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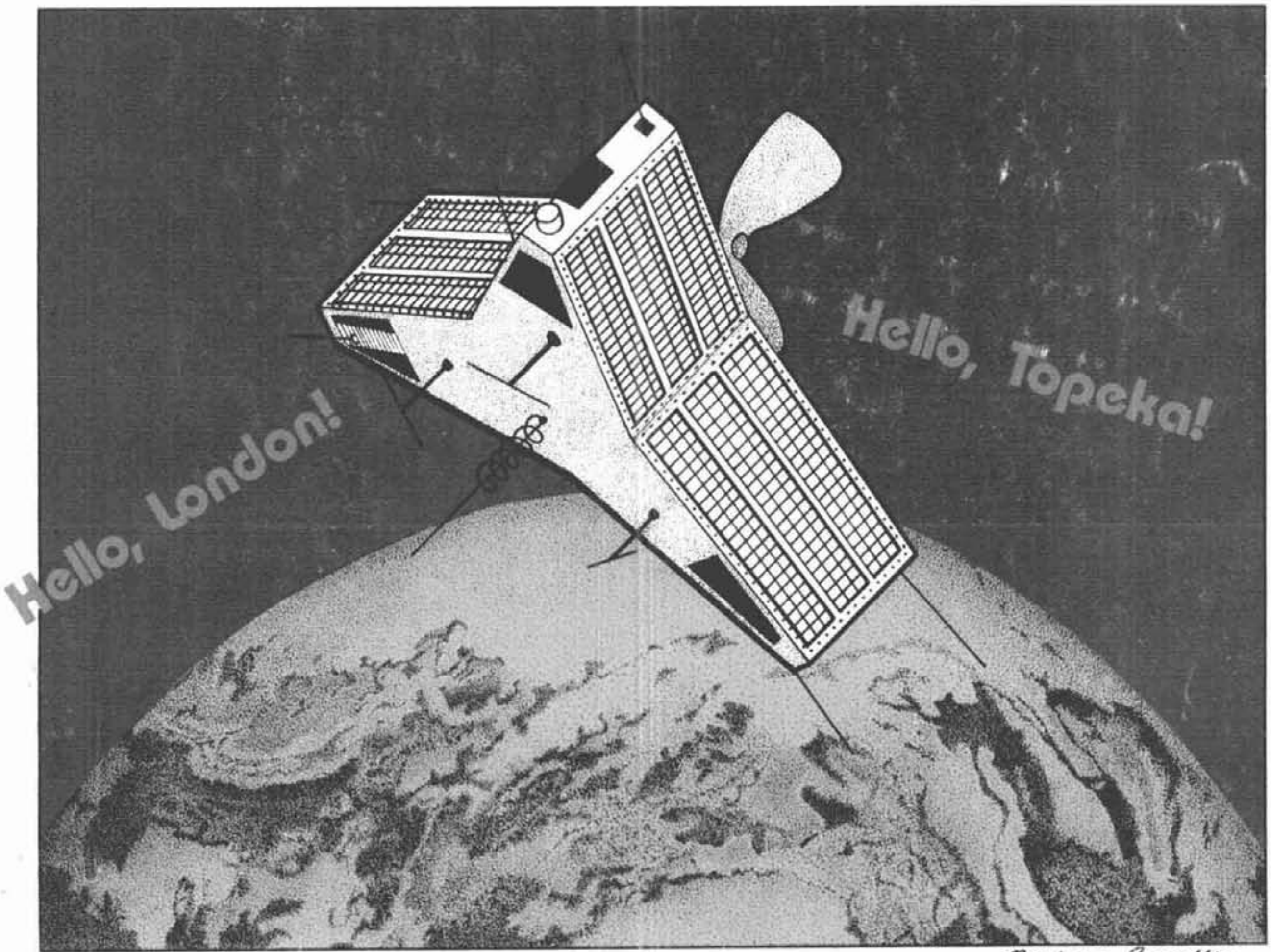
ham radio magazine



satellite communications

hr

focus on communications technology

ICOM 144, 220 and 440MHz

MOBILES

The World's Most Compact Mobiles

ICOM's three ultra compact mobiles...the IC-27A 2-meter, the IC-37A 220MHz and the IC-47A 440MHz... are the smallest mobiles available.

Even in such a small package the 25 watt mobiles contain an internal speaker which makes them fully self-contained and easy to mount.

Size. The ICOM compacts measure only 5½"W x 1½"H x 7"D (IC-47A is 9" deep)... which allows them to be mounted in various "compact" locations. Yet the compacts have large operating knobs which are easy to use in the mobile environment.

More Features. Other IC-27A/37A/47A standard features include a mobile mount, IC-HM23 DTMF mic with up/down scan and memory scan, and internally adjustable transmit power. An optional IC-PS45 slim-line external power supply and IC-SP10 external speaker are also available.

32 PL Frequencies. The IC-27A/37A/47A come complete with 32 PL frequencies.

9 Memories. The compact mobiles have 9 memories which will store the receive frequency, transmit offset, offset direction and PL tone. All memories are backed up with a lithium battery.

Speech Synthesizer. To verbally announce the receive frequency, an optional UT-16 voice synthesizer is available.

Scanning. The ICOM compacts have four scanning systems...memory scan, band scan, program scan and priority scan. Priority may be a memory or a VFO channel...and the scanning speed is adjustable.

Stacking Mobile Mounts. The IC-27A/37A/47A can be stacked to provide a three band mobile station. Each band is full featured and will operate even when another band is in use.

The IC-27A/37A/47A provide superb performance in the mobile radio environment. See them at your local ICOM dealer.

ICOM

First in Communications

✓101

ICOM America, Inc., 2380-116th Ave NE, Bellevue, WA 98004 / 3331 Towerwood Drive, Suite 307, Dallas, TX 75234

KENWOOD

...pacesetter in Amateur radio

WAIT! 220 MHz Coming soon!

Power-Full...70 Watts!

TM-2570A/2550A/2530A

Sophisticated FM transceivers

Kenwood sets the pace again! The all-new "25-Series" brings the industry's *first* compact 70-watt 2-meter FM mobile transceiver. There is even an *auto dialer* which stores 15 telephone numbers! There are three power versions to choose from: The TM-2570A 70-watt model, the TM-2550A for 45-watts, and the 25-watt TM-2530A.

- **First** 70-watt FM mobile (TM-2570A)
- **First** mobile transceiver with telephone number memory and auto-dialer (up to 15 telephone numbers)
- Direct keyboard entry of frequency
- Automatic repeater offset selection according to the ARRL 2-meter band plan—**a Kenwood exclusive!**
- Extended frequency coverage for MARS and CAP (142-149 MHz; 141-151 MHz modifiable)
- 23 channel memory for offset, frequency and sub-tone
- Big multi-color LCD and back-lit controls for excellent visibility
- Front panel programmable 38-tone CTCSS encoder **includes 97.4 Hz** (optional)
- 16-key DTMF pad, with audible monitor
- Center-stop tuning—**another Kenwood exclusive!**
- Frequency lock switch
- **New** 5-way adjustable mounting system
- **Unique** offset microphone connector—relieves stress on microphone cord

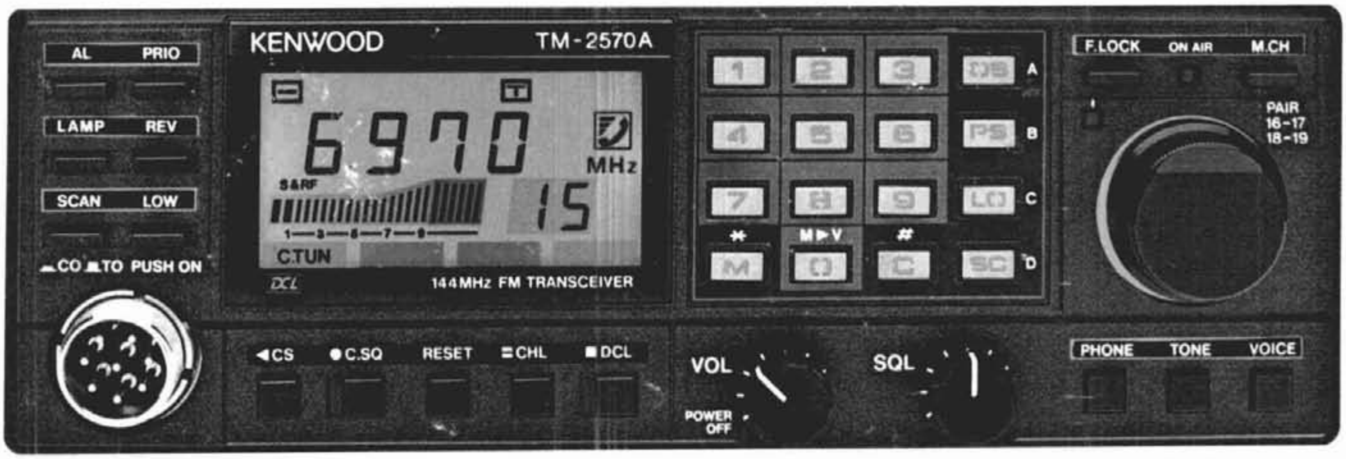
Large heatsink with built-in cooling fan (TM-2570A)

- HI/LOW Power switch (adjustable LOW power)
- Compact DIN size

DCL Introducing... Digital Channel Link

Compatible with Kenwood's DCS (Digital Code Squelch), the DCL system enables your rig to **automatically** QSY to an open channel. Now you can automatically switch over to a simplex channel after repeater contact! Here's how it works:

The DCL system searches for an open channel, remembers it, returns to the original frequency and transmits control information to another DCL-equipped station that switches **both** radios to the open channel. Microprocessor control assures fast and reliable operation. The whole process happens in an instant!



Actual size front panel

Optional Accessories

- **TU-7** 38-tone CTCSS encoder
- **MU-1** DCL modem unit
- **VS-1** voice synthesizer
- **PG-2K** extra DC cable
- **PG-3A** DC line noise filter
- **MB-10** extra mobile bracket
- **CD-10** call sign display
- **PS-430** DC power supply for TM-2550A/2530A
- **PS-50** DC power supply for TM-2570A
- **MC-60A/MC-80/MC-85** desk mics.
- **MC-48** extra DTMF mic. with UP/DWN switch
- **MC-42S** UP/DWN mic.
- **MC-55** (8-pin) mobile mic. with time-out timer
- **SP-40** compact mobile speaker
- **SP-50** mobile speaker
- **SW-200A/SW-200B** SWR/power meters
- **SW-100A/SW-100B** compact SWR/power meters
- **SWT-1** 2m antenna tuner

KENWOOD

TRIO-KENWOOD COMMUNICATIONS
1111 West Walnut Street
Compton, California 90220

Complete service manuals are available for all Trio-Kenwood transceivers and most accessories.
Specifications and prices are subject to change without notice or obligation.

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contents

REFLECTIONS

dual roles

When is an "amateur" not an "amateur?" One possible definition is when he applies his knowledge and uses it in a technical trade such as Engineering or Science. At the recent RF Technology Expo 86 (January 30-February 1), thousands of similarly interested technical individuals got together for three days in Los Angeles to discuss the latest developments in the RF communications field. The technical exhibition, sponsored by *rf design*, featured technical forums in which 79 papers on HF through microwave subjects were presented and an exhibition by 133 manufacturers and their representatives who displayed their wares, from crystal oscillators through interactive computer-aided design applications and software.

Just a brief scan of the titles of some of the papers presented at the show reveals topics of considerable interest to Radio Amateurs. For example, Eyring Research Institute showed the proper way to evaluate HF antennas on a large scale. Believe me, their antenna "test bed," instrumentation, and procedures had many in the audience on the edge of their chairs, taking in every word for possible use — on a more limited basis, perhaps — back at their own QTH. Actually, many of the engineers who remained after the end of this session in order to dig for more facts turned out to be Radio Amateurs who happened to be engineers as well. It was difficult to tell which aspect of their experience elicited more questions — the "amateur" or "commercial."

Which brings me to my main point. The engineers and scientists at the show were, in many cases, Radio Amateurs who, over the years, had been able to combine their interest and avocation to the mutual benefit of both. That a connection exists was further indicated by several speakers who quite independently mentioned that they find both *rf design* and *ham radio* good sources of HF communications information.

"But wait a second," you say, "what do our interests have in common with the topics discussed at the show? To answer that question, take a look at this abbreviated list of some of the topics covered:

Choosing the right crystal and oscillator
High efficiency power amplifiers
IM, phase noise, and receiver dynamic range
High-pass filter design
Increasing the bandwidth of helical antennas
How to make simple test equipment
New low-power SSB circuits
Designing combline and interdigital bandpass filters
How to bias RF and microwave transistors
Wideband modules using FETs
Practical wideband RF power transformers, splitters, and combiners
RF power amplifier design
Understanding RF transistor data sheets
1-kW solid-state L-band amplifier (What about you 1296 fans?)
Broadband HF antenna testing
ACSSB and SSB communication receiver testing
RF circuit design using interactive computer-aided graphics
Wideband high dynamic range front-ends
High-Q inductors using powdered iron cores

If you're interested in reading any of the 79 papers, the complete set* has been bound into a 2-inch thick compendium that weighs in at approximately 4 pounds. (I should know, I carried mine around with me for the entire three days.)

If you find some of these "engineering" topics of special interest, let me know . . . perhaps some of the authors would be interested in writing for *ham radio*.

I truly believe that as a result of intense interest and hard work on the part of many Radio Amateurs, great strides have been made in the most technically demanding fields of communications and will continue to be made by those individuals sharing this dual role.

Rich Rosen, K2RR
Editor-in-Chief

*For information, contact Cardiff Publishing, 6530 South Yosemite Street, Englewood, Colorado 80111 (303-694-1522).

KENWOOD

...pacesetter in Amateur radio

The Smallest HT!

TH-21AT/31AT/41AT

Kenwood's advanced technology brings you a new standard in pocket/handheld transceivers!

- **High or low power.** Choose 1 watt high—enough to "hit" most local repeaters; or a battery-saving 150 mW low.
- **Pocket portability!** Kenwood's TH-series HTs pack convenient, reliable performance in a package so small, it slips into your shirt pocket! It measures only 57 (2.24) W x 120 (4.72) H x 28 (1.1) D mm (inch) and weighs 260 g (.57 lb) **with PB-21.**
- **Expanded frequency coverage (TH-21AT/A).** Covers 141.000-150.995 MHz in 5 kHz steps, includes certain MARS and CAP frequencies. **TH-31AT/A:** 220.000-224.995 MHz in 5 kHz steps. **TH-41AT/A:** 440.000-449.995 MHz in 5 kHz steps.

- **Easy-to-operate, functional design.** Three digit thumbwheel frequency selection and handy top-mounted controls increase operating ease.

- **Repeater offset switch.** **TH-21AT/A:** ±600 kHz, simplex. **TH-31AT/A:** −1.6 MHz, reverse, simplex. **TH-41AT/A:** ±5 MHz, simplex.
- **Standard accessories:** Rubber flex antenna, earphone, wall charger, 180 mAH NiCd battery pack, wrist strap.

NOW! Extended-life battery pack

- **Quick change, locking battery case.** The rechargeable battery case snaps securely into place. Optional battery cases and adapters are available.
- **Rugged, high impact molded case.** The high impact case is scuff resistant, to retain its attractive styling, even with hard use.

See your authorized Kenwood dealer and take home a pocketful of performance today!

Optional accessories:

- **HMC-1** headset with VOX
- **SMC-30** speaker microphone
- **PB-21** NiCd 180 mAH battery
- **PB-21H** NiCd 500 mAH battery
- **DC-21** DC-DC converter for mobile use
- **BT-2** manganese/alkaline battery case
- **EB-2** external C manganese/alkaline battery case
- **SC-8/8T** soft cases
- **TU-6** programmable sub-tone unit
- **AJ-3** thread-loc to BNC female adapter
- **BC-6** 2-pack quick charger
- **BC-2** wall charger for PB-21H
- **RA-8A/9A/10A** StubbyDuk antenna
- **BH-3** belt hook

KENWOOD

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Compton, California 90220

TH series transceivers shown with optional StubbyDuk antenna. TH-31AT shown with PB-21H.
Specifications and prices are subject to change without notice or obligation.
Complete service manuals are available for all Trio-Kenwood transceivers and most accessories.

presstop de W9JUV

SIGNIFICANT IMPACT ON THE "ELECTRONIC COMMUNICATIONS PRIVACY ACT" appeared likely as a result of the January 30 House subcommittee meetings in Washington. Strongly supporting the bill were two spokesmen for the telephone system and a Tandy representative -- though Tandy's speaker was teamed with ARRL and the Association of North American Radio Clubs (ANARC) in the apparent belief Tandy would oppose the bill as scanner supporters. However, Tandy came out in favor of it from their position as a cellular telephone supplier.

ARRL Shifted From Its Previous Position That Exempting Amateur Radio satisfied League concerns; Perry Williams, W1UED, while approving the exemption, pointed out that Amateurs -- and others, as well -- have many legitimate reasons to listen across the radio spectrum and the bill would make many such activities illegal. Probably the most telling testimony came from ANARC's Terry Colgan, WD5GWC, who not only pointed out various fallacies in the bill when applied to radio communications but demonstrated how effective and inexpensive available encryption devices are. (An article on the hearing will appear soon in Ham Radio.)

THE COMIC BOOK PROMOTION FOR AMATEUR RADIO being funded by the Amateur Radio industry is moving along well, ARRL's Dave Sumner, K1ZZ, reported at a February 7 meeting during the Miami Tropical Hamboree. The group decided to proceed with a story line based on the popular "Archie and His Friends" strip, with final approval in the near future.

Lack of Well-Qualified Amateur Radio Instructors is a major problem in effective training and growth, Gordon West, WB6AOA, told the group. He proposes a program, possibly through the ARRL, to promote instructor training. Dealer involvement in Amateur Radio promotion was also considered. The next industry group meeting is set for April 24 in Dayton.

MODULATED CW IS NOW PERMITTED ON 10 METERS, but only from 29.5-29.7 MHz. Acting on PR Docket 85-168 at its February 19 meeting, the FCC authorized F2A emission on the band's top portion in order to enable repeaters to identify using Morse code (effective date: April 23).

THE "PACIFIC AREA COORDINATION ASSOCIATION" is a newly formed regional VHF-UHF effort to promote wide-area coordination. Organizer WA6DPJ has sent invitations to coordinators west of the Continental Divide; send SASE to Box 23183, Pleasant Hill, CA 94523 for details.

Mississippi Will Retain 15 kHz Spacing On 2 Meters' top end. Southern California is now the only area of the country to use inverted 15 kHz splits on 2 meters, following a shift to "upright" splits by repeaters in western Colorado.

Northern California Could Shift To 20 kHz Spacing on 146-148 MHz and still accomodate all existing repeaters in its area, the Northern California Relay Council (NARC) reports. The plan will be considered at NARC's April 5 meeting in Sacramento.

NARC Has Also Proposed A 33-cm Band Plan that is essentially identical to the ARRL's interim plan developed by the VUAC. A push seems to be building within the VUAC to come up with a satisfactory final plan for the new 902-928 MHz band.

Repeater Coordination And Spectrum Management Will Be The Subjects of an on-going workshop during the Dayton Hamvention weekend. Location and other details of this crucial activity may not make the printed program, so check with Hamvention officials upon arrival.

REPLACEMENT OF THE GMRS WITH A NEW "CONSUMER RADIO SERVICE" was proposed by the FCC in a Notice of Inquiry adopted January 30. A total surprise to the GMRS's sophisticated and well organized users, the proposal apparently stemmed from a synthesis of the GMRS's own proposal to expand its utility through new technologies and from the Commission's desire to establish a new short-range quality radio service for the general public. After previous efforts to find spectrum for such a service in the 900-MHz band fell flat, the FCC apparently decided that GMRS's two 200-kHz slots in the 460 MHz band was an acceptable alternative.

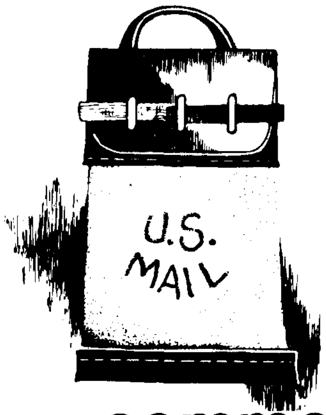
"Personal Directed Communications" Is The Apparent Direction of the FCC's thinking, employing "user transparent" sophisticated portable equipment "designed to control users' actions automatically." They also ask whether "one-way" (paging) should be included, and for suggestions as to how much and what kind of automation should be included.

GMRS Licensees And Users Are Extremely Upset, and understandably so, with their well established system of repeaters, mobiles, and portables -- very active in personal, business and public service communications -- threatened with extinction.

Comments On PR Docket 86-38 Are Due At The FCC May 30, and the Reply Comments June 30.

User-Programmable Land Mobile Radios May Be Banned as a result of a Notice of Proposed Rule Making approved by the Commissioners at their January 30 meeting. In response to complaints of interference from radios reprogrammed to unauthorized frequencies, PR Docket 86-37 would prohibit the FCC from type accepting Part 90 radios operating above 25 MHz that have external frequency control. Though it's known at the FCC that many synthesized Amateur radios are reprogrammable to non-Amateur frequencies, Part 97 equipment wasn't included.

21 SCHOLARSHIPS FOR STUDENTS WITH GENERAL OR HIGHER LICENSES are available from the Foundation For Amateur Radio. Write FAR, 6903 Rhode Island Ave., College Park, MD 20740.



comments

spreadsheets for EME

Dear HR:

I enjoyed KE6ZE's informative article on EME ("EME-link Calculator Program," February, page 70). By a very odd coincidence I used the same equation from the *ARRL Handbook* to illustrate the convenience of spreadsheet programs for difficult calculations in an article in the same month's *QST*.

I hope that those readers who can compare David Engle's program written in BASIC with my speadsheet template will comment on the relative merits of the two approaches. It is, I think, important for hams to show leadership in matters of this sort which test techniques of immediate importance for technology.

My prejudice, of course, is that the spreadsheet is faster, allows for easier correction of errors, and has more versatility in printing results, than programs written in traditional programming languages.

I would be pleased to hear your readers' opinions.

Dick Ward, KC8OH
East Detroit, Michigan

understanding telephones

Dear HR:

Thank you for the many articles such as "Understanding Telephones" (by Julian Macassey, N6ARE), which appeared in the September issue.

Please do not assume we should know it. *Print it.*

Owen Zweiger, KD7WL
McMinnville, Oregon

propagation disks available

Dear HR:

Response to my VHF propagation articles (July, 1985 and January, 1986) has been surprising, with dozens of hams requesting my program on disk for the Commodore 64. Because of requests from owners of other computers, I now have a working version ready for the IBM-PC.

I will supply a disk with the complete program (VHF through L-Band) in an IBM-PC format for $8.00.

Lynn Gerig, WA9GFR
Route 1
Monroeville, Indiana 46773

cable comments

Dear HR:

Joe Reisert's column, "VHF/UHF World," in the October, 1985, issue of *ham radio*, is one of the best synopses on coaxial cable that I have read in Amateur publications, and, for that matter, in industry publications in some time. My sincerest compliments and congratulations. It was obvious that W1JR made some extra efforts in trying to document and assemble the information.

Two comments that I should like to make with respect to his article are not a reflection of my current job description and/or position. Rather, they are a reflection of my past experience as a product engineer with specific responsibilities of developing and obtaining MIL-SPEC qualification on coaxial cables.

On page 89, Joe indicates avoiding the contaminating types of jackets at all costs.

Yes, I agree with his basic position ("Don't be penny-wise and pound-foolish") but at the same time, his position does cost the average Amateur Radio Operator some unnecessary dollar expenditures. The difference between contaminating and non-contaminating jackets is the amount of plasticizer in the vinyl compound, which then provides flexibility at low temperature extremes. It has been my experience in laboratory environments with so-called contaminating jackets that circulating ovens of 120 degree C (which is more than adequate temperature to drive out plasticizers) after seven days shows only a minimal amount of plasticizer migration. Outside of the laboratory environment, I personally have not experienced plasticizer migration problems with coax, both buried and fully exposed to the elements. After eight to 10 years of service, no attenuation increases.

At the same time, I have examined many pieces of coaxial cable in which plasticizer migration and/or contamination has been submitted as the cause of high attenuation. To date I have not seen a piece of coaxial cable in which that has been the cause of high attenuation in real-life operation. It has always been water and moisture getting into the cable. Water and moisture entry most commonly come about from inadequate sealing at the connector ends of the cable and/or cuts or pin holes caused by abrasion to the jacket. Yes, I see W1JR's point — and I have heard the myth many, many times throughout my active days as an engineer and in my current position as well.

One other small picky comment is in the last part of his article on page 91. He indicates that CATV transmission line is typically specified up to 350 MHz. This typical specification has to do only with structural return loss, which is a test for periodicity, which causes frequency suck-out. His advice is quite proper, then, to test it at the frequency of interest before installing it, but specifications up to 350 MHz have nothing to do with power handling capabilities and/or attenuation characteristics.

Once again, as an active and involved Amateur Radio Operator for better than 25 years, a tip of my hat for a fine article.

Ronald L. Steir, W9ICZ
Marketing Director
Belden Electronic Wire and Cable
Richmond, Indiana 47375

introducing satellite communications

Basic information to get you started

Do you want to access a new Amateur band that's always open when it's supposed to be? A band that doesn't fade away without warning, that makes DX contacts sound like locals, and has no skip zones?

Listening to, or working through Amateur communications spacecraft isn't difficult, but most newcomers simply don't know how to go about it properly. Not sure of what they're doing, they usually achieve disappointing results; deciding that the amount of effort invested must be so much more than the results achieved, they give up and go back to their regular haunts, where they can usually at least find someone to talk to. This is a shame, because satellites have come of age and commercial equipment is as readily available for the satellite bands as for the regular HF or VHF bands. You can buy or roll your own, but in either case — just like on 20 meters or the other HF bands — you have to have some knowledge of what's going on if you're going to get the maximum enjoyment out of the equipment.

terminology

A communications satellite is basically a repeater in the sky. It receives signals transmitted up from the ground on one Amateur band and retransmits the same signals down to the earth on a second Amateur band. It's part of a communications link between two Amateur stations on the ground as shown in **fig. 1**; signals on their way up to the satellite are said to be *uplinked* by stations on the ground while the corresponding signals coming down from the satellite are being *downlinked*. As the satellite orbits the earth it passes over different locations; the point immediately beneath the satellite at any time is called the *subsatellite point*.

The area of the earth's surface that the satellite can "see" depends on its altitude; the higher it is, the more it can see. A commercial communications satellite in a high altitude over the equator can see about one third of the earth's surface. A satellite at a low altitude sees much less.

Any station that the spacecraft can see, can see the spacecraft. When a station can see the spacecraft, it is said to be *in range*. Thus any two stations in range of the satellite at the same time are said to have a *window* into the satellite and can communicate through it.

Most orbits are elliptical rather than circular. The highest point above the surface of the earth in the orbit is called the *apogee*; the lowest point of that same orbit is the *perigee*.

Even though the orbit of the satellite is fixed, the earth rotates beneath it. The time it takes for the satellite to travel once around its orbit from the place where the sub-satellite point crosses the equator to the next time the sub-satellite point crosses the equator going in the same direction is called the *period* of the orbit. When the sub-satellite point has returned to the equator, the point on earth that was previously below it will have moved away because of the rotation of the earth; consequently, a new location will be beneath it. The number of degrees of longitude that have passed by during this time is known as the *orbital increment* (see **fig. 2**). The first orbit of the day is known as the *reference orbit*.

Earth stations will see different parts of different orbits as shown in **fig. 3**. The azimuth, or horizontal bearing and elevation angle to the spacecraft, will change with the orbit. The spacecraft will appear to rise above the horizon when it enters the range of the ground station. The time at which the spacecraft rises above the horizon is called *Acquisition Of Signals*, or

By Joe Kasser, G3ZCZ, P.O. Box 3419, Silver Spring, Maryland 20901

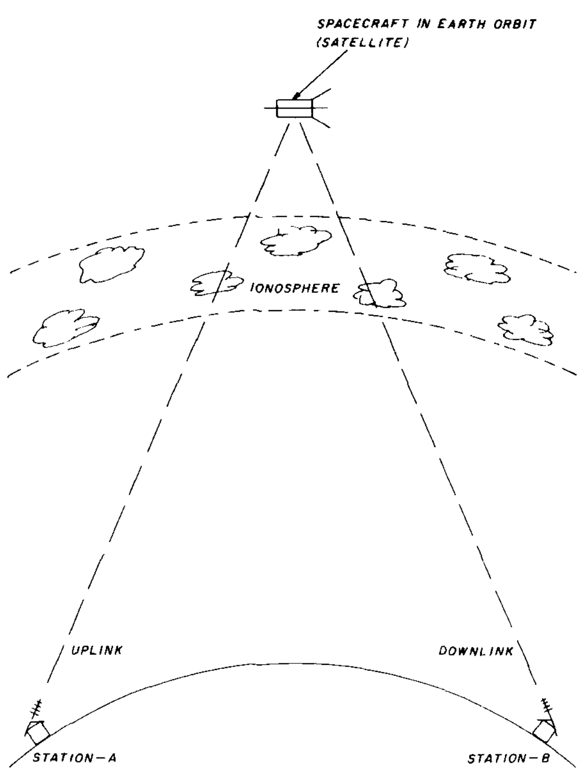


fig. 1. Satellite communications path. Station A is transmitting (uplink). Signals are received by the satellite and re-transmitted down to station B (downlink).

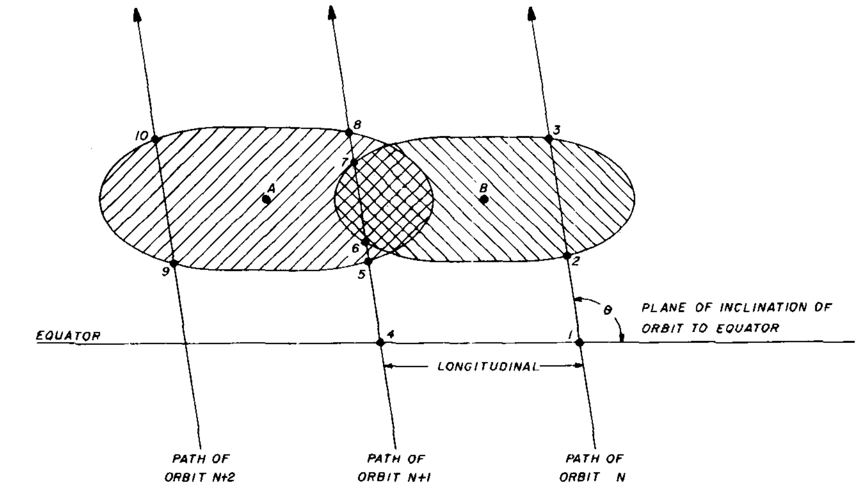
AOS. The position of the satellite in the sky as seen by the ground observer will change as it passes along its orbit, rising higher and passing across the sky, getting lower, and then finally setting on the horizon. The time at which it sets beneath the horizon of the ground station is known as *Loss of Signals*, or *LOS*.

The path traced by a satellite in the sky as seen by a particular ground station will vary according to the type of orbit. The path traced by a satellite in a circular orbit will usually approximate a section, or chord, of a circle. The path traced by a satellite in an elliptical orbit will depend on the apogee and perigee of the orbit and how close the observer is to the subsatellite point.

characteristics of satellite signals

In order to copy signals from satellites, we first need to know a little about the types of signals we're trying to receive. At any particular time, an observer on the ground may see the satellite in any direction with respect to the horizon (*azimuth*) and at any altitude between the horizon and a point directly overhead (*elevation*). This means that signals from various satellites arrive at a receiving station from any angle in any direction.

Radio waves are generated in a polarized manner. Conventional Amateur station antennas may generate vertically or horizontally polarized signals, depending on the position of the antenna with respect to the



1. Satellite crosses equator (heading North) at start of orbit N.
2. Satellite crosses range circle of station B and comes up over its horizon (AOS).
3. Satellite crosses range circle of station B and sets on its horizon (LOS).
4. Satellite crosses equator at start of orbit N + 1.
5. Satellite crosses range circle of station A (AOS).
6. Satellite crosses range circle of station B (mutual access window opens).
7. Satellite crosses range circle of station B (mutual access window closes).
8. Satellite crosses range circle of station A (LOS).
9. Satellite crosses range circle of station A on orbit N + 2 (AOS).
10. Satellite crosses range circle of station A on orbit N + 2 (LOS).

fig. 2. Looking down on the earth from the satellite showing track of spacecraft on surface (subsatellite point). Range circles are drawn as ellipses on rectangular (map) projection. Circles overlap to give mutual access window on orbit N + 1 between points 6 and 7.

TYPICAL SATELLITE ANGLES FOR ONE GROUND LOCATION ON ONE DAY

OSCAR-9

U.T.C. HHMM:SS	AZIMUTH DEGREES	ELEVATION DEGREES
1330:00	102	10
1332:00	68	14
1334:00	35	9
1336:00	16	2
1500:00	194	1
1502:00	207	10

OSCAR-11

U.T.C. HHMM:SS	AZIMUTH DEGREES	ELEVATION DEGREES
0824:00	359	5
0826:00	350	15
0828:00	327	31
0830:00	269	38
0832:00	231	21
0834:00	218	9

OSCAR-10

U.T.C. HHMM:SS	AZIMUTH DEGREES	ELEVATION DEGREES
1600:00	256	7
1700:00	240	12
1800:00	236	10
1900:00	235	6
2000:00	236	1

RS-7

U.T.C. HHMM:SS	AZIMUTH DEGREES	ELEVATION DEGREES
1856:00	347	5
1858:00	344	12
1900:00	340	21
1902:00	333	32
1904:00	318	45
1906:00	286	56
1908:00	242	54
1910:00	217	41
1912:00	205	28
1914:00	199	18
1916:00	195	10
1918:00	192	3

RS-5

U.T.C. HHMM:SS	AZIMUTH DEGREES	ELEVATION DEGREES
1748:00	4	3
1750:00	8	9
1752:00	15	17
1754:00	24	25
1756:00	39	34
1758:00	62	41
1800:00	91	42
1802:00	115	35
1804:00	131	26
1806:00	140	17
1808:00	147	10
1810:00	151	3

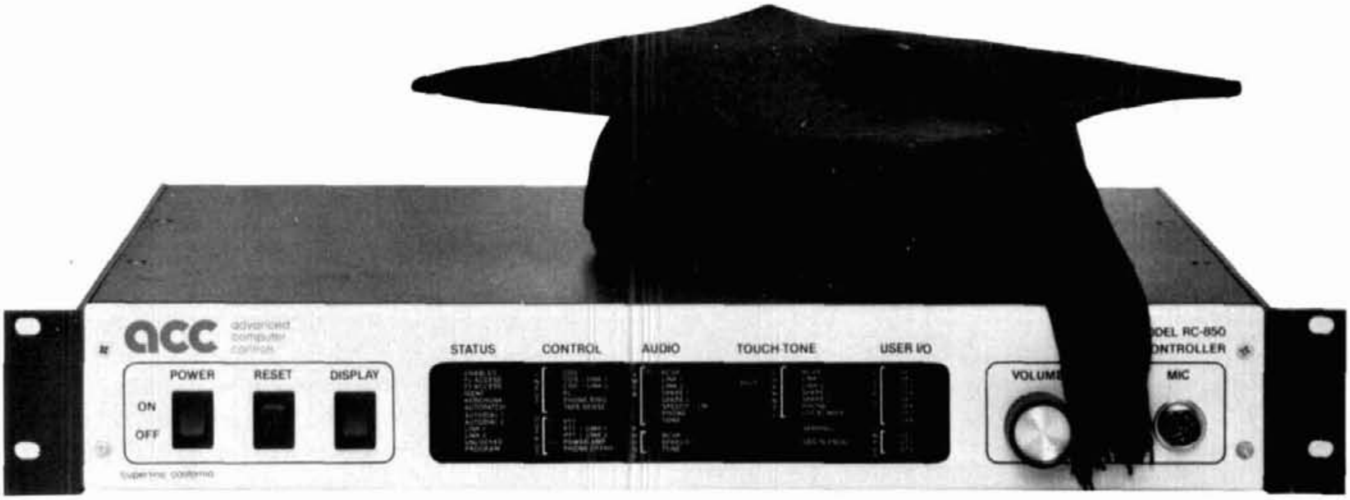
Space shuttle Challenger

U.T.C. HHMM:SS	AZIMUTH DEGREES	ELEVATION DEGREES
0625:00	328	0
0626:00	330	5
0627:00	334	10
0628:00	343	20
0629:00	7	37
0630:00	77	43
0631:00	113	24
0632:00	124	13

Shown are azimuth and elevation angles from the ground station to the different spacecraft at different times of the day. It can be seen that in order to adequately copy signals from the spacecraft, the ground station must be able to receive signals coming from any azimuth or elevation. This figure only lists data for one of the daily passes for each satellite. As a rule they will be audible at other times of the day with signals coming from other directions.

fig. 3. Typical satellite azimuth and elevation angles for various passes as seen by a representative ground station.

ground. If the radiating elements are horizontal, the antenna is said to be generating horizontally polarized signals; conversely, if the elements are vertical, the antenna is vertically polarized. The same polarization also holds for reception. Thus, vertical antennas receive vertically polarized signals best and horizontal antennas receive horizontally polarized signals best. True vertically polarized antennas will copy little or no horizontally polarized signals. Two-meter and other VHF/UHF FM antennas are vertically polarized, while base stations working SSB/CW use horizontal antennas. This is because automobile antennas are vertically polarized, and the mobile stations put weak signals into horizontal antennas. (In the early days of mobile radio communications, Amateurs fitted "halo" antennas on their cars to send and receive horizontally polarized signals in order to be compatible with the base stations. When the mobiles using FM began to outnumber



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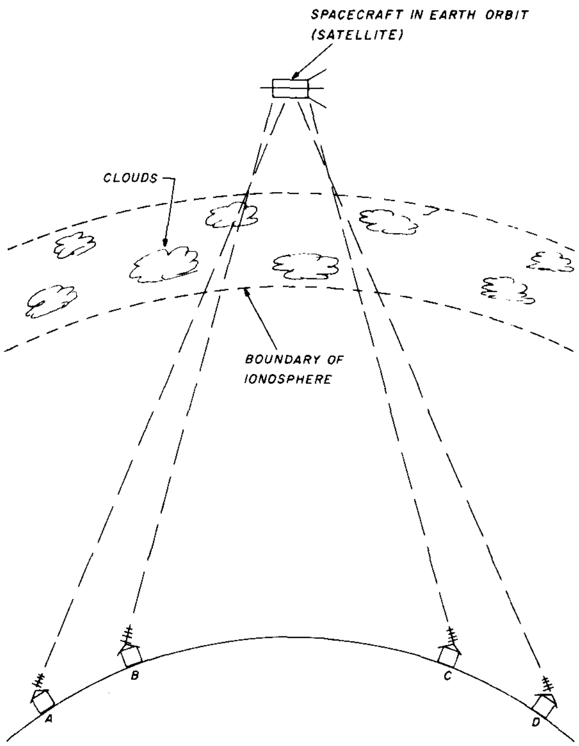

1. "Clouds" move around and change shape.
2. Effects are different at different frequencies.
3. Satellite itself may shield on-board antenna from one or more ground station(s). Such shielding was first noted on OSCAR 6.
4. Clouds attenuate or (polarization) rotate signals.

fig. 4. Some factors affecting satellite communications.

the fixed stations, there was no further need to use horizontal polarization and verticals became the rule. Nowadays, any base station that wants to use FM has to use vertical polarization.

On the HF bands both types of antennas are used interchangeably and everyone manages to work everybody. This is because the polarization of the radio waves changes as the signals pass through the ionosphere. A process known as *Faraday rotation* rotates the polarization of the signals. The signal as received on the ground is not entirely vertically or horizontally polarized and as such may be copied at somewhat lower signal strength on any antenna. Perhaps the good performance of quad antennas is due to their having both vertical and horizontal elements. When conditions in the ionosphere are changing, the received signals may appear to fade — i.e., get weaker and stronger as the plane of polarization is rotated by the ionosphere.

Satellite orbits are outside the ionosphere, which means that signals from the spacecraft are affected by the ionosphere in a manner similar to that which affects conventional terrestrial signals: the polarization of their signals changes. Conventional contacts tend to use the same part of the ionosphere. The ionosphere is not a constant layer above the earth, of course, but is instead made up of patches, or clouds. Since the satellite is moving, its uplink and downlink signals will pass through different parts of the ionosphere at different times, and the effects of the ionosphere on the signals will differ as time passes, as shown in **fig. 4**.

Not only does the ionosphere refract radio waves and change their polarization, it may also attenuate signals or even absorb them. As the spacecraft travels along its orbit, it may be spinning or tumbling, or the satellite itself may shield the on-board antenna from the receiving station. Because of the limitations of its equipment, the transmitter on the space vehicle is transmitting at a relatively low power — less than 10 watts output. Consequently, signals from satellites may arrive at the ground from any direction in azimuth or elevation, with any polarization, and at any signal strength (usually very weak). All these may, and usually do, vary as a function of time.

an ideal satellite receiving antenna

The ideal antenna for copying satellite signals should be rotatable in azimuth and elevation in order to cope with all the possible directions from which signals may arrive. It must be immune to changes in polarization if it is to cope with horizontal, vertical, and in-between polarization caused by Faraday rotation in the ionosphere. It must also have a reasonable amount of gain in order to cope with the fading in the already weak signals generated at the satellite.

