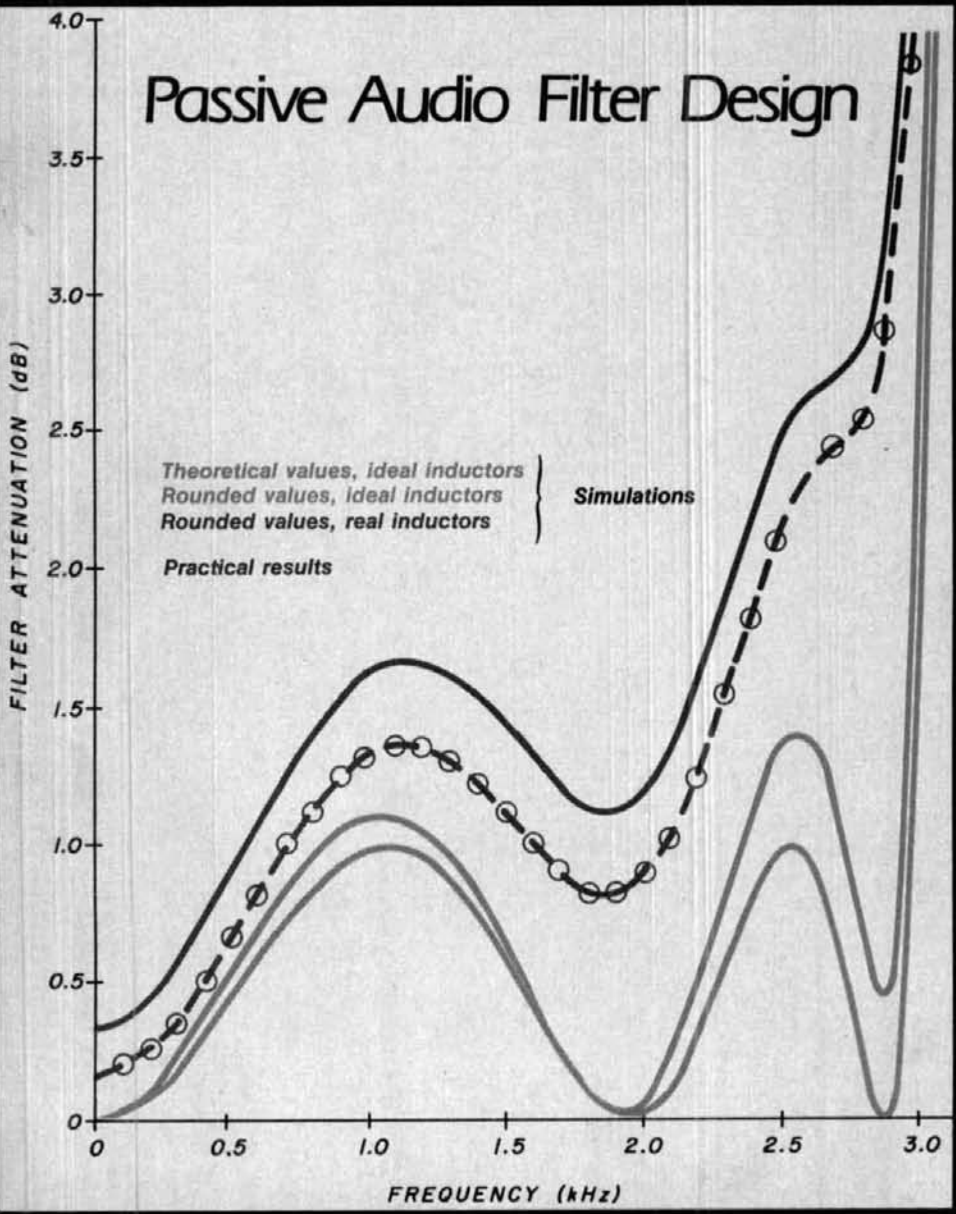
SEPTEMBER 1985 / $2.50

new column:
PRACTICALLY SPEAKING
by Joe Carr, K4IPV

ham radio magazine



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focus on communications technology

- adjusting SSB amplifiers
- understanding telephones
- a DTMF controller for repeaters
- a look at probes
- digital satellite tracker
- carrier-activated CW reception limiter
- simple continuity tester
- plus W9JUV, W6SAI, W1JR, W6MGI, KØRYW

IC-1271A

ICOM 1.2GHz Transceiver

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Explore the world of 1.2GHz with ICOM's new IC-1271A base station transceiver. ICOM has a complete line of 1.2GHz gear to meet your operating requirements...the IC-1271A base station, IC-120 mobile and RP-1210 repeater.

