to 200 MHz Bandwidth: 3dB Foemtu
-1.99 Gain'
-50 Ohm Input & Output Impedance
-Short Board Size: 7/8" x 1-1/8"
-Absolutely No Tuning Required
-Extremely Stable
-Draws Only 10mA@12VDC
-Designed for Sensitivity of Receivers, Transmitters, etc.
-Fully Assembled and Tested
-Instructions Provided, Full Warranty

Only $8.95

Portable 600 MHz Frequency Counter

-1 MHz Range
-1 KHz or 10 Hz Resolution
-Assembled and Tested
-Full 1 Year Warranty
-Size: 5 x 2 x 1-1/2" Long
-BCN Whip Antenna (58-89)

$59.95

Cushcraft HA-2 Antenna

North Carolina

HA-2 HORIZONTAL/VERTICAL 2 METER ANTENNA

The HA-2 is a low profile half-wave, horizontally polarized omnidirectional 2 meter antenna. Although the HA-2 was designed for mobile operation, it will work well as a fixed or portable antenna and its small size provides the traveling ham with an antenna that can easily be packed in a briefcase. The HA-2 comes complete with RG-58, which is fed through the center of the mast section. PL-259 RF connector and 3/8 x 24 stud base. A rain gutter mount is recommended for mobile openion.
Forward Gain: 8 dBi
Front to back ratio avg: 25 dB
V.S.W.R: 1.2:1 Typical
Average Bandwidth: 500 KHz
Power Rating: 2000 w PEP
Feed Point Impedance: 50 ohm
Connector: Twin terminal stainless steel takes all coax.
Boom: 1/8" - 1 1/8" x 14'
Elements/Longest: 1 1/8" - 5 7/8" x 27' 9"
Wind Stc. area: 5.6 Feet²
Weight: 35 Pounds
Turn Radius: 15' 6"
Mast Diameter: 1 1/8" min. 2" max.
Material: 6063-T832 Seamless aluminum
Fasteners: Zinc Plated Steel
Telescope Method: Taper tubing with full circle clamps
UPS Shippable: No balun required

$199.95

The full power, full performance 20-15-10 meter beam.

Enjoy the thrill of working rare DX with excellent A3 forward gain. Increase the pleasure of your daily contacts with A3 interference reducing front to back ratio. Use your linear amplifier with confidence in our new A3 high power traps.

Make friends of your neighbors with A3 compact dimensions, low profile, and small turn radius. Satisfy your budget with A3 economy pricing.

The Cushcraft engineering team has again created that unique combination of quality materials, easy assembly and high performance with A3, the three band beam for the eighties.

A LEADER FOR OVER 30 YEARS

Cushcraft CORPORATION
The Antenna Company
48 Perimeter Road, P.O. Box 4680
Manchester, NH 03108
The PHW-150 comes without fish-line, weight and coaxial cable. For more information, write John Beaman, Larsen Electronics, Inc., P.O. Box 1686, Vancouver, Washington 98663.

**new “Pro” antenna line**

**DSI 50 Hz to 550 MHz frequency counter**

A new 50-Hz to 550-MHz nine-digit frequency counter is available from DSI Instruments, Inc. The model 5600A combines a 10-MHz proportional-oven time-base accuracy of 0.2 ppm (from 10° C to 40° C) with a 10-mW sensitivity and resolutions to 0.1 Hz.

Its bright 0.5-inch-high nine-digit LED array — with automatic zero blanking — provides enhanced readability at a distance and at wide viewing angles, even in bright light.

Two input channels are provided: one covering the 50-Hz to 500-MHz range, the other covering 50 MHz to 550 MHz. High-visibility indicator lights for “Standby,” “Oven-Ready,” and “Gate-Time” status are standard features. The user can select a desired resolution from 0.1 Hz to 1.0 kHz by push-button. Additional features include an rf preamplifier and a 500-MHz prescaler.

Housed in an impact-resistant, molded cabinet with a multi-position carrying handle-easel, the 5600A operates directly on an internal 8.2 to 14.5 Vdc battery or a 115-Vac adapter. It measures 3.25 x 9.5 x 9 inches, including a self-contained battery compartment.

Options include a 10-hour rechargeable battery pack, an audio multiplier that allows up to 0.001-Hz resolution, and a 25-dB preamplifier with a variable sensitivity control.

The 5600A is available in two forms: a kit, 95 per cent factory-assembled, for $149.95, and factory-assembled for $179.95.

For more information contact DSI Instruments, Inc., 9550 Chesapeake Drive, San Diego, California 92123.

Users of two-way radio communications are welcoming the announcement of a new “Professional” line of Antler Antennas. The new Antler “Pro” antennas include four basic base-loaded models spanning from 30-174 MHz frequencies, plus a “short” quarter-wave, roof-mounted unit tuned to resonate on frequencies between 108 and 174 MHz.

The Professional Antler antennas feature individual testing, and precision electronic tuning of each base coil to ensure efficient, dependable transmissions. The four base-loaded models are for frequencies from 30-36, 36-42, 45-50, and 130-174 MHz. Each antenna is provided with an accurate cutting chart to pinpoint desired frequencies. All coil fittings are precision-machined of chrome-plated, solid brass.

A popular feature of the new Antler line is the buyer’s flexibility to order the exact equipment he needs. There are three mounts, including a “no-hole” trunk-lip mount complete with...
an attractive, chrome-plated dress cup which hides the attaching clamp. A roof or cowl mount with an easy-to-install snap-in expansion collet is also available, along with Antler’s proved “Posi-grip” magnetic mount. Stainless steel shock springs are also available where desired. All mountings include factory-made, low-loss coax cable assemblies.

A handy, short, quarter-wave roof-mount model is also available where “in-city” use encounters low-clearance problems of parking garages and overhanging obstructions.

The Antler “Pro” line is distributed nationally through electronic distributors and two-way or Amateur Radio dealers. For more information, address Antler Antennas, 6200 South Freeway, Fort Worth, Texas 76134.

