

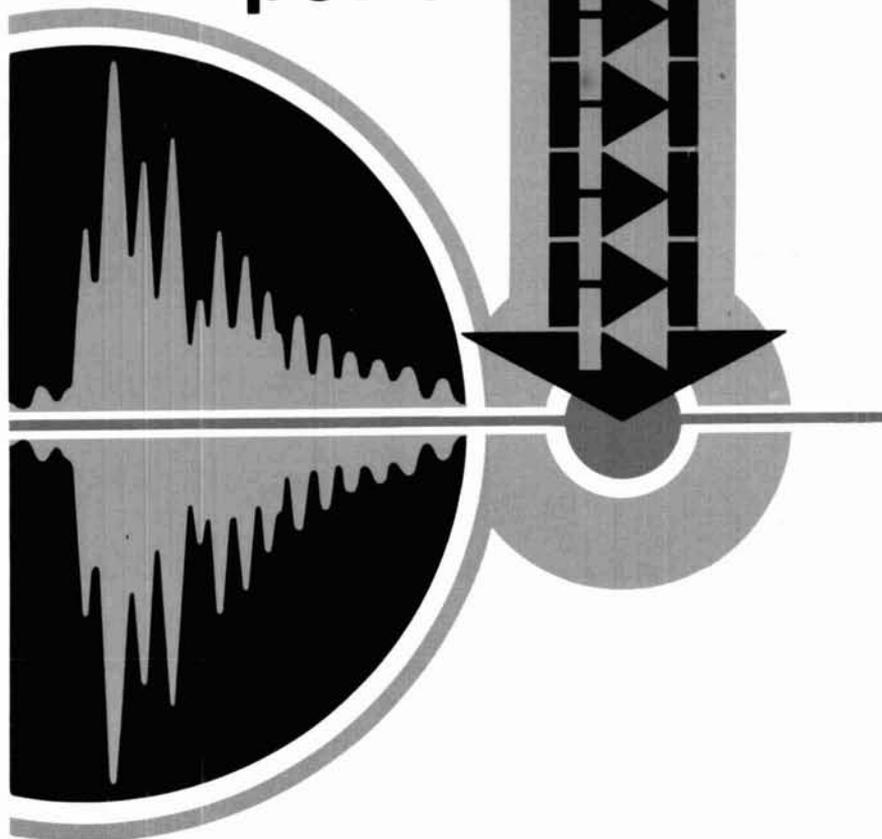
ham **radio** *magazine*

- 75/160 short verticals
- vertical phased arrays
- smart squelch
- harmonic product detector
- 10 GHz stable oscillator
- TRS 80 and RTTY
- CW — a new approach

hr 

*focus
on
communications
technology*

measurement of PEP output power



IC-471A

NEW!

The New Deluxe 430-450 MHz Base Transceiver from ICOM



WRITE OFFSET INTO
MEMORY

NEW DISPLAY

32 CHANNEL
MEMORY

1 MHz UP/DOWN
FOR FAST QSY

32 full function memories / subaudible tones / PLL locked to 10 Hz / two color florescent display / RIT readout / scanning / new size.

32 Memories. Each memory holds frequency, mode, offset direction, offset frequency and subaudible tone for easy return to an off used frequency or for remembering a new repeater or simplex frequency.

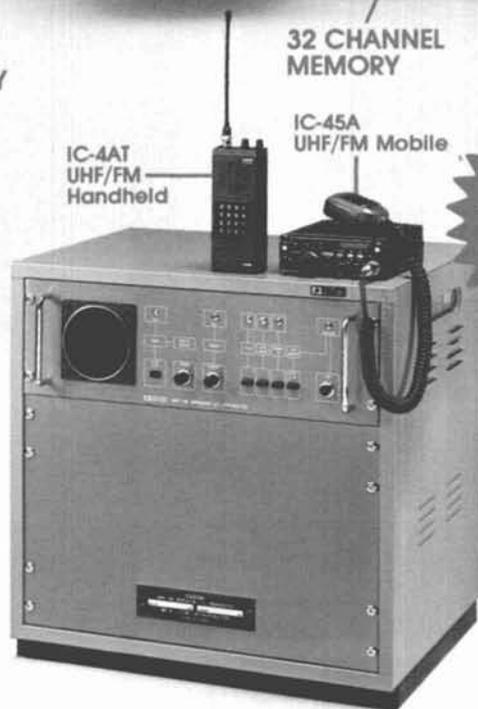
Subaudible Tones. Subaudible tones are selected by rotating the main tuning knob. These tones may then be stored into memory along with the frequency, offering ease of operation.

Phase Lock Loop. Extremely low noise and good signal to noise ratio PLL design allows the IC-471A to lock to 10 Hz for extreme accuracy.

New Display. ICOM's new easy-to-read two color florescent transceiver situation display shows frequency, mode, offset direction, VFO in use, memory channel, and RIT offset direction and amount.

Scanning. Scanning of memories, programmable band scan, and mode scanning are available and easy to use.

New Size. Only 11 1/2"W x 4 3/8"H x 10 3/4"D the IC-471A is styled to look good and engineered for ease of operation.



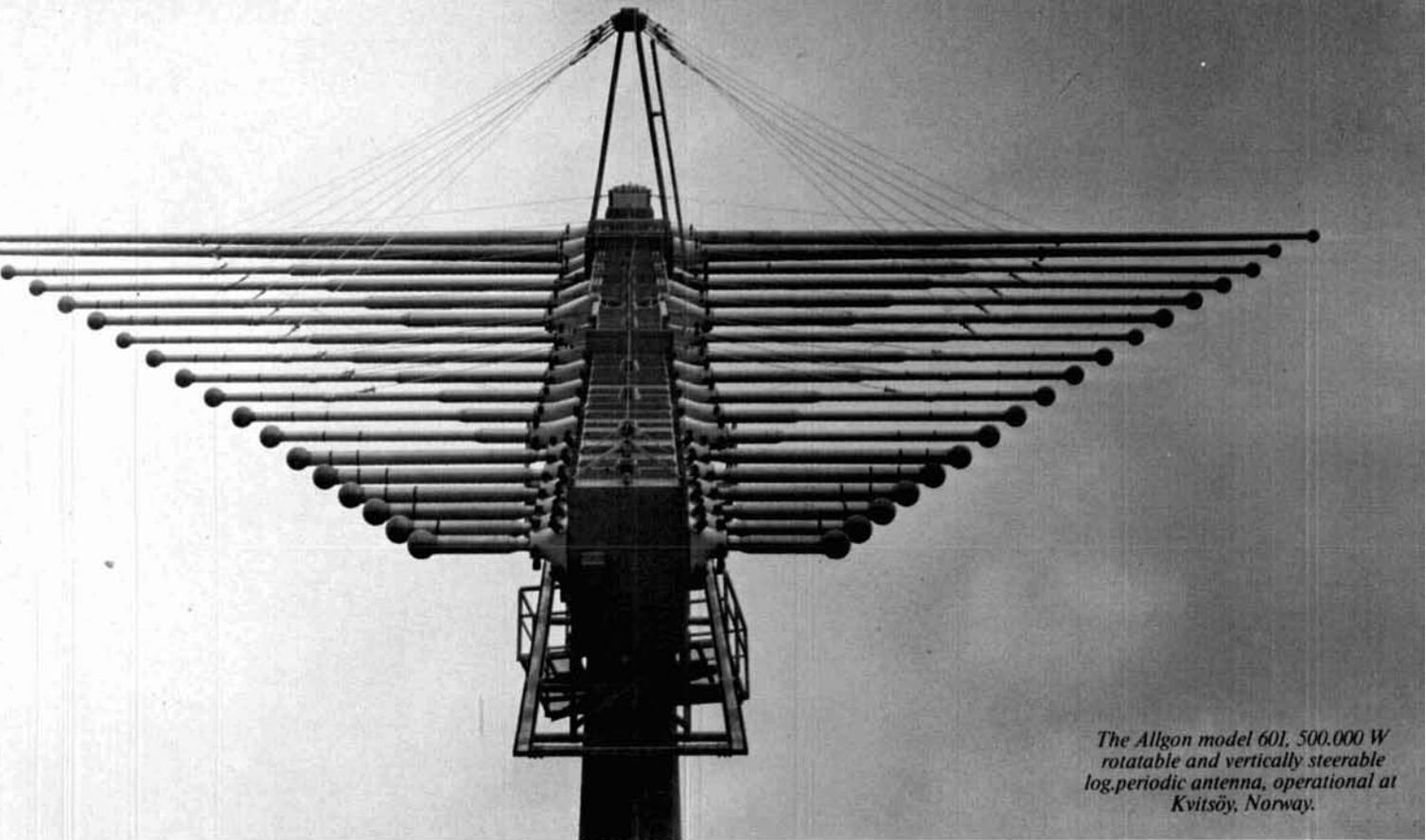
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ICOM

The World System



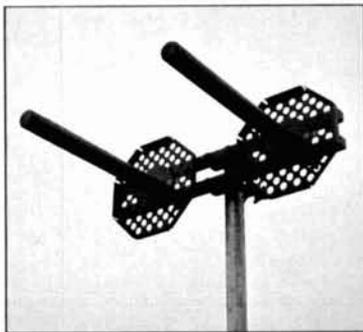
The Allgon model 601, 500,000 W rotatable and vertically steerable log periodic antenna, operational at Kvitsøy, Norway.

The ionosphere never sets on an Allgon antenna.

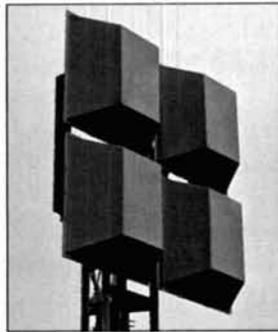
Survivable antennas installed in over 115 countries around the world.

Allgon antennas are designed using advanced analytical techniques for optimum performance and mechanical reliability.

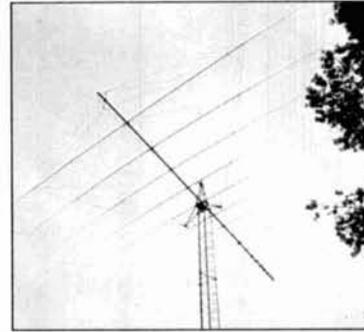
Allgon manufactures antennas for military, government, commercial and amateur applications (3–3000 MHz).



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*Phased dipole array
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*Lightweight 616
log periodic antenna 6–30 MHz*

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R-2000 FEATURES:

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- **Optional 118-174 MHz coverage.** Through use of innovative microprocessor technology, frequency, band, and mode data of stations in the 118-174 MHz range may be tuned, displayed (full frequency, i.e., 146.000.0), stored in memory, recalled, and scanned, using the R-2000 front panel controls and frequency display, allowing maximum convenience and ease of operation.
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- HC-10 World digital quartz clock.
- AL-2 Surge Shunt

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REFLECTIONS REFLECTIONS

window on the world — the “foreign” press

It's always interesting to examine the approaches taken by others in solving problems common to all of us.

At *ham radio*, we have the opportunity to provide readers with a window on the world of Amateur Radio. Dozens of foreign language publications pass over our desk each month*; and as we promised last year, we'll do all we can to provide technical notes, articles, and other items of interest carefully selected from these numerous and informative sources.

In our lead article VK3AFQ provides us with a view of technical requirements facing Australian hams in 1983. Not surprisingly, we, here in the States, have the same situation — how to specify and measure rf power.

Up till now we have met the FCC stipulated power requirements by measuring the dc power input to the final amplifier stage (including drive) while keeping it under 1 kW. Recent discussions have focused on increasing that power level to 1500 watts of PEP output. It's a simple enough matter to measure dc power input — plate voltage x plate current. But how do you measure PEP output? We return to the land down under and see how VK3AFQ solved the problem simply and effectively in his article, “Measurement of PEP Output Power.”

While still “down under,” three magazines that have provided Australian and New Zealand hams with the latest in technical information are *Amateur Radio*, (VK); *Amateur Radio Action*, (VK); and *Break-In*, (ZL). Ron Cook, VK3AFW, in his “Novice Notes” (*Amateur Radio*, February, 1983) addresses a situation many of us now face — the need to provide a low VSWR load (antenna) to our solid-state rigs. His article discusses antenna tuners including the L, T, and Pi networks, the ultimate transmatch, and a special wide-range tuner while providing theory and application information.

A very popular antenna these days, especially with the lower band (40, 80, 160) enthusiasts is the delta loop. Probably one of the best descriptions of its operation recently appeared in *Amateur Radio Action*. In the March, 1983 issue, VK2EAO details “Loaded Corner-Fed Delta Loops.” After a brief historical description of its development the author provides construction details extending this antenna's use to any of the hf ham bands.

Satellite users will find some notes of interest in New Zealand's Amateur journal *Break-In*. The regularly featured column “Satellite News” by ZL1TGC provides the latest data on the Phase III-B, UO-9, RS-8, and RK-03 (Iskra-3) “birds” perhaps from a different slant. For example, if you'd like to know what the UoSAT satellite is experiencing in space, examine the detailed telemetry information from its sensors provided on channels 00 through 59 as delineated in this February's column.

Rotating our sights to the northwest we briefly pause to examine Japan's monthly journal, *CQ ham radio*. This 500 plus page magazine features columns for SSTV, RTTY, VHF, UHF, and Microwave enthusiasts, to name just a few. For example, in the March, 1983 issue, construction details, polar and VSWR plots are provided for a 36-element 2400 MHz single boom Yagi. Being a lower band “aficionado,” I can't help but notice the 14 page DX “column” and wonder how I could possibly have recently missed so many 80-meter stations such as A92NH, DU1PJS, HL0CCA, 5V7AL and 9N1RFT — all heard from Japan. It's necessary to mention that except for a single page column called “The English Service of CQ ham radio,” all the rest of the magazine is in Japanese.

Continuing in a clockwise rotation, we arrive at the British Isles and notice English language publications such as *Radio Communications*, *The Short Wave Magazine*, *Practical Wireless*, and *Radio and Electronics World*. Though the last one is not specifically dedicated to Amateur Radio, it includes several articles of direct interest to hams. An excellent article by A.J. Rogers in the April, 1983, issue on “Crystal Filter Design” provides useful data for the experimenter to enable him to develop his own. One example illustrated in the article is a 6-crystal filter featuring a half-power bandwidth of ± 4.5 kHz, 60 dB bandwidth of ± 12.5 kHz with a maximum passband ripple and insertion loss of 1 and 1.75 dB, respectively. Imagine putting one of these in front of your receiver on your favorite band. It should go a long way toward reducing that neighboring ham's strong signal 20 kHz away from you.

From this editor's position, I see so many articles that would be of interest to you, the reader. For example, across the channel in France we have two excellent ham magazines, *Megahertz* and *Ondes Courtes Informations* (Short Wave Information). This month they feature articles on . . . But wait. I'll tell you about them and others in future issues — if you'd like. Let me know your thoughts.

Rich Rosen, K2RR
Editor-in-Chief

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TRAGEDY IN THE SOUTH CHINA SEA ENDED A DXPEDITION to Spratly Island April 10. Two of the four Amateurs in the all-German group died as a consequence of Vietnamese shellfire after their chartered catamaran strayed too close to an occupied atoll in the hotly disputed islands. After the vivid on-the-air account of the attack ended abruptly, the fate of the four DXers, their vessel and its two-person crew was unknown for over a week until a Panamanian freighter, the Linden, pulled the four survivors from a liferaft.
DJ6SI and DF6FK Survived The Unprovoked Attack, while DJ3NG and DJ4EF both died.

THE ARRL'S OPPOSITION TO A "NO-CODE" LICENSE WAS FIRMLY MAINTAINED by the directors at their April 21-22 meeting. Despite recent indications of a more conciliatory attitude on the part of some League staff, and strong support for a codeless license by several of the directors, the outcome of the meeting was a resolution "stating in the strongest possible terms the opposition of the League to the creation of an Amateur license class that does not require demonstration of a knowledge of Morse Code."

ADDITIONAL PHONE FREQUENCIES ON 75, 15, AND 10 METERS were proposed in a new FCC Notice of Proposed Rule Making that accompanied the 20-meter expansion announced in last month's Presstop. On 75 meters the FCC proposes moving the lower phone limit down 25 kHz to 3750 for Extras, to 3775 for Advanced, and to 3850 for Generals. On 15 meters 21200 would be the new bottom edge for Extras, 21225 for Advanced, and 21300 for Generals. The 10 meter phone band would start at 28300, a full 200 kHz lower for these three license classes.

40 Meters Would Remain As Is For All U.S. Amateurs except those in Hawaii and nearby islands. In those areas the phone band edge would be lowered to 7075 kHz, to bring their phone privileges in line with those of others in the Pacific area.

Comments On The Additional Expansion Are Due July 1st; Reply Comments August 1. The same docket number as before, PR Docket 82-83, still applies.

The New 14150-14200 Phone Allocation Became Available to U.S. Amateurs May 22.

The Commission Proposal To Extend The Term Of Amateur Licenses to 10 years has been designated PR Docket 83-337. Comments are due at the FCC June 13; Reply Comments July 13.

LAUNCH OF THE PHASE III-B SPACECRAFT HAS BEEN DELAYED AGAIN, probably into July. After checkout of the new Amateur satellite was completed in Germany, AMSAT engineering VP W3IWI and AMSAT-DL Amateurs took the bird to the Kourou, French Guiana launch site for integration with the Ariane launch vehicle. Now, however, problems have developed with Ariane that are likely to push the actual launch back at least another month.

An Extensive Launch Day Net Operation Has Been Planned, to provide AMSAT members and other interested Amateurs with last minute developments as the launch proceeds. The launch day net will begin operation at 1130Z the day of the launch on the regular AMSAT net frequencies: 3850, 7280, 14282, and 21280 kHz. Net operation will continue through the launch window (about 3 hours) or until the launch vehicle and its cargo are in orbit.

For The New Launch Date Check The AMSAT Domestic Nets on Tuesday evening (Wednesday morning GMT) starting at 0200Z on 3850 kHz, or WIAW bulletin.

CB AND RADIO CONTROL LICENSING WAS ELIMINATED at the FCC April 27th Agenda Meeting. Effective immediately no CB or RC licenses will be processed though the effective date had not been set at press time.

W5LFL/SPACESHIP MOBILE IS NOW DEFINITE and will become a reality when the Spaceship Columbia carries the joint U.S.-European Spacelab aloft on the STS-9 flight the end of September. Operation is to be simplex on the low end of 2 meters to give Amateurs in other ITU regions, where the band is 144-146 MHz, a chance to work W5LFL. He'll operate about an hour a day, during "off duty" periods, with an operating protocol that's still being worked out that's hoped will avoid the typical DXpedition "pileups."

Operation Will Be Conducted By FCC Rules Under International Procedures established at the 1971 Space Conference. These require formal notification of the appropriate agency well in advance of such an operation, though at press time no notification had been received by the FCC. Scheduled date of the STS-9 launch is September 30.

DAYTON HAMVENTION'S "HAM OF THE YEAR" IS KH6IJ, who's internationally known as one of the world's top contest operators but whose lifelong efforts in promoting Amateur Radio are equally impressive if less well known. The Hamvention "Special Achievement Award" went to Lenore Jensen, W6NAZ, for her outstanding success in promoting public recognition of Amateur Radio. It's been principally through her efforts that so many celebrities took part in the ARRL sponsored Public Service Announcement program. Congratulations to both!

FCC COMMISSIONER ANNE JONES HAS ANNOUNCED HER RESIGNATION from the Commission to return to private law practice. Ms. Jones has been a real friend of Amateur Radio since becoming a Commissioner in 1975, with a better-than-average understanding of Amateur concerns. Her valuable contributions will be missed.

ADDITIONAL FREQUENCIES FOR CORDLESS PHONES WERE PROPOSED by the FCC in a March 31 Notice of Proposed Rule Making. The new frequencies, between 46.6 and 47 MHz, would supplement the present 49.6-50 MHz frequencies on a five-year interim basis until a more suitable permanent spot could be found for the burgeoning portable phone industry.

Interference To Amateur 160 And 80 Meter Operation by the base station portion of cordless phone systems, which operate around 1.7 MHz, has become a growing problem. It's hoped this new FCC proposal, General Docket 83-325, can help to end this interference.

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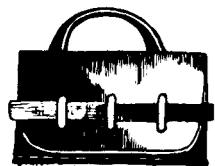
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comments

switching circuit

Dear HR:

The switching circuit described by Fred Dahnke, WB6IQV, on page 70 of the January, 1983, issue of *ham radio* may cause problems in many of the newer GM automobile radio systems. Neither side of the speakers in the newer systems is grounded, and introducing a ground, as in the drawing, may cause component failure within the radio.

Modifications to the circuit may be made so the speaker system remains balanced, both with the speaker, and a load resistor, yet work with the unbalanced configuration for the two-way radio. On the other hand, some consideration must be given to the fact the car radio speaker system will be open during the switching time of the relay, and the possibility of damage to the radio because of this.

The final decision is up to the vehicle owner, and the above must be weighed in this consideration.

Sheldon Daitch, WA4MZZ
Louisville, Georgia

wire sizes

Dear HR:

I noted in Forrest Gehrke's article ("A Precision Noise Bridge") in the March issue of *ham radio* that you have religiously converted English units to metric. This has become a popular custom in many publications

even though such a procedure is frequently cumbersome, and sometimes even improper.

One good example is in converting wire gauges (the machine tool industry dropped that useless "Micro" thirty years ago) to a dimension in millimeters. Giving a wire size as "No. 24" is a wire size, but 0.5 mm is not a wire size. To be perfectly explicit, the size should be given as, for example, No. 24 AWG (for American Wire Gauge), or B&S for Brown & Sharpe, or Birmingham, or Stubs, or Washburn & Moen, or Imperial, to name a few).

If you want to be completely confused, take a look at some wire tables such as those in the *Handbook of Chemistry and Physics*. While you are at it, you might notice that successive wire size numbers are 1 dB (voltage) apart. Thus if you can remember that No. 16 B&S is 0.05083 inch (0.1291 cm), you can figure out the other sizes with fair accuracy.

But please, don't confuse wire gauges with the metric system. They are simply a preferred number system based on a logical progression of diameters no matter what units are used.

Donald E. Williamson, K4HVI
Miami, Florida

data bandwidths

Dear HR:

In the article "Data Bandwidths Compared" (December, 1982, *ham radio*) the suggestion that phase modulation permits transmission of data at a rate faster than the corresponding receiver bandwidth is very misleading. Granted the sidebands may be more than 15 dB down, but those sidebands become increasingly important as the data rate goes up. The author notes that the error rate is higher; I wonder whether he considers 50 percent errors satisfactory for

800 BPS transmission through a 400-Hz channel.

A more useful study would have included bit sequences other than the (1,0,0,1,0,1,1,0) in the examples. Though this may be random, it is by no means the only possible eight-bit sequence. Each has a different spectrum. A proper analysis would have found the average spectrum from all possible eight-bit sequences.

This article had a lot of potential. I'm afraid it will leave many readers with some incorrect ideas about data rates and channel bandwidths.

Dick Simpson, W6JTH
Palo Alto, California

the battlefield

Dear HR:

The editorial "The Battlefield" by K2RR calls for respect for the DXers' right to 3795-3800 kHz. Before many Amateurs could respect special DX frequencies, they would first have to respect the wham-bam, touch-and-go-type of contacts. Today's DXing is very disappointing for those Amateurs who have known DXing as a means of gaining a personal or meaningful acquaintance with foreign hams. Too many so-called DXers, I believe, have only graduated from matchbook collecting, and their DXing techniques do not deserve any special respect.

Warren U. Amfahr, W0WL
Des Moines, Iowa

good job

Dear HR:

I'm writing to let you know that I'm renewing my subscription because of your February issue. I hope you keep having articles on UHF/microwave equipment. There are too many general-interest articles and magazines. Keep up the good work.

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Port Hueneme, California

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measurement of PEP output power

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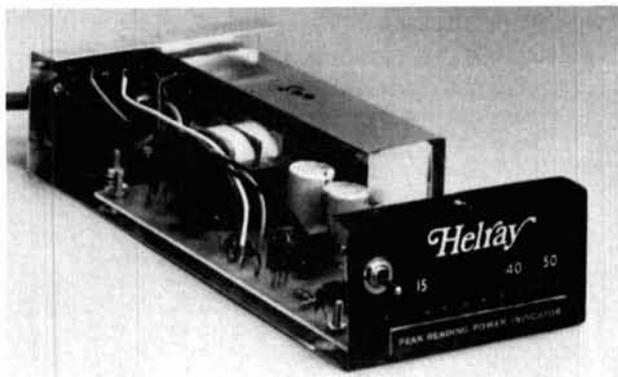
Ever since single sideband first became popular among Amateurs in the early 1960s, a problem has existed which has plagued both the Amateur and the regulating authorities. The problem has been to accurately measure the output power of an SSB transmitter when actually on the air — especially when operating near the maximum legal limit. Most countries specify a maximum power level that must not be exceeded by the Amateur. In the U.S.A., a

limit is set on the allowable dc input power to the final amplifying devices — be they valve or solid state. In Australia, the United Kingdom, and many other countries, a limit is set on the allowable peak rf output from a transmitter.

While measurement of peak output power has much to commend it in terms of the extra freedom it gives to the designer of the transmitter, the problem of accurately measuring this peak output power persists. The Australian and British authorities recommend use of an oscilloscope and a two-tone oscillator to establish the permissible limit of 400 watts PEP output, and then impose a requirement on the individual Amateur not to exceed this limit when in actual operation. This method is, at best, clumsy, and it has the additional drawback that the recommended equipment is expensive. Furthermore, the oscilloscope method really requires a long-persistence tube if any worthwhile degree of control is to be exercised. It is the purpose of this article to describe a simple device which can be used to accurately measure peak output power and which uses a dc voltage for calibration purposes.

Consider first the completely conventional method of measuring rf voltages. Fig. 1 is typical of the sort of "rf voltmeter" that has been described in the literature for decades. A diode in series with a capacitor is placed across the load. Provided the source gives a steady rf output, the capacitor then charges to the peak value of the rf waveform and this voltage can be measured with a normal, high-impedance dc voltmeter.

However, in the case of SSB, the output is not steady but varies at a syllabic rate. The normal mov-



Interior view of a 50-watt model PEP indicator. The assembly slides into an extruded aluminum case. The sampling head is contained in the rectangular housing at the rear. All other components, including the power supply, are mounted on an L-shaped PCB.

By H.L. Hepburn, VK3AFQ, 4 Elizabeth Street,
East Brighton, VIC, 3187, Australia

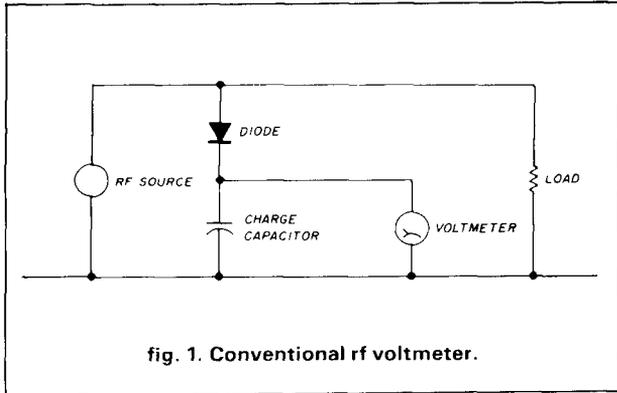


fig. 1. Conventional rf voltmeter.

ing coil or taut band meter movement has considerable mechanical inertia and is not able to follow fast variations in level. Indeed the meter will act as a sort of integrator and, to an extent which is set by its mechanical construction, will tend to average out the peaks of the speech waveform. Under these circumstances, it is just not possible for a mechanical device to register the fast peaks which cause over-limit operation. (Editors' note: The manifestations of which can be splatter, broad signals, and bad feelings on a crowded band.) This deficiency in mechanical meter movements makes the measurement of peak speech power impossible regardless of whether the license limits are defined in terms of input or output power.

What's needed is a device that gives an accurate and unambiguous indication when license limits have been exceeded. Calibration of such a device should preferably be by way of easily measured dc voltages.

Before I describe such a device, a few relationships are provided as background: The relationship between the voltage on a feedline having a 1:1 SWR and the peak output power into the load is given by the formula:

$$E = \sqrt{2PR}$$

where E is the instantaneous voltage on the feedline; P is the peak power in watts; and R is the load resistance in ohms.

In the case of the conventional 50-ohm antenna system, this expression simplifies to:

$$E = 10 \sqrt{P}$$

Working with the Australian "allowance" (that is, maximum power limit) of 400 watts PEP output, the voltage on the 50-ohm feedline must not exceed:

$$10 \sqrt{400} = 200 \text{ volts}$$

Thus, to meet the Australian license requirements, this 200 volts on the 50-ohm feedline must not be exceeded at any time.

threshold circuit

Fig. 2 is a circuit diagram of a simple over-limit indicator. It shows whether the voltage on the 50-ohm feedline has or has not, even momentarily, exceeded 200 volts (or 400 watts PEP) into a 50-ohm load. First, the voltage on the line must be reduced in a controlled fashion so that the capabilities of the diode are not exceeded. A resistive divider is used, which, at dc only, has a divide-by-5 ratio. At rf this ratio can still be maintained with the addition of several compensating components. The method of compensating the divider is detailed later.

At the output of the primary divider, the 400 watts peak on the feedline is now represented by:

$$\frac{200}{5} = 40 \text{ volts}$$

Forty volts is still a bit high for solid-state devices, so a secondary divider consisting of a 5.6 megohms in series with a 1.2-megohm fixed resistor and 1.0-megohm trimpot is used. This secondary divider has a

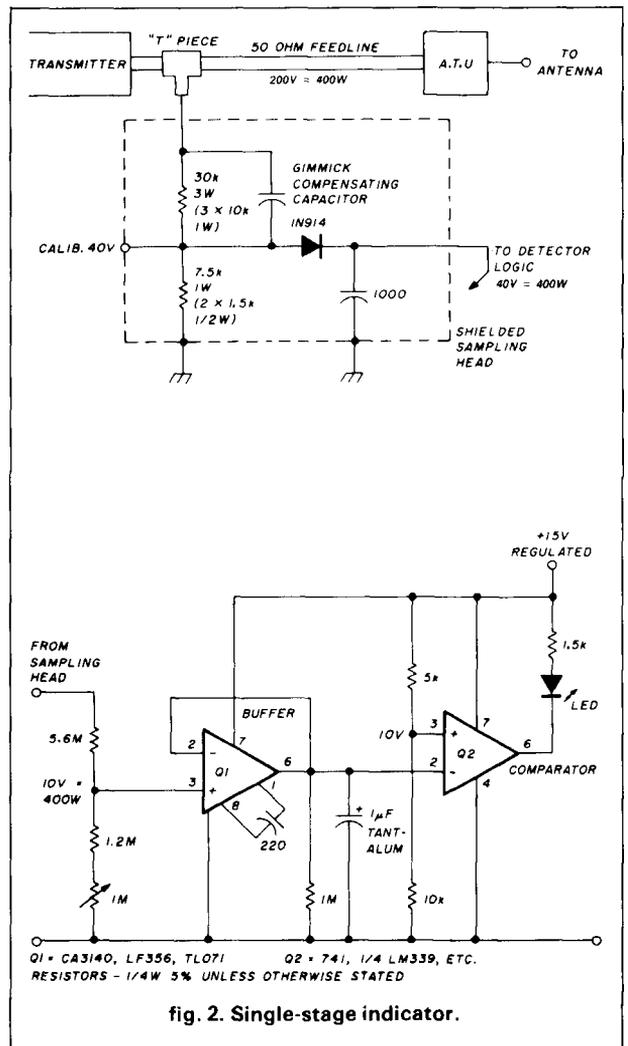


fig. 2. Single-stage indicator.

nominal ratio of 4:1 so that when it's adjusted, the original 200 volts on the feedline is now reduced to 10 volts. Since the output from the sampling head after rectification is audio with frequency components up to only 3 kHz, no compensation of the secondary divider is necessary.

Output from the secondary divider is buffered using a high-input impedance FET op-amp (CA 3140, LF 356, TL 071, etc.) connected as a voltage follower. Output from the buffer is applied to the inverting input of an op-amp set up as a comparator. The noninverting input is held at exactly 10.0 volts by means of the resistors across the 15-volt regulated supply. With no voltage input from the feedline there is no voltage on the inverting input of the comparator. The output of the comparator will be close to the 15-volt supply line and the LED does not draw current.

As soon as the 50-ohm feedline exceeds 200 volts (equal to 400 watts PEP), 10 volts or more is applied to the inverting input of the comparator. The comparator output drops, and the LED lights indicate that the allowable limit has been exceeded. For very short voice peaks, the eye may not register the fact that the LED was on. A rudimentary pulse stretcher consisting of a 1-megohm resistor and 1.0- μ F tantalum capacitor is attached to the output of the buffer to ensure that there is a minimum on time for the LED. Calibration of the device requires a dc voltage source variable around 40 volts.

The sampling head is removed from the feedline and the variable dc supply applied to the **CALIB 40 volts** point on the primary divider. An accurate voltmeter is used to adjust the calibrating supply to exactly 40.0 volts. The 1.0-megohm trimpot is then adjusted so that the LED just lights. The variables in the system (voltage drop across the diode, offset voltage of the op-amps, inaccuracies in the resistors, and so forth) are all nicely taken care of by this dc calibrating procedure.

Physically, the sampling head and primary divider may be separate from the comparator logic and should be fully shielded. A $5 \times 1\frac{1}{4} \times 1\frac{1}{4}$ inch ($135 \times 32 \times 32$ mm) box made of double-sided circuit board makes a very simple shielded enclosure for the dropping resistors, the diode, the charge capacitor, and the calibrating voltage input point. The rf input can be a standard SO-239 socket, the rectified output an RCA socket, and the calibrating voltage input a standard banana plug socket. **Fig. 3** shows how the head is assembled. A suitable power supply incorporating both logic and calibrating voltages is shown in **fig. 4**.

sampling head compensation

The rectifying diode in the sampling head has a small but finite series capacitance. This capacitance

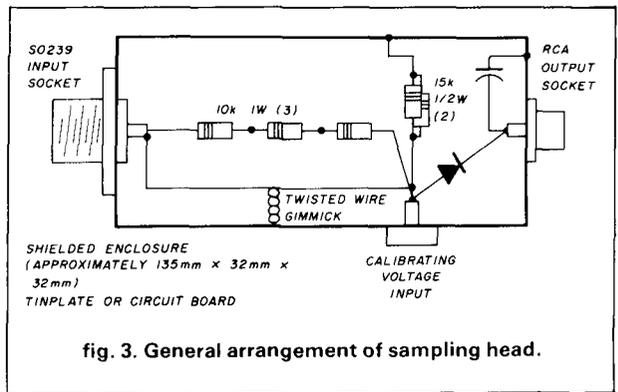


fig. 3. General arrangement of sampling head.