IC-1271A. ICOM introduces the first full-featured 1240 to 1300MHz base station transceiver, the IC-1271A. With 10 watts of RF output power, 32 memories, scanning and multi-mode operation including ATV (amateur TV), the IC-1271A is a pioneer in 1.2GHz technology.

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TV-1200. The interface *unit allows amateur television* (ATV) operation when used in conjunction with a video recorder or a video camera for transmission, and a television monitor for reception. Explore the new facet of amateur radio, "video hamming."

RP-1210. Complete your 1.2GHz system with the RP-1210 repeater. The RP-1210 features PLL frequency selection (198 channel, DIP switch), high stability PLL, repeater access to CTCSS, three digit DTMF decoder for control of special functions, 10 watts, selectable hang time and ID'er.

IC-120. The 1.2GHz mobi[le] transceiver features six memory channels, scanning, an *HM-14 up/down scannin[g]* mic, RIT, LED readout and three tuning rates. Accessori[es] include the ML-12 10 watt amplifier and the PS-45 slim line power supply.

See ICOM's full line of 1.2GHz gear at your local ICOM dealer.

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All stated specifications are approximate and subject to change without notice or obligation. All ICOM radios significantly exceed FCC regulations limiting spurious emissions. 1271A

What To Look For In A Phone Patch

The best way to decide what patch is right for you is to first decide what a patch should do. A patch should:

- Give complete control to the mobile, allowing full break in operation.
- Not interfere with the normal operation of your base station. It should not require you to connect and disconnect cables (or flip switches!) every time you wish to use your radio as a normal base station.
- Not depend on volume or squelch settings of your radio. It should work the same regardless of what you do with these controls.
- You should be able to hear your base station speaker with the patch installed. Remember, you have a base station because there are mobiles. ONE OF THEM MIGHT NEED HELP.
- The patch should have standard features at no extra cost. These should include programmable toll restrict (dip switches), tone or rotary dialing, programmable patch and activity timers, and front panel indicators of channel and patch status.

ONLY SMART PATCH HAS ALL OF THE ABOVE.

Vow Mobile Operators Can Enjoy An Affordable Personal Phone Patch. . .

- Without an expensive repeater.
- Using any FM tranceiver as a base station.

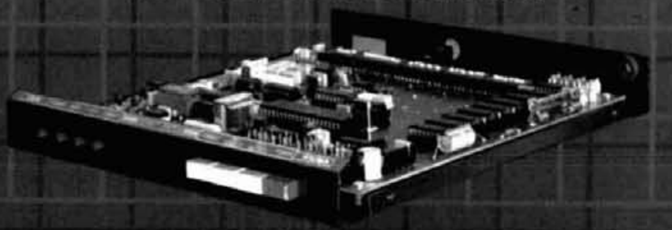
The secret is a SIMPLEX autopatch, The *SMART PATCH.*

SMART PATCH Is Easy To Install

o install *SMART PATCH*, onnect the multicolored omputer style ribbon cable mic audio, receiver iscriminator, PTT, and ower. A modular phone ord is provided for conection to your phone sysm. Sound simple? . . . T IS!

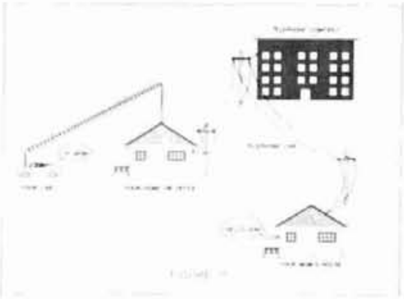
With SMART PATCH You are in CONTROL

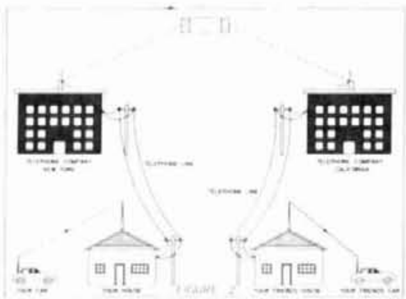
With CES 510SA Simplex Autopatch, there's no waiting for VOX circuits to drop. Simply key your transmitter to take control.



SMART PATCH is all you need to turn your base station into a personal autopatch. SMART PATCH uses the only operating system that gives the mobile complete control. Full break-in capability allows the mobile user to actually interrupt the telephone party. SMART PATCH does not interfere with the normal use of your base station. SMART PATCH works well with any FM transceiver and provides switch selectable tone or rotary dialing, toll restrict, programmable control codes, CW ID and much more.

To Take CONTROL with Smart Patch – Call 800-327-9956 Ext. 101 today.