Antenna Specialists

low-cost Yagi

Exceptional performance at moderate cost were the key design requirements for a new uhf Yagi antenna, model ASP-766, announced by The Antenna Specialists Co., Cleveland, Ohio. The five-element beam antenna is applicable to both point-to-point or repeater-control station installations, where large gain values are secondary in importance to reliability. Directivity necessary to repeater control stations is ensured by the antenna’s 15-dB front-to-back ratio. The antenna is designed to provide 50 degree E-plane beamwidth for appropriate azimuthal selectivity in crowded rf environments. Construction is of aluminum, with gold iridite for both appearance and resistance to pitting and corrosion. The ASP-766 is a broadband antenna covering the 450-470 MHz range, exhibiting 7.5 dB gain in conformity with EIA specification RS-329. Maximum rf power rating is 100 watts. For detailed product information, write to Professional Products Division, The Antenna Specialists Co., 12435 Euclid Avenue, Cleveland, Ohio 44106.

- Learn the truth about your antenna.
- Find its resonant frequency.
- Adjust it to your operating frequency quickly and easily.

If there is one place in your station where you cannot risk uncertain results it is in your antenna.

The Palomar Engineers R-X Noise Bridge tells you if your antenna is resonant or not and, if it is not, whether it is too long or too short. All this in one measurement reading. And it works just as well with ham-band-only receivers as with general coverage equipment because it gives perfect null readings even when the antenna is not resonant. It gives resistance and reactance readings on dipoles, inverted Vees, quads, beams multiband trap dipoles and verticals. No station is complete without this up-to-date instrument.

Why work in the dark? Your SWR meter or your resistance noise bridge tells you only half the story. Get the instrument that really works, the Palomar Engineers R-X Noise Bridge. Use it to check your antennas from 1 to 100 MHz. And use it in your shack to adjust resonant frequencies of both series and parallel tuned circuits. Works better than a dip meter and costs a lot less. Send for our free brochure.

The price is $55.00 in the U.S. and Canada. Add $3.00 shipping/handling. California residents add sales tax.

Fully guaranteed by the originator of the R-X Noise Bridge. ORDER YOURS NOW!

Palomar Engineers

Box 455, Escondido, CA. 92025 • Phone: [714] 747-3343

More Details? CHECK — OFF Page 94
STEP UP TO TELREX
Professionally Engineered Antenna Systems

Single transmission line “TRI-BAND® ARRAY”

“MONARCH” 10, 15, 20 Meter
Model TB5EM/4KWP

ONLY TELREX GIVES YOU ALL THESE FEATURES...
- Power rating 4 KWP ... rain or shine.
- Wind rating survival 110 mph
- Patented broad-band coaxial “Balun”.
- Heavy-duty steel gusset mounting plate.
- Aluminum boom 2”, 2-1/2” O.D.
- 1.8 ft.
- Large diameter .058 wall tapered dural elements for minimum weight and exceptional strength to weight ratio.
- Stainless steel electrical hardware.

By the only test that means anything ... on the air comparison ... this array continues to outperform all competition ... and has for two decades. Here's why ... Telrex uses a unique trap design employing 20 HIQ7500 V ceramic condensers per antenna. Telrex uses 3 optimum-spaced, optimum-tuned reflectors to provide maximum gain and true F/B Tri-Band performance.

At 50 ft. or more (above ground) a rugged Telrex “Tri-Band” is the only answer to longevity ... a true money saver.

Illustrated: Rugged gusset mounting plate, Broad-Band - non ferrite - “Balun”, and Driven Element center section.

For technical data and prices on complete Telrex line, write for Catalog PL-7.

TV and Communications Antennas Since 1921

telrex LABORATORIES
P.O. Box 879 - Asbury Park, New Jersey 07712
Phone 201-775-7252

NEW FROM GLB
A complete line of QUALITY 50 thru 450 MHz TRANSMITTER AND RECEIVER KITS. Only two boards for a complete receiver. 4 pole crystal filter is standard. Use with our CHANNELIZER or your crystals. Priced from $69.95. Matching transmitter strips. Easy construction, clean spectrum, TWO WATTS output, unsurpassed audio quality and built in TONE PAD INTERFACE. Priced from $29.95.

SYNTHESIZER KITS from 50 to 450 MHz. Prices start at $119.95.

Now available in KIT FORM — GLB Model 200 MINI-SIZER.
Fits any HT. Only 3.5 mA current drain. Kit price $159.95 Wired and tested. $239.95
Send for FREE 16 page catalog.
We welcome Mastercharge or VISA

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1952 Clinton St., Buffalo, N.Y. 14206

Send 10¢ for our latest catalog. Write or phone for details.

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Send 40¢ for complete catalog.

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- CB standard
- 2 meter
- Scanners
- Amateur Bands
- General Communication
- Industry
- Marine VHF
- Micro processor crystals

More Details? CHECK — OFF Page 94
Now... better than ever. Over 320 items in stock. A more complete line of components and kits cannot be found anywhere! Everything needed for the amateur electronics buff to the advanced engineer. Reliable components for repair or construction. A variety of kits designed for easy assembly, yet rugged enough for everyday applications. Stop by your local distributor and check out the JIM-PAK line today!

one-stop component center

Ask your Distributor to stock JIM-PAK today!

Call or write for distributor information:

JIM-PAK ELECTRONICS, 1355 Shoreway Road, Belmont, CA 94002 (415) 595-5936

May 1980
there's nothing like it at any price

**MORSE PAK-B $350.00**

with all the receive features of MORSE PAK-A, it also is a complete MORSE KBD

Features include:

1. Speed set from KBD 5 to 80 wpm
2. Defeatable side tone
3. 40 key full travel KBD
4. 16 character transmit buffer
5. Displays received and transmitted text
6. Same excellent MORSE PAK-A receiver and demodulator
7. Relay keyed output for complete compatibility
8. Unbelievable price $350 plus $5 shipping

MORSE PAK

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ALBUQUERQUE, NM 87123
505/293-3553

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490-T Ant. Tuning Unit
(Also known as CU1658 and CU1669)

4CX150
4CX250
4CX300A
4CX350A

4CX1000
4CX1500
4CX3000
4CX5000

4CX10.000 4-65 4-250 4-1000
5CX1500 4-125A 4-400 304TL

Other tubes and Klystrons also wanted.