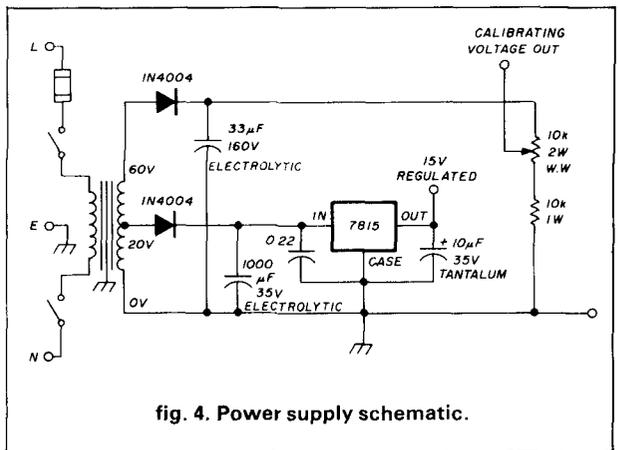


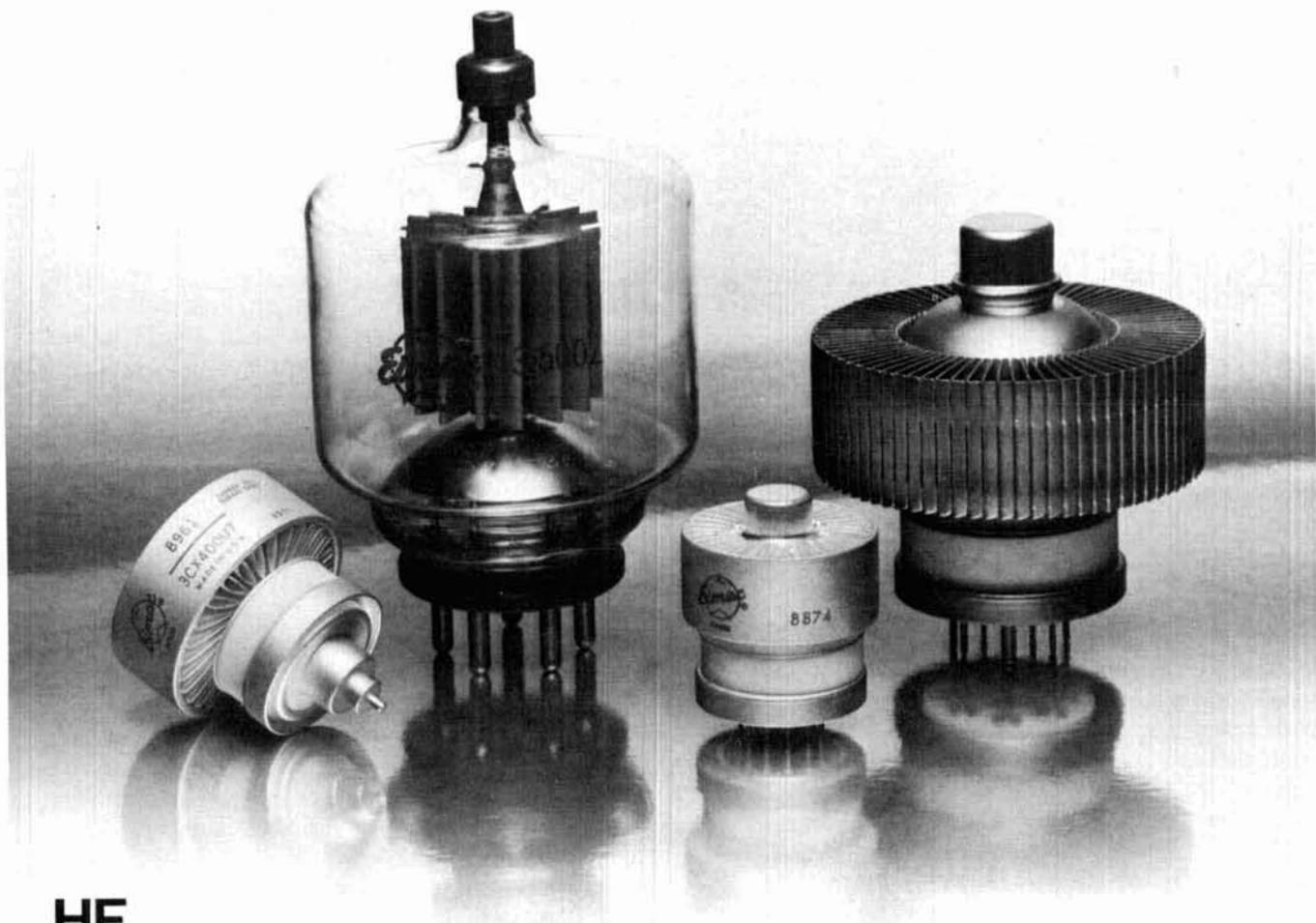
fig. 4. Power supply schematic.

is effectively across the 7.5-kilohm base resistor of the primary divider. At all significant rf frequencies this capacitance has a reactance which effectively reduces the 7.5 kilohms to a considerably lower value depending on frequency. Unless something is done, the 5:1 ratio of the primary divider no longer holds.

If a compensating capacitor is placed across the three 10-kilohm resistors forming the upper half of the primary divider, and adjusted so that its capacitance is exactly one quarter of the diode capacity, then the division ratio will remain at 5:1 although the effective resistance values may be significantly different from the dc resistance values. The compensating capacitor is a "gimmick" formed by attaching two insulated wires, one to the input socket and the other to the diode/7.5 kilohm junction, and twisting them together as shown in **fig. 3**. The test set-up for adjusting the compensating capacitor is given in **fig. 5**.

calibrating the sampling head

The station transmitter in the CW mode is operated into a standard rf wattmeter. This wattmeter need not be a high-power one — 10 to 20 watts is adequate. The sampling head is T'd into the line connecting the transmitter to the wattmeter. The transmitter is set to 3.5 MHz and the carrier level control



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table 1. Eight-level indicator voltages and resistor values.

A	B	C	D	E	F	G	H	I
power level PEP watts	peak voltage on 50-ohm line	voltage out of first divider	voltage out of second divider	fixed dc voltage required on noninvert inputs	required ladder resistor value ohms	make-up of ladder resistors by paralleling	actual value of ladder resistors ohms	percentage error
					R9-3820	39, 180K	3817	-0.08
500	223.61	44.721	11.180	Q8-11.180	R8- 573	620, 8.2K	576	-0.52
450	212.13	42.426	10.607	Q7-10.607	R7- 607	620, 27K	606	-0.16
400	200.00	40.000	10.000	Q6-10.000	R6- 646	680, 12K	643	-0.46
350	187.08	37.416	9.354	Q5- 9.354	R5- 694	820, 4.7K	698	+0.58
300	173.21	34.641	8.660	Q4- 8.660	R4- 754	820, 9.1K	752	-0.26
250	158.13	31.623	7.906	Q3- 7.906	R3- 835	910, 10K	834	-0.12
200	141.42	28.284	7.071	Q2- 7.071	R2- 947	1.0K, 18K	947	-
150	122.47	24.495	6.124	Q1- 6.124	R1-6124	6.2K	6200	+1.2

advanced until a suitable reading — say 10 watts — is registered on the wattmeter. The absolute accuracy of the wattmeter is unimportant. It is only necessary that the transmitter output be set to a fixed value during the calibration procedure. Now read the value on the voltmeter attached to the output socket of the sampling head.

The transmitter is switched to 29.5 MHz and the carrier level advanced until the same 10-watt output is registered on the wattmeter. The voltmeter is again read.

If the 3.5-MHz voltmeter reading is greater than

the 29.5-MHz reading, there is insufficient capacitance in the "gimmick" and more twists should be added. If the 29.5-MHz reading is higher than the 3.5-MHz reading, the head has been over-compensated for, and the "gimmick" should be untwisted. The aim is to get the voltmeter readings at both 3.5 and 29.5 MHz to be the same. Note that putting the cover on the sampling head enclosure has a slight effect on the readings and should be allowed for.

additional level indicators

The single LED indicator described above serves one fundamental purpose, to show whether a set power level on the feedline has been exceeded. Other levels can be set simply by changing the dc voltage on the comparator noninverting input.

A useful and practical extension is to use a multiplicity of comparators, whose inverting inputs are fed in parallel by the buffer and whose noninverting inputs are set at different dc levels, each dc level corresponding to a specific rf output power level. Fig. 6 gives the schematic of such an arrangement suitable for eight levels. The resistive ladder (R1 to R9) is calculated on the basis of 1000 ohms per volt. In most cases it will be necessary to parallel two standard 5-percent resistor values to obtain the (usually odd!) values required by each "rung" of the ladder. The appendix details the method of calculating resistor values.

However, the internal resistive ladders are characterized for either a linear or logarithmic relationship between input and comparator trigger points and are not applicable when the input/output voltages have a square root relationship, as is the case when power is being measured. By using devices such as the National LM339 (which have four comparators in a single 14 pin DIP), and an external resistive ladder the

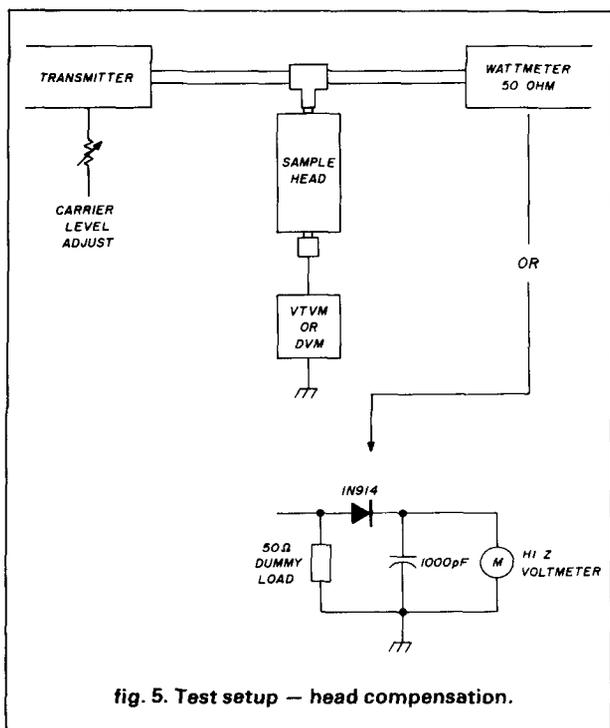
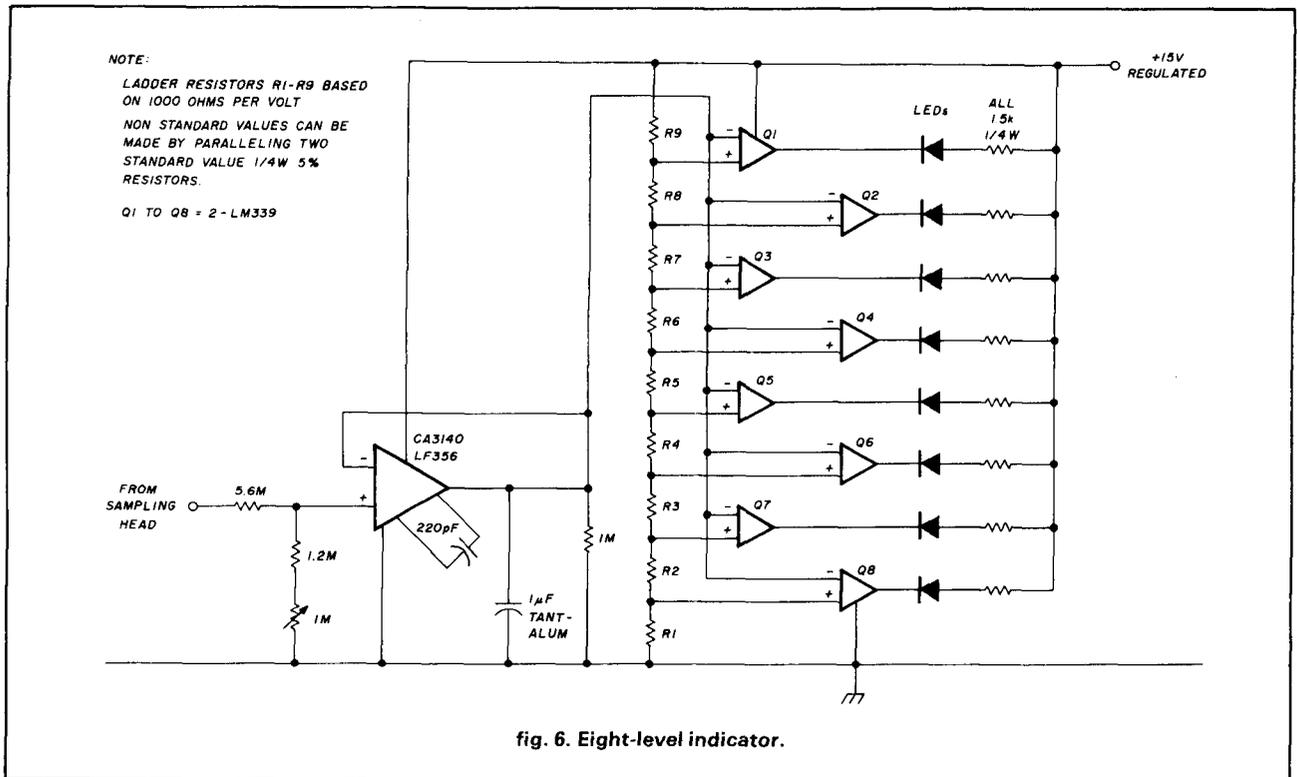


fig. 5. Test setup — head compensation.



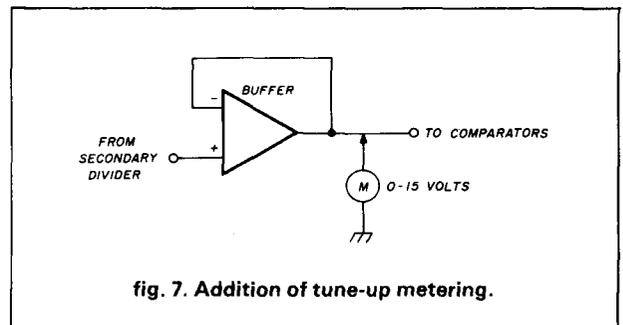
design can be made very flexible and varied to suit most applications.

In practice, an eight-step indicator covering 150-500 watts in 50-watt steps is a very useful device. Using green LEDs up to the 350-watt mark and red LEDs for the 400, 450 and 500 watt levels, the green/red transition is very obvious. It is necessary only to place the indicator lights where they will be easily seen. It's not necessary to watch the indicator; you will notice the change to the red LED even if you are not consciously watching for it. The device was developed as a means of showing when the allowable output power is exceeded during actual "on air" operation. For this purpose the stepwise approach is more than adequate.

For tune up purposes, using a carrier only, there is no doubt that a continuous indication is advantageous. The simple addition of a high impedance voltmeter (10,000 ohms per volt or better) between the output of the buffer op-amp and ground accomplishes just this, since, at that point, the voltage varies exactly in step with the voltage on the feed-line. The voltmeter 0-15 volt range should be calibrated according to the power output being used. Fig. 7 shows how this is done.

conclusion

A commercial version of this indicator, based on the principles outlined above is presently being mar-

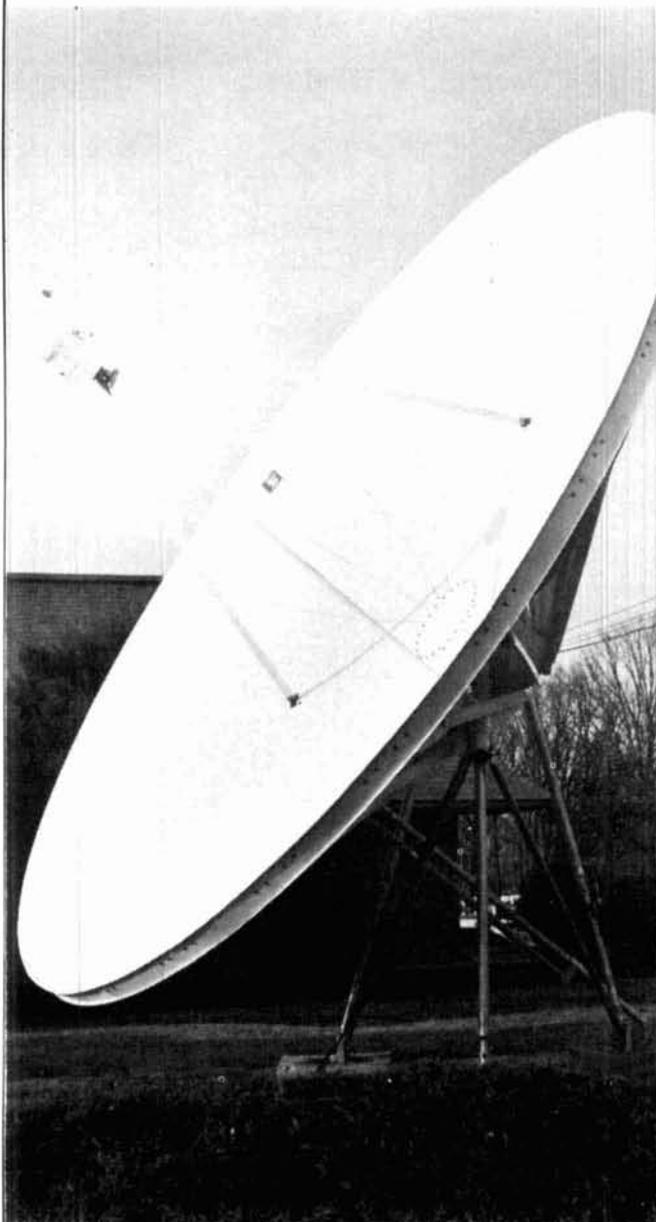


keted in Australia. More importantly, the Australian regulatory authorities have tested the device and have pronounced it as an acceptable alternative to the official oscilloscope method. The three standard ranges used in VK are 5-40 watts PEP in 5-watt steps, 25-200 PEP in 25-watt steps, and 150-400 PEP in 50-watt steps. Additionally, many "specials" have been made for other than Amateur use with 2 kW PEP being the maximum to date. The only changes necessary to do this have been in the values of the primary divider resistors and their wattage. The use of 5-percent-tolerance resistors in the unit has proved to be entirely satisfactory.

appendix

Calculation of ladder resistor values: table 1 includes data for an eight-step indicator covering 150-500 watts PEP in 50-watt steps. It can be revised for other ranges and other spacings by the following procedure. A supply of 15.0 volts regulated is required.

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1. List in column **A** the power levels and spacings required
2. List in column **B** the peak voltage on a 50-ohm line for each power level calculated from the formula $E = 10 \sqrt{P}$
3. List in column **C** the voltages expected out of the 5:1 primary divider for each power level calculated from the formula $E_{prim} = 0.2 E$
4. List in column **D** the voltages expected out of the 4:1 secondary divider for each power level calculated from this formula:

$$E_{sec} = 0.25 E_{prim}$$

$$\text{or } E_{sec} = 0.05 E$$

Note that the E_{sec} voltages calculated in step 4 are the trigger voltages, which have to be set on the noninvert inputs of the comparators. Call these $E_{trig} Q1$ to $E_{trig} Q8$ and enter in column **E**.

5. The resistance required between ground and the noninvert input of $Q1$ is given by the formula $E_{trig} Q1 \times 1000$. This resistor is shown in **fig. 6** as $R1$. If the resistance value is not within 2 percent of a standard resistor value, two resistors will have to be paralleled to get the correct value.

(a) Let R_a be the value required

(b) Choose the next standard value of resistor higher than R_a . Call this Resistor R_s .

(c) Calculate the value of the paralleling resistor required with this formula:

$$R_{par} = \frac{R_s \times R_a}{R_s - R_a}$$

This calculation will usually give a result which is not a standard value but which is between standard values. Again, choose a standard value for R_{par} which is the next one above the calculated value of R_{par} .

(d) Check that R_s paralleled with R_{par} is within 1 to 2 percent of the required value of R_a using this formula:

$$R = \frac{R_s \times R_{par}}{R_s + R_{par}}$$

Enter the resistor values to be used and their effective parallel value in columns **G** and **H**.

6. The value of R_2 is given by the formula

$$(E_{trig} Q2 - E_{trig} Q1) \times 1000$$

To realize the correct resistance value, steps 5(a) and 5(d) are repeated.

7. The values of $R3$ to $R8$ are calculated much like R_2 , using the general formula:

$$(E_{trig} Qx - E_{trig} Qx - 1) \times 1000$$

and steps 5(a) to 5(d) as before.

8. The value of $R9$ is calculated from this formula:

$$(15.0 - E_{trig} Q8) \times 1000$$

Note that if the actual voltage available on the regulated 15-volt line is significantly different from 15.0 volts (say, over 15.3 volts or under 14.7 volts) then calculate $R9$ using this formula:

$$(Actual\ volts - E_{trig} Q8) \times 1000$$

- (a) Calculate the percentage variation of the used values of $R1$ to $R9$ as shown in column **H** from the theoretical values of R shown in column **F**. Provided they are within 2 percent, no change is required. As **table 1** shows, the error in each step is likely to be very much less than 2 percent and of no practical significance.

ham radio

design of short vertical antennas for the low bands: part 2

An efficient radiator
for 160 and 75
that uses two top hats

a good radial ground system in a small back yard

You don't need a large back yard to have a good radial ground system. I helped a friend install a good system in a back yard that measured only 65 × 40 feet (20 × 12 meters). At that location there are chain-link fences around the entire yard, and about thirty fence posts. Other fences terminate near the corners, but they are not bonded to the back yard fence. We placed an aluminum plate on the grass, approximately in the center of the yard, and each fence post was connected to that plate by a No. 17 galvanized steel wire. The wires were buried in a slot dug by an ordinary edger. That made thirty radials, the longest of which was not more than about 40 feet (12 meters).

The fence posts and the plate were drilled, tapped, and provided with solder lugs, and the wires were soldered at each end. A temporary base-loaded whip was then resonated to 1.850 MHz, and the impedance was measured with a noise bridge. During these measurements, various fence corners were temporarily connected together with clip leads, and the effects were immediately noticeable. Within an hour, the ground system measured a fairly reliable 10 ohms. No measurement was performed at 3.8 MHz; however, it certainly would measure less than 10 ohms. Note that this minimal, small-lot radial system is *better* than the hypothetical ground used as the basis for calculations in this article.

The first half of this article reviewed the characteristics of several short verticals over ordinary ground radial systems. This information is now applied to the construction of a very short two-band trapped vertical.

the antenna system

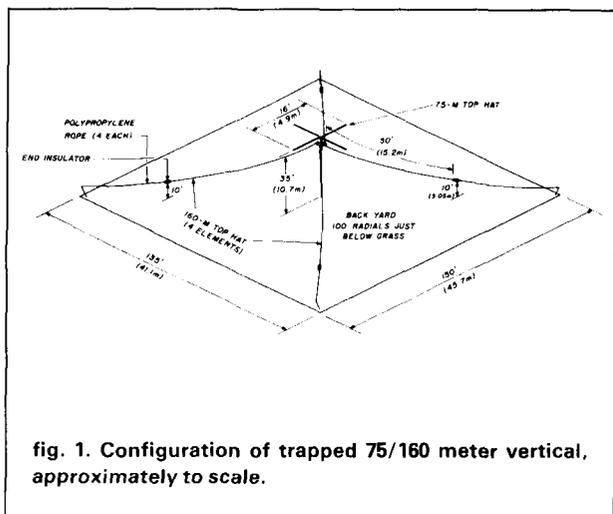
The antenna consists of two top hats separated by a parallel resonant 75-meter trap and a 35-foot-long (10.67-meter-long) section of 2-inch aluminum irrigation pipe. It resonates on 1.836 MHz and 3.830 MHz. The 75-meter top hat comprises four 8-foot (2.44-meter) pieces of 3/4-inch aluminum tubing, mounted at right angles to themselves and to the mast.

Four 50-foot-long (15.24-meter-long) sections of No. 8 aluminum clothesline wire double as the top guys and the 160 meter top-hat. The trap is placed between these wires and the top of the mast. For design purposes the trap inductance is 4.5 μ H with an equivalent inductance when paralleled with 400 pF of slightly over 5 μ H at 1.8 MHz. With the trap shorted the antenna resonates at 3 MHz.

The general layout is as shown in fig. 1. Six rather small trees and the lower guys are not shown. Fig. 2 shows the electrical connections.

Since 2-inch irrigation pipe is very limber, it needs to be guyed. The first installation had eight guys; four comprised the 160-meter top-hat, plus four more at the 60-percent level. On one windy day the mast section below the lower guys vibrated at 20 to 30 Hz, displacing at least half an inch. Wind velocity at the time was probably 30 to 40 mph (50-65 kph). Another set of guys was subsequently installed at the 12.5-foot (3.8-meter) level. The positions are now at 35 feet (10.7 meters), 21 feet (6.4 meters), and 12.5 feet (3.8 meters). This damped the motion.

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Robbinsville, New Jersey 08691



The system is resilient enough so that continued vibration certainly would not have damaged the structure, but it does stranger things: it unscrews nuts, bolts, and machine screws, and it causes fatigue in electrical connections. The fastening points for the guys on the mast are steel devices designed for connecting 2-inch fence posts together. All guys are broken up into sections approximately 10 feet (3 meters) long, insulated by TV-mast-type "egg" strain insulators.

A 30-kV ceramic stand-off insulator is used, supporting the weight of the antenna system. In this application the potential across it is under 100 volts. For this (and even more stringent requirements) an empty (but corked) champagne bottle will do just as well: they have heavier walls than soft-drink or beer bottles. An alternative base insulator for this antenna could be a 500-ohm "glo-bar" resistor, since the higher antenna input resistance (achieved on 75 meters) is only 19.6 ohms.

It is a much different story, however, if a *base loading* coil is either wound around the insulator or connected across it. Assuming total base-loading, the rf potential on a $\lambda/16$ vertical could reach 5000 volts, and that puts insulator requirements in an entirely different light.

the ground system

Short verticals must have good rf grounds. At my location the longest radial wires are the four diagonals that run across the back yard, each about 90 feet (28 meters) long. The shortest are the two that span the short side, each 65 feet (20 meters) long. All other radials are of lengths between those limits. Since all are shorter than $\lambda/4$, it was decided to put as many radials down as would be practicable. One

hundred radials were installed, utilizing 7,300 feet (2250 meters) of galvanized steel, 17-gauge electric fence wire.

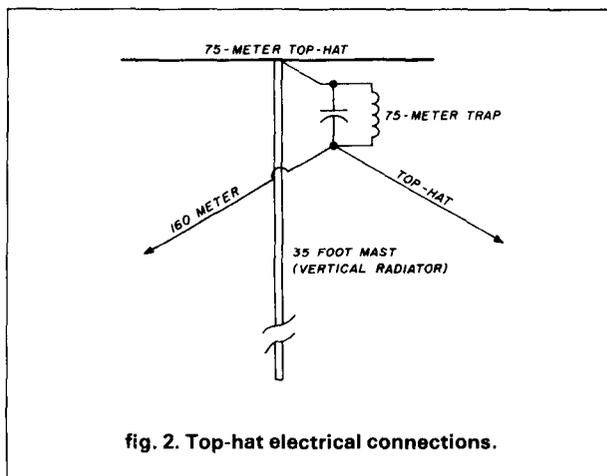
Heeding the advice of Jerry Sevick, they were laid down, in October, 1978, on the surface of freshly close-cut lawn. At those places where the ground dipped a wooden stake was driven in flush with the average ground height, and the radial wire was stapled to the top of the stake. None of the radials were buried. By midsummer, 1979, grass had concealed all the wires. By that time a metal detector would have been necessary to find even one of them. A couple of wires did catch in the mower in the spring of 1979, but these two were replaced and there has been no trouble since.

The radials are attached to the base plate by solder lugs and No. 6-32 (M3.5) stainless steel screws. The base plate is an 18-inch (0.5-meter) square piece of 6061-T6 aluminum, 1/4 inch thick. One hundred holes were drilled with a 6-32 (M3.5) tap-drill (twenty-five on a side) and then tapped by hand.

Most radial wires are terminated by an 18-inch (0.5-meter) piece of reinforcing rod, supplied and cut by a local building supply company. Some are terminated by 4-foot (1.2-meter) ground rods. These were reserved for the shortest radials. All this paid off; the ground loss was very small.

lightning protection

Something should be said about grounds for lightning protection. At my location some of the larger trees and also some of the power-line poles are higher than the antenna, but none of them are in the immediate vicinity of the antenna. I drove four 4-foot (1.2-meter) rods below ground level several feet off the corners of the baseplate and connected them to the corners by a No. 8 solid copper wire. The rods are on about 6-foot (1.8-meter) centers.



A little research into grounding revealed that if two rods are spaced close together, say less than a foot or two, their parallel resistance to ground is no less than that of one rod. In other words, rod surface area alone has very little to do with contact resistance. Ground rods should be spaced at a distance *at least* equal to their length for minimum resistance to ground. It has been shown also that although there is little correlation between their surface areas (rod diameter) and resistance, there is a *direct* correlation with their length. So the proper lightning ground should have been composed of 8-foot (2.5-meter) rods spaced approximately 10 feet (3 meters) apart.

Even if the ground resistance could be reduced to 5 ohms (ohmic resistance, dc), a direct hit delivering a pulse current as low as 2,000 amps would still produce a voltage at the base of the antenna of 10 kilovolts with respect to nearby objects such as coaxial feedline and the shack. Lightning ground rods can help protect the shack or the house; *they will not protect the equipment*. Despite the rods, when I leave the shack for the day I uncouple the coaxial transmission line and leave it dangling on the wall.

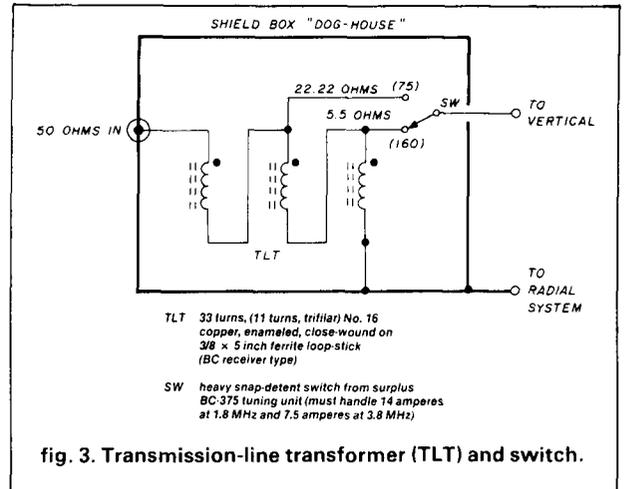
matching

The system exhibits two distinct resistive feed-point impedances, both less than 50 ohms. Several options exist for feeding the antenna, but the one I chose involves running a "flat" transmission line (that is, matched at both ends), the impedance transformation being accomplished by a transmission line transformer (TLT) at the base of the antenna. Construction details are given in **fig. 3**. There is a slight mismatch at the 75-meter tap. The load impedance (measured) is 19.6 ohms. At the 2/3 point of the TLT, the impedance is 22.22 ohms, providing a best-case match (VSWR) of 1.13. The 160-meter tap is exactly at the measured value of antenna resistance, 5.5 ohms, which occurred by lucky coincidence. Those two taps could be switched by a relay energized in the shack. At the time I didn't have a relay with sufficient contact force or size to do the job. At the kilowatt level, the base current in the 160-meter antenna is nearly 13.5 amperes. At this level each 0.1-ohm circuit resistance dissipates 18 watts, a loss which would hardly be missed in the resultant signal but which is serious if it happens to occur in a relay contact, which may have a total volume of less than one-tenth of a cubic centimeter.

Another option is to use a quarter-wave matching section, computed in the usual way:

$$Z_M = \sqrt{Z_i Z_o}$$

For $Z_i = 50$ ohms, and $Z_o = 5.5$ ohms, $Z_M = 16.6$



ohms, almost exactly one-third of 50 ohms. It would require a total of 350 feet (107 meters) of RG-58: three cables, each 117-feet (35.6-meters) long and operated in parallel. That is a lot of cable but it works. On 75 meters, the length would approximate $\lambda/2$, and the 19.6-ohm resistance would be repeated at the transmitter with an intermediate point SWR on the 16.6-ohm transmission line as low as 1.18. Its use would require a transmatch at the transmitter, however.

When it's cold outside it's a chore to go out and switch the TLT. I soon discovered that with the TLT on the 5.5-ohm tap and the excitation on 3.8 MHz, the resultant 4:1 SWR could be compensated for by the transmatch at the transmitter with apparently no loss in efficiency. The loss due to that mismatch is about 1 dB. Whenever the weather is foul enough to discourage a "switching trek" I use the transmatch. Note that the loss is low only for frequencies of 4 MHz and lower. It would not be true at 30 MHz.

Figs. 4 and 5 are plots of the measured VSWR within the two bands. The measurements were taken from the shack at the end of the long RG-8/U transmission line. I used a Bird Model 43 wattmeter and the barefoot exciter with its digital frequency display. The readings reveal a couple of important facts:

1. The measured impedances at the antenna base were correct.
2. The transmission line transformer is adequately designed.

The antenna systems, although narrow in bandwidth, can be tuned by means of transmatches. I use two, one for 160 meters and the other for 80 through 10 meters, enabling me to operate over a range of 200 kHz on 75 meters and 100 kHz on 160 meters

with little loss. Mine are both the McCoy "ultimate transmatch" type. In general, transmatches are recommended for use with trapped systems to reduce harmonic radiation.

performance

The 75/160 meter antenna has proven to be an effective radiator. Because of the low-angle radiation and the efficiency (high radiated field), I can make two-way contacts on 160 meters at high noon in mid summer over distances of up to 200 miles. At the equinoxes, I've made two-way SSB QSOs with New Zealand. At various other times in the winter the system has enabled me to work England, Brazil, Panama, Nova Scotia, Bermuda, and most of the United States. On 75 meters the performance is much the same; I've made contacts with all of the above places plus Germany, Alaska, and western Australia. All of these contacts were incidental, since I do not seek DX actively.

conclusion

In various contacts I've made with other users of verticals, it's become obvious to me that the Amateurs who have become disillusioned with, and consequently abandoned, short verticals did not fully understand just how important the ground system is. The shorter the antenna, the more sensitive it is to ground losses. The problem becomes worse when the antenna is both short and base loaded. Consequently, more attention should be paid to the ground system than to the "top-works," while not neglecting the reduction of ohmic losses in coils, relay contacts, electrical connections, and bonding strips.

I also often hear it said that the antenna should be erected over a high water table: "The water table is only five feet below the surface here, and I have

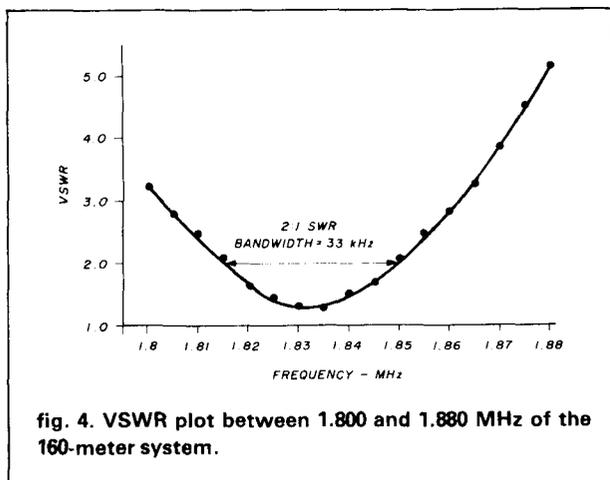


fig. 4. VSWR plot between 1.800 and 1.880 MHz of the 160-meter system.