How To Use SMART PATCH

Placing a call is simple. Send your access code from your mobile (example: *73). This brings up the Patch and you will hear dial tone transmitted from your base station. Since *SMART PATCH* is checking about once per second to see if you want to dial, all you have to do is key your transmitter, then dial the phone number. You will now hear the phone ring and someone answer. Since the enhanced control system of *SMART PATCH* is constantly checking to see if you wish to talk, you need to simply key your transmitter and then talk. That's right, you simply key your transmitter to interrupt the phone line. The base station automatically stops transmitting after you key your mic. *SMART PATCH* does not require any special tone equipment to control your base station. It samples very high frequency noise present at your receivers discriminator to determine if a mobile is present. No words or syllables are ever lost.

SMART PATCH Is All You Need To Automatically Patch Your Base Station To Your Phone Line.

Use *SMART PATCH* for:

- Mobile (or remote base) to phone line via Simplex base. (see fig 1.)
- Mobile to Mobile via interconnected base stations for extended range. (see fig. 2.)
- Telephone line to mobile (or remote base).
- *SMART PATCH* uses SIMPLEX BASE STATION EQUIPMENT. Use your ordinary base station. *SMART PATCH* does this without interfering with the normal use of your radio.

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YES, 180 days of warranty protection. You simply can't go wrong.

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Telephone: (305) 645-0474 **Or call toll-free (800)327-9956**

ham radio magazine

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contents

REFLECTIONS

it can happen to anyone

One of the more pleasurable obligations of working in the Amateur Radio industry is keeping up-to-date on all the latest equipment, accessories, and doo-dads that come along.

One night not too long ago I took one of the newest radios home to do a little informal testing. Like most radios on the market today, this one is loaded with just about every feature you'd want to have. In fact, if it had legs, I guess it would walk the dog in the morning — if I remembered to set the timer the night before. After making up all the cables and installing the radio, I sit down to make its acquaintance. All goes well for the first few minutes . . . signals are strong and the radio operates flawlessly. Until, that is, I decide to QSY to the broadcast band to listen to the local news.

The radio goes dead.

My first reaction is to assume I'd either turned the wrong knob or pushed the wrong button, so I run through the standard drill of trouble-shooting: punch every knob and turn every button to see if *that* solves the problem. Five minutes of this pass, and the problem is still there . . . the radio is *dead.*

Now what? "Back to the manufacturer," I sigh, and off I go to bed. It's late, and I'm completely discouraged. "Why can't they build something that *works*?" I complain to my sleeping XYL. I am utterly discouraged.

After I turn out the light, and I'm lying there waiting to fall asleep, I ask myself, "Did I try the *squelch?*" I'm not sure, so I throw on a robe and head for the door. My wife stirs in her sleep, pulls the covers to *her* side, and murmurs something good-naturedly unintelligible. I run downstairs, turn on the radio, set it to the broadcast band, and wait for the problem to reappear. It does, I turn off the squelch.

BINGO.

The bottom line, I guess, is that problems like this can strike us all. From Novice to Extra, no one is immune. The increasing complexity of our world — and of Amateur Radio — makes it hard to be fully expert on the many different pieces of equipment and in the varied technologies we use. So when a problem occurs, all we can do is walk through a step-by-step check of each and every control to determine whether it's really an equipment problem or just another embarrassing incidence of "cockpit error." If the malfunction escapes this scrutiny, then we can consult the owner's manual to see if the problem is one that the manufacturer has already anticipated. If this step fails, we can check with the dealer to see what he has to say. (Most likely, he'll be thoroughly equipped to handle the problem.)