Highest price paid for these units. Parts purchased.
Phone Ted, W2KUW collect. We will trade for new amateur gear. GRC106, ARC105, ARC112, ARC114, ARC115, ARC116, and some aircraft units also required.

DCO, INC.

10 Schuyler Avenue
No. Arlington, N. J. 07032
(201) 998-4246

Evenings (201) 998-6475

WANTED FOR CASH

4CX5000
4CX5000

DIODE SWITCHING BOARDS available to permit 1, 2 or more filters than those for which manufacturer provides room. SPECIFY make and model.

- Single-filter type: $12 Airmail postpaid
- Dual-filter type: $21 Airmail postpaid

Florida residents add 4% sales tax  (FOREIGN ADD $3 per filter)

BROCHURE ON REQUEST
Dealer Inquiries Welcomed
WILSON SYSTEMS, INC. PRESENTS . . .
THE NEW SYSTEM 40 TRIBANDER

3 MONOBAND ANTENNAS IN ONE-EACH WITH FULL MONOBAND PERFORMANCE

FACTORY DIRECT
ONLY
$299.95

MONEY BACK GUARANTEE
Available for the month of May and valid for 31 days. If not satisfied, return antenna for full refund.

A NEW CONCEPT IN ANTENNA DESIGN
USING A 26 FT. BOOM

• FOR THE SERIOUS DXer WHO WANTS MONOBANDERS ON 10-15-20
• FOUR FULL SIZE 20 MTR ELEMENTS WITH 10 dbd GAIN
• THREE WIDE SPACED 15 MTR ELEMENTS WITH 8.2 dbd GAIN
• FOUR WIDE SPACED 10 MTR ELEMENTS WITH 10.2 dbd GAIN
• ONLY ONE FEED LINE REQUIRED
• DESIGNED WITH NO INTERACTIONS BETWEEN ELEMENTS
• ALL PARASITIC ELEMENTS ARE FULL SIZE
• BROADBANDED — NO SEPARATE SETTINGS REQUIRED FOR PHONE OR CW
• SAME QUALITY HARDWARE AS USED IN ALL WILSON ANTENNAS

SPECIFICATIONS

Max. Per. Input: 1.2:1
VSWR @ Res.: 1.2:1
Impedance: 50 ohm
Feed Method: Coax Balun Supplied
Matching Method: Modified Beta
F/B Ratio: 25 dB

Longest Element: 36'
Turning Radius: 22' 6"
Surface Area: 12.1 sq. ft.
Wind Loading @ 80 mph: 309 lbs.
Assem. Weight: 75 lbs.
Shipping Weight: 84 lbs.

AVAILABLE ONLY
FACTORY DIRECT
CALL
1-800-634-6898 TOLL FREE

WIS WILSON SYSTEMS, INC.
4286 S. Polaris, Las Vegas, Nevada 89103

Prices and specifications subject to change without notice.
A trap loaded antenna that performs like a monobander! That's the characteristic of this six element three band beam. Through the use of wide spacing and interlacing of elements, the following is possible: three active elements on 20, three active elements on 15, and four active elements on 10 meters. No need to run separate coax feed lines for each band, as the bandswitching is automatically made via the High-Q Wilson traps. Designed to handle the maximum legal power, the traps are capped at each end to provide a weather-proof seal against rain and dust. The special High-Q traps are the strongest available in the industry today.

**Compare the SY-36 with others...**

Compare the size and strength of the boom to element clamps. See who offers the largest and heaviest duty. Which would you prefer?

Wilson Systems traps offer a larger diameter trap coil and a larger outside housing, giving excellent Q and power capabilities.

**CALL FACTORY DIRECT**
1-800-634-6898

---

**SPECIFICATIONS**

Band MHz: 14.21-28
Maximum power input: Legal Limit
Gain (DB): 9 db
VSWR @ resonance: 1.3:1
Impedance: 50 ohm
FB Ratio: 20 db or Better
Boom (I.D. x Length): 2" x 24/2.5'
No. of Elements: 6
Longest Element: 28'/2.5'
Turning Radius: 18'/2'
Maximum Mast Diameter: 2'
Surface Area: 8.6 sq. ft.
Matching Method: Beta
Wind Loading @ 80 mph: 210 lbs.
Maximum Wind Survival: 100 mph
Feed Method: Coaxial Balun (supplied)
Assembled Weight (approx.): 53 lbs.
Shipping Weight (approx.): 62 lbs.
Capable of handling the Legal Limit, the SYSTEM 33 is the finest compact tri-bander available to the amateur. Designed and produced by one of the world's largest antenna manufacturers, the traditional quality of workmanship and materials excells with the SYSTEM 33.

New boom-to-element mount consists of two 1/8" thick formed aluminum plates that will provide more clamping and holding strength to prevent element misalignment. Superior clamping power is obtained with the use of a rugged 1/4" thick aluminum plate for boom to mast mounting.

The use of large diameter High-Q Traps in the SYSTEM 33 makes it a high performing tri-bander and at a very economical price. A complete step-by-step illustrated instruction manual guides you to easy assembly and the lightweight antenna makes installation of the SYSTEM 33 quick and simple.

**SPECIFICATIONS**

<table>
<thead>
<tr>
<th>Band MHz</th>
<th>14-21-28</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. power input</td>
<td>Legal limit</td>
</tr>
<tr>
<td>Gain (dbd)</td>
<td>Up to 8 dB</td>
</tr>
<tr>
<td>VSWR at resonance</td>
<td>1.3:1</td>
</tr>
<tr>
<td>Impedence</td>
<td>50 ohms</td>
</tr>
<tr>
<td>F/B ratio</td>
<td>20 dB or better</td>
</tr>
</tbody>
</table>

**Wind load @ 80 mph** | 114 lbs |

**Assembled Wt.** | 37 lbs |

**Shipping Wt.** | 42 lbs |

**Direct 52 ohm feed**

**Max. wind survival** | 100 mph

**COMPARISON**

**ADD 40 METERS TO YOUR TRI-BAND WITH THE NEW 33-6 MK**

Now you can have the capabilities of 40-meter operation on the SYSTEM 36 and SYSTEM 33. Using the same type high quality traps, the 40-meter addition will offer 200 KHz of bandwidth at less than 2:1 SWR. The new 33-6 MK will fit your present SY36, SY33, or SY3 and use the same single feed line.