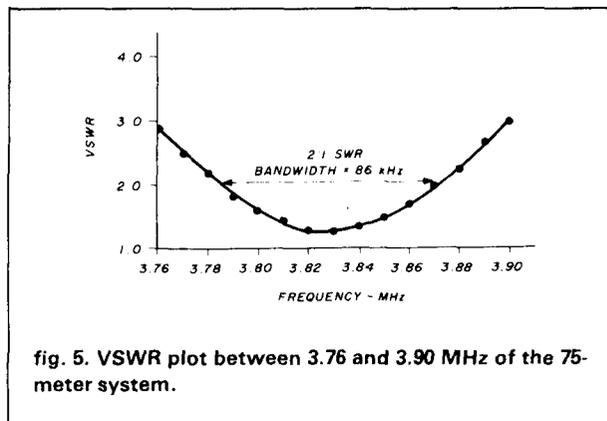


fig. 5. VSWR plot between 3.76 and 3.90 MHz of the 75-meter system.

grounding rods driven right down into it." That means absolutely nothing, unless that "ground water" is salt water. Fresh water, particularly if it is potable, has the conductivity of *poor earth*. The answer to all this, of course, is to know what the antenna should "look" like, and to measure the base-impedance over the ground system. If the system should present a 20-ohm load and has no ohmic loss but measures 50 ohms, you know immediately that the ground resistance is 30 ohms. Consequently, the signal from that antenna will be considerably reduced, *even though it will present a very good match to the transmission line*.

The use of a very short base-loaded whip (such as a mobile whip) reveals something interesting. It is such an inefficient radiator that it can be used to estimate ground loss. Resonate the whip over the ground system and measure the total resistance. Then remove the whip above the coil and replace it with a variable capacitor to ground. Reresonate the coil.

When all this is done, the radial system is effectively removed from the circuit. You can then make another noise-resistance measurement, determining the coil resistance. Absence of the whip ($R_r \cong 0$) has no measurable effect. The ground resistance is then the difference between the two measurements.

acknowledgements

I wish to acknowledge the encouragement I received from W1DB, the late Nick Lefor, who persuaded me to write this article. I also wish to thank Tony Sivo, W2FJ, Walter Schulz, K3OQF, and Nevell Greenough, N2GX, for reading drafts and for other assistance; also Jerry Sevick, W2FMI, from whom I learned to make my first transmission-line transformer; and Edmund Laport, my principal reviewer.

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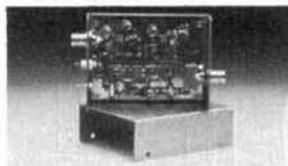
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vertical phased arrays: part 2

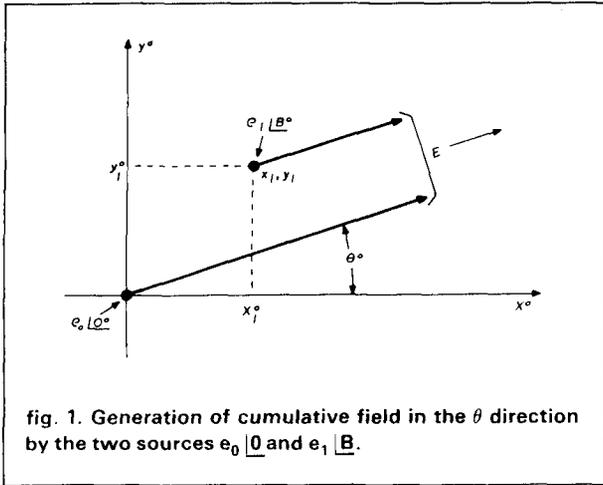
Part two examines
array siting, field plot calculations,
and minor lobe determinations

The theoretical design of vertical phased arrays will be the subject of this article, the second in this series on vertical antennas. Every designer must balance his performance requirements for high gain and F/B (front-to-back ratio) against his resources (space, money, and time). There is always a strong temptation to skip past the theoretical work and proceed with the more engrossing task of construction. But after having relocated the elements of an array (complete with one-hundred radial ground systems) more than once, I can tell you that a few thoughtful hours spent on design can save many hours of wasted construction time.

For example, you might want to start with a two-element array. But before you clear a site of brush and trees, consider what you might be faced with should you later decide to add elements to this array. And consider the directions of the main lobe of the changed array. For instance, a two-element array has a main lobe whose half-power beamwidth is 180 degrees. Before you decide to aim this array toward Europe or Japan remember that the signal loss sustained in orienting this array exactly east and west is about 1/2 dB (down from Europe or Japan) and only 3 dB — half an S-unit — down in a north or south direction (see **figs. 3 and 4**)*. I live in a wooded area and, not being willing to become involved in a lum-

**By Forrest Gehrke, K2BT, 75 Crestview,
Mountain Lakes, New Jersey 07046**

*Charts as introduced in the text are not in sequence. However, they are grouped as follows: two-element arrays, **figs. 3 and 4**; three-element arrays, **figs. 5 through 11**; four-element arrays, **figs. 12 through 17**.
Editor.



bering operation, I had to strategically locate a 4-square array among the trees. Because I failed to give some advance thought to these considerations, relocations of elements were required with every addition to my array.

In a previous article,¹ I discussed some of the reasons for less-than-anticipated performance in vertical phased arrays, particularly in front-to-back ratio. The major fault in many designs is a failure to consider the real and significant effects of mutual coupling between elements; neglecting these terms can result in an incorrectly designed feed network.

symmetry is essential

Knowing the characteristics of the array, we can ensure that the correct current magnitude and phase exist at the input terminals of each element — for a particular direction.

However, in a switchable array the magnitude and phase drive current requirements to a specific element will depend on position (direction) chosen. Conversely each element must perform correctly for each switched direction of the array. If we expect to have identical field patterns in each direction it is necessary to ensure electrical symmetry. For example, referring to the driving-point element impedances of a typical 4-square array, spaced 1/4 wavelength, with equal amplitude current ratios, phased -90 and -180 degrees we have:

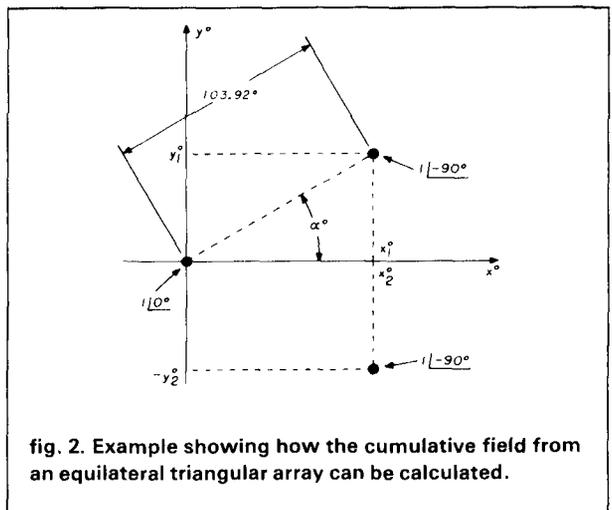
$$\begin{aligned} Z_1 &= 7.9 - j7.8 \\ Z_2 &= Z_3 = 35.7 - j12.7 \\ Z_4 &= 59.2 + j42.6 \end{aligned}$$

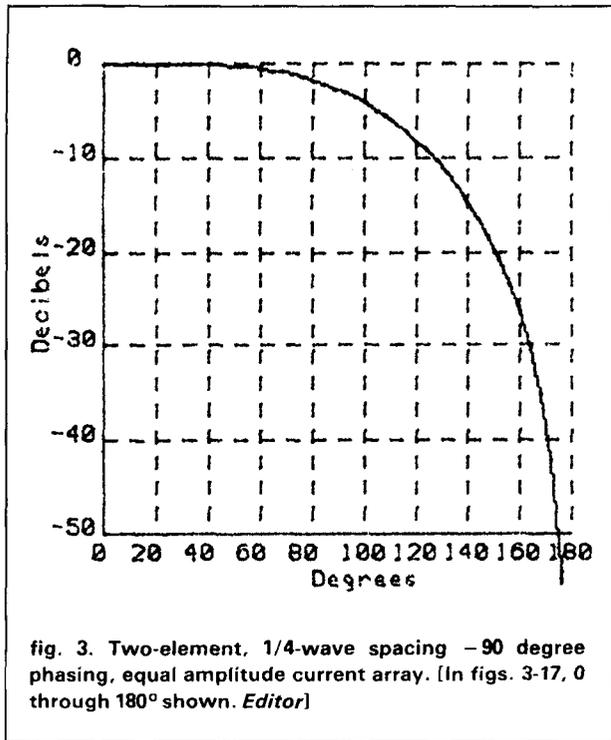
The zero degree phase reference elements driving point impedance is Z_1 . The diagonally opposite element is phased -180 degrees and its driving point impedance is Z_4 . The two middle ele-

ments, each phased -90 degrees present the same impedances Z_2 and Z_3 . When this array is switched through its four directions, each element, in turn, assumes each of the four electrical positions in the array. For identical patterns in each direction each element must exhibit the particular driving point impedances appropriate to these electrical positions. For example, as each element is switched to occupy electrical position 4, the same driving point impedance Z_4 must be presented to the feed network. Similarly, as each element is switched into electrical position 1 it must present the much different impedance Z_1 . So, instead of physically rotating this antenna, keeping each element fixed in its electrical relationship as with Yagis, we rotate the electrical relationship of the elements and keep the physical relationship fixed.

This is an important difference from the design of a-m broadcast arrays. Broadcast arrays are seldom switched, being designed for a particular listening area, and with departures from symmetry often intentional. For a switched array, each element's self-impedance, and each of its mutual impedances, must be as similar as possible.

Electrical symmetry is a function of the physical symmetry of the array which includes groundplanes and other nearby conductive structures. Metal towers, other antennas, guy wires, roof gutters, and leaders — that is, any conductive line within a wavelength of any part of the array, especially if it is at or near resonance (a multiple of a half-wavelength and ungrounded, or a quarter-wavelength and grounded) — should be avoided. Otherwise, a means must be found to prevent resonance. An example of preventing resonance would be to break up guy wires with insulators, making them ungrounded quarter-wave sections. When siting an array, then, look carefully around the area before starting work for anything that can act as another antenna. Unlike Yagis, where making spacing adjustments involves loosening a few clamps, low-band vertical arrays, with their groundplanes, are not easy to make adjustments on.





extensive ground systems

Don't scrimp on the groundplane. At least sixty radials a quarter-wavelength or longer should be under each element. If in some directions this is not possible, use radials at least an eighth wavelength long in even larger quantity. At those azimuths your array will probably have a higher elevation angle. However, more radials, even if short, help keep the angle down.

Theoretically, an infinitely conducting groundplane is required, but it's not practical to copper plate the neighborhood. Don't make the mistake of thinking that twenty or thirty radials is approaching the point of overdoing it! Incidentally, if you can, lay radials on the surface. If you must bury them, keep them as close to the surface as possible. Large-size wire is not necessary; I use No. 24 PVC hookup wire. Galvanized steel fence wire is not a good idea: it corrodes very quickly, becoming totally ineffective as a radial.

characterizing the array

After choosing the site it's necessary to see what kind of an array can be fitted within that area, what its characteristics might be and its switchable directions. The calculation of horizontal field patterns is an exercise in trigonometry.

Since F/B ratio is a major interest, we need to explore in greater detail the pattern in the rear area of the array. Inspection of the field equation shows that

subtractive operations take place here, often resulting in small fields which have large variations with little changes in azimuth. This necessitates many azimuth calculations to reduce the granularity of the plot. Compare the similar arrays of fig. 13, a plot in 2-degree increments, with fig. 16, plotted in 10-degree increments. We would not want to miss seeing the actual variations, since deep nulls may be used later in checking out the array. A programmable calculator or a small computer is an obvious choice for handling this drudgery. When the HP-35 scientific calculator was introduced 10 years ago I plotted a three-element in-line array using 10-degree increments. The process required about 8 hours and seemed lightning-fast, but everything is relative; now I watch a Sharp PC-1500 do this in 2-degree increments in 5 minutes — including drawing a graphical representation.

multi-element array equation

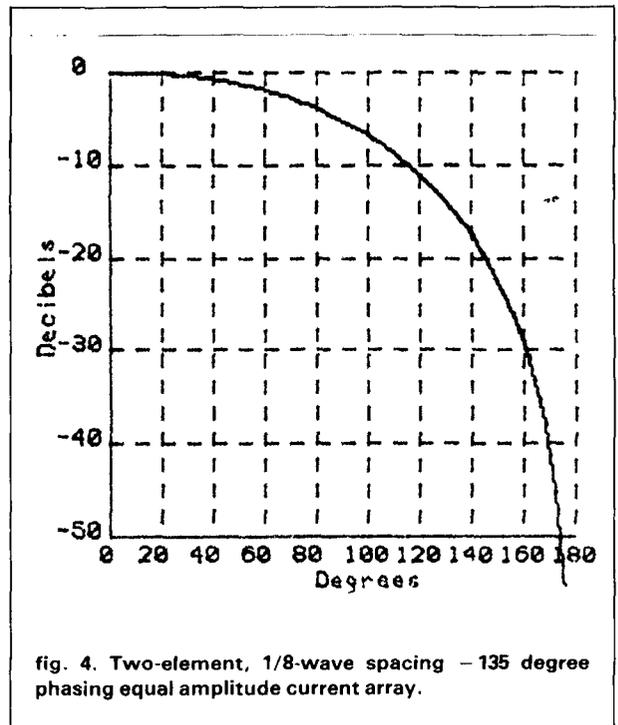
The equation for the total field from any multiple element antenna is:

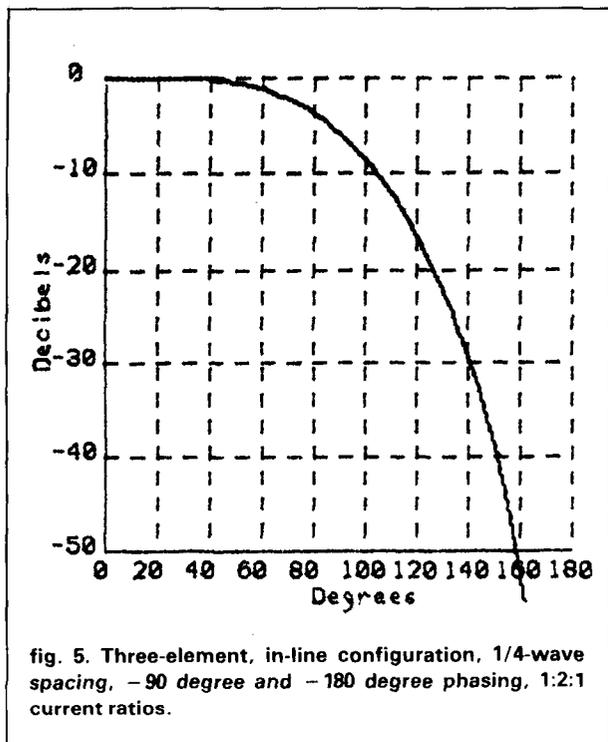
$$* E = e_0 / B_0^\circ + X_0 \cos \theta^\circ + Y_0 \sin \theta^\circ + \dots + e_n / B_n^\circ + X_n \cos \theta^\circ + Y_n \sin \theta^\circ$$

* Choosing a common unit of dimension (e.g. degrees) for the vector terms allows simplification of the programming task.

where E is the total field term

e_0, \dots, e_n are the individual term amplitudes
 B_0, \dots, B_n are the driving-point phase displacements with respect to the reference term





X_0, \dots, X_n and Y_0, \dots, Y_n are the physical distances in terms of degrees of wavelength from the $0, 0$ coordinates
 θ = horizontal direction considered

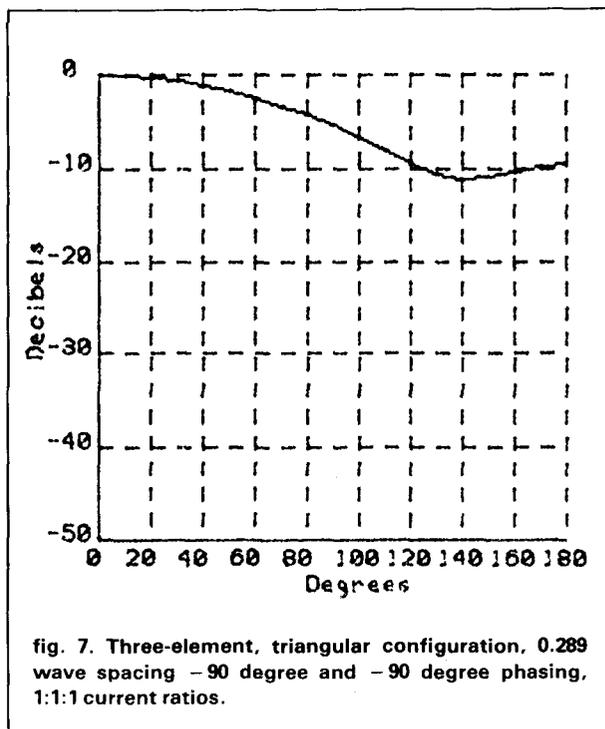
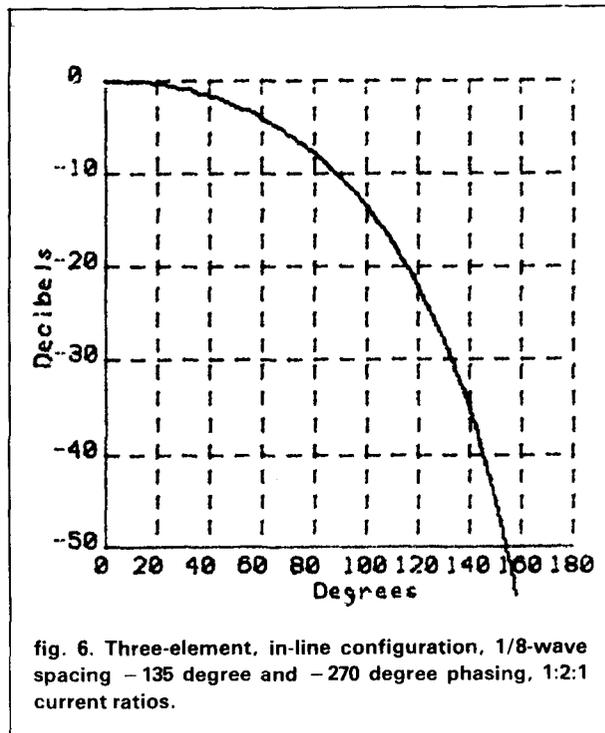
There will be as many terms as there are elements. It is usually convenient to place one of the elements at the X - Y axis (origin) and to consider this element the reference element. This also simplifies calculations since all of its angular components then equate to zero. Since we are interested only in the magnitude of the vector sum of the individual terms, the angle resulting from this calculation is discarded.

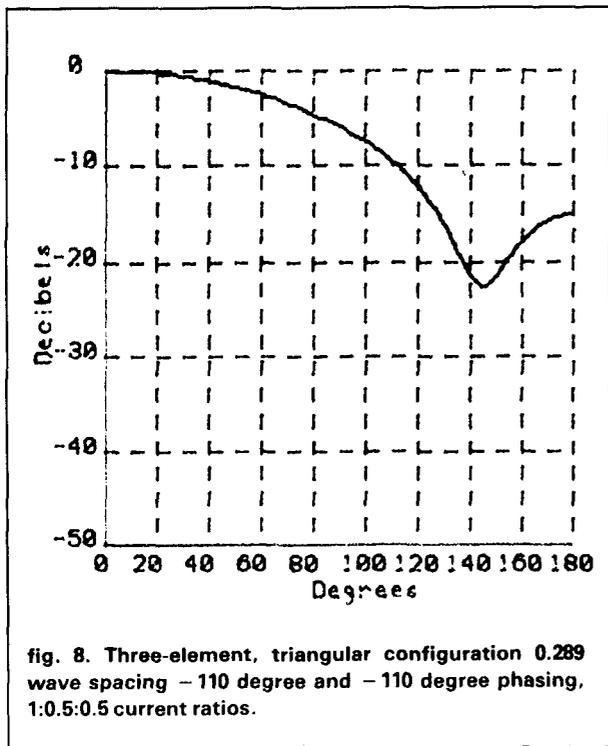
two-element array calculations

Referring to fig. 1, consider a two-element array, with the reference element located at the origin. e_0 is the amplitude of the electric field of this element at some given distance in any direction, with a drive phase displacement B_0 of 0 degrees. Similarly, at the same distance, the field of the other element is e_1 with its driving-point phase displacement of B_1 degrees with respect to the reference element. At the given distance (assumed to be far enough removed from the array so that the combined field can be considered a plane wave) E is the vector sum of the fields e_0 and e_1 in the horizontal direction θ degrees. Note that both displacements, the physical and the electrical terms, are given in degrees.

We are interested only in determining a relative field plot for an array. We want to know what the fields are at various azimuths relative to the field at

some fixed angle (usually chosen as the maximum field direction). Provided all the elements are identical, we can substitute current for voltage and we can state this current as a ratio of the reference-element current amplitude. For example, if each element were to be fed with equal current amplitude, the ratio would be 1 for each element.





three-element array calculations

A specific example illustrates how to use this equation. Referring to fig. 2, assume an equilateral triangular array with 0.289 wavelength spacing (that is, 103.92 degrees):

Since this is an equilateral triangle, $\alpha = 30$ degrees.

$$X_1 = X_2 = 103.923 \cos 30^\circ = 90^\circ$$

$$Y_1 = 90 \tan 30^\circ = 51.962^\circ$$

$$Y_2 = 90 \tan (-30^\circ) = -51.962^\circ$$

If equal amplitude current drive feeds the array and elements 2 and 3 are both phased - 90 degrees, the field at any azimuth θ degrees is:

$$I = 1 / 0^\circ + 1 / -90^\circ + 90 \cos \theta^\circ + 51.962 \sin \theta^\circ + 1 / -90^\circ + 90 \cos \theta^\circ - 51.962 \sin \theta^\circ$$

Substituting values for θ° , we get:

θ°	I (relative current magnitude)
0	3.00
30	2.78
60	2.24
90	1.59
120	1.00
150	0.85
180	1.00

Refer to fig. 7 for a relative power plot of this array.

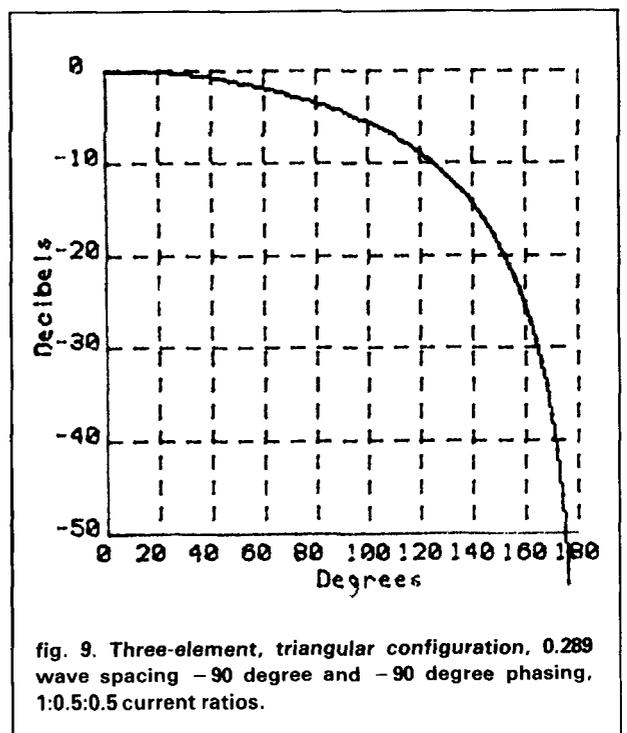
This graph requires explanation, since I have further manipulated the results for the portrayal of this data. First, the results are normalized, by dividing each result by the maximum value. Second, the logarithm (base ten) is taken of each normalized value and multiplied by 20 to make all the calculated points relative to 0 dB. Thus:

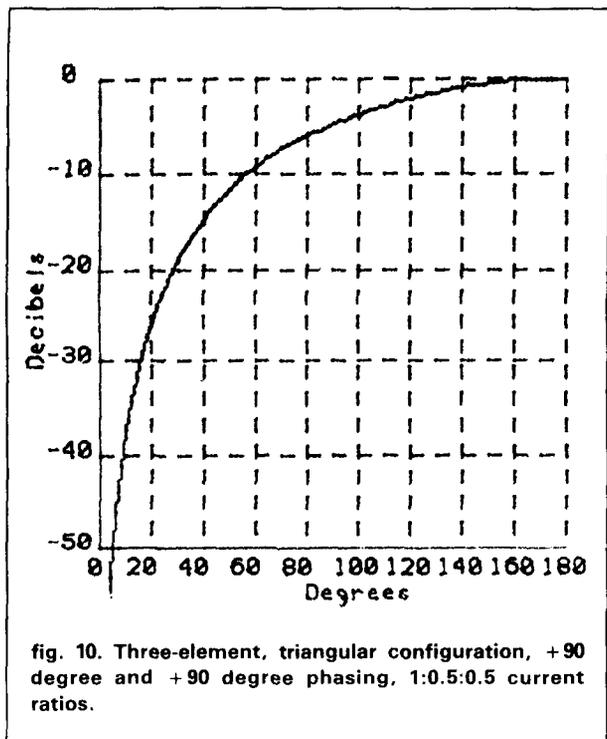
$$dB \text{ (at azimuth } \theta^\circ) = 20 \log_{10} I / I_{max}$$

Since the maximum value for I occurs at 0° azimuth, then normalizing to this value in terms of dB for the data listed above:

θ°	decibels
0	+0
30	-0.65
60	-2.55
90	-5.53
120	-9.54
150	-10.99
180	-9.54

This method of representation best displays array rejection capabilities, not easily shown in a polar plot. For example, assume an array with a respectable - 30 dB F/B ratio. Whatever scale is used for the direction of maximum signal must now be divided by 1000 to show this rejection. This will appear as little more than a flyspeck on a polar plot and provide no clear indication of variation with azimuth. Suppose we are listening to an S 9 + 30 dB signal at the front of our array; switching the array around, to the rear





we will still see S 9, a not insignificant signal. Yet the reduction is by a factor of 1000, and if the transmitter is running a kilowatt, our array will treat it as though it were only one watt! This illustrates the need for working with logarithmic decibels. But we should not forget what they represent; they are not linear.

If the array is symmetrical and has been located symmetrically about the x or y axis, it is not necessary to plot more than 180 degrees; the other half is a mirror image.

determining array gain

The value for I , in the direction of maximum signal, is not an *absolute* gain figure. This value is merely derived from the number of elements and the absolute current ratios used. An indication of gain is obtained by observing the total included angle of the main lobe between the half-power (-3 dB) points; thus the smaller the included angle the higher the gain. The simplest way to determine gain is to make a polar power plot (square each azimuth calculation result). Calculate the area of this lobe and then determine the equivalent radius of a circle having the same area. Using the same scale, the ratio of the length of the maximum lobe vector to this equivalent radius is the gain of the array over a single vertical element. However, on the low bands F/B ratio is much more important than gain. For the purposes of making vertical array evaluations from the field equation, keep in mind these implied assumptions:

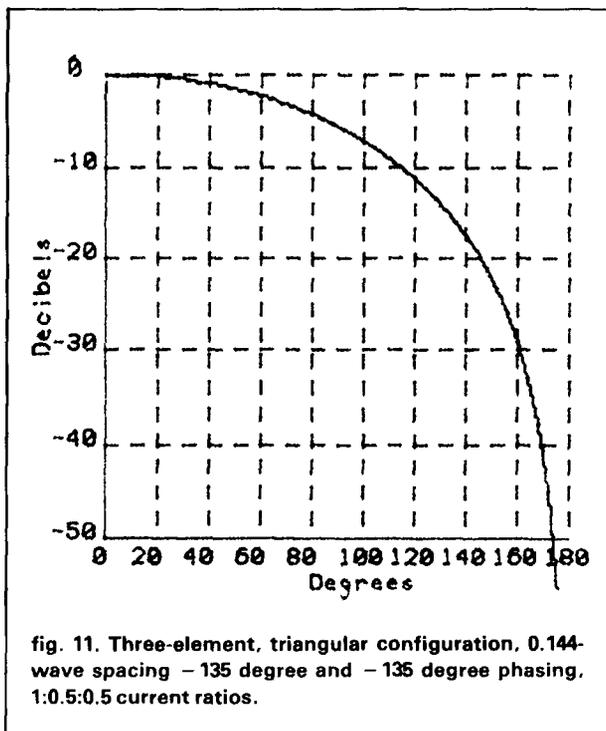
1. There is an infinitely conducting groundplane.
2. All elements are electrically identical.

Any departure from an infinitely conductive groundplane results in lower efficiency due to ground losses and a higher vertical radiation angle (of maximum signal). If the elements are not electrically identical, the real field pattern differs from the calculated one. For switchable arrays using the same feed network, further complications occur. Even the real field patterns will not be alike.

n-element array calculations

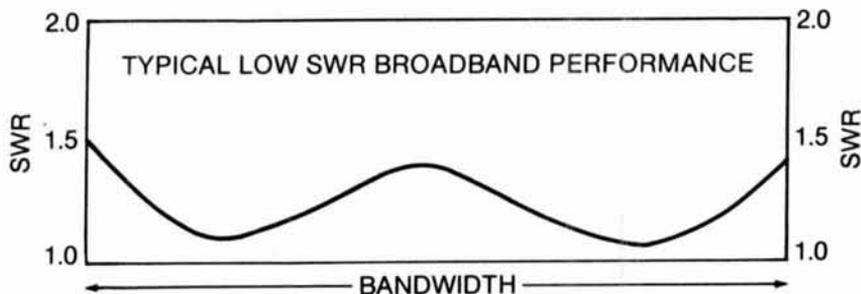
Using the field plotting equation and a programmable calculator, any array layout can be examined. Simply choose the angular coordinates for each element, their drive current amplitude ratios and phase displacements. There are no restraints in choices of current amplitude ratios and phase displacements. (Later, these values will be used in calculating the element driving-point impedances, which in turn will determine the feed network.)

Experimentation shows that equal current to all elements is not always best; neither are element spacings of $1/4$ wavelength or current phase displacements of 90 degrees always optimum. Fig. 11, an equilateral triangle array, best illustrates these points. This array has elements spaced $1/8$ wavelength apart with two of its elements operated at a current amplitude ratio of 0.5 and current phase dis-



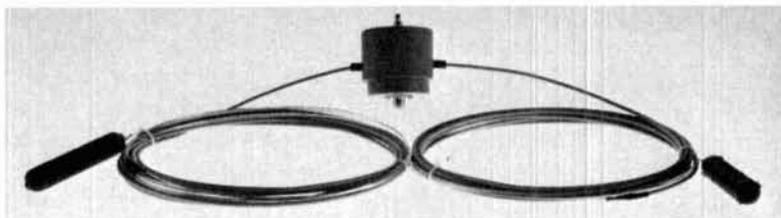
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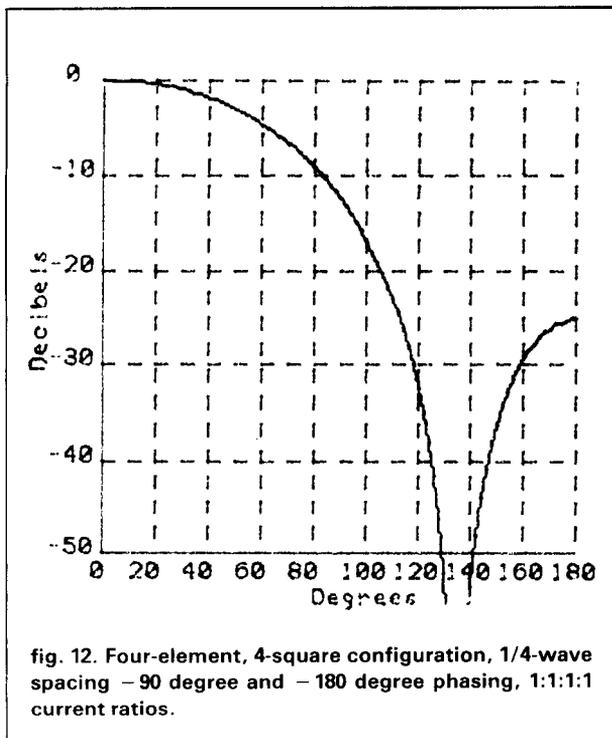
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placement of -135 degrees. A number of representative arrays have been plotted to show their general properties and to illustrate the variations that occur with changes in physical layout or varying input drive conditions.

two-element arrays

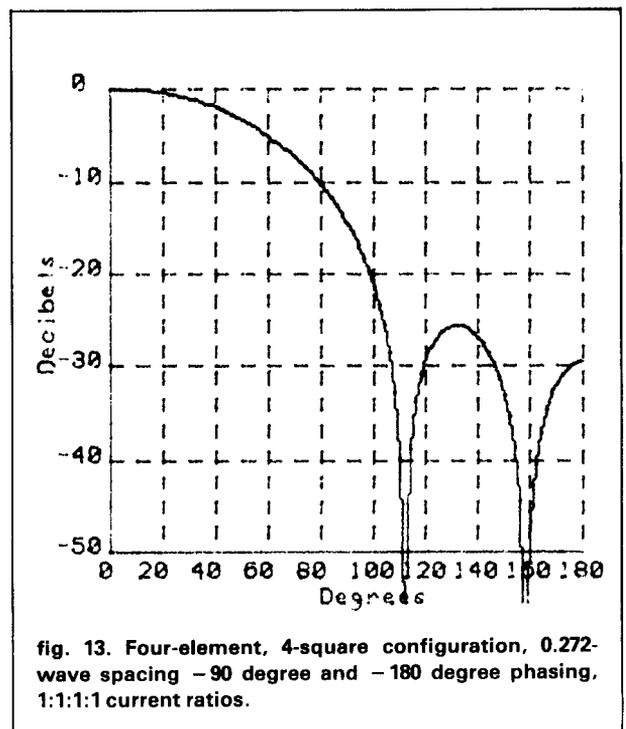
Figs. 3 and 4 are two-element array plots. These produce cardioid field patterns when driven with equal amplitude current with a phase displacement of -90 degrees. The half-power beamwidth is about 180 degrees with a theoretically infinite F/B at precisely 180 degrees azimuth. The 1/8 wavelength spaced array has a slight edge in F/B performance but because of close spacing it has some special problems of its own which I will discuss presently.

The 1/4-wavelength version is quite tolerant of drive condition deviations and displays a useful F/B ratio even with phase displacements far from optimum. These characteristics, plus its simplicity and small space requirement, account for its popularity. The easy tolerance of this design may also account for the unwarranted but widespread belief that more complex arrays will be equally amenable. It so happens that if the feed network of this array consists of 50-ohm, 1/4-wavelength coaxial feeders to the elements and a 1/4-wavelength delay line, nearly optimum drive conditions will exist for best F/B.

triangular arrays

The triangular array plots aptly illustrate design parameter variation (figs. 7, 8, and 9). Prior articles^{3,4} proposed 0.289-wavelength element spacing (resulting in 0.25 wavelength for the distance from apex to base of the triangle). W1CF proposed unity current ratios, with two of the elements phased -90 degrees (fig. 7). W2PV proposed phasing these two elements at -110 degrees and reducing their current amplitude ratios to 0.5 (fig. 8). The result for both of these arrays, while providing three alternatives for beam direction, is a not very spectacular maximum F/B ratio of -10 and -15 dB, respectively. If parts of both proposals are combined, that is, phases of -90 degrees and current ratios of 0.5 for these two elements, maximum F/B ratio improves to nearly infinity (fig. 9). A little time spent with a calculator has changed a not-too-interesting array into an exciting performer.