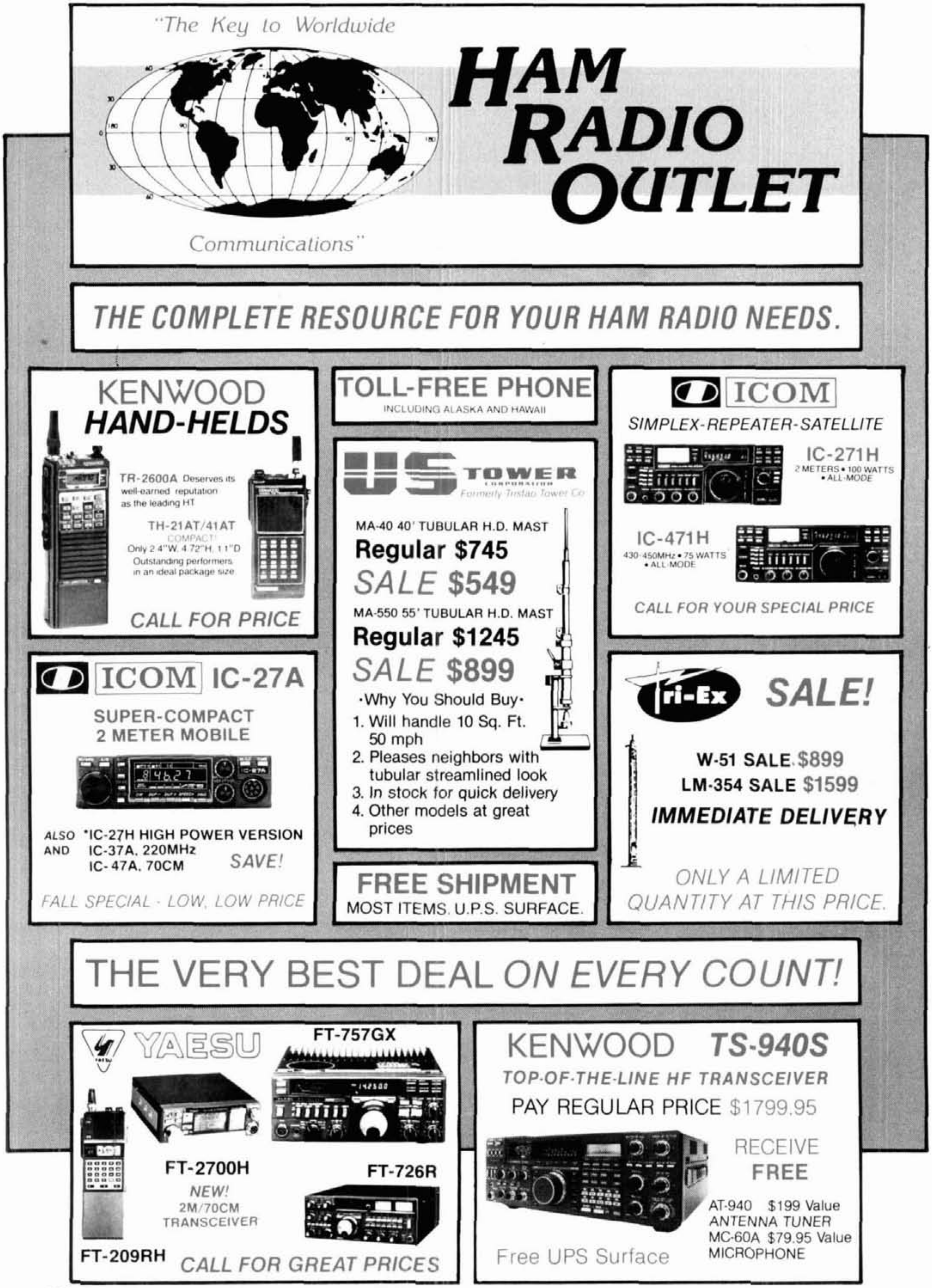
My point is that sending equipment back to the manufacturer is always the action of last resort. Yes, the manufacturer has a skilled service staff to troubleshoot and repair equipment. But as Joe Carr, K4IPV, points out in his new *ham radio* column (see page 67), as much as 40 percent of the equipment that lands on the benches of professional service technicians has absolutely nothing wrong with it! By not taking time to really check things out first, its owners are inconvenienced, off the air, and out the cost of packing and postage.

These newfangled radios sure are nice. But they're a whole different world from the Hammarlund HQ-129 and Johnson Ranger I started out with.

Craig Clark, N1ACH
Assistant Publisher

More Details? CHECK—OFF Page 158

157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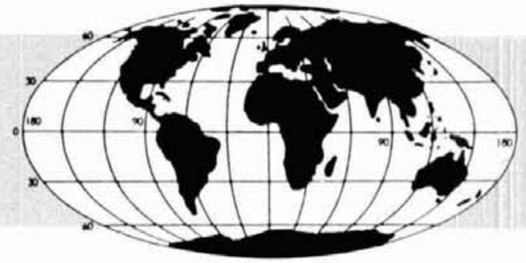