The 33-6 MK adds approximately 20' to the driven element of your tri-bander, increasing the tuning radius by 5 to 6 feet. This addition will offer an effective rotatable dipole at the same height of your beam. The 33-6 MK will not interfere with the operation of 10, 15 or 20 mtr.

**ORDER FACTORY DIRECT**

1-800-634-6898

**NEW!**

**GR-1**

The GR-1 is the complete ground radial kit for the WV-1A. It consists of: 150' of 7/14 stranded copper wire and heavy duty egg insulators, instructions. The GR-1 will increase the efficiency of the GR-1 by providing the correct counterpoise.
WIND LOADING

<table>
<thead>
<tr>
<th>Tower</th>
<th>Height</th>
<th>Sq. Ft.</th>
<th>Footage</th>
<th>Based on 50 MPH Wind</th>
</tr>
</thead>
<tbody>
<tr>
<td>ST-77B</td>
<td>69</td>
<td>18</td>
<td>5'</td>
<td>~0.618</td>
</tr>
<tr>
<td>MT-61B</td>
<td>53</td>
<td>12</td>
<td>5'</td>
<td>~0.618</td>
</tr>
<tr>
<td>TT-45B</td>
<td>37</td>
<td>18</td>
<td>5'</td>
<td>~0.618</td>
</tr>
</tbody>
</table>

Wilson Systems uses a new high strength carbon steel tube manufactured especially for Wilson Systems. It is 25% stronger than conventional pipe or tubing. The tubing size used is: 2" ½ ³/₁₆, 4½" ¼ ³/₈, 6" ½ ¹/₁₆. All tubing is hot dip galvanized. Top section is 2" O.D. for proper rotor and antenna mounting.

The TT-45B and MT-61B come complete with house bracket and hinged base plate for against house mounting. For totally freestanding installation, use either of the tilt-over bases shown below.

The ST-77B can only be mounted against the house and must be used with the tilt-over base FF-77B or RB-77B shown below.

The three towers above are able to handle large arrays of up to 20 sq. ft. at 80 mph WHEN GUED with one set of 4-point Guys at the top of the 3½" section. Guying Kits are available at the following prices: GK-45B—$99.95; GK-61B—$79.95; GK-77B—$99.95. When using the Guy System with RB Series Rotating Base, an additional thrust bearing at the top is required. The WTB-1 is available for $49.95.

TILT-OVER BASES FOR TOWERS

**FIXED BASE**
The FB Series was designed to provide an economical method of moving the tower away from the house. It will support the tower in a completely free-standing vertical position, while also having the capabilities of tilting the tower over to provide an easy access to the antenna. The rotor mounts at the top of the tower in the conventional manner, and will not rotate the complete tower.

- FB-45B...112 lbs...$159.95
- FB-61B...169 lbs...$219.95
- FB-77B...250 lbs...$304.95

**ROTATING BASE**
The RB Series was designed for the Amateur who wants the added convenience of being able to work on the rotor from the ground position. This series of bases will give that ease plus rotate the complete tower and antenna system by the use of a heavy duty thrust bearing at the base of the tower mounting position, while still being able to tilt the tower over when desiring to make changes on the antenna system.

- RB-45B...144 lbs...$224.95
- RB-61B...229 lbs...$304.95
- RB-77B...300 lbs...$454.95

**ORDER FACTORY DIRECT**
1-800-634-6898

**BASE CHART**

<table>
<thead>
<tr>
<th>TOWER</th>
<th>WIDTH</th>
<th>DEPTH</th>
</tr>
</thead>
<tbody>
<tr>
<td>TT-45B</td>
<td>12&quot; x 12&quot;</td>
<td>30&quot;</td>
</tr>
<tr>
<td>FB-45B</td>
<td>30&quot; x 30&quot;</td>
<td>4½&quot;</td>
</tr>
<tr>
<td>RB-45B</td>
<td>30&quot; x 30&quot;</td>
<td>4½&quot;</td>
</tr>
<tr>
<td>MT-61B</td>
<td>18&quot; x 18&quot;</td>
<td>4½&quot;</td>
</tr>
<tr>
<td>FB-61B</td>
<td>3&quot; x 3&quot;</td>
<td>5½&quot;</td>
</tr>
<tr>
<td>RB-61B</td>
<td>3&quot; x 3&quot;</td>
<td>5½&quot;</td>
</tr>
<tr>
<td>ST-77B</td>
<td>See Below</td>
<td>Bases</td>
</tr>
<tr>
<td>FF-77B</td>
<td>3½&quot; x 3½&quot;</td>
<td>6&quot;</td>
</tr>
<tr>
<td>RB-77B</td>
<td>3½&quot; x 3½&quot;</td>
<td>6&quot;</td>
</tr>
</tbody>
</table>

Tilting the tower over is a one-man task with the Wilson bases. (Shown above is the RB-61B. Rotor is not included.)
TO: ALL AMATEURS
FROM: WILSON SYSTEMS, INC.

Two months ago we had the pleasure of introducing two new products—the 40 mtr add on kit and the ST-77 tower. This month we would like to introduce an exciting new antenna.

This is the antenna for the serious DX enthusiast... for the Ham who has decided to leave the average antenna alone and go for the best. If this describes you, or if you have been wanting monobanders for each of the 10, 15, and 20 mtr bands, but have held back due to the space or tower requirements to stack them—then wait no longer. Wilson Systems has the answer to the problem.

The "System 40"—a full monoband antenna for each band—on one boom and using only one feed line. It is broadbanded enough that a separate setting is not required for phone or cw operation. The parasitic elements are full size and with wide spacing so that there is no interaction between elements.