Both writers proposed to make these arrays switchable in six directions; W2PV omitted explaining how, and W1CF proposed an equal power divider. However, since the elements will not present equal and resistive driving-point impedances (in any of these variations), W1CF's intended field plot cannot be achieved with equal power division. Since the half-power beamwidth of these arrays is about 135 degrees, the additional complexity required to switch



this array in six directions makes it of questionable value. Nevertheless, we can develop a feed network which produces a leading phase of +90 degrees, making the array switchable in six directions (see fig. 10). Two feed networks are required. A future article will present a lumped constant network equivalent to coaxial lines, except that current phase may be advanced as well as delayed (and may be designed for any characteristic impedance one happens to require!).

three-element in-line arrays

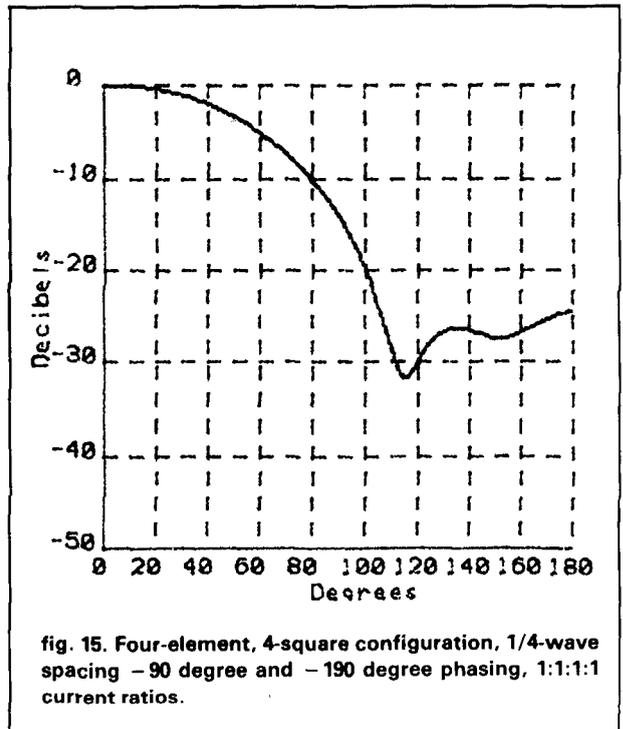
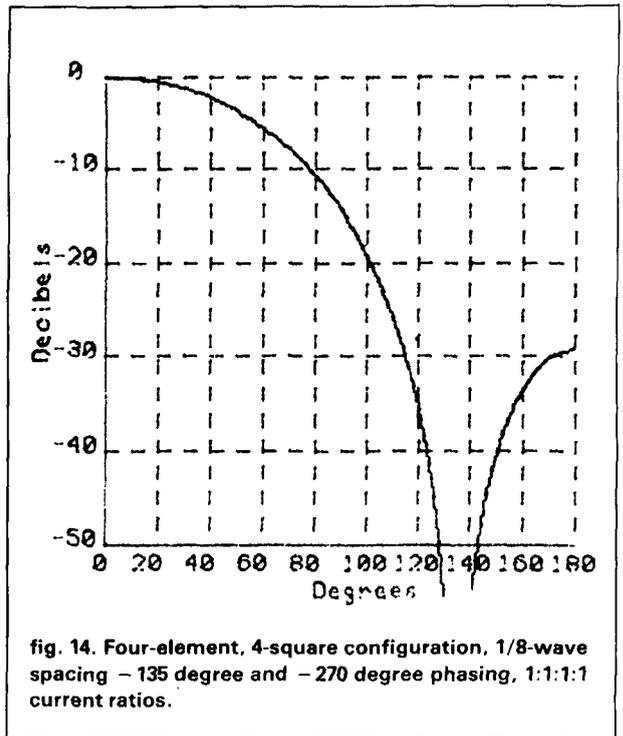
This antenna is another example of an unequal current-amplitude-ratio driven array. The middle element current is twice that of the reference element. The 1/4-wavelength spaced version, properly driven, has a 90 degree included angle over which the F/B is better than -25 dB (approaching infinity at the 180 degree azimuth). The half-power beamwidth is about 150 degrees and is down -6 dB, or one S-unit, at the ± 90 degree azimuths. On 80 meters the F/B capability of this array has been impressive in listening tests, even with nearby stations (within 20 miles), the ultimate test of F/B on the low bands. I have often considered the possibilities of an antenna consisting of two such arrays, operated at right angles to each other.

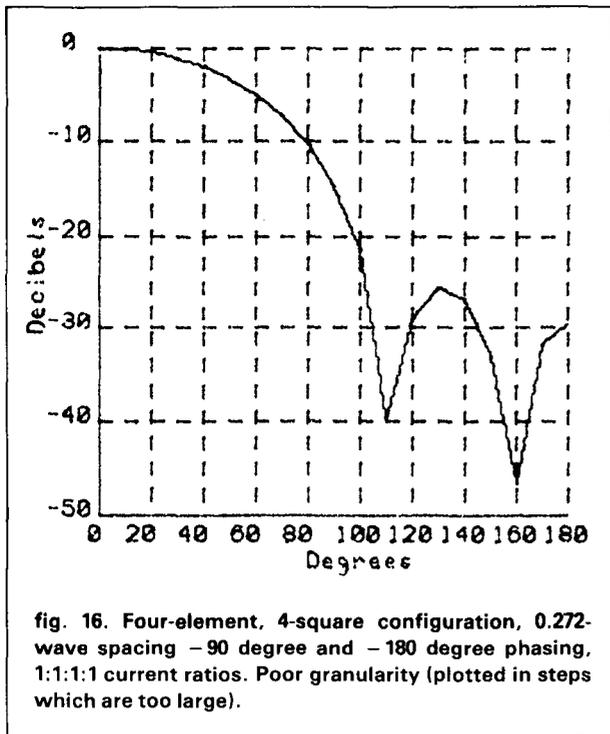
The 1/8-wavelength spaced array plot is a near duplicate of the wider spaced array. It has slightly higher gain as a result of its narrower half-power beamwidth of 110 degrees and it has a wider width over which F/B exceeds -25 dB.

4-square arrays

These arrays, although having four elements, are closely related to the three-element in-line type. The array projects its main lobe along a diagonal of the square, with the two middle elements driven at the same phase and the current divided between them. In effect, the middle element is split into two elements. Half-power beamwidth is about 95 degrees, indicating a gain increase over the three-element in-line. The width over which the F/B is -25 dB or better has increased to 150 degrees, though the average rejection over this range is not as deep as with three-element in-line arrays. The symmetry of this element arrangement allows the array to be switched in four directions using the same feed network; that is, the main lobe may be formed in either direction along either diagonal. As has been pointed out earlier, due to the significant dissimilarity of drive-point impedances of any element as the array direction is switched, more than ordinary care must be taken to ensure electrical symmetry. Experiments with the field equation demonstrates the high minor lobe sen-

sitivity of this array to small deviations in any of its design parameters. For example, changing element spacing from 0.25 wavelength (fig. 12) to 0.272 results in the formation of two additional minor lobes at





130 and 230 degrees (fig. 13). If the phasing is changed from exact multiples to -90 and -190 degrees (fig. 15), the additional lobes have formed but without definition to the nulls. The same sensitivity is shown to small dissimilarities in drive current ratios among the elements.

array of arrays

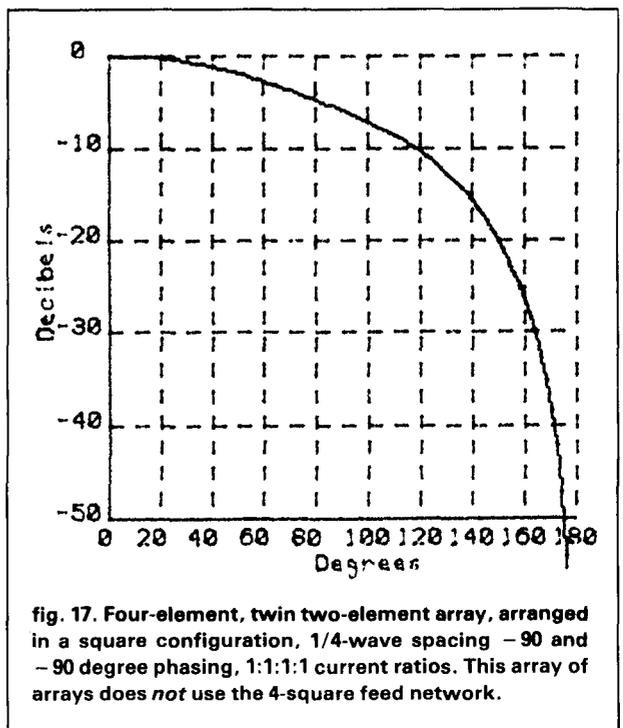
This name refers to an antenna arranged to consist of arrays which are themselves arrayed. The simplest example consists of two two-element arrays configured as a square. Two adjacent elements are treated as reference elements fed in phase, and the remaining two elements are also fed in phase but displaced -90 degrees. Current amplitudes are all equal. This scheme allows switching the main lobe in four directions, except these are offset 45 degrees from the diagonal directions. In combination with the 4 square feed network we could have eight directions. As commented in connection with the triangular array, since the half-power beamwidth of the 4-square fed connection is about 95 degrees, switching in a different feed network for these additional directions appears to be a needless complication. (Perhaps more useful would be the provision for a separate feed network for optimum F/B operation of the array in the 80-meter phone and CW subbands.)

With 1/4 wave spacing, -90 degrees phasing and

all elements fed equal current (amplitude), the half-power beamwidth is about 140 degrees as seen in fig. 7. The -25 dB or better F/B width is a paltry 40 degrees, although at 180 degrees azimuth it approaches infinity. Except for increased gain over a single two-element array, the performance of this antenna is not notable and is not nearly equivalent to that obtained from the same physical layout when connected as a 4-square.

As noted earlier for simpler arrays, the 1/8-wavelength-spaced 4-square field pattern is nearly identical to the 1/4-wavelength-spaced pattern. In each type of array examined we can note differences which show improvements in all characteristics over its equivalent larger size array. However, closer spacing means high mutual coupling, which in turn means even greater sensitivity to element variations. Such an array is difficult to provide identical field patterns for all switchable directions. Unless you have prior experience with these arrays and have equipment for accurate measurements of the self- and mutual impedances of the array elements, you are strongly advised to avoid these closely spaced arrays.

One-eighth-wavelength arrays present an interesting challenge and some opportunities. They offer the same array in much less area — and two-band operation is possible. But if the height of the elements is 1/8 wavelength at the lowest frequency, the self-im-





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pedances are going to be quite low. The resistive component will be about 6 ohms — not easy to work with, and placing a high premium on the need for a low-loss groundplane. If the element length is significantly more than 1/4 wavelength at the highest frequency, temporary sectioning of these elements has to be provided so that impedance measurements can be made (the elements have to be electrically separable into 1/4 wavelength or shorter sections for the measurements).

other possibilities

An interesting possibility is a five-element array which places an additional element in the center of a 4-square. Since this element is always occupying the same electrical position in the array regardless of beam direction it represents no increased switching complication. F/B ratio width can be increased over that of the 4-square even if -30 dB is used as the limiting criterion. Alternatively, if a way could be found to keep the "outrigger" elements from entering into the act, this arrangement of elements could also be operated as crossed three-element in-line arrays. Although there would be some loss in gain, the tradeoff is a significant improvement in F/B depth.

conclusion

So much for the theoretical design. With the concepts and suggestions reviewed in this article, I hope I have given experimenters the tools and some ideas for selecting and siting an array.

The next part of this series deals with self- and mutual impedances; how to measure them, and, most crucial of all, what to do with them. Until we know the driving-point impedances, the feed network design cannot proceed.

acknowledgement

I am indebted to WB6SXV who derived the field strength algorithm used.

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smart squelch

A circuit to enhance voice reception in the presence of interference

I did not plan to build a squelch. But now that the design is complete, I cannot find a better description. What I started out to do was simply to automate a feature that is already available on my Comm Audio Processor (CAP), Model 210.¹ I have named this new device the smart squelch or SSB squelch, because it is considerably more involved than those simple systems that just open an audio channel when signal energy becomes present in a receiver's i-f amplifier.

Most of those who bought or built the CAP design soon discovered that tuning an SSB signal is easier if you reduce gain on the high-band side of the binaural audio pair and then tune until vowel and vowel-like sounds fill the low-band channel. Then, you just raise gain on the high-band again to obtain full comprehension and clarity. The explanation is that, with SSB, we are forced to tune an audio bandwidth at rf frequencies across a fixed oscillator associated with a receiver's product detector until the heterodyne process produces audio frequencies that sound normal. Tuning from one side you first get that high-pitched, nasal-sounding monkey chatter as the powerful, and relatively long, voiced energy is heterodyned to produce higher than normal audio frequencies. Conversely, tuning from the other side first produces sort of "wush, wush" sounds, as shorter high-frequency transient-like sounds translate at lower than normal audio frequencies. Of the two, the high-frequency nasal sounds contain much more energy and seem to be the more offensive.

Clearly, it seemed, I would have to detect only

when the low-band binaural audio band contains signal energy, and use that information to *un-squelch* a normally squelched high-band channel. This would automate the rejection of the offensive monkey chatter, and in the process make tuning easier. Sounds simple, it is, and it works — but only when signal-to-noise ratio is good and noise interference is minimal. I wanted a system that would work in the real world of interference and noise.

My design solution employs a particular set of filters and a non-linear detection process that regenerates the fundamental frequency of laryngeal voice sounds. This frequency is then rectified and used as a control signal. With this technique, much of the energy that would often false-trigger the squelch is rejected in the detection system. In effect, the squelch system is matched to particular aspects of human speech. Understanding my system requires some understanding of how humans speak.

human speech

Fig. 1 is a drawing made to simulate a voice spectrogram. To produce such a spectrogram, a phrase one or two seconds long is recorded and then repeated to give a picture showing the frequencies generated and a crude indication of relative amplitudes. Key features to note include the relative frequencies, the duration of various parts of speech, and the typical time between utterances.

The fricative and plosive parts of speech contain energy starting from 1 or 2 kHz and rising to as high as 10 kHz or more. In our typical receiver's 3-kHz audio bandwidth we throw away most of this energy without too much loss in comprehension. But without some of this energy, however, words such as *sat* and *fat* would simply be heard as *at*.

Voiced energy appears in lower-frequency regions of the sound spectrum (voiced speech means sounds

By Don E. Hildreth, W6NRW, 936 Azalea Drive, Sunnyvale, California 94086

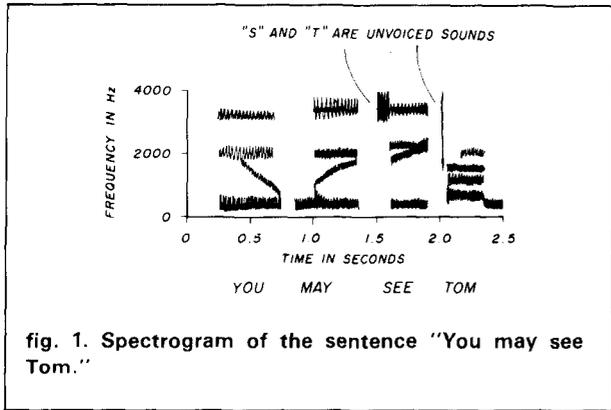


fig. 1. Spectrogram of the sentence "You may see Tom."

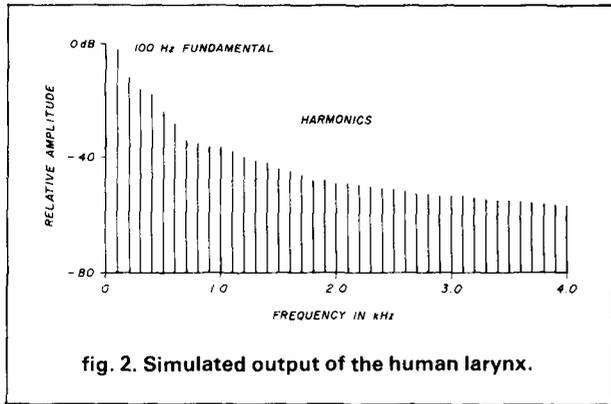


fig. 2. Simulated output of the human larynx.

produced by vibrating the vocal cords, such as in the enunciation of the vowels a, e, i, o, u, or the nasals m or n; unvoiced sounds, such as the consonants t and p, are produced without the vocal cords). To get a feel for how voiced sounds are made, consider what happens when you fill a toy balloon with air and then let the air escape through stretched lips at the end of the neck (this simulates our lungs, vocal cords, and larynx). The sound emitted is similar to the sound that comes from our own vocal cords.

Fig. 2 shows a spectrum of sound recorded right at the vocal cords. Fig. 3 shows what comes out (that is, what we actually hear) when the spectrum of fig. 2 is filtered through the acoustic chambers of our mouth and nasal passages. The areas of relative peak amplitude are called formants. And where the formants are located is determined by how you hold your mouth while sounding your vocal cords.

Fig. 3 shows the detailed structure and the relatively accurate amplitudes for a short time interval in the spectrogram; the abscissa of fig. 3 corresponds to the ordinate of fig. 1 at a point in time when the formants match. In man, the voiced fundamental frequency, indicated by the first line and separation between all harmonic lines, lies mostly between 80 and 160 Hz. The first — and most powerful — formant ranges from about 300 to 600 Hz. These frequencies,

and an average 0.3-second gap between elements of speech (observed as average in many spectrograms) provide the key factors to the system's design.

References 2 through 5 provide more information on speech and its production.

system requirements

The block diagram in fig. 4 shows everything required to add the squelch system to an existing receiver. If you already have a CAP or something similar, you need only the laryngeal fundamental detector, timing control circuits, and solid-state switch.

Since the binaural synthesizer has been covered in previous articles, a functional description will not be repeated. Note, however, that the binaural cross-over frequency is set at 750 Hz. This choice was made originally because most receivers have chosen this for CW band center. A very slight improvement would theoretically result if 600 Hz were used for the cross-over when using the squelch system. I could not hear an audible improvement, however, when 600 Hz was tried, so the cross-over was left at 750 Hz. Performance was quite good, however, when the squelch system was used with the CAP's VOICE

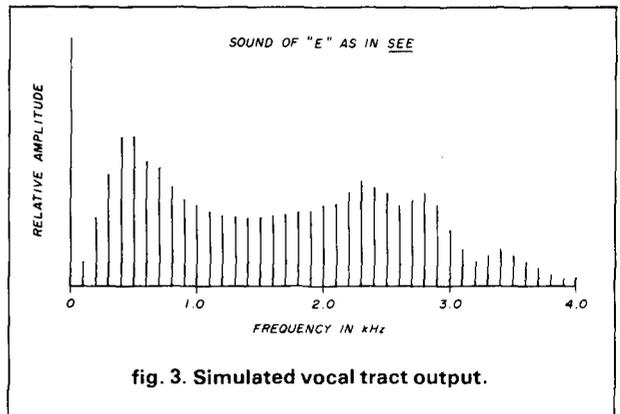


fig. 3. Simulated vocal tract output.

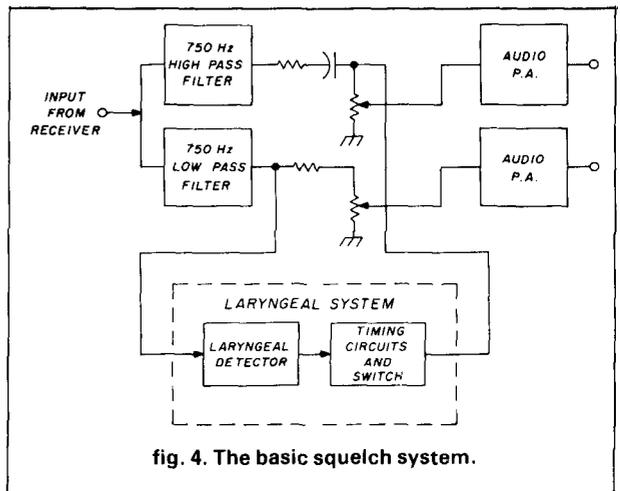


fig. 4. The basic squelch system.

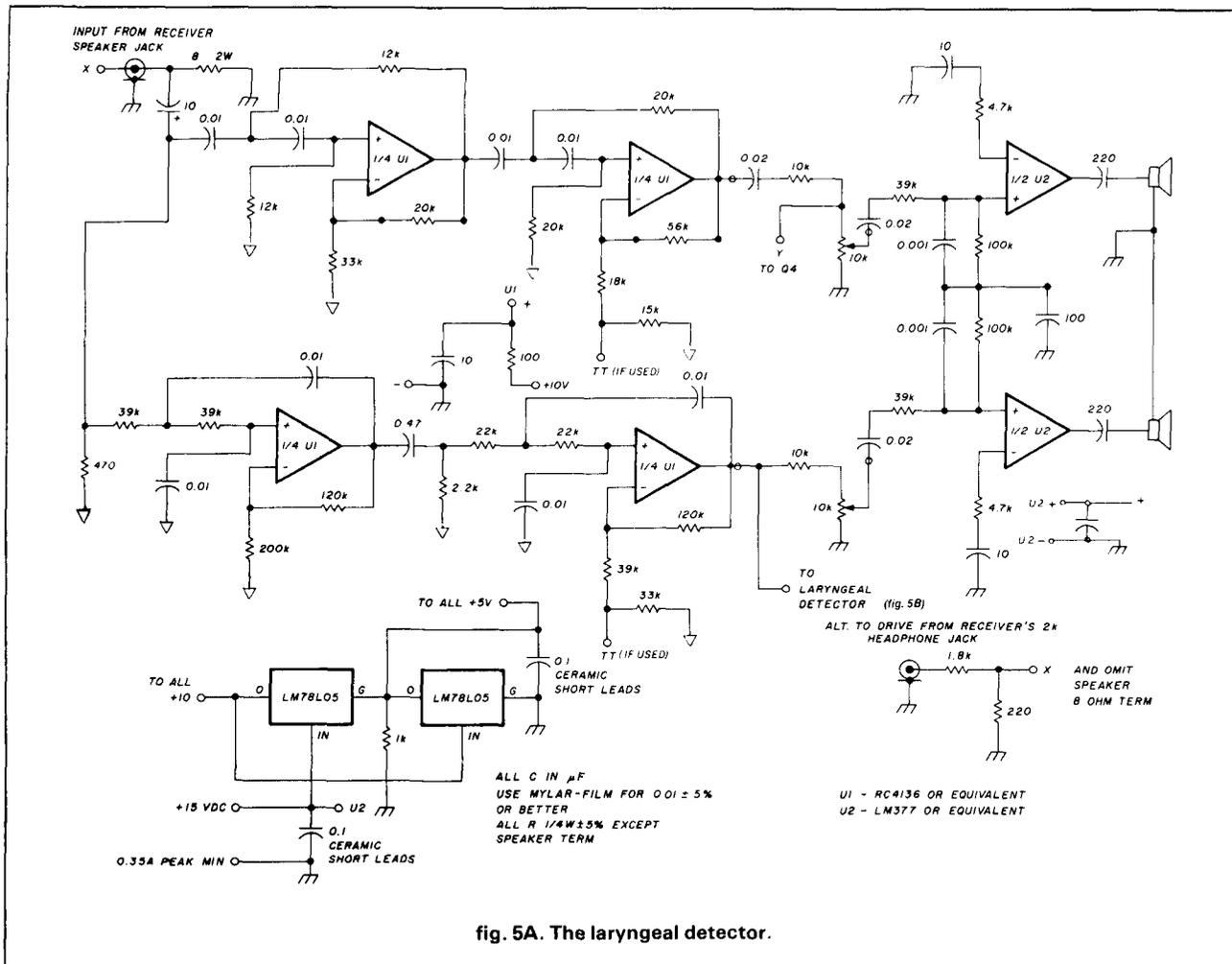


fig. 5A. The laryngeal detector.

FILTER position. A description of the remaining circuits follows.

laryngeal fundamental detector

A level sensitivity control precedes the first filter. That filter is designed to accept and amplify two or more of the voiced fundamental harmonics in the general frequency range of the first formant. These harmonics are separated by an amount equal to the fundamental frequency, and feeding a pair or more of them into a diode and load circuit will result in the generation of a large number of harmonics — as well as sum and difference frequencies. The second filter/amplifier selects the difference frequency and rejects all others, effectively reconstituting the fundamental voice frequency without any of its harmonics. This sine-wave energy is then fed to an absolute value circuit (a full-wave rectifier).

The result of all this is the fast appearance of a dc level when your receiver is tuned at — or very nearly at — the proper frequency for an incoming SSB signal. Remaining circuitry provides a fast release of switch Q4. This switch keeps the high-band audio

channel normally squelched — until tuning presents a normal (or nearly normal) voice signal to the detector. Finally, a selectable “hang-time” is provided to enable the system to re-squelch quickly, or to remain open long enough to bridge time gaps between the words and phrases in normal speech, or to remain open somewhat longer still.

interference rejection

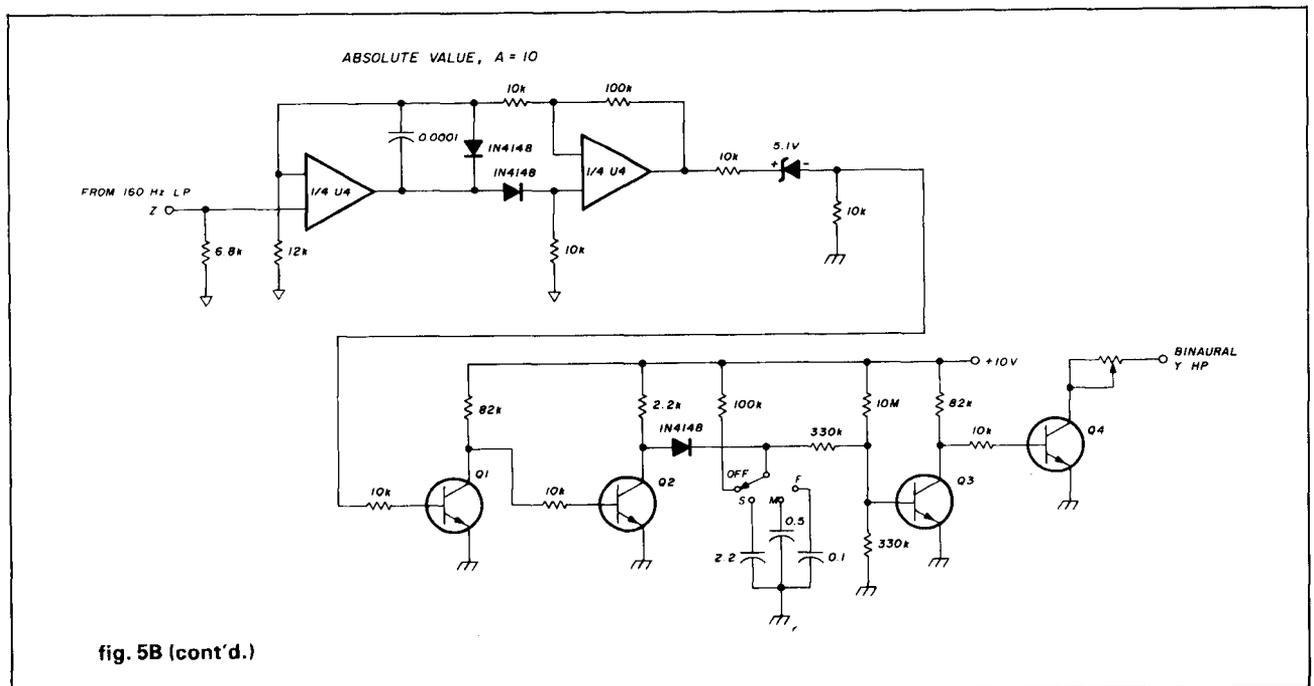
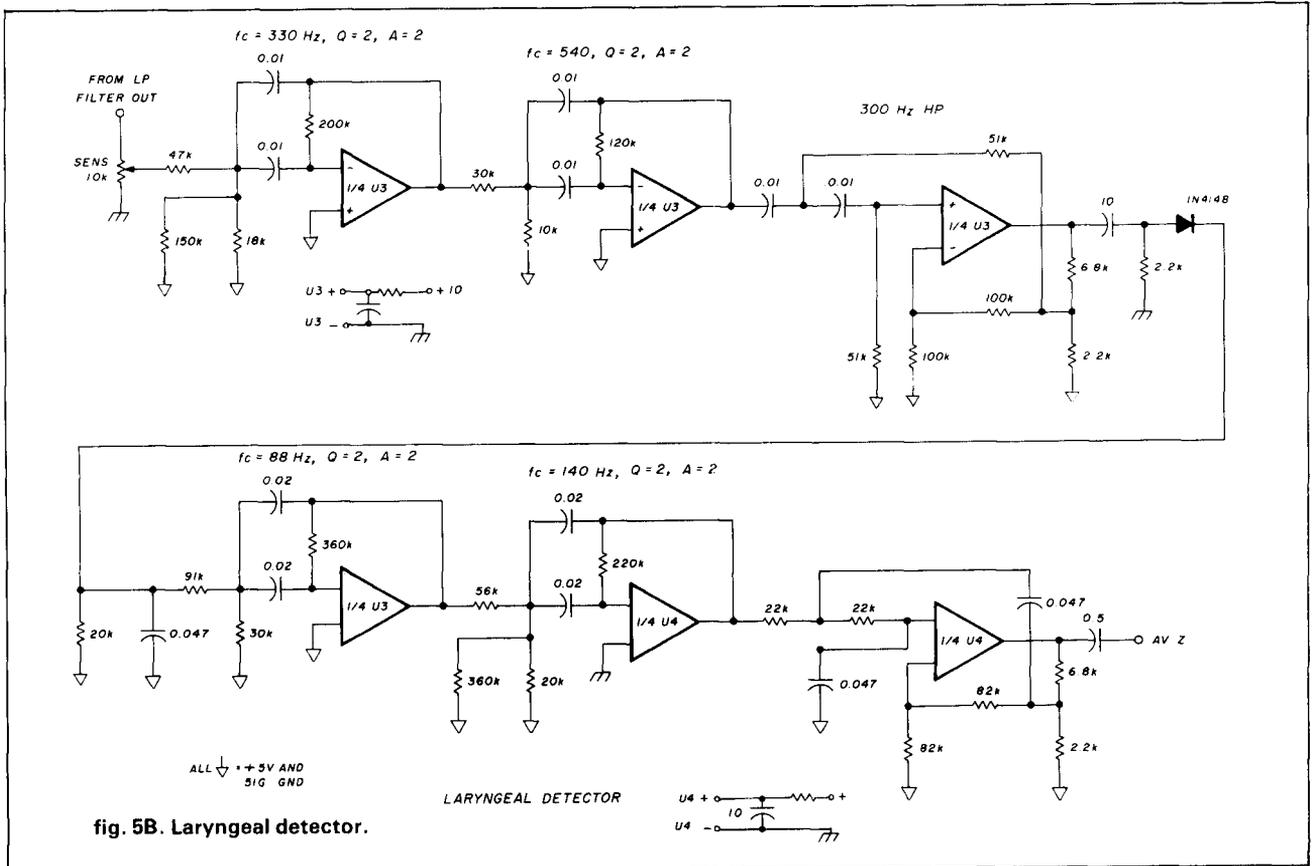
Ideally, the 300 to 600 Hz filter assembly should reject any audio energy outside of its bandwidth. Also, no single-line signal (and no dual-line signal with a frequency separation of more than 160 Hz within the 300 Hz bandwidth) can produce a difference frequency at the diode load output that can get through the 80 to 160 Hz filter assembly. The system is thus matched to basic voice characteristics, making it much better at interference rejection than the first technique. The interference rejection is not perfect, however, because various combinations of other signals and high noise levels will occasionally meet the detection requirements. When this happens the squelch opens, looks around for the hang-time period, and clamps down again.

circuit details

Fig. 5 shows the complete circuit with binaural synthesizer and a 2-watt audio output capability.* A level-setting potentiometer is connected to the low-band audio channel to provide an input to the 300

600 Hz filter, which is made up of an active staggered pair bandpass filter driving an active two-pole high-pass filter. The output from this filter is fed to a diode

*Write to Hildreth Engineering, P.O. Box 60003, Sunnyvale, California 94088 for PC board and kit information.



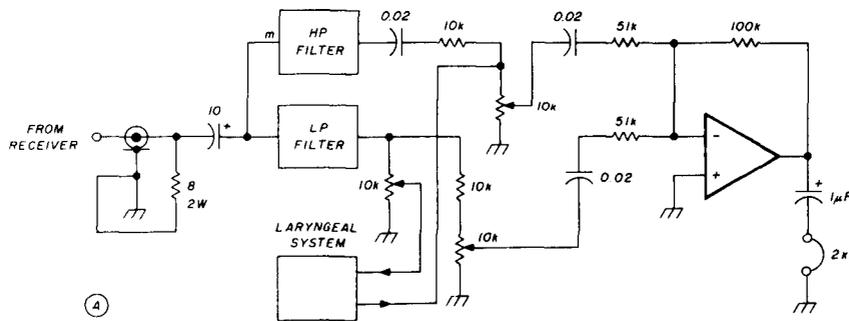


fig. 6A. Combined spectrum for monaural sum to headsets.

and its load circuit. Following the non-linear process is an active, staggered-pair bandpass filter and an active, two-pole lowpass filter that provides an 80 to 160 Hz bandpass with a steep cutoff above 160 Hz. The output from this filter is fed to an absolute value circuit, which also provides an additional voltage gain of 10. Transistors Q1 through Q3 provide start and stop timing control, and Q4 functions as a clamp. Zener diode CR1 restores the no-signal +5 volt input from the absolute value circuit to ground reference, thus ensuring that CR1 is off. This, in turn, results in Q2 and Q4 being on, and Q3 being off.

When a signal activates the laryngeal detector, Q1 conducts and shuts Q2 off. The timing capacitor is quickly charged through RT1, which results in Q3 being on and Q4 being off, thereby un-squelching the high-band audio channel. When an input signal disappears Q2 clamps, but the voltage is left high on the timing capacitor, C, which must now discharge through RT2 before Q4 can re-clamp. Three values of C are shown from which you can choose fast, medium, or slow squelch. The last switch position locks the squelch off.