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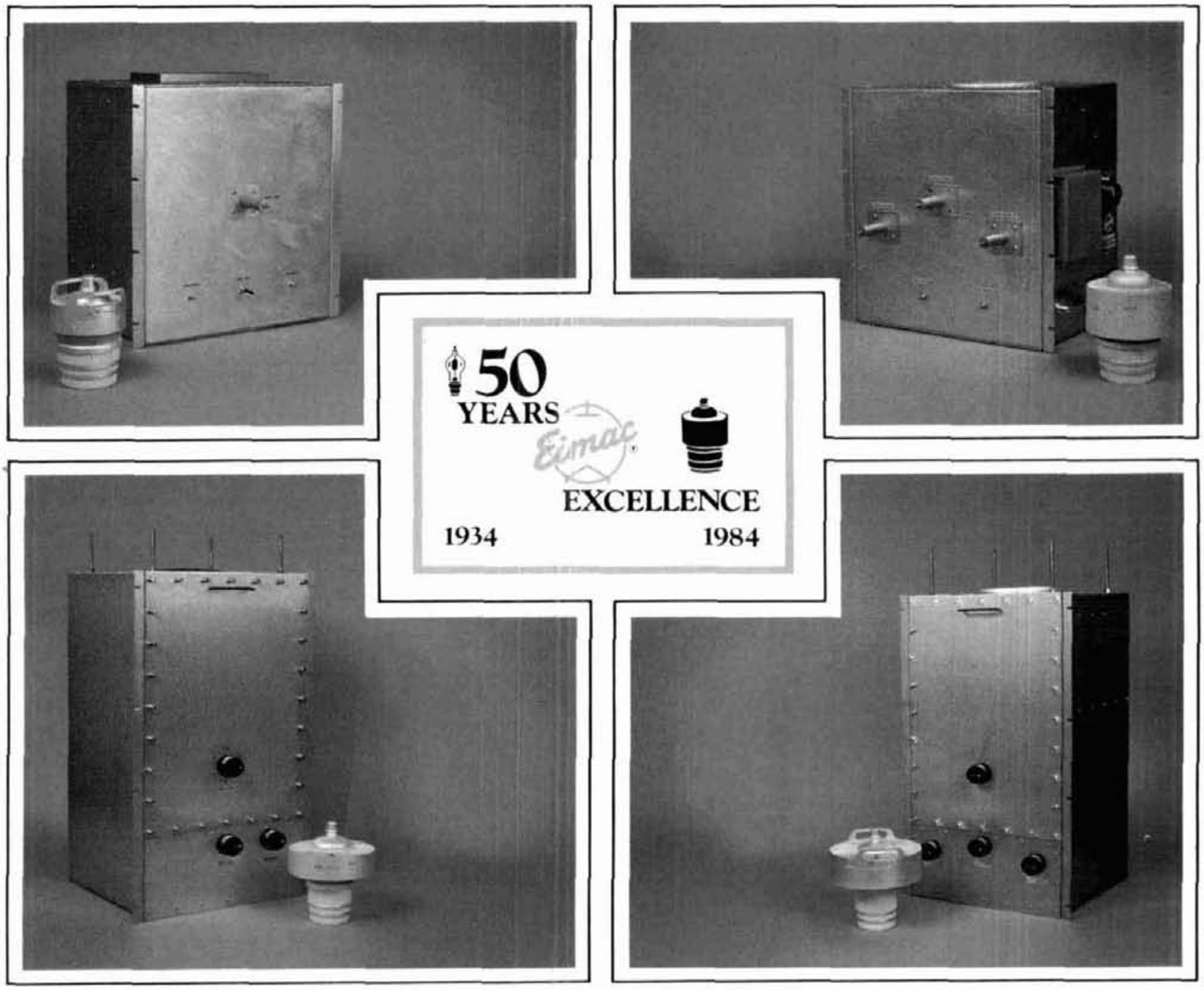

109

Invitation to Authors

ham radio welcomes manuscripts from readers. If you have an idea for an article you'd like to have considered for publication, send for a free copy of the *ham radio* Author's Guide. Address your request to *ham radio*, Greenville, New Hampshire 03048 (SASE appreciated).

presstop de W9JUV

AMATEUR USE OF A GEOSTATIONARY SATELLITE has been proposed by NASA. One of NASA's Advanced Communications Technology Satellites (ACTS) is to be made available for use by experimenters for a two-year period starting in 1989; Amateur Radio is one of the groups that NASA expects to be interested in using it. Uplink band will be 27.5-30 GHz; downlink, 17.7-20.2 GHz. As these are outside the Amateur bands, it's likely either an STA or experimental license will be required for them. The satellite will use highly directive antennas aimed at some major population centers, but NASA even suggests Amateurs might use repeater techniques to permit others outside the bird's antenna "footprint" access to it. Interested Amateurs should request NASA's November 1984 "Notice of Intent" from Ron Schertler, ACTS Projects Experiment Manager, MS-54-6, NASA, 21000 Brookpark Road, Cleveland, Ohio 44135.

BROADCASTERS MAY DO ANYTHING THEY WISH WITH AMATEUR TRANSMISSIONS, but Amateurs are strictly forbidden to use Amateur Radio in any way that might be construed to benefit any "broadcaster." The FCC's Report and Order on BC Docket 79-47 now appears to almost forbid such well established Amateur Radio "public service" activities as, for example, any direct tie between an Amateur Radio weather net and the U.S. Weather Bureau, since Weather Bureau information is "broadcast" on NOAA's 162-MHz weather stations.
The Redefinition Of "Emergency" in Part 97 Is At The Heart of the problem. Verified emergency communications such as "The dam has broken" or "A tornado just crossed the river" would still be permitted, of course. What appears to be against the new rules is letting an Amateur station in a weather net tell the Weather Bureau "The dam looks shaky" or "The sky's getting very dark." Under the new rules, however, nothing would prevent the Weather Bureau, broadcasters, or anyone else from monitoring an Amateur Radio weather net and using the reports heard in any way they wished.
A Petition For Reconsideration Has Been Filed By ARRL, asking the Commission to go back to the former less stringent definition of "Emergency," or to temper the new one so it won't preclude public service ties between weather nets and the Weather Bureau.

AUXILIARY OPERATION ON ALL AMATEUR FREQUENCIES except 431-433 MHz and 435-438 MHz has been proposed by the Commission in PR Docket 85-215. The present rules restrict auxiliary operation (principally control links) to above 220.5 MHz. However, the FCC feels that there is no reason, given the present state of the art, that such auxiliary operation shouldn't be permitted on the other Amateur bands, as well.
Comments On PR Docket 85-215 Are Due At The Commission September 24, and Reply Comments by October 25.

NEVADA HAS JOINED THE SHIFT TO 20 KHZ 2-METER SPACING, except for the Las Vegas area, which has traditionally gone along with Southern California. Eastern Nevada will be coordinated by the Utah coordinator, and the western part by NARC's northern California coordinator. Iowa's council, however, has voted to remain at 15 kHz and the ARRL bandplan though with a voluntary state-wide tone access system. They also intend shifting the 145-MHz repeater subband to 15 kHz spacing in order to pick up additional channels.

800-MHZ SCANNERS WOULD BE OUTLAWED IN CALIFORNIA under a proposal, SB 1431, presently being considered in the state legislature. The proposal, apparently the result of phone company concern over the security of cellular communications, has California Amateurs worried over possible negative impact on Amateurs. Los Angeles attorney Joe Merdler, N6AHU, has been instrumental in delaying the bill's approval, though scanner manufacturers haven't seemed very concerned about it. If it becomes law a court challenge seems likely.

AN 800 NUMBER FOR QUESTIONS ABOUT ITS VEC PROGRAM, including its own or any other VEC's exam schedule, has been installed by DeVry. The number, which is presently accessible only in the greater Midwest area, is 1-800-327-2444; A DeVry WATS line covering the entire Continental U.S. will be announced in the near future.
"The Volunteer Examiner," A VE Newsletter created and edited by DeVry VE KI9R, is now being distributed by DeVry. An SASE to Jim Georgius, W9JUG, DeVry ARS, 3300 N. Campbell, Chicago, Illinois 60618 will bring a sample copy.
W9JUG's Sunday VE Net Now Meets On 7173 kHz, 1400Z, with a second session at 1800Z.

"12-12 WORLDWIDE" IS A NEWLY FORMED ORGANIZATION to promote activities on the new 24 MHz (12 meter) WARC band. For details send an SASE to Steve Walz, WA5UTO, Box 222, 318 S. Massachusetts Avenue, Cherokee, Oklahoma 73728, or call him at (405) 596-3487.

AN FCC CITATION FOR "BROADCASTING" HAS COST K6KPS $2000. K6KPS, James Brantley, has been a problem to 20-meter phone band users for decades, calling CQ but ignoring responses and carrying on imaginary QSOs on top of various nets, DX pileups, phone patches, and ordinary rag chews with a big signal from the Los Angeles area. Though he's done this for years (K6KPS often broke up a 14295 "commuter's net"—in which Presstop editor W9JUV participated in the mid-60s) and has been the subject of previous FCC investigations, the fine was levied for his operating tactics observed during last December.

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THE INTELLIGENT SATELLITE TELEVISION SYSTEM

THE LUXOR 9900 KNOWS

Where all the satellites are

Up to 36 satellite locations can be programmed for instant recall. The antenna controller is integrated into the satellite receiver. The hand-held remote control activates a 3-speed actuator action which precisely locates the satellite and fine tunes the antenna position for maximum signal reception.

Where all the channels are

Every channel on every satellite is individually factory programmed prior to delivery. All audio and video information is ready for recall automatically. As new channels are added they can be added to the program. The 9900 is ready to receive individual channel selection information for up to 864 separate selections.

All about stereo Hi-Fi sound

5 audio modes, factory programmed to individual transponders, deliver the right sound system automatically when a channel is selected. Dozens of audio subcarriers can be added to the program for audio only hi-fi enjoyment (including Dolby® Noise Reduction) in addition to television.

ALL YOU NEED TO KNOW IS WHAT SHOW YOU WANT TO WATCH

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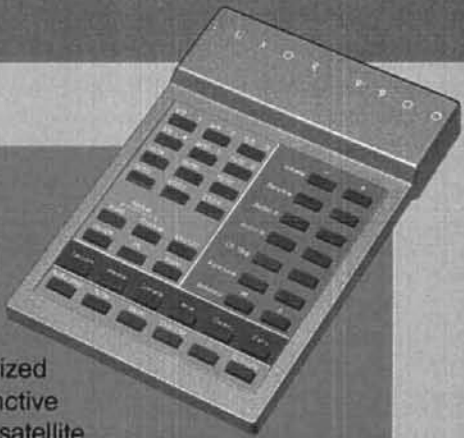
NOW LUXOR HAS UNIFIED SATELLITE, VIDEO, AUDIO AND COMPUTER TECHNOLOGY IN A SINGLE INTEGRATED HOME SATELLITE TV SYSTEM

So advanced it's as easy to operate as an ordinary TV

The front panel LED display tells you what satellite you're on, what channel you're watching, what sound system you're receiving and a signal bar graph indicates signal strength. All functions are controlled from the hand-held wireless remote.

Simple, clear and color-coded



The Luxor hand-held remote is clearly organized to make life easy. Distinctive color sections present satellite and channel selection functions, tuning functions and switching functions. For most viewing however, video and audio delivery will be automatic. When a channel is selected, the exclusive Luxor Micro-Step™ Tuning System (LMS) automatically seeks out the right signal within that channel's frequency. The receiver automatically compensates for any form of frequency drift due to climate or transponder variances.

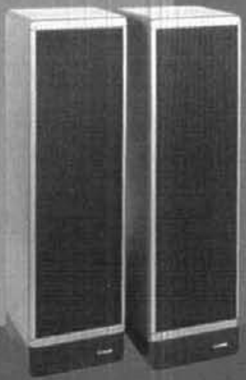
An internal TI filter can be assigned to individual channels to minimize terrestrial interference.

And a discrete parental lock-out can eliminate one or more individual channels on a single satellite, as desired.

That's it. Advanced Luxor technology has produced a system so simple to operate, yet complete enough to satisfy the most fanatic videophile and audiophile. For the technician, the Luxor 9900 even has its own diagnostic system built-in and ready at the touch of a button.

The sky is alive with the sound of music

Luxor loudspeakers bring new life to TV audio, mono or stereo, and much more. Satellite audio sub-carriers broadcast a wide range of music for audio only. These optional high quality 6-speaker sets (3 per side) are available in passive or active models with sound power up to 40 W per channel. They are specially magnetic shielded for close location to your TV set.



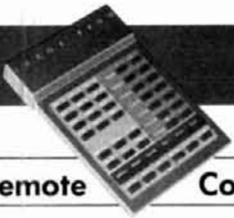
Here is the best of Scandanavian design and high technology. Because Luxor is a leading European manufacturer of satellite products, TV's, audio hi-fi systems, and computers, the company is able to combine these technologies in the advanced 9900 series. After all, Luxor has been a leader in radio, television and electronic technology since 1923.

The perfect companion

The Luxor Model 9995 Block Satellite Receiver is designed and built to function as an add-on receiver to Luxor 9900 multiple TV's installations. This low cost manually operated receiver offers independent channel selection for TV's located throughout the house. The 9995 can also be used as a stand-alone receiver for both C-Band and Ku-Band reception.

LUXOR HAS ADVANCED THE STATE-OF-THE-ART TO THE POINT OF ELEGANT SIMPLICITY FOR THE CONSUMER AND THE TECHNICIAN

Each electronic innovation is incorporated to aid ease of operation, assure high performance reliability, and maintain outstanding quality of both picture and sound.



9900 Block Receiver

Control Functions

+ Integrated satellite receiver and antenna controller.
• C-band (4 GHz) and Ku-band (12 GHz) capable. Remote control switchable.
• Satellite direct access.
• Transponder direct access.
+ Built-in A/B switch.
+ "Normal" button return to factory pre-set values.
• Built-in polarotor drive.
• Built-in RF modulator.
• Non-volatile memory unaffected by power outages.
• Remote sensor interface.

Programs

+ Factory programmed for individual transponders on each satellite.
+ Automatic correct audio system factory programmed for each satellite and each transponder.
+ Program capacity up to 864 individual selections, audio video matched and fine tuned.
+ Self-diagnostic microprocessor.
+ LED display of satellite, channel, audio system and signal strength

Video Functions

+ Luxor Micro-Step™ tuning system (LMS).
• Baseband audio and video output for VCR or monitor.
+ Baseband input for other video sources.
• Built-in polarity control.
+ Built-in programmable TI filter.
• Raw video (unfiltered, unclamped) for descrambler connection.

Audio Functions

+ Audio subcarrier frequency read-out.
• Wide/Narrow Bandwidth selection.
+ Remote audio volume control.
+ Remote stereo balance control.
+ Remote Dolby® on/off
+ 5 audio modes–2 mono, 2 matrix, and discrete stereo. Automatic multiplex selection.
• Built-in stereo processor.
+ Direct loudspeaker drive.

9902 Remote Sensor

• Controls satellite system from any room.
• Low-cost add-on for other TV's.
• Comes complete with hand-held IR remote control.

9901 Remote Control

+ Full-function, color-coded IR wireless remote control.
+ Remote ON/OFF
+ Discrete parental lock-out for individual channels.
+ Remote mute.
+ Volume control.
+ Stereo balance.
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+ Audio fine tune
• Antenna fine tune.
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• Channel selection.
+ Divided into 4 easy-to-read segments: Satellite selection, channel selection, tuning functions, switching functions.

9904 Actuator Interface

+ 36V power supply to antenna drive.
+ Surge protected.
+ Voltage spikes protected.
+ Design coordinated with 9900.
+ Can be wall-mounted out of sight.

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+ Passive or active models.
+ Up to 40 W per channel.
+ 3 elements per side; tweeter, mid-range and woofer.
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+ Complete with line cable feed.

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9995 Block Satellite Receiver

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+ Can function as a stand-alone block receiver; C-band and Ku-band reception.
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+ Polarotor One control output.

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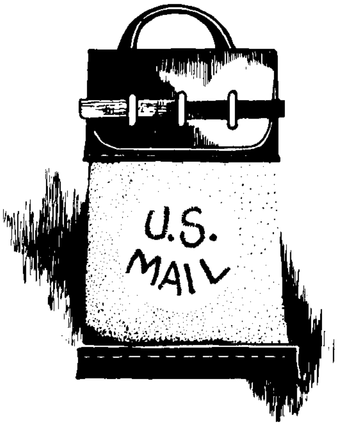


comments

new band privileges for Novice operators

Dear HR:

I was amazed and very pleased to see your July *Presstop* item about the proposed upgrading of Novice privileges. I have been a Novice ham operator since 1979 and am pleased to see the prospect of a reward in the form of more privileges being considered for the Novice class license.

I would like to encourage all Novice operators who read *ham radio* to speak out and let their feelings on this subject be known to the ARRL and the FCC. This may be our only chance to assist in changing the long-time rules and regulations regarding our hobby. It may very well be a turning point that will create the interest to save the hobby as we know it.

Allowing the Novice use of phone on 10 meters, 220 MHz, and 23 cm can only help to encourage us to strive for the privileges of the higher grade licenses. CW is an entertaining and rewarding mode of communication, but I believe the Novice license should give more to encourage us to seek out our full potential as operators. A simple pat-on-the-back in the form of a reward would be all it would take for many of us.

Technicians would, of course, benefit from these new privileges also by allowing phone on 10 meters. I might go even a step further and suggest not only the use of SSB, but even FM for both license grades.

I do not believe for a minute that this rule change would degrade the bands with "glorified CB operators" because the license elements are still sufficiently difficult to discourage such abuse. Besides, that era was just a passing fancy for many.

With today's increasing use of digital communications, the new rules would also allow Novices to utilize the state-of-the-art computer systems to further their knowledge of present-day communications.

All in all, I think it would be foolish to not allow us the opportunity to take part in this ever growing advancement in technology.

T. Dillingham, KAØDOE
Aspen, Colorado

used equipment for new hams

Dear HR:

Much has been said recently about bringing new blood into the Amateur Radio hobby, and several articles have focused on the wonderful services being provided in the public interest, convenience, or necessity. All of these remarks are laudable, and the two situations can easily go hand-in-hand. Additionally, a few other problems we must each face someday can easily be solved now, while helping with the first two I mentioned: what will become of our equipment when we tire of it, or leave for the land of the silent key? And how can we find replacements for the tax loopholes about the run out of town on the Amtrak rails? (These remarks are addressed to dealers as well as the average ham.)

I suppose we have all seen on the "used" shelf at the few remaining Amateur Radio stores some piece of equipment that could be put to better use in a shack somewhere. Perhaps we have a piece or two in our attic or garage that we haven't really been using in the recent past, but hesitate to just throw away. Maybe one of our senior citizens has some neat stuff that his or her surviving spouse will have some problem with disposing of in some coming period of distress. One cure would be to put that gear to good use now, getting the tax advantage now, providing a service now, and perhaps helping out some youngster getting started down that primrose path we have each delighted in