Extensive engineering and design has produced an antenna that offers all the advantages of separate stacked monobanders but with an added advantage of low cost. The price of the SY-40 is only $299.95. This price is possible only because we are factory direct to you, the amateur.

To introduce the SY-40, during the month of May we are offering a money-back guarantee. It is as simple as this: If you purchase the antenna during the month of May, 1980, you may try it out for thirty (30) days. At the end of that time, if you are not satisfied with its performance, return it for a full refund. That's how confident we are that you will like this antenna.

See the full page advertisement on the SY-40 elsewhere in this magazine. If you have any questions, please feel free to call on the toll free line (1-800-634-6898).

Yours truly,

JIM WILSON
Wilson Systems, Inc.
Repeater Jammers Running You Ragged?

Here's a portable direction finder that REALLY works—on AM, FM, pulsed signals and random noise! Unique left-right DF allows you to take accurate (up to 2”) and fast bearings, even on short bursts. Its 3dB antenna gain and .06pV typical DF sensitivity allow this crystal-controlled unit to hear and positively track a weak signal at very long ranges—while the built-in RF gain control with 120 dB range permits positive DF to within a few feet of the transmitter. It has no 180° ambiguity and the antenna can be rotated for horizontal polarization.

The DF is battery-powered, can be used with accessory antennas, and is 12/24V for use in vehicles or aircraft. It is available in the 140-150 MHz VHF band and/or 220-230 MHz UHF band. This DF has been successful in locating malicious interference sources, as well as hidden transmitters in "T-hunts", ELTs, and noise sources in RFI situations.

Price for the single band unit is $195, for the VHF/UHF dual band unit is $235, plus crystals. Write or call for information and free brochure.

L-TRONICS
5546 Cathedral Oaks Road
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Santa Barbara, CA 93111

S-Line owners enhance your investment with TUBESTERS™
Plug-in, solid state tube replacements
• S-line performance—solid state!
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TUBESTERS cost less than two tubes, and are guaranteed for so long as you own your S-line.

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Write or phone for specs and prices (707) 462-6882

More Details? CHECK—OFF Page 94
**Boost your Ham Skills on the Blue Ridge**

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Two weeks saturation learning program in Amateur Radio:
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- General or Technician to Advanced
- Advanced to Amateur Extra

Expert Instruction starting at your level, Code and Theory in depth along with Friendly Amateurs, Who Care About You.

C. L. PETERS, K4DNJ, Director
Oak Hill Academy Amateur Radio Session
Mouth of Wilson, Virginia 24363

Name: ____________________________
Address: ____________________________
City/State/Zip: ____________________________

---

**Why Are Antenna Makers Angry about the New AEA IsoPoLE™?**

- has less than 2:1 SWR over the entire 2 meter band.
- has a beam pattern independent of feedline length.
- requires no ground plane.
- features completely weather protected RF connections.
- is designed for maximum legal power.
- mounts easily on a standard TV mast. (TV mast NOT supplied by AEA)

**Prove it to yourself.**

Let us send you a design for a simple tester you can use to see just how much RF spillover is coming off your own equipment.

The design is included in a copy of our free booklet: "FACTS ABOUT PROPER VHF VERTICAL ANTENNA DESIGN. To get your copy, or information about ordering an AEA IsoPoLE™, write or call Advanced Electronic Applications, Inc., P.O. Box 2160, Lynnwood, Washington 98036. Call 206/775-7373.

---

**Brings you the breakthrough!**

May 1980
QUALITY THAT SPEAKS FOR ITSELF!

Hustler fixed station two meter gain antennas.

Hustler is the choice of those who know quality. Because we're known for precision engineering and electronic expertise.

Only the finest materials are used to make a Hustler amateur antenna. And each model is the result of years of design excellence.

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Comming Events

MICHIGAN: Chelsea Swap and Shop, Sunday, June 1st, Chelsea Fairgrounds, Chelsea. Gates open 5 a.m. for sellers; 8 a.m. - 2 p.m. for admission. $1.50 adult, $1.00 child, $3.00 family. Registration is $15.00 in advance. Write: Almeter Industries, 3132 Timberglen Pl, Northville, MI 48167.

ONTARIO: Lake Simcoe Hamfest, June 13th and 14th, at Molson's Park, Barrie, Ontario, Canada. Registration: $4 by mail, $5 at the door, under 12 free. Gates open at 9 a.m. and close at 5 p.m. Food and beverages available. Write: The Queen, Box 664, Oro-Medonte, Ontario, Canada.

ILLINOIS: SIRC Hamfest, June 1st. Furnish large SASE for complete info. Starved Rock Radio Club — W9KMS/W9RAGF, RDF #1, Box 171, Oglesby, IL 61348. (312) 667-4147.

NEW YORK: Rochester Hamfest & NY State ARRL Convention, June 1st. Call for QSL to Rochester Hamfest, Box 1386, Rochester, NY 14603. Phone 716-424-1100.

CALIFORNIA: North Hills Radio Club's (Kenn's) K6SV Sacramen- to Valley Amateur Radio Ham Swap, Sunday May 4th from 9 a.m. to 3 p.m., at 5411 Steele Road. Call for QSL to Rochester Hamfest, Box 1386, Rochester, NY 14603. Phone 716-424-1100.

PENNSYLVANIA: The Ham Mart sponsored by the War- minister Amateur Radio Club will be held on May 4th (Sunday), at the 9th and 10th Ward Tunnels, High School, Wilkinsburg. Door prizes, FM clinic, auction, flea market, special drawing for used gear and new gear. Food and drinks available. Admission $3.00. Call for details. Bring your own table, $3.00. Phone 412-249-3567.


NEW ENGLAND: The Aerosnatchers will hold its seventh annual Tailgate Swapfest, Sunday, May 10, at Deerfield N.H. Fairgrounds (covered buildings in case of rain). Admission $1.00, no commission or percentage. Excess revenues benefit Boston Burns Unit of Shinners' Hospital for Crippled Children. Last year we raised $1350.00. Questions about New England's biggest flea market? S.A.S.E to Joe, K1QRO, Star Route Box 56, Buckport, ME 04541, or Norm, WA1YVB, Box 32, Cornish, ME 04020.