Vertical and horizontal polarization are two kinds of linear polarization. Radio signals can also be circularly polarized. A circularly polarized antenna will respond equally to horizontally or vertically polarized signals — that is, changes in the plane of polarization will not be detected. Circular polarization also comes in two kinds, left-hand and right-hand (clockwise and counter-clockwise). To compound the problem, lefthand circularly polarized signals are not well received on righthand circularly polarized antennas and vice-versa.

antennas in common use on 10 meters

Figure 5 lists the commonly used bands in the Amateur Satellite Service. The most commonly used downlink bands are 10 meters, 2 meters and 70 cm. The first band combination that most people try is the 10-meter downlink and the 2-meter uplink commonly known as *Mode A*. This is because they usually have 10-meter capability in their stations and can thus attempt to copy the satellite without adding too much equipment.


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1. ASSIGNMENTS

10 METERS	29.3 - 29.55 MHz	
2 METERS	145.8 - 146.00 MHz	
70 CENTIMETES	435.0 - 438.00 MHz	

2. SATELLITE TRANSPONDERS

SPACECRAFT	MODE	UPLINK	DOWNLINK
AMSAT - OSCAR 6	A	145.85 - 145.95MHz	29.45 - 29.55MHz
AMSAT - OSCAR 7	A	145.85 - 145.95MHz	29.40 - 29.50MHz
AMSAT - OSCAR 7	B	432.125 - 432.175MHz	145.975 - 145.925MHz
AMSAT - OSCAR 8	A	145.85 - 145.95MHz	29.40 - 29.50MHz
AMSAT - OSCAR 8	J	145.90 - 146.00MHz	435.10 - 435.20MHz

The data supplied on AMSAT - OSCARs 6 - 8 is for historic purposes as the spacecraft are no longer operational.

CURRENTLY ACTIVE

SPACECRAFT	MODE	UPLINK	DOWNLINK
AMSAT - OSCAR 10	B	435.05 - 435.15MHz	145.95 - 145.85MHz
AMSAT - OSCAR 10	L	1269.05 - 1269.85MHz	436.95 - 436.15MHz
RS - 5	A	145.91 - 145.95MHz	29.41 - 29.45MHz
RS - 7	A	145.96 - 146.00MHz	29.46 - 29.50MHz

FUTURE (PROPOSED) SPACECRAFT

For launch in early 1986

SPACECRAFT	MODE	UPLINK	DOWNLINK
RS - 9/10	A	145.96 - 146.00MHz	29.46 - 29.50MHz
RS - 9/10	K	21.26 - 21.30MHz	29.46 - 29.50MHz
RS - 9/10	?	21.26 - 21.30MHz	145.96 - 146.00MHz

The RS spacecraft have been ground tested and are due for launch in 1986.

SPACECRAFT	MODE	UPLINK	DOWNLINK
FUJI - 1	A	145.85 - 145.95MHz	29.40 - 29.50MHz
FUJI - 1	M	1267.55 - 1267.75MHz	436.00 - 435.80MHz

The FUJI spacecraft is being built in Japan under the control of JAMSAT, a group of Japanese Radio Amateurs.

ARSENE

The ARSENE spacecraft built by a group of French Radio Amateurs is supposed to be launched in the demonstration flight of the ARIANE 4 rocket in 1986. It will contain a Mode B transponder.

AMSAT -PHASE 3C

The AMSAT Phase 3C spacecraft is also scheduled for launch in mid 1986. It will contain a Mode B transponder as well as other transponders having either uplink or downlink capability on the higher frequency bands.

AMSAT has a policy of not obsoleting user equipment, so mode B will be around for a long time. As mode A is an excellent introductory mode, it can be expected on any further general purpose Phase 2 type spacecraft. The Russians also tend to favour hf so mode A and possibly mode K will also be around for a while.

fig. 5. Commonly used satellite communications bands.

Once you're hooked on receiving, the price of a transmitter usually becomes a justifiable expense. Although putting together a minimal receiving and transmitting station isn't difficult, steerable antennas for the 10-meter band are relatively large. Therefore relatively few Amateurs can steer their 10-meter antennas in both azimuth and elevation. Steerable antennas for 2-meters and 70 cm are much smaller and as a result, more manageable.

Antennas in common use on the 10-meter band include verticals and multi-element beams optimized for working DX. As such, they have very good responses to signals arriving from low angles but are not at all suited for signals arriving at high angles. Vertical antennas respond to low-angle radiation from all directions, while beams respond to low-angle signals from the direction in

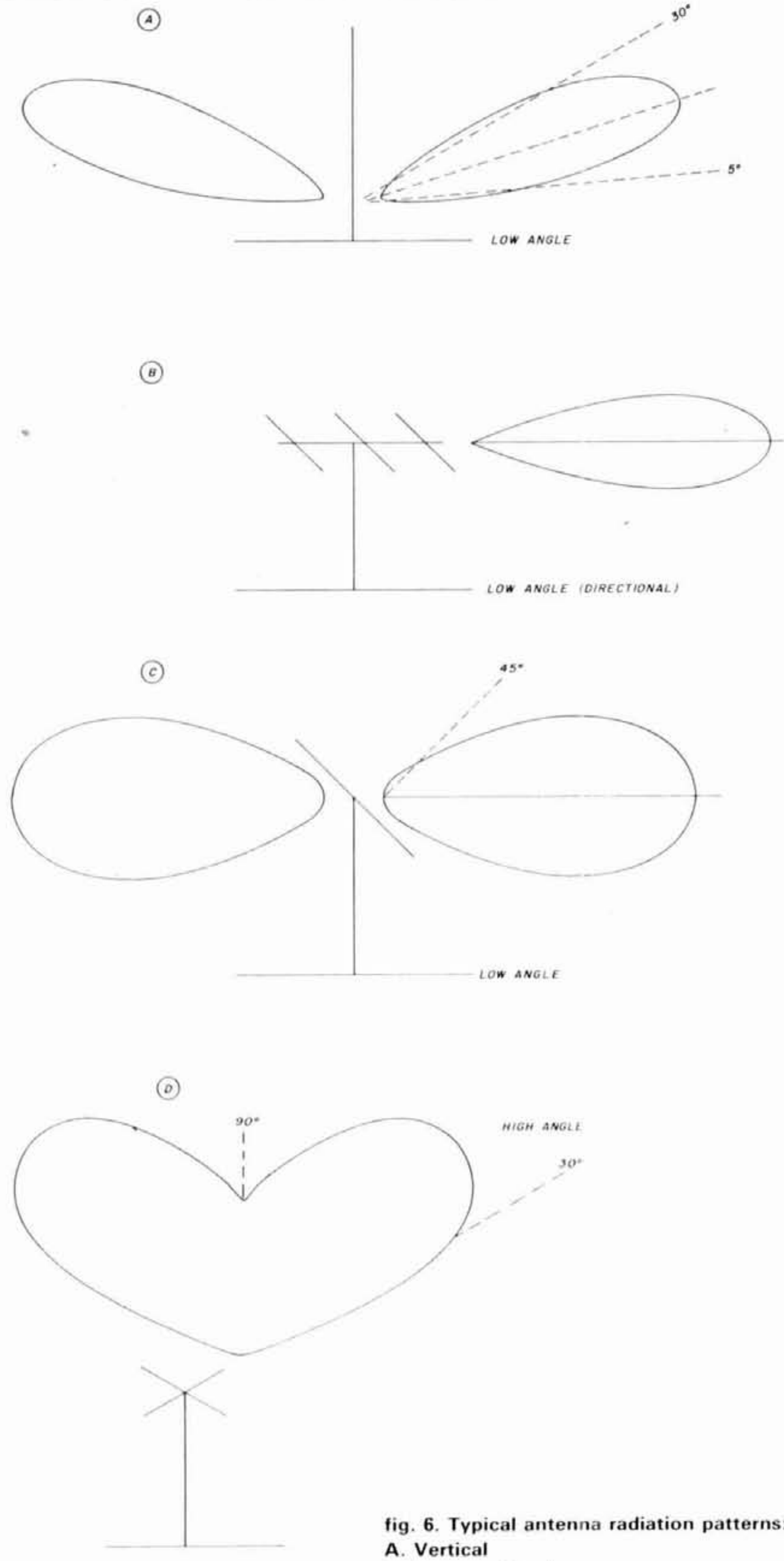

fig. 6. Typical antenna radiation patterns:
A. Vertical
B. Beam or Quad
C. Horizontal dipole
D. Turnstile.

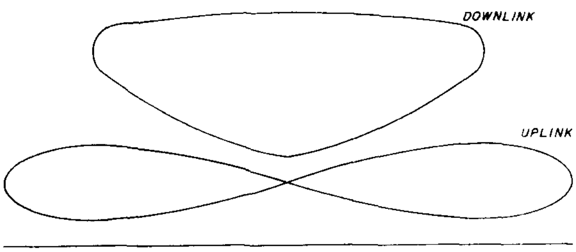

fig. 7. Typical VHF/UHF operator antenna characteristics. Hears well when satellite is high in sky. Talks well when satellite is low in sky.

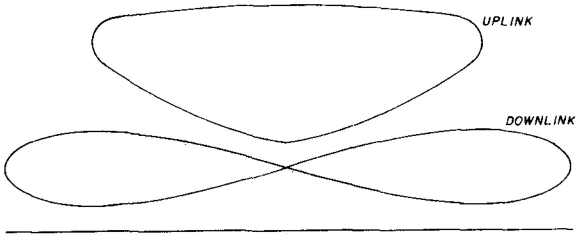

fig. 8. Typical HF operator antenna characteristics. Hears well when satellite is low in sky. Talks well when it is high in sky.

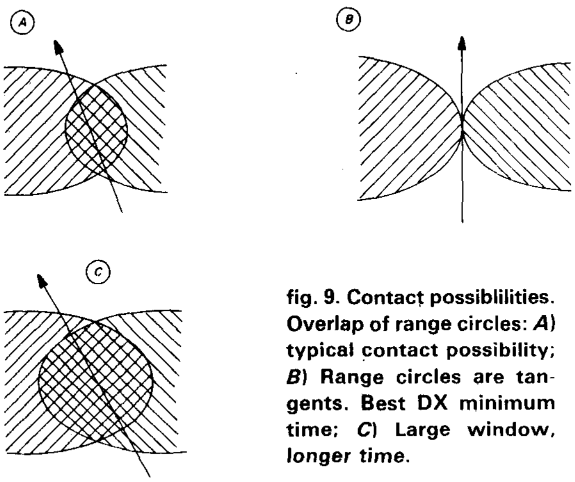

fig. 9. Contact possiblilities. Overlap of range circles: *A*) typical contact possibility; *B*) Range circles are tangents. Best DX minimum time; *C*) Large window, longer time.

which they happen to be pointed. Stations using these antennas have trouble hearing signals arriving from higher angles.

Conventional literature has touted the turnstile, or crossed dipole antenna, as the answer to the problems of satellite reception at 10 meters. It has circular polarization and a high-angle response pattern. It does very well when the satellite is located at elevations greater than about 30 degrees as seen by the observer, but has a poor response to signals arriving at low angles (close to the horizon). Typical radiation patterns for these antennas are shown in **fig. 6**.

Most Amateurs who have problems working Mode A fall into one of two categories. The first category includes the VHF/UHF operator who decides that satellites offer both a technical challenge and increased opportunity for some exciting DX. This operator usually has excellent linear (horizontal or vertical) polarized antennas for the 2-meter uplink bands but has nothing for 10 meters. Reading that a turnstile can be a simple, effective device for reception, he builds one and finds that, sure enough, he can hear something. It may be weak, but, by golly, those signals are coming from outer space!

Step back for a minute and analyze this situation as sketched in **fig. 7**. The uplink antennas on 2 meters can put a powerful signal into the satellite when it's at low angles of elevation as seen by this operator. His downlink antenna, however, receives best when the satellite is at a high angle. In other words, when he can hear it, he can't access it . . . and when he can access it, he can't hear it — meaning, he cannot hear himself.

The second type of Amateur who decides to have a go at satellite operation is the HF operator, who usually has a good beam antenna for 10 meters. Reading that a turnstile antenna is a good choice for satellite operation, he builds one and uses it. Now analyze this situation as sketched in **fig. 8**. The uplink antenna on 2 meters puts a weak signal into the satellite when it is at low angles of elevation as seen by this operator. His downlink antenna, however, receives best when the satellite is at low angles. In other words, when he can hear it, he cannot access it . . . and when he can access it, he cannot hear it — meaning that he cannot hear himself. Although this is the inverse situation to that of the VHF/UHF operator it has the same characteristics: both are "alligator operators" — all mouth and no ears.

There is a third category: the apartment dweller who cannot put up HF antennas at all. This type of operator can usually install some kind of VHF/UHF array on a balcony and work Mode B quite well. But when he tries Mode A, he has problems because of the size of his 10-meter receiving antenna.

It's no surprise, then, that the vast majority of Radio Amateurs who decide to become active in satellites have trouble working them at first.

matching uplink and downlink antennas

In order to get the most enjoyment out of satellite operation, it's necessary to match the uplink and downlink antennas. Before doing this, however, it's necessary to consider other aspects of the satellite communications path.

The Earth-Satellite-Earth ccommunications link is a line-of-sight path. Each ground station has a range circle for which a window allows communications into the satellite. In order to work any other station, the range circles of the two stations must overlap as shown in **fig. 9**. The duration of any contact is governed by the time that the spacecraft spends in that window. Thus, the higher the elevation of the satellite as seen by the ground station, the shorter its communications range along the surface of the Earth. The best DX contact between any two stations occurs when the sub-satellite point of the orbit of the spacecraft passes over the ground where their range circles just touch — that is, at a tangent to both range circles. They will, however, also have very little time to make that contact.

antenna characteristics

The usual three-element Quad or Yagi-type antenna puts out a good directional low-angle signal. The turnstile antenna puts out a good omnidirectional high-angle signal. Vertical antennas put out good omnidirectinal low-angle signals. The 3/8 and 5/8 wave antennas used on 2-meters have good omnidirectional low-angle radiation characteristics. Somewhat directional high-angle radiation may be obtained from sloping dipoles attached between the top of a mast and the ground in the manner of guy wires (but don't ever use them as such), as shown in **fig. 10**. If you want to work the satellites successfully, you must match the characteristics of your uplink (transmitting) and downlink (receiving) antennas so that they have similiar radiation patterns.

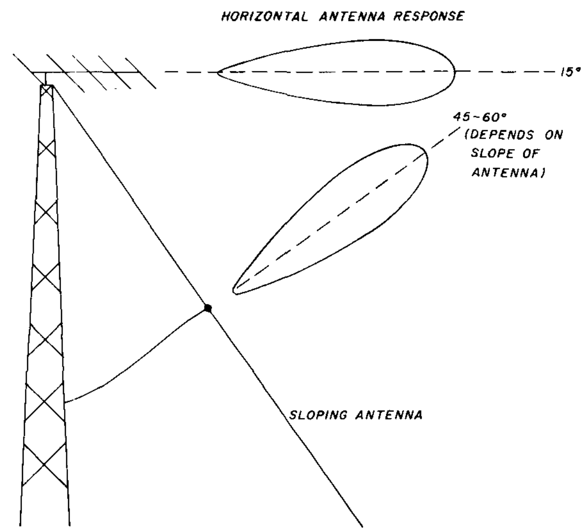

fig. 10. Sloping antennas for 10 meters. Optimally, put slopers on four sides of tower. These will work well for regular 10 meter contacts. Put dipole or beam on tower.

receiving signals

The satellite downlink is usually marginal because the spacecraft is using low power and is far away. Every ESE (earth-satellite-earth) contact practically qualifies the spacecraft for yet another 1000-mile-per-watt award for QRP communications.

Most modern receivers (and others not so modern) suffer from a loss of sensitivity at the top end of the 10-meter band so that using a preamplifier to increase the strength of the received signals is a good idea. Most Amateurs feel that to communicate with DX stations they need the biggest antenna they can put up and the maximum power they can put out. But there's a fallacy at work in this kind of thinking; if the minimum amount of transmitted power to put an S-9 signal into a DX location is, for example, 100 watts, then for that transmitter to use 1000 watts would be a waste of power . . . or would it? For the moment, ignore the QRM factor in which the more power you use, the louder you are and the more likely you are to be heard over the rest of the pack. If the signal is made weaker or attenuated by the ionosphere for one reason or another, what happens? In our example, we are receiving signals from a transmitter having the calculated 100 watts. If a fade equal to 5 S-units takes place, the received signal will drop down to S-4. This isn't too serious; S-4 signals can be copied, but what happens if the station is using the QRP and was S-4 to begin with? The same fade would take it down to S minus 1 or below the noise level, and no signals could be copied. The communications link should contain enough gain to minimize or avoid loss of reception due to extreme fading. In other words, some kind of margin should be built into the link.

the communications link

The communications link in a satellite contact can readily be split into two parts, the uplink and the downlink. Consider each of these in turn.

In the downlink, the transmitter output power is not under the control of the Radio Amateur, but is instead fixed by the satellite. The attenuation of the signals radiated by the satellite is a function of the distance between the spacecraft and the receiving station. The actual strength of the received signal at the ground station antenna will vary because of the attenuation due to fading and polarization changes in the ionosphere. Thus all the ground station operator can do is make sure that he has the best and most sensitive receiving capability that he can have. Ideally, the receiver should be such that the beacons on the downlink are receivable at good signal strength. In most cases, this means that a receiving preamplifier should be used ahead of the receiver.

In the uplink, the receiving antenna and on-board receiver sensitivity are governed by the design of the satellite. The attenuation of the signals from the ground as received by the satellite is a function of the distance from the spacecraft to the transmitting station. The actual strength of the received signal from the ground station antenna will vary because of the attenuation due to fading and polarization changes in the ionosphere. The effects of the ionosphere on the uplink may differ from those on the downlink. In the past, AMSAT has performed the link calculations before the launch of the spacecraft and released a recommended value in radiated uplink power (EIRP) for Amateurs to use with the satellite. This number has usually been conservative, and most satellite users have no trouble working through the transponder with much less power. The common solution to this problem is to boost the transmitter power until a good return signal is heard. This is not the optimal solution, because stations that have problems hearing themselves will tend to use too much power, not because they can't get into the satellite, but because they cannot hear themselves getting into it. The ionosphere may also behave differently in different places at any time, so that although the sending station may be having trouble hearing his own downlink, other stations further away may be copying him with ease. There's no easy solution to this situation. The compromise is to attempt to make your own signal as received on the downlink equal in strength to that of the transponder beacon. This means that you adjust your transmitter power to keep your own signal as strong as the beacon on your receiver. You can do this either by reducing the transmitter power gain or by aiming the antenna away from the spacecraft.

Gain in the communications link can be obtained by using amplifiers or directional antennas. Directional antennas are at a disadvantage in that they must be moved to track the satellite during the pass, while omnidirectional ones do not. On the other hand, they're usually cheaper than amplifiers, particularly high power UHF transmitting types. Thus, to obtain a certain power output level on the uplink, the Amateur has the choice of a directional antenna and low power or an omnidirectional antenna and high power, or something in between. Similarly, on the downlink, if the directional antennas are used, a receiving preamplifier may not be an absolute necessity. In any event, for reasonable results, make sure that the characteristics of your uplink and downlink antennas are matched.

locating the satellite

The common adage, "If you can't hear them, you can't work them" must be modified for satellite users to read, "If you can't locate them, you won't hear them . . . and if you can't hear them, you can't work them."

In order to work satellites, an Amateur has to know not only when a satellite is in range, but also where to aim his antenna in order to put a signal into it. A number of different techniques have been developed over the past few years: graphical "circular slide rules" were first used very successfully for Phase 2 low-orbit satellites. As the personal computer found its way into ham stations, computer programs were developed to locate the satellites and the graphical plotters could be used to augment computer-generated data.

Fortunately, the first OSCAR satellites used by large numbers of Amateurs (AMSAT's OSCAR 6, 7, and 8 and the early RADIO spacecraft) were in circular orbits, which made locating them easy. All you had to do was pick a "reference orbit" as published in the Amateur Radio press and add the orbital increment to determine the position of the next equator crossing (start of the next orbit) and then add the period of the orbit to find the time of the following orbit.

When the first Phase 3 satellite (AMSAT's OSCAR 10) was put into service, it was placed into an elliptical orbit with a high apogee and a low perigee — definitely a non-circular orbit. AMSAT's Tom Clark, W3IWI, an astronomer by profession, wrote a program that utilized Keplerian elements for keeping track of the position of any satellite in the Amateur Satellite Service. This and many other programs have been widely disseminated and there should be at least one member of each radio club who knows how to get hold of them. (AMSAT can supply copies of such software through its Software Exchange.) Locating the satellite, therefore, should not be a problem.

reference

1. Tom Clark, W3IWI, "Basic Orbits," *Orbit*, March/April, 1981.

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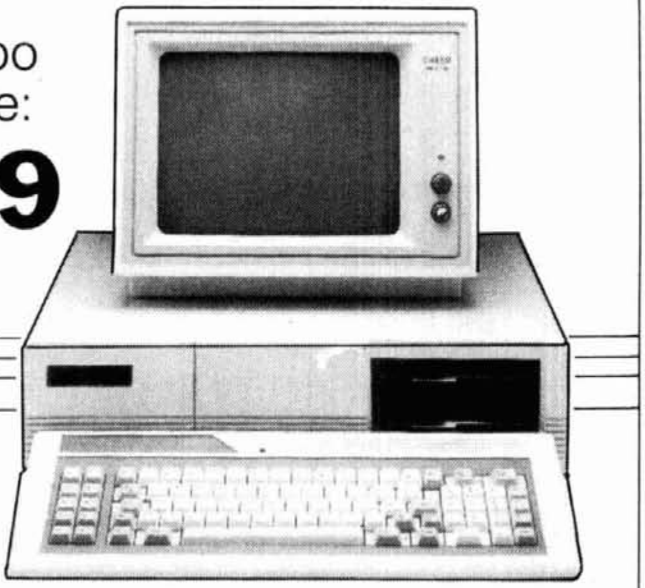

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I had used an LM11 operational amplifier in designing an earlier project and a friend later introduced me to an even better one. Some of the new chips coming on the market offer unbelievable performance and are slowly making system designers out of us circuit designers. A chip here, a chip there, follow the spec sheet as to optimum feeding — and we have a piece of test equipment that rivals commercial units.

I combined some of these into an RF power meter that features a 30 dB (useful to 35 dB) range from −15 dBm to −45 dBm, remote control, and good temperature stability. Although the antenna range is still in the future, the power meter has been used on the bench for evaluating hybrid couplers, helical filters, cavity filters, IF amplifiers, and such. I plan to use the power meter on the 70 cm band. But it can also be used from the HF band up into the GHz range.

theory of operation

The heart of the unit is the Hewlett-Packard HSCH-3486 zero-bias Schottky diode used as the detector. This device offers high voltage sensitivity and doesn't need the biasing featured in other detection schemes. The response curve is logarithmic from −50 dBm to −20 dBm; above −20 dBm the diode becomes increasingly nonlinear in detection response. The lower end is limited by the amplifier used.

To avoid using a modulation method of detection, a chopper stabilized operational amplifier was used. (The schematic is shown in **fig. 1**). The Intersil ICL7650 features an extremely low input offset voltage of 1 μvolt over a wide temperature range. The chopper op-amp basically converts the input DC voltage to AC, amplifies it, and converts it back to DC. Amplifying the DC output from the detector 150 times with a chopper op-amp puts the signal at a level that simpler op-amps such as the LM11 can handle. The National Semiconductor LM11 is a precision DC amplifier that combines the best features of existing bipolar and FET op-amps. Offset voltage is 100 μvolts and drift is 1 μv/°C. Six ranges in 5 dB steps are accomplished by this circuit by changing the gain of the amplifier. Each range is controlled remotely by reed relays. Offset voltages in the amplifier are nulled with two pots, one for the high range and one for the lower three ranges. These three devices — a diode which converts RF power into a logarithmic output equal to a dB scale and a pair of operational amplifiers — amplify AC microvolt level signals to volt levels, while introducing little drift.

construction

Originally the unit was to be mounted directly at the antenna and was therefore constructed in a diecast box for good shielding. Power is supplied remotely from a separate box, which also contains the meter and scale change (**fig. 2**). A schematic of the power supply is included in (**fig. 3**). When purchasing a dB scale meter make sure that the −3dB point falls exactly at half scale. Some meters have been "fudged" to accomodate circuit nonlinearities.

The inside of the box is shown in **fig. 4**. Its detection circuitry, visible on the left side, is shown in an enlarged view in **fig. 5**. The parts are mounted on a small piece of 0.015 inch brass shim stock and held in place by the TNC connector. Note the chip capacitor on the left, supporting the 50-ohm resistor. A value of 100 pF is adequate down to 10 MHz; below 10 MHz this value should be increased. For work above 70 cm up to 4.2 GHz, a coaxial-mounted detector is recom-

By Rudolf E. Six, KA8OBL, 30725 Tennessee, Roseville, Michigan 48066

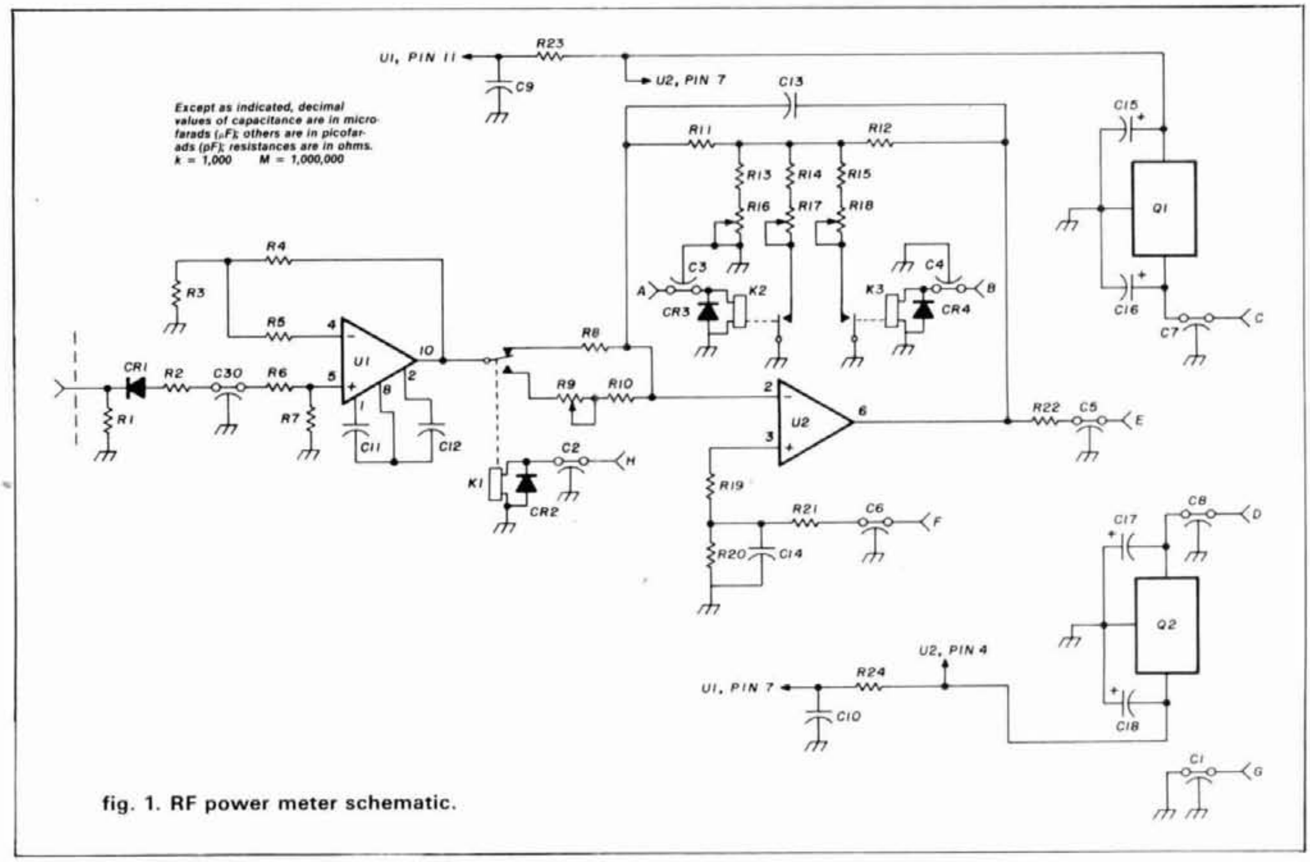

fig. 1. RF power meter schematic.

table 1. RF power meter and power supply parts list

C1 thru C8	1000 pF feedthru (Erie, Cambion)
C9,10,15,18	1 µF 10wvdc tantalum
C11-12	0.1 µF metalized film
C13	500 pF disc
C14	0.01 µF disc ceramic
C16,17	2.2 µF 25 wvdc tantalum
C19,21	100 µF 15 wvdc electrolytic
C20	500 µF 15 wvdc electrolytic
C22,23	0.01 µF disc
C30	100pF chip capacitor
CR1	HSCH-3486 Hewlett-Packard
CR2,3,4,9,10	1N914 or equivalent
CR5,6,7,8	1N4003 or equivalent
K1	SPDT reed Magnecraft W172-DIP5 (internal diode — CR2 not used)
K2,3,4,5	SPST reed EAC EAC Z610-ND
M1	1 mA DC meter with dB scale
Q1,4	78LO5 regulator
Q2	79LO5 regulator
Q3	78L12 regulator
R1,2	50 ohm 1/8 watt carbon film
All resistors 1% metal film 1/4 watt	
R3,6,14,22	1k
R5,7	100k
R10	120k
R4	150k
R8,19	4.99k
R11,12	20k
R13	2.74k
R15	165 ohm
All resistors 5% carbon film 1/4 watt	
R20	100 ohm
R21	1 megohm
R23, 24	10 ohm
R27	1.5k
R9	50k Panasonic CEG54 trimpot
R16	500 ohm Panasonic CEG52 trimpot
R17	200 ohm Panasonic CEG22 trimpot
R18	100 ohm Panasonic CEG12 trimpot
R25,26	10k potentiometer
S1	DP6T rotary switch
T1,T2	6.3 VAC transformers
U1	ICL76508CPD Intersil
U2	LM11CLH National
Box	CU-124 BUD
Chassis	9 1/2 x 5 x 2 chassis BUD Ac-403

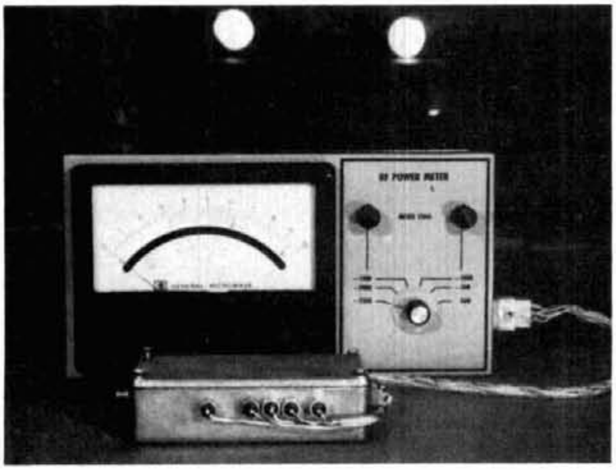

fig. 2. RF detector and amplifier mounted in a shielded enclosure. Range selection, meter and power supply are in a separate unit.

mended. A suitable unit, Model CD-51, is available from Elcom Systems Inc., 4032 Clint Moore Road, Boca Raton, Florida 33431-2895. The printed circuit board is suspended in the box (**fig. 6**). Two hangers made from 0.015-inch (0.038 cm) brass shim stock are soldered to the ground foil of the printed circuit board and are held by the feedthrough capacitors. Metal and

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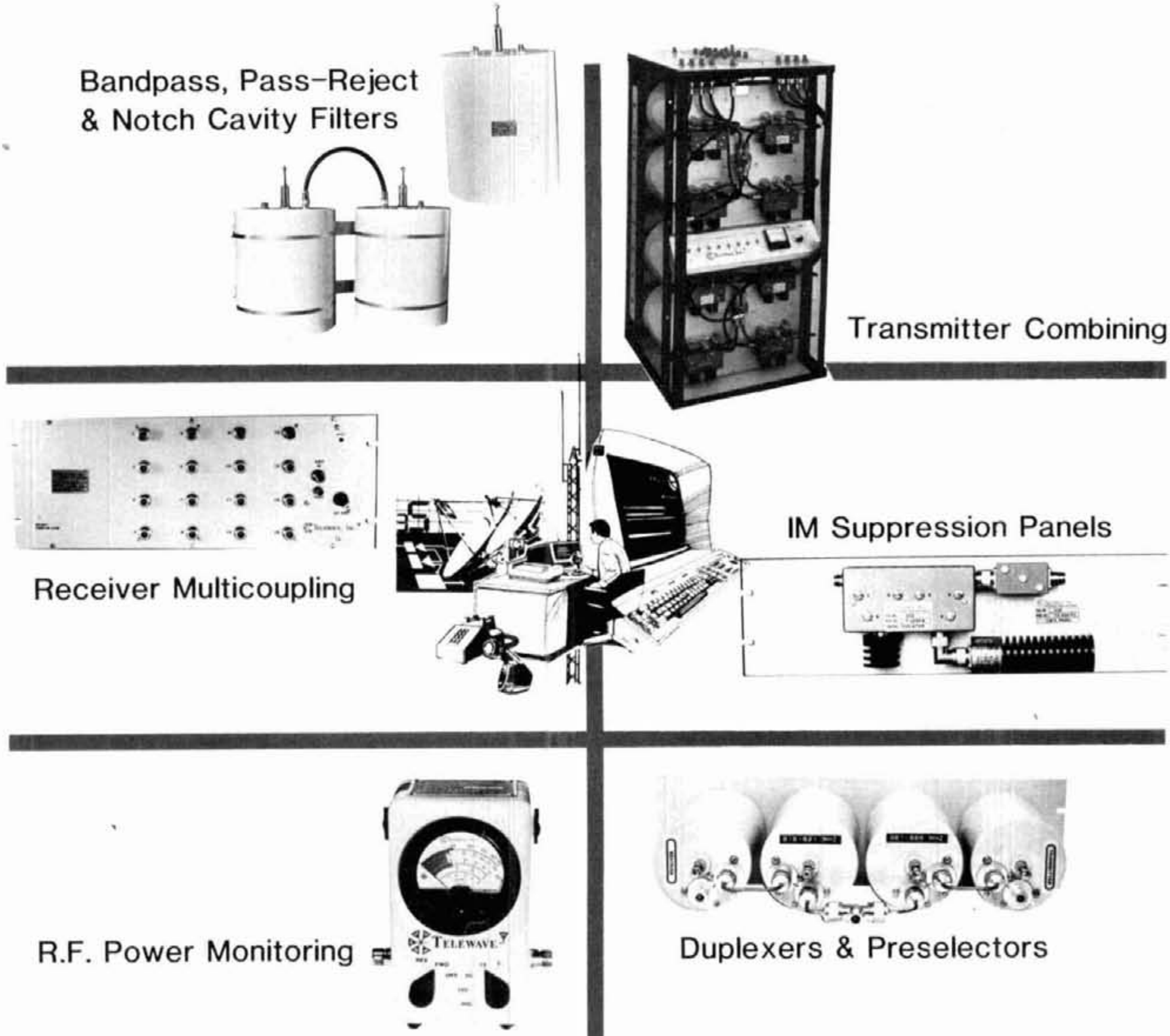

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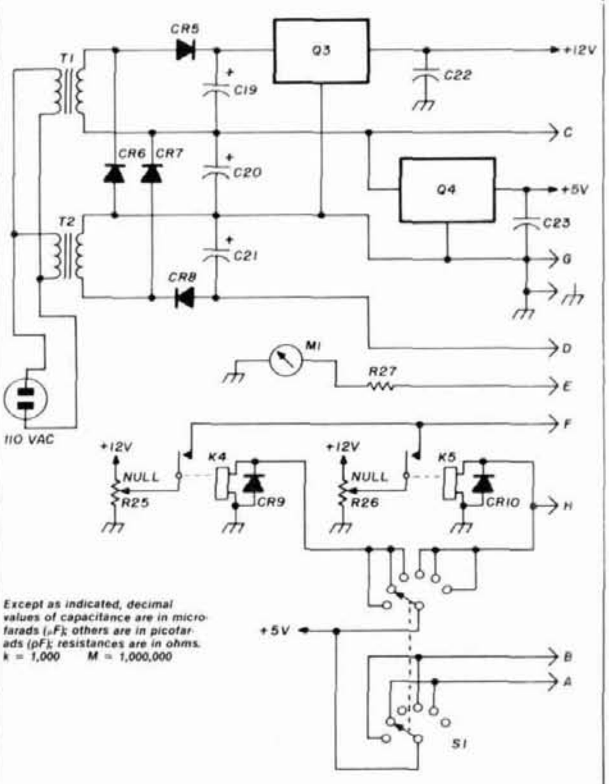

fig. 3. RF power meter power supply schematic.

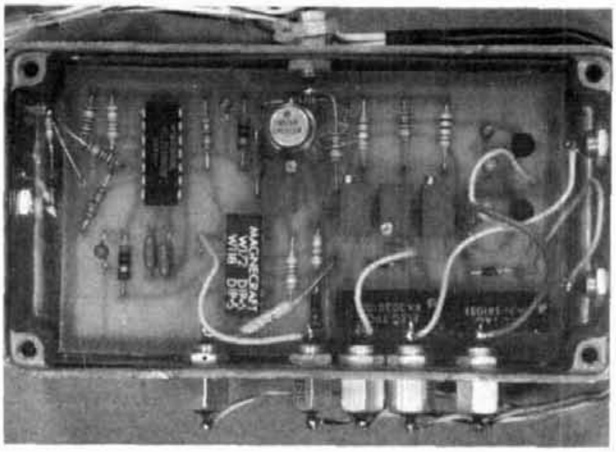

fig. 4. Parts layout in the detector-amplifier. R21, 22, and 6 are soldered between the box and the pc board. C13 is soldered on the back of the pc board under U2.

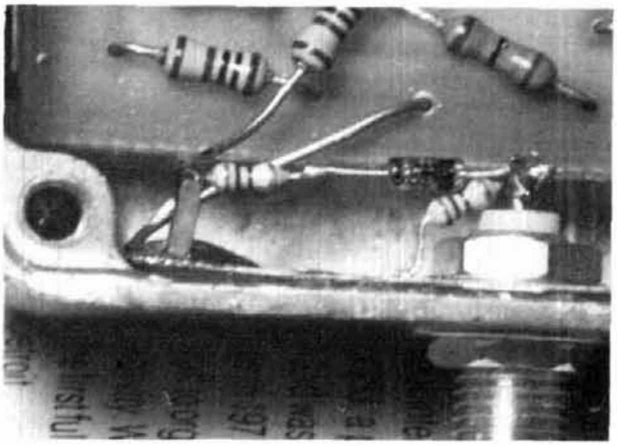

fig. 5. Close-up of the detector circuitry.

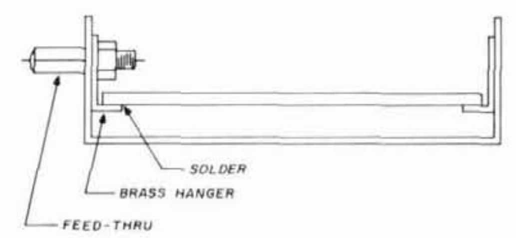

fig. 6. Printed circuit board is supported by brass shim stock.

carbon film resistors are used for accuracy and low noise. The PC board artwork and components layout are shown in **figs. 7** and **8**, respectively.

calibration

Calibration depends on the accuracy of the standard used. If you have no fixed attenuator, purchase the Model AT-51 5 dB TNC from Elcom ($14). Set the meter to the −15 dB range, check and adjust for zero with no signal applied. The meter zero pot has little control on this scale and if the meter doesn't read zero, there's something wrong with the circuit. Adjust a signal generator for a +30 dBm output level and turn R16 for full scale or 0 dB on the meter. The frequency of the generator is not important — in this case, 150 MHz was simply convenient. If the signal generator has no dBm scale, turn R16 to midpoint and adjust the signal generator for 0 dB. Insert a 5 dB attenuator. The meter should read −5 dB. Turn to the −20 dB scale while momentarily disconnecting the signal generator, then check and adjust for zero. The meter zero pot should show more control. Reconnect the signal generator and adjust for 0 dB with R17. Insert 5 dB of attenuation and the meter should again read −5 dB. Turn to the −25 dB scale and repeat the above procedure. The meter zero pot will have quite a lot of control. Note that on the −25 dB scale the needle shows some jitter or drift. This is circuit noise. This drift should be less than ±1/10 dB at full scale. Return to the −15 dB scale, insert 5 dB of attenuation and increase output for a 0 dB reading. Turn to the −10 dB scale, remove the signal generator and adjust for zero with the right side meter zero pot. Remove the attenuator and reconnect the signal generator. Adjust R9 for 0dB. Insert attenuator; adjust signal generator

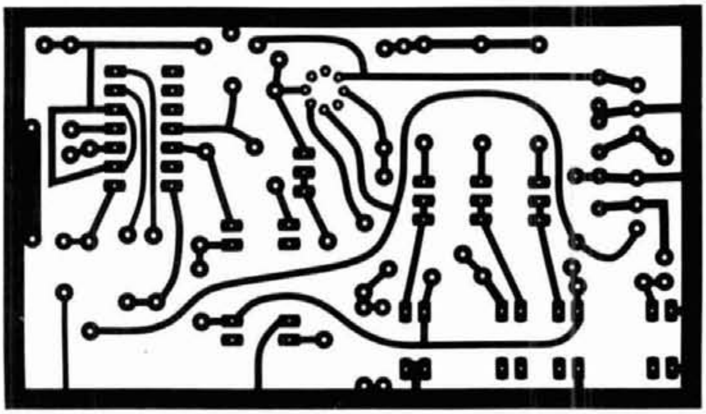

fig. 7. RF power meter artwork.