The power supply system uses small, totem-poled, 5-volt regulators with a pull-down resistor to provide +10 volts and +5 volts at signal ground for op-amp bias. This arrangement works well with a +15 volt main source. It will function down to +12.5 volts with some loss in available audio power.

construction details

This system employs a collection of relatively un-critical circuits. All filters are of low Q, which makes the use of 5-percent tolerance resistors and capacitors adequate. Paralleled trimming resistors are used in a few places where the calculated value falls right in between the normal 5-percent value. Calculated center frequency values are given for each bandpass filter — and this is the most critical factor. Center frequency of these elements may be "tweaked," if desired, by adjusting the resistance value on the resistor from the two capacitor and input resistor junction

to ground. NPO ceramic capacitors and precision resistors are recommended only if the unit is to be used in extreme environments.

operation

It is best to first turn the squelch off and get used to tuning SSB signals with the normal binaural system, as indicated in the CAP article. Then, once you have a properly tuned signal and the squelch sensitivity control all the way down, switch the squelch control to **FAST**. This will immediately squelch the high-band channel. (The degree of squelch is determined by the resistance between the collector of Q4 and the high-band gain control. With R at 0 ohms you get maximum squelch; at 500 ohms you get 20 dB.) As you bring the sensitivity control up, a point will be reached at which the high-band audio will come on. Crank the control up a little higher to take care of any fade, then just listen for a while. Unless the speaker keeps up a fast monologue without pause, you will get an occasional squelch during pauses in speech, followed by an immediate squelch release as speech continues.

How fast to set the hang-time is a matter of personal preference and band conditions. If you are listening to someone who has the habit of saying, "Well . . . (3 or 4 seconds) . . . I talked to Joe the other night . . .," you may want the squelch on fast if there is nearby interference, so that you won't be bothered with that other stuff during the hesitation. On the other hand, if conditions are quiet, you may want the squelch on slow for less chop. A careful listener will note that the squelch system will shave unvoiced sound if it is at the beginning of an opening statement. As it turns out, context saves the day and you just won't miss that occasional burst of noise.

Other variables include relative gain settings on the binaural channels as well as your receiver's AGC time constant, and **OFF** selection in addition to the relative settings of your rf and af gain controls. No doubt there are more.

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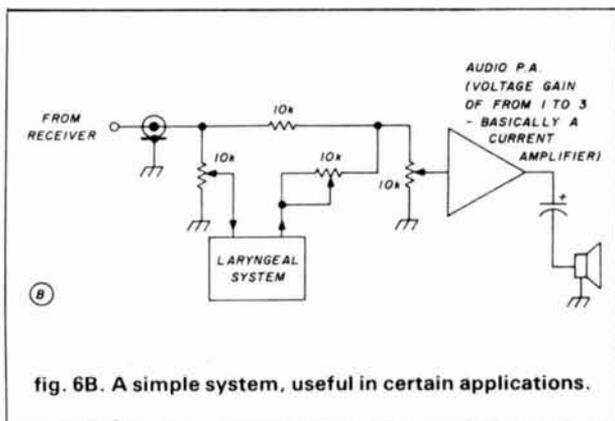


fig. 6B. A simple system, useful in certain applications.

alternative applications

Fig. 6 shows two of many potential applications. Those who use headsets often prefer the same spectrum in both ears. This is provided by using the circuit in fig. 6A. You can also get this with speakers by making them coaxial. The simple application in fig. 6B omits the SSB tuning assistance advantage, but may be useful in some cases.

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glossary

- low-band** — The audio band from 100 Hz nominal to 750 Hz.
high-band — The audio band from 750 Hz to a nominal 3 kHz.
laryngeal — Sounds produced with the human larynx.
fricative — Speech sound generated by breath forced through a restricted area, such as the sounds s and v.
plosive — Speech sounds created when the breath is expelled suddenly from a completely closed oral cavity, as in the sounds of p and d.
formant — Regions of a sound spectrum in which certain of the harmonics of laryngeal sound are passed with minimal attenuation (that is, areas of greatest amplitude). They are seen in the dark bands of fig. 1 and the peaked areas of fig. 3.
hang-time — The time period during which the squelch remains open after voice sounds stop.
timing management — Control of rise, fall, or delay times.
phoneme — A member of the set of the smallest units of speech that serve to distinguish one utterance from another in a language or dialect.

ham radio



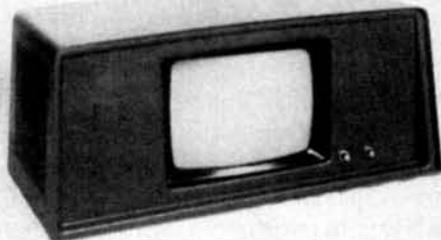
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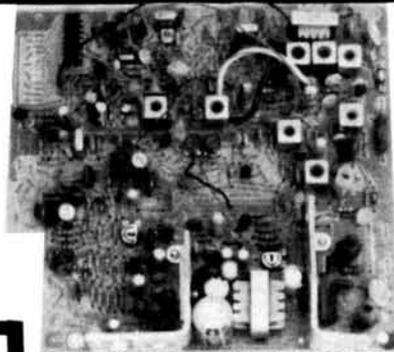
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harmonic product detector for QRP transceivers

A circuit that overcomes
amplifier feedback problems
in small QRP rigs

Compact QRP transceivers that use a direct-conversion receiver on **receive** and a chain of amplifiers to boost a VFO signal in **transmit** often produce poor-quality transmitted signals. This is generally caused by insufficient decoupling or shielding in the amplifier chain, which permits feedback from one or more of the amplifiers to get into the VFO. That results in instability in the form of frequency pulling, rough note, and the like.

I first noticed this problem during the construction of a QRP transceiver similar to the unit described by W7EL.¹ Although my unit was not quite as compact as his it was still crowded, because my version incor-

porated two bands, a keyer, and two 0.9-AH rechargeable batteries all in a 4 × 6 × 2-inch (10.16 × 15.24 × 5.08 cm) box. Naturally, the smaller the rig the worse the problem, because of the proximity of components and wiring.

While trying to think of a solution to this problem, I recalled the old ECO (electron-coupled oscillator) of many years ago. The approach there was to use a screen grid tube like the 6F6. The grid circuit operated at one-half the desired output frequency, and the plate circuit doubled to the output frequency. Even with the wide-open breadboard layout used in those days, the transmitted signal was quite acceptable. Feedback into the ECO grid circuit had little or no effect on signal quality because of the difference in frequency between the grid and plate circuits and that of the following stages.

Adapting this concept to my two-band solid-state transceiver (without adding more stages) became a possibility when I discovered in the literature a unique product detector that requires oscillator injection at one-half the output frequency, thereby minimizing the feedback problem?

The basic harmonic back-to-back mixer (or detector) is shown in **fig. 1A**. As explained by the author, V. Polyakov, RA3AEE, the diodes provide the voltage-current characteristic shown by the dotted line in **fig. 1B**. It is a symmetrical, cubical parabola, which can be achieved by connecting two matched diodes back-to-back.

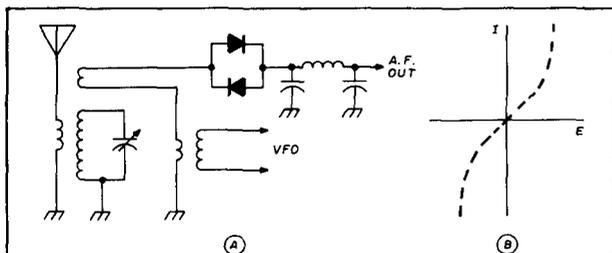
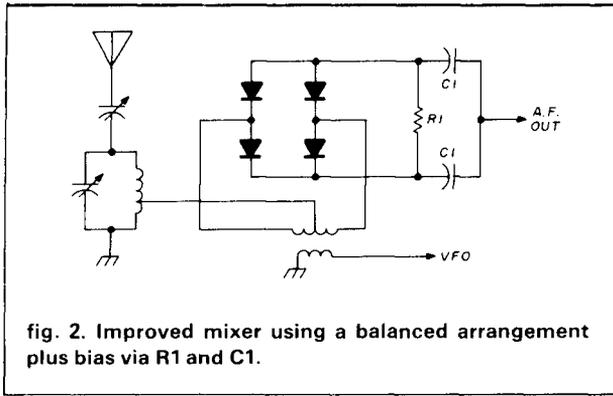


fig. 1. (A) Basic back-to-back mixer. (B) Voltage-current characteristics of the back-to-back matched diodes.

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Tulsa, Oklahoma 74136



RA3AEE describes the operation of the detector as follows: "When the local oscillator voltage goes through zero, both diodes are open circuit and the circuit current vanishes. At the peaks of both positive and negative half-waves of this voltage, one or the other of the diodes conducts and the signal source is connected to the load. In this way the mixer works like a switch, closing the circuit at a frequency equal to twice that of the local oscillator."

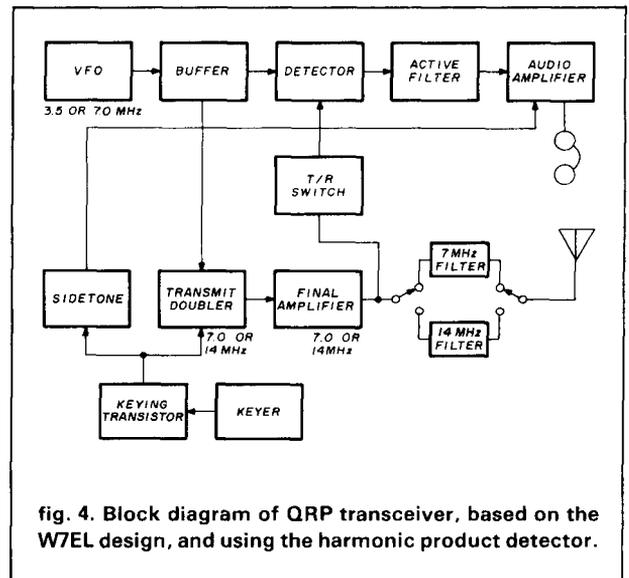
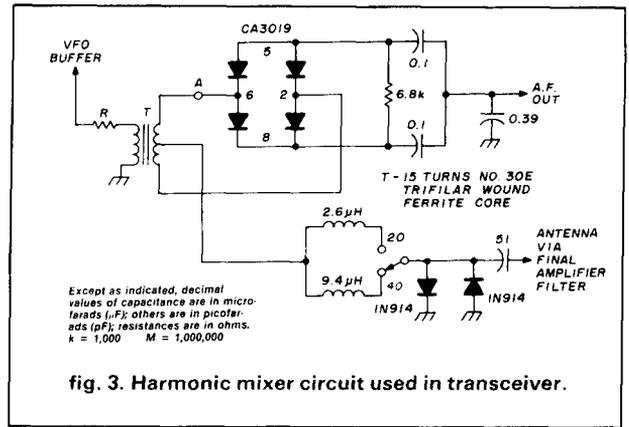
This mixer has two significant characteristics. First, the local oscillator must be tuned to a frequency one-half that of the incoming signal. Second, there is no direct current in the load circuit, which means that signals from high-power interfering stations are not detected and thus produce no noise. This second characteristic is true only if symmetry is preserved in the detector.

The circuit has several disadvantages, namely loss of signal power in coupling to the local oscillator and excessive sensitivity to oscillator injection for optimum conversion gain. RA3AEE devised several revisions to overcome these problems (see fig. 2). A balanced arrangement using four diodes overcomes the coupling loss, and, by applying a bias voltage to the diodes via R1 C1, the circuit becomes less sensitive to oscillator injection.

Fig. 3 shows the final version of this detector, the one I used. Oscillator injection at point A should be adjusted by means of resistor R to achieve approximately 1 volt RMS. Too low an oscillator injection will reduce conversion gain, but I noticed no ill effects from higher levels of injection. The optimum value of R in my case was 270 ohms, but this value will depend on individual circuitry.

I used an RCA CA3019 diode IC for the detector with pin connections as shown. The usual 1N914 or hot carrier diodes would also be suitable. The RA3AEE version used germanium diodes, and the reported optimum oscillator injection voltage for these was 0.6 to 0.7 volts RMS.

My transceiver follows the basic pattern of the W7EL unit, shown in block form in fig. 4. The driver



transistor, however, now becomes a doubler. There remains enough drive for the desired input of 2 watts to the final, for output on 40 or 20 meters of about 1 watt.

I have a 5-kW broadcast station almost in my back yard, and I was pleased to find that the harmonic detector, as claimed, was not susceptible to fundamental overload. The original article also claims excellent isolation between oscillator and antenna. Finally, because the oscillator is operating at a lower frequency, drift is reduced and stability enhanced.

For those interested in the higher frequencies, see the article by WAØRDX on the twin-diode microwave mixer in *ham radio*, October, 1978, page 84.

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ham radio TECHNIQUES

Bill *over* W6 SA1

The technical advances made in ham radio during the last two decades have been amazing. Moonbounce (EME) and satellite communications are now commonplace. Some avid operators have made DXCC via satellite and others have made WAC via moonbounce.

On the lower frequency bands, the technical advances have been equally impressive. Solid state has supplanted vacuum tubes up to power levels of several hundred watts and a new order of frequency control has been provided by digitized, frequency-synthesized transceivers using a high-stability crystal oscillator as master frequency control. Frequency synthesis with 10-Hz readout is practical for ham equipment and synthesis to 1 Hz is often used in commercial gear.

So here we are in mid 1983, with all this great equipment that would make the Amateur of the sixties turn green with envy. But what price have we paid for these technical advances?

One problem with the new gear that's showing up on the ham bands, but which has been largely ignored except by those affected, is that of white noise interference.

White noise is uniform-spectrum,

random noise heard as an unwanted signal in communications equipment. It is caused primarily by random motion of electrons in a circuit and has been a well-known problem in telephone circuits for years. It's been largely overlooked in Amateur Radio because the signal levels encountered in the past were great enough so that white noise was not a problem — and also because the relatively unsophisticated circuits used until recently did not generate much white noise. That is no longer true. Improvement in receiver sensitivity, stability, and dynamic range, coupled with frequency synthesis and phase-locked-loop systems, has created a white noise problem that is hard to ignore today. Here's a typical example of a white noise problem that was encountered by a good friend of mine:

My friend Joe finally traded in his VFO-controlled, tube-type transceiver for a brand new, solid-state, synthesized PLL rig. He was hugely pleased with its sensitivity, stability, dynamic range, and its frequency readout to 100 Hz. When his close friend John (who lives on the next block) decided to get a new rig, Joe encouraged him to buy a transceiver just like his. John did, and soon there

were two identical transceivers on the air in the same neighborhood.

Up till then the two friends had operated with no problems. Each ran about 200 watts input to a high-grade, tube-type transceiver, and when their tri-band beams were not pointed directly at each other, causing receiver overload, they could both work the same band at the same time. When they worked different bands, neither knew the other was on the air. This situation had existed for many years. But soon both Amateurs were dismayed to discover that their brand new transceivers generated so much white noise hash that operation on the same band at the same time was impossible. Even operation on *adjacent bands* was marred by an S3 background noise level from the nearby transceiver!

Joe told me, "When my friend is listening on the same band I am listening to, I hear a rushing noise within 30 kHz of where he is tuning. When he transmits, the white noise completely wipes out reception on that band and ruins reception on the adjacent bands. And my transceiver does the same to him!"

The white noise problem is plaguing another local Amateur: Harry lives

about a quarter mile from another DXer. Both Amateurs run full power. Harry has a tube-type receiver and transmitter of the highest quality. His friend has a solid-state receiver and exciter. Harry tells me his reception is completely blocked out when he aims his beam at the other DXer's house. Unfortunately, that direction is the direct path to Europe! When both are operating at the "low end" of 20 meters, most DX signals below S5 or thereabouts are lost in the white noise hiss generated by the solid-state equipment hooked up to the nearby DXer's beam. For the last six months Harry hasn't had many European contacts, and he is *very* unhappy about it.

Disturbed by these stories, I called up a local ham who has a solid-state, synthesized hf transceiver. I ran some tests, listening to his equipment while he was both receiving and transmitting. The results were negative: I heard no white noise at all from his rig, which was about two miles away.

After checking with some other Amateurs in the area I came to the reluctant conclusions that little is known about the white noise problem with respect to Amateur gear, that the amount of noise interference generated by hf gear varies between manufacturers from type to type, and even from unit to unit. One rig may generate a lot of white noise interference for nearby Amateurs while another will be relatively clear of it. No general conclusions can be drawn about individual pieces of equipment at this time, except that the problem seems to be widespread.

Does your equipment generate white noise interference? Ask a neighborhood ham to listen on the skirts of your signal for the characteristic hissing sound. It may go out as far as 100 kHz from the carrier frequency. Or, if you have an auxiliary receiver, remove the antenna and listen yourself. You may be surprised!

I'll be interested to hear from any Amateurs on this subject. Let me

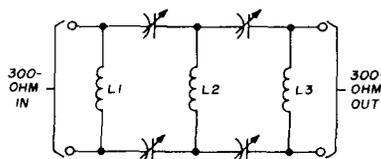


fig. 1. The K5BDZ TVI filter. The capacitors are 20-pF variable ceramic units. Coils L1 and L3 are forty turns No. 30, closewound, 1/8-inch diameter. Coil L2 is twenty-two turns No. 30 closewound, 1/8-inch diameter.

know the type of equipment and the noise problem you encounter.

I think the subject of white noise is best summed up by an editorial in the newsletter *Amateur Radio Today* which says, in part, "The question is not whether the hash exists, but rather to what degree, and whether or not it is bothersome . . .

"While any unnecessary hash in a receiver is unwanted, we at *Amateur Radio Today* feel that the tradeoff between a small amount of noise and having the frequency-selection flexibility offered by a synthesizer may be worthwhile. That's a judgment each individual will have to make."

a thoughtful review of signal reporting

The present RST system for reporting signal strength was devised by Art Braaten, W2BSR, about 1934. It certainly has withstood the test of time; it is still being used nearly fifty years later. Old Timers will remember the previous QSA and R system, (Your sigs are QSA 5 R9), which rapidly faded away as the RST system took over.

It is apparent, however, that flaws are appearing in the venerable RST system. Sideband operators have expanded the system to include "decibels over S9" and CW operators have clipped the system so an RST 599 signal is now 5NN. Obviously, the technical advances in communications

over the last few decades have outstripped the system of reporting signal strength.

two solutions to the RST problem

It is simple enough to add decibel ratings at the top end of the scale as the sidebanders have done. CW operators could use the scheme by substituting an exclamation point for each additional 10 dB of signal strength. Example: 5NN!! means 20 dB over 599. Simple!

But the system really breaks down when it comes to weak-signal reporting. Nobody wants to give an S1 or an S0 report, and some rare DX signals are really weaker than that!

Two 1983-style solutions to the weak signal report have surfaced recently. One system is for weak-signal (moonbounce) VHF work, and the other for 75-meter DX work. Both bands are well known for long-distance DX contacts under adverse conditions.

The problems seem to arise when the DX signal is virtually buried in the noise. Listening to such a signal after a length of time can produce some queer effects on the listener. He imagines that he hears the DX signal calling him! Perhaps it is only an uneven change in the background noise, or merely a hunch, but the listener is *sure* he is in QSO with the almost-inaudible DX station. And, by George, many times he is correct.

the 80-meter reporting system

Experienced DXers are well aware of this phenomenon. (In fact, some DXers can work a station when it isn't even there. But such a situation is outside the scope of this discussion.)

The 80-meter reporting system (attributable to Gordon, W7FU, I believe) is termed the "ESP System," the initials standing for extra-sensory perception. Signals are graded on an ESP scale of one to five. The scale

- R tuner (inductance wound on a 4-inch-diameter cardboard tube)
- 2 two holes 1/2-inch apart for anchoring wire at the start of inductance winding
- U detail of a tapping on the inductance
- V & Y switch arms: V used for rough tuning by selecting tappings ten turns apart; Y used for finer tuning by selecting individual turns
- W switch contacts (machine screws or studs or even nails)
- 3 detail showing wire from tapping on inductance, connected to switch contact
- 4 gripping screw of terminal
- 5 nail passed through the hole in the terminal, with a small piece of dowel at one end for a handle
- 6 catswhisker made from bare copper wire, one end twisted around the nail, the other resting lightly on the crystal
- 1 piece of suitable crystal held to baseboard by the three screws
- T high resistance headphones
- X screw-type terminals

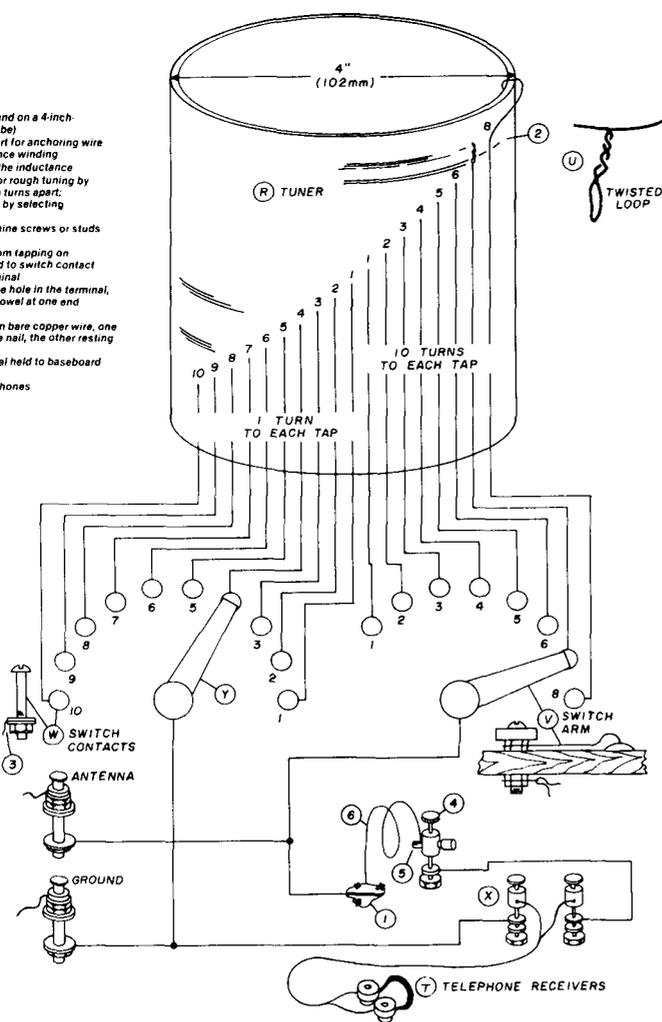


fig. 2. Construction details of the U.S. Bureau of Standards crystal radio receiver (1920).

has not been standardized, as far as I know, the outer limits being ESP-1 ("the DX station is thinking of coming on the air,") to ESP-5 ("the DX station is inaudible but workable"). From all reports, the ESP system seems to be functioning quite well for both sideband and CW service on the lower frequency bands. I'll be happy to report on this exciting new aspect of Amateur Radio as it develops.

the EME (moonbounce) reporting system

I understand this signal reporting

system was developed by Dave, K1WHS. During low-signal moonbounce work he noticed that very weak signals could be described as "musical noise," that is, noise that varied in tone as the receiver tuning dial was moved slightly. After listening to an evening of such noise, trying to dig a signal out of the background that he knew was there, Dave coined the term "Imagination-Enhanced QSO," the signal strength of which could be reported in IEQ units ranging from one to five. The IEQ scale has not been established yet, as most IEQ reports have run be-

tween zero and one. Much work remains to be done on this interesting system of signal reporting, however, before it becomes practical. Stay tuned in and I'll keep you up to date on late developments.

an adjustable TVI filter for 300-ohm line

Bill, K5BDZ, has used an interesting TVI filter for a number of years with good success. It is the basic *handbook* filter which has been around for a number of years, except that Bill has changed the fixed capacitors to variable ones (fig. 1). The filter can be made up on a piece of perf-board for a trial run and later placed in a shielded box, if desired. The filter is installed at the 300-ohm TV receiver antenna terminals, or close to the tuner. Simply adjust the trimmer capacitors for maximum TVI rejection. If the filter is in a box, holes drilled in the cover will permit adjustment.

Bill has built about forty of these filters and has had good luck with all of them.

a construction project for beginners

Shown in fig. 2 is a simple all-wave receiver for beginners that was designed by the U.S. Bureau of Standards. It can be easily built in a wooden cigar box by even the inexperienced. Designed about 1920, this venerable old circuit was featured recently in *Practical Wireless* (England). The magazine had this to say about the circuit:

"The object is to contact the crystal gently with the catswhisker in the hope of finding a sensitive spot which would cause rectification of the signal to take place. Many gentle applications were generally required before the spot could be found. Unfortunately, the slightest vibration would usually destroy this delicate setting, and the tedious business would have to be repeated."

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The Explorer 14 includes passivated stainless steel hardware and heavy gauge, pre-formed element and mast brackets. High grade 6063-T832 thick wall swaged aluminum tubing is used throughout. A BN86 balun is included and a new Beta Multi-Match provides DC ground to reduce lightning hazard and precipitation static. It's a rugged, easily assembled antenna that survives winds to 100 mph (160 km/h).

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Lew McCoy, W1ICP is among the most authoritative writers in amateur radio. For over 30 years he served on the ARRL technical staff with his last position as assistant senior technical editor. Presently he is the technical editor for CQ magazine. Here is what he had to say about the Explorer 14:

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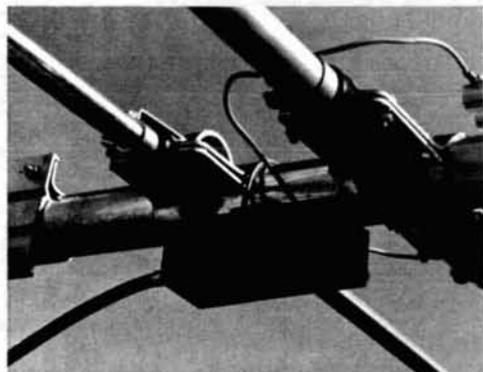
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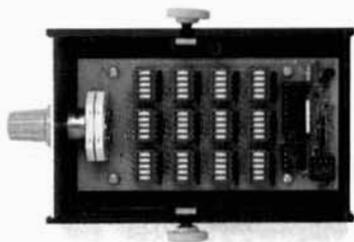
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10 GHz ultra stable oscillator

Frequency stability
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microwave source

The original work for the oscillator described in this article was for use as an LO in a DBS (direct broadcast satellite) downconverter. The frequency of oscillation is 10.76 GHz and all test data given is for this frequency. The 10.0 - 10.5 GHz Amateur band can also be easily accessed using this same oscillator. With correct selection of dielectric size, the same circuit can be made to oscillate from 7 to 16 GHz.

There are two key elements which make the application of a simple, stable microwave oscillator possible. The first is the GaAs FET (gallium arsenide field effect transistor); the second is a temperature-stable, high-dielectric, low-loss material (barium tetratitanate). The GaAs FET used for this oscillator is an ALF3000/ALF3003 and the dielectric material is type D8512 by Trans-Tech, Inc., Gaithersburg, Maryland.

The superior microwave performance of GaAs MESFETS is well documented, and usable gains are now possible from dc to over 40 GHz. The Alpha ALF3000 GaAs FET has over 9 dB of gain available at 10 GHz and simplifies the conditions for oscillation. It also has moderate power-handling capability and achieves +17 dBm (50 milliwatts) of output power at 10 GHz with an efficiency of almost 28 percent.

Oscillator stability of better than 3 parts per million over a temperature range of -20 to +60 degrees C results from using the Trans-Tech dielectric. This type D8512 material has a Q_u (unloaded Q) of over 3000 at 10 GHz and is responsible for the high stability. Fig. 1 shows a rough selection of material size for a given aspect ratio (diameter/height ratio) versus frequency. Final dielectric size will depend on what

the housing (cavity) shape is and how it affects the resonant frequency.

Fig. 2 shows how the physical spacing of the dielectric from a cavity wall varies the frequency of oscillation. The oscillator has a large mechanical tuning range and therefore a stable housing (cavity) is a must for maximum stability.

A quick estimate of the frequency stability performance of any dielectric from barium tetratitanate can be obtained from knowledge of the dielectric's relative permittivity change with temperature. This constant, when divided by two (with reverse sign), is approximately equal to the frequency stability of the material impressed in a metal sandwich. A further improvement by a factor of two is achieved when 1/8 wave (length) of air spacing is included between the metal and the dielectric material.

There is a trade-off involved in Q_L , resonant frequency, and tuning range available in any given cavity size. Frequency resonance of the dielectric goes up as it is brought closer to a wall and Q_L goes down. Smaller cavity sizes also have the same effect.

Fig. 3 shows the quality of signal produced. Fm noise is extremely low and typically less than 0.1 Hz/ $\sqrt{\text{Hz}}$ at 100 kHz off carrier.

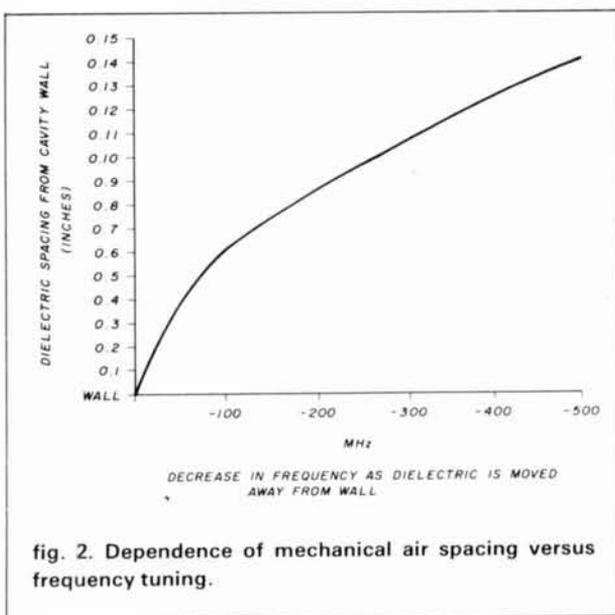
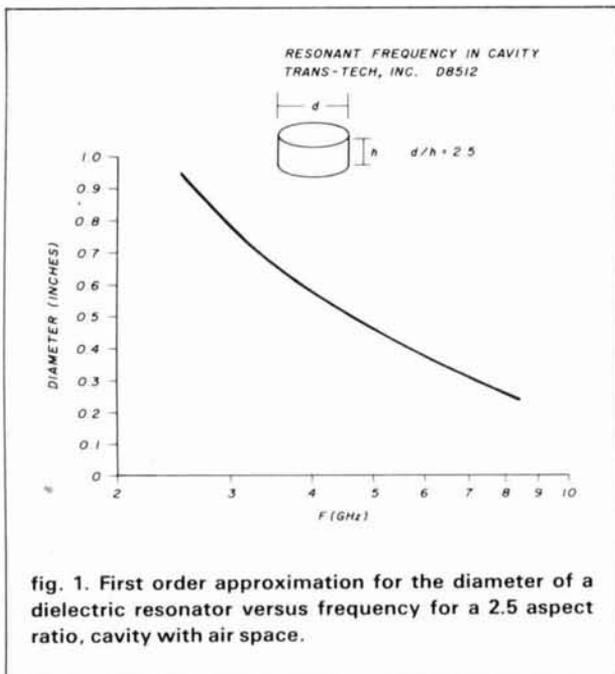
It should be mentioned that many modes of oscillation are available, and care has been taken so as to couple only magnetically into the dominant TE01 mode.

In high dielectric material, the lines of magnetic flux are more tightly contained than in lower dielectric material. Fig. 4 shows a simple view of this magnetic coupling of the dielectric material to microstrip.

The ability to frequency modulate this oscillator is shown by viewing the dc supply voltage versus frequency characteristics in fig. 5. Also shown is the output power versus dc supply voltage.

Figs. 6 and 7 show the actual circuit and PC artwork needed to reproduce this oscillator. PC board material is Duroid D5880, 31 mils thick, 1/2-ounce

By Dennis Mitchell, K8UR, 35 Mt. Pleasant Street, Marlboro, Massachusetts 01752



copper on two sides with a dielectric constant of 2.55. This board was placed in an aluminum housing with conductive silver epoxy. A plated through-hole in the ground area at the end of the gate strip provides a good ground to the gate resistor. This resistor is a 50-ohm chip. If this is not in your parts box, a 1/8-watt carbon with short leads can also be made to work. GaAs FET devices used were in both chip and packaged form. In the packaged form (ALF3003) the

Note: While the ALF 3000/3003 is no longer commercially available, many other common FETs may be used in its place. — KBUR

gate lead was bent around the device to attach to the gate strip.

The design is very forgiving and has worked even with such problematic components at 10 GHz as 1/8-watt carbon resistors. The dielectric material was fixed in place on the PC board with Eastman 310 Superglue, which appeared to have no ill effects on performance once hardened. The circuit did not oscillate while the glue was wet and curing, however.

I believe that the circuit could be placed on Tef-Glas PC material and would perform as well. Fiberglass G-10 material could possibly be used for a housing, eliminating the aluminum machined housing.

conclusion

This puts 10 GHz well within reach of any Amateur with GaAs FETs and chip caps. (Even starting without any of these items, cost is still under \$20.) The LO described here could be FM'ed on transmit with a reasonable power (50 mW) and used as the LO for a receiver with an i-f offset of, say, 28-30 MHz. The

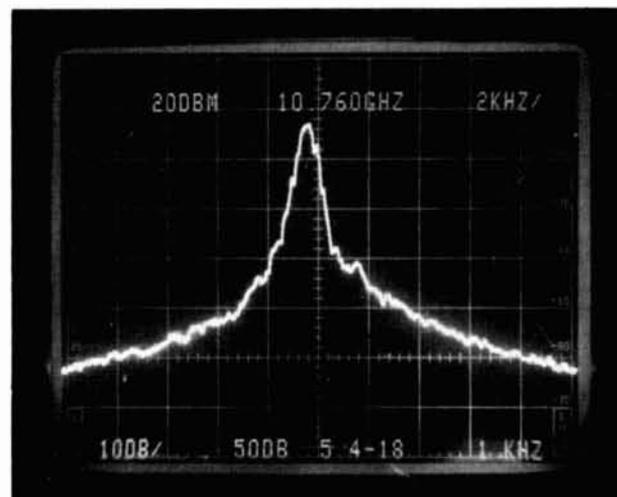


fig. 3. Spectral frequency response of a dielectric resonator oscillator.

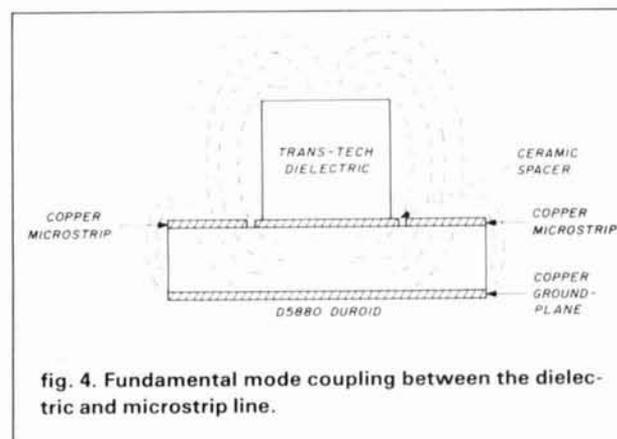


fig. 4. Fundamental mode coupling between the dielectric and microstrip line.