CALIFORNIA: 1980 Santa Maria Swapfest and BBQ, Sunday, June 15th. Best steak and biggest hamfest in the west. Includes the Yaesu FT-707, Swap busts available. Door prizes. Tickets: $2 adults, $1 children 6-12. Write Santa Maria Swapfest, P.O. Box 1015, Vandenberg AFB, CA 93437 or call K6AKG (905) 734-1360.

PLEASANT: Sixth Annual Northwestern Pennsylvania Hamfest. May 3, Crawford County Fairgrounds, Meadville, Note date change. Gates open at 8 a.m. Bring tickets or $5.00 per table to display inside. $2 per space outside. $3 admission, children under 12 free. Refreshments, Commercial displays welcome. Talk in on 144.380, 144.510, 144.585, ME3, 144.610, 144.685, Mead- ville PA 633. Attic: Hamfest Committee.

MARYLAND: The Easton Radio Amateurs Society's Hamfest, May 8th, 10 a.m. to 4 p.m., Easter Senior High School cafeteria, Easton. Donation $2.00, $4 for tables of 12 or more. Talk-in 144.517/144.545 repeater on Easton. For more info write: R.C. Thompson, K3BA, Box 1473, Easton, MD 21601 or E.A.R.S., Box 791, Easton, MD 21601.

INDIANA: Wabash County ARC Hamfest, May 18th starting at 6 a.m. at the 4th Fairgrounds, Wabash. For more info write: Larry Manning, W9CRA, 215 Southwood Dr., Wabash, IN 46982.

MICHIGAN: Wexaukeee Amateur Radio Association's Swap Shop, Saturday, May 17th, 9 a.m. to 4 p.m., at the National Guard Armory, Waukesha. Registration $3.00, free parking, lunches available. Talk-in on 146.379, WDEBR, P.O. Box 163, Cadillac, MI 49601.


NORTH CAROLINA: Durham F.M. Association's annual durhamfest, May 17th 18, South Square Mall, Durham. Prices: flea market, free tailgating, overnight parking, P.C.C. exams, free admission, Sunday bingo for the family. Tables, power available, $3.00 admission, including dealers. Talk-in: 147.825/225, 146.349/94, 224.994/94. For information: Durham Shack, Box 865, Durham, NC 27707.

NEW JERSEY: The Devy Tech Amateur Radio Club will hold its Field Day on Saturday, May 17th at the Devy Technical Institute, 479 Green St., Woodbridge. Space is $3.00, free admission. Talk-in on 146.52.

NEW YORK: The ARRL Hamfest '80 is being sponsored by the Long Island Mobile Amateur Radio Club on May 19th, 9 a.m. to 4 p.m., at the Isipway Speedway, Isipway, Long Island (exit 43 off the Southern State Parkway). ARRL info, door prizes, free parking, no reservations needed, Admission $2.00, exhibitors $4.00. Refreshments available at track. For further information contact (at night): Sid Wosin, K2LNI, (609) 879-58; John Wosin, W2LWZ (516) 484-4322. Rain date: June 1st.

MARYLAND: Maryland FM Association's third hamfest, Saturday May 24th, 9 a.m. to 4 p.m., at the Greenbelt Arena, Greenbelt. Cash prizes, catered food, indoor display, freebies, no reservations needed. Admission: $3.00, temperatures to $2.00, tables $5.00. For further information write: Fred Siebert, K3P5, 8357 Reservation Rd., Fulton, MD 20739.

FLORIDA: The Daytona Beach Family Funfest was sponsored by the Daytona Beach Amateur Radio Association on May 31st and June 1st, at the Desert Inn, Daytona Beach. Commercial exhibits, swap tables, door prizes, ladies activities, auction. Admission $3.00 advance, $4.00 at door. Swap busts $5.00 for both days. For more information write or call: Dave Rustler, WA4ZTF, 1452 Hope Dr., Ormond Beach, FL 32074, (904) 672-9535.

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NEW YORK: Poughkeepsie Amateur Radio Club is celebrating “Morse Day” Sunday, May 18 from 9 a.m. to 9 p.m. EST, "Lotus Grove," Poughkeepsie. The club station, K2KN will operate on CW and Phone, on HF bands 80 through 10 meters, and on 2 meter Phone on 146.52 MHz. For special QSL cards send legal size S.A.S.E. to: P. O. Box 3070, Poughkeepsie, NY 12603.

HOLLYWOOD AMATEUR RADIO CLUB'S 10TH ANNIVERSARY QSO PARTY — 1100 UTC May 24 to 1900 UTC May 24, 2300 UTC May 24 to 0700 UTC May 25, 1500 UTC May 25 to 2300 UTC May 25. Frequencies: CW - 10500 kHz from each band edge and Novice bands; PH - 3980, 7280, 14280, 21380, 28580. Exchange (members) RST, consecutive serial number; non-members - RST, state, province, country. Copies of logs should be mailed to: Bob Patton, NAFB, 2311 Nassau Dr, Miramar, FL 33023 by June 20th. HARC members include dupe sheets for entries of over 500 QSO's.

COLORADO: The Northern Colorado Amateur Radio Club's Superfest II (Colorado Hamfest). June 7th, Weld County Exhibition Building, Greeley. Exhibits, talks, contest, auction, baby sitting and food service provided. Featured will be a Satellite TVRO terminal. Swap tables free with $3.00 admission. For further information contact: Greg Sonn, W2EE, Box 895, Greeley, CO 80632. Talk-in on 146.235 and 146.52.

Pennsylvania: Reading Radio Club Hamfest, Sunday, May 25th, Hamburg at the fieldhouse. Take RT 22 from east or west, Rt 61 from north or south. Huge indoor plus outdoor site, no weather worries. Many cash and equipment prizes. Talk-in on 34-94, 25-85, 01-61. For more information contact Ken Zahn, KAT70WH, 4 North 16th Ave, Yakima, WA 98902.