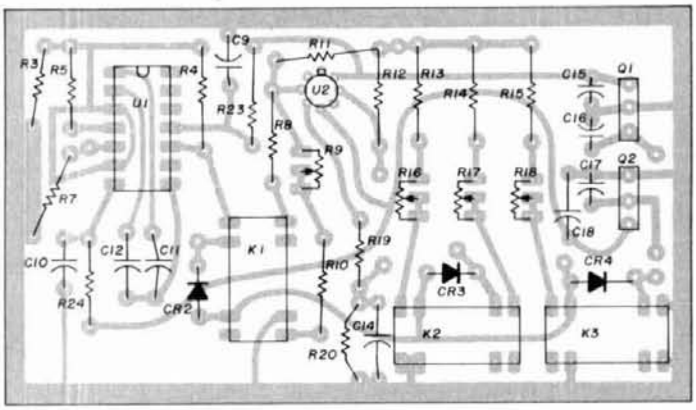

fig. 8. Component layout.

fig. 9. RF power meter is used, in a typical application, to determine hybrid coupler isolation value.

table 2. Parts suppliers.

Parts	Supplier
C1 thru C8, C30, R1, 2, TNC connectors	*Microwave Components, 11216 Cape Cod, Taylor, Michigan 48180*
U1, CR1	*Hamilton-Avnet. Local outlets in most states. Distributor will ship COD to individuals. Cost of part approximately $25.*
U2	*Jameco Electronics, 1355 Shoreway Road, Belmont, California 94002*
K1 and Bud chassis and box	*Newark Electronics. Distributors in most states.*
All other parts	*Digi-Key, 701 Brooks Avenue, South, Thief River, Minnesota 56701*

Printed circuit is available from author for $11.00. Please add $1 for shipping.

for 0dB. Turn to the −5 dB scale and remove the attenuator. The meter should read 0 dB. Insert the attenuator again and adjust the signal generator for 0 dB. Turn to the 0 dB scale and remove the attenuator. Note that the meter doesn't read 0 dB, but it should be within 1/4 dB of full scale. We are now starting to run into the nonlinear portion of the detector diode.

using the power meter

Figure 9 shows a typical set-up in which the power meter is used. A 70 cm hybrid coupler is checked for isolation between port 1 and port 2. The ICOM-471A provides the signal with its output reduced by a 10dB-10 watt attenuator to less than 1 watt. Further attenuation is introduced by a step attenuator.

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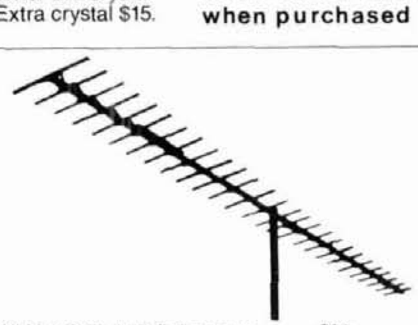

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More Details? CHECK—OFF Page 126

✓ 215

grounded-grid amplifier parasitics

Simple cure extends amplifier life

For several years, my kit-built amplifier with a pair of 3-500Zs had been spitting at me because of arcing at the plate tuning capacitor. I figured that either my line voltage was too high or that some flying insect was getting into the amplifier tuning capacitor and causing the arcing. This went on until the plate parasitic suppressor on the inboard tube started to smoke. (This would have been a clue for anybody who was paying attention . . . but I wasn't). I replaced the plate parasitic-suppressor and got an instant replay: I smelled burning resistor again. I didn't know what to do next, so I just lived with the stink of burning phenolic for a while. I operated the amplifier for some time, but the spitting continued. Something was wrong, but I was running out of ideas.

Nothing changed until I tried a new set of tubes and the amplifier made a noise like a shot from a 22 rifle. I pulled the plug and removed the case to inspect for damage. The problem wasn't hard to find; the grid-to-ground choke on the inboard tube had exploded its wire. One of the 200 pF capacitors from grid to ground had also exploded.

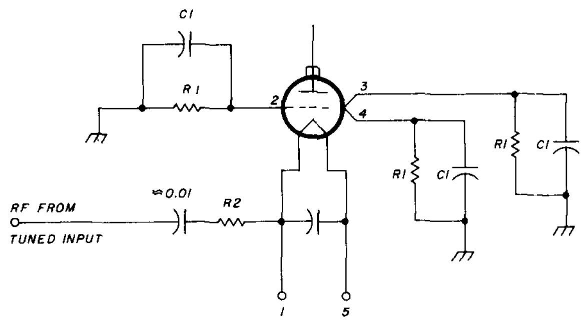
probable cause

I asked around and it seemed that other hams had experienced the same problem. The consensus was that the tube had shorted from grid to filament, causing the choke and capacitor to explode. This was confirmed by the fact that many others with this problem had found the tube to be shorted from grid to filament during the investigation following the big bang. This seemed unlikely to me because you can place a short from grid to filament on a zero-bias triode without anything cataclysmic happening. Naturally, you can't drive the cathode because the cathode is grounded, but there wouldn't be any fireworks. The answer had to be some condition that would create a grid voltage of over 2000 volts (it would take that much to destroy the 200 pF mica capacitor from the grid to ground) and more than 3 amperes of grid current which would be necesary to explode the choke wire. It had to be caused by parasitic oscillation. Light loading causes high grid current and no loading causes potentially destructive grid current and voltage. A high impedance path by the plate tank inductor would account for the "light loading" condition to VHF energy.

casualty list

*Parasitic oscillation can destroy the following ampli*fier parts: tubes, due to grid to cathode shorts; grid current meters and shunts; zener bias diodes in the cathode circuit; contacts on the plate circuit bandswitch — usually on the 160 or 80 meter plate tuning capacitor padder contact; small chokes and capacitors in the grid to ground circuit; and, almost unbelieveably, filament transformers, because of voltage breakdown. This voltage surge is the result of the positive high voltage temporarily going to near ground potential when the tube arcs internally as the grid wires explode. With the positive high voltage at ground potential, the negative lead rises to the supply voltage, which is usually around −3000 volts in a typical amplifier. This dumps the stored energy of the HV filter capacitor into the only current path from negative HV to ground: the grid current meter and shunt resistor, which explode. This leaves an open circuit, and the negative HV arrives at the zener bias diode and the center tap of the filament transformer. Filament transformers are not usually designed to withstand high voltages, and the insulation may break down. This creates a current path inside the transformer, and

By Richard Measures, AG6K, 6455 LaCumbre Road, Somis, California 93066



R1 = 75 TO 100-OHM, 1 OR 2-WATT, NON-INDUCTIVE.
R2 ≈ 3 10-OHM, 2 WATT, NON-INDUCTIVE, PARALLELED. FOR TWO TUBES IN PARALLEL, USE 3 10-OHM RESISTORS. FOR ONE TUBE, USE 3 20-OHM, 1-WATT RESISTORS.
C1 = 47 TO 75 pF, 500V DISC CERAMIC.

fig. 1. Grid and cathode modifications reduce tendency to oscillate at VHF.

the transformer will slowly melt unless the fuse opens. I personally know of two, a commerical pair of 3-500Z amplifiers that suffered from all of the above difficulties after the big bang.

a previous solution

Long before the 3-500Z was invented, the Collins Radio Company ran into a similar problem during the design of their 811A amplifier, the 30L-1. In order to prevent the amplifier from "taking off," a degenerative parallel R-C circuit was connected from each tube's grid-to-ground. The resistor destroyed the Q of the grid-to-ground resonant circuit. At some VHF frequency the grid structure inductance and plate to cathode capacitance resonated. This looks like a very high impedance, causing positive feedback at or near the frequency. This unavoidable situation will always develop at some frequency in any gounded-grid amplifier. But one would hope there will not be a resonant circuit in the plate compartment or in the input circuitry or associated wiring that would allow the oscillation to take place.

The Collins solution used a resistor that lowered the Q and small series capacitor that cancelled some of the built-in inductance in the grid structure, the tube base, and the socket, thereby increasing the grid resonant frequency *above* the natural resonant frequency of the grid if it had been directly grounded with a short copper strap. Other amplifier manufacturers copied the capacitor- to-ground trick, but they didn't understand that the capacitor was part of a tuned circuit. Instead, they thought it was some sort of bypass. With the belief that "bigger is better," especially when you're bypasssing, they used more than the 200 pF that Collins had wisely chosen. My troublesome amplifier used 600 pF total, with 200 pF from each of the three grid pins to ground. (See **fig. 1** for a typical circuit). I copied the Collins grid suppressor circuit. The amplifier did not oscillate. These results were published in a *ham radio* "ham note" in October, 1982.

does it work with other amplifiers?

Since that time I've learned more about the subject: whether or not an amplifier can oscillate depends on the gain of the particular tubes you have in your amplifier. New tubes may have more gain than old tubes. So the parasitic cure I used successfully in my amplifier did not always work in someone else's amplifier. After some trial and error, I found that using three separate paralleled R-C suppressors, one from each grid pin to ground, worked better in more cases than the simple circuit I described in my original article. The best values seemed to be about 50 to 70 pF for the capacitors and from 75 to 100 ohms for the resistors. This circuit worked in over 90 percent of the amplifiers.

At this point I didn't know what to do about the few remaining amplifiers that still had a tendency to take off. Fortunately, the metal-film, non-inductive resistors most people were using for the grid-to-ground resistors were acting like fast-acting fuses in the grid current path, so that no one lost any tubes. The last piece of the puzzle was furnished by a ham in Samoa who had read the original aritcle. He owned a conduction-cooled amplifier (SB-230) that used an expensive high-μ triode. He experienced a meltdown with the typical fireworks assoicated with a parasitic oscillation. The tube was ruined and the 1000 pF grid-to-ground bypass capacitor was shorted. He had installed new parts, but was worried it would happen again, since the amplifier was still spitting occasionally. I could see from the schematic that the Collins grid parasitic suppressor circuit was not going to be a possibility since there was no way to remove the existing grid bypass circuit. Any parasitic suppression would have to be done elsewhere. With a triode, this wouldn't leave you with many choices. The cathode seemed like a good bet, since EIMAC says that it takes only 27 watts to drive an 8873 to full output, so we could afford to make the tube harder to drive. This might also keep the tube from flat-topping when driven with the average 100-watt radio. A non-inductive resistor in the cathode would cause degeneration or negative feedback. This trick is often used in the emitters of bipolar transistors to prevent regeneration or instability. The trade-off is that the device is going to be slightly harder to drive. Only the drive requirement, not the power output, will be affected. I looked at the

EIMAC data sheet and noticed that the peak cathode current for an 8873 was about 1.8 amperes. Some quick calculations indicated that 11 ohms might be a good place to start. The power rating for the resistor is not easy to figure since the waveform is neither DC nor a simple sine-wave, but instead a pulse with a sine-wave shape and a duration of about 200 degrees. The peak power is 1.8 x 1.8 x 11 = 35.64 watts. The average power will be less than this for teletype operation and much less than that for SSB voice service because of the low duty-cycle.

As a simple rule, divide the peak power by 2 for teletype duty and by 3 or 4 for SSB. Dividing by 2 is recommended for the speech processor fans who like their audio to sound like creatures in a grade-B science fiction movie. Another consideration in selecting the wattage value is the fact that the average 2-watt metal-film resistor will dissipate 4 watts for at least 60 seconds with no ill effects.

Unfortunately, 2 watts is the largest size metal-film or metal-oxide-film resistor commonly available. More dissipation can be achieved by paralleling as many 2 watt units as needed. The 11-ohm resistor was installed at the socket of the 8873, in series from the cathode lead(s) to the wire that delivered the input RF drive. During peak drive conditions, 19.8 volts of RF negative feedback will be developed (1.8 amps x 11 ohms). 100 volts of peak RF output was available to drive the cathode. Losing 20 volts still left more than enough drive to give full ouput. The circuit worked. The man in Samoa was happy. No more unwelcome surprises when using the amplifier!

The same fix was tried on the 3-500Z amplifiers that had proved so difficult to tame. The same resistor bank can be used with an 8877 — in the cathode lead, of course. The cathode resistor stopped the tendency of these unruly amplifiers to oscillate. In amplifiers with a pair of 3-500Zs the peak cathode current is close to 3 amperes. This means that you can get more negative feedback voltage with fewer ohms in the cathode circuit. It was found that approximately 3 ohms of resistance would do the job. Three 10-ohm, 2-watt metal-film resistors in parallel with some space between them will work fine. These resistors were installed between the RF drive coupling capacitor — usually a 0.01 μF 1000 volt unit — and the place on the filament lead (cathode in a 3-500Z) where the coupling capacitor was originally soldered.

When 3.33 ohms are inserted into the cathode lead, the driving impedance of the cathode will be increased. This will affect the input SWR of the amplifier. This effect is greater on the higher frequency bands because the input capacity of the tubes becomes a large part of the output capacity of the tuned Pi network, and this capacity is connected through a 3.33-ohm resistor. If you don't want to adjust the tuned inputs for the 21 and 28 MHz bands, you can use a plate parasitic suppressor, made from a 47-Ohm, 2-watt resistor and four turns of Number 16 wire wound on the resistor, in place of the RF negative feedback resistor. The parasitic suppressor will not improve the linearity of the amplifier, like the RF negative feedback resistor, but it will reduce the VHF gain of the circuit and improve stability.

The 4-1000A is a stable, grounded-grid amplifier tube with plate voltages up to about 3500 volts. Above 4000 volts, the gain of the tube increases, and parasitic oscillation is possible. The quality of the amplifier tube and the frequencies of the VHF resonances are determining factors in sustaining a parasitic oscillation. A 4-1000A amplifier that proved to be unstable above 4000 plate volts was stabalized in a manner similar to the method used on the stubborn 3-500Z amplifiers. The copper, grid-grounding straps were removed. Each of the three grid pins was connected to ground through a 75-ohm resistor in parallel with a 56 pF capacitor. The screen and control grid pins were left connected to the copper plate that was previously used to bond the grids pins together. A 3.33-ohm, 6-watt resistor made from three 10-ohm, 2-watt, metal film resistors in parallel, was connected in series with the 0.01 μF capacitor that couples the drive from the tuned input circuit to the cathode (filament). After modification, the amplifier showed no sign of instability with a plate voltage in excess of 9000 volts. At this plate voltage the amplifier exhibited 15.5 dB gain. This was done to test the stability of the amplifier. Everyday use at this plate voltage is probably not going to result in normal tube life. Plate voltages this high can also produce soft X-rays, which may cause injury to the operator as well.

grid-driven amplifiers

Another use for RF negative-feedback cathode resistors is in grid-driven amplifiers, so often plagued with high-intermodulation-distortion products, or splatter. For example, a friend who owned an NCL-2000 was concerned about the interference he was causing. The root of the problem was with the 8122 tubes themselves, since the best you can expect is about −30 dB of distortion products. This is roughly 10 times worse than what you can expect from the 3-500Z. The 4CX250 series tubes have approximately the same distortion specs as the 8122. To make matters even worse, the NCL-2000 design allowed grid current to flow freely during modulation. This causes the tube's plate current curve to take a nasty jag at low values of plate voltage. My friend was able to make the amplifier acceptably clean by installing three 2-watt, 51-ohm, metal-oxide-film resistors per tube, with one resistor in series with each of the three cathode connections per socket. He also changed the tap on the 50-ohm grid-swamping resistor to avoid driving the control grid into conduction. This depends on how much driver power you have. The result was appreciated by all concerned.

There are other external-anode triodes besides the 8873, 8874, and 8875s that are capable of taking off at VHF or even UHF frequencies. I have recently talked to two people who experienced instability problems with the 8877. For some reason, the problem seems to occur only when these tubes are used in HF amplifier circuits. Perhaps this is because of the extra lead-lengths required in a HF amplifier design and by the fact that these tubes have excellent gain up into the UHF region. One of the 8877 amplifiers was a DTR-2000. The owner had discovered one of these no-longer-made amplifiers in an unopened box in a dealer's warehouse. He bought it for not much more than the price of a new tube. He was delighted with his "find" until the "big bang" occurred during his first day's use.

With a 3-500Z parasitic, the grid may weld to the cathode. I've occasionally seen grid wires blown loose and rattling around inside the bottom of the glass envelope. Such a tube may continue to work. The 8877 in the DTR-2000 also had a wire from the grid blown loose, but from only one end. The free end of the wire had shorted to the plate of the tube.

Another problem with the DTR-2000 is that 5.9 volts is applied to the filament, which, according to EIMAC, should never have more than 5.25 volts. This situation will appreciably shorten the life of the 8877's oxide-coated cathode. Some owners have corrected the problem by installing a 0.1 ohm, 10 watt resistor in series with the filament.

The important thing to keep in mind is that the average amplifier tube, with average gain at VHF, probably will not oscillate in a typical HF amplifier design. The problem shows up when you happen to get a unusually *good* tube — with lots of VHF amplifying ability — in a HF amplifier circuit.

the why of it

If you wanted to build an oscillator, you would need at least one tuned cirucit, an amplifier, and a feedback path. If you had two tuned circuits, one for the input and one for the output, your chances of building a successful oscillator would be even better. Keeping these facts in mind, I started sniffing around the input and output circuitry of my amplifier with a dip-meter. The bandswitch was set to 40 meters — the same band in which the big bang was heard. The drive coupling capacitor at the cathode of the 3-500Zs, which connects to a short length of 50-ohm coax, showed a good dip at 110 MHz. The lead from the plate of the tubes to the plate tuning capacitor showed a good dip at 105 MHz despite the presence of the parasitic suppressor. The plate circuit dip could be moved to 110 MHz by slightly adjusting the plate tuning capacitor. The grid showed a dip near 90 MHz. We have two tuned circuits. We have a feedback path through the "grounded" grid. The 3-500Zs are rated at 110 MHz. It should be capable of sustaining oscillation. It does.

These resonances are nobody's fault. They are caused by the laws of physics and they cannot be eliminated by any practical amplifier design. The way to control the problem is to use non-inductive resistors in the input and output circuits to destroy the *Q* of the VHF resonances. Most people are accustomed to using a resistor in the plate lead to control parasitics, but the idea of using such a device in the cathode lead is sadly missing in most HF amplifier designs. This is sad because the cathode lead is an ideal place to accomplish the job, since a resistance in the cathode lead will cause desireable negative feedback — which the plate circuit cannot do. If I had to pick just one place to put a parasitic suppressor, the cathode would be a good choice.

If you're thinking that your amplifier is immune to the problem, uou may be right — for the particular set of tubes that are in service . . . . The next time you're doing your annual spring cleaning inside the amplifier, check the plate lead for resonances with a dip-meter; you're going to get a nasty surprise. The drive coupling capacitor will also show a resonance whose frequency is mainly dependent on the length of coax that connects to the input bandswitch. The schematic does not show any VHF tuned circuits, but they're always there. Remember this when you plug in that hot new set of tubes. Two-watt resistors are cheaper than new tubes.

If you own an amplifier that sometimes snaps or spits, this isn't something to ignore unless you enjoy fixing broken linear amplifiers. The amplifier is trying to tell you something — if you're paying attention, you can save yourself some expensive grief.

neutralizing grounded-grid amplifiers

Why can't a grounded-grid amplifier be neutralized, like a Class AB, grid-driven amplifier? In EIMAC's book *Care and Feeding of Power Grid Tubes*, it's stated that grounded-grid amplifiers don't normally need to be neutralized. This is not a very comforting statement, considering that there appears to be no way to neutralize a single-ended, grounded-grid amplifier, even if you want to. Gonset tried to neutralize a four-tube 811A amplifier with notoriously poor results. If you own one of these, the Collins circuit will cure the problem.

references

1. Richard Measures, AG6K, "3-500Z Tube Failure," *ham radio*, October, 1982, page 78.

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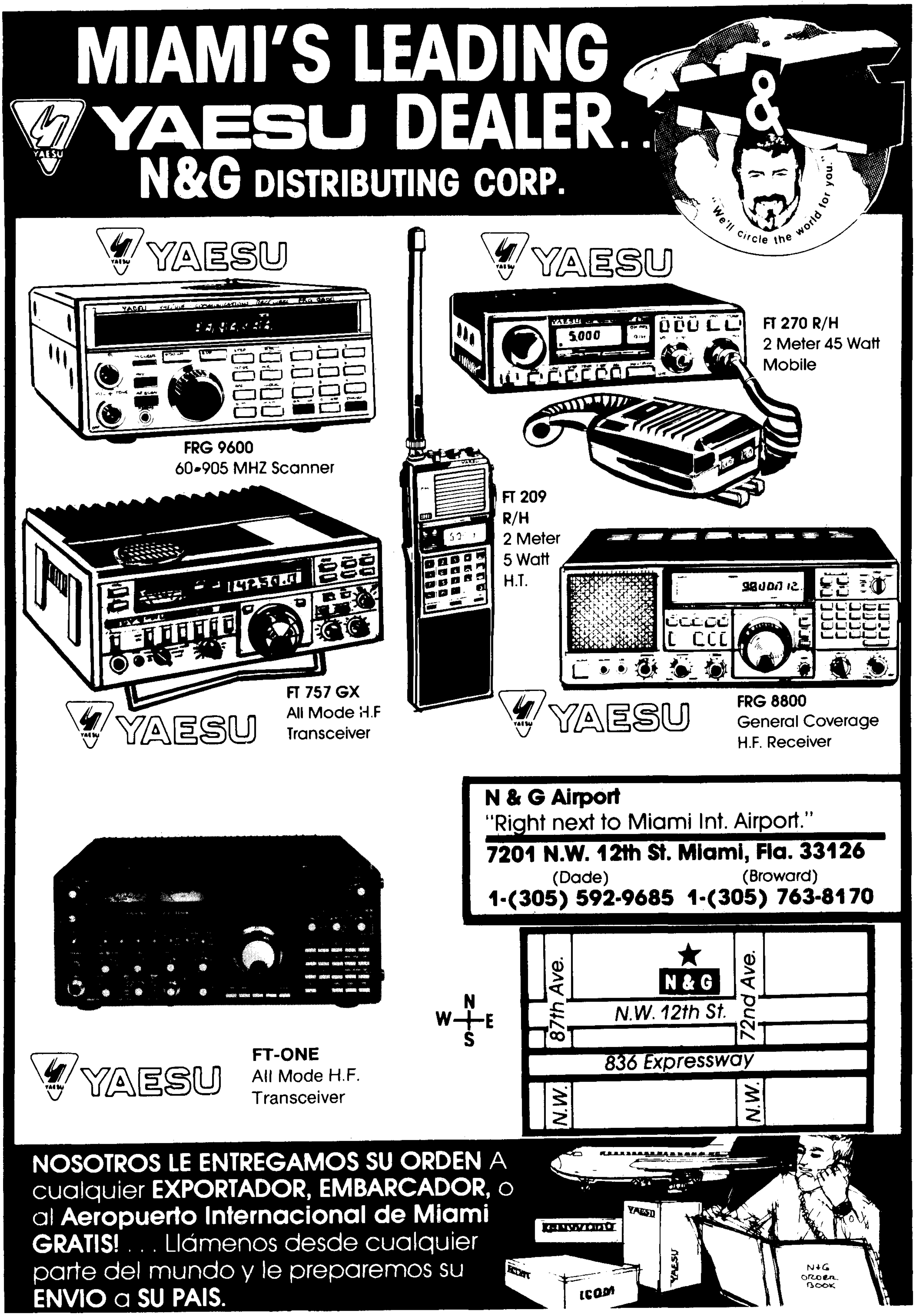
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universal oscillator circuit

Test crystals over a 200:1 frequency range

For more years than I care to remember, I've been collecting crystal oscillator circuits with the hope that one day I'd stumble across the ultimate oscillator circuit. The ultimate circuit would allow me to test the oscillating frequency of all types of crystals from 100 kHz to 20 MHz. No tuning or parts changes would be needed; I'd just swap the crystal and watch the activity on some kind of meter. I'd also be able to measure the frequency as accurately as possible.

Over the years I've yet to see a circuit with this capability that could be duplicated without too much trouble and, most of all, some kind of explanation of why things were done as they were including all relevant technical details, complete with accurate parts information so you'd know what can and what cannot be substituted. Being in radio repair myself, I felt it would be very nice to have something to count on; not finding anything really suitable, I finally had to come up with some ideas myself. The circuit shown in **fig. 1**, which I call the OmniTek oscillator, shows the results. It may not be the ultimate oscillator circuit, but so far I've not seen one more versatile or better suited for my needs.

circuit description

Figure 1 shows the oscillator, Q1, and its associated parts: Q2 (the buffer) and Q3 (the emitter follower with dual output, one for the indicating meter and the other for a counter or other uses). I've seen variations of it before, but not with the 200:1 range this one has. The secret seems to be in the 10 mH choke (scramble-wound miniature coil on a ferrite core) on the drain of Q1. Having tried all kinds of combinations, including other types and makes of L1, I found that only the specified choke worked well and consistently every time.

Various versions of this oscillator — including a handheld test unit with meter and also one that replaced a master multiple crystal oscillator that used a tube (in that well known 6BH6 circuit) — were built.

The Activator button is for low activity or 3rd overtone crystals that may need an additional jolt to start. Most of the time, however, it isn't necessary and could certainly be omitted. If you don't want to, or cannot, calibrate the oscillator for a 32 pF load by plugging in a known crystal calibrated for 32 pF, omit capacitors C1 and C4. Just be sure that the values of C2 and C3 are correct because their ratio, 51 to 56 pF, is very important for the correct operation of the oscillator. They're also the correct values for a very close approximation of a 32 pF load. Use 5 percent silver micas or NPO ceramics here. As a matter of fact, all capacitors in the vicinity of Q1 — that is, C2, C3, C4, C5, C7 and C13 — should be either silver micas or NPO ceramics. (I prefer the ceramics because they're so much smaller.) The trimmer, C1, if used, is often an N450 or N750, though the temperature coefficient really doesn't matter much. All other capacitors may be standard, and will not affect the operation of the oscillator at all. All resistors should be at least 1/4 watt, except the pot, which should be 1/2 watt. The meter can be just about anything you can find, but full scale deflection sensitivity should not be much over 200 μA; if it is, you won't get a good (i.e., more than half-scale) indication on the meter on the higher frequencies. The diode across the meter is used to limit the maximum voltage on the meter (to about 300 mV) because on crystals below 10 MHz the output may be high enough to damage the more sensitive meter movements. The

By **Robert H. Fransen, VE6RF,** 227 Cottonwood Avenue, Sherwood Park, Alberta, Canada T8A 1Y3

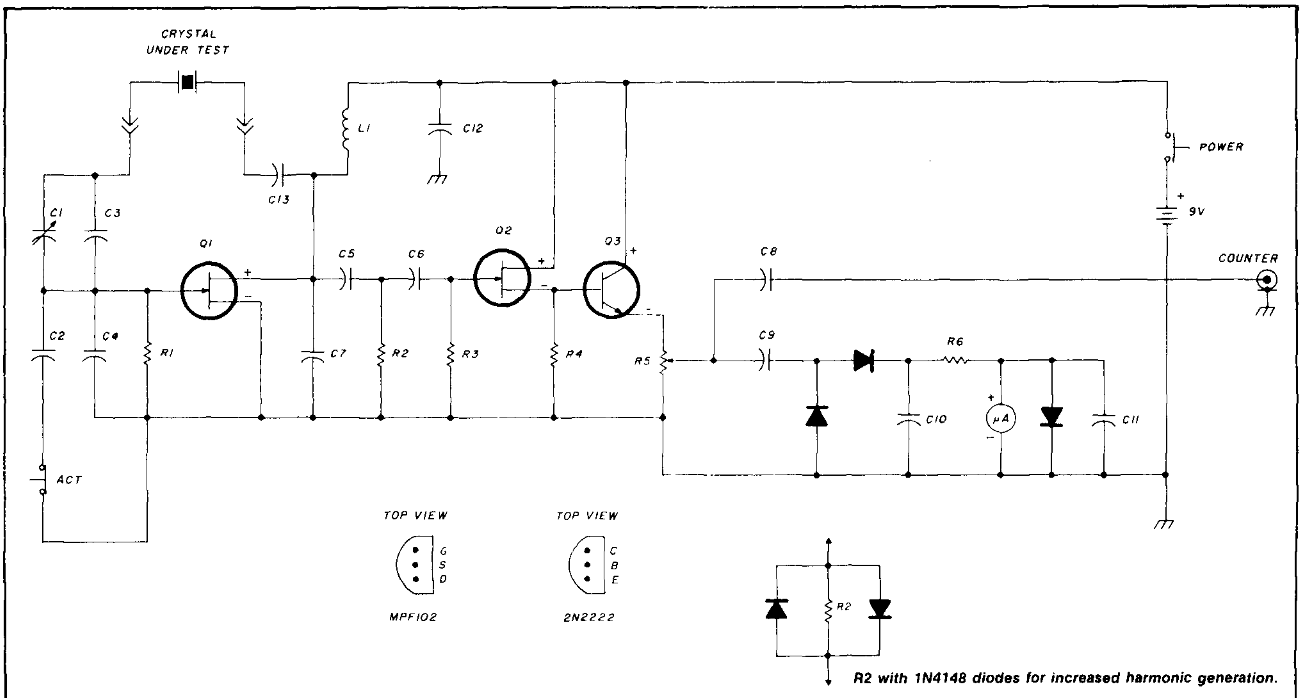

fig. 1. 100 kHz to 20 MHz crystal oscillator (32 pF load).

counter output is tied to the wiper of the pot but could also be connected directly to the emitter of Q3, if desired.

To check the battery (with the terminals mounted downward in the case of the portable version), I drilled a small hole through the bottom below the + terminal. By sticking a probe through the hole (don't short the probe to the case) you can test the battery voltage without taking the box apart.

application

Although the unit is intended for checking crystals, it can also be used as a rough-and-ready signal generator or spotting calibrator. If you use it for spotting and you want plenty of harmonics, connect two diodes (1N4148) in parallel back-to-back across R2 (see insert in **fig. 1**). The only effect on the oscillator characteristics will be an increase in the harmonic output.

If you have a circuit board with soldered-on crystals, checking the crystals can be very difficult because taking them off the board very often destroys them. A much easier way is to cut the traces to the crystal and put two No. 18 sewing machine needles (mounting shaft ground off) in the oscillator socket holes. Press them against the traces of the board; the oscillator will indicate the crystal quality.

If you don't intend to use the circuit for this purpose, C13 can be omitted. It's there only to keep DC off the crystal socket. Omitting C13 allows you to test the battery voltage on the socket connected to the drain of Q1 so no holes have to be drilled. Never try to insert a crystal without holding the box in your hand; if you do, static will damage Q1. A good indication of damage to Q1 (gate leakage) is if the unit oscillates only on the higher frequencies. Although the PWR button can also be a switch, whenever you

Crystal oscillator parts list.

C1	2.5 - 11 pF
C2	51 pF
C3	56 pF
C4	3 pF
C5	560 pF
C6	100 pF
C7	270 pF
C8	100 pF
C9,C10,C11	0.01 μF
C12	0.47 μF
C13	1500 pF
R1	2.2M ohms
R2	2.2K ohms
R3	1M ohms
R4	4.7K ohms
R5	500 ohms
R6	150 ohms
Q1	MPF 102
Q2	MPF 102
Q3	2N2222

All diodes: IN270
L1 is Hammond Number 1530 C102
10 μH resistance is 1000 ohms (@ 38 mA, maximum).
Meter is 140 μA at 140 microvolts F.S.

Minimum current at 100 kHz is about 6 mA. Maximum current at 20 MHz is between 14 and 22 mA, depending on the gain of Q1. Frequency shift over a supply voltage range from 5 to 10 VDC is less than 0.5 PPM. Battery is 9 VDC type, Number 1604. Some waveform distortion takes place below about 3 MHz. The ACTivate button is used to test and start 3rd overtone crystals that may need more feedback to start. The 5th, 7th, and 9th overtone crystals will probably not oscillate in this untuned circuit. Basic circuit (with C1 and C4 left out) is for a 32 pF load. Meter can be up to 200 μA full scale, though 50 to 100 μA are preferred. Minimum and maximum currents are for the whole circuit.
R2 with 1N4148 diodes for increased harmonic generation.

check the battery make sure there's no crystal installed so the circuit uses maximum current.

Construction and wiring are not critical. Just try to keep the leads near Q1 as short as possible and install Q1 in a manner that will allow it to be replaced easily, because it's easily destroyed.

If you want to keep things simple and not use C1 or C4 or the ACT button, install C2 (51pF) and C3 (56pF) and check your frequency. If it's too high, a gimmick wire capacitor across C2 will bring the frequency down. If the frequency is too low, replace C2 with a 47 pF capacitor and try the gimmick capacitor again on C2 — that is, if you have a good calibrated crystal. If you don't, install the caps and forget about calibration. Also keep in mind that 3rd overtone crystals don't oscillate at precisely 1/3 of their frequency because they're series-calibrated. It's understood, of course, that the indication on the meter is strictly relative. But after a bit of use, and a knob on the pot with a calibrated skirt, you'll get the hang of it pretty quickly and know what to expect.

Other variations of this circuit are possible. Since supply voltage and load variation don't, for all practical purposes, affect the frequency (keep your hands away from the crystal), further experimenting may be in order, perhaps with other 10 mH chokes.

ham radio

ham radio TECHNIQUES

Bill Orr, W6SAI

surface-wave OTH radar — more QRM?

The Wireless Institute of Australia is reportedly developing an experimental over-the-horizon (OTH) radar that operates only over the sea. The radar transmits a vertically-polarized radio wave close to the sea surface, inducing electrical currents in the water. This causes the radio wave to adhere to the sea surface and therefore travel around the curvature of the earth. There is a possibility that the reflected energy will couple with the sea surface for the return journey.[1]

When I read this, it rang a bell; somewhere I'd heard that experiments have been run in the Caribbean in which long-distance VHF communication was established between ships by placing vertical Yagi antennas very close to the waterline. When the antennas were raised more than a few feet above the sea, the signals dropped in strength. The guess was that the layer of ocean moisture directly above the surface of the water provided the conduit for the radio wave.

That's all I know about the Australian report and the Caribbean experiment. If any reader knows more about the ocean-wave experiments, I'd certainly like to hear about it. How about a test between California and Hawaii?

the "underwater antenna"

Jokes and tall stories about underground transmitting antennas and antennas immersed in water have appeared in Amateur literature for decades. I've also heard that an antenna immersed in water will not only work, but because of the dielectric constant of the liquid, be markedly smaller in size, for a given radio wavelength, than antennas not immersed in water. Sounds like a great idea — a 160-meter antenna in the back yard swimming pool!

In 1978 a British patent (GB2,001,804) was filed by the Plessey Company for an "underwater antenna" **(fig. 1)**. The idea proposed in this patent is a variation of the principle of dielectric loading. According to an article in *Radio Communication*, the patent application reads, in part, as follows:

It has been proposed to submerge an antenna consisting, for example, of a metallic rod in water, but this has been found to suffer from the practical disadvantage that through contamination and absorption of carbon dioxide into the water, degradation results and the antenna efficiency rapidly deteriorates.

It is therefore proposed to use an antenna structure surrounded by water or similar acceptable liquid by including a sealed container shaped so that the element is completely surrounded by the liquid. This can take the form of a sealed glass or plastic container filled with water (some anti-freeze can be added for low temperature conditions). The process of filling and sealing the container is preferably carried out under chemically-clean conditions.[2]

The patent claimed that an antenna rod length of 15 cm (about 6 inches) used at 100 MHz gave an increase in signal strength of over 200 percent compared with a rod of the same length in free air.

Discussing this antenna, Pat Hawker, G3VA, says, "The idea of surrounding an element with water reminds me of a problem known to exist with some wideband television receiving arrays: a significant fall-off in performance on the higher frequency channels when it rains and water collects on the elements. Clearly what is happening is that the resonant frequency of the array is being lowered by the rain — further proof of the effects of dielectric loading. . . . But one foresees an unhappy operator reporting: 'Sorry OM, signals are fading, my antenna has sprung a leak.'"

great circle maps

Not easy to find, these days. I wanted a large Great Circle Map centered on San Francisco. But where to get it? I did a little footwork and found out that these maps can be obtained from the Office of Distribution Services of the Defense Mapping Agency (Hydrographic Center). The mailing address is: DMA-ODS, attention DCCP, Washington, DC 20315. Great Circle maps cost $5.50 each and may be ordered by stock number from the catalog. To order the catalog, send $2.25 to the address above and request catalog No. CAT-P2V1O which, according to the obliging individual who answered my call, is a "goldmine of information."

more on the 160-meter end-fed antenna

In my last column I mentioned my long, 160-meter end-fed antenna, series tuned with a capacitor and matched to 50 ohms with a shunt coil. I've had it on the air for some weeks now and find it to be the best antenna that I've been able to put up on this particular piece of property, considering the zoning restrictions. Best DX to date has been Japan and Siberia, zone 19.

For those who have less space, the quarter-wave Marconi is still a good antenna. It can be easily matched to a 50-ohm feed system by the technique shown in **fig. 2**. The antenna is cut to your favorite operating frequency in the band by the formula: length = 234/f (MHz). For 1825 kHz, the antenna is about 128 feet, 3 inches (39.09 meters) long. If the antenna is entirely vertical (an unlikely assumption), the feedpoint resistance (R) at resonance will be about 36 ohms. As more and more of the antenna lies in the horizontal plane, the feedpoint resistance decreases. In my tests, with most of the antenna wire running horizontally about 40 feet above ground, the feedpoint resistance ran close to 15 ohms.

You see that a simple L-network (A) can be used, made up of a series- connected coil and a shunt capacitor. The coil is quite small, but the capacitor value is rather large. The coil can be a small B & W "Miniductor" about 2 inches (5.08 cm) in diameter, with a tapping clip for adjustment. Only 2.5 μH is required to do the job under all circumstances (see chart). Note that maximum inductance is required when the feedpoint resistance is *one-half* the value of the input resistance of the network.

The tapped coil presents no problem, but obtaining the shunt capacitor can be vexing. Most end-fed 160-meter Marconi antennas fall into a feedpoint resistance range of 10 to 25 ohms. This calls for a shunt capacitor value of approximately 3500 to 1500 pF. The total capacitance can be made up of several "postage stamp" silver mica capacitors placed in parallel with a large variable capacitor. In my case, I have a 900 pF variable capacitor picked up at a flea market and a rotary switch that adds fixed capacitance at 500 pF per switch position.

This combination allows excellent antenna matching to be obtained all across the 160-meter band. I use an SWR meter to determine antenna match (the meter being placed between the network and the short coax line to the transmitter). A practice run, tuning up every 25 kHz across the band, provides logging points for the *coil and capacitor settings so that no* time is lost when I want to QSY from 1810 kHz to work a UA0 calling CQ on 1915 kHz.

The chart also shows why it's sometimes difficult to get a good match to a low frequency mobile antenna. The matching coil becomes quite small for

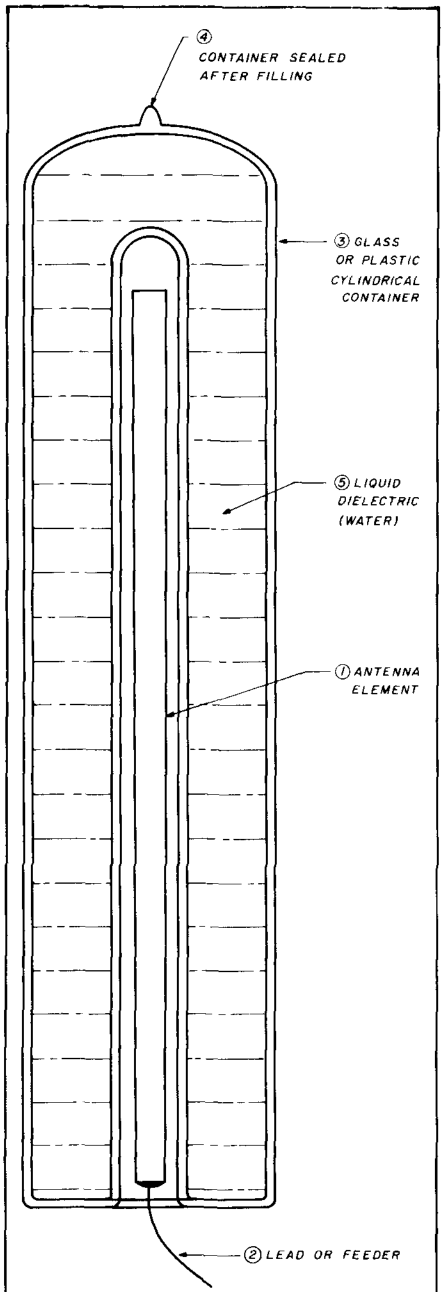

fig. 1. Short "water-jacketed" dielectric-loaded antenna as disclosed in UK Patent Application GB 2,001 804 by the Plessey Company.