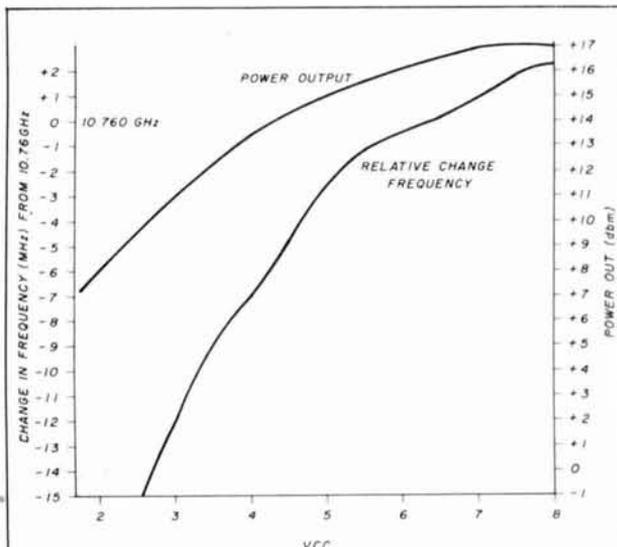


fig. 5. Dc tuning and power output versus supply voltage for the DRO.

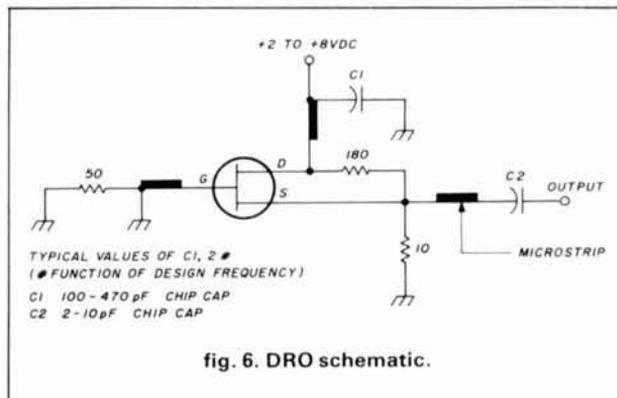


fig. 6. DRO schematic.

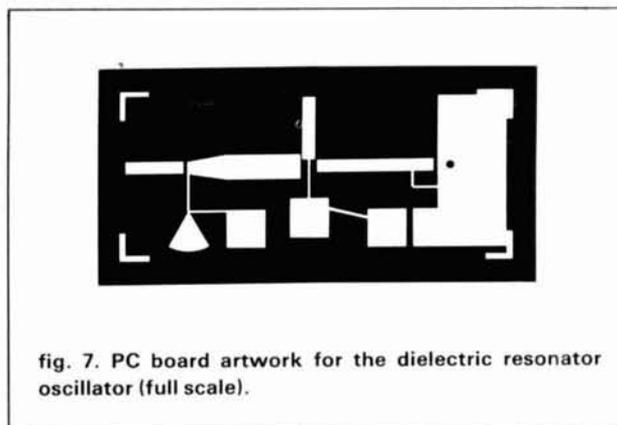


fig. 7. PC board artwork for the dielectric resonator oscillator (full scale).

cost is not much more than that of the FET alone, and it's my hope it will stimulate some 10-GHz interest.

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XF-9C	AM	3.75 kHz	8	77.40
XF-9D	AM	5.0 kHz	8	77.40
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XF-9M	CW	500 Hz	4	54.10
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- P432C, UHF Kit with case \$24.95
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Wired \$59.95	145-147	28-30
	144-144.4	27-27.4
	146-148	28-30
	144-148	50-54
	220-222	28-30
	220-224	144-148
	222-226	144-148
	220-224	50-54
	222-224	28-30

	Antenna Input Range	Receiver Output
UHF MODELS	432-434	28-30
	435-437	28-30
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(Specify band)	28-30	220-222
	50-54	220-224
	144-146	50-52
	50-54	144-148
	144-146	28-30

For UHF,	28-30	432-434
Model XV4	28-30	435-437
Kit \$99.95	50-54	432-436
Wired \$149.95	61.25	439.25
	144-148	432-436*

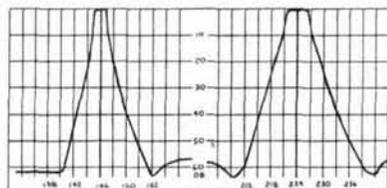
*Add \$35 for 2M input

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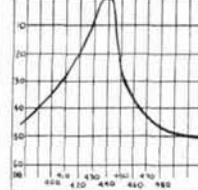
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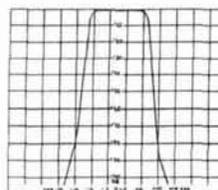
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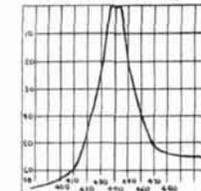


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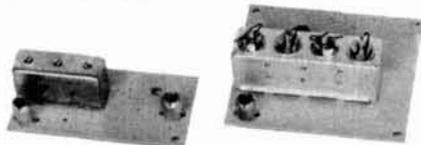
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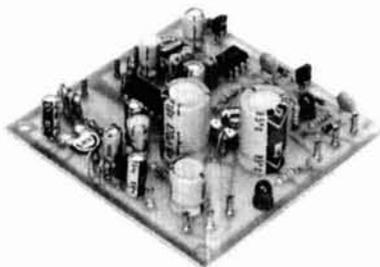
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After much looking, I finally located a program that did not cost too much yet had all the features I wanted. I loaded the tape into the computer and the TV monitor became alive with menus displaying Morse and RTTY commands. This was very nice, but all of my problems were not yet solved.

A TU and AFSK unit had to be built if the computer was going to be able to accept the RTTY tones

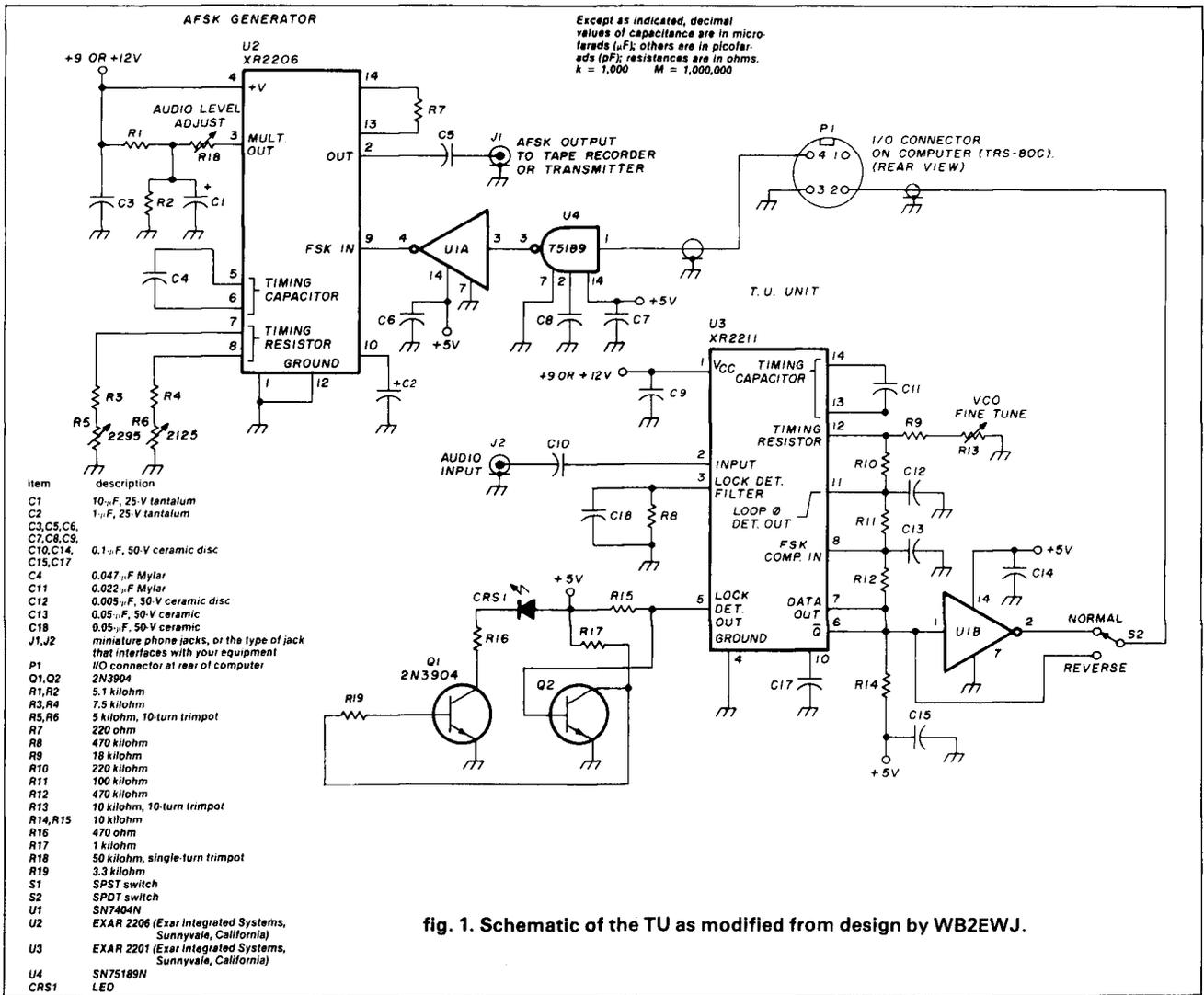
emanating from the receiver. I remembered a TU design from the December, 1980, issue of *QST*. It was an excellent design, and modifying it seemed quite feasible.

Fig. 1 shows the schematic diagram as I modified it. I had no intention of running a TTY machine in series with the loop, so I deleted the optical isolator and the TTY driver circuit. The computer output line from pin 4 of connector P1 is an RS232-type of output (plus and minus swing around ground level). The RS232 level must be converted to a TTL level (zero to plus 4-volt level) fed to pin 9 of U2. U4 is an RS232-to-TTL converter; U1A in conjunction with U4 applies the correct polarity to the AFSK unit.

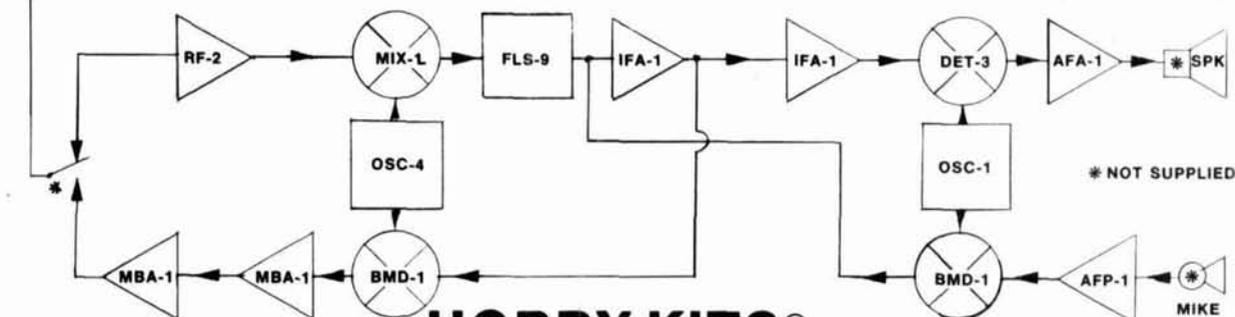
Pin 2 of P1 is the input line to the computer. Data out at pin 7 of U3 is connected to a 10-kilohm pullup resistor and the input of U1B.

A comment concerning the lack of audio filtering at the TU input: The Exar 2211 phase-locked loop is actually a filter. It works well without any bandpass filter at the input. But an audio bandpass filter with a bandwidth of approximately 400 Hz, with the MARK and SPACE tones centered in it, should improve TU

By Don Kadish, W1OER, 135 Barbara Road,
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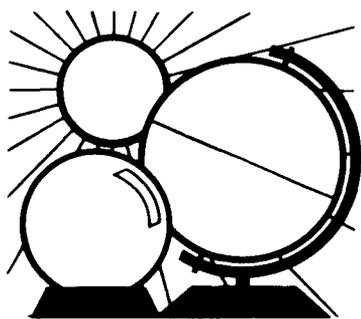
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DX FORECASTER

Garth Stonehocker, KØRYW

last-minute forecast

The higher-frequency bands (6-30 meters) are expected to be best during the first and last weeks of the month, during periods of maximum solar flux. A slump may be experienced during the weeks in between, when the 10 and 15 meter bands are not able to support long skip, with only sporadic-E short-skip openings occurring. Try the lower frequency night bands: thunderstorm QRN isn't expected to be severe enough to wipe out evening and early-night DXing. Propagation disturbances are expected, however, around the 8th through the 14th. These geomagnetic-ionospheric disturbances (weak and fading signals) will probably not be intense but will probably last longer than usual (five to six days).

This year's June sunspot number is forecast to be only between 60 and 70. That is a significant drop from last year's value of 117. There will be quite a restricted frequency range for long-skip DX, even more restricted than usual during the summer. A total eclipse of the sun will occur in the Southern Hemisphere on June 11, from 0200 to 0715 UCT. The path begins near the Malagasy Republic, continues across southeast Asia, Indonesia, and Australia, to the west of New Zealand. Of note to moon-bounce enthusiasts, a full moon will occur on the 25th and perigee on the 13th. And there will be a partial lunar eclipse on the 25th, which will be seen in the Americas and Australia. Summer solstice is June 21 at 2309 UT.

summertime DX

Each season of the year, the winter

and summer solstices, the equinoxes, all produce their own distinct propagation characteristics, which can be put to work for DXing. Some of these characteristics can be turned to advantages, and some of the disadvantages can be circumvented. In the summer, the sun is more directly overhead in the Northern Hemisphere. The production of ions and electrons increases in the D, E (short skip) and lower F regions of the ionosphere. Greater concentrations of ions cause higher, lowest-usable-frequencies (LUFs), resulting in reduced signal strengths during the daylight hours. The higher number of E-region ions accumulate, producing sporadic-E (Es) layers; the F region, then lacking its ions (and electrons), provides the lowest maximum usable frequency (MUF) season of the year.

Summer also means more hours of daylight available for operating the higher DX bands. Summer thunderstorms are caused by air-mass heating because of the hot daytime temperatures. That makes these storms very different from storms caused by frontal passages, which occur during the equinoxes and in winter. Therefore QRN noise is now more common in the evenings and early night, after thunderstorms build up, and lasts until they dissipate.

Good DX on the lower bands can occur in the evening or after local midnight. Try short skip, since greater signal strength via Es might be effective in overcoming QRN. During the day, DX operation will be restricted to high-power transmitters capable of overcoming the high signal absorption of skywave and for good ground wave propagation. If you choose to use the longer daylight

hours on the higher bands, despite the restricted operating frequency range for long skip (lower MUF and higher LUF), the evening is best, as the LUF falls with the sun and the MUF on 20 lasts into the night. If you'll settle for possible short-skip openings on 10 or 15 meters, try mid-day local time for the highest probability of openings.

band-by-band summary

Ten and fifteen meters should provide good daytime openings to the southeast, south, and southwest, using F-region long-skip hops of 2500 miles (4000 kilometers). Short-skip hops of 1200 miles (2000 kilometers) via sporadic-E should be possible during many days of the month in the above directions near local noon, and east and west before and after noon. Don't expect to find much one-hop trans-equatorial DX during disturbed periods this time of the year.

Twenty and thirty meters will be open to some parts of the world for nearly twenty-four hours a day. If 20 isn't useful some nights, 30 meters probably will be. Sporadic-E propagation will fill in the pre-sunrise dip in usable frequencies during many mornings to help make round-the-clock openings possible. The direction of the openings will be similar to those for 10 and 15 meters, plus the northern paths indicated on the chart.

Forty meters will provide the best DX conditions from sunset until just after sunrise, although static levels may be high at times. Watch for local storm passages and operate near sporadic-E peaks around sunrise and sunset (particularly at sunrise, when fewer thunderstorms are around).

GMT	PDT	WESTERN USA								MDT	MID USA								CDT	EDT	EASTERN USA							
		N	NE	E	SE	S	SW	W	NW		N	NE	E	SE	S	SW	W	NW			N	NE	E	SE	S	SW	W	NW
0000	5:00	20	20	30	15	15	10	10	20	6:00	15	20	30	15	15	10	10	15	7:00	15	20	30	15	15	10	10	15	
0100	6:00	20*	20	30	15	15	10	10	15	7:00	15	20	30	15	15	10	10	15	8:00	15	20	30	15	15	10	10	15	
0200	7:00	20*	20	30	15	20*	10	10	20	8:00	15	20	30	15	20	10	10	15	9:00	20*	20	30	15	15	10	10	15	
0300	8:00	20	20	30	15	20	10	10	20	9:00	20	20	30	15	20	10	15	15	10:00	20	20	30	15	15	10	10	15	
0400	9:00	20	20	40	20	20	10	10*	15	10:00	20	20	40	20	20	15	15	20	11:00	20	20	40	20	15	15	10	15	
0500	10:00	20	20	40	20	20	10	15*	15	11:00	20	20	40	20	20	15	15	20	12:00	20	20	40	20	15	15	10	15	
0600	11:00	20	20	20	20	20	15	15	15	1:00	20	20	20	20	15	15	20	20	2:00	20	20	20	20	15	15	10	15	
0700	12:00	20	20	20	20	20	15	15	20	2:00	20	20	20	20	15	15	20	20	3:00	20	20	20	20	15	15	10	15	
0800	1:00	20	20	20	20	20	15	15	20	3:00	20	20	20	20	15	15	20	20	4:00	20	20	20	20	15	15	10	15	
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2200	3:00	20	20	20	15	15	15	15	20	5:00	20	20	20	20	15	15	20	20	6:00	20	20	20	20	15	15	10	15	
2300	4:00	20	20	30*	15	15	15	15	20	6:00	20	20	20	20	15	15	20	20	7:00	20	20	20	20	15	15	10	15	

* Look at next higher band for possible openings.

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Eighty meters during hours of darkness until sunrise can have DX openings to areas of interest. Static from thunderstorm activity, both long distance and local, may limit working the rare ones when propagation is otherwise all right. Coastal stations usually have more favorable propagation paths under summer conditions than do inland stations. Sporadic-E propagation around sunrise and sunset is good for this band also. Day-time work will be limited to within about 200 miles (360 kilometers).

One-sixty-meter DX activities really require a lot of work this time of year. During hours of darkness, between storm-front passages, you may work 1000 miles (1600 kilometers) if your ears hold up against the thunderstorm QRN. DXing in the predawn hours, after the thunderstorms have dissipated, may be the answer.

(Unfortunately an important path "looking" toward the west normally exists at this time; thunderstorm activity might not yet have subsided. — Editor)

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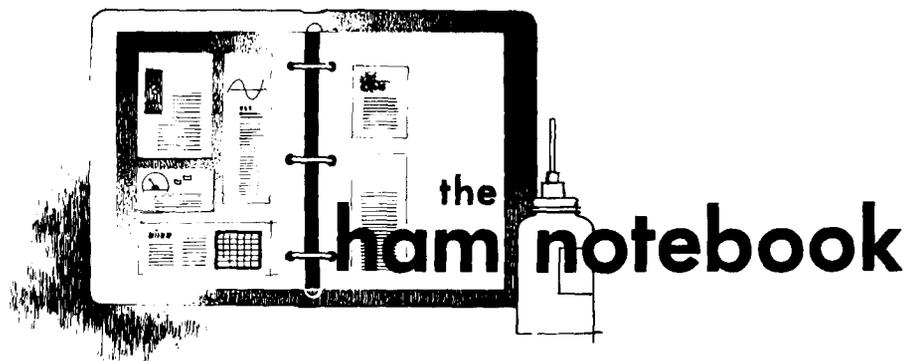
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nomogram design of custom resistors

In Amateur work, it's sometimes necessary to fabricate a "customized" resistor in order to effect a quick design or repair. Though the right part may eventually be available, lengths of wire (in the right sizes, of course) may do in a pinch. The trick is to choose the right size wire and the right length (given the composition of the wire) to come up with the proper overall resistance. The equation itself is fairly simple:

$$R = \frac{\rho L}{1000K}$$

where R = resistance in ohms
 ρ = resistivity of copper in ohms per 1000 feet at 20 degrees C (from wire tables)
 L = length in feet
 K = the ratio of the resistivity of copper to the resistivity of the wire's material

The nomogram simplifies solutions to the equation, in that resistivities have been converted to AWG (B&S) wire sizes. Also, the resistivities of various materials are given (fig. 1).

Two scales for resistivity and resistance are shown. If the outer resistiv-

ity scale is used, the outer resistance scale must also be used, and vice versa. The Length and Resistance scales may be changed proportionately. That is, if you need a range of the lengths of from zero to ten feet, the ranges of the resistances would also have to be reduced by a factor of ten — resulting in maximum resistances of 0.5 and 5.0. The relative resistivities of other materials may be plotted similarly. The chart also has usefulness in the design of control circuits, where the resistance of long runs of wire may be critical. Here's an example of how the chart is used: *Problem:* What length of No. 26 copper wire is needed to produce a resistance of 0.9 ohm? *Solution:* A line is drawn connecting copper on the Material scale to the proper wire size on the outer Resistivity scale. A second line is drawn from 0.9 on the outer Resistance scale (through the intersection of the first line and the diagonal), and it intercepts the Length scale at about 22 feet.

James McAlister, WA5EKA

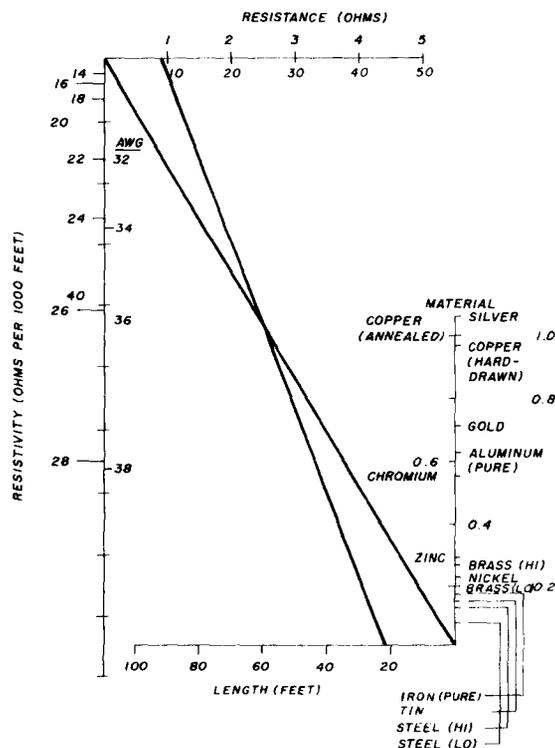


fig. 1. Nomograph for designing custom resistors.

operating the Triton IV on 30 meters

The TenTec Triton IV, which features QSK, can easily be converted for use on the new CW band, 30 meters. All that's needed is the addition of two switched capacitors and the modification of an outboard unit, the model 240 160-meter converter. Since many hams are more willing to work on an accessory than on a complex transceiver, this approach is very desirable.

Triton mods first

Remove the top cover and locate the bandpass filter board (No. 80291). Refer to the manual to find T2, the 14-MHz bandpass filter. C7 and C8 are within the T2 can and must be shunted by 56 pF of additional parallel

capacitance to lower the filter pass-band from 14 to 10 MHz. The terminals of C7 and C8 may be accessed without disturbing the can. Small wire-wrap wire connects C7 and C8 to a DPST N.O. (normally open) reed switch (taped to the top of T1, 2, 3, and 4). The 56-pF capacitors are soldered between the reed switch and the ground foil of the board. The reed switch is externally actuated by plac-

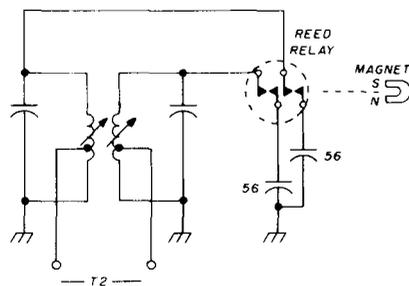


fig. 1. Magnet pulls in additional 56-pF capacitors, lowering the Triton IV bandpass filter to 10 MHz.

ing a magnet on top of the unit in a specific location; removing the magnet returns operation to 14 MHz. This is illustrated in fig. 1.

modifying the 160-meter converter

Relay K2 must be disabled on the converter filter board (No. 80328). Normally, K2 inserts a lowpass filter in the transceiver output line. This is necessary because the 3.5-MHz band lowpass in the Triton itself would allow second harmonic energy from 160-meter operation to pass along with the fundamental. This filter is not needed for 30-meter operation and is eliminated by opening the 12-volt switched line at pin 4 of the 80328 board. Don't be concerned about not having a filter in the line when 30 meters is being used. The internal Triton output filter already does that job.

Most of the work in modifying the model 240 is done on the mixer board

No. 80327. Replace Y1 with a 4.0-MHz crystal. Inexpensive microprocessor crystals work well. Remove C18 and C21 from the circuit and replace C17 with approximately 3 to 4 pF. Remember that C17 now conducts 10-MHz rf, not 1.8-MHz. Also, we're already decreasing the Q of these tuned circuits by altering the L/C ratio. Consequently, only a small coupling capacitor is needed. Repeak C19 and C20 to receive signals between 10 and 10.5 MHz with the Triton band-switch set for 20 meters: 10.0 corresponds to 14.0 on the dial.

IC1 on the mixer board is now fed by a 5.0-MHz VFO and a 4.0-MHz crystal oscillator. T1 needs to be centered at 1.0 MHz, the difference frequency. Remove T1 and C5, C6, and C7. T1 should be replaced with a 455-kHz i-f can from a tube-type radio, that is, a transformer with two high-impedance windings.

Before installing the new i-f can, open it and determine the value of capacitance. Remove this capacitor. The externally added capacitors will have approximately half the old value and resonate both windings of the transformer at 1 MHz. Some cans have a low-impedance tap on one winding or the other. The tapped winding becomes the output winding and the **MIX OUT** pin is fed directly

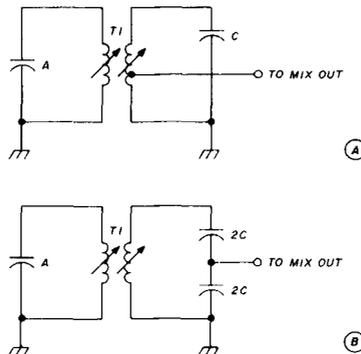


fig. 2. Two methods of obtaining a mixer output signal from the new 1-MHz i-f. (A) low impedance tap; (B) capacitive voltage divider.

from this tap. If your new can has no tap, just make a voltage divider to feed **MIX OUT**: simply obtain two capacitors of twice the value needed to resonate the output winding; *series* connect these two capacitors and tap at the junction for the **MIX OUT**. See fig. 2.

The desired mixer output voltage level is set as high as possible without driving the buffer transistor stage (80329) into distortion. Observe the output waveform of the buffer while peaking the primary and secondary of transformer T1.

For normal operation of the Triton, leave the Model 240 panel switch in the 3.5-30 position. For 30-meter operation, turn the Model 240 switch on and put the magnet in place on the Triton top cover (or switch in the extra capacitors via whatever switching mechanism you've chosen). For increased sensitivity, transformers T2 and T3 can be rewound for narrower bandwidth.

Raymond Henry, Jr., AA4LL

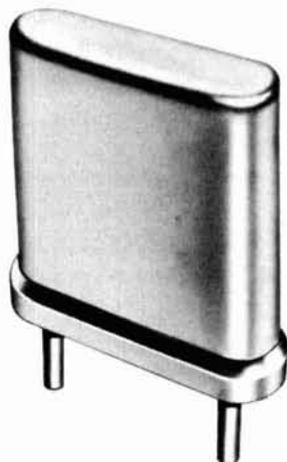
using the Astro 103 as a frequency counter

The Astro 103 transceiver's digital readout may be used as a general frequency counter without modifying the equipment. A phono jack labeled **EXT LO** on the rear panel is for connecting an external local oscillator, to obtain general coverage between 1.5 and 30 MHz. The **EXT LO** input circuitry is shown in fig. 1.

Because counter sensitivity is less than 10 millivolts, precautions must be taken to limit damaging voltages which might be applied accidentally. This is accomplished by assembling a simple, small, coaxial-line test lead to a phone plug, with a 10-pF, 1000-volt disc capacitor in series with the center conductor. This small value also prevents the overloading of any sensitive circuits *being measured*.

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Channels	200		
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Power source	13.8 V DC		
Receiver			
Sensitivity	AM — 1 micro-V @ 10 dB S/N	FM — 1 micro V @ 20 dB S/N	SSB/CW — 0.5 micro-V @ 20 dB S/N
Selectivity	60 dB		
Audio Output	2 W @ 8 Ohm		
Fine Tune range	± 800 Hz		
Course Tune range	± 5 kHz		
Squelch range	0.5 to 300 micro-V		
Intermediate freq.	AM/FM — 10.695 MHz/455 kHz	SSB/CW — 10.695 MHz	
Transmitter			
RF power output	High	Mid	Low
SSB/CW	12 W	8 W	2 W
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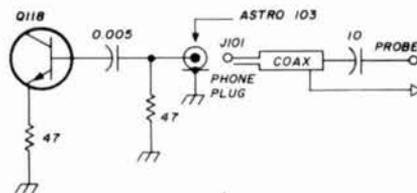


fig. 1. Connection of counter probe to external LO jack is shown.

table 1. Bandswitch settings.

measured frequency	bandswitch
2 through 8.999 MHz	40 meters
9 through 17.999 MHz	30 meters
19 through 28.999 MHz	15 meters

set the PTO MODE switch to EXT and select lower sideband. The band-switch settings for various counting ranges are given in table 1. With no input signal applied, the counter displays the internally generated carrier from the local oscillator whose value depends on the band selected. Actual frequency is the displayed value minus 1 MHz. For example, a display of 8250 indicates an actual frequency of 7250 kHz.

Gene Brizendine, W4ATE

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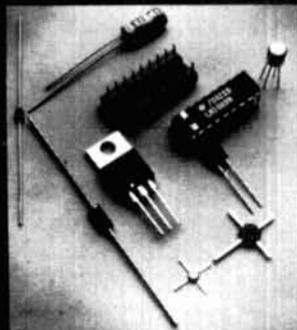
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sending CW: a digital approach

A simple way to clean up your CW sending technique

International Morse code appears to be fairly simple on the surface. Many licensed Amateurs can testify to having mastered it with varying degrees of proficiency. When compared to modern digital codes, Morse code is really quite complex: two different on elements, dots and dashes, are used along with three different off elements to represent many letters, numbers, and special characters and symbols. Transmission speeds vary widely in a single transmission and dots, dashes, and spaces often become mashed in a stream of indecipherable information. This article details the use of digital circuits to accurately time and filter out-going Morse code sent with a straight key or other mechanical key so that dots and dashes are reproducible and well-timed. No new hand motions are required.

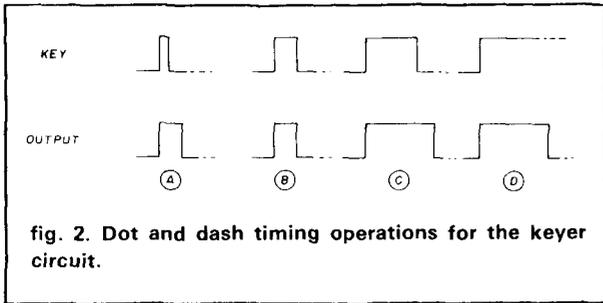
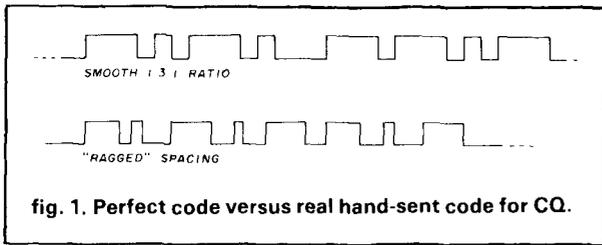
Someone who has listened to the CW ham bands for a short time will realize there are Amateurs who send code poorly. You may be unpleasantly surprised by your own CW-sending skills if you record one of

your contacts and replay it. The main problem in sending good code is shown in **fig. 1**. A perfect transmission is shown at the top, and a typical on-the-air transmission is shown below. Note that real dots and dashes vary in length and the spacing is less than perfect. While the human brain is capable of adjusting for most of these changes, it is difficult to decipher a transmission in which dots and dashes are almost the same length and spaced in a semi-random fashion. Electronic paddle keyers, keyboards and computers are one answer, but they require mastery of new hand motions or skills and are frequently expensive. Many Amateurs would like to continue using their mechanical keys and improve their code-sending skills.

defining the circuit

The problem is to design a circuit that will accurately time dots, dashes, and spaces so they sound perfect on the air. Before the circuit can be designed, we need to specify what it is supposed to do. First we define the dot:dash:space ratio as being 1:3:1, the standard generally accepted for good Morse code transmissions. While many hams use weighting

By Jonathan Titus, KA4QVK, The Blacksburg Group, Inc., P.O. Box 242, Blacksburg, Virginia 24060



to vary the dot:dash ratio, it is better to use a well-known standard. Next, the dot/dash operation must be defined (shown in fig. 2). There are four actions:

- A. If the key is closed for a very short time, a self-completing dot is generated.
- B. If the key is closed and held closed up until the end of a dot, the same length dot is generated.
- C. If the key is closed and held closed beyond the dot length, a self-completing dash is generated.
- D. If the key is held closed for a long time, only a single dash is generated.

After each dot or dash, an off time of one dot-period is enforced to prevent code elements from being produced too tightly. If the key is activated during the off time, the action is remembered and acted upon as soon as the off time is finished. Perfectly-timed and spaced code can be generated by slightly leading the actions of the circuit.

using monostables

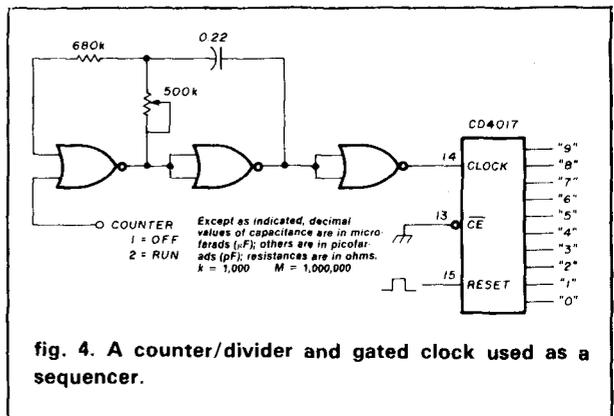
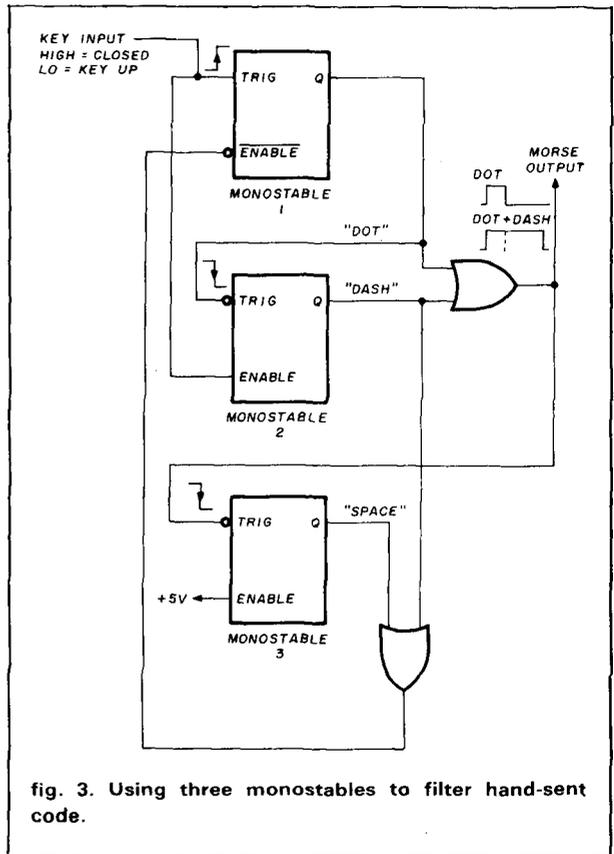
A simple timing circuit can be built using monostables, as shown in fig. 3. Monostable 1 is triggered by the key closure and generates a pulse one unit long. The negative-going edge of this dot pulse will trigger monostable 2 if the key is still pressed at this time. Monostable 2 generates a pulse that is two units long; when added to the length of the dot pulse, a dash pulse of three units is generated. The outputs of monostables 1 and 2 are gated to generate the Morse code output.