Connecticut: Dogwood Festival QSO Party sponsored by the Greater Fairfield Amateur Radio Assoc., 1300-2200 UTC May 17th. To work W1BCC0 check SSBI frequencies: 3975, 7235, 14330, 21420, 28710. FM: 146.55 simplex. Special QSLs will be sent. IRCs: WA8OHQ, WA8TBE, W01ZQ to: Joe Weinberg, 284 Eucalou Ave, Fairfield, CT 06432.

1986 Florida QSO Party sponsored by Florida Skip, 1500 UTC May 17 to 2359 UTC May 18. All amateur bands may be used — submit separate Phone and CW logs. Florida stations send signal report and county of operation. Out-of-state stations send signal report and U.S. State, Canadian province or country. Suggested frequencies: CW — 3555, 7055, 14055, 21055, 28055; Phone — 3945, 7235, 14319, 21379, 28579. For more info write: W4MNZ. Deadline for entries: June 15th. Mail to: Florida Skip Contest Committee, Box 660501, Miami Springs, FL 33166.

California: 25th Annual West Coast VHF Conference, May 9th through 11th 1980, Miramar Hotel, Santa Barbara, California. Hospitality room, technical sessions, special programs, noise figure measurements, antenna gain measurements, technical exhibits, prizes, drawings! Special convention rates (write directly to Miramar Hotel, Box M, Santa Barbara, California 93102 for room reservations). Pre-registration $4 person until May 1st, $5 at door. Make checks payable to the West Coast VHF Conference, and mail to Wayne Overbeck, N8NIS, 5818 Woodlake Avenue, Woodland Hills, California 91367.

Germany: Hamfest sponsored by Wiesbaden A.R.C. and DQK F20 club, starts 10 a.m., Sunday, May 4th, Auringen (5km north of Wiesbaden). Talk-in 145.55 MHz, follow signs on major autobahns. Flea market, vendors, displays, demonstrations, technical assistance, left-foot CW contest, prizes, food, and beverages. For information, write Stephen Hutchins, DA2HSD/6BWKA, Box 4573, APO New York 09109.

Dxpedition: Liechtenstein, 23 May - 31 May 1980. Call sign DAXVA8H. Frequencies: Phone — 3730, 7030, 14260, 21550, 28650; CW — up 25 kHz from bottom end of band. Stateside: QSL and SASE (154) by regular U.S. Mail to Stephen Hutchins, Box 4573, APO NY 09109. All others, QSL via Hugo Jakobiievich, DZ1C, Am Weinberg 10, 6201 Auringen, West Germany.

"DXpedition": Law West of the Pecos fun DX-pedition, 1800 GMT Saturday, April 19 to 1800 GMT Sunday, April 20th. Frequencies: 5000 - 7225, 14285, 21080, 28110. Call sign: W5EX3. QSL and SASE to LWQD, 2618 Rigby Avenue, San Antonio, TX 78222.


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THE 1980 MASSACHUSETTS SQO PARTY sponsored by The Greater New Bedford Contesters, 1600 GMT May 17th to 0200 GMT May 19th. A station may be worked once on each band. FONE and CW are separate bands. Frequencies suggested: CW — 1810, 3560, 7060, 7120, 14060, 21060, 21120, 28060, 28120. FONE — 1820, 1920, 3560, 24980, 29010, 50110. For info and results write: KIKJ, Ed Peters, 29 Greenbrier Dr., New Bedford, MA 02745.

GEORGIA SQO PARTY Sponsored by the Atlanta Radio Club, 1800 GMT May 17th to 0200 GMT May 19th. Exchanging QSO number (RST), and GTH, county, province, or country. Georgia to Georgia contacts permitted. Frequencies: CW — 1805, 3590, 7060, 14060, 21060, 28060, 3960, 7960, 7240, 11240, 21360, 28215, 28305, 283125, Phone — 1830, 7220, 12400, 21360, 21360. VHF — 50125, 14525. Mailing deadline June 30 to: Mark Shaw, K8ED, 3810 Woodward, Troy, MI 48084.

RADIO EXPO "80" Lake County fairgrounds, Rt. 45 & 20, Dept. 6 & 7 — advanced tickets $2.00, $3.00 at gate. Write: Radio Expo Tickets, P.O. Box 1532, Evanston, IL 60204. Exhibitor information call (312) BST-EXPO.

ALABAMA: The Birmingham Amateur Radio Club's 5th Annual "AMFest '80" will be held on May 17th & 18th at the Birmingham-Jefferson Civic Center Exhibition Hall. Exhibitors, flea market, prizes, and special speech at banquet — Archie Campbell from TV's Hee-Haw. For tickets and information write: Birmingham AMFest '80, P.O. Box 603, Birmingham, AL 35201.

RHODE ISLAND: The Newport County Radio Club will hold an auction at the Seawave Institute, 18 Market Square, Newport on May 7th at 7 p.m.

MASSACHUSETTS: Hampden County Radio Association's Flea Market will be held on Friday, May 7th at at the Feeding Hills Congregational Church, Feeding Hills. Admission 75c per person. Table reservation fee $5. Contact Andy Bouchard, WB1BV, for more information at (413) 726-2301.

MASSACHUSETTS: The Bristol County Amateur Radio Association's Flea Market and Radio Auction will be held on Sunday, May 9th from 9 a.m. to 5 p.m., at the Knights of Columbus Hall in Fall River. Talk-in on 146.219. For more information write AA1Q.

NEW JERSEY: The Tri-County Radio Association's indoor Hamfest/Flea Market will be held at the Passaic Township Youth Center, Valley Rd., Stirling, on Sunday, May 6th from 9 a.m. to 4 p.m. Admission $1.00. Tickets and info see K1SAD at (201) 647-3461.

MICHIGAN: Central Michigan Amateur Repeater Association's Swap & Shop, Midland, June 21st, at the Midland County Fairgrounds. Computer demonstrations, door prizes. Talk-in on 146.73 W9ABF. For more information, write: GECV, 309 E. Gordon Rd., #122, Midland, MI 48640.