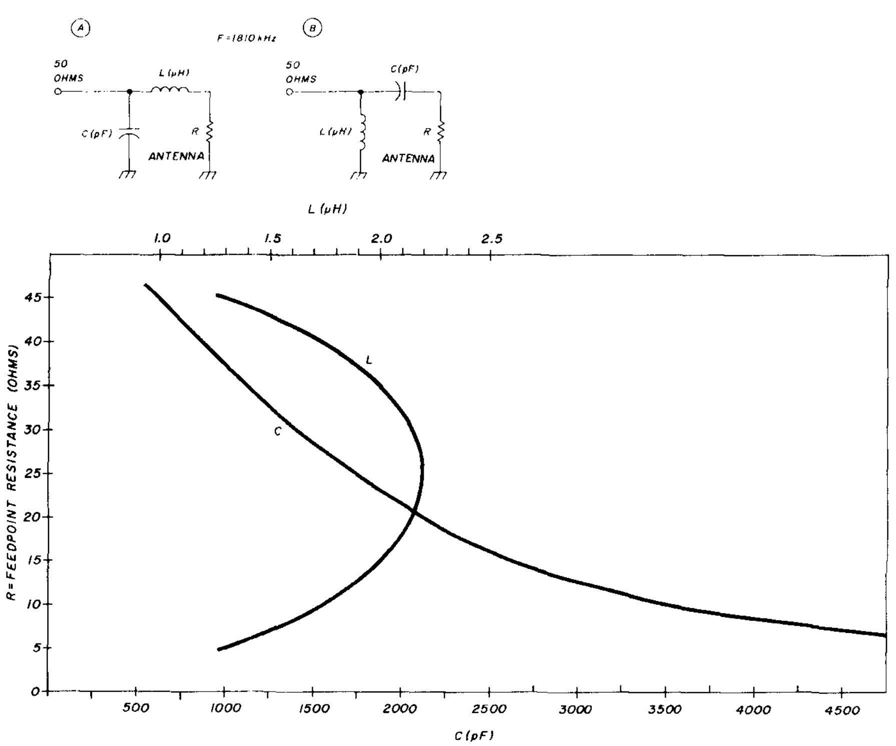

fig. 2. L-network components for 160 meters and chart to determine component values for network A.

low values of feedpoint resistance and the shunt capacitor becomes quite large!

match for the HF mobile antenna

The 80- or 160-meter mobile antenna presents a matching and loading problem. It's generally agreed that center loading provides the greatest operating efficiency for such an antenna, and many Amateurs have had success with an 8-foot (2.43 meter) antenna loaded in this fashion. Unfortunately, the feedpoint impedance of such a loaded antenna on the 80 and 160-meter bands, runs in the region of 20 ohms, of which only about 0.5 ohms is radiation resistance, the balance being made up of loading coil losses.

The B-network shown in **fig. 2** is often used for mobile whip antennas. All that's required is a small shunt inductance in the range of 1.5 to 2.5 μH for 160-meter operation. The series capacitance can be the actual antenna adjusted to provide a capacitive reactance at the base, that is, one that's slightly shorter than its resonant length.

Adjusting the antenna is quite simple. With the base matching inductor removed, a two-turn coil is connected between the base of the antenna and the grounding point on the vehicle directly below the antenna. A dip oscillator is used to set the antenna on frequency. Loading coil turns are adjusted to provide indication of antenna resonance. The base coil is now inserted in place of the dip oscillator loop and an SWR meter is placed in the coax line to the transceiver. Reduced power is applied to the antenna at the resonant frequency and the antenna is readjusted to resonance by pruning the loading coil. Lastly, the base inductor is adjusted for lowest SWR at the antenna resonant frequency.

The adjustments are slightly interactive and the presence of the experimenter in the immediate field of the antenna will tend to detune it a bit. The process sounds tricky, but it really isn't . . . it just takes a bit of patience and common sense.

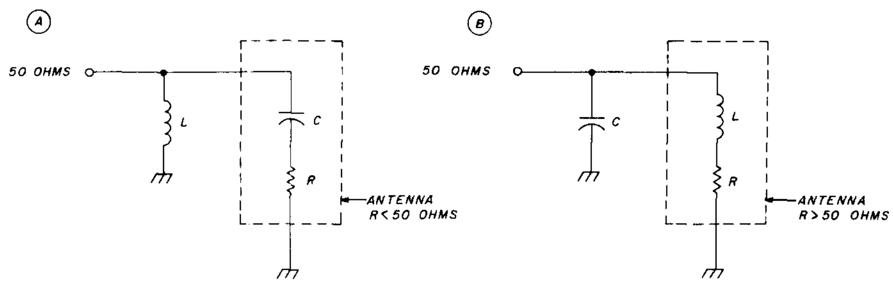

fig. 3. Antenna has reactive feedpoint impedance if not resonant at required frequency. (*A*) Capacitive reactance if shorter and (*B*) inductive reactance if longer.

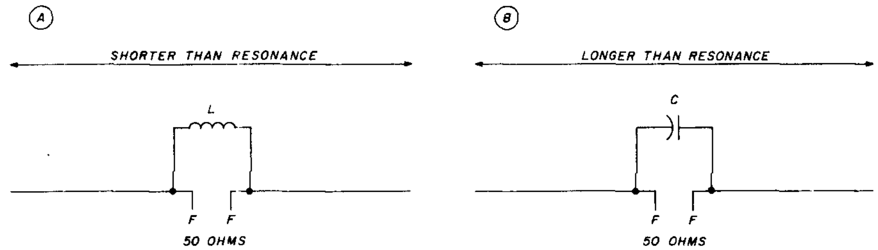

fig. 4. Yagi driven elements shorter (*A*) and longer (*B*) than resonance can be matched to coax line with appropriate type shunt reactance.

the simplified L-network

The two matching networks shown in **fig. 2** can be redrawn as shown in **fig. 3** in which the series component is represented by an off-resonant antenna. **Figure 3A** illustrates the case in which the antenna is shorter than the resonant length. **Figure 3B** shows the case in which the antenna is longer than resonant length. The circuit shown in **fig. 3A** is used in some Yagi beam antennas, where the inductor takes the form of a coil, or hairpin, placed across the feedpoint in shunt with the driven element. In this case, the driven element is shortened slightly to provide a capacitive reactance at the feedpoint.

By using the reactance of the antenna element as one arm of the L-network, either by lengthening or shortening the element past the resonant point, an effective and inexpensive matching system that requires only one additional shunt element — either a capacitor or an inductor — can be made.

Use of this matching scheme with a balanced Yagi element is illustrated in **fig. 4**. In **fig. 4A** the driven element is made slightly shorter than resonance and an inductor is placed across the feedpoint. The inductor may take the form of a balancing device so that impedance transformation and transformation to a coaxial line is accomplished with the same device.[3] Most high frequency commercial matching devices take this form because it's easier to make a waterproof inductor that will withstand high power than a suitable capacitor. (Matching systems of this general type are discussed in detail in the new edition of the *Beam Antenna Handbook.**)

the EME directory

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1. B. Martin, "The Woodpecker Project," *Amateur Radio* (Australia), August, 1985, page 13.
2. Pat Hawker, G3VA, "Technical Topics," *Radio Communication*, (England), September, 1985, page 708.
3. Bill Orr, W6SAI, and Stu Cowan, W2LX, *Beam Antenna Handbook*, pages 164-175.

ham radio

short circuits

reflector antennas

Eqn. 1 in W1JR's February column ("Reflector Antennas, Part 1," page 54) should be corrected to read as follows:

$$G = 10 \log [0.55 \cdot 4\pi A/\lambda^2]$$
$$= 10 \log (6.9A/\lambda^2)$$

calibrated S-meter

The value of the Pin 12 resistor shown in **fig. 3** of W7SX's article, "A Calibrated S-Meter" (January, page 23) is 2000 ohms.

upside-down battery

In **fig. 8** of YB9ATA's February article, "Two-Tone Signal Generator," the battery was inadvertently shown upside-down.

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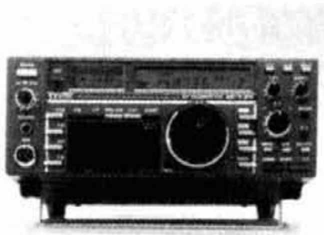

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computer control
of ICOM R-71, 271, 471, and 751 radios

Extend performance and versatility by combining analog and digital techniques

Does the idea of using a computer to control your radios conjure up images of driving elaborate remote bases with touchtone commands from a handheld? It needn't. There are less exotic uses of computer control that can really make things easier around the shack.

What else can you do with computer control? Suppose you want to monitor a net, a beacon, or a bulletin, but can't be near the radio. No problem — *get a computer*. It can turn on the radio at a prescribed time (say 18 minutes past the hour), tune it (perhaps to WWV), turn on a tape recorder (to record a minute's worth of propagation bulletin), and then turn everything off. You can listen to the tape at your convenience.

Working satellites such as OSCAR-10 is another area in which a computer can generally simplify operation. If you've ever listened to an Amateur satellite, you've found the passband filled with "aaahhh" or machine-gun strings of dits. Why?

To use a satellite, you must transmit on one band and receive on another; few Amateurs are adept at *operating two radios simultaneously*. To complicate matters, the radios are on opposite sidebands . . . to tune, you turn one knob clockwise and the other counter-clockwise — a trick easily learned by 5-year-olds, but not by adults. Doppler shift also has to be accounted for. As a result, Amateurs spend half their time trying to find their signal in the satellite's passband. The solution? *Get a computer.* Tune the receiver and let the computer read its frequency and tune the transmitter. A piece of cake!

Interested in these and other applications of *computer-controlled radios?* Computer control of ICOM's latest series of radios can be an interesting project, and requires only some simple hardware. Read on.

computer-controllable radios

ICOM has been manufacturing computer-controllable radios for many years, beginning with the 701/211/245 series and continuing with the R-70/720/251/255/260/451 series. Control of the earlier radios was generally limited to changing frequency and mode. ICOM's latest series of radios, the R-71, 751, 271, and 471, allow additional radio functions to be controlled by the computer, including the 32 memories. The newly announced 1271 will almost certainly be controllable in the same way. Like earlier ICOM radios, the interface uses a parallel handshake, with all radios daisy-chained on a common bus. Unlike earlier radios, the computer interface isn't included with the radio, but must be purchased separately. The interface is the EX-309 Microprocessor Interface Connector, which sells for $37 and consists of a small board, approximately 2 inches by 2 1/4 inches (5.08 by 5.72 cm), containing two octal latch ICs, a voltage regulator, and a 24-pin female IEEE-488 (Centronix-type) connector. (Previous ICOM radios used pins on the 24-pin Molex accessory connector for computer interface signals.)

required interface board

The EX-309 interface allows external 8-bit data to be gated onto and off of the radio CPU's internal 8-bit data bus. Signals available on the external connector are an 8-bit bidirectional data bus, a service request ($\overline{SRQ}$) line, read (RP) and write (WP) request lines, a data valid ($\overline{DAV}$) line, and squelch and send lines that parallel signals on the Molex connector (see **fig. 1**). Ground and 13.8 volts (100 mA maximum) are also available on the connector. You'll need 14 TTL lines on your computer: eight bidirectional, four output, and two input. If you don't already have these lines, you can add them using a parallel interface adapter chip (e.g., a 6522, 6820, 6821, or 8255) or build them out of TTL latches.

The EX-309 is easy to install once you realize that

By Richard Bisbey II, NG6Q, Suite 1001, 4676 Admiralty Way, Marina del Rey, California 90292-6695

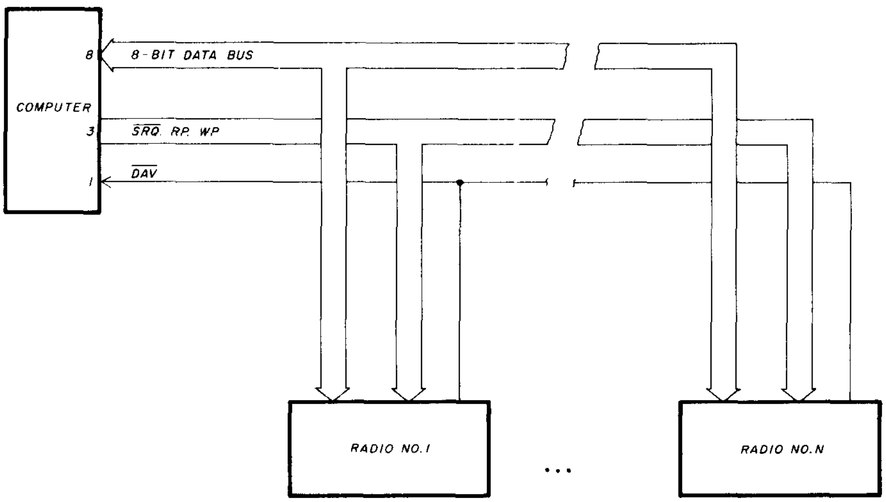


fig. 1. Radio to computer connection.

you can get the connector through its mounting hole if you insert it "end first." (You'll have to remove either the metal plate or the rubber dust cap covering the mounting hole first, of course.) The board mounts on the rear left bottom of the 271/471 and on the rear right side of the 751. There are RF chokes on the EX-309 board. However, you may want to insert ferrite beads in the lines to minimize external signals entering the radio and being re-radiated between the connector and the board. If you go to the trouble of desoldering the connector, you might consider replacing it with a DB-25, which takes the same space, is cheaper, and is more readily available. You don't have to worry about maintaining compatibility with other accessories, since the only ICOM accessory that uses the EX-309 is the CT-10 RTTY TU, which is not currently being imported into the United States by ICOM America. If you stick with the original connector, you can get its ribbon connector male mate for $7.95 from Jameco, 1355 Shoreway Road, Belmont, California. Be sure to specify the spring type, although the screw type will work satisfactorily.

The EX-309 has three connections inside the radio: data bus (P4), control bus (P5), and send/squelch (J3). For the 271/471, P4 goes to Logic Board J3, P5 to Logic Board J1. For the 751, P4 goes to Logic Board J15, P5 to Logic Board J10. If you are installing the EX-309 in a 471, be sure to correct your schematic by adding the 13.8-volt line to Pin 9 on P5. The third connection, from J3 to the send/squelch lines, is made to Front Panel P12 on the 271/471, to the AF VR board on the 751. *This connection is not listed in the instruction sheet that comes with the EX-309.* If you have more than one radio on the external bus, you probably won't want to make this third connection. If you were to make the third connection, the squelch and send lines for all the radios on the bus would be connected in parallel, and you couldn't remotely key individual radios or tell which radios were or were not squelched. Also, the squelch line on the 751 is 8 volts and requires a 5.1 volt zener diode to ground at the connector to make it TTL-compatible.

Once installed, the interface is easy to use. The protocol to use in communicating with the radio is as follows:

1. Drop $\overline{SRQ}$ to 0V (to get the radio's attention).
2. Use procedure A or B (see below) to send or receive a byte.
3. If not finished, go back to step 2.
4. Raise $\overline{SRQ}$ to 5V (to tell the radio you are finished).

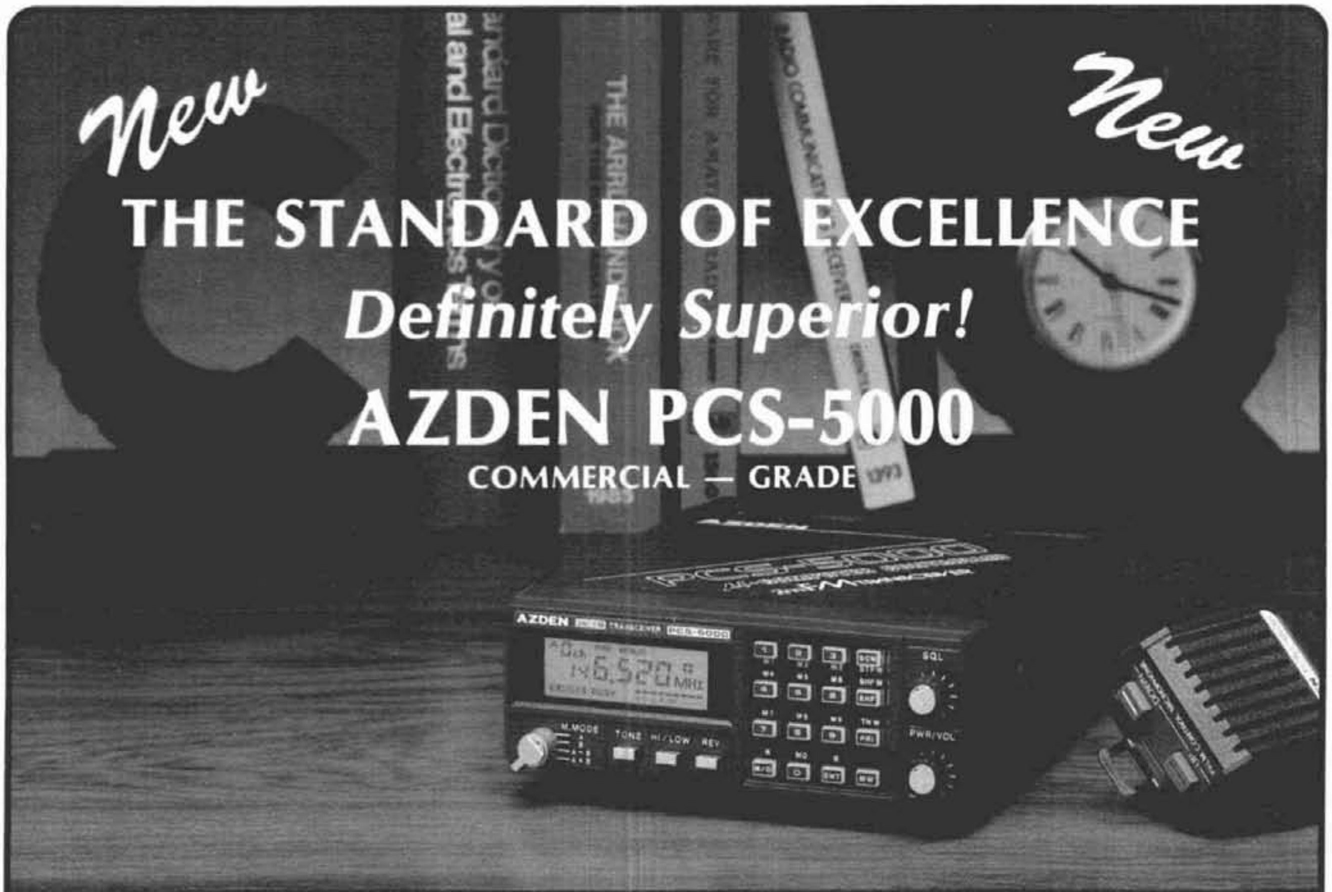
To send a byte to the radio, follow *Procedure A*, as follows:

1. Set 8 bits of data on the data bus.
2. Raise WP to 5V (to tell the radio you are writing data to it).
3. Wait for the radio to drop $\overline{DAV}$ to 0V (to ACK receiving the data).
4. Drop WP back to 0V (to ACK the ACK).
5. Wait for the radio to raise $\overline{DAV}$ to 5V.

To receive a byte from the radio, follow *Procedure B*, as follows:

1. Raise RP to 5V (to tell the radio you are reading data from it).
2. Wait for the radio to drop $\overline{DAV}$ to 0V (to ACK sending the data).
3. Get 8 bits of data from the data bus.
4. Drop RP back to 0V (to ACK receiving the data).
5. Wait for the radio to raise $\overline{DAV}$ to 5V.

Only one command can be issued to the radio each time the $\overline{SRQ}$ line is lowered. Also, there is a mini-



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LITHIUM BATTERY BACKUP: Memory information can be stored for up to 5 years even if power is removed.
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mum time the $\overline{SRQ}$ line must remain high before it can again be lowered as well as a minimum time between lowering WP and raising $\overline{SRQ}$ when sending data to the radio. This limits the rate at which commands can be issued. Generally, the radios can accept up to about 50 commands per second. Thus, the minimum dwell time for frequency-hopping, spread-spectrum uses would be 20 msec (subject to the settling time of the radio's PLL). Finally, if a radio fails to acknowledge an RP or WP within one second, it is either not connected or not powered on, or is simply otherwise occupied (e.g., scanning).

commands and their operands

Each 8-bit byte on the data bus is actually two 4-bit nibbles. The four most significant bits of each byte encode the command (or operation code). They are:

- 1x—Band Data (read only).
- 2x—Frequency Data (read/write).
- 3x—Mode Data (read/write).
- 4x—Offset Data (read/write).
- 5x—Set Memory/VFO (write only).
- 6x—Memory Read/Write (write only).

The four least significant bits of each byte encode address and data operands. The first hex digit is the radio's address. It is always written to the radio. Valid addresses are:

- x1—HF — R-71 or 751
- x2—50 MHz
- x3—144 MHz — 271
- x4—220 MHz
- x5—440 MHz — 471
- x6—1200 MHz — 1271

(Too bad ICOM didn't leave x6 for 902 through 928 MHz and move 1200 MHz to x7.) Data operands follow the address, and, depending on the command, may be either written to or read from the radio. Each data operand consists of a string of hex digits delimited by "D" and "E." The radio will ignore all write data between the address operand and the first delimiter, "D."

specific command information

The following is a description of each command along with its operands. The actual hex bytes exchanged with the radio are shown, with the command in the high nibble and the operand values in the low nibble.

Command 1 — band data. This command allows the computer to read the frequency range of a radio. The frequency range is returned as:

1D 1m 1m 1m 1m 1m 1m 1E 1D 1n 1n 1n 1n 1n 1n 1E

where mmmmmm and nnnnnn are the upper and lower frequency limits in tens of kHz. To request the frequency range of a 471, send the hex byte 15 (command 1, address 5), and then read back the following sixteen bytes:

1D 10 14 14 19 19 19 1E 1D 10 14 13 10 10 10 1E
i.e., 0 4 4 9. 9 9 to 0 4 3 0. 0 0 MHz.

Command 2 — frequency data. This command allows the computer to read or write the radio's frequency. The frequency is a nine-digit number; the most significant digit is GHz, the least significant is tens of Hz. Attempts to set a radio to a frequency outside its band limits are ignored. To set a 271 to 145.67893 MHz, send:

23 2D 20 21 24 25 26 27 28 29 23 2E
i.e., 0 1 4 5. 6 7 8 9 3 MHz.

The radio will set unsent digits to zero, so the sequence: 21 2D 20 20 21 2E would set a 751 or R-71 to WWV at 10 MHz. To read a radio's frequency, send hex 2# (where # is the radio's address) and read back eleven bytes (2D, nine digits with 2 in the leftmost nibble, and 2E).

Command 3—mode data. This command allows the computer to read or write the radio's operating mode. Operand values are:

0 — LSB
1 — USB
2 — AM
3 — CW
4 — RTTY
5 — FM
6 — CW-Narrow
7 — RTTY-Narrow
8 — LSB
9 — USB
A — AM
B — CW-Narrow
C — RTTY-Narrow
D — FM

Not all modes are possible on all radios. For example, the 271 and 471 lack RTTY capability. Thus, 4, 7, and C wouldn't make sense for those radios, and, in fact, would leave the radio in an indeterminate mode. The sequence 31 3D 3C 3E would set a 751 to RTTY-Narrow, while the sequence 35 3D 31 3E would set a 471 to USB. To read mode data, send hex 3# (where # is the radio's address) and read three bytes (3D, one byte of mode with 3 in the leftmost nibble, and 3E).

Command 4 — offset data. This command allows the computer to read or write the DUPLEX offset. It is similar to the OW button on the 271/471. The operand is a five-digit number, the offset in kHz. The sequence:

43 4D 40 40 46 40 40 4E
i.e., 0 0 6 0 0 kHz.

would set the offset of a 271 to 600 kHz (we didn't really need the last two zeros), while the sequence:

45 4D 40 45 4E would set the offset of a 471 to 5 MHz. You can also read back an offset.

The Offset command is of dubious value. First, there's no way to specify the offset direction or turn DUPLEX on or off. DUPLEX operation can be controlled only by front panel buttons. Also, while DUPLEX values can be stored and retrieved on the 751, DUPLEX operation is not a supported feature! The DUPLEX button on the front panel of the 751 is really SPLIT — i.e., you transmit using one VFO and receive using the other.

Command 5 — set Memory/VFO. This command allows the computer to switch between a VFO and the 32 memories. It is write-only. Memory/VFO is denoted by two hex digits. The values are:

00	— VFO	11	— 17
01	— 1	12	— 18
02	— 2	13	— 19
03	— 3	14	— 20
04	— 4	15	— 21
05	— 5	16	— 22
06	— 6	17	— 23
07	— 7	18	— 24
08	— 8	19	— 25
09	— 9	1A	— 26
0A	— 10	1B	— 27
0B	— 11	1C	— 28
0C	— 12	1D	— 29
0D	— 13	1E	— 30
0E	— 14	1F	— 31
0F	— 15	20	— 32
10	— 16		

The sequence: 51 5D 51 53 5E would set a 751 to memory 19, while the sequence: 53 5D 50 50 5E would set a 271 to the current VFO. Note that this command gives you no way to switch between VFOs. You're stuck with whatever VFO you started with. Also, the command is write-only, so you can't read the current VFO/Memory — your program will have to remember it. Finally, this command is an example of the radio not really using "E" as a delimiter. If it did, 0E and 1E would not be valid operands.

Command 6 — Memory read/write. This command allows the computer to transfer information between the VFO and memory. The command is write-only and is functionally identical to the WRITE and M>VFO buttons on the front panel. The operand is a single digit:

1—VFO to Memory
2—Memory to VFO

The sequence: 63 6D 61 6E stores the information in the current memory on a 271.

a sample basic program

Figure 2 is a simple BASIC program to control a 271 and 471 for use with OSCAR-10. The program reads the 2-meter downlink receive frequency, then calculates and sets the 70-cm uplink transmit frequency. In this simple example, doppler can be accounted for by using the RIT on the 271. A more elaborate program would include automatic doppler correction computed from Keplerian orbital elements.

```
0010 REM        6522 addresses, constants, and masks
0020 DPORT = &HFF4F              ' data port address
0030 CPORT = &HFF40              ' control port address
0040 SRQ = &H04                  ' SRQ bit
0050 WP = &H02                   ' WP bit
0060 RP = &H01                   ' RP bit
0070 DAV = &H80                  ' DAV bit
0080 DDIR = &HFF43               ' data port direction register address
0090 DOUT = &HFF                 ' data port lines to output mode
0100 DIN = &H00                  ' data port lines to input mode
0110 CDIR = &HFF42               ' control port direction register address

0200 POKE CPORT,SRQ              ' set SRQ high, WP and RP low
0210 POKE CDIR,SRQ+WP+RP         ' set SRQ, WP, and RP lines output, DAV input

0300 POKE CPORT,0                ' set SRQ low (begin command)
0310 Y = &H23                    ' command 2, address 3 (freq data for 271)
0320 GOSUB 2000                  ' send Y to radio
0330 GOSUB 3000                  ' read and discard the "D"
0340 FREQ = 0
0350 FOR I = 1 TO 9              ' read 9 digits of frequency
0360 GOSUB 3000
0370 FREQ = FREQ * 10 + Y
0380 NEXT I
0390 GOSUB 3000                  ' read and discard the "E"
0400 POKE CPORT,SRQ              ' set SRQ high (end command)

0450 X$ = "0" + RIGHT$(STR$(58100400-FREQ),8)   ' calculate up-link frequency

0500 POKE CPORT,0                ' set SRQ low (begin command)
0510 Y = &H25                    ' command 2, address 5 (freq data for 471)
0520 GOSUB 2000                  ' send Y to the radio
0530 Y = &H2D                    ' send delimiter "D"
0540 GOSUB 2000
0550 FOR I= 1 TO 9               ' send 9 digits of frequency
0560 Y = VAL(MID$(X$,I,1)) + &H20
0570 GOSUB 2000
0580 NEXT I
0590 Y = &H2E                    ' send delimiter "E"
0600 GOSUB 2000
0610 POKE CPORT,SRQ              ' set SRQ high (end command)
0620 STOP

2000 REM        subroutine A - write the value Y to the radio
2010 POKE DDIR,DOUT              ' set data port to output
2020 POKE DPORT,Y                ' set data
2030 POKE CPORT,WP               ' set write strobe
2040 IF (PEEK(CPORT) AND DAV) <> 0 THEN GOTO 2040
2050 POKE CPORT,0                ' clear write strobe
2060 IF (PEEK(CPORT) AND DAV) = 0 THEN GOTO 2060
2070 RETURN

3000 REM        subroutine B - read a byte from the radio into Y
3010 POKE DDIR,DIN               ' set data port to input
3020 POKE CPORT,RP               ' set read strobe
3030 IF (PEEK(CPORT) AND DAV) <> 0 THEN GOTO 3030
3040 Y = PEEK(DPORT) AND &H0F    ' get data (without command nibble)
3050 POKE CPORT,0                ' clear read strobe
3060 IF (PEEK(CPORT) AND DAV) = 0 THEN GOTO 3060
3070 RETURN
```

fig. 2. BASIC program controls ICOM 271 and 471 for use with OSCAR 10.

Since most personal computers use BASIC, the example is written in "generic BASIC." It is, however, virtually guaranteed *not* to run on your "Acceleratron-J4Q" computer without some massaging, particularly with respect to I/O port assignments. It should be fairly simple, however, to translate it verbatim to your favorite microprocessor. The example uses a memory-mapped 6522 VIA chip to exchange information with the radio. I/O addresses and constants are defined in **lines 10** through **110**; control lines are initialized in **lines 200** and **210. Lines 300** through **400** read the downlink frequency, **line 450** calculates the uplink frequency, and **lines 500** through **610** set the new uplink frequency. The subroutines at **lines 2000** through **2070** and **3000** through **3070** correspond to *Procedures A* and *B*, respectively.

extending ICOM computer control

ICOM provides a very powerful, but incomplete command set for controlling the radios. Unfortunately, the radios lack direct commands to:

- Control the DUPLEX direction or turn DUPLEX on/off.
- Switch between VFOs or read the current VFO/Memory number.
- Turn SPLIT on/off (for repeaters or HF split operations).
- Control PL frequency or turn PL on/off.
- Control filters (other than CW/RTTY-Narrow).
- Switch between HAM and GEN mode on the 751.
- Control RIT/XIT.
- Control volume, squelch, tone, RF gain, power, or noise blanker.

First, the good news: combinations of the six standard commands can be used to achieve many of the above functions. In what follows, I'll discuss several interesting functions that can be performed. Many others are possible.

Now, the bad news: what I'm about to describe is not for the meek or timid. We're talking major brain surgery — i.e., changing the contents of your radio's RAM. There are downside risks. Even *thinking* about changing the contents of this memory probably voids your radio's warranty 87 different ways. Furthermore, what I'm about to describe may not even work on your radio. There's no guarantee that the memory map — i.e., the addresses and values — for my radios is the same as the memory map for yours. Nor is there any guarantee that the memory map will stay the same in future ICOM products (or even later models of the same product). Also, a slip of the scalpel, so to speak, can leave your radio lobotimized, and in need of a brain transplant (or at least a fresh memory, available from ICOM for $25). *Proceed at your own risk!*

Before venturing further, we must delve a bit deeper into the computer architecture of the radios. From a computer standpoint, the radios look like your garden-variety, vanilla-flavored microcomputer. They have CPU, a memory, display, and an 8 x 10 keyboard. The R-71, 751, 271, and 471 — and most likely the 1271 — use the same computer architecture. In fact, they all use the same CPU chip and ROM program. The program supports all the features of all the radios. The "personality" of each radio is determined by a small 2 x 2-inch (5.08 x 5.08 cm), removable board containing a CMOS RAM. This RAM contains the radio's bands and band limits, the current VFO and memory channel, and the number of memories available, as well as the frequency, mode, band, duplex offset, duplex direction, and PL frequency for each VFO and memory. Changes to the contents of this RAM can result in drastic behavioral changes in the radio. All sorts of wonderful, unintended functions can be performed, such as switching between HAM/GEN modes and extending the frequency coverage.

The R-71, 751, 271, and 471 each have 32 memories for saving user information. The RAM to be changed is mapped into frequency and mode information for memories 33 to 255. These locations are inaccessible to the casual user operating the radio from the front panel controls. However, the memories are accessible via the computer interface.

switching bands

Each radio can cover one or more bands. The bands are expressed as upper/lower frequency bounds as in the Band Data command. The 751 has ten bands:

0	30.0 – 0.1 MHz
1	2.0 – 1.8
2	4.1 – 3.45
3	7.5 – 6.95
4	10.5 – 9.95
5	14.5 – 13.95
6	18.5 – 17.95
7	21.5 – 20.95
8	25.1 – 24.45
9	30.0 – 27.95

On the 751, band 0 is the General Coverage mode, while bands 1 through 9 are Ham mode. The 271 has two bands:

0	150.0 – 140.0 MHz
1	148.2 – 143.8

The CPU stores a single-digit band index, along with the frequency for each memory and VFO. The hundreds-of-kHz frequency digit at memory channel 38 is also the band of channel 38. To switch bands, first issue a Set Memory/VFO command with hex 26 as the operand. Next issue a Frequency Data command to write a frequency with the appropriate band index in the hundreds-of-kHz digit followed by a **M**emory **W**rite command. The frequency that you use must be within the band limits of the radio. Also, be very careful in selecting the band index, as an invalid band will result in an upper/lower frequency pair of 0.00 through 0.00 Hz, not a very useful pair! Finally, issue a Set Memory/VFO command with 00 as the operand to return the radio to the current VFO followed by a **M**emory **R**ead command. The bands of Memory channels 1 through 32 can also be changed through memory manipulation, but, in general, it's easier to change the band of a VFO and then store the VFO in a memory than it is to change the band of a memory directly.

greater frequency coverage

The frequency coverage of several of the radios can be extended beyond the band limits. For example, many 751s can be tuned below 100 kHz and above

30.0 MHz. The additional frequency coverage appears to be both model- and radio- dependent. It is sometimes even mode-dependent.

All frequencies entered via the dial, the keypad, or the computer interface are checked to ensure that they are within the band limits. Frequencies outside the band limits are rejected. However, there are several ways to evade this check. The simplest is to find a frequency in memories 33 through 255 and transfer it to the current VFO. The radio does no checking on memory/VFO transfers. Frequencies both above and below the band limits can be obtained. Frequencies above the band limits can also be generated by using the hex digits "A," "B," "C," and "F" in certain digit positions in the Frequency Data command. Use of these digits generates a carry in the next higher digit.

In general, whenever you are outside the radio's band limits, you may tune only *towards* the band limits. For example, if you are above the band limits, you may tune only lower in frequency. If below, you may tune only higher in frequency. Attempts to tune in the opposite direction will place you at the opposite band limit.

conclusion

ICOM has incorporated computer control into its radios, and its current product line continues that innovative trend. With minimal hardware, any microcomputer can be used to control the radios. The standard command set is simple, easy to use, and sufficient for most applications. Many functions not provided for by the standard command set can be realized by combinations of commands. Although it's not discussed here, it's also a simple task to intercept the radio's keyboard matrix and simulate button pushes with a computer. There's no question that computer-controlled radios can take the drudgery out of, and put the fun back into, Amateur Radio operation.

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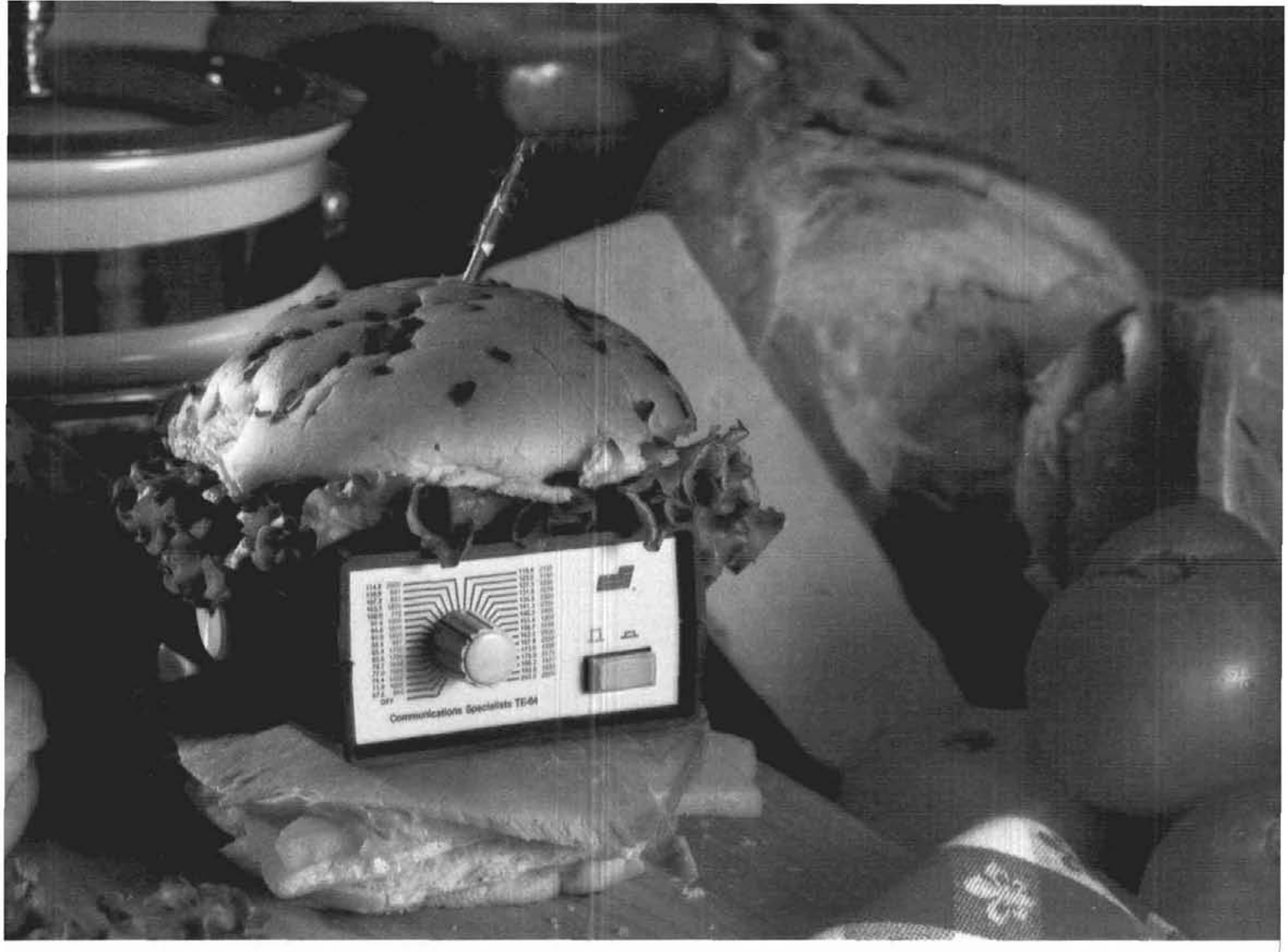
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AC line transient protection

It all started when I destroyed my VCR with a lawnmower. Perhaps I should explain in greater detail. One summer day as I was trimming the weeds in my front lawn, my electric lawnmower blew a motor field rectifier and began to draw considerable current from the AC line. This situation was quickly, but not instantly, corrected by the house circuit breaker, which tripped and broke the circuit, as it's intended to do. Then, however, the electric fields in the motor collapsed, producing a large back EMF on the now-open circuit AC cord. Unfortunately, this cord connected the mower to the same circuit on which my VCR was patiently awaiting the start of a "Sky King" rerun.

The VCR, like a lot of new equipment — including most new Amateur rigs and the computer on which I write — doesn't like to see high voltage spikes coupled into its relatively fragile CMOS logic integrated circuitry. On a computer, line spikes or transients can cause data drop-outs, so-called "soft" errors in the RAM memory, or other grief. In my VCR, the unusually large transient simply fried some component on the microprocessor board. Fortunately, the VCR was still under warranty.

I decided that some transient protection would be necessary. A quick check of the catalogs showed that many manufacturers make line cord sets with transient suppression to reduce the chances of just this sort of occurrence. But these outlet boxes cost at least $30.00, so I decided to try to build some lower-cost version of these outlet boxes, using the same type of line transient protection devices. I could then distribute these protective boxes about my house to protect any electronic equipment that would be sensitive to high voltage transient peaks on the AC mains.

In this project, I've taken a low-cost approach to transient protection that uses commonly available metal oxide varistors. The method could easily be adapted to many of the commercially-available outlet boxes or AC junction strips found in most hardware stores. The total cost of each protected outlet box is about $5.00.

metal oxide varistors

A metal oxide varistor (MOV) is a voltage-dependent semiconductor device that acts much like a pair of back-to-back zener diodes. The MOV is placed across the AC input of the device to be protected. Under normal conditions, the MOV has a high input impedance so it draws a minimal amount of power. However, if the voltage across the AC line increases to a point above the turn-on voltage of the MOV, it suddenly switches to a low-impedance state. This low impedance is in shunt with the line, so the AC voltage is limited. Once the transient passes — i.e., the AC line voltage returns to normal — the MOV recovers and returns to its high-impedance, stand-by state.

Most of the voltage increases that appear on the AC mains are of momentary duration and are caused by switching large loads, especially inductive loads, on or off, or by lightning strikes (at a distance, not directly on the equipment). This means that even though the transient may be many hundreds or even thousands of volts, since it does not last long (a "typical" transient might last a few tens of microseconds) there is little total energy in the spike, and the energy can be safely dissipated in the MOV.

A typical MOV intended for use on a 120 volt AC line has the specifications shown in **table 1**. It can take up to 4500 Amperes in a spike with a total energy of 35 Joules, which means that if it is clamping the line at the specified maximum of 225 volts, the transient may last only about 30 microseconds. This explains how a small device, no bigger than a rather large disk capacitor, can tolerate 4500 amperes — it does so only for a few microseconds, and not too often, at that. However, by clamping the line to 225 volts, the MOV can do a great service to us in protecting the seemingly delicate, certainly complex equipment we now find commonplace in our homes, computer rooms and ham shacks.

By Jerry Hinshaw, N6JH, 4558 Margery Drive, Fremont, California 94538

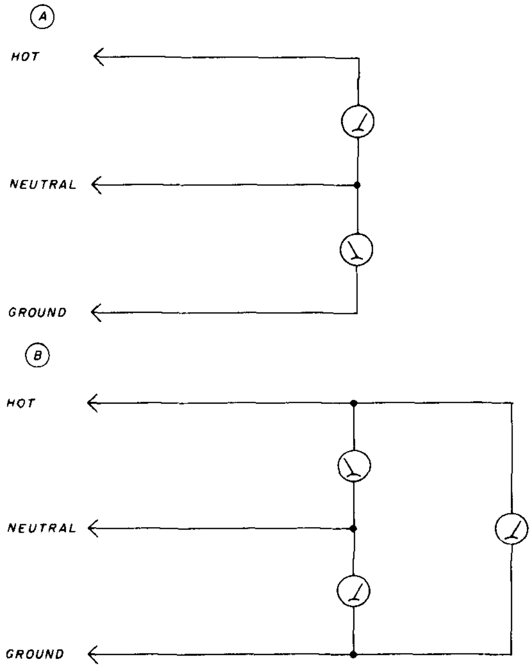

fig. 1. An illustration of the two modes of voltage transient which are encountered on a typical 3 wire circuit. *(A)*, the case when the potential between hot and neutral is abnormally high due to a transient. *(B)*, an alternate transient mode where the power-carrying lines are elevated above the safety ground.

The manufacturers' data sheets provide detailed design information that permits us to calculate the type of MOV needed for any expected transient. However, I found such data to be of little practical use because I can't predict what type of transient one might expect on the AC lines in my typical tract home. Therefore, I merely selected a MOV that had a large current capacity and the lowest available varistor voltage because these factors seemed likely to offer the maximum protection. Furthermore, there was only one type available at the local Radio Shack, which pretty well directed my choice. In general, though, it's best to select a MOV with the lowest turn-on voltage that will still permit normal operation of the equipment you choose to protect. This choice means that a maximum range of clamping is available and that the minimum excess spike is coupled into the equipment. More detailed information is available from the manufacturers.

There are two modes of voltage transient which the suppressor should be able to shunt. In the first, a transient may cause the voltage across the AC lines to rise above the nominal 120 volts rms (I am speaking about the US standard mains, but these concepts apply to power mains worldwide). In this case, the voltage between the two lines rises abruptly above the nominal value with respect to a ground reference. This can be called a differential mode transient because there's a difference between the reference point and each of the two lines.

Figure 1A shows this common mode voltage transient schematically, with two hypothetical voltmeters placed across the AC lines. These meters are hypothetical in that they are presumed to have instantaneous response and are depicted at the exact moment a transient has caused the voltage across the hot and neutral lines to soar far beyond the nominal value. However, the neutral-to-ground voltage is not significantly disturbed.

The second type of transient is shown in **fig. 1B**. Note that the potential across the hot and neutral lines can be normal, or nearly so, while their potential to ground can be very great. This type of "elevation" can be as damaging to electronic circuitry as the differential type of transient. In order to protect equipment from these two distinct modes of transient behavior, we need to have two sets of suppressors. One suppressor must be placed across the AC line and a second set should be placed from each side of the line to ground **fig. 2B**. Clearly, if there is no ground line present, as in **fig. 2A**, only one MOV suppressor is needed for protection, as long as no other path to a safety gound exists.

table 1. Specifications of a typical MOV designed for 120 VAC use, the General Electric V130LA10A.

Varistor voltage, minimum	185 volts
Varistor voltage, nominal	200 volts
Varistor voltage, maximum	225 volts
Peak current, maximum	4500 amperes
Energy	35 joules

construction

Now that the MOV has been selected, it must be safely installed across the AC input of the equipment to be protected. One good way to do this is to install it inside the equipment itself. Another way is to somehow place the MOV across the input line between the equipment and the AC outlet. I chose to do the latter because I found a source of low-cost AC outlet boxes that suited my needs.

The AC box I chose is a plastic unit originally designed to expand a US standard two-plug outlet into a six-outlet box. It is easily installed by removing the usual switchplate and plugging the new unit into the wall. A single screw secures the outlet box into the threaded insert that originally held the outlet cover

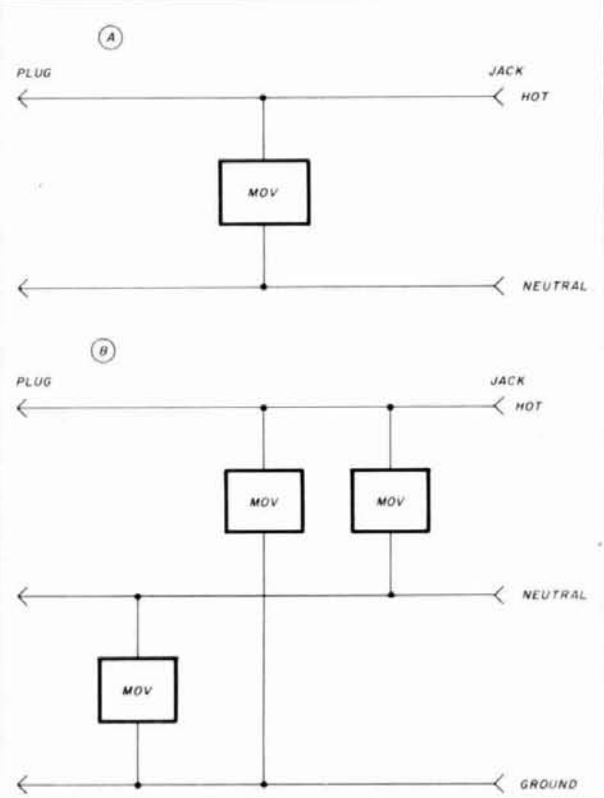

fig. 2. A simple schematic diagram showing how the MOV is installed to protect equipment from power line transients. (*A*), placement of the MOV in a two-wire system. (*B*), Three MOVs are used to fully protect a system which has a third conductor as safety ground.

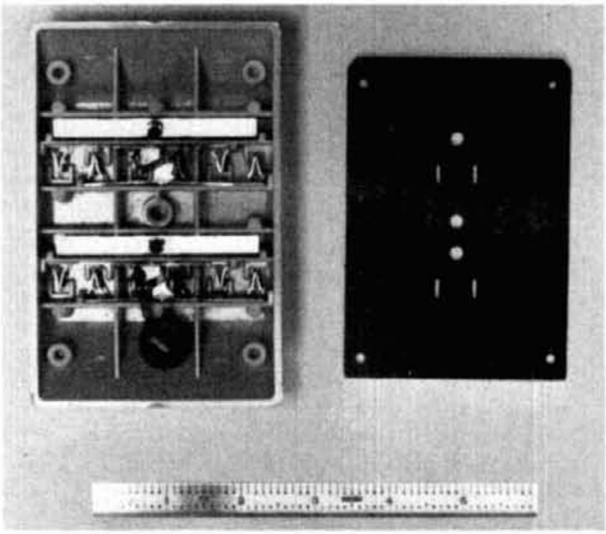

fig. 3. Interior view of the accessory outlet box with one MOV installed across the AC hot and neutral lines. Note the protective sleeving on one of the MOV's leads.

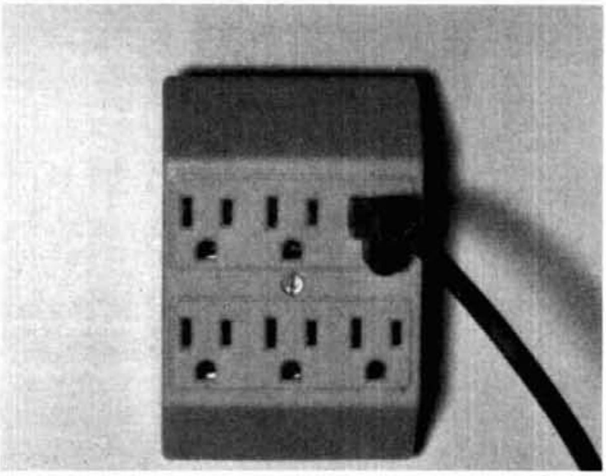

fig. 4. The completed outlet box installed and in use.

plate. This type of accessory box seems widely available and has the advantage of providing extra outlets, which are often useful. Furthermore, it has enough room inside to mount several MOVs easily. You can separate the box into two independently protected circuits, if you desire.

The outlet box I chose was designed to convert two standard three-wire outlets into six three-wire outlets. Made of plastic, it contains two sets of contacts, each set consisting of three conductors, one each for the ground, neutral and hot sides of the AC line. The interior construction of the box is shown in **fig. 3**. The box protrudes perhaps 1.5 inches out from the wall when it's installed, so there's space inside for installing the MOVs.

The figure also shows one MOV installed across the two main conductors of one set of three outlets. No protection against common mode transients has been installed, so there's no MOV installed between the ground pin and either of the other two pins. This is because in my house, although some of the outlets do have ground pins, there are, in fact, no ground connections actually present inside the wall. The original outlets in this house are two-wire outlets, which is typical of most houses built before the 1960s, when local electrical codes gradually began to require the use of three-wire, grounded outlets. Thus, there's only one MOV installed in this box. This MOV is placed across the hot and neutral lines as shown. The metal conductors easily take regular tin-lead soldering, so that it is simple to permanently solder the leads of the MOV across the circuit. Note that one of the leads of the MOV must cross over the other lead's AC connection. At this point it is imperative that you install good insulation. I used two pieces of heat-shrink tubing, one inside the other. Remember, this circuit is not powered by a low-voltage supply like a typical digital breadboard — think "safety" throughout the project!

Once the MOV circuitry is installed, replace the back cover of the box. This particular unit is installed after the cover plate of the old outlet has been removed. A long screw secures the box to the wall. The completed unit, ready to install on a wall outlet, is shown in **fig. 4**. It protrudes a bit from the wall, but where there were two unprotected outlets before, there are now six transient-protected outlets available. The total construction time, if you want to call such a simple procedure by so elaborate a term, is well under an hour.

Now my VCR, my ham shack, and my computer each have their own transient protection box. The lawnmower has yet to blow another motor rectifier, but I have fair confidence that, should it happen again, the delicate electronics components will be better off than before, when they faced high voltage transients completely unprotected. The cost of a few of these suppressor outlet boxes seems like cheap insurance to me.

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modifying the Trio-Kenwood TS-930S

Kenwood's TS-930S transceiver includes a number of unadvertised capabilities. This article describes four of them that can be enabled by making just four simple modifications. These modifications require no additional parts except for one solder lug and about 3 feet (0.9 meter) of No. 18 (or smaller) insulated wire. They can be completed within an hour after removing the 930's covers.

I'll describe the modifications first, then explain how to install them.

four simple mods

- **Mod 1: eight additional memories.** Adding one jumper results in each VFO (A and B) having 8 memories, creating a total of 16.
- **Mod 2: 10 Hz readout.** Ever notice the unused seven-segment LED on the left end of the frequency display? One jumper makes it usable by shifting the frequency display one digit to the left, resulting in 10 Hz resolution of the displayed frequency.
- **Mod 3: Scanning.** Add one jumper and the 930 will scan through the 8 frequencies stored in either of the VFO A or B memories.
- **Mod 4: Full coverage on transmit.** Add three jumpers and the 930 is ready to transmit on WARC, MARS, and the remainder of the *nonamateur* frequencies in the 1.5–30 MHz range.

getting ready

As with all modification articles, please read this article several times before you heat up the soldering iron. Doing so may well save you headaches later when you apply power to the set.

After disconnecting everything from your 930, remove the top and bottom covers (16 screws) and place the rig top side up, facing you, on a cushioned surface. Each of the modifications requires access to the digital-unit board, which is hidden under the speaker and VOX control assembly, which can be removed by removing the four screws that hold it to the main chassis of the 930. Lift the assembly upward slightly and disconnect the small 2-conductor plug (with the red and white wires) from the digital-unit board. Disconnect the speaker leads (remember their polarity) and the other two connectors that plug into the small board directly beneath the VOX controls. Set the assembly aside.

Two of the mods require access to the back of the front panel. This is easily accomplished thanks to the cabinet's sensible design. On each side of the 930 you'll find the front panel mounting brackets. There are two flathead screws and one roundhead screw in each bracket. Refer to **fig. 1** for their locations. Move the 930 toward the front of your work table so that a few inches of the rig hangs over the edge. The panel will tilt forward after (1) removal of the two flathead screws from each bracket and (2) careful loosening — *not removal* — of the roundhead screws. The panel may tilt on its own, so keep one hand on it while you

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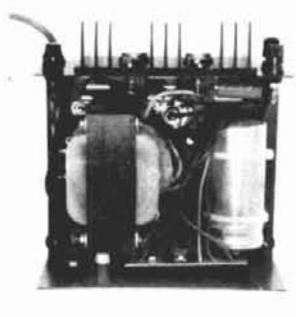

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MODEL RS-50A

MODEL RS-50M

MODEL VS-50M

RM-A Series

MODEL RM-35A

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RM-50A	37	50	5¼ × 19 × 12½	50

• Separate Volt and Amp Meters

Model	Continuous Duty (AMPS)	ICS* (AMPS)	Size (IN) HXWXD	Shipping Wt. (lbs.)
RM-35M	25	35	5¼ × 19 × 12½	38
RM-50M	37	50	5¼ × 19 × 12½	50

RS-A SERIES

MODEL RS-7A

MODEL	Continuous Duty (Amps)	ICS* (Amps)	Size (IN) H x W x D	Shipping Wt (lbs)
RS-4A	3	4	3¾ x 6½ x 9	5
RS-7A	5	7	3¾ x 6½ x 9	9
RS-7B	5	7	4 x 7½ x 10¾	10
RS-10A	7.5	10	4 x 7½ x 10¾	11
RS-12A	9	12	4½ x 8 x 9	13
RS-20A	16	20	5 x 9 x 10½	18
RS-35A	25	35	5 x 11 x 11	27
RS-50A	37	50	6 x 13¾ x 11	46

RS-M SERIES

MODEL RS-35M

• Switchable volt and Amp meter

MODEL	Continuous Duty (Amps)	ICS* (Amps)	Size (IN) H x W x D	Shipping Wt (lbs)
RS-12M	9	12	4½ x 8 x 9	13
RS-20M	16	20	5 x 9 x 10½	18
RS-35M	25	35	5 x 11 x 11	27
RS-50M	37	50	6 x 13¾ x 11	46

VS-M SERIES

MODEL VS-20M

- Separate Volt and Amp Meters
- Output Voltage adjustable from 2-15 volts
- Current limit adjustable from 1.5 amps to Full Load

MODEL	Continuous Duty (Amps) @13.8VDC	@10VDC	@5VDC	ICS* (Amps) @13.8V	Size (IN) H x W x D	Shipping Wt (lbs)
VS-20M	16	9	4	20	5 x 9 x 10½	20
VS-35M	25	15	7	35	5 x 11 x 11	29
VS-50M	37	22	10	50	6 x 13¾ x 11	46

RS-S SERIES

MODEL RS-12S

• Built in speaker

MODEL	Continous Duty (Amps)	ICS* Amps	Size (IN) H x W x D	Shipping Wt (lbs)
RS-7S	5	7	4 x 7½ x 10¾	10
RS-10S	7.5	10	4 x 7½ x 10¾	12
RS-10L (For LTR)	7.5	10	4 x 9 x 13	13
RS-12S	9	12	4½ x 8 x 9	13
RS-20S	16	20	5 x 9 x 10½	18

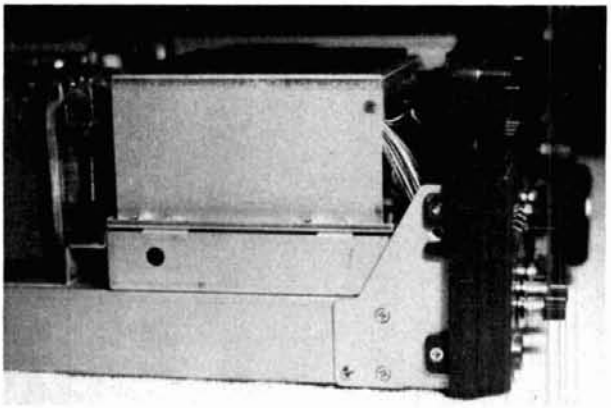

fig. 1. Front panel mounting bracket screws.

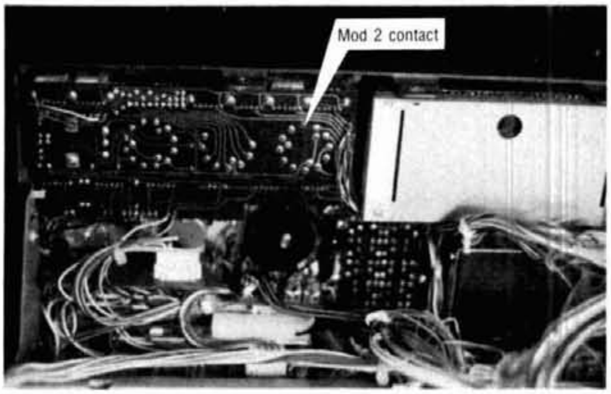

fig 2. Contact for mod 2 is at 12 o'clock position.

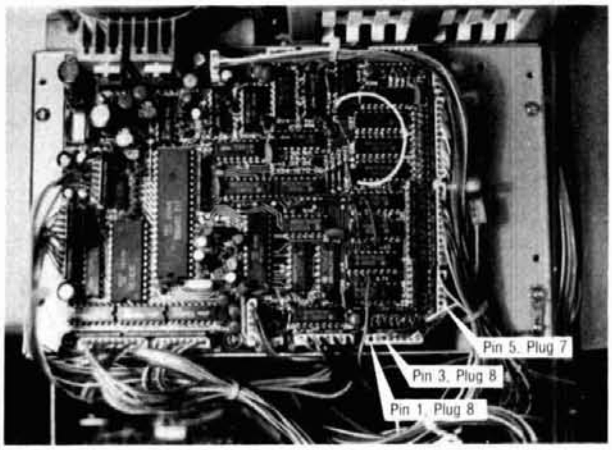

fig. 3. Connections for mods 1, 2, and 3 on digital unit board.

loosen the roundhead screws. Tilt the panel down about 60 degrees and retighten the roundheads. This will help to maintain the tilt of the panel and will prevent straining the multitude of wires connected to it.

mod installations

Mod 1 (8 additional memories) requires a jumper from pin 5, plug 7 on the digital-unit board to ground through a switch. The function switch (VFO A, VFO B, etc.) has an empty contact to ground when it is placed in the VFO B position. **Figure 2** shows the location of the switch contact on the back of the switch's circuit board. Check continuity to ground through this contact to verify that you have the right one. Remember to place the switch in the VFO B position for this check. Solder one end of the jumper to this contact. The other end of the jumper needs to be bent into a small hairpin loop and fitted into the empty hole for pin 5, plug 7. (See **fig. 3** for the location of plug 7.) My 930 is seldom moved, so I don't worry about the jumper possibly pulling out of the hole. You'll need to experiment a bit with the size and shape of the hairpin to achieve a snug fit.

When finished, power up the 930 and program a few frequencies into the VFO A memories as you normally would. Then select VFO B and program a few more frequencies. Recall the memories, switching between VFO A and B. You'll notice that you now have the capability of 16 memories. If not, go back and check your jumper.

Mod 2 (10-Hz readout) requires installation of a jumper from pin 1, plug 8 on the digital-unit board to ground. (See **fig. 3** for the location of plug 8.) I used the hairpin trick again to connect the plug end of the jumper. A solder lug is connected to the other end, which can then be connected to any convenient screw in the chassis. I used one of the speaker/VOX assembly holddown screws. Test the mod by powering up the rig.

Mod 3 (scanning) requires a jumper from pin 3, plug 8 on the digital-unit board to ground through a switch. Use the hairpin method to connect the jumper to the plug. The other end of the jumper connects to the panel light DIM switch, which has an extra contact to ground when it's in the DIM position. (**Figure 4A** shows the location of this contact, with **Figure 4B** showing this in greater detail. Again, check continuity to ground with the switch in the DIM position to verify that you have the correct contact. When you've finished this modification, power up again, load up the memories, select VFO A and depress the DIM switch. Notice that the scanning starts with memory channel 1, scans to 8, and repeats, stopping on each channel for about 2 seconds. To scan VFO B memory channels, you must first initiate scanning in VFO A and then select VFO B. Scanning will not initiate in VFO B. In addition, only 8 channels can be scanned (that is, either VFO A or VFO B).

Mod 4 (full coverage transmit) requires three jumpers on the digital-unit board. The first one provides transmit coverage for the WARC bands. The other two provide the remaining coverage. If the WARC jumper is not installed, the 930 will still trans-

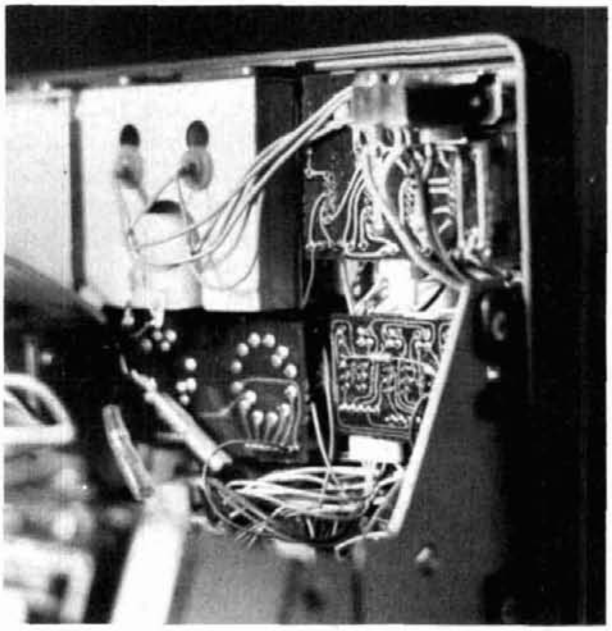

fig. 4A. Dim switch circuit board.

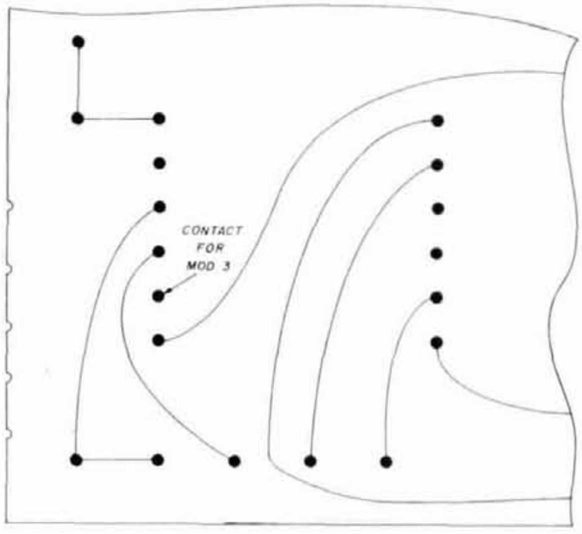

fig. 4B. Lower left corner of dim switch circuit board.

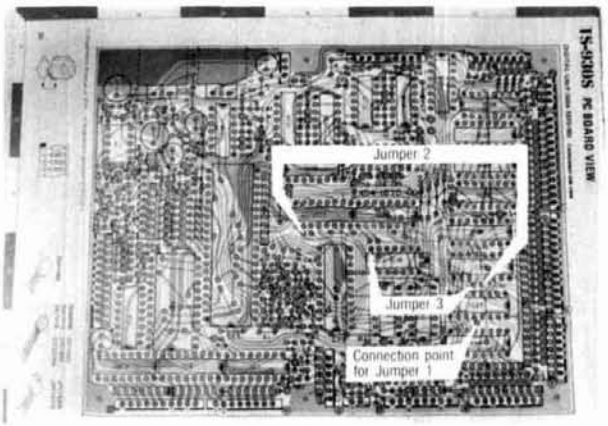

fig. 5. Location of connection points for mod 4.

mit over the entire 1.5 to 30-MHz range with the exception of the 0.5-MHz segments, that contain the WARC bands. If you want only the WARC coverage, install only the first jumper, which goes from pin 12, U23 to ground. (Note: on two of the three 930s I've modified, the WARC jumper had already been installed at the factory). The second jumper goes from pin 9, U11 to pin 12, U21. The third jumper goes from pin 9, U12 to pin 12, U22. A close inspection of **fig. 5** will show that each of the connections to the above ICs can be made on unused solder pads on the digital-unit board. I melted a small amount of solder on each of the pads before installing the jumpers. The grounded end of the WARC jumper can be attached to the same solder lug that was used for the 10-Hz mod. You'll find that the optional tuner (AT-930) covers the WARC bands, but not the general-coverage bands.

final steps

Reinstall the speaker/VOX assembly, remembering to reconnect the four cable assemblies that were disconnected earlier. Reattach the front panel, taking care not to pinch any wires. Replace the covers, and enjoy!

conclusion

What's my assessment of the mods? Well, I hardly ever used the eight memories that came with the 930, so I really didn't need eight more, although I do use some of them now for scanning. I use the scanning feature to locate the family net at 14.177 MHz ($\pm$) by programming from 14.175.5 to 14.179.0 in 50-Hz steps and scanning through them while attending to other tasks in the station. I also use it for checking band openings by programming frequencies in different bands. One caution: the 930 will scan as long as the DIM switch is depressed. This includes the transmit mode, so be sure to disable the scanning before transmitting! The 10-Hz resolution isn't needed except to program scanning frequencies, so it's really just a novelty. The full transmit coverage is necessary if you want to use the 930 on some of the MARS frequencies, as I do.

Thanks go to DL3AM and KW9G (ex-WA9GMK), who assisted in installing these modifications. Thanks also to Trio-Kenwood for its courteous approval of my request to reproduce portions of the 930 Technical Service manual for this article. Copies are available from TRIO-KENWOOD, 1111 West Walnut Street, Compton, California 90220.

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"Keep cool" — good advice for people on a hot day, and good advice for electronic equipment anytime. Heat is the number-one assassin of electronic equipment.

Many device ratings are based on maintaining certain operating temperatures. One manufacturer of a "hobbyist grade" audio power transistor, for example, offers (and advertises prominently) a transistor with a seemingly tremendous collector power dissipation. But there's a catch: the power is available only at room temperature (77-86 degrees F, or 25-30 degrees C). At temperatures above 30 degrees Celsius, the transistor must be derated substantially. No matter where the transistor is used, if it's inside a cabinet or box the temperature will almost certainly exceed 30 degrees C!

Similarly, RF power transistors in transmitters die as often from overheating as from that elusive gremlin, VSWR, but the problem is less well recognized. I know one ham who lost the power transistors in his trunk-mounted 100-watt 2-meter power amplifier several times before he realized that the heat was the culprit! During the summer months, the trunk of a car will sizzle even though the air-conditioned passenger cabin cools off within a few minutes. Moving the amplifier to behind the dashboard cured the problem.

Reliability experts measure equipment performance in terms of "Mean Time Between Failure" (MTBF), which is usually expressed in hours. For example, an MTBF of 1000 hours implies that, for a large number of samples of the equipment, an average of one soul-destroying failure per thousand hours of operation will occur. One source claims that a 10-degree C rise in operating temperature will cut the MTBF almost in half.

Just how important is cooling in electronic equipment? Let's consider some examples. About ten years ago I worked in a university hospital, repairing patient-monitoring equipment. The EKG oscilloscopes at the nurses' central station were a reliability nightmare. About once a week, usually at 3 AM, the staff would call me to come repair one of the four 'scopes. Yet the same model 'scopes operated reliably at the patients' bedsides. The problem was overheating of the central station 'scopes, which were mounted inside a completely closed desk/console. After ten 1-inch ventilation holes were cut and a pair of 100-CFM "whisper fans" were installed, central station 'scopes became as reliable as the bedside 'scopes.

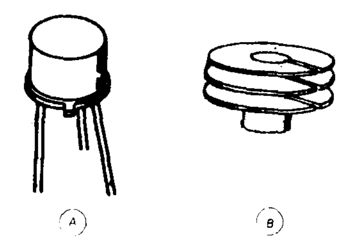


fig. 1. (*A*) Typical low-signal (low-heat transistor) does not use a heatsink. (*B*) Top-hat finned heatsink helps power transistors run cooler.

A second example is a story of tragedy prevented. My first personal computer was a Digital Group, Inc., Z80-based machine with 26K (2102 chips) of static memory. In those days, my kilobuck bought (in kit form) a motherboard, three 8K memory boards, a CPU board, a 64-line TV/cassette interface board (with some static memory chips on-board), and several input/output boards. All of those boards contained lots of TTL devices, and they generated a large amount of heat. The builder had to supply the cabinet, a ±12 VDC, 1-ampere dual-polarity power supply, and a +5 volt DC, 10-ampere regulated power supply. Since I operated the computer next to a ham rig, EMI both to and from the computer was an issue, so I had to use a well-shielded aluminum cabinet—and shielding isn't always compatible with heat dissipation.

At first all those cards and the two DC power supplies were buttoned up inside the almost unvented aluminum cabinet. Needless to say, the temperature of the cabinet rose to egg-frying levels, and the HEP S-7000 power transistor used as the series-pass element in the voltage regulator operated hot enough to take off skin when touched. I knew that computer would be a reliability headache if the heat were not removed, so I installed a pair of 40-50 CFM fans: a 3.5-inch (8.89 cm) model blowing across the S-7000 heatsink and a 4.5 inch (11.43 cm) model cooling the printed circuit board compartment. Because of the EMI

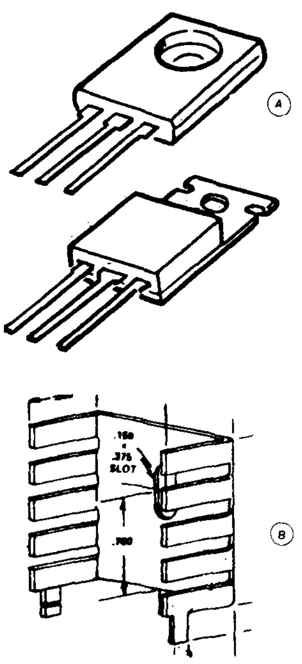


fig. 2. *(A)* Two forms of plastic power devices packages. *(B)* Vertical or horizontal finned sheet metal heatsinks for the above devices.

problem, the ventilation and blower opening were covered with perforated aluminum sheet metal.

No one with any electronics experience — however slight — can deny that heat is the primary killer of electronic devices. Projects or equipment that pass or deliver large amounts of either current or power must be kept cool for proper operation. The methods given in this article are simple and should be sufficient for most reader's applications. While reliability engineers and thermodynamicists may flinch at the lack of mathematical elegance, the methods are nonetheless effective.

There's only one simple rule: where there's excessive heat, remove it. What do I mean by "excessive?" If the equipment feels too hot to touch, or has a history of unexplained failures and/or repairs, then it's probably running too hot. An engineer will have specifications to meet and calculations to make, but these are beyond the scope of this article. The empirical "skin of the thumb" rule, however, suffices for our needs.

Three basic tactics can be used either singly or in combination to dissipate heat:

- radiate more heat,
- improve natural ventilation, or
- add or increase forced-air cooling.

For most readers, water cooling isn't relevant even though some commercial broadcast transmitters use circulating water for cooling. In fact, I once worked in a 10 kW AM broadcast station that used the waste heat from the transmitter's water radiator to heat the transmitter building!

protecting transistors and IC regulators

On small projects where it's not practical (or possible) to use forced-air cooling, you'll have to provide heatsinking for the semiconductors. In fact, even most forced-air cooled projects will need these metal radiators. **Figure 1A** shows the metal TO-5 transistor package. Most of these transistors are mounted on printed circuit boards and are low-signal (and low-heat) devices. But certain TO-5 transistors operate at moderate power levels (in audio drivers, for example). A "top-hat" finned heatsink (**fig. 1B**) is mounted on the TO-5 package to radiate heat. There are also other "spring clip" versions of this same kind of heatsink.

Figure 2A shows two forms of plastic power device package. You'll find these packages in power transistors (e.g., 2N5249), thyristors, and three-terminal IC voltage regulators. In the

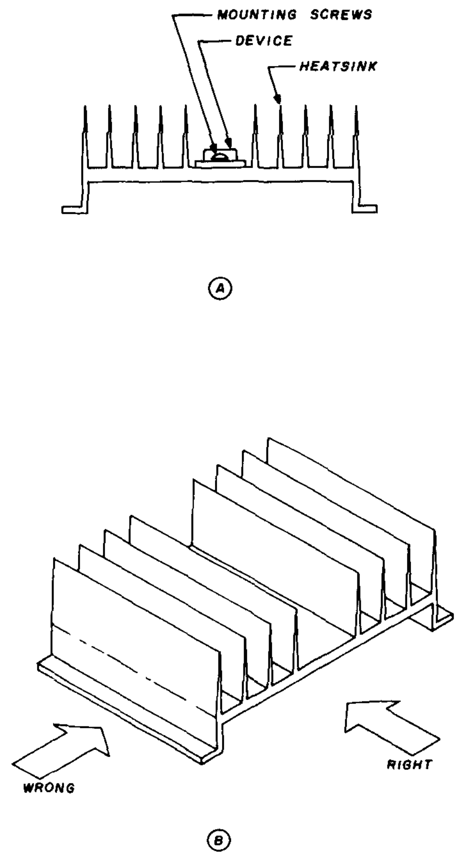


fig. 3. *(A)* Large finned heatsink used with TO-3 transistors, high-current voltage regulators, high current diodes and SCRs. *(B)* The "right" and "wrong" way of forcing air over finned surfaces.

case of regulators, the devices are often rated at 750mA in free air and 1000mA when heatsinked. Either vertical or horizontal finned sheet metal heatsinks (**fig 2B**) are used to provide heat dissipation. Be sure to use a thin layer of silicone heat transfer grease between the metal tab surface on the transistor (or regulator) and the heatsink. Also be sure to tighten the mounting screw properly in order to facilitate heat transfer to the heatsink.

Sheetmetal heatsinks are used for TO-3 transistors and three-terminal regulators that are mounted on printed circuit boards. The bent sheetmetal heatsinks are good for up to about 10 watts of power, or voltage regulators up to 1.5 amperes. For the 3-ampere, 5-ampere, and 10-ampere voltage regulators that also use a TO-3 package, it would be better to use a larger finned heatsink.

Often the metal chassis itself is used for heatsinking. In these cases the transistors are bolted either directly to the metal chassis or mounted with mica insulators. In both cases, silicone heat transfer grease is used between the semiconductor device and the chassis. This method is especially successful when the chassis is large or unusually thick.

Some printed circuit boards use large areas of unetched copper foil and/or large metal ridges or blocks to provide better heatsinking. This method is used especially where there are not single particular devices that can be individually heatsinked (e.g., a TO-220 transistor), but rather when there are a large number of heat-producing devices (such as TTL ICs).

There are many different forms of large, finned heatsinks used for TO-3 (and other) transistors, high current voltage regulators, high current diodes, and SCRs; **fig. 3A** shows a side view of one of these heatsinks. In this case, the TO-3 transistor (or other device) is mounted on the flat central surface of the heatsink with screws. In most situations, it's wise to use a thin smear of silicone heat transfer grease between the device and the heatsink. This grease is especially necessary when a mica insulator is placed between the semiconductor device and the heatsink. Again, it's essential to make sure that the mounting screws are cinched down tight enough to allow maximum heat transfer (but not enough to distort the device package). The big concern in selecting a heatsink is the amount of surface area, measured in square inches or square centimeters.

When forced air is used to cool a heatsink — always a good idea when the power and/or current is high — then the orientation of the heatsink with respect to the airflow is sometimes important. **Figure 3B** shows right and wrong ways to force air over the finned surfaces. Keep in mind, however, that the orientation is not always critical, especially when air from the "wrong" direction is suffi-

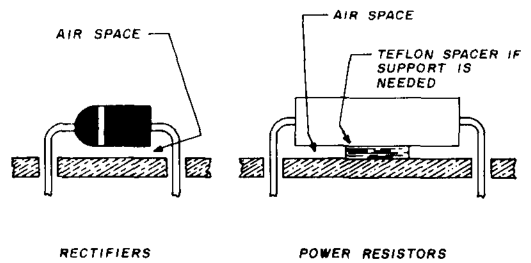


fig. 4. Suspending components above boards aids in air circulation and subsequent cooling.

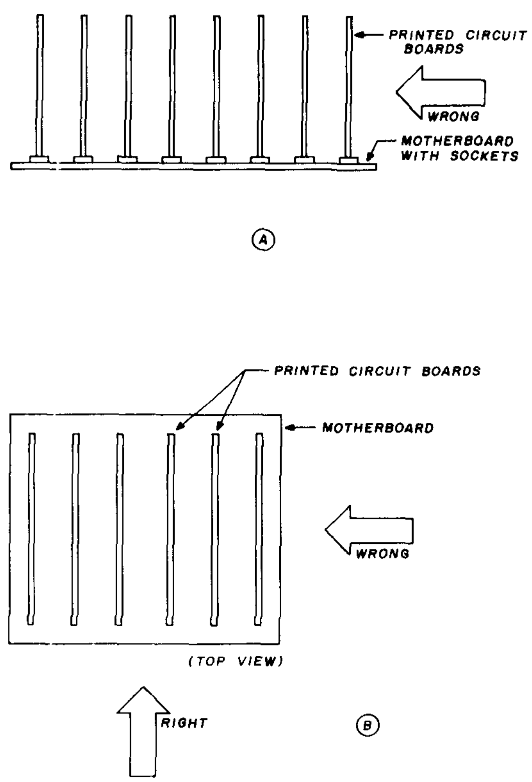


fig. 5. Correct way of forcing air past multi-bands. (A) side view (B) top view.

cient or blows over the entire surface. The designations "right" or "wrong" are merely general considerations for some critical applications.

other components

Not only power transistors generate heat. Rectifier diodes and power resistors should be mounted with their bodies 0.125 to 0.250 inches (0.317 to 0.635 cm) off the printed circuit board (see **fig. 4**). This procedure allows the heat to dissipate into the air instead of into the PCB material. I've seen many phenolic and some fiberglass printed wiring boards badly damaged from the effects of a 10-watt power resistor mounted flush to the surface. Some "bargain basement" rectifier diodes can meet their rated forward current only when the rectifier is mounted 0.50-inch (1.27 cm) off the board and has its axial leads cut to 0.75-inches (1.9 cm) or longer. Those diodes are overrated and should be used only in lower current applications or shunned entirely.

Layout is important when power components are mounted on the PCB. Try to avoid clustering power components in one small area of the board, especially when using cheap phenolic board material. Avoid placing heat-sensitive parts near power components. For example, 10-watt resistors should not be mounted adjacent to polystyrene capacitors or small transistors.

Besides reducing the operating life or limiting the power output of circuits, overheating can also decrease performance in other ways. Certain circuits — oscillators, for example — are inherently sensitive to heat. There was once a popular three-band kit-form HF transceiver that suffered immense VFO drift because the JFET VFO was located right next to the RF/IF strip tubes. Although that was such a bad design error that nothing would really "fix" the situation, a lot of Amateurs were able to improve the frequency stability markedly with some thermal insulating material placed between the RF/IF PCB and the aluminum VFO housing.

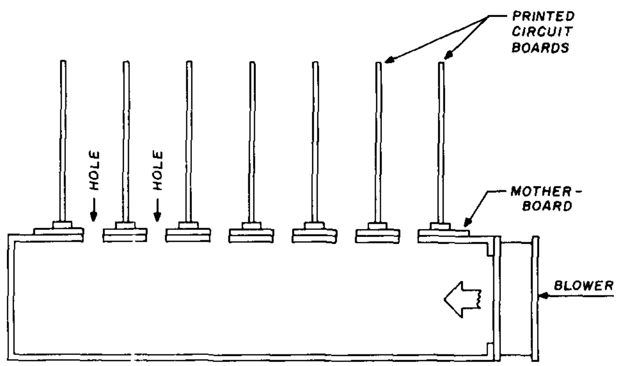


fig. 6. Another method of cooling multi-boards requires slots to be cut in socket-mounting chassis.

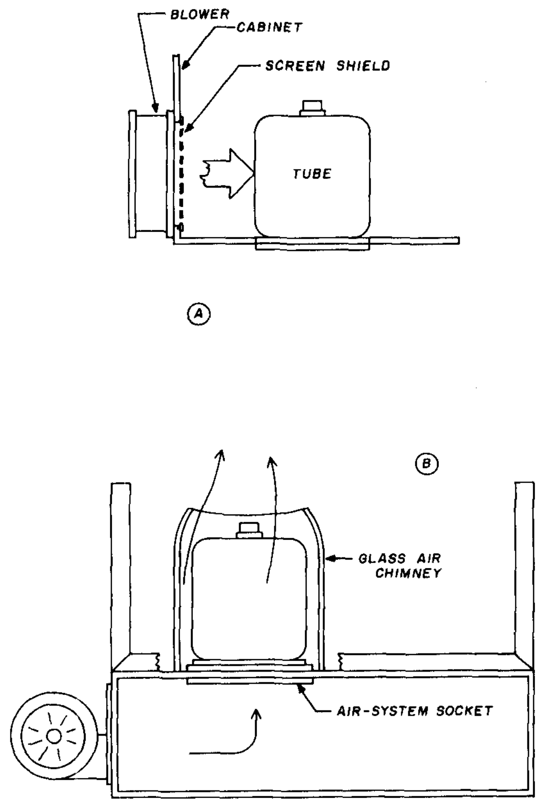


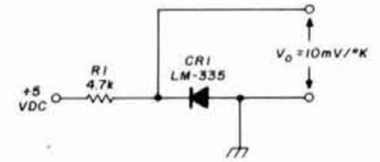
fig. 7. Several methods available for cooling RF power amplifier tubes. (*A*) Airflow is directed across glass envelope by fan. (*B*) Air flow is forced through socket and glass air chimney.

large multi-board projects

When I first felt the temperature of my Digital Group, Inc., cabinet I took steps to get rid of the heat, and reliability was improved. Rarely does the homebrew builder have the flexibility that I had with my Vector Electronics S-100 cabinet. In most cases, the builder must make do with only a single fan and must be clever to make best use of it. **Figure 5A** shows a typical large-scale multi-board project —

✓ 156

✓ 155



Except as indicated, decimal values of capacitance are in microfarads (μF); others are in picofarads (pF); resistances are in ohms.
k = 1,000 M = 1,000,000

fig. 8. Temperature sensing circuit provides voltage proportional to circuit temperature.

such as a microcomputer or transceiver — in which plug-in printed wiring boards are installed on a socketed motherboard. Usually, these PCBs are mounted in a closed cabinet for reasons of both EMI shielding and aesthetics.

If we apply air broadside to the PCBs, then only the first board in the line-up will benefit. **Figure 5B** shows a top view that allows visualizing right and wrong airflow directions. Obviously, air coming in from the sides is able to remove heat from more of the PCBs with greater efficiency.

Figure 6 shows a method used by a friend of mine who built a home-brewed 6502-based computer. He used a large metal chassis with a motherboard mounted on it to hold the PCBs. He cut 3/4 inch (1.9 cm) holes in both the chassis top and the motherboard to admit air between the boards. (Although only one hole is shown between each board in this side view, there were four per row in the actual project.) Air from the blower flowed up through the holes and across the electronics components on the PCBs.

Linear amplifiers and high-power transmitters pose special heat problems. Some linears, for example, are only 45 percent efficient. Therefore, a 1000-watt linear amplifier delivers 450 watts of usable RF power and 550 watts of waste heat. To make matters even worse, the necessity of keeping harmonics at home means we button up all that heat in a shielded metal cabinet.

Most RF power amplifier tubes used in Amateur Radio equipment must be cooled with forced air in order to realize their full ratings (some are absolutely dependent on cooling). **Figure 7** shows two methods for providing the needed cooling air. In **fig. 7A** we see a situation in which a blower is mounted so that the air flow is directly over the glass envelope. The fan may be mounted either outside the RF compartment (as shown) or inside, as in the Heath SB-221.

The other method, shown in **fig. 7B**, assumes the use of "air system" tube sockets. A blower or fan supplies air to the bottom side of the socket and the air is directed upwards through holes in the socket and around the glass evelope. A "chimney" aids in keeping the airflow against the glass. Some air system sockets have plumbing connections for the air hose, while others depend upon pressurization of the lower compartment. In either case, this socket is better because the pin seals with the glass are kept cooler.

The plate cap pin seal should also be kept cool, if possible. Toward this end, some builders use a finned "heat dissipating" plate cap to make electrical connection to the anode.

temperature measurement

In some cases we'll want to provide either continuous for temporary monitoring of the actual operating temperatures. Although there are elegant methods using thermocouple junctions, we can use a simple, low-cost PN junction temperature sensor. National Semiconductor and others manufacture such devices. **Figure 8** shows the simplest circuit for the National Semiconductor LM-335 diode device. The LM-335 will measure temperature over the range −10 to +100 degrees F (−23 to +38 degrees C). In the circuit shown, the output across the diode will be 10 millivolts per degree Kelvin. Degrees Kelvin are the same as degrees Celsius, except that they're referenced to absolute zero instead of the freezing point of water (note: 0 degrees C = 273 degrees K).

If you merely want to measure the temperature, then install the LM-335 "diode" on the PCB and solder-tack the wires to it. The temperature can then be measured with an ordinary voltmeter. Otherwise, mount it permanently on the PCB. Another application is to use the voltage from the LM-335 to turn on a fan or an alarm when the temperature reaches a certain critical limit. A high-power commercial transmitter uses one of these devices on each PCB and inside each subassembly compartment and then monitors all of them with a multichannel A/D converter connected to a small "single-board computer/controller." A shut-down program can turn off the transmitter in an orderly manner — or warn the operator — when the temperature gets too high.

conclusion

Heat is the great destroyer of electronic components. If a piece of equipment runs too hot, then the result will be unreliable operation, frequent breakdowns, and all the headaches that accompany low reliability. The simple methods shown in this article will enable you to build and/or modify equipment to gain the longest and most reliable use possible.

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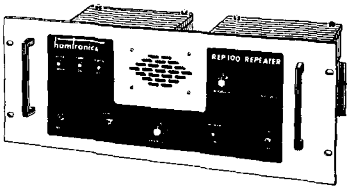

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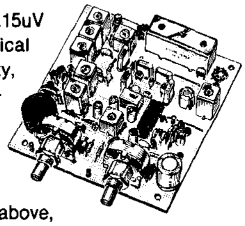

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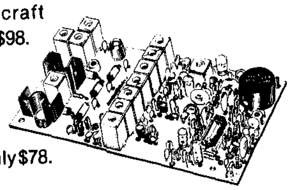

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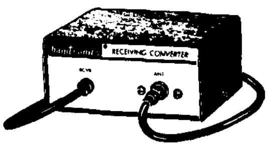

Antenna Input Range	Receiver Output
28-32	144-148
50-52	28-30
50-54	144-148
144-146	28-30
145-147	28-30
144-144.4	27-27.4
146-148	28-30
144-148	50-54
220-222	28-30
220-224	144-148
222-226	144-148
220-224	50-54
222-224	28-30

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Kit with Case	$49
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435-437	28-30
432-436	144-148
432-436	50-54
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28-29	145-146
28-30	50-52
27-27.4	144-144.4
28-30	220-222*
50-54	220-224
144-146	50-52
50-54	144-148
144-146	28-30

For UHF, Model XV4 Kit $99 Wired $169

Exciter Input Range	Antenna Output
28-30	432-434
28-30	435-437
50-54	432-436
61.25	439.25
144-148	432-436*

*Add $20 for 2M input

VHF & UHF LINEAR AMPLIFIERS. Use with above. Power levels from 10 to 45 Watts. Several models, kits from $78.

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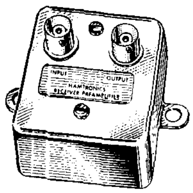

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LNG-50	46-56 MHz	$49
LNG-144	137-150 MHz	$49
LNG-160	150-172 MHz	$49
LNG-220	210-230 MHz	$49
LNG-432	400-470 MHz	$49
LNG-800	800-960 MHz	$49

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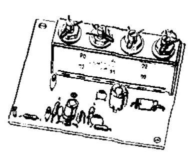
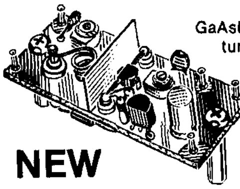


Model	Tuning Range	Price
HRA-144	143-150 MHz	$49
HRA-220	213-233 MHz	$49
HRA-432	420-450 MHz	$59
HRA-( )	150-174 MHz	$54
HRA-( )	450-470 MHz	$64

MINIATURE PREAMPS



GaAsFET Preamps with features similar to LNG, except designed for LOW COST and SMALL SIZE: only 5/8"W × 1-5/8L × 3/4H. Easily mounts inside many radios.

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MODEL	TUNES RANGE	KIT	WIRED
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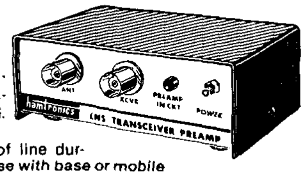
LNW-160	150-200 MHz	$19	$34
LNW-220	200-270 MHz	$19	$34
LNW-432	400-500 MHz	$19	$34

IN-LINE PREAMPS

NEW



GaAsFET Preamp with features like LNG. Automatically switches out of line during transmit. Use with base or mobile transceivers up to 25W. Tower mtg hdwr incl.

MODEL	TUNES RANGE	KIT	WIRED
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33 cm — our newest band

CQ, CQ, CQ, this is KM2XMS calling CQ 33 centimeters . . .

Silence . . . except for white noise.

No one in my area had gear, although a few of us had FCC Experimental Licenses with those funny call signs. But now that's all changed, because on September 28, 1985, the FCC released our newest band, 33 cm, 902-928 MHz. Unfortunately for me, an initial band opening QSO was cancelled as hurricane Gloria flattened our area that very day. Power wasn't restored for five days, so no opening day QSO's were possible. (Yes, I have a generator on order, but so do 5000 other people in my area.)

Now that it's ours, the new 33-cm band holds lots of promise for Amateurs. It's a generous chunk of spectrum — 26 MHz — nestled between the prime real estate of the communications companies and adjacent to the UHF television band. This means that there should be more equipment (components especially) available, than for the 23-cm band (1240-1300 MHz), where high power linear tubes are scarce.

Amateur Service on the 33-cm band is secondary to industrial, scientific, and medical (ISM), but this probably won't cause too many Amateurs any grief. However, restrictions will apply to Amateurs in Colorado, Wyoming, the United States possessions in Region 3 and those hams located near the White Sands Missile Range. The rest of us should enjoy a clean spectrum free of spurious generators and radars.

In order to get the ball rolling on 33 cm, I've updated the material I presented at the Eighth Annual Eastern VHF/UHF Conference in Nashua, New Hampshire, on May 17, 1983. This month's column will illustrate these entry-level circuits and techniques and should provide the necessary impetus to generate activity on the 33-cm band until more Amateur designs and commercial gear are forthcoming.

overview of the band

Our newest Amateur UHF band, large compared with the lower VHF and HF bands, permits the greatest variety of authorized transmission modes. Hence, there's considerable interest in how the band will be subdivided among the various interest groups.

The ARRL VUAC (VHF/UHF Advisory Committee), in conjunction with the VRAC (VHF Repeater Advisory Committee) has set up the interim band plan shown in **table 1**.[1] Note that the narrow-bandwidth, weak-signal segment (the frequencies to which this column is usually dedicated) is the lower 2 MHz of the band. Of prime interest is the weak signal calling frequency, 903.1 MHz, around which most of the communications on CW and SSB will probably prevail.

table 1. Abbreviated ARRL 33-cm Interim VUAC Bandplan. See Ref. 1 for more detail.

Segment	Use
902-904 MHz	Narrow-bandwidth weak-signal communications with 903.0-903.05 exclusively for EME and 903.1 MHz as the weak signal calling frequency.
904-906 MHz	Digital communictions.
906-907 MHz	Narrow-bandwidth FM simplex with 906.5 MHz as National simplex frequency.
907-910 MHz	FM repeater inputs.
910-916 MHz	ATV.
916-918 MHz	Digital communications.
918-919 MHz	Narrow-bandwidth FM control links and remote bases.
919-922 MHz	FM repeater outputs.
922-928 MHz	Wide-bandwidth experimental, simplex, ATV, spread spectrum.

Radio propagation on this band will be very similar to that experienced on the 70- (420-450) and 23-cm bands. Foliage attenuation will be more of a problem on 33 cm than on 70 cm, but scatter propagation should be better. This band should be perfect for EME, since small (i.e. 12-15 feet or 3.5-4.5 meter) diameter parabolic dishes should be sufficient to produce reasonable echos with 500 watts of transmitted power at the antenna feed. Additional information on propagation can be found in references 2 and 3.

antennas and transmission lines

This band is in a transitional antenna region. While Yagi types of antennas should work, they will require close tolerances (0.04 inch or 1 mm) if the desired performance is to be attained.

158

The most probable antennas will be the parabolic dish and the loop Yagi. Details on parabolic dish design and construction can be found in references 4 and 5. Several loop Yagi designs are described in reference 6.

The loop Yagi designs described in reference 6 can be scaled to the 33-cm band, but they will be either too long or too short, based on commonly available boom material. Therefore, I designed a 12-foot (3.65 meter), 33-element loop Yagi for 903 MHz using standard material stock. Its construction is shown in **fig. 1**.

This loop Yagi design should be duplicated exactly as shown if the gain of 19-19.5 dBi is to be attained. If any changes in the boom diameter, loop thickness or width are desired, the loops must be lengthened or shortened accordingly. This procedure, described in detail in reference 6, should be followed very closely.

Transmission lines must be carefully chosen. RG-8 and RG-213/U types should be used sparingly since they have a loss of about 8 dB per 100 feet (30.5 meters). Belden 9913, hardline and Heliax™ are recommended. A thorough discussion of transmission line selection and nominal losses are covered in reference 7.

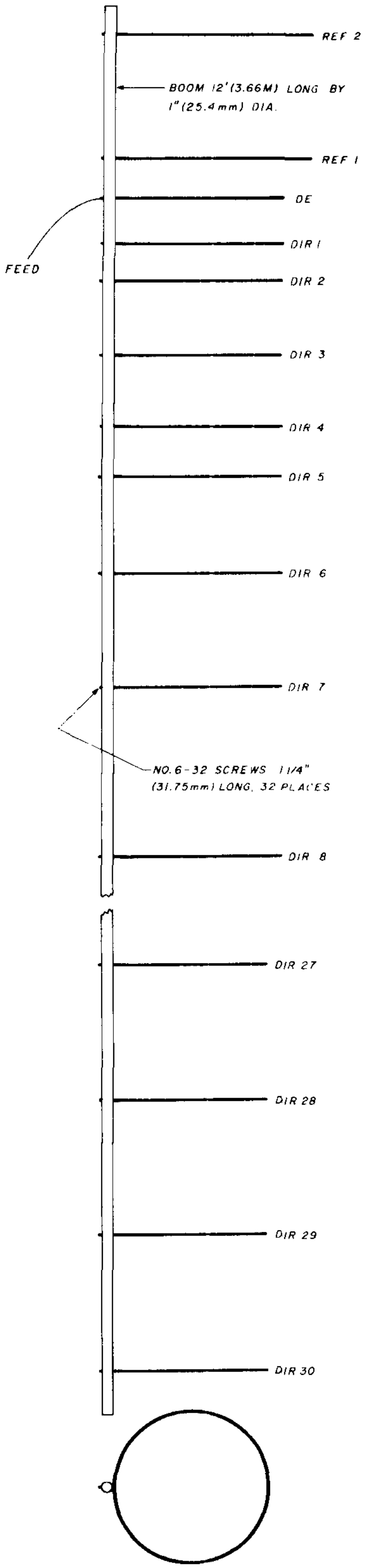
up/down converters and transverters

Receive and transmit up/down converters are often used on the VHF/UHF bands. More recently, transverters have been gaining popularity; the advantages and disadvantages were discussed in references 8 and 9, so they won't be repeated here.

Suffice it to say that transmit upconverters/transverters are preferred to multipliers since they will allow CW and SSB to be used at will. Furthermore, I recommend the modular approach to design, especially since this band is new and components and circuits can be easily upgraded as the available devices are selected and designed into improved circuits.

mixers

When designing a linear up/down



Element	Spacing	Circumference
Refl. 2	1.000	13.949
Refl. 1	5.454	13.949
Dr.El.	6.819	13.313
Dir. 1	8.428	11.900
Dir. 2	9.621	11.900
Dir. 3	12.178	11.900
Dir. 4	14.736	11.900
Dir. 5	16.532	11.900
Dir. 6	19.851	11.900
Dir. 7	24.966	11.900
Dir. 8	30.081	11.900
Dir. 9	35.196	11.900
Dir. 10	40.311	11.900
Dir. 11	45.426	11.900
Dir. 12	50.541	11.539
Dir. 13	55.656	11.539
Dir. 14	60.771	11.539
Dir. 15	65.886	11.539
Dir. 16	71.001	11.539
Dir. 17	76.116	11.539
Dir. 18	81.231	11.107
Dir. 19	86.346	11.107
Dir. 20	91.461	11.107
Dir. 21	96.576	11.107
Dir. 22	101.691	11.107
Dir. 23	106.806	11.107
Dir. 24	111.922	11.107
Dir. 25	117.037	11.107
Dir. 26	122.152	11.107
Dir. 27	127.267	11.107
Dir. 28	132.382	11.107
Dir. 29	137.497	11.107
Dir. 30	142.612	11.107

Notes:

1. Dimensional tolerances should be held to ±0.013 with ±0.04 inch maximum.
2. Reference all spacing from end of boom to prevent tolerance buildup.
3. Loop length should be approximately 1/2 inch longer than circumference shown to allow 1/4-inch overlap on each end of strap. The circumference dimension shown is the actual distance between holes as shown. The straps on this design are made from 0.062-inch thick aluminum 3/8 inch wide. Any deviations from this width or thickness must be compensated for or performance will deteriorate.
4. The driven element is made from brass 0.020 inch thick and 3/8 inch wide. Details are shown below.
5. Adjust height for best VSWR.

fig. 1. A recommended 33 element loop Yagi for the 33 cm band. Gain is approximately 19 dBi and beamwidth is approximately 20 degrees. Recommended stacking distance is 34 inches (86 cm) in the E plane and 32 inches (81 cm) in the H plane. See reference 6 and text for further details.

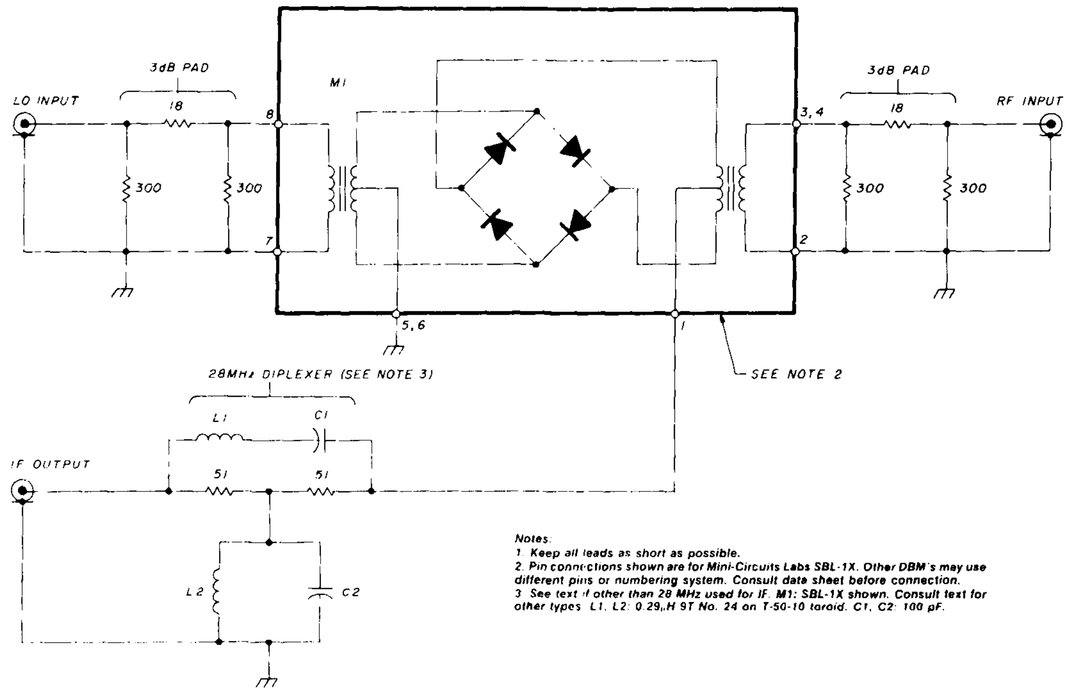


fig. 2. A recommended mixer circuit for a receive type down-converter. Conversion loss is approximately 9 dB overall. LO level should be between 5 and 15 milliwatts. If a 28 MHz IF is not used, the diplexer must be modified as described in text. See text for other recommended dBm's.

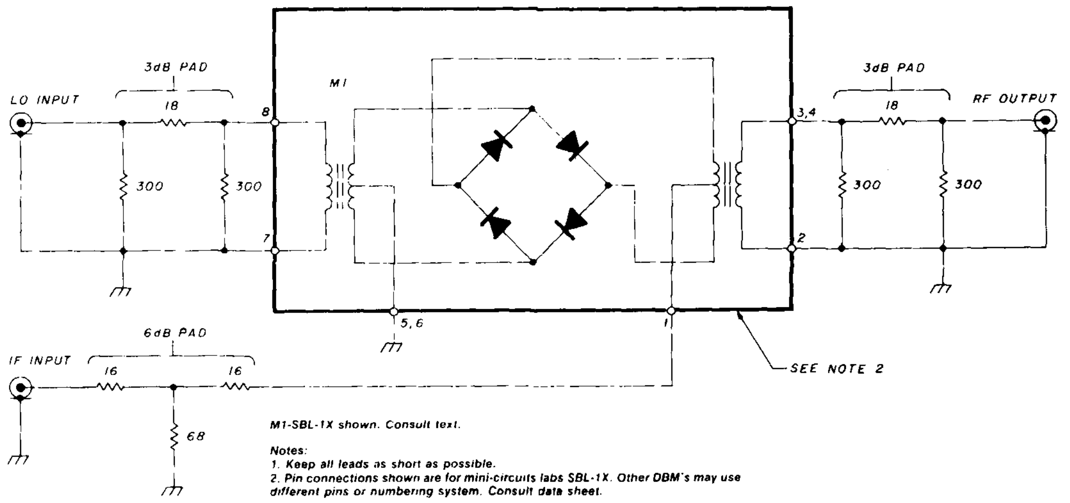
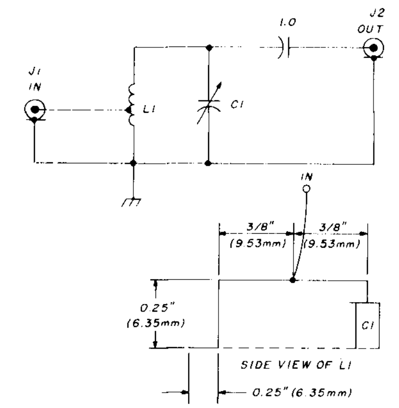


fig. 3. A recommended mixer circuit for a transmit type up-converter. Overall conversion loss is approximately 9 dB. LO level should be between 5 and 15 milliwatts. IF input level should not exceed 1 milliwatt. See text for other recommended dBm's.

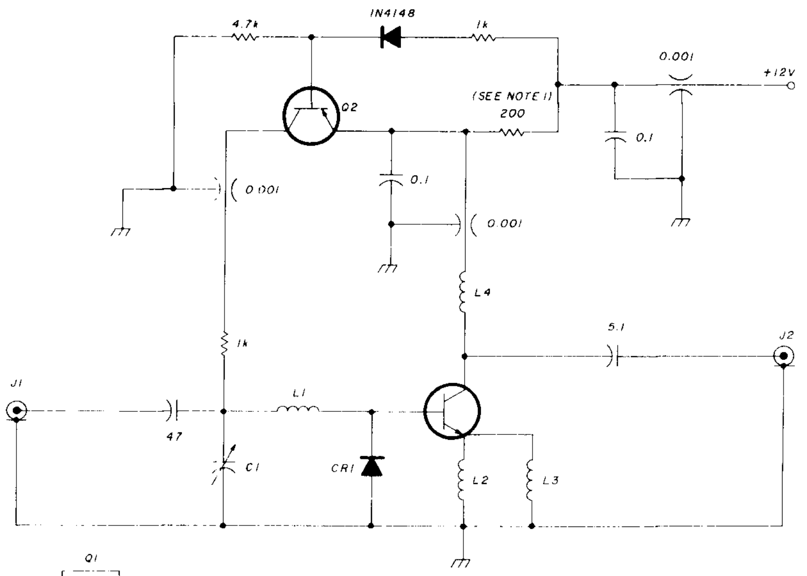
converter, the first requirement is to choose a mixer. For many of the reasons mentioned in references 8 and 9, I recommend the doubly-balanced mixer (DBM) and, more specifically, the commercial packaged units. Many are available, but they must be carefully chosen since most of the commonly available types are restricted to 500 MHz and down.

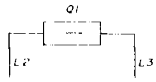
The Minicircuits Labs SBL-1X (at \$5.95), the SBL-1Z (at \$6.95), the TFM-2 (at \$11.95) — all prices are given for quantities of 10 to 49 — or the Anzac Electronics MD 110 (at



J1,J2: Low loss connectors.
L1: 0.25-inch (6.35 mm) wide brass or copper thin strip 1.25 inch (32 mm) overall length tapped as shown in sketch. C1: 1-6 pF low-loss air variable recommended

fig. 4. A simple single section 903 MHz bandpass filter for protecting the front end of a receiver. Bandwidth is approximately 100 MHz and insertion loss is 0.5 dB maximum.

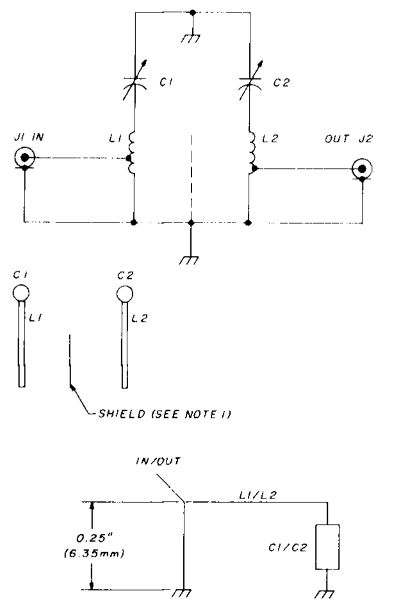




C1: 1-10 pF air variable.
CR1: HP 5082-2810 hot carrier diode or equivalent.
L1: Base lead of Q1 plus 1/8 inch (3 mm) or No. 24 wire to C1.
L2,L3: Use full lead of MRF901 and tack end to end per sketch.
L4: 2T No. 24 1/10 inch (2.54 mm) inside diameter.
Q1: MRF 901 or equivalent.
Q2: 2N2907 or equivalent high gain PNP transistor.

Notes
1. Use 100 ohms if used as transmitter amplifier. (See text.)

fig. 6. A simple low noise preamplifier for a 33 cm receive type converter. Gain is approximately 12 dB and noise figure is 2.5-3 dB typical. If the 200 ohm resistor in the constant current source is changed to 100 ohms, it will function well as a low-level linear transmitter amplifier stage as discussed in text.



L1,L2: 0.125-inch (3.2 mm) wide copper or brass strap 1 inch (2.54 cm) long tapped at 0.25 inch from grounded end. C1, C2: 1-6 pF low-loss air variable.

Notes:
1. L1 and L2 are in parallel and spaced 0.5 inch (1.27 cm) center to center. The shield is 0.5 inch (1.27 cm) long and placed in middle between L1 and L2. It extends from the grounded end upwards per sketch.

fig. 5. Circuit of a simple two-section bandpass filter suitable for a 33 cm low-level receiver or transmitter. Bandwidth is approximately 50 MHz and insertion loss is 0.5 dB.

$19.00 each) are recommended. DBMs from other suppliers are likewise usable as long as they're specified to work up to at least 1 GHz.

A recommended receive-type down-converter DBM circuit is shown in **fig. 2.** I prefer 28 MHz for an IF. The diplexer shown on this circuit is for 28 MHz, per reference 9. Other IF's can be used, but the diplexer shown will have to be scaled to the new IF frequency or be eliminated. A recommended IF post amplifier is described in reference 10.

Figure 3 shows a recommended low-level DBM circuit for a transmit up-converter. The operation of this circuit is described in reference 8. This circuit will easily handle any desired IF up to 150 MHz. The IF input level must not exceed 1 milliwatt.

filters

Figure 4 shows a simple input filter that can be used ahead of a receive down-converter, especially if the input stage is untuned. It is not exotic, but will eliminate such out-of-band signals as TV, FM, etc. This filter is easier to build than a coaxial cavity, and its unique topology has a symmetrical response.[11]

A simple two-section bandpass filter is shown in **fig. 5.** It should be used in the receive down-converter just ahead of the mixer to eliminate any out-of-band signals from reaching the mixer. This filter should also be used after the transmit mixer to prevent amplification of local oscillator, image and spurious signals generated by the mixer from being amplified in the transmitter.

These filters are simple, but neither is real state-of-the-art. Interdigital types of filters with three sections are recommended for improved filtering per reference 11, but are beyond the scope of this month's column.

low-level receiver preamplifiers.

The MRF 901 bipolar transistor is a readily available (Radio Shack), low-cost device (under $2.00) that is simple and straightforward to use. A

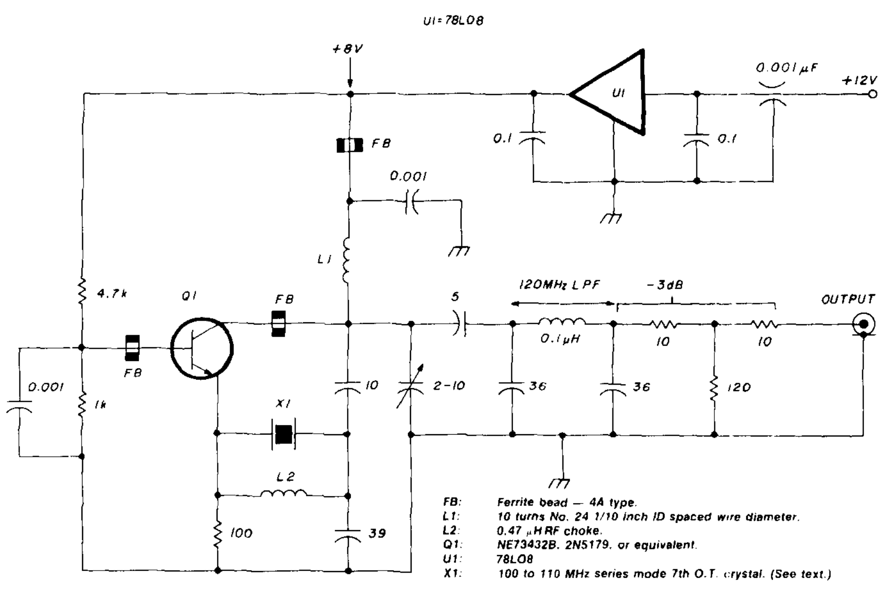


fig. 7. A recommended local oscillator circuit for a 33 cm up or down-converter. Any frequency between 100 and 115 MHz will work well. 109.3625 MHz is recommended for a 28.1 MHz IF. Output power level is approximately 10 milliwatts.

recommended circuit patterned after a previous design[12] is shown in **fig. 6**. It uses series feedback and simple matching to achieve a moderate 2.5-3 dB noise figure. It also has some built-in selectivity and reasonably high output power (over 5 milliwatts at 1 dB compression).

A single preamplifier stage such as this one will normally be sufficient to yield an overall 3-4 dB noise figure in a typical converter as just described. Two such preamplifers can be used in cascade if a lower noise figure is desired.

If a very low noise figure (less than 1 dB) is required, the 902 MHz GaAs FET preamplifier in reference 13 can be used. However, this particular design has little if any input selectivity to reject transient or lower frequency emitters. Therefore, if this circuit is used, I recommend adding a 25-100 pF, low-loss ceramic chip-type capacitor in series between the input connector and the first circuit elements.

Other GaAs FET circuit recommendations are described in reference 14. Reducing the size of the input inductor and capacitors in the circuit in this reference should yield a very acceptable noise figure with "built-in" front-end selectivity, thus killing two-birds with one stone.

local oscillators and multipliers

So far I have not mentioned a suitable local oscillator. The 33-cm band is unique in that it can be easily served with a simple crystal oscillator operating in the 100 MHz region and followed by three doublers. This is a recommended approach.[9]

Figure 7 shows a recommended oscillator circuit similar to the one described in reference 9. If a crystal cut for 109.3625 MHz is used, the IF for 903.0 MHz will be 28.1 MHz, a favorite IF of mine.[9] This circuit has been widely used. A low-pass filter has been added to the output to decrease oscillator harmonics. I recommend placing this oscillator in its own shielded box, away from heat and extraneous RF signals.

Figure 8 shows a recommended multiplier circuit that consists of three doublers. It has a clean output and is relatively easy to align. The RF output level is sufficient to directly drive the DBM circuits. This circuitry is similar to that described in reference 9 and has been extended to the 33-cm band. It should also be placed in its entirety in a shielded box.

If a transverter is used, the multiplier output power is sufficiently high enough so that it can be divided into two equal outputs. A Wilkinson-type power splitter is recommended since it has negligible loss (over the inherent 3 dB power split) and provides high isolation (20 dB typical) between the two outputs. Hence there will be very little, if any, interaction between the receiver and transmitter. The Wilkinson-type power splitter I use is shown in **fig. 9**. Both transmission lines are 75 ohms and are electrically a quarter-wavelength long at the local oscillator output frequency.

transmitter circuits

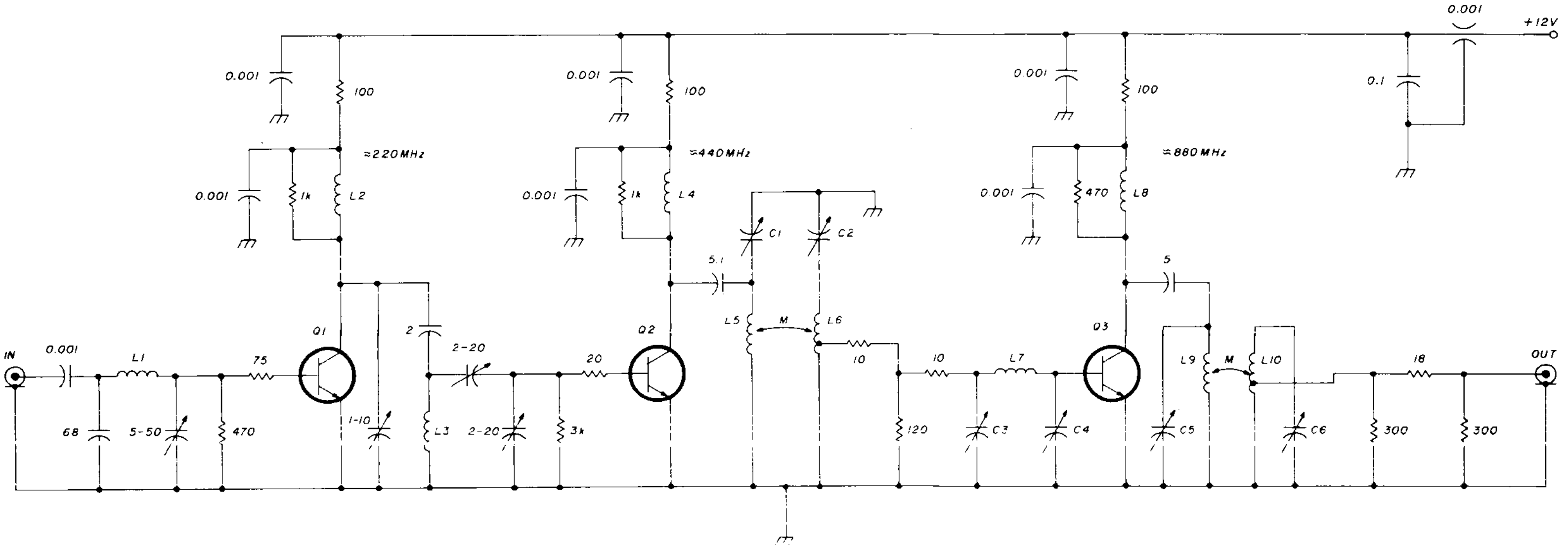
Finally we come to the transmitter. The output of the DBM shown in **fig. 3** will be about 16-17 dB below a milliwatt with one milliwatt of IF drive, the maximum recommended level for a clean transmitter output. The DBM should be followed by either the filter shown in **fig. 5** or an equivalent as described.

This low-level output after the filter can be easily boosted up to a moderate power level with two amplifier stages, similar to the receive preamplifier shown in **fig. 6**. All that's required is to change the 200-ohm resistor in the constant current source to 100 ohms and remove the protection diode, CR1. Gain will then be about 13 dB per stage and the 1 dB output compression point will increase to about 10 milliwatts.

Alternatively, Toshiba and NEC now make low-cost ($7-10), 902-905 MHz low-level linear hybrid modules. The Toshiba module part number is S-AU15; the NEC model part number is MC-5809.* Both units require about 8 volts DC. Gain is just over 20 dB and the 1 dB output compression point is

*Toshiba is represented in the United States by Matcom, Inc., 450 San Antonio Road, Palo Alto, California 94036.

**NEC is represented in the United States by California Eastern Labs, 3260 Jay Street, Santa Clara, California 95054.



C1-C6: 1-10 pF air variables.
L1: 12T No. 24 C.W. 1/10-inch ID.
L2,L3: 4T No. 24 1/4-inch long 1/10-inch ID.
L4: 0.1μH RF choke.
L5,L6: 1/8-inch brass strap, 3/4-inch overall length, spaced 3/4 inch L6 tapped 1/4 inch above ground.
L7: 4 turns No. 24 1/10-inch ID, 1/4 inch long.
L8: 8 turns No. 24 1/10-inch ID, 1/4 inch long.
L9,L10: Same as L5, L6. Tap 1/4 inch up on L10.
Q1,Q2: NE73432B or 2N5179.
Q3: NE02132 preferred, but NE73432B OK at slightly lower power output.

fig. 8. A recommended multiplier circuit suitable for a 33 cm local oscillator. Each stage is a doubler with the final output frequency in the 800-900 MHz region. The oscillator in figure 7 is recommended as the driver. Output power is approximately 10-20 milliwatts with an input of 5-10 milliwatts.

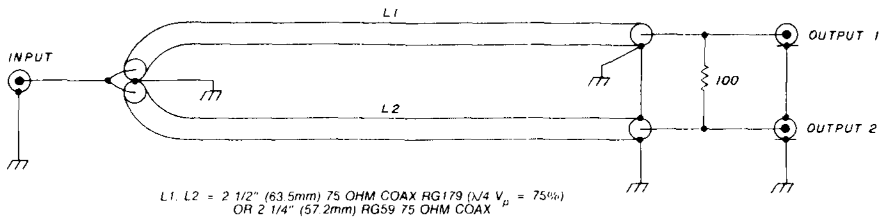


fig. 9. A Wilkinson type two-way in-phase power splitter suitable for local oscillator power splitting in the range of 800-900 MHz. Other frequencies can be used by adjusting the length of the 75 ohm coax for 0.25 electrical wavelength at the desired frequency.

over 100 milliwatts. A typical circuit using these modules is shown in **fig. 10**.

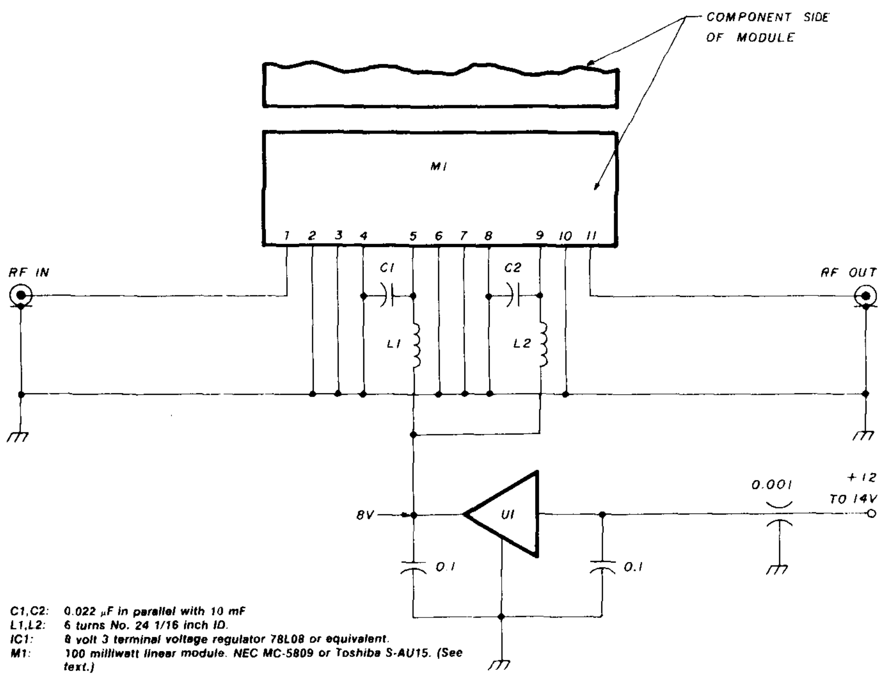


fig. 10. A recommended low-level linear transmit amplifier circuit using commercial hybrids. Unit requires approximately 8 volts at 100 milliamps. See text for further details and suppliers.

For higher linear power, CATV-UHF type bipolar transistors can be used. A recommended circuit, patterned after the circuits described in reference 8, is shown in **fig. 11**. Gain is typcially 13 dB per stage with a 1 dB compression point of 300 milliwatts. One or two stages can be used, depending on the desired gain and output power. This power level is more than adequate for local (i.e. up to 25 miles or 40 km) QSO's.

For even higher solid-state linear output power, transistors similar to the NEC NE0801 (11 watts) are recommended.[2] I'm sure there are many other devices available from suppliers such as Acrian, Motorola, TRW, and Thompson-CSF's Solid State Microwave Division. Time and space does not allow for a detailed description of such circuitry at this time.

For "quick and dirty" gain, Class "C" can be used. The same suppliers just mentioned can supply suitable class "C" bipolar transistors to at least 25-50 watts.

Furthermore, if only class "C" operation is desired, both NEC and Toshiba make 7-12 watt output hybrid modules for the 33-cm band, which is, incidentally, a citizens' band in Japan. The NEC part number is MC-5843 and the Toshiba part number is S-AU11.

A suitable circuit using these modules is shown in **fig. 12**. These hybrid modules provide a power gain of approximately 30 dB and can be driven to full output with 100-200 milliwatts of drive. They require a nominal supply of 12.5 volts at 2-3 Amperes of current and are great for portable operation.

high power

High-power amplifier designs are probably already available, but we have to seek them out. For moderate power (25-200 watts), the ubiquitous 2C39/7829 in a cavity is recommended.[14,15] I'm sure Amateur designs using these tubes will be published shortly.

For even higher power, I'm aware of only one published Amateur design.[16] UHF TV tansmitting tubes should be readily available, especially as "pullouts." The RCA 7650 and 7213 immediately comes to mind. Cavity-type amplifiers using these or other suitable tubes are recommended.[15,16] I'm sure that many designs will be forthcoming as interest picks up in this new band.

summary

This month's column was mainly focused on getting started on the new 33-cm band. Easy-to-build and duplicate circuitry was discussed. Although the power level available from this is low, it should be more than adequate for DX from 50 to 250 miles (80 to 400 km) for band "warmer-upper's" and further if extended propagation conditions are present.

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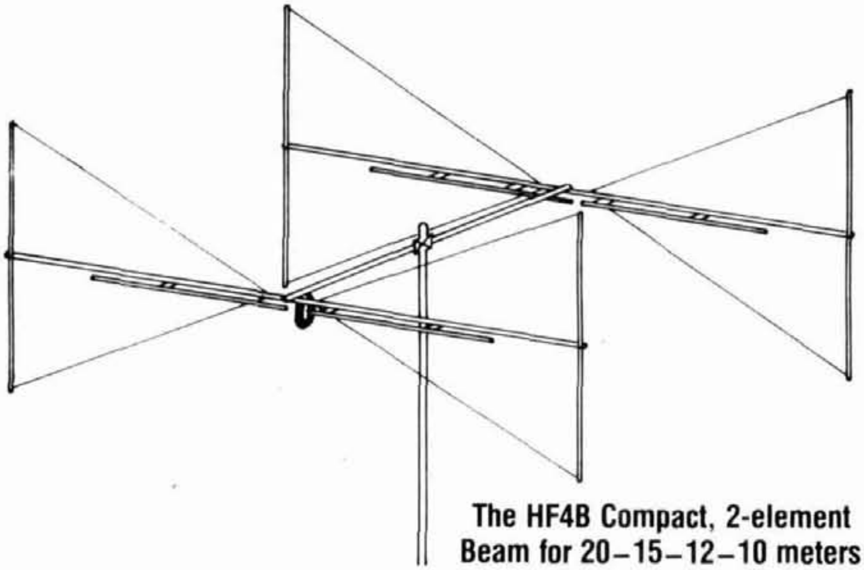

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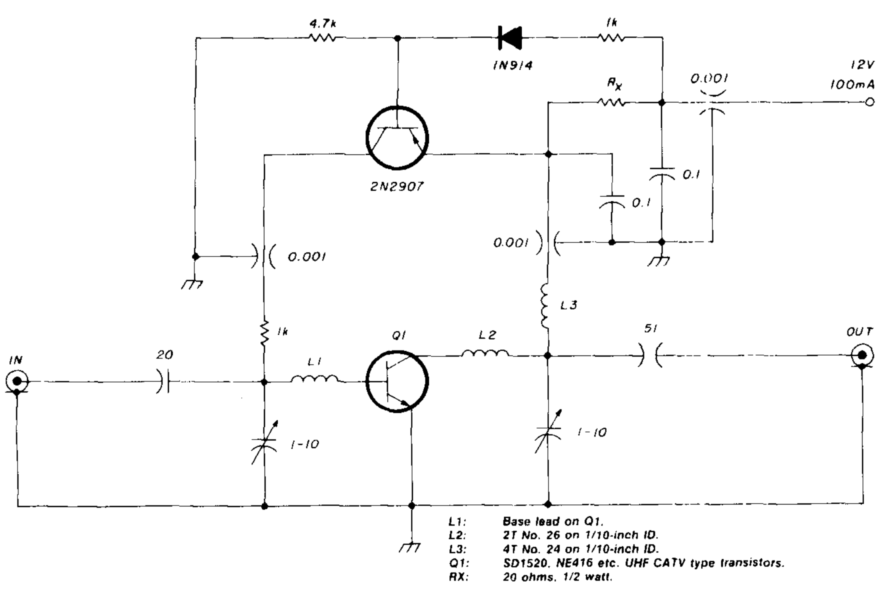

fig. 11. A recommended medium-power linear transmit amplifier. Gain is approximately 13 dB and maximum output power at 1 dB compression is approximately 300 milliwatts.

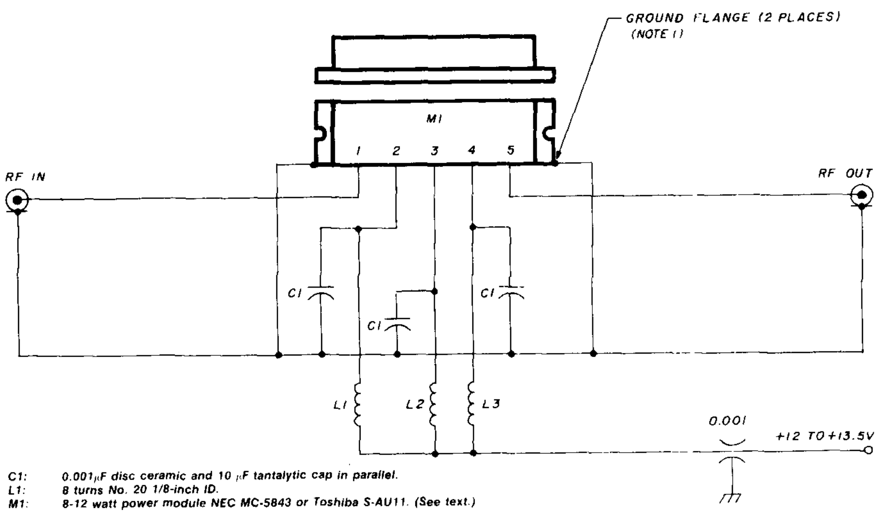

fig. 12. A recommended medium power class "C" amplifier circuit using commercial hybrids. Gain is approximately 30 dB and output is 7-12 watts with 100 milliwatts drive. See text for suppliers. Be sure to provide adequate heat sink with several radiating fins. Under normal operation the heat sink will have to dissipate up to 25 watts of power.

The designs just discussed are more than adequate for transmitter drivers and basic receive converters. Improved designs and higher power transmitter designs should be forthcoming and can be easily substituted or added on to the circuitry shown, especially if the modular approach is used.

Let's welcome our "newest" UHF band. It was only a few years ago that power levels above 10 watts were uncommon on 23 cm, and we all know that great DX was worked there under good conditions. I'm sure the same DX is more probable on 33 cm. See you on 903.1 MHz!

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108	120	132	144	156	168	180	192	204	216	228	240	252	264	276	288	300	312	324	336	348
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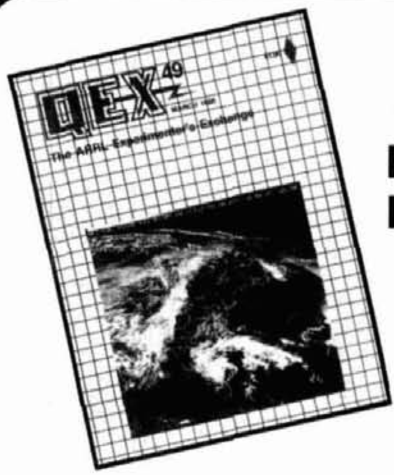

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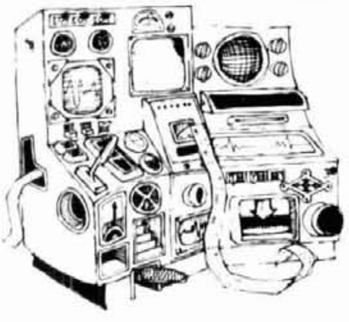

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DX FORECASTER

Garth Stonehocker, KØRYW

1985 review

Six months have passed since our last review of propagation conditions; now that data for 1985 is complete, it's time for a review of the year as a whole.

The sunspot numbers (SSN) during the first four months of 1985 were just under 20, increasing through July to 35 and diminishing during the final months of the year to 13. This represented a decrease, over the year, of 7 SSNs, or approximately 0.5 SSN per month. If this trend continues, we could expect a low of about 6 SSNs by late fall of 1986. Although new 11-year cycle SSN sunspots were tentatively identified from polarization differences on September 11, no opposite polarity spots at high latitudes have yet been seen. The cycle 21 SSN minimum may occur in September, 1986.

An equivalent pattern emerged in review of the 10 cm solar flux data. *Monthly* solar flux numbers in early 1985 matched those of late 1984 at 74 ± 2 units. A mid-year bulge of up to 80 occurred instead of the minimum number expected; a minimum of 69.5 occurred in September. The year closed with a 75 again. Note that the minimum monthly average in October, 1984, was 73.5; in 1985, it was 69.5, which represents a decrease of four units. A continued reduction to 67 units in a late summer month of 1986 will be necessary for the solar flux minimum to be reached.

The lowest *daily* solar flux value in the 11-year cycle so far, 66, occurred on August 17 and from October 6 through the 9th. The highest value during 1985 was 101, on July 9. (The daily flux number will probably reach 63 or 64 by next fall.) The 27-day solar flux variation of daily numbers, whose increase raise the monthly average, was 20 units or more in January, in the period between April and July (with May the highest solar flux, at 80.3), and in the month of October; a variation of about 10 units occurred in February, March,, August, November, and December. September was quite "flat," devoid of any 27-day solar cycle activity, and therefore provided the minimum monthly average of the year. Four days of a solar flux of 66 were the year's minimum recorded just before solar activity began to increase again in mid-October.

The geomagnetic *A* figure monthly average was, as usual, highest in April, the most disturbed month, and May, the quietest. Note the May inverse relationship to solar flux, a surprisingly frequent occurrence. Of the disturbed periods, April 20 to May 2 stands out as the highest and longest. The other months had two or three milder periods of disturbance separated by a few days of quiet conditions. That's the difference between the geomagnetic conditions in the winter minimum months and those of the equinox maximum and summer months: the number of big events decreases and the number of quiet days (at a lower *A* level) increases. As SSN minimum approaches this summer, the periods of solar 27-day activity should get further apart and be lower in intensity. The periods of geomagnetic disturbance should also decrease in number and intensity. The sun simply takes a rest — Hi!

You may recall from my December, 1985, column on maximum usable frequencies (MUF) that an increase of one unit in solar flux results in an increase in MUF of 1 percent. The base line to start from for mid-latitude MUFs is MUF = 2.5 (0.036 SSN + 5.28). The decrease in MUF from a geomagnetic disturbance is percentage MUF = 0.375A + 3.75. Listen to WWV at 18 minutes after the hour for the data.

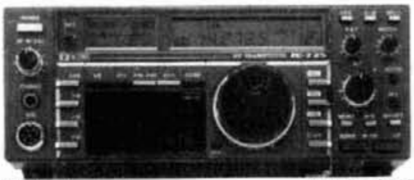
last-minute forecast

The first two weeks of April are expected to have low solar flux levels. Because the amplitude variation isn't more than a few units during this part of the 11-year sunspot cycle, the lower frequency bands are expected to provide the best DX activity. The geomagnetic field should still be a problem this close to equinox, so look for disturbances around the 4th to the 8th, from the 18th to the 22nd, and again on the 28th of the month. Signal level variations will be greatest during these periods and conditions won't be really stable in between, either, since equinoctial periods don't produce many quiet days. The best days for the higher frequency band DX are more likely to occur from the end of the second week through the third. Expect some enhanced equatorial openings during the disturbances of the 21st.

The perigee of the moon's orbit (for moonbounce DX) is on the 25th, with the moon showing full phase on the 1st. There will be a short meteor shower, the Lyrid, on April 20-22, with a rate of five per hour — hardly much help for meteor-scatter DX. But a bigger shower, the Aquarid, starts before the end of April, peaks on May 5, and ends in mid-May. Its rate is 10 to 30 per hour.

band-by-band summary

Ten, twelve, fifteen, and twenty meters will be open from morning until early evening almost every day, and to most areas of the world. The openings on the higher of these bands will be shorter to the southern hemisphere and will occur closer to local noon. Transequatorial propagation on these bands will more likely occur toward evening during conditions of highest



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SM-5 8-pin electret desk mic	39.00	
MB-5 Mobile mount	19.50	

Other Accessories:	Regular	SALE
PS-15 20A external power supply	149.00	134^{95}
CF-1 Cooling fan for PS-15	45.00	
EX-144 Adaptor for CF-1/PS-15	6.50	
PS-30 Systems p/s w/cord, 6-pin plug	259.95	234^{95}
OPC Opt. cord, specify 2, 4 or 6-pin	5.50	
SP-3 External base station speaker	49.50	
SP-5 Remote speaker for mobiles	25.00	
CR-64 High stab. ref. xtal (745/751)	56.00	
PP-1 Speaker/patch (specify radio)	139.00	129^{95}
SM-8 Desk mic - two cables, Scan	69.95	
SM-10 Compressor/graph EQ, 8 pin mic	119.00	
AT-100 100W 8-band auto. antenna tuner	349.00	314^{95}
AT-500 500W 9-band auto. antenna tuner	449.00	399^{95}
AH-1 5-band mobile antenna w/tuner	289.00	259^{95}

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Other Accessories cont.	Regular	SALE
AH-2 8-band tuner w/mount & whip	549.00	
GC-4 World clock • (CLOSEOUT) •	99.95	79^{95}
HF linear amplifier	Regular	SALE
IC-2KL 160-15m solid state amp w/ps	1795.00	1299
6-meter VHF Portable	Regular	SALE
IC-505 3/10W 6m SSB/CW portable	449.00	399^{95}
BP-10 Internal Nicad battery pack	79.50	
BP-15 AC charger	12.50	
EX-248 FM unit	49.50	
LC-10 Leather case	34.95	
VHF/UHF base multi-modes	Regular	SALE
IC-551D 80W 6-meter SSB/CW	699.00	599^{95}
EX-106 FM option	125.00	112^{95}
BC-10A Memory back-up	8.50	
SM-2 Electret desk microphone	39.00	
IC-271A 25W 2m FM/SSB/CW	699.00	569^{95}
AG-20 Internal preamplifier*	56.95	
IC-271H 100W 2m FM/SSB/CW	899.00	759^{95}
AG-25 Mast mounted preamplifier*	84.95	
IC-471A 25W 430-450 SSB/CW/FM xcvr	799.00	699^{95}
AG-1 Mast mounted preamplifier*	89.00	
IC-471H 75W 430-450 SSB/CW/FM	1099.00	969^{95}
AG-35 Mast mounted preamplifier*	84.95	

Limiter Offer! • Matching preamp* only 1^{00} extra with purchase of **IC-271A/H** or **IC-471A/H**.

Accessories common to 271A/H and 471A/H	Regular	SALE
PS-25 Internal power supply for (A)	99.00	89^{95}
PS-35 Internal power supply for (H)	160.00	144^{95}
PS-15 External power supply	149.00	134^{95}
SM-6 Desk microphone	39.00	
EX-310 Voice synthesizer	39.95	
TS-32 CommSpec encode/decoder	59.95	
UT-15 Encoder/decoder interface	12.50	
UT-15S UT-15S w/TS-32 installed	79.95	
VHF/UHF mobile multi-modes	Regular	SALE
IC-290H 25W 2m SSB/FM, TTP mic	549.00	479^{95}
IC-490A 10W 430-440 SSB/FM/CW	649.00	579^{95}
VHF/UHF/1.2 GHz FM	Regular	SALE
IC-27A Compact 25W 2m FM w/TTP mic	369.00	329^{95}
IC-27H Compact 45W 2m FM w/TTP mic	409.00	359^{95}
IC-37A Compact 25W 220 FM, TTP mic	449.00	329^{95}
IC-47A Compact 25W 440 FM, TTP mic	469.00	399^{95}
PS-45 Compact 8A power supply	112.95	99^{95}
UT-16/EX-388 Voice synthesizer	29.95	
SP-10 Slim-line external speaker	29.95	
IC-3200A 25W 2m/440 FM w/TTP	549.00	489^{95}
UT-23 Voice synthesizer	29.95	
AH-32 2m/440 Dual Band antenna	32.95	
Larsen PO-K Roof mount	20.00	
Larsen PO-TLM Trunk-lip mount	20.18	
Larsen PO-MM Magnetic mount	19.63	
IC-1271A 10W 1.2 GHz SSB/CW Base	999.00	889^{95}
ATV-1200 ATV interface unit	TBA	
PS-25 Internal power supply	99.00	89^{95}
EX-310 Voice synthesizer	39.95	
UT-15S CTCSS encoder/decoder	79.95	
IC-120 1W 1.2 GHz FM Mobile	499.00	449^{95}
ML-12 1.2 GHz 10W amplifier	339.00	299^{95}
Repeaters	Regular	SALE
RP-3010 440 MHz, 10W FM, xtal cont.	999.00	899^{95}
RP-1210 1.2 GHz, 10W FM, 99 ch. synth	1199.00	1089
Duplexer 1210 1.2 GHz duplexer	1199.00	1089
Cabinet for RP-1210	249.00	

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Hand-held Transceivers Deluxe models	Regular	SALE
IC-02AT for 2m	349.00	289^{95}
IC-04AT for 440 MHz	379.00	319^{95}
Standard models	Regular	SALE
IC-2A for 2m	239.50	189^{95}
IC-2AT with TTP	269.50	199^{95}
IC-3AT 220 MHz, TTP	299.95	239^{95}
IC-4AT 440 MHz, TTP	299.95	239^{95}

Accessories for Deluxe models	Regular
BP-7 425mah/13.2V Nicad Pak - use BC-35	67.50
BP-8 800mah/8.4V Nicad Pak - use BC-35	62.50
BC-35 Drop in desk charger for all batteries	69.00
BC-60 6-position gang charger, all batts	SALE 359.95
BC-16U Wall charger for BP7/BP8	10.00
LC-11 Vinyl case	17.95
LC-14 Vinyl case for Dlx using BP-7/8	17.95
LC-02AT Leather case for Dlx models w/BP-7/8	39.95
Accessories for both models	Regular
BP-2 425mah/7.2V Nicad Pak - use BC35	39.50
BP-3 Extra Std. 250 mah/8.4V Nicad Pak	29.50
BP-4 Alkaline battery case	12.50
BP-5 425mah/10.8V Nicad Pak - use BC35	49.50
CA-2 Telescoping 2m antenna	10.00
CA-5 5/8-wave telescoping 2m antenna	18.95
FA-2 Extra 2m flexible antenna	10.00
CP-1 Cig. lighter plug/cord for BP3 or Dlx	9.50
DC-1 DC operation pak for standard models	17.50
LC-2AT Leather case for standard models	34.95
RB-1 Vinyl waterproof radio bag	30.00
HH-SS Handheld shoulder strap	14.95
HM-9 Speaker microphone	34.50
HS10 Boom microphone/headset	19.50
HS-10SA Vox unit for HS-10 & Deluxe only	19.50
HS-10SB PTT unit for HS-10	19.50
ML-1 2m 2.3w in/10w out amplifier	SALE 79.95
SS-32M Commspec 32-tone encoder	29.95

Receivers	Regular	SALE
R-7000 25-2000 MHz, 117V AC	899.00	789^{95}
RC-12 Infrared remote controller	TBA	
R-71A 100 kHz-30 MHz, 117V AC	$799.00	649^{95}
RC-11 Infrared remote controller	59.95	49^{95}
FL-32 500 Hz CW filter	59.50	
FL-63 250 Hz CW filter (1st IF)	48.50	
FL-44A SSB filter (2nd IF)	159.00	144^{95}
EX-257 FM unit	38.00	
EX-310 Voice synthesizer	39.95	
CR-64 High stability oscillator xtal	56.00	
SP-3 External speaker	49.50	
CK-70 (EX-299) 12V DC option	9.95	
MB-12 Mobile mount	19.50	

(4)

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GMT	2300	2200	2100	2000	1900	1800	1700	1600	1500	1400	1300	1200	1100	1000	0900	0800	0700	0600	0500	0400	0300	0200	0100	0000	
PST	3:00	2:00	1:00	12:00	11:00	10:00	9:00	8:00	7:00	6:00	5:00	4:00	3:00	2:00	1:00	12:00	11:00	10:00	9:00	8:00	7:00	6:00	5:00	4:00	
ASIA FAR EAST	20	20	30	40	40	40	30	30	30	20	20	30	40	40	30	30	30	20	20	20	20	20	20*	20	N
EUROPE	30	20	20	20	20	20*	15	15	15	20	20	20	20	40	40	40	30	30	30	30	40	40	40	30	NE
S. AFRICA	20	15	12	12	10	10	10	10	10	10	12	15	20	20	20	20	20	20	20	20	20	20	20	20	E
S. AMERICA	10	10	10	10	10	10	10	12	12	15	20	20	20	20	20	20	20	20	20	20	15	12	12	10	SE
ANTARCTICA	12	12	15	15	15	15	20	20	30	30	30	30	30	30	30	30	30	30	20	20	15	15	15	15	S
NEW ZEALAND	10	10	12	12	15	15	20	20	20	20	20	20	20	20	20	20	15	12	12	10	10	10	10	10	SW
OCEANIA AUSTRALIA	10	10	12	12	20	30	20	20	20	20	20	20	20	20	20	15	12	12	10	10	10	10	10	10	W
JAPAN	15	15	20	20	20	30	40	30	30	30	40	40*	30	30	30	30	20	20	20	20	15	15	15	15	NW

MID USA

MST	4:00	3:00	2:00	1:00	12:00	11:00	10:00	9:00	8:00	7:00	6:00	5:00	4:00	3:00	2:00	1:00	12:00	11:00	10:00	9:00	8:00	7:00	6:00	5:00	
ASIA FAR EAST	20	20	40	40	40	30	30	30	20	20	20	20	20	20	30	40	40	40	30	30	30	20	20	20	N
EUROPE	30	20	20	20	20	20*	15	15	15	15	15	20	20	20	20	40	40	30	30	40	40	40	30	30	NE
S. AFRICA	20	15	15	12	10	10	10	10	10	10	10	12	15	20	20	20	20	20	20	20	20	20	20	20	E
S. AMERICA	10	10	10	10	10	10	10	10	12	12	15	20	20	20	20	20	20	20	20	20	15	12	12	10	SE
ANTARCTICA	15	15	15	15	15	15	20	20	20	40	40	40	40	40	30	30	30	30	30	20	20	20	15	15	S
NEW ZEALAND	10	10	10	12	12	15	20	20	20	20	20	20	20	20	20	20	15	15	12	12	10	10	10	10	SW
OCEANIA AUSTRALIA	10	10	12	12	15	20	30	20	20	20	20	20	20	20	20	20	15	15	15	12	10	10	10	10	W
JAPAN	15	15	20	20	20	30	40	40	30	30	30	30	40	40	40	30	30	30	20	20	20	20	15	15	NW
CST	5:00	4:00	3:00	2:00	1:00	12:00	11:00	10:00	9:00	8:00	7:00	6:00	5:00	4:00	3:00	2:00	1:00	12:00	11:00	10:00	9:00	8:00	7:00	6:00	

EASTERN USA

EST	6:00	5:00	4:00	3:00	2:00	1:00	12:00	11:00	10:00	9:00	8:00	7:00	6:00	5:00	4:00	3:00	2:00	1:00	12:00	11:00	10:00	9:00	8:00	7:00	
ASIA FAR EAST	20	30	40	40	30	30	30	30	20	20	20	20*	20	20	20	20	40	40	40	30	30	30	20	20	N
EUROPE	30	20	20	20	20	20	20	20*	15	15	20	20	20	20	20	30	40	40	40	40	40	40	30	30	NE
S. AFRICA	20	15	15	12	10	10	10	10	10	10	10	12	12	15	20	20	20	20	20	20	20	20	20	20	E
CARIBBEAN S. AMERICA	10	10	10	10	10	10	10	10	12*	12	12	15	20	20	20	20	20	20	20	20	15	15	12	10	SE
ANTARCTICA	15	15	15	15	15	15	20	20	20	40	40	40	40	40	40	30	30	30	30	30	20	20	15	15	S
NEW ZEALAND	10	10	10	12	12	15	20	20	20	20	20	20	20	20	20	20	20	15	15	12	12	10	10	10	SW
OCEANIA AUSTRALIA	10	10	10	12	15	30	30	20	20	20	20	20	20	20	20	20	20	15	15	12	10	10	10	10	W
JAPAN	15	15	20	20	20	30	40	40	30	30	30	30	20	20	40	40	40	30	30	30	30	20	20	20	NW

The italicized numbers signify the bands to try during the transition and early morning hours, while the standard type provides MUF during "normal" hours.

*Look at next **higher** band for possible openings.

solar flux and a disturbed geomagnetic field.

Thirty and forty meters will be useful almost 24 hours a day. Daytime conditions will resemble those on 20 meters except that skip distances and signal strength may decrease during midday on days that coincide with the higher solar flux values. Nighttime DX will be good except during pre-dawn hours after days of high MUF conditions and during periods of geomagnetic disturbance.

Eighty and one-sixty meters will exhibit short-skip propagation during daylight hours and lengthen for DX at dusk. These bands follow the darkness regions, opening to the east just before your sunset and swinging more to the north near midnight, ending up in the Pacific areas during the hour or so before dawn on the path of your interest. The 160-meter band opens later and ends earlier than the 80-meter band.

ham radio

the ham notebook

improved repeater/transmitter noise performance

Solid-state technology has dramatically improved the reliability of most Amateur repeater systems. However, the changeover from tubes to semiconductors has not always progressed as smoothly as expected for some repeater operators.

Repeater desense is normally caused by inadequate transmitter-to-receiver isolation, allowing gain compression to occur in the repeater receiver. The 100 dB isolation characteristics provided by modern duplexers, when properly installed, make this an unlikely possibility. Alas, the duplexer is often blamed for poor repeater performance even though the problem is actually in the transmitter.

If repeater desense occurs when a new solid-state exciter replaces an older tube type, chances are the problem is caused by excessive transmitter noise products. The standard cure recommended for this is usually the addition of another transmitter notch cavity. Unfortunately, this is an expensive, bulky, and lossy (about 1 dB) solution. Earlier tube exciters, with their hi-Q interstage coupling networks, minimized this problem.[1] The low-Q interstage networks in solid-state transmitters increases the bandwidth and thus the noise output on the receiver frequency.

what can be done?

Commercial repeater manufacturers have been aware that the single stage most often responsible for transmitter noise is the phase modulator. For this reason, most commercial repeater systems now use direct FM techniques — i.e., varactors — rather than phase modulators. Another approach involves the use of a two- or four-pole monolithic filter after the last multiplier stage, or frequency synthesizer, preceding the power stages.[2] (These filters, normally used to increase the IMD performance of the VHF receivers, are capable of handling only about 5 mW of power.)

One advantage of using a crystal filter lies in reducing transmitter noise at all frequencies on either side of the transmitter carrier; in the same application, a notch filter would only protect the receiver channel. Crystal filters are expensive ($100-$200), and considering their power restraints, 50-ohm termination impedances and insertion losses might prohibit their use in most existing transmitter designs.

Repeater operators seeking a new solid-state exciter should look for one using low-noise direct FM. Avoid phase modulation. If a homebrew transmitter design is being contemplated, consider including both direct FM and a four-pole monolithic filter to further reduce the transmitter's noise products. The improvements are dramatic and well worth the effort.

references

1. *FM and Repeaters for the Radio Amateur*, First Edition, American Radio Relay League, 1972, Chapter 9, pages 148-150.

2. "DigiCap VHF Transmitters," Bulletin No. 100-0006-008, June, 1981, Quintron Corporation, Quincy, Illinois 62301.

Peter Bertini, K1ZJH

Invitation to Authors

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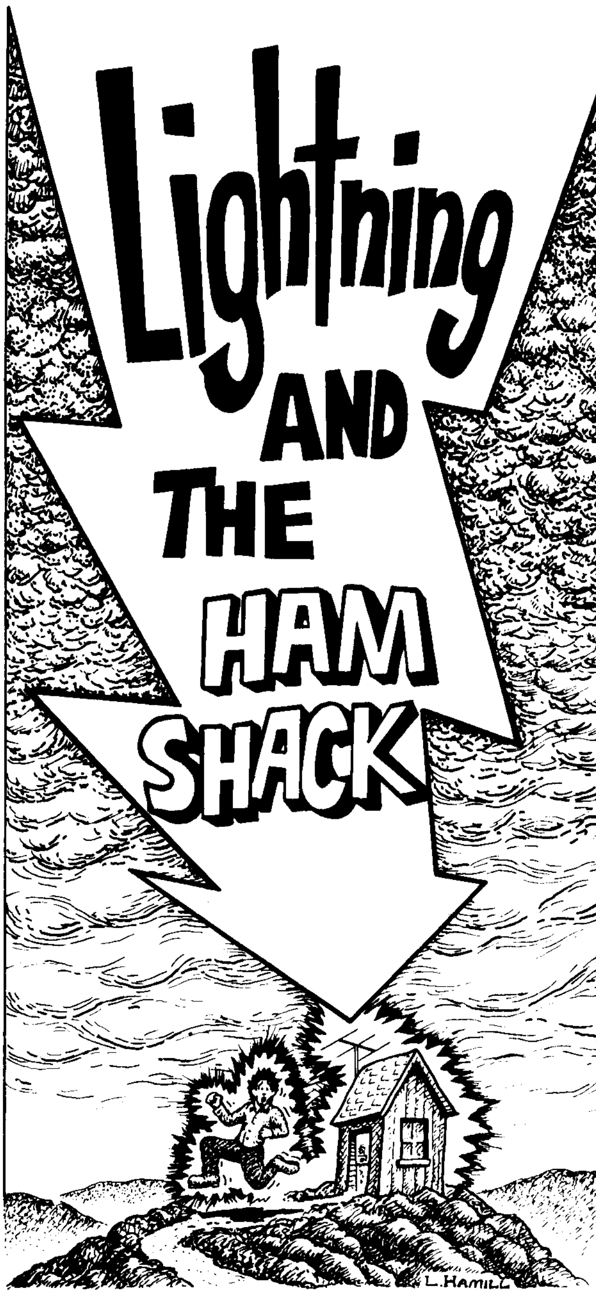

Alpha Delta Transi-Trap™ ceramic gas tube protectors *do* provide effective protection because they were designed and tested to be used with the most sensitive semiconductors. They do this because they fire fast enough, (less than 100 nanoseconds), and at a low enough level to effectively by-pass the typical range of induced currents and voltages. Standard air-gap devices cannot reach this performance level due to variations in atmospheric conditions that will effect conduction of the static charge to ground.

In addition, Transi-Trap™ protectors are the only devices in the industry employing a combination of "fail-safe" isolated ground design and a field replaceable ARC-PLUG™ cartridge. Isolated ground prevents the ARC discharge from flowing to the equipment chassis via the coax shield. "Fail-safe" means the ARC-PLUG cartridge is designed to fail "shorted" instead of "open" in the event of a heavy discharge in excess of its rating. In this event, the equipment is still protected until the cartridge is replaced. Replacement is indicated by a "dead" receiver and high VSWR during tune-up.

Competitve air-gap devices suffer electrode disintegration and fail "open." You will lose your protection and you don't even know it! One competitive gas tube device is designed to melt its solder connections and fail "open" in the event of heavy current flow. The protection is gone, the element is non-replaceable and you still don't know it!

Transi-Trap™ protectors have been thoroughly tested by independent government and military test labs, and have been ordered for use around the world in a number of government and military programs. An Avionics user recently reported that since installing Transi-Trap™ devices, there has been no loss of communications due to induced transients. A leading designer of quality HF and VHF antennas, Butternut Electronics, suggests the use of Transi-Trap protectors in their literature.

A major computer manufacturer has selected MACC Master AC Control Consoles to protect their own systems from AC line transient related damage. This was done after extensive testing of all devices presently available.

Do They Really Work

First, let's settle one issue. Most storm damage comes from either voltage *induced* into the antenna from a near-hit lightning strike (as much as a mile away) or static buildup. No manufacturer claims their device will protect you from a direct lightning hit. That's because there is no standard by which to describe one. Some hits can generate currents of over 100,000 amperes. These might even destroy a house! Others are in the range of hundreds of amperes and may be satisfactorily by-passed to ground through a lightning protector.

Since the chances for damage from induced (non-direct hit) sources are several thousand times greater than direct hits, an effective protector has a definite place in a communications system.

Why Are There Several Different Models

We offer a choice of models to provide the most effective cost/power/frequency/connector combination.

STEP #1: Select your power range. The 200-watt models are the most sensitive to transient pulses and are the best choice for *receivers* and *transceivers*. The 2 kW models are designed for overall station protection and for linear amplifiers.

STEP #2: Select your frequency range. The UHF "T" connector model (LT) offers low insertion loss protection through 30 MHz. The lowest-loss devices are the R-T and HV (typically 0.1 dB at 500 MHz) with UHF-type connectors. The R-T and HV models utilizing type "N" or "BNC" connectors offer even less loss through 1000 MHz! They are perfect for cellular radio and STL operation in the 800 and 900 MHz ranges.

Models available are:

Model LT:	UHF "T" type, 200 W, through 30 MHz........19.95
Model R-T:	UHF connectors, 200 W, through 500 MHz.....29.95
Model HV:	UHF connectors, 2 kW, through 500 MHz......32.95
Model R-T/N:	N connectors, 200 W, through 1000 MHz.......36.95
Model HV/N:	N connectors, 2 kW, through 1000 MHz........39.95

(BNC connectors also available)

The surge protected MACC model is: Model MACC - 8 outlets, and master switch control 79.95. ACTT - wall socket direct plug-in with 2 outlets 29.95.

Alpha Delta Transi-Trap antenna line protectors and MACC Master AC Control Consoles provide more than near-hit lightning protection. They will give you protection to cover all forms of static and transient surges from your antenna to your power line — at an attractive price.

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AA

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current solutions to current problems

a new class of directive antennas

Improve Yagi performance with curved 1.5λ elements

In the May, 1983 issue of *Transactions on Antennas and Propagation*,[1] Chang and Cheng introduced a new class of antennas that appear to offer much promise for VHF use. Based on concepts developed earlier by F. M. Landstorfer,[2] these antennas feature curved elements, each longer than a wavelength and shaped to compensate for the reversals in phase that occur each half wavelength along an element.

With the 1.5 wavelength elements in the classic reflector-driven-director configuration used in the original experiments Landstorfer claimed gains of 11.5 dBi. The same gain in a conventional Yagi using straight half-wave elements would require about nine elements and a much longer boom. While the new design requires greater width, the combination of gain, short boom length, and mounting simplicity form the attractive features of the design.

principle of operation

The general concept and plan of these antennas is shown in **fig. 1**. The center part of the elements resembles a V radiator. The phase center of the V radiation lies along the center axis, and some distance from the apex of the V. A wave radiated from this section will arrive at the other element parts after a time delay that corresponds to a phase rotation. As a result, even though the outer sections are out of phase with respect to the center section, the delayed wave will be at least partly in phase with the waves radiated by the outer sections. This addition of wave components accounts for the increase in gain over a conventional straight-element Yagi.

The design problem presented by these antennas is to determine the shaping of the elements for maximum gain. This subject was addressed by Chang and Cheng in their article.[1] They approximate the current distributions on the array elements by the method of moments, dividing each element into 22 sections and analytically determining the shaping for maximum gain. The computations are extensive, involving a 63 by 63 complex matrix manipulation (a solution requires

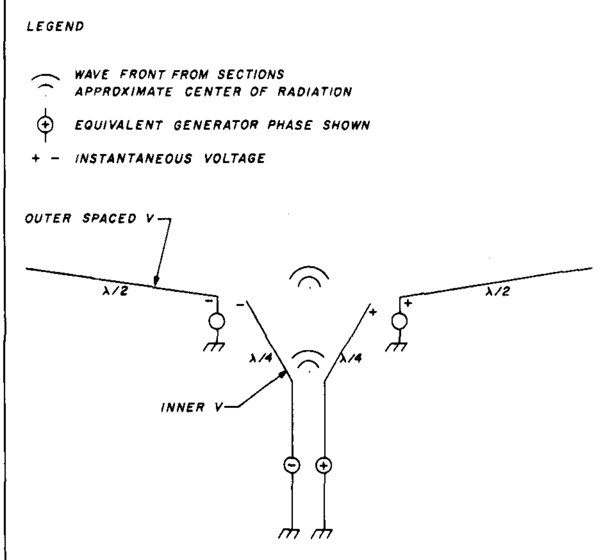


fig. 1. General principle of operation using a shaped element. The center of radiation of the outer half-wave sections is in front of the radiation center for the center section, giving both a spacing and a phase difference, as in the ZL-Special. The outer sections may be separately excited, as shown, or joined to the center part. This illustration assumes that the middle half-wave section is center-fed.

By R. P. Haviland, W4MB, 1035 Green Acres Circle, No., Daytona Beach, Florida 32019

```
READY.


10 REM HIGH GAIN YAGI "HGAINYAGI", IN COMMODORE SIMONS BASIC
20 REM R P HAVILAND,6 JUNE 1984
30 REM REFER TO TRANS IEEE AP-31,MAY 1983
40 PRINT "{CLR}"
50 DIM A(3),B(3),C(3),D(3),Z(3)
60 DIM Y(20,4)
70 A(1)=.38:A(2)=.395:A(3)=.364
80 B(1)=20.77:B(2)=53.014:B(3)=204.532
90 C(1)=-.162:C(2)=0:C(3)=.151
100 D(1)=.645:D(2)=.59:D(3)=.55
110 INPUT "PRINTOUT,Y OR N  ";T$
120 PRINT"PRESS SPACE TO END SCREEN DISPLAY"
130 PRINT "ENTER FREQUENCY, MHZ ";
140 INPUT F: LAMDA= 984/F
150 PRINT F: PRINT"ELEMENT LENGTH= ";1.5*LAMDA;" FEET"
160 PRINT "ELEMENT DIAMETER ";12*LAMDA/100;" INCHES"
170 FOR N=1 TO 20: FOR M= 3 TO 1 STEP -1
180 X=(N-1)/20
190 IF X>D(M) THEN Y(N,M)=0:GOTO 220
200 Y(N,M)=A(M)*(1-1/(1+B(M)*X*X))+C(M)
210 Y(N,4)=X
220 NEXTM:NEXTN
230 PRINT"Y VS X COORDINATES, INCHES"
240 PRINT"X";TAB(10);"DIR";TAB(20);"ANT";TAB(30);"REF"
250 FOR N=1 TO 20
260 X=INT (1200*LAMDA*Y(N,4))/100
270 FOR M=1 TO 3
280 Z(M)=INT (1200*LAMDA*Y(N,M))/100
290 NEXT M
300 PRINT X;TAB(10);Z(1);TAB(20);Z(2);TAB(30)Z(3),
310 NEXT N
320 WAIT 197,32
330 IF T$="Y" THEN HRDCPY
340 HIRES 0,1
350 FOR M=1 TO 3:FOR N=2 TO 16
360 T=N-1
370 IF Y(N,M)=0 GOTO 400
380 LINE 160-200*Y(T,4),200*Y(T,M)+40,160-200*Y(N,4),200*Y(N,M)+40,1
390 LINE 160+200*Y(T,4),200*Y(T,M)+40,160+200*Y(N,4),200*Y(N,M)+40,1
400 NEXT N:NEXT M
410 IF T$="Y" THEN COPY
420 WAIT 197,32:NRM

READY.
```

fig. 2. Computer program provides dimensions of a three-element version of the shaped element array. While the program is written in Simons' BASIC for the Commodore 64, translation for other computers should not be difficult.

approximately 40 minutes of DEC-10 computer time). The problem is far beyond the capability of home computers.

program listing aids 3-element design

Fortunately, Chang and Cheng have summarized their results in such a form that makes it possible to duplicate their optimized design for a three-element Yagi array. For convenience, the results have been arranged as a computer program, **fig. 2**, written in Simon's BASIC for the Commodore 64. The program is written for easy translation to other versions of BASIC; only the graphic generation section may require a complete rewrite.

ELEMENT LENGTH= 10.109589 FEET
ELEMENT DIAMETER .808767123 INCHES
Y VS X COORDINATES, INCHES

X	DIR	ANT	REF
0	-13.11	0	12.21
4.04	-11.59	3.73	22.17
8.08	-7.82	11.06	31.98
12.13	-3.32	17.37	36.39
16.17	.84	21.7	38.44
20.21	4.25	24.53	39.51
24.26	6.92	26.41	40.13
28.3	8.96	27.68	40.52
32.35	10.52	28.57	40.77
36.39	11.72	29.22	40.95
40.43	12.66	29.7	41.08
44.48	13.41	30.07	41.18
48.52	14	0	0
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0

fig 3A. Tabular output of the computer program for a frequency of 147 MHz. X and Y are normal Cartesian coordinates. The 0's indicate that the end of the element has been passed. These values may be scaled for other frequencies.

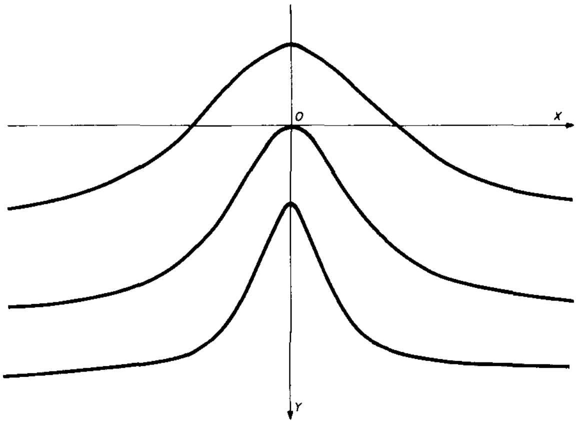


fig. 3B. High resolution computer plot of the data of fig. 3A, showing the center line of the elements. Although each element is 1.5 wavelength long, the shaping makes the reflector appear longer and the director shorter than the radiator.

The program first determines whether hard copy is needed, then requests its only input, the design frequency. Element length and diameter are then outputted, followed by a table of X, Y values that define the center-line position of each element. The feedpoint, or center of the radiator is taken as the coordinate origin. **Figure 3A** shows the screen presentation (the ending 0's indicate that the end of the element has been passed). Pressing the space bar produces a plot of the lines defining the element centers, as shown in **fig 3B**. Pressing the space bar again either initiates a hard copy or terminates the program.

The general resemblance of this type of antenna to a conventional Yagi is apparent in the figures. The element shaping causes a taper towards the forward direction, even though the elements are the same length. And the deep V of the director gives an effective wide spacing for the director.

high gain is achieved

The performance of this optimized design is very good. According to Chang and Cheng,[1] gain calculates to be 11.8 dBi. Beamwidth is 32 degrees in the element plane, and 62 degrees at right angles to it. Front-to-back ratio is just less than 15 dB in both planes. Feed impedance of the 3/2 wavelength radiator is calculated to be 14 + j33 ohms.

It should be noted that the design values are optimum only for the element diameter given. This was arbitrarily set at 0.01 wavelength by Chang and Cheng. Performance should not be greatly affected by a reasonable change in element diameter.

Because of the complexity of the required calculations, and the many hours of mainframe computer time necessary to perform them, it is unlikely that there will be much further analysis of the type. Further work will have to be experimental. None has been attempted by the author, but it would seem that additional gain could be secured by placing additional directors of similar shapes in front of the present single director, using appropriate spacings. It would also seem that any of the common matching methods would be usable. Stacking spacing rules of high-gain Yagi type would appear necessary.

conclusion

Those who do not have a computer available, or who wish to avoid the tedium of typing in the program, can use these results by simple frequency scaling. All table dimensions should be multiplied by the ratio, 147/new frequency, since the table was calculated for 147 MHz. Element diameter and length vary in the same way.

references

1. Chang-Hong Liang and David K. Cheng, "Directivity Optimization for Yagi-Uda Arrays of Shaped Dipoles," *IEEE Transactions on Antennas and Propagation*, AP-31, Volume 31, No. 3, May, 1983, pages 522-525.

2. F. M. Landstorfer, "A New Type of Directional Antenna," *Antennas and Propagation Society International Symposium Digest*, IEEE, 1976, pages 169-172.

ham radio

product REVIEW

RTTY/CW computer interface

Quite a while ago, I quit operating RTTY and retired my old Model 15 because my ham shack wasn't all that soundproof. A few years ago, articles and ads appeared about RTTY computer interfaces. And that meant quiet . . . and no paper! But it wasn't until just a few weeks ago that I finally got an MFJ Model 1224 RTTY/CW Computer Interface Unit. I had a VIC-20, bought for another purpose, and so in less than an hour, I was on RTTY again!

Much of that time was taken finding a power supply to run it. There's a lot of information in the Owner's Manual, but not how much current was needed. A look at the diagram showed only a few chips and transistors. So I took a chance and hooked up a couple of 6-volt lantern batteries and measured it. It turned out to be a little over 200 mA.

specifications

Size: 8.5' W x 6.5" D x 1.5" H.
Power required: 12 volts DC at 250 mA.
Computer: C-64 or VIC-20.
RS-232 interface: available (MFJ-1223).
Software: MFJ-1252 or MFJ-1264 (works with other software).
Accessories supplied: cable with 5-pin plug; 4-pin microphone plug; RCA interface cable.

installation

The unit comes with a cable to connect to the VIC-20 or the C-64. Two clip leads and a Radio Shack cable with RCA phono plugs were used to connect up the audio from the rig. It took a few moments to load the cassette program into the VIC-20 and a few more to get the hang of tuning in the RTTY signal. But right there on the screen was the first RTTY QSO I had "listened" to in years.

operation:

Because the MFJ-1224 doesn't have all the bell and whistles of some of the more expensive units, it takes a little while to get the hang of tuning. Instead of using a 'scope with the familiar "plus" pattern, two LED tuning indicators are used. One is marked "PHASE LOCK" and the other "DATA."

The receiver should be on LSB for receiving RTTY. Most RTTY signals are 60 WPM and 170 Hz shift. Tune from the low tone to a high tone. Watch the phase lock LED. It will flicker and then lock on.

If the station is sending at 60 WPM, the QSO should appear on the screen. If your receiver has an IF shift control, adjust it so the signal is centered in the passband.

switching from RTTY to CW

The RTTY and CW programs are on the same tape. So to switch to CW, you only have to load in the other program, and start tuning. On CW both tuning LEDs flicker with the signal. The MFJ-1224 uses the 2125-Hz RTTY filter in the CW mode. Because 2125 Hz is down the slope of the pass band of most modern-day receivers, IF shift control is almost a necessity for receiving weak CW signals.

transmit

The instructions for using the MFJ-1224 on CW or RTTY transmit are quite complete. Audio Shift is used on RTTY; either Grid Block or Direct Keying can be used for CW.

software

MFJ has software available for both the VIC-20 and the C-64. But they also provide a listing showing the DIP switch positions for most of the other popular RTTY software packages as well. An RS-232 interface (MFJ-1223) is available.

Purchasers of this unit need some experience in RTTY to use it to its full potential, but it is a relatively low-cost way of trying out this mode before leaping in with both feet. The unit *is* well built; I accidentally dropped mine on the basement floor!

For information contact MFJ Enterprises, Box 494, Mississippi State, Mississippi 39762.

—VE3ZL

Circle #302 on Reader Service Card.

NEW products

new 2 meter transceivers from Kenwood

Trio-Kenwood Communications has announced the all-new TM-2570A — the first compact 70-watt, 2-meter FM mobile transceiver — and the TM-2550A and TM-2530A 2-meter FM transceivers. The 25-Series includes many new features never before seen in 2-meter FM equipment. All three models have a bult-in telephone number memory and automatic dialer. Up to 15 seven-digit telephone numbers may be stored.

All front panel controls, including the 16-key DTMF pad, are back-lighted for nighttime visibility. Twenty-three memory channels store frequency, offset subtone, and telephone number. The CTCSS encoder is programmable from the front panel when the optional TU-7 subtone unit is installed. All standard EIA tones are included, plus the Motorola 97.4 Hz tone, for a total of 38 separate CTCSS tones.

Frequencies are entered into either the VFO or memory with direct keyboard entry. The 25-Series includes frequency coverage for MARS and CAP operation and is modifiable to cover 141-151 MHz. Programmable scanning with priority alert and center stop tuning are standard features.

Digital Channel Link (DCL), a revolutionary new signalling concept compatible with Kenwood's Digital Code Squelch (DCS) system, is available as an option. DCL enables the 25-Series radio to automatically switch to an open channel. Practically speaking, this feature will allow you to automatically QSY to an open simplex channel after making initial contact via repeater.

Supplied accessories include a hand-held microphone with up/down frequency controls, DC cable with fuse, mounting bracket, and microphone hanger. Optional accessories include the PS-50 heavy power duty supply for the TM-2570A, PS-430 DC supply for the TM-2550A and TM-2530A, TU-7 38-tone CTCSS encoder, VS-1 voice synthesizer, MU-1 DCL modem unit, SP-50 deluce mobile speaker, SP-40 compact mobile speaker, CD-10 call sign display, SWT-1 compact antenna tuner, and a wide variety of other station accessories.

For further information, contact Trio-Kenwood Communications, 1111 West Walnut Street, Compton, California 90220.

in-line GaAsFET preamp

Hamtronics, Inc. has announced a new low-cost preamplifier designed to be operated in the antenna line of VHF or UHF transceivers. The new model LNS (low noise switching) preamp is patterned after the popular LNG series, which was the first of the affordable GaAsFET preamps on the market. The heart of the unit is a stable, dual-gate GaAsFET amplifier combined with two special low-loss UHF relays, which use gold-plated contacts for long life. A microstrip PC board combines with these special relays for low VSWR on the transmit throughput.

The preamp is switched out of the signal path automatically whenever a transmit signal is present. It may also be remotely bypassed manually as desired. The LNS is designed for base or mobile operation, and mounting brackets are provided to allow tower mounting. The LNS can be used with any transceiver up to 25 Watts; and if a separate PA is used, the LNS can be used between the transceiver and the PA. The preamp works with any mode: FM, SSB, CW, ATV, etc. A delay in the RF sensing circuit prevents relay chatter on SSB or CW.

Typical gain of the preamp is 18 dB and typical noise figure is 0.8 dB. Transmit signal attenuation is only 1/2 dB. An LED indicates when the preamp is active. The unit is housed in an attractive aluminum case only 3-7/8"W x 2-7/8"D x 1-1/2"H.

The LNS Transceiver Preamp is available in the following models:

model	tuning range	3 dB bandwidth
LNS-144	120-150 MHz	± 5 MHz
LNS-160	150-180 MHz	± 10 MHz
LNS-220	200-240 MHz	± 12 MHz
LNS-432	400-500 MHz	± 15 MHz

The price of the LNS Transceiver Preamp is only $68 in kit form and $98 wired and tested.

A complete 40-page catalog describing this and other Hamtronics products is available from Hamtronics, Inc., 65-F Moul Road, Hilton, New York 14468-9535. (Add $1.00 for first-class mailing; for overseas mailing, please send $2.)

new packet video helps get you started

Would you like to learn more about packet radio? Are you having a hard time getting started up in packet? Well, help is on the way, thanks to Kantronics' first instructional video, *Basic Packet*.

In the course of answering service calls and talking to Amateurs around the country, Kantronics — manufacturers of the new KPC Packet Communicator, an AX.25 Version 2.0 TNC — found that many operators were having difficulty getting started on packet. The difficulties were not with the equipment, but rather with understanding the basic operating procedures of packet radio itself.

Conducted by Phil Anderson, WØXI, the video covers basic subjects such as initial installation and hook-up, VHF and HF operation, digipeating, parameter perming, and some command demonstrations. The tape begins in the classroom, then takes you into the shack for on-the-air demonstrations.

The tape is available to individuals and clubs in both VHS and BETA formats. Suggested retail is $22.50 plus $2.50 shipping and handling. Clubs only can receive a $10 refund if the tape is

NEW products

returned within 45 days. Payments can be made by check or credit card (no COD).

For information, contact Kantronics, 1202 East 23rd Street, Lawrence, Kansas 66046.

Circle #301 on Reader Service Card.

CES RepeaterMaker™

Communications Electronics Specialists, Inc. (CES), has announced the availability of the new CES RepeaterMaker, which allows two mobile radios to be used in a repeater configuration. Features include adjustable hangtime, adjustable time-out timer (TOT), "Roger" or courtesy beep, remote repeat inhibit input and front panel switch, auxiliary PTT relay, inputs for half and full duplex autopatch, connections for CTCSS decoder, LEDs for power, COR,and PTT, all in a compact, attractive case. The CES RepeaterMaker is ideal for use in establishing a primary repeater installation or a back-up repeater utilizing conventional two-way mobile radios.

For more information, contact CES, Inc., 803C S. Orlando Avenue, Winter Park, Florida 32789.

Circle #304 on Reader Service Card.

Yaesu in-line SWR meters

Yaesu Electronics Corporation has released two new in-line SWR and Power Meters. The YS-60 measures both average and peak power output, reflected power, and VSWR in the range from 1.6 to 60 MHz. The YS-500 performs the same measurements covering 140 to 525 MHz range. Three functions provide monitoring of either forward or reflected average transmitter output power for CW, AM, FM, and FSK modes, and VSWR for testing the performance of antennas. The efficient linear circuit design assures accurate measurements with minimum insertion loss over the entire specified frequency range, even at low power levels.

For further information, contact Yaesu Electroncis Corporation, 17210 Edwards Road, Cerritos, California 90701.

Circle #303 on Reader Service Card.

87 STAR for Mac, IBM

Circuit Busters' popular RF and microwave analysis and optimization program, STAR, is now available for the Apple Macintosh and the IBM PC/XT/AT/Jr with floating point coprocessor. The Macintosh version works with either the 128 or 512K machine and the Imagewriter

NEW products

printer. 87STAR for the IBM PC/ST/AT requires the 8087 or 80287 coprocessor, but runs six to seven times faster than the earlier version. 87STAR includes the older version for users who don't have the coprocessor yet installed.

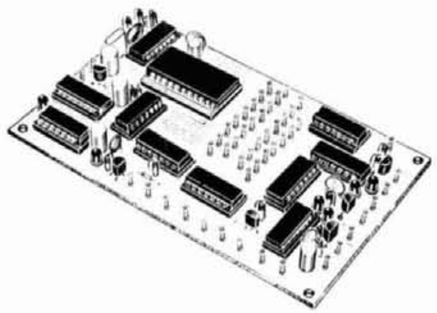
STAR is still available for the Apple II +, IIc and IIe, the Commodore 64, and the Kaypro 2/2X/4/10 CP/M 2.2. 87STAR is priced at $195.00; all other versions are priced under $100.00.

For information, contact Circuit Busters, Inc., 1750 Mountain Glen, Stone Mountain, Georgia 80087

Circle #305 on Reader Service Card.

tone decoder controller module

The new TD-2 DTMF decoder/controller from Hamtronics introduces many new and advanced features. The heart of the TD-2 is a new central-office grade, 16-digit, crystal-controlled DTMF decoder chip with built-in filters to prevent falsing on noise or voice signals. Reliable operation is maintained for any audio input level from 100 mV to 2V p-p. Low power consumption is made possible by use of CMOS circuitry throughout. Power consumption is only 15mA, and the module operates on 10 to 15VDC, with an on-board regulator.



The TD-2 provides five latching on-off functions and up to 12 momentary outputs. This means, for example, that you can control a repeater and autopatch, three other latching functions such as sub-audible tone activation, and several momentary functions. Latching outputs can drive solid-state circuits directly, sinking up to 50mA, or they can drive small relays to switch power loads. The 12 momentary outputs provide a standard 5V logic output.

Codes are easily changed with jumpers; there are no program plugs to replace or eproms to burn. For each function, you have the choice of using a high-security four-digit password or a convenient single-digit command. The TD-2 can be used with any tone source, including radio receivers and telephone lines (with autopatch board). When used with an autopatch, the TD-2 has a built-in "0" and "1" toll call restrictor at no extra charge. A data strobe output, used with the autopatch module, prevents retransmission of confidential control tones.

The TD-2 is suitable for remote control of repeaters, autopatches, and subaudible tone decoders; for selective calling, industrial control, telemetry, computer interface, and other applications. LEDs indicate latch circuits automatically reset to default values on power up. The size of the double-sided PC board is only 3 x 5 inches, so it fits in easily with other equipment.

The TD-2 sells for $110 in kit form and $160 wired and tested. Full documentation is provided with helpful application data.

A complete 40-page catalog of Hamtronics products is available for $1.00 from Hamtronics, Inc., 65-F Moul Road; Hilton, New York 14468-9535. (For overseas mailing, please send $2.00)

new signalling concept

A revolutionary new selective calling/selective linking system has been developed by Kenwood for Amateur Radio use. Called Digital Channel Link, or DCL for short, its many features include automatic connection, frequency recall, vacant channel location, and selective calling of individual transceivers or groups of transceivers.

Here's how it works: the DCL system searches for an open channel, remembers it, returns to the the original frequency and transmits control information to the DCL-equipped station that switches both transceivers to the open channel. High speed digital information allows the whole process to take only an instant.

In addition to this selective linking feature, DCL can also be used for selective calling, similar to Kenwood's DCS system: a five-digit code group is sent which opens squelch on a DCS transceiver with the matching code. Additionally, a six-character burst of ASCII is sent. Station call signs are normally programmed into this ASCII portion. The CD-10 Call Sign Display unit, which can be used with any receiver, may be used to display the transmitted DCS or DCL (ASCII) call sign. The CD-10 can store up to twenty incoming call signs for monitoring and logging purposes.

The digital Channel Link system should add more convenience to repeater operations. Using DCL, it becomes a simple matter to QSY to an open simplex channel after making initial contact via repeater.

For details, contact Trio-Kenwood Communications, 1111 West Walnut Street, Compton, California 90220.

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BACK ISSUES HR Oct 71 thru Dec 81. 72-77 in binders. $65. VE3BJY, B. Brenko, 2 Vista Dr., Foothill, Ontario L0S 1E0

DIGITAL AUTOMATIC DISPLAYS. All transceivers. Six 1/2" digits. 5" wide x 1-1/4" cabinet! Send $1.00 for information. Receive a $25.00 discount. Grand Systems, POB 2171, Blaine, Washington 98230.

WANTED: Service and operating manual for Gonset GSB-100 model 3233 transmitter. Also wanted a Viking Challenger transmitter that is complete. Fadden, Box 1223, Blaine, WA 908230.

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IMRA, International Mission Radio Association helps missionaries. Equipment loaned. Weekday net, 14.280 MHz, 2-3 PM Eastern. Eight hundred Amateurs in 40 countries. Brother Frey, 1 Pryer Manor Road, Larchmont, New York 10538.

RUBBER STAMPS: 3 lines $4.50 PPD. Send check or MO to G.L. Pierce, 5521 Birkdale Way, San Diego, CA 92117. SASE brings information.

ELECTRON TUBES: Receiving, transmitting, microwave... all types available. Large stock. Next day delivery, most cases. Daily Electronics, PO Box 5029, Compton, CA 09224. (213) 774-1255.

IBM-PC RTTY/CW CompRtty II is the complete RTTY/CW program for the IBM-PC and compatibles. Virtually any speed ASCII, BAUDOT, CW. Text entry via built-in editor! 10,000 character transmit/receive buffers. Adjustable split screen display. Instant mode/speed change. Hardcopy, diskcopy, break-in buffer, select calling, text file transfer, customizable full screen logging, 24 programmable 1000 character messages. Now with WRU (simple mailbox). Ideal for MARS and traffic handling. Requires 128k PC, XT, AT, PCjr, PC-DOS, serial port, RS-232C TU. $65. Send call letters (including MARS) with order. David A. Rice, KC2HO, 7373 Jessica Drive, North Syracuse, NY 13212.

CUSTOM MADE EMBROIDERED PATCHES. Any size, shape, colors. Five patch minimum. Free sample, prices and ordering information. Hein Specialties, Inc., Dept 301, 4202 N. Drake, Chicago, IL 60618.

RECONDITIONED TEST EQUIPMENT $1.25 for catalog. Walter, 2697 Nickel, San Pablo, CA 94806.

PRINTED CIRCUIT BOARDS and kits for QST articles. Call or write for information. A&A Engineering, 7970 Orchid Drive, Buena Park, CA 90620. (714) 521-4160.

PACKET/ASCII/BAUDOT/CW for IBM-PC. SASE to: Emile Alline, 773 Rosa, Metairie, LA 70005.

WANTED NC400 receiver. Any condition. W2PUA, 112 Tilford Road, Somerdale, NJ 08083. (609) 783-4175

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DISCOUNT CABLE TELEVISION EQUIPMENT. We have IN STOCK complete systems for Hamlin, Oak, Jerrold and other cable systems. Please send for a free information package—it could save you big money on your purchase of these and other CATV items. Easy View, PO Box 221, Arlington Heights, IL 60006 (312) 952-8504. Ask for Rudy Valentine.

HAPN (Hamilton and Area Packet Network) announces the availability of a packet radio terminal node controller (TNC) on a card that plugs into a slot in an IBM-PC or compatible computer. Card contains terminal node controller and 1200 baud 202-type modem. Card available as bare board ($75 US) or assembled and tested unit ($199 US). AX.25 software included with each order. For order outside N.A. please add $3.00. For information/orders: HAPN, Box4466, Station D, Hamilton, Ontario, Canada L8V 4S7.

CHASSIS and cabinet kits. SASE K3IWK, 5120 Harmony Grove Road, Dover, PA 17315.

ELECTRON TUBES Radio, TV & Industrial Types- Huge Inventory.Send for 80% off tube listing. Call Toll Free (800) 221-5802 or write Box HR, Transleteronic, Inc., 1365 39th Street, Brooklyn, NY 11218 (718) 633-2800.

WORLD TOP BAND Frequency Allocations Listing. Handy "Top Band" operating and contains all currently available CW and SSB allocations for countries on ARRL DXCC list. (317 total, 10 no authorization, 61 no information available). Also includes QST sent/received column for keeping track of cards. $5.50 USA, Canada and Mexico. $7.50 elsewhere. Dennis Peterson, N7CKD, 4248 A Street SE, Space 609, Auburn, WA 98002.

WANTED: Heath Curve Tracer IT-3121 kit/assembled. Mission School needs 10 units. Call Manila, P.I. 832-1773 or write Mission POB 1651 MCC Makati MM, P.I.*FM3 SALE: HW101 with power supply - manual. Best offer over 150. Single bander (20m) offer. Both prof. wired. Excellent condition. W2PUA, 112 Tilford Road, Somerdale, NJ 08083. (609) 783-4175.

CAPS with call/handle. Mesh or foam backs. 12 colors/white fronts; brown/tan. Mens/ladies styles. $7.50 net. CERAMIFUN 315—11th Street, Ramona, CA 92065 (619) 789-4730. Visa/MC accepted. Quantity rates to clubs.

FOR SALE: Knight 50W transmitter. Matching VFO. 10-80 meters. $75.00. Collins Type 32V Transmitter $250.00. Donald M. Cox, 318 Park Blvd., Orange Cove, CA 93646. (209) 626-4219.

ELECTRONIC COMPONENTS Resistors, any value/quantity (minimum 20/value). 1/4 watt $.01@, 1/2 watt $.02@—$1.25 shipping. Quantity discounts, 1,000+. Send wattage(s), value(s) quantity(s) and remittance. Capacitors—50V Ceramic Disk, all values $.10@, minimum order $1.00—$1.25 shipping. T.O.R.C.C.C. Electronics, Box 47148, Chicago, IL 60647 (312) 342-9171.

CLEANING out Ham Shack. 35 years of receivers, transmitters, accessories, tubes and parts. Send SASE for 6 page list. W9VZR, 4627 North Bartlett Avenue, Milwaukee, WI 53211.

REPEATER FOR SALE: Spectrum model SCR-1000 2 meter, 2-1/2 years old, freshly factory reconditioned and upgraded. John L. Hackman, WB4VVA, PO Box 194, Mount Pleasant, MI 48858.

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RIW-19 432 MHz beams by K3IPW. SASE for information.

COMING EVENTS

Activities — "Places to go . . ."

CALIFORNIA: Flea Market/Boneyard Sale. Foothill College, Los Altos Hills. March-Sept. 2nd Saturday of every month. 7 AM Sellers. 7:15 AM buyers. Talk in 145.27(-) or 147.570 simplex. FCC exams (408) 255-9000.

GEORGIA: The 7th annual Lake Hartwell Hamfest, sponsored by the Anderson, Hartwell and Toccoa Amateur Radio Clubs. May 17 and 18, Lake Hartwell Group Camp, Hwy 29, Hartwell. Free admission, free camping and free flea market space. Activities for the entire family. For information: Merrick A. Counsell, W2BNS, 215 Nottingham Way, Anderson, SC 29621.

ILLINOIS: The Starved Rock Radio Club Hamfest, June 1, Princeton. Same place as last year. SASE please for complete registration materials, map, etc. SRRC, W9MKS, RFD 1, Box 171, Oglesby, IL 61348 (815) 667-4614

OHIO: The Medina County Hamfest, May 11, Medina County Community Center Building, 735 Lafayette Rd., Medina. Sponsored by the Medina 2 Meter Group. 8 AM to 2 PM. Building and flea market setup 6 AM. Tickets $3.50 advance, $4.00 at the door. Tables $6.00. Flea market space $4.00. Talk in on 147.63/03, K8TV/R. For tickets, table reservations: PO Box 452, Medina, Ohio 44258. (216) 725-4492 or (216) 769-3033.

ILLINOIS: The Moultrie Amateur Radio Klub Hamfest, April 20, Coles County Airport, Mattoon. Contact MARK, PO Box 79, Sullivan, IL 61951.

CALIFORNIA:FCC exams, Novice-Extra. Sunnyvale VEC ARC. (408) 255-9000 24 hour. 73, Gordon, W6NLG, VEC

OHIO: The all new 17th Annual B*A*S*H — New Location, new entertainment, new food — will be held on Friday night of the Hamvention, April 25, 1986. The new location is in the Conference Center at the HARA Arena and Exhibition Center, (the same location as the Hamvention) starting at 7 PM. There is no admission charge, and free continuous entertainment. Food and beverages available. Two exciting top awards, and many others. Stay right at HARA when the Hamvention closes on Friday evening and meet your friends and join us for an evening of fun and entertainment. Sponsored by the Miami Valley FM Association, POBox 263, Dayton, Ohio 45401.

OKLAHOMA: The Great Plains ARC's 5th annual Northwest Oklahoma Eyeball & Swapmeet. Sunday, April 13, 9 AM, Mooreland. Admission $2.00 at door. Dealer and swap tables available no charge. VE tests Saturday, April 12. Campsites available. Talk in on 147.72/12, 146.13/73 and 146.52 simplex. For information: (405) 994-5394 or 994-5453. Write: NR5L, Gordon Richmond, Rt. 1, Box 12, Mooreland, OK 73852 or N5CCV, Gerald Bowman, Box 356, Mooreland, OK 73852.

COLORADO: The Aurora Repeater Association will hold its annual ARA Swapfest, Sunday, April 27, National Guard Armory, 55 S. Potomac, Aurora, 8 AM to 3 PM. Tables, raffle, FCC exams. For information: Aurora Repeater Assoc., PO Box 31043, Aurora, CO 80041 or call John(303) 344-1915.

INDIANA: *The third annual Columbus Amateur Radio Club* Swapfest, Saturday, April 5, 9 AM to 5 PM, 4H Fairgrounds, SR 11 South, Columbus. Talk in 146.79 repeater. For reservations: Chuck Roberts, 2950 S. Lake Drive, Columbus, IN 47203.

NEW JERSEY: TCRA Hamfest Tri-County Radio Association, Sunday, May 4, Passaic Valley Community Center, off Valley Road, Stirling. 9 AM to 3 PM. Tables $7. AC $10. Registration $2. *Limited tailgating by reservation only. All* reservations W2EUF, Dick Franklin, Box 182, Westfield, NJ 07090. (201) 232-5955.

OHIO: The Portage Amateur Radio Club's Hamfair, Sunday May 18, Randolph Fairgrounds, Ravenna. Gates open 6 AM for dealers. 7:30 for public. Indoor/outdoor flea market. ARES, ARRL, DX, packet and computer forums. Tickets $3.00 advance, $3.50 at the gate. Mobile check in 144.79/145.39 repeater. For tickets send check and SASE to PARC, c/o Joanne Solak, KJ3O/8, 9971 Diagonal Road, Mantua, Ohio 44255. For information call (216)274-8240.

LOUISIANA: BRARC Hamfest, May 3 and 4, Baton Rouge. Free admission. VE exams Saturday and Sunday, 8:30 AM. 30 day advance registration. Send SASE, Form 610 and check for $4.25 payable to ARRL/VEC to George Perry, W5LVX, 17424 Lady Constance, Greenwell Springs, LA 70739. Some walk-ins. For further info SASE to Rick Pourciau, NV5A, 879 Castle Kirk, Baton Rouge, LA 70808.

ARKANSAS: The Northwest Arkansas ARC will hold its 6th annual Hamfest, Saturday, May 3, Rogers Youth Center, 315 W. Olive Street, Rogers, AR. 8 AM to 4 PM. Exhibitors and flea market tables $2.00 per space. Doors open 6 AM for exhibitors only. General admission free. Talk in on 16/76, 63/03 and 52 simplex. For more information: Roy Milliren, AF5W, 2014 S. 16th Street, Rogers, AR 72756.

CALIFORNIA: The Fresno Amateur Radio Club will hold its 44th annual Hamfest, May 2, 3 and 4. Airport Holiday Inn. FCC exams will be given. DX and Emergency programs. Forums and demonstrations. Talk inon 146-34-94. For information: Harry H. Billings, Fresno ARC, PO Box 783, Fresno, CA 93712. (209) 268-6314.

INDIANA: The Putnam County Amateur Radio Club's 4th annual Hamfest and Auction, April 12, Putnam County Fairgrounds, north of Greencastle. Setup time 6:30 AM. Doors open to public 8:00 AM. Auction 1:00 PM. Admission $3.00. Children under 12 free. Flea market tables $3.00 each. Your tables $2.00 each. Talk in 147.33/93. For information or table reservations SASE to Kent Douglas, K9JCR, RR4 Box 586, Greencastle, IN 46135 (317) 672-8237 or Nick Aubrey, N9FCB, RR2, Box 592, Greencastle, IN 46135 (317) 653-5290.

MISSOURI: The PHD Amateur Radio Assn.'s annual State ARRL Convention, April 11-13, old Kansas City Airport, north of downtown KC. Registration $4.00 (good for all 3 days). Swap tables $10.00, includes one registration. Saturday night banquet $10.50 by advance registration. VE exams. Talk in on 34/94 repeater. For information/registration: PHD Amateur Radio Assn, Inc., PO Box 11, Liberty, MO 64068-0011 (816) 781-7313 or 452-9321.

WISCONSIN: The Ozaukee Radio Club's 8th annual Cedarburg Swapfest, Saturday, May 3, 8 AM to 1 PM, Circle B Recreation Center, Highway 60 and County I, Cedarburg. Admission $2.00 advance, $3.00 at the door. 4' tables $3.00 each. Sellers setup 7 AM. For tickets, table reservations or more info SASE to ORC Swapfest, 101 E. Clay St., Saukville, WI 53080.

NEW YORK: The Suffolk County Radio Club's Indoor/Outdoor Flea Market, Sunday, May 4, 8 AM to 3 PM, Republic Lodge No. 1987, 585 Broadhollow Road, Melville, LI. General admission $2.00. Wives and children under 12 free. Indoor tables $7.00. Outdoor space $5.00. Each includes one admission. Talke in on 144.a61/145.21 and 146.52. For more information: Bill Sullivan, N2ETG (516) 689-9871 evenings.

NEW YORK: Manhattan's Quarterly Computer Show and Electronic Flea Market, April 5, 10 AM to 4 PM, Christ Church Auditorium, Park Avenue and East 60th Street. And, again on April 26, 10 AM to 4 PM, St. Anthony's Church Community Hall, Sullivan and Houston Streets. Admission to each show $2.50. *For more information:* Mr. Johnson, Public Domain Software Copying Company, 33 Gold Street, New York, NY 10038. (212) 732-2565.

NORTH CAROLINA: Raleigh, the City of Oaks and the Raleigh Amateur Radio Society presents the 14th annual RARS Hamfest, NC State ARRL Convention and Computer Fair, Jim Graham Building, NC State Fairgrounds, Hillsborough Street. Advance registration $3.50 until April 7. $5.00 at the door. Flea market space, one table and 2 chairs (ours only) $6.00 each. FCC exams by pre-registration prior to April 1. Contact John Johnson, WM4P *direct. Free welcoming party in Graham Building* Saturday night, 7 – 10 PM. Wouff Hong Ceremony. Talk in 04/64 and 28/88. For more information: Rollin Ransom, NF4P, 2447 Fairway Drive, Raleigh, NC 27603. (919) 779-5021.

MASSACHUSETTS: The 12th annual ECARA Flea Market, April 27, 10 AM to 2 PM, 200 Sportsmen's Club, Sutton Road, Webster. Tables $5.00 advance; $7.00 at the door. Admission $2.00. Free parking. For information: Tom Francis, KB1SP (617) 743-7283. Dick Spahl, K1SYI (617) 943-4420. Don Amirault, K1APE (203) 923-2727.

MASSACHUSETTS: The Montachusett Amateur Radio Association will hold an indoor flea market, Saturday, April 26, Knights of Columbus Hall, Electric Avenue, Fitchburg. 9 AM to 3 PM. Admission $1.00. Reserved tables $8.00 advance. $10.00 at the door. Refreshments and free parking. Doors open 8 AM for sellers. Talk in on 144.85/5.45 and 52 simplex. For table reservations send check payable to MARA, c/o Jim Beauregard, KB1AY, 7 Mountain Avenue, Fitchburg, MA 01420.

MASSACHUSETTS: Tailgate High Tech, computer and Amateur Radio Flea Market, Sunday, April 20, 10 AM to 4 PM, Albany and Main Street, Cambridge. Admission $1.50. Sellers $5 per space includes 1 admission. Setup 9 AM. Talk in 146.52 and 449.2/444.2, W1XM/R. For space reservations or further *information: Jamie (617) 262-5090 or 253-2060. Sponsored by* the MIT Electronics Research Society and W1XM/R.

PENNSYLVANIA: The 4th annual Southern Aleghenies Hamfest, Sunday, April 13, 7 AM to 4 PM, Bedford County Fairgrounds, Bedford. Sponsored by the Horseshoe Radio Club, Blue Knob Repeater Assn, Bedford Co. ARC, Mountain ARC and Somerset Co. ARC. Admission $3.00. Tailgating available. Reserved inside tables. Refreshments and a consignment auction. Talk in on 145.49/89, 444.2/9.2 and 146.52 simplex. For information: Gay Rembold, W3DFW, 949 Winifed Rd, Cumberland, MD 21502 (301) 724-0674 or (814) 445-7486.

NEW HAMPSHIRE: Deerfield. The Hosstraders will present their Spring Tailgate Swapfest, Saturday, May 10 at Deerfield, NH Fairgrounds. Admission $2 per person; no extra charge for sellers. Friday night camping at nominal fee, but no entry before 4 PM Friday. Profits benefit Shriners' Hospital. Last year's gift: $11,754.46. Talk-in 146.40-147.00. New England's biggest Hamfest is sponsored by Bob, W1GWU, Joe, K1RQG, and Norm, WA1IVB. For map SASE to WA1IVB, RFD Box 57, West Baldwin, ME 04091.

MASSACHUSETTS: The MIT UHF Repeater Association and the MIt Radio Society offer monthly Ham Exams. All classes Novice to Extra. Wednesday, April 23, 1986,7 PM, MIT Room 1-134, 77Mass Ave, Cambridge, MA. Reservations requested 2 days in advance. Contact Ron Hoffmann (617) 253-5820/646-1641 or Craige Rodgers at 225-6616. Exam fee $4.00. Bring copy of current license, 2 forms of picture ID and completed form 610 (available from FCC in Boston. 223-6609).

OPERATING EVENTS

"Things to do . . ."

ARMED FORCES DAY: In recognition of the 37th anniversary of this event, Amateur Radio Station W4ODR, located Northside aboard Naval Air Station Memphis, Millington, Tennessee, will be operated by sailors and Marines on Saturday, 17 May from 1400Z to 220Z. For information on W4ODR, NAS Memphis contact: Station Custodian, Chief Petty Officer Bob Donan, KA4FAL, (901) 872-2007.

QRP ARCI Spring CW Contest, April 19 to April 20. For information Eugene Smith, KA5NLY, Chairman, POBox 55010, Little Rock, AR 72225.

ATLANTA, GA: The Metro Atlanta Telephone Pioneers ARC will operate W4OTA, April 18-20 to help celebrate A Taste of Atlanta 1986. Telephone Pioneers nationwide are encouraged to participate. For Special Event QSL SASE with log info to MATPARC/Taste of Atlanta, John C.Parker, PO Box 54017, Atlanta, GA 30308.

Groton, CT: The Radio Amateur Society of Norwich (RASON) will operate Croaker Memorial Special Event Station KA1IFG from 1700ZApril 19 to 1700Z April 20 from the submarine USS Croaker to commemorate the 42nd anniversary of its commissioning. Frequencies: SSB—3.890, 21.290. CW—3.730, 7.130, 21.130. QSL with SASE to RASON, PO Box 903,Norwich, CT 06360.

SCHOLARSHIP AWARD: The Atlanta Radio Club is pleased to announce its 1986 scholarship awards program. Two sums of $1250.00 each will be awarded to the winners. Applicants must be licensed Radio Amateurs graduating from high school and entering an accredited college or university as Freshmen for the first time in 1986. Judging is based on school grades, citizenship, ham radio achievements and financial need. For application blanks write: Phil Latta, W4GTS, 259 Weatherstone Parkway, Marietta, GA 30067.

THE FOUNDATION FOR AMATEUR RADIO, INC., a non-profit organization with headquarters in Washington, DC, plans to award 21 scholarships for academic year 1986-87. Licensed Radio Amateurs may apply for these awards if they plan to pursue a full-time course of studies at an accredited university, college or technical school. For additional information and application form send letter prior to May 31, 1986 to FAR Scholarships, 6903 Rhode Island Avenue, College Park, MD 20740.

Derby and District Amateur Radio, incorporating Derby Wireless Club 1911, will be celebrating its 75th anniversary during 1986. The Society plans at least one event per month throughout the year each from a different location with the City of Derby. The callsign to listen for will be GB3ERD.

1986 marks the 50th anniversary of the Greater Cincinnati Amateur Radio Association. A number of special events are planned. Watch for announcements here.

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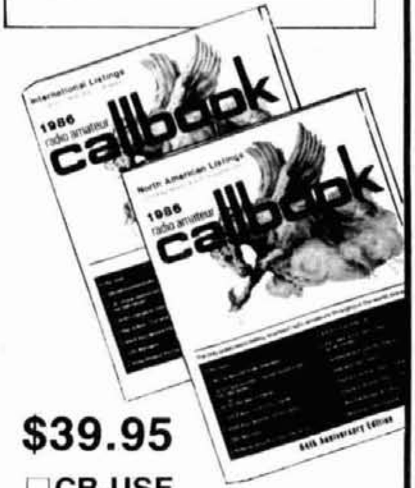

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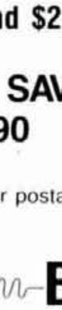

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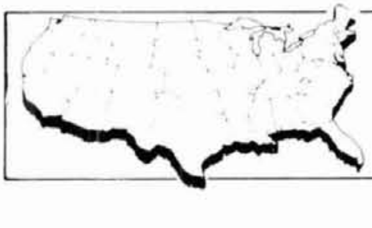

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THE GUERRI REPORT by Ernie Guerri, W6MGI

analog vs. digital — the difference blurs

It wasn't too long ago that the line between analog and digital operators (devices that perform functions in their respective domains) was easily distinguished. We accept the idea that analog functions have an "unlimited" number of steps and that digital functions are easily distinguished by the fact that the function takes place in discrete steps. But what do we really mean by "unlimited" or "discrete?" Well, it turns out that for most analog functions, the "limit" is set by the resolution of the relevant human sense — touch, smell, hearing, etc. But in reality we find that the presumption of a continuous gradient of sensory perception has its limits. The average eye can distinguish between 55 and 75 levels of gray. This means that 6-bit digitizers (64 shades) are all that is necessary to present an image that has appears to have continuous tones. This is well within the capabilities of today's digital techniques, and literally thousands of shades and colors are possible for even the most demanding visual applications such as computer-aided design and engineering.

The same is true for the acoustic domain. Much professional recording is now done with equipment that converts the analog signal to a purely digital form. Because the digital signal has better "resolution" than the human ear, it's a simple matter to process the signal for noise reduction, echo, timbre, and other characteristics that would be nearly impossible to correct in analog form. The result is the splendid performance of compact disks and the spectacular recordings possible with the 16-bit pulse code modulation (PCM) adapters that are available for use with VCRs.

Similar strides are being made in the development of tactile and olfactory sensors and processors. The principal applications for these devices are as enhancements for robots on the factory floor. Digital signal processors, combined with motion controllers that "naturally" respond to digital signals (rather than analog signals) are soon to perform the most delicate human tasks, with significant improvement in repeatability. Reliability and availability are issues yet to be resolved. It may well be that as the level of robot complexity increases, the robots may also get "sick," but in ways we have yet to determine.

A practical application for the newest breed of digital signal processors will be the re-emergence of the picturephone. When the first Bell picturephone was implemented over 10 years ago, it offered only black and white images and was limited by a rather poor ability to transmit motion. (The bandwidth compression technique used at that time was called *conditional replenishment* — which meant that only the portions of the picture that had changed were transmitted.) Processing speed limitations kept the image from having the quality that consumers demanded, and, of course, color images were not available.

The same basic coding scheme is now being used by companies in both the United States and Japan to offer video teleconferencing in full-color motion over standard 56-bit data lines. High-speed digital signal processing chips, combined with some enhancements to the original replenishment scheme, have made the desired results possible at costs that are quite affordable for business applications.

microscope can "see" atoms

Researchers at IBM Laboratories in Switzerland are refining a recently developed technique that permits a scanning microscope to display the individual atoms of a surface structure. The device operates by scanning a very small probe a few atomic diameters above the surface. An electric field proportional to the distance between the probe and the surface is measured and converted to a visual "image" of the surface. Since the field is proportional to the square of the distance, surface characteristics are easily distinguished from background or "noise." The technique can be used in conjunction with other microscopy methods to serve as a magnifier or zoom device. Typical operation requires a few minutes to scan the surface under examination and produce a three-dimensional image of the atomic structure. Because most surfaces are not uniform for a distance of more than a few dozen atoms, the actual area scanned is quite small. This is not a real limitation, however, since the purpose of the device is extreme magnification of very specific features. The device will have special benefit for those who are working at the limits of semiconductor fabrication technology and are seeking to develop the smallest possible features or achieve the highest levels of integration.

ham radio

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- Your patch should sound just like your home phone.
- There should not be any sampling noises to distract you and rob important syllables. The best phone patches do not use the cheap sampling method. (Did you know that the competition uses VOX rather than sampling in their $1000 commercial model?)
- A patch should disconnect automatically if the number dialed is busy.
- A patch should be flexible. You should be able to use it simplex, repeater aided simplex, or semi-duplex.
- A patch should allow you to manually connect any mobile or HT on your local repeater to the phone system for a fully automatic conversation. Someone may need to report an emergency!
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- You should be able to connect a patch to the MIC and EXT. speaker jack of your radio for a quick and effortless interface.
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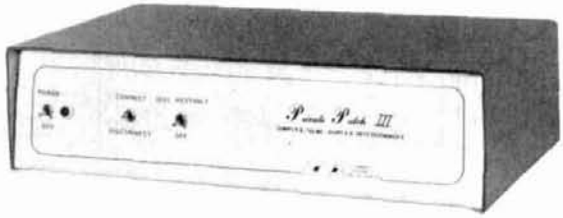

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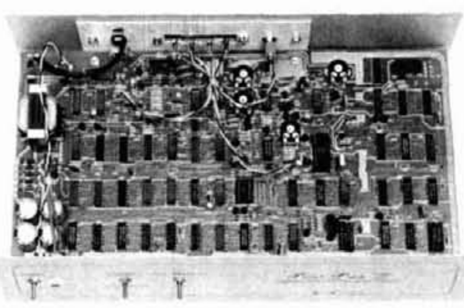

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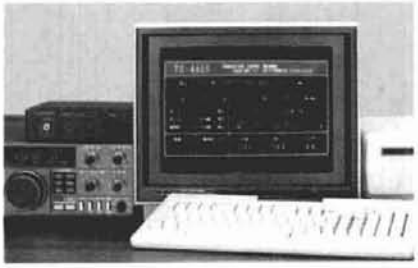

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