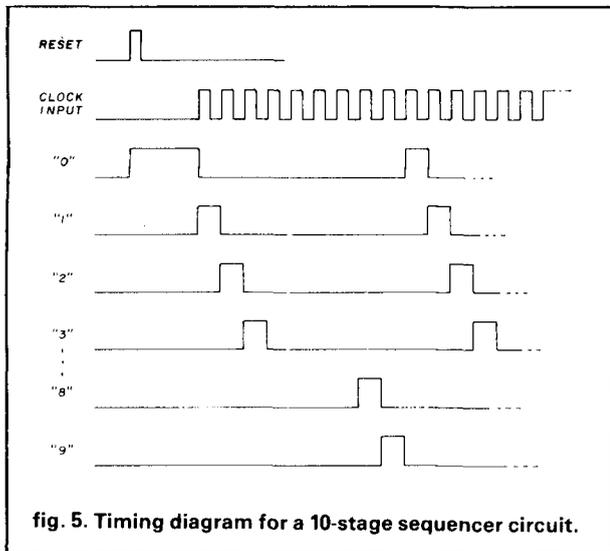
The output of monostable 2 is also used to disable the key input to monostable 1 so it cannot be re-triggered during a dash. A third monostable is

preset for one dot-time to generate the minimum required off period between dots and dashes. Monostable 1 is re-enabled so that the process may be repeated at the end of a dot or dash. While this circuit is useful in explaining the operations we would like, it does have some limitations: three monostables must be adjusted to change the speed of transmission, and key closures during the off period are not recognized. The circuit can be made to work but is impractical.

using a sequencer

A more reasonable approach uses a master clock





to sequence through a series of code-generating and condition-testing steps. Only the frequency of the clock need be adjusted to vary the code timing. The circuit described here was designed using digital complementary metal-oxide semiconductor (CMOS) integrated circuits to reduce power consumption.

As shown in fig. 4, the heart of the circuit is a CMOS CD4017 decimal counter/divider integrated circuit and a gated clock used as a sequencer. The CD4017 accepts input pulses at pin 14 and increments an internal count by one for each pulse. Only one of the ten outputs can be a logic one, indicating the state of the counter. Thus, ten external circuits can be turned on and off in a regular sequence, governed by the frequency of the clock signal applied to the CD4017. This is illustrated by the timing diagram in fig. 5. This sequencing circuit is used to generate the dot/dash/space times and to sequence various circuit elements that can test the key input for changing on and off conditions.

If the output of a free-running square-wave oscillator is controlled with a gate as shown in fig. 6, the first cycle output will be of arbitrary length. All subsequent cycles will be of equal length. This type of gated waveform cannot be used for accurate timing. The trick is to use an oscillator that is triggered or started by the enabling signal. The first clock cycle generated by a gated clock is always the same length as following cycles. When such a gated clock is used with the CD4017 sequencer circuit, the first sequence will be the same length as those that follow. The gated clock is simply a monostable that re-triggers itself when gated on.

The Morse-generator portion of the circuit can be built from the sequencer and several CD4025 three-input NOR gates, shown in fig. 7. The dash input

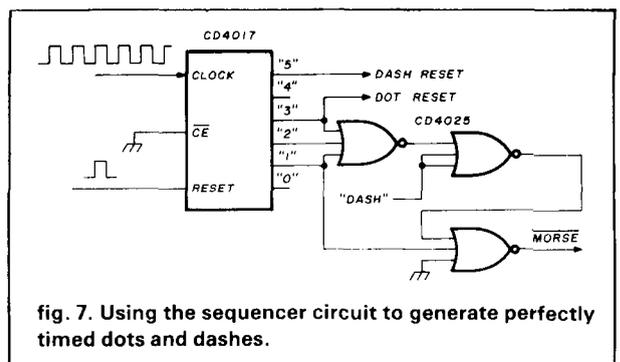
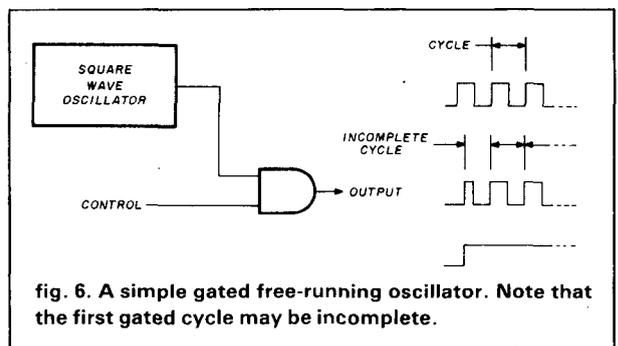
control line determines whether or not a dash is sent. If $DASH = 1$, then a dot is sent. If $DASH = 0$, the sequence is extended and the dot is stretched into a dash. A dot is always sent on sequence start.

generating a dot

The rest state of the sequencer is a logic one at the 0 output with logic zeros at all other outputs. This is the sequencer state when the gated clock is enabled. The first edge of the clock signal increments the internal sequencer count, moving the logic one to the 1 output. The logic one at the 1 output causes the lower NOR gate to output a logic zero. The sequencer moves the logic one to the 2 output on the next clock cycle and the output of the lower NOR gate goes back to the logic one state. This generates a logic-zero dot one clock cycle long. There is no other effect: any action through the upper NOR gates is blocked by the logic one on the dash control line. The time of the sequencer 2 output generates the off period (one clock cycle) at the end of each dot. Output 3 is the dot reset line (described in detail shortly). It resets the dot-generating sequence.

generating a dash

Let's see what happens when a logic zero on the dash control line allows the sequencer outputs to pass through the two upper NOR gates. The se-



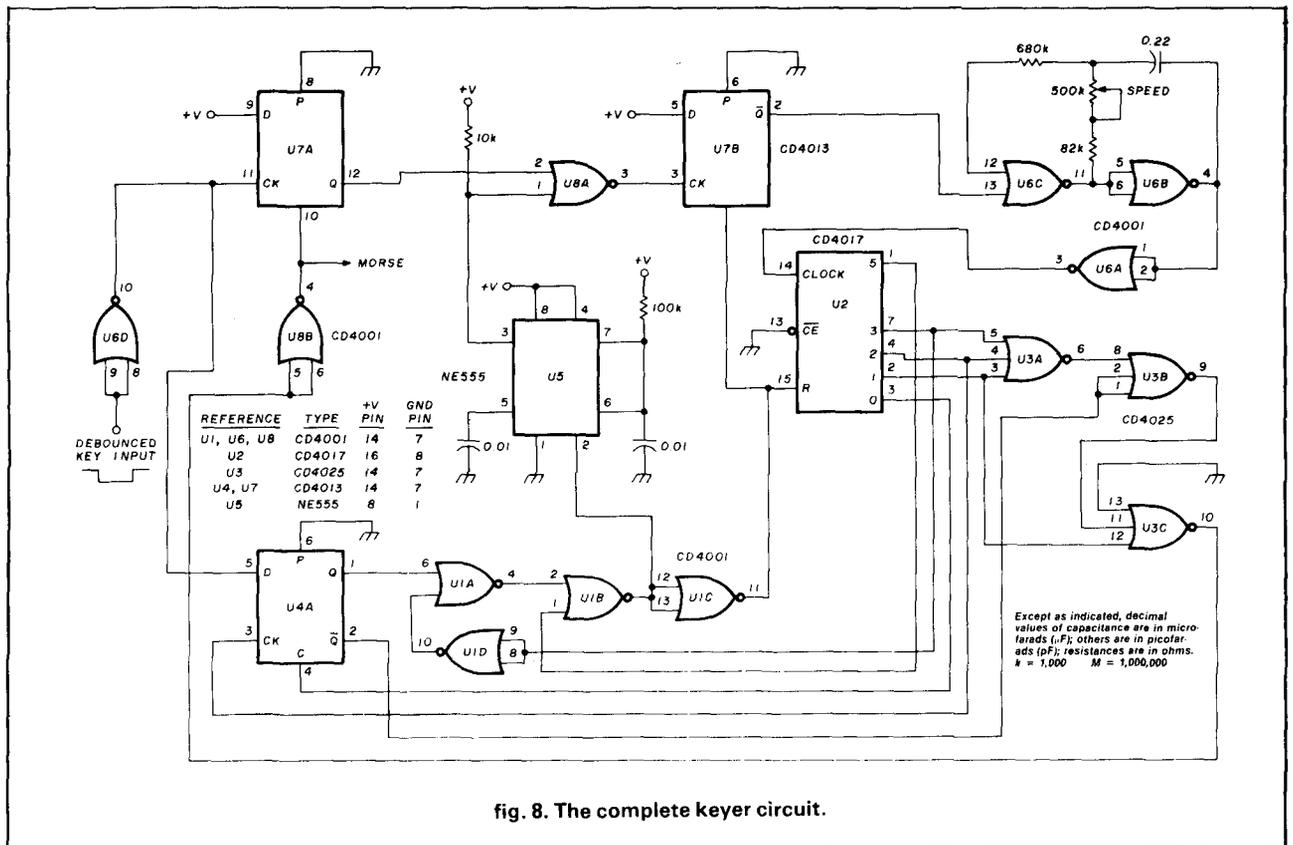


fig. 8. The complete keyer circuit.

quencer has been reset to 0 and the first clock pulse moves it to the 1 state. The output of the lower NOR gate goes to a logic zero once again. Since the two upper NOR gates are now enabled by the dash control line, the logic one outputs at 2 and 3 are passed through the lower NOR gate to generate a logic zero that is present for three clock cycles. This forms a dash exactly three times as long as a dot. Output 4 is not used and this sequence time provides the off period at the end of each dash. Output 5 is the dash reset line which resets the dash-generating sequence.

completing the circuit

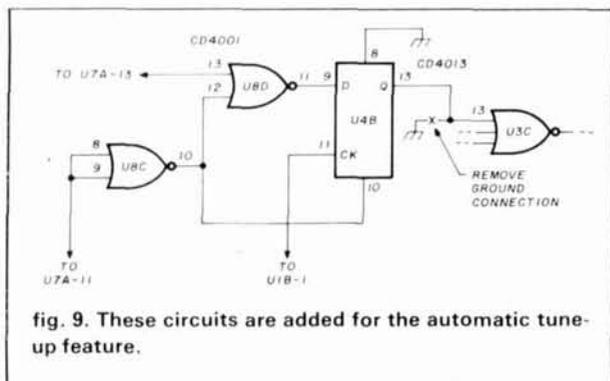
Generating the dot and dash sequences is straightforward. Other circuits are used to detect the key closure and decide whether to send a dot or to extend the sequence and send a dash. A series of CD4013 D-type flip-flops and CD4001 two-input NOR gates are used for this, and shown in fig. 8.

The key input clocks a CD4013 flip-flop, U7A. The \bar{Q} output from this flip-flop goes through a NOR gate to clock flip-flop U7B. U7B-2 turns on the gated clock to start the timing sequence. The Morse output from the sequencer/gating circuit is inverted and applied to the reset input of flip-flop U7A. This clears U7A and holds it in the cleared state for the length of any Morse element (dot or dash) being generated.

The circuit is insensitive to any keying actions while it is generating a dot or dash. Since the clearing signal is the dot or dash, it is not present during the enforced off period and the circuit can detect another key closure during this time.

Several of the sequencer outputs are used to control another flip-flop, U4A, and four two-input NOR gates, U1. This part of the circuit determines whether or not to change from a dot to a dash sequence. Here is how it works: flip-flop U4A is used to determine whether or not the key is still pressed at the end of the dot now being generated. The key input provides the data (D input) signal to the flip-flop clocked at the start of the off period following a dot. If the key is open (as it would be for a properly sent dot) the state of the flip-flop will not be changed; the Q output remains a logic zero and the \bar{Q} a logic one. So, when sequencer output 3 becomes a logic one, it will be passed through the four NOR gates (U1) and reset both the sequencer and flip-flop U7B. This ends the dot-generating sequence. Remember that the 0 output is a logic one when the sequencer is reset.

The key is held closed to send a dash. When the positive edge of sequencer output 2 appears, it clocks the key-closed condition into flip-flop U4A and the sequence is modified. The \bar{Q} output (dash) from the flip-flop enables NOR gate U3B so the dash



sequence can be completed. The reset pulse normally generated by sequencer output 3 is blocked since the Q output from flip-flop U4A is now a logic one. This means that when the sequencer completes step 3, it will continue on to step 4 and then to step 5. The 5 output is now fed into NOR gates U1B and U1C to reset the system. When the sequencer returns to its reset condition, the logic one from the 0 output resets flip-flop U4A.

The same pulse that resets the sequencer counter/divider also resets flip-flop U7B, which controls the gated clock, turning the clock off. Since key-sensing flip-flop U7A may have detected a key closure during the enforced off time between elements, its condition must be tested and passed through to flip-flop U7B after the system has been reset. The sequence must be started again if a key closure is waiting. The testing operation is done by the NE555 monostable, U5, which is triggered by the reset pulse that clears the system. The pulse generated by monostable U5 is longer than the reset pulse. This allows the circuit to be completely reset before any new key-closure information is passed through to flip-flop U7B to restart the Morse-generating sequences. As mentioned previously, this allows the circuit to detect a key closure taking place during the enforced off time between dot and dash elements.

adding a tune-up circuit

Two unused gates and an unused flip-flop exist in the original circuit. These have been used to form an automatic tune-up circuit. Many hams like to make quick on-the-air adjustments to their transmitter or antenna, using key-down tuning for this. Most electronic keyer circuits use another switch or control function to constantly key the rig. If the keyer described here is used, you could only generate dots and dashes. The simple addition shown in fig. 9 allows for constant keying.

This circuit checks to see if you still have your key

closed at the end of a complete dash-generating cycle. If you depress your key and hold it closed, the keyer will generate a dash, a space and then go into a constantly-keyed mode so you can tune your rig. Releasing the key resets this operation so you can send code normally. No added tune control is needed when this tune-up circuit is used. Note: keep on-the-air tune-ups as short as possible! A complete keyer unit is shown in fig. 10.

The circuit described here follows your key operations instantaneously. There is no annoying dead-time or delay between your key closure and start of keying. The decision as to whether or not to send a dash is made on the fly. If you try and send too fast for the speed setting, you will immediately hear the result from your side-tone oscillator and can adjust your speed accordingly.

This circuit will generate accurately timed and spaced code for you and no new hand motions are required. Most hams take about 10 to 15 minutes to become accustomed to sending accurately-timed code with this keyer circuit. Since most of us are a bit inconsistent in our sending, the circuit will clean up the ragged edges of our code so it sounds almost perfect. Of course, it's up to you to generate the required spaces between characters and words.

learning the code

One of the reasons for designing this code-timing circuit was for hams to learn the sound of well-sent code and to learn sending good code with a straight key. Since you can only send code elements in the ratio of 1:3 with this keyer circuit, you quickly learn from the aural feedback whether you are sending good code or not. The ratio of 1:3:1 for dots, dashes and spaces is a bit difficult to master and this circuit can be used to great advantage in teaching newcomers the proper way to send code.

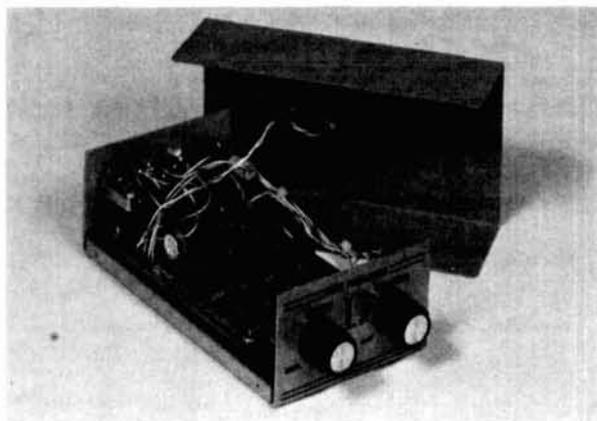


fig. 10. The completed keyer.

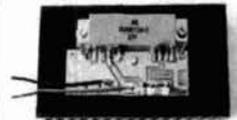
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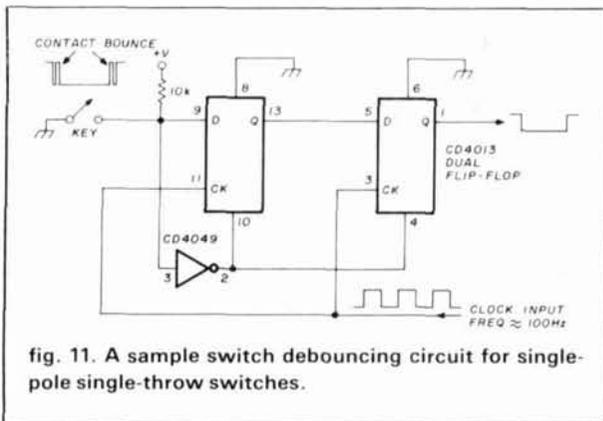


fig. 11. A sample switch debouncing circuit for single-pole single-throw switches.

finishing touches

The circuit in this article needs a key-debouncer as well as a transmitter keying circuit. A sidetone oscillator can be added if desired. The debouncer circuit can be a simple RC network or clocked circuit to filter multiple-contact closures characteristic of mechanical switches. A typical debounce circuit is shown in fig. 11. The external clock is set at about 100 Hz for 100 ms bounces of the key. The transmitter-keying circuit will depend on your rig; a small reed relay with appropriate contact rating and transistor oscillator can be used. A sidetone oscillator is easy to build with a 555 timer. This is recommended for off-the-air use, particularly if you're helping someone get started in ham radio.

CMOS devices in this design allow a power supply that provides 5 to 15 volts. I recommend using at least 9 volts. Most modern solid-state rigs use 12 to 14 Vdc, quite adequate. I don't recommend plug-in battery eliminators as a power source unless voltage regulating and filtering circuits are added.

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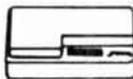


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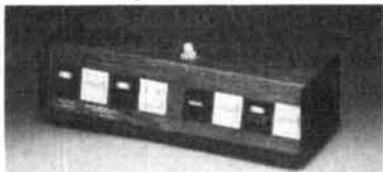
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MARYLAND: The Frederick Amateur Radio Club's 6th annual Hamfest, June 19, 8 AM to 4 PM, Frederick Fairgrounds. Admission \$3.00. YLs and children free. Tailgaters \$2.00 extra. Gates open for exhibitors 8 PM, June 18. Overnight parking welcomed. Exhibitor tables \$10.00 for the first, each extra \$5.00. For more information: V. A. Simmons, KA3CVD, 7301 Pin Oak Drive, Middletown, MD 21769. (301) 371-5735.

NEW JERSEY: The Jersey Shore Chaverim are sponsoring the Jersey Shore Hamfest and electronic flea market, June 12, 9 AM to 3:30 PM, Jewish Community Center, 100 Grand Avenue, Deal. Admission \$3 per person. Children under 12 and YLs free. Refreshments available. Table \$5. Tailgating \$2.50. Reserve spaces by SASE and advance payment to Jersey Shore Hamfest, PO Box 192, West Long Branch, NJ 07764 by May 15. Talk in on 147.045 + .6; 146.52 simplex.

NEW JERSEY: The Raritan Valley Radio Club's 12th annual Hamfest, Saturday, June 18. Gates open 8:30 AM at Columbia Park, Dunellen. Sellers \$3.00 each spot, no tables provided. Lookers \$2.00 donation. Advance tickets purchased from any club member. Talk in on Club repeater, W2OW/R 146.025/625 and 146.52 simplex. For further information: Bob, KB2EF or Mary, WA2JWS (201) 369-7038 — 10 AM to 10 PM.

NEW YORK CITY: The Hall of Science Amateur Radio Club's annual indoor/outdoor, rain or shine, Electronic Hamfest, Sunday, June 12, 9 AM to 4 PM, Municipal Parking Lot, 80-25 126th Street, (1 block off Queens Blvd.) Kew Gardens, Queens. Sellers donation \$3.00; buyers \$2.00; YLs and kids free. Walk/talk in on 146.520. For information: Tony Russo, WB2OLB (212) 441-6545. John Powers, KA2AHJ (212) 847-8007.

NEW YORK: The Skyline Amateur Radio Club (SARC) Hamfest, June 18, 9 AM to 5 PM, Cortland County Fairgrounds, I-81, Cortland. Rain or shine, indoor/outdoor flea markets. Talk in on 52 simplex. Welcome all!

NEW YORK: The Genesee Radio Amateurs' third annual Batavia Hamfest, Sunday, July 10, 6 AM to 5 PM, Alexander Firemen's Grounds, Rt. 98, Alexander. Registration \$2 advance, \$3 at the gate. Large exhibit area, contests, OM/YL programs, food, boat anchor auction, overnight camping. Fun for all! Talk in to W2RCX on 6.52 or 4.71/5.31. For advance tickets (check payable to Batavia Hamfest) or information: GRAM, PO Box 572, Batavia, NY 14020.

OHIO: The Champaign Logan Amateur Radio Club's annual Hamfest and Flea Market, Sunday, June 12, Logan County Fairgrounds, Bellefontaine. Gates open 7 AM EDT. Tickets \$1.50 advance; \$2.00 at door. Tables \$3.00 advance. For information, tickets or tables: Michael DeVault, KUBI, 7157 Road 158, East Liberty, OHIO 43319.

OHIO: The Goodyear Amateur Radio Club's 16th annual Hamfest, Sunday, June 12, Goodyear Wingfoot Lake Park near Akron. Picnic and flea market 10 AM to 5 PM. Family admission \$2.50 advance, \$3.00 gate. Outdoor flea market \$2.00 per space. Dealers inside \$5.00 per table (advance reservations suggested). For tickets and information SASE to: Don Rogers, WA8SXJ, 161 S. Hawkins Avenue, Akron, Ohio 44313. (216) 864-3665.

OHIO: The Battelle Amateur Radio Club (WBQCQ) is sponsoring the 3rd annual Columbus Hamfest, Saturday, June 18, Battelle Memorial Institute Auditorium parking lot, Rt. 315 and King Avenue. Admission \$1.00. Trunk sales \$2.00 per space. Talk in on 75/15 and 52. For information: Bill, WB8LLU (614) 261-7053 or Kevin, WA8OHI (614) 891-2205.

PENNSYLVANIA: The Nittany Amateur Radio Club's annual Hamfest, and now including a computer faire, July 9, Pleasant Gap Firemen's Park, Route 144, Pleasant Gap. Opens 8 AM. Tickets \$3.00. Tailgaters \$5.00 per space. Programs and flea market. Refreshments. Talk in on 146.16/76 and 146.25/85. For information: Dave Buckwalter, KC3CL, 1635 Circleville Rd., State College, PA 16801 (814) 234-0759.

PENNSYLVANIA: The Harrisburg Radio Amateur Club's annual Firecracker Hamfest, Monday, July 4, Shellsville VFW picnic grounds, I-81 north of Harrisburg. Shaded pavilion and tables. Admission \$3.00. YL and children free. Free tailgating. For information and table reservations: KA3HZW, 131 Livingston Street, Swatara, PA 17113 (717) 939-4957.

PENNSYLVANIA: The Murgas Amateur Radio Club (K3YTL) will hold the annual Wilkes-Barre Hamfest, Sunday, June 19, Kingston Armory, Market Street, Kingston. Doors open 6 AM for setup, 8 AM for general admission. Donation \$3.00. YLs and children under 12 free. Tailgating \$1.00 extra per space. Rain or shine. Talk in on 146.61, 146.88, 224.66, 146.52, simplex. For information: Hamfest Committee, PO Box 1094, Wilkes-Barre, PA 18703 (717) 779-3882.

PENNSYLVANIA: The Milton ARC's 12th annual Hamfest, Sunday, June 12, rain or shine, Winfield Fire Co. grounds, Route 15, south of Lewisburg. Note new location. 8 AM to 5 PM. Registration \$3.00. Spouse and kids free. Flea market, auction and contests. Talk in on

146.37/97, 146.025/625. For further details: Ken Hering, WA3JUU, RFD #1, Box 381, Allenwood, PA 17810. (717) 538-9168.

VIRGINIA: The Ole Virginia Hams ARC's ninth annual Manassas Hamfest, June 5, Prince William County Fairgrounds, Rt. 234, south of Manassas. Gates open 8 AM. Tailgating setup 7 AM. Admission \$4.00. Tailgaters \$3.00 extra per space. Under 12 free. Indoor exhibits, YL program, CW proficiency awards. Bring the family for an enjoyable day! For information: Bob Kelly, KA4NES, 7700 Anderson Ct., Manassas, VA 22110.

WEST VIRGINIA: The Triple States Radio Amateur Club will present its 5th annual Wheeling, WV Hamfest at Wheeling Park on Sunday, July 24, from 9 AM to 4 PM. Dealers, flea market and auction, free parking, refreshments, ARRL, SWOT booths, etc. Admission \$2.00, children under 12 free. Indoor display, tables available, price of admission only but reserve space. CONTACT: TSARC, Box 240, RD 2, Adena, OH 43901. Phone (614) 546-3930.

WISCONSIN: The South Milwaukee Amateur Radio Club's annual Swapfest, Saturday, July 9, The American Legion Post 434, 9327 South Shepard Avenue, Oak Creek. Activities being at 7 AM. Admission \$3.00 per person and includes a "Happy Hour" with free beverages. Parking, picnicking, refreshments available. Also free overnight camping. Talk in on 146.94. For information and a local map: South Milwaukee ARC, Inc., PO Box 102, South Milwaukee, WI 53172.

ONTARIO: The ninth annual Ontario Hamfest, sponsored by the Burlington Amateur Radio Club, Saturday, July 9, Milton Fairgrounds. For information: Burlington ARC, PO Box 836, Burlington, Ontario L7R 3Y7.

BRITISH COLUMBIA: The Maple Ridge ARC is hosting Hamfest '83, July 2 and 3, Maple Ridge Fairgrounds, 30 miles east of Vancouver on #7 Hwy. Registration Hams \$5.00; non-Hams over 12 \$2.00. Food displays, swap & shop, bunny hunts. Ladies' and children's programs. Plenty of camping space. Talk in on 146.20/80, 146.34/94. 20% off pre-registration. Contact: Bob Houghton, VE7BZH, Box 292, Maple Ridge, BC V2X 7G2.

OPERATING EVENTS "Things to do..."

JUNE 11-12: The Macomb Emergency Communication Association will operate special event station KA8KTV in commemoration of Michigan tornado season. 1300Z June 11 to 2100Z June 12. 20m RTTY, 14.080 - 14.090, 2m FM 146.07/67 and the upper general class phone portion of 15, 40 and 80m. QSL with 8 1/2 x 11 SASE to: KA8KTV, Box 291, Utica, MI 48087.

JUNE 11: The Libertyville and Mundelein Amateur Radio Society (LAMARS) will operate W9HOQ near the site of the largest train robbery in the United States history from 0000Z to 2400Z. Frequencies: Phone and CW — 15 kHz up from lower 40-15m General Class band edges; Novice — 21.135 ± QRM. Certificate for large SASE to KB9BR or "Big Robbery", Box 656, Libertyville, IL 60048.

JUNE 21 - July 11: State Line ARC, Hobbs, NM, will operate station W5SZS during the World Soaring Competition, 2200 to 0400 UTC weekdays and 1200 to 0400 UTC weekends on 80 through 10 meters, 2 meters FM and SSTV. Pilots from twenty or more countries will be participating. For a special certificate send QSL info with QSO number and \$1.00 to W5SZS Special Event, 209 W. Gold, Hobbs, NM 88240. SWL's are also eligible.

JUNE 18: Cape Fear ARS will operate WB4YZF from 1300-2100 Z, for the 15th annual National Hollerlin Contest. Phone 7.235. For details: Lee Brown, N4DTB, 462 Shoreline Drive, Fayetteville, NC 28301.

JUNE 10-11: The annual Bell Tower Festival in conjunction with the National Corn Throwing Contest will operate W0MLY, 1400Z to 000Z each day. Bottom 10 KC General Band. Send #10 SASE to Box 7, Rippey, IA 50235 for a nice certificate.

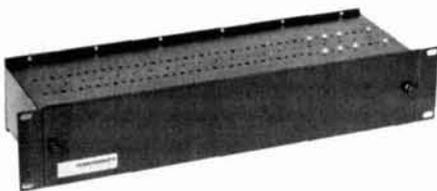
JUNE 11: The Wireless Institute of Northern Ohio (WINO) will operate special event station KO80 to commemorate Ohio Wine Week. Saturday evening 7 and 11 PM EDT on 3900 MHz and 7235 MHz. Sunday afternoon, 11 AM and 4 PM on 7235 MHz and 21360 MHz. The station will be located at an actual winery in Madison, Ohio. For a special QSL certificate send legal SASE plus 40¢ to: KO80, 7126 Andover Drive, Mentor, Ohio 44060.

JUNE 11-13: World Communication Year RTTY Contest. Conducted by the Australian National ARTS (replacing the VK/ZL Oceania RTTY DX Contest for 1983). 0000Z-0800Z; 1600Z-2400Z; 0800Z-1600Z. Bands: 3, 5, 7, 14, 21 & 28 MHz. Classes: Single operator, multi operator and SWL. Logs of multi operators must be signed by all operators with their call signs. Exchange: RST, Zone, Time in UTC. For more information: W.J. (Bill) Storer, VK2EG, 55 Prince Charles Rd., Frenchs Forest, 2086, N.S.W. Australia.

NEW products

community repeater panel

Ferritronics Inc. has introduced a new Community Repeater Panel, the FT124C. The FT124C is compatible with digital-coded squelch schemes, such as Digital Private Line, Digital Channel Guard, etc., in addition to the conventional EIA CTCSS tones. Up to eighteen users may be accommodated by the new panel, which includes complete audio processing, drop-out delay and time-out timer circuits on plug-in boards in a sturdy rf-shielded enclosure.



Only six connections, including power and ground, are required to interface the panel to any full duplex station, to create a very cost-effective shared repeater. For more information, contact Ferritronics, Inc., 1319 Pine Avenue, Niagara Falls, New York 14301. RS#301

antenna rotator control

The DRC-1 rotator control incorporates a crystal-controlled modem allowing all control signals to pass over standard two-wire telephone lines up to distances of five miles. With leased phone lines this distance can be increased indefinitely.

The DRC-1 control offers high versatility in azimuth control of larger antennas with shortest path-continuous rotation, or north-center 360-degree rotation, verified by a digital azimuth readout. Switch-selectable 110/220-volt operation and line-fault indicator are standard. The DRC-1 is housed for tabletop operation or can be rack mounted. The DRC-1 controls any one of three heavy-duty Hy-Gain antenna rotators with torques of 9,000, 16,000, and 23,700 inch pounds supporting vertical loads of 1,000, 7,000, and 20,000 pounds respectively.

For further information, please contact the CIM Department, Hy-Gain Division of Telex Communications, Inc., 8601 Northeast Highway 6, Lincoln, Nebraska 68505.

"To Win The World" film

"To Win The World" is a 29-minute color film that follows the crew of the million-dollar K2GL mountaintop station in Tuxedo Park, New York, during a recent DX contest. The film highlights scenes from the contest, includ-



ing the raising of a four-element 80-meter Yagi onto a 200-foot tower. It is directed and produced by Peter Bizlewicz with Larry Miller, and narrated by Bill Leonard. This film is available in 16-mm print and videotape.

"To Win The World" is a movie that will interest both ham and non-ham viewers. It's the story of a technological sport, presented in a way that captures the excitement and challenge of contesting. Films are available in three formats: 1/2-inch VHS or Beta, \$75; 3/4-inch video cassette, \$300; and 16-mm print, \$425. The 16-mm prints are also available for rental. For more information, contact Peter Bizlewicz, 1209 Pines Lake Dr. W., Wayne, New Jersey 07470. RS#302

compact hf transceiver

The FT-77 is an extremely compact HF transceiver for active mobile or space-conscious operators. Using computer-aided design and automated insertion techniques, the FT-77 represents an advance in manufacturing efficiency and reliability. Equipped for SSB and CW operation (fm optional), the FT-77 includes digital frequency display, CW wide/narrow selection, selectable AGC, RIT, and a highly effective noise blander.

For more information, contact Yaesu Electronics Corp., P.O. Box 49, Paramount, California 90723. RS#303



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For more information, contact Aluma Tower Company, P.O. Box 2806, 1639 Old Dixie Highway, Vero Beach, Florida 32960. RS#304

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Also available from Encomm is the HL-32V. This amplifier is similar to the HL-30V but has an FM/SSB switch to allow SSB/CW operation. It also has a high/low power switch which cuts output power by one half. Suggested retail price for the HL-32V is \$89.95.

For more information, write THL Sales Department, Encomm, Inc., 2000 Ave. G, Suite 800, Plano, Texas 75074. RS#305

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- ✓ Sweepstakes
- ✓ Cordless telephones
- ✓ FCC ideas on 1500 watts output
- ✓ Manufacturer responses to 10.1 MHz equip. mods.
- ✓ Six-meter openings
- ✓ How to calculate your system noise figure
- ✓ Worldwide network of 20-meter beacons
- ✓ 900 MHz ssb
- ✓ 160-meter DXing
- ✓ Big antennas at K2GL
- ✓ Antenna heading calculations
- ✓ Review of Yaesu FT-102, ICOM-740, and others
- ✓ How Packet Radio works
- ✓ Meteor scatter
- ✓ The Satellite Program
- ✓ Interview with Madison Electronics
- ✓ and much, much more!

Amateur Radio Today ✓ 107
Post Office Box 6243H, Wolcott, CT 06716



MFJ provides a thirty-day money back trial period. If you are not satisfied, you may return the clock for a full refund (less shipping). MFJ also provides a one-year limited warranty.

The MFJ-105 clock is available from MFJ Enterprises, Inc., for \$49.95 plus shipping and handling. For more information, contact MFJ Enterprises, Inc., P.O. Box 494, Mississippi State, Mississippi 39762. RS#306

hand-held. When used in mobile-in-motion, the electronics do an excellent job of averaging out reflections from nearby objects, permitting stable, accurate bearings to be taken. Not having to stop to take bearings cuts down the time required to reach the transmitter.

The SuperDF is available in kit form or assembled. Kits include plated and drilled box, drilled antenna boom, and antenna elements. The instructions include figures, diagrams, theory of operation, operating instructions, check-out and troubleshooting section, and extensive hints on hunting with the system. Construction and adjustment requires only simple hand tools, epoxy glue, and a VOM. For more information, send an SASE to: BMG Engineering, 9935 Garibaldi Avenue, Temple City, California 91780. RS#307

NEW

BASIC PROGRAM MANUAL FOR AMATEURS

Programs Design: Antennas, Op-amps, Smith-charts, R.F. Coils, Pads, Filters, Striplines, Microwave and more.

All for **\$9.95** (INCLUDES SHIPPING AND HANDLING)

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15 minutes to install; scan restarts when carrier drops off; busy switch controls automatic scan on-off; includes module and instructions.

Model AS-1 \$25.00

NEW BATTERY SAVER KIT Model BS-1 \$14.95

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- 45 mA receiver drain reduced to 30 mA
- Improved audio fidelity and loudness ✓ 134

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radio direction finder

BMG Engineering announces a new radio direction finder, the Super DF. Hams can use the system for sport transmitter hunts, finding stuck microphones, and hunting jammers. It's also useful for finding stuck or stolen transmitters, and search and rescue teams can use it to triangulate on boats at sea or downed aircraft.

This easy to use unit connects to any unmodified NBFM receiver (such as a scanner, hand-held, or transceiver) at the antenna input and external speaker jack. It will work on any frequency between 100 and 260 MHz with one antenna, and between 200 and 550 MHz with another antenna. This non-ambiguous system resists overloading, and neither an S-meter nor attenuator is required. All strengths of signals can be hunted. One control unit can be used with any antenna unit: base station, mobile, or

off-the-shelf enclosures

PacTec Corporation has released a new four-page color brochure outlining its off-the-shelf line of enclosures for the electronics and related industries. The brochure includes dimensions and prices for all injection-molded ABS enclosures, from the small, hand-held Series H enclosures to the large Series CL enclosures, measuring 12.5 x 11.6 x 8.8 inches. Enclosures for desktop and computer systems are also described.

Standard accessories such as tilt stands, wrist and shoulder straps, and cord wraps are presented, as well as a list of available design options including speaker grills, ventilation slots, and EMI/RFI shielding.

For more information, contact PacTec Corporation, Enterprise and Executive Avenues, Philadelphia, Pennsylvania 19153. RS#308



scientific instrument interference control

A new forty-page catalog (Number 831) from Electronic Specialists presents their line of instrument and computer interference control products. Protective devices for smooth instrumentation operation include equipment isolators, ac power line filter/suppressors, line voltage regulators, and ac power interrupters.

Sections describing particular scientific and computer problems and suggested solutions are included. Typical applications and uses are highlighted.

For a copy of the catalog or further information, contact Electronic Specialists, Inc., 171 South Main Street, Natick, Massachusetts 01760. RS#309

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 COD's / Dealers Wanted




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new antenna

Bilal Company has introduced a new antenna to its product line, the Isotron 15. Designed to operate on the 15-meter band, this antenna will give performance comparable to a full-size dipole in just a fraction of the space. The Isotron 15 will handle full legal power and has a bandwidth of 450 kHz, with less than 2:1 VSWR. Center frequency is adjustable for optimum performance on your favorite frequency. The antenna weighs less than 2 pounds and is just 21 inches in length. The Isotron 15 can be mounted on any 1-3/8 inch or smaller mast and in the vicinity of other Isotron antennas for a compact and unobtrusive multiband installation.

For more information, contact Bilal Antennas, Star Route 2, Eucha, Oklahoma 74342. RS#310

rf wattmeter

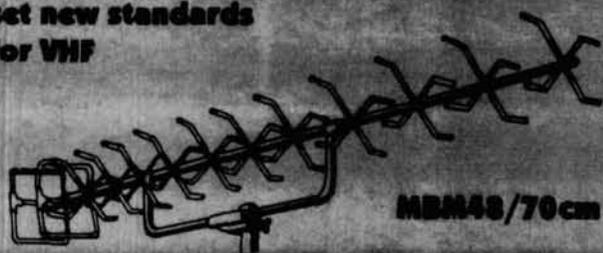
The new ThruLine® directional wattmeter model 4410 expands the usual single full-scale power level of its plug-in element to seven overlapping power ranges.

Designed for CW and fm systems from 200 kHz to 1000 MHz and 1/4 watt to 10,000 watts, the new precision instrument uses special elements providing seven levels instead of one. The 37-dB power range covers 1/3/10/30/100/300/1000 or 10/30/100/300/1000/3000/10,000 watts with ± 5 percent accuracy. Range is selected by a front-panel rotary switch which also includes a battery-level position. Elements are simply rotated for either forward or reflected power measurement.

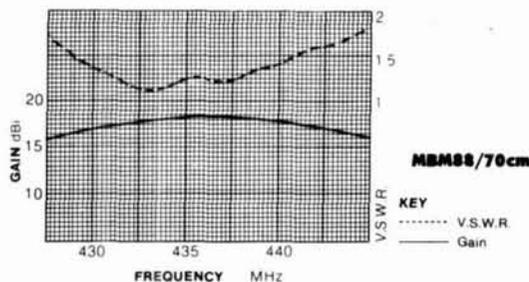
Model 4410 ThruLine® wattmeters feature



Jaybeam MULTIBEAMS set new standards for VHF



MULTIBEAMS have a quad configuration of directors on a single boom, together with a slot dipole and slot reflector. This unique design delivers exceptionally high gain across the entire 430-450 MHz band with very low vswr.



SPECIFICATIONS

	MBM28	MBM48	MBM88
FREQUENCY (MHz)	430-450	430-450	430-450
GAIN (dbd)	11.5	14.0	16.3
FRONT TO BACK RATIO	18dB	20dB	22dB
3 dB BEAMWIDTH	E45° H40°	E35° H28°	E28° H23°
BOOM LENGTH	4.1'	6'	13'
LONGEST ELEMENT	16.5"	16.5"	16.5"
TURNING RADIUS (APPROX)	4.1'	3.28'	6.56'
DESIGN IMPEDANCE	50 Ohms	50 Ohms	50 Ohms
POWER RATING (PEAK)	1 kw P.E.P.	1 kw P.E.P.	1 kw P.E.P.
WINDLOADING AT 80MPH	14.1 lbs/f	25.1 lbs/f	47.2 lbs/f
WEIGHT	4 lbs.	6 lbs.	10.4 lbs.

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Contact one of the authorized dealers listed below.

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low-insertion VSWR of 1.05 or less, temperature compensation to maintain full rated accuracy from 0 to 50 degrees C, 120-percent over-range protection regardless of the selector switch position, and a choice of eighteen common rf connectors interchangeable in the field.

For additional information, contact Bird Electronic Corporation, 30303 Aurora Road, Cleveland (Solon), Ohio 44139. RS#311

ITC-32 TT control board

Advanced Computer Controls is proud to introduce its new ITC-32 Intelligent Touch-Tone® Control Board. The ITC-32 addresses the need for TouchTone® control in Amateur Radio, commercial, and industrial applications with microcomputer-based flexibility and state-of-the-art Mitel tone decoding (No PLLs!).

Nampa Satellite SYSTEMS

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AUTO-TECH GLR 500..\$1994

LUXOR STEREO, Infra-Red remote control.....\$2395

UNIVERSAL COMMUNICATIONS

DL2000.....\$1999

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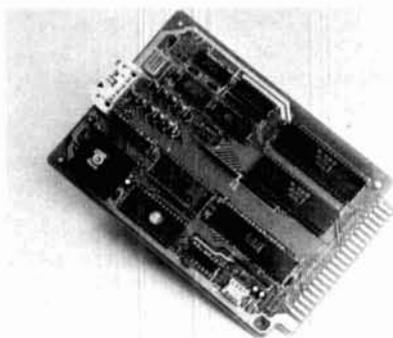
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The ITC-32 provides twenty-eight remotely controllable logic outputs and four remotely sensed inputs. Morse code or tone encoded response messages verify command entry, and enable remote interrogation of output and input logic states. Eight of the twenty-eight outputs are buffered for high current/high voltage-drive capability, such as for direct relay drive. The other twenty outputs are TTL compatible levels. The outputs may be commanded singly, or in groups, allowing a variety of control possibilities, such as antenna direction, PL frequency, and gain controls. An additional command allows BCD programming for control of remote base frequency synthesizers.

The logic inputs may be interrogated, or may function as alarm inputs, such as for intrusion detection, over-temperature, or flood indication with external sensors. Optional connection to our telephone interface board allows land-line control, and auto-dial out on alarm conditions.



For more information, contact Ed Ingber, WA6AXX, Advanced Computer Controls, 10816 Northridge Square, Cupertino, California 95014. RS#312

plastic cable wrap

The M.M. Newman Corporation introduces a multi-purpose plastic cable wrap that comes in handy packaged lengths for organizing and protecting wires, tubing, and hoses. M.M. Newman cable wrap is an expandable polyethylene cable harness that snugly grips, organizes, and protects. It is as easy to apply as tape and stays in place without adhesives or glue.

M.M. Newman cable wrap comes in three standard sizes: 1-3/8-inch diameter × 10-foot black UV resistant; a 1/4-inch diameter × 10-foot black; and an assortment pack of 1/8-inch, 1/4-inch, and 3/8-inch sizes in 5-foot

lengths. Private labeling with two-color headers is also available.

For additional information, contact M.M. Newman Corporation, 7 Hawkes Street, Marblehead, Massachusetts 01945. RS#313

high-band and UHF RF amplifier

A new line of fm RF amplifiers that increase the output of low-power high band or UHF portables and mobiles from as little as 2 watts to as much as 100 watts is now available from The Antenna Specialists Co.

The compact, self-contained A/S RF amplifiers operate on 12 Vdc (negative ground) and are field-tunable across the range of 136-174 MHz in high band models or 430-512 MHz in UHF. Six high band models accept nominal RF inputs of 2, 10, or 25 watts and produce a nominal output of 25, 50, or 100 watts. The four UHF models deliver a nominal 25, 50, or 80 watt output with a nominal input of 4 watts, or 80 watts RF out with 25 watts in. Unit size varies depending on the frequency range and power output. The smallest measures only 1.56 inches high by 3.75 inches long (including connectors) and is supplied with an under-dash mounting bracket. The medium power models are 6.6 inches long by 4.6 inches wide by 2.5 inches high (including connectors) and the high power models are 2 inches longer; both have mounting flanges with four bolt holes.

For further information, contact The Antenna Specialists Co., 12435 Euclid Avenue, Cleveland, Ohio 44106. RS#314

30-meter mobile antenna

A new resonator has been added to the line of Hustler hf mobile antennas. Model RM-30 is designed for operation in the newly allocated 10.100 to 10.150 MHz band when used with a MO-1 or MO-2 foldover mast. VSWR at resonance is 1.15:1 (50 kHz under 2:1), and power handling capability is 250 watts.

For more information, contact Hustler, Inc., 3275 North B Avenue, Kissimmee, Florida 32741. RS#315

HT conversion

VoCom announces its new HT conversion system, which makes possible the conversion of virtually any hand-held radio to full mobile operation through use of the VoCom Power Packet. The Power Packet gives 3 watts of audio output power to cover road noise, and its unique charging system keeps your HT charged and ready for portable operation. Also included is a microphone preamp to accommodate near-

ly any microphone and a hooded lamp to illuminate the HT at night. When the unit is dash-mounted, all front panel HT controls are conveniently accessible.

Smaller than many control heads, the Power Packet measures only 5 x 3-1/4 x 1-1/2 inches, thereby simplifying mounting in automobiles. The packet, external speaker, rf amplifier and the HT can all be mounted in separate locations within the vehicle, making them less conspicuous from outside the car. The packet functions as a "control head" for the system.

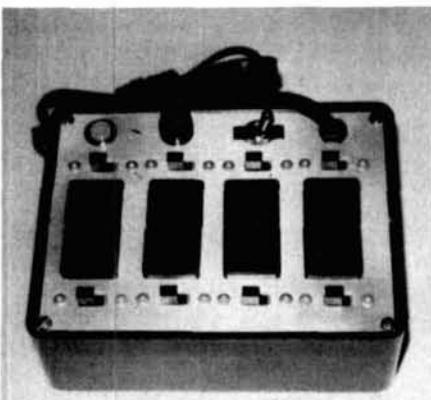


Suggested retail is \$84.95; matching speaker, \$19.95; external rf amplifiers are priced from \$84.95. For more information, contact VoCom Products Corporation, 65 E. Palatine Road, Prospect Heights, Illinois 60070. RS#316

surge suppressor and noise filter

Kalglo Electronics Co., Inc., has added a new console-model Spike-Spiker to its existing line of voltage surge suppressors and noise filtering devices for protecting sensitive equipment from damaging voltage spikes and line noise. Called the DPC-Plus, it provides eight individually switched 120-volt, 15-ampere outlets divided into two banks of four outlets each, a main on/off switch, fuse, status lights, and 7-foot grounded heavy-duty cordset.

Voltage spikes are suppressed in six different



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Hamtext™, our new program, is available for the VIC-20 and Commodore 64, with all the features of Hamsoft™ plus the ability to save received information to disc or tape, variable buffer sizes, VIC printer compatibility, and much more. Our combination of hardware and software gives you the system you want, with computer versatility, at a reasonable price.

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RTTY send/receive 60, 67, 75, 100 WPM
ASCII send/receive 110, 300 Baud

Hamsoft™ Prices

Apple Diskette	\$29.00
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VIC-20 Board	\$49.95
TRS-80C Board	\$59.95
TI-99 Board	\$99.95

Hamtext™ Prices

VIC-20 Board	\$99.95
Commodore 64 Board	\$99.95



Suggested Retail \$169.95

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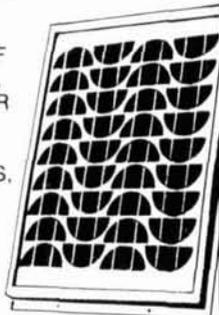
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For more information, contact Kalglo Electronics Co., Inc., 6584 Ruch Road, E. Allen Township/Bethlehem, Pennsylvania 18017. RS#317

44-pound generator

WINCO, a division of Dyna Technology, Inc., announces the new K900 Dynamight Generator, which delivers 900 watts of ac power. The K900 weighs only 44 pounds and is UPS shippable. It features a USDA forestry-approved muffler for super-quiet running. In addition, the K900 offers automatic reset overload protection, automatic throttle control, a 76cc four-cycle Kawasaki engine and two 120-volt outlets. The K900 is manufactured in the U.S.A.



For more information, contact Walt Brammer, Sales Administration, WINCO Division of Dyna Technology, Inc., 7850 Metro Parkway, Minneapolis, Minnesota 55420. RS#318

code training programs

Three new audio cassette training programs for operators who want to increase their copying speed are available from Twin Oaks Associates.

Developed over a four-year period by Amateur Radio operators who are also mental

health professionals, the programs employ the principles of the psychology of learning to teaching code and upgrading ham skills.

The System 12 Alphabet Book[®] introduces basic Morse through a series of six thirty-minute cassettes. Suitable for individual or classroom use, the Alphabet Book takes students up to and beyond 7 WPM. The cost for the set is \$15.

System 12[®], consisting of five sixty-minute cassettes, is designed to help Novices and Technicians pass the 13 WPM FCC code test, with a speed range of 2½ to 17 WPM. The set includes a study guide and is priced at \$30.

Operators already copying at 10 WPM and preparing for the Amateur Extra Class test can use System 24[®] to help increase their copying speed. Through a series of five one-hour cassettes, System 24[®] takes the operator from six to well over 30 WPM. With a study guide, System 24 sells for \$30.

For additional information, contact Twin Oaks Associates, Route 5, Box 37, Knoxville, Iowa 50138. RS#319

pro-amTM

Mobile HF Antennas

The Pro-Am HF mobile series are heavy-duty, slim line construction, designed for the HF Amateur Bands, 75M, 40M, 20M, 15M, and 10M.

Heavy-gauge copper wire wound on 3/8" fiberglass, with nickel-chrome brass fittings and 17-7 taper ground S.S. whips assure dependable mobile operation. The 4' S.S. whip is field tunable for lowest VSWR and double locked with S.S. set screws. The antenna features 3/8-24 ferrule to fit standard mobile mounts. Power-rated at 500 watts P.E.P. for top mobile performance. Approx. 8' length.

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PHF15	15 Meters
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DTMF receiver kit

The new Teltone M-956 DTMF receiver is now available with all the parts necessary to breadboard a central-office-quality DTMF detection system. You supply only the power source.

The features and performance of the M-956 make it ideal for applications such as computer data entry, equipment remote control, telephone switching, and mobile radio. The unit's sensitivity, dynamic range, noise immunity, and low power consumption make it particularly well suited for use in communications products, and it comes in a twenty-two-pin DIP industry-standard pinout.

For more information, contact Teltone Corporation, 10801 120th Avenue Northeast, Kirkland, Washington 98033-0657. RS#320



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CS2012	PHOTOGRAPHY & LIGHTING I.C. APPLICATIONS FOR EXPOSURE (SHUTTER) CONTROL, PROGRAMMABLE PHOTO SWITCH, LINEAR PHOTOMETER, AUTO HEADLIGHT CONTROL w/DELAY. ON CHIP PHOTO DIODE. LINEAR PHOTO CURRENT COMPARTOR MARKS. THIS A VERSATILE OPTOELECTRONIC DETECTOR INTERFACE. 8 pin DIP.	\$ 5.95
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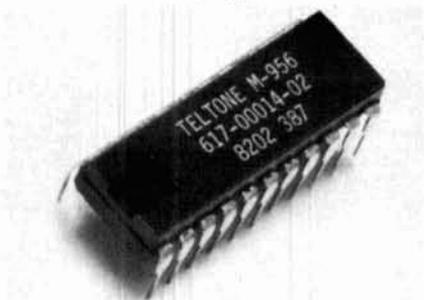


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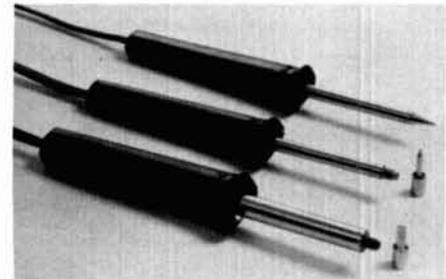
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energy-saving soldering irons

Three new low-priced "consumer" soldering irons with advanced "Thermo-Duric" heaters were introduced by the Ungar Division of Eldon Industries, Inc., at the Electronic Distribution Show in Las Vegas.

"Thermo-Duric" heating elements reach soldering temperature faster, use less energy, last longer, and take less space than earlier wire-wound heating elements. Since the heaters were developed for industrial soldering systems, the new "consumer" line has soldering qualities and dependability appropriate for electronic technicians and serious hobbyists.

The CM-25 (\$8.50), has an integral nickel-plated cone tip suitable for small and large connections. The 25-watt iron heats to 750 degrees F.

The 45-watt CM-45 and 80-watt CM-80 can use any of eleven standard Ungar screw-on tips, and have three-wire cords to prevent leakage current damage.

The CM-45 (\$11.25), comes with an iron-plated pencil-tip point. Operating temperature is 700 degrees F. The large-capacity CM-80 (\$17.50), comes with an iron-plated chisel tip and operates at 800 degrees F.

Slimmer, cooler handles were made possible by the more efficient "Thermo-Duric" heaters.

For further information, contact Ungar, 100 West Manville Street, Compton, California 90220. In Canada, contact Eldon Industries of Canada, Inc., 500 Esna Park Drive, Markham, Ontario L3R 1H5. RS#321

single chip repeater control

Digital Microsystems, Inc., has announced the release of a single chip repeater control (SCRC) that features crystal-controlled timing accuracy for ID, tail, and timeout timers, with the period of each timer programmable by the user. Each chip features an audio generator for generating the repeater station's call sign as well as several useful control messages such as

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SB-5	5 position 1 section use with 811's or sweep tubes	\$ 9.50	PC-8877-1	Aluminum Heat Sink For 8874, 8875, 8877, 3-1000, 572, specify tube	\$ 7.50
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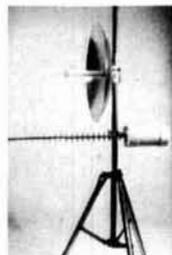
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For more information, contact Digital Microsystems, Inc., 607 Sudbury Street, Marlboro, Massachusetts 01752. RS#322

autopatch and DTMF decoder modules

Hamtronics recently released two new modules to complement their line of VHF and UHF repeaters. The autopatch module provides full telephone patch and reverse autopatch functions for a repeater or duplex rural radio telephone installation. In addition, it allows both primary repeater control via phone line and secondary control via the repeater receiver; it also allows a control operator to monitor the repeater receiver by telephone even when the transmitter is off. The autopatch features a choice of either automatic answer or on-air tone ringing when a party calls the reverse patch function. It also features automatic level limiting, time-out timer, tape recorder relay for logging, and access code tone muting for security. The price of the autopatch is \$89.95 in kit form, \$159.95 wired.

The DTMF decoder/controller module can be used with the autopatch, or can be used alone for control of repeaters and other devices by radio link. It has outputs to control two on/off functions independently. Typically, it is used to control a repeater and autopatch, but there are many other remote control jobs it can perform in radio, industrial, mining, and scientific applications. The decoder uses a four-digit DTMF code, and several safety features are provided for security against falsing or tampering. The unit is all solid-state (no relays) and uses commonly available ICs. The kit costs \$89.95; the wired unit, \$159.95.

For more information and complete catalog, write Hamtronics, Inc., 65F Moul Road, Hilton, New York 14468-9535. (For overseas mailing, please enclose \$1 or 4 IRCs.) RS#323

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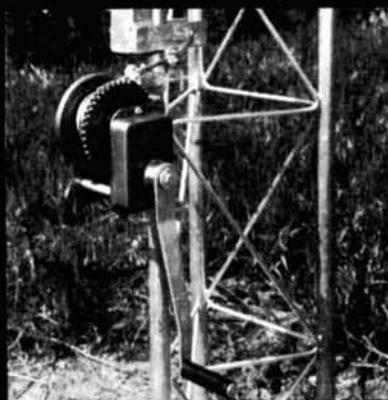
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technical forum

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Each month our editors will select the best answer received to a question previously posed in *Technical Forum*. We'll send the writer a book from our Bookstore as a way of saying thanks.

noise blanker

I need a noise blanker circuit that could be used in a National HRO 500. Any suggestions? — Bill Blackwell, K8LO

pacemakers and rfi

Some time ago I saw an article about the very poor shielding of pacemaker devices used to regulate the heartbeat. It was written by a doctor in Dallas, and it should have scared any Amateur who has had a pacemaker installed. I have no idea how many, if any, hams have died because of rf getting inside a pacemaker, but recently in the cardiac section of a local hospital I was disturbed to overhear a conversation between a pacemaker recipient (an Amateur) and his doctor. The doctor did not know what my Amateur friend was talking about when he asked about the effects of rfi on the pacemaker, nor did he understand the problem when it was explained.

Here in Florida there are probably more retired hams with heart problems than anywhere else, yet I have been unable to find out how many have died as a result of pacer failures caused by rf, nor have I been able to obtain specs on any of these devices. As I understand it, the pacemaker is simply a device that emits a controlled pulse to the heart.

Do any of the readers of *ham radio* have any information on this important question? — Edwin M. Hollis, K4CN.

making verticals quieter

Bill Orr's article on vertical versus dipole antennas in the October, 1982, issue of *ham radio* verified what those of us who have used both types of antennas have found in their performance. The noisy vertical antenna can be quieted, however, without changing or modifying the vertical antenna in any way.

In order to "tame" a vertical, one technique employs a transformer at the feed point of the vertical. My first experience was with a simple quarter-wave vertical designed for 40 meters. The transformer consisted of eleven bifilar turns wound on the core supplied for an Amidon balun kit. The transformer can be used to match a

200-ohm load by connecting the windings as in **fig. 2**.

I used this configuration on a non-resonant antenna I built. Since this antenna has about a 200-ohm impedance, I used a 4:1 ratio transformer to bring it down to 50 ohms.

Ace Collins, K6VV, suggested this idea a few years ago when he was doing some experimental work on ground-independent antennas. The first time I tried it I thought my feed line was not connected, the antenna was so quiet! I pass this suggestion along for what it may be worth to those who favor vertical antennas because of their low radiation angle, omnidirectional characteristics, or the space limitations of small city lots. — Robert L. Crawford, WA6RYZ.

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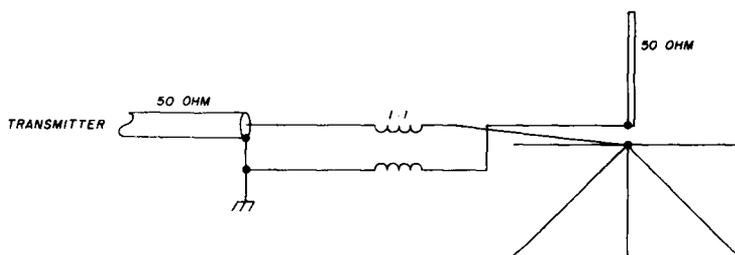


fig. 1. Bifilar 1:1 wound transformer reduces noise in 50 ohm vertical.

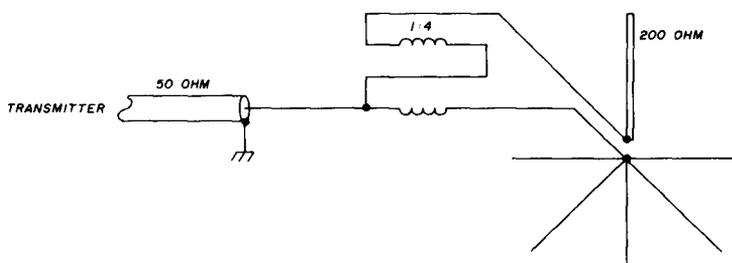


fig. 2. Bifilar 4:1 wound transformer reduces noise in 200 ohm vertical.

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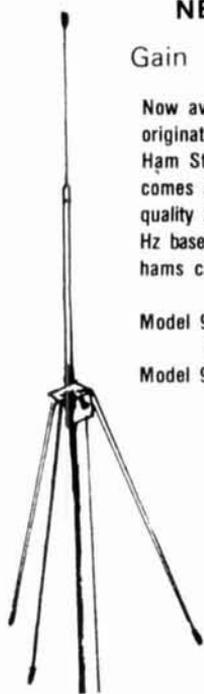
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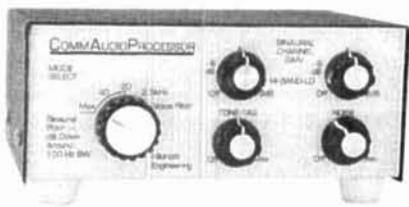
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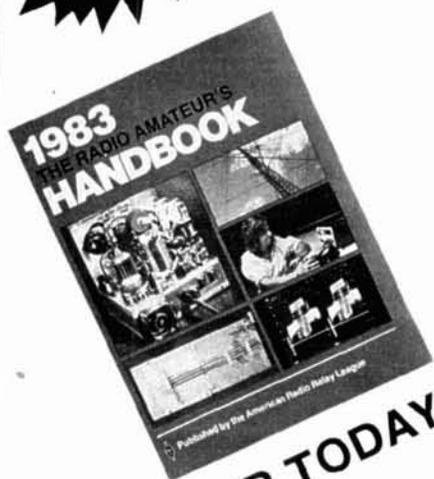


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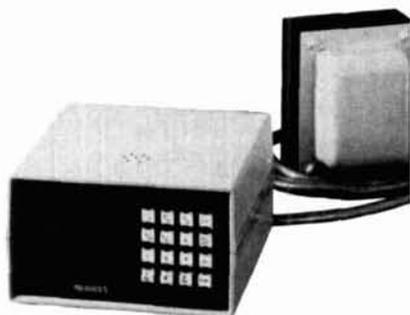
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HDR-300*

PSE-1A will save you lots of time in your favorite contests. No more hanging on the rotor control...Gives you positive control with DIGITAL readout plus 10 memories, command positioning, and single button manual movement.

The "DX'ER" Package...Couple this unit with a rotor and you have the best non talking control we make. Expandable, plus has 5 scan functions, 2 DIGITAL displays and REC/LAST to check long path or short path. Has all internal hardware to plug into our computer interface. Can be remotely controlled from accessory jack.

Try this with any of the TELEX/HY-GAIN* Rotors! This will give you the broadest of functions with a mid-range price.

The "Delux" is the most sophisticated antenna control unit ever made. With the "Delux" you have all the functions of our other units, plus talks...Yes it talks. Not only do you have your headings digitally displayed, but is also said when your antenna stops...All commands are spoken plus as your antenna turns you hear a 400Hz tone in one direction and an 80Hz in the other, giving you positive verification of movement. This unit when combined with the HAM IV, T2X or HDR-300 gives you the best buy anywhere at any price...

Package Special

PSE-1 + HAM IV \$508.95
PSE-1 + T2X 548.95
PSE-3 + HDR-300 677.95

Package Special

PSE-2 + HAM IV \$608.95
PSE-2 + T2X 655.00
PSE-4 + HDR-300 784.00

PSE-1A + HAM IV \$369.95
PSE-1A + T2X 415.95
PSE-3A + HDR-300 544.95

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Controllers also available for other rotors. Prices and specifications subject to change without notice or obligation.

U.S. and Foreign Patents

* For PSE, 3A, 3, 4 add \$24.50 for 12 amp power pack

FT-77 The Rig for All Seasons!

Answering the call for an HF rig that goes everywhere, sounds great, and is cost-effective, Yaesu proudly introduces the FT-77 Compact HF Transceiver System.



Computerized Design and Manufacture

The FT-77 design engineers utilized the latest computerized circuit board layout methods, resulting in a compact, reliable transceiver with maximum utilization of available space. Automated insertion techniques are used in assembly, providing improved reliability and quality control over earlier designs.

Operating Versatility

The FT-77 is equipped for operation on all amateur bands between 3.5 and 29.7 MHz, including the three new WARC bands. Fully operational on SSB and CW, the FT-77 includes a dual width noise blanker (designed to minimize the "Woodpecker" or ignition noise), full SWR metering, R.I.T., and optional CW filter with wide/narrow selection. The optional FM-77 permits operation on the FM mode, with front panel squelch sensitivity control.

Expandable Station Concept

Ideal for mobile operation because of its compact size and light weight, the FT-77 forms the nucleus of a versatile base station. Available as options for the FT-77 are the FP-700 AC Power Supply, FV-700DM Synthesized External VFO and Memory System, FTV-707 VHF/UHF Transverter, and FC-700 Antenna Coupler, providing top performance at an extraordinarily low price.

Best of All, It's a Yaesu!

With the most experience in transceiver design and manufacture, the Yaesu trademark is your guarantee of quality and durability. We've got all-new technology and an all-new warranty policy to back it up.

See the FT-77 and the all new line of Yaesu HF, VHF, and UHF transceivers, receivers and accessories at your Yaesu Dealer today! *It's time you tried a Yaesu!*

Price And Specifications Subject To
Change Without Notice Or Obligation

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YAESU
The radio.



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YAESU CINCINNATI SERVICE CENTER 9070 Gold Park Drive, Hamilton, OH 45011 • (513) 874-3100

NEW

Digital DX-terity...



General coverage, Superior dynamic range, 2 VFO's, 8 memories, Scan, Notch... COMPACT!

TS-430S

The TS-430S combines the ultimate in compact styling with advanced circuit design and performance. An all solid-state SSB, CW, and AM transceiver, with FM optional, covering the 160-10 meter Amateur bands, it also incorporates a 150 kHz-30 MHz general coverage receiver having a superior dynamic range, dual digital VFO's, 8 memories, memory scan, programmable band scan, IF shift, notch filter, all-mode squelch, and built-in speech processor.

TS-430S FEATURES:

- **160-10 meter operation, with general coverage receiver**
With 160-10 meter Amateur band coverage, including WARC 30, 17, and 12 meter bands, it also features a 150 kHz-30 MHz general coverage receiver. Innovative UP-conversion digital PLL circuit, for superior frequency stability and accuracy. UP/DOWN band switches for Amateur bands or 1-MHz steps across entire 150 kHz-30 MHz range. Two digital VFO's continuously tuneable from band to band. Band information output on rear panel.
- **USB, LSB, CW, AM, with optional FM**
Operates on USB, LSB, CW, and AM, with optional FM, internally installed. AGC time constant automatically selected by mode.
- **Compact, lightweight design**
Measures only 10-5/8 (270) W x 3-3/4 (96) H x 10-7/8 (275) D, inches (mm), weighs only 14.3 lbs. (6.5 kg.).
- **Superior receiver dynamic range**
Use of 2SK125 junction-type FET's in the Dyna-Mix high sensitivity, balanced, direct mixer circuit provides superior dynamic range.
- **10-Hz step dual digital VFO's**
10-Hz step dual digital VFO's operate independently, include band and mode information. Different band and mode cross operation possible. Dial torque adjustable. STEP switch for tuning in 10-Hz or 100-Hz steps. A-B switch quickly shifts "B" VFO

to the same frequency and mode as "A" VFO, or vice-versa. VFO LOCK switch provided. RIT control tunes VFO or memory. UP/DOWN manual scan possible using optional microphone.

- **Eight memories store frequency, mode, and band data**
Memories store frequency, mode, and band data. Eighth memory stores receive and transmit frequencies independently. M.CH switch for operation of memory as independent VFO, or fixed frequency.
- **Lithium battery memory back-up**
Estimated five-year life.
- **Memory scan**
Scans memories in which data is stored.
- **Programmable automatic band scan**
Scans programmed band width. Scan speed adjustable. HOLD switch interrupts band or memory scan.
- **IF shift circuit for minimum GRM.**
IF passband may be moved to place interfering signals outside the passband, for best interference rejection.
- **Tuneable notch filter built-in**
Deep, sharp, tuneable, audio notch filter.
- **Narrow-wide filter selection**
NAR-WIDE switch for IF filter selection on SSB, CW, or AM, when optional filters are installed. (2.4 kHz IF filter built-in.)
- **Speech processor built-in**
Improves intelligibility, increases average "talk-power".
- **Fluorescent tube digital display**
Indicates frequency to 100 Hz (10 Hz modifiable).

- **All solid-state technology**
Input rated 250 W PEP on SSB, 200 W DC on CW, 120 W on FM (optional), 60 W on AM. Built-in cooling fan, multi-circuit final protection. Operates on 12 VDC, or 120 VAC, or 220/240 VAC with optional PS-430 AC power supply.

- **All-mode squelch circuit, built-in**
- **Noise blanker, built-in**
- **RF attenuator (20 dB)**
- **Vox circuit, plus semi break-in with side-tone**

Optional accessories:

- PS-430 compact AC power supply.
- PS-30 or KPS-21 AC power supplies.
- SP-430 external speaker.
- MB-430 mobile mounting bracket.
- AT-130 compact antenna tuner, 80-10 m incl. WARC.
- AT-230 base antenna tuner, 160-10 m incl. WARC.
- FM-430 FM unit.
- YK-88C (500 Hz) or YK-88CN (270 Hz) CW filters.
- YK-88SN (1.8 kHz) narrow SSB filter.
- YK-88A (6 kHz) AM filter.
- MC-42S UP/DOWN hand microphone.
- MC-60A deluxe desk microphone, UP/DOWN switch.

More information on the TS-430S is available from all authorized dealers of Trio-Kenwood Communications, 1111 West Walnut Street, Compton, California 90220.

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Specifications and prices are subject to change without notice or obligation.