INDIANA: The Lake County Radio Club's Dad's Day Hamfest, June 15th, Lake County Fairgrounds, Crown Point. Tickets $1.50 in advance, $2.00 at door. Talk-in on 147.9842 or 146.52 simplex. For tickets and information write: Tickets, P.O. Box 1009, Gary, IN 46409.

OHIO: Sandusky Valley Amateur Radio Club's Hamfest, May 25th beginning at 7 a.m. at the Sandusky County Fairgrounds. All tables free, admission $1.00. Talk-in: 5580, 146.3191. For tickets and info see SASE to: Ron Winkle, W8BNMK, 1200 Stilwell Ave., Fremont, OH 43420.

MAINE: A Flea Market sponsored by the Portland Amateur Wireless Assoc. and the University of Southern Maine Radio Club, May 24th, Gorham-Maine campus of University of Maine, Gorham. Time: 9 a.m. to 5 p.m. Indoor & outdoor sites available. Admission $1.00. Talk-in: 52, 73, 195. For more information, John Taylor, 44 Mitton St., Portland, ME 04102, or call (207) 772-2651.

MICHIGAN: The Ford Lin Lizzy Club, North Metro Chapter's "Tip-Off-The-Thumb" Expedition, Point Aux Barques reef, 22002 May 16th through 1400Z May 18th. Primary frequencies: 7275 and 21360 MHz. For OSWs write: AJ8K.

MISSOURI: Amateur Radio and Computer Hobbyists Convention sponsored by the Gateway Amateur Radio Assoc., on May 24-25th, Cervantes Convention Center, St. Louis. Many special events planned — for further information write: Gateway Amateur Radio Assoc., Box 68, Marissa, IL 62257.

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<th>Frequency Range</th>
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<td>350 MHz Prec. Div. by 10/11</td>
<td>$9.50</td>
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<tr>
<td>95191DC</td>
<td>350 MHz Prec. Div. by 5/6</td>
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<tr>
<td>11C90DC</td>
<td>650 MHz Prec. Div. by 10/11</td>
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<td>11C91DC</td>
<td>650 MHz Prec. Div. by 5/6</td>
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<tr>
<td>11C603DC</td>
<td>1 GHz Divide by 240/256 Prec.</td>
<td>$28.90</td>
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<tr>
<td>11C707DC</td>
<td>600 MHz Flip/Flop with reset</td>
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<tr>
<td>11C506DC</td>
<td>ECL VCXO</td>
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<tr>
<td>11C404C/MC4044 Phase Frequency Detector</td>
<td>$3.62</td>
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<td>11C204C/MC4024 Dual TTL VCXO</td>
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<tr>
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<tr>
<td>612A 450 to 1300 mc. 1 uV to 5 V into 50 ohms Signal Generator</td>
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<td>614A 900 to 2100 mc Signal Generator</td>
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<td>8693A 4 to 8 Gc Plug In For 8690A Sweeper</td>
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<td>8742A Reflection Test Unit 2 to 12.4 Gc</td>
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<td>2N2637 2N2636 2N5417</td>
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May 1980

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KLM KT-34A Tribander
20, 15, and 10m antenna
Freq. coverage of 20, 15, and 10 meters, gain: 7dB, VSWR: 1.5:1, feed impedance: 50 ohms unbalanced, 4 elements on each band, power rating: 4 KW PEP, boom length: 16 ft, turning radius: 15 ft., and wind survival: 100 MPH. Mounting requirements: 2" OD mast or larger. No boom bracing necessary.

359.95 List. Call for quote.

CDE Ham IV antenna rotor
Designed for large communications antenna arrays up to 15 sq. ft. wind load area. Features electric locking wedge, auto pre-brake, illuminated directional indicator, snap-action control switches, and low voltage control for safe operation. Must be tower mounted.

198.00 List. Call for quote.

HYGAIN 14 AVQ Vertical Antenna

69.95 List. Call today.
The introduction of the "WAYFARER" by Yaesu is the beginning of a new era in compact solid state transceivers. The FT-707 "WAYFARER" offers you a full 100 watts output on 80-10 meters and operates SSB, CW, and AM modes. Don't let the small size fool you! Though it is not much larger than a book, this is a full-featured transceiver which is ideally suited for your home station or as a traveling companion for mobile or portable operation.

The receiver offers sensitivity of .25 uV/10 dB SN as well as a degree of selectivity previously unavailable in a package this small. The "WAYFARER" comes equipped with 16 poles of IF filtering, variable bandwidth and optional crystal filters for 600 Hz or 350 Hz. Just look at these additional features:

**FT-707 with Standard Features**
- Fast/slow AGC selection
- Advanced noise blanker
- Built-in calibrator
- WWV/JJY Band
- Bright Digital Readout
- Fixed crystal position
- 2 auxiliary bands for future expansion
- Unique multi-color bar metering—monitors signal strength, power output, and ALC voltage.

**FT-707 with Optional FV-707DM & Scanning Microphone**
- Choice of 2 rates of scan
- Remote scanning from microphone
- Scans in 10 cycle steps
- Synthesized VFO
- Selection of receiver/transmitter functions from either front panel or external VFO
- "DMS" (Digital Memory Shift)

Impressive as the "WAYFARER" is its versatility can be greatly increased by the addition of the FV-707DM (optional). The FV-707DM, though only one inch high, allows the storage of 13 discrete frequencies and with the use of "DMS" (Digital Memory Shift) each memory can be band-spread 500 KHz. These 500 KHz bands may be remotely scanned from the microphone at the very smooth rate of 10 Hz steps.

The FT-707 "WAYFARER" is a truly unique rig. See it today at your authorized Yaesu Dealer.

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EIMAC's 3-500Z is first choice for Henry's 1KD-5 linear amplifier.

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For more information on the 1KD-5 amplifier write to Henry Radio, 11240 West Olympic Boulevard, Los Angeles, CA 90064. And for a data sheet on the 3-500Z and more information on EIMAC power grid tubes, write to Varian, EIMAC Division, 301 Industrial Way, San Carlos, CA 94070. Telephone (415) 592-1221. Or contact the more than 30 Varian Electron Device Group Sales Offices throughout the world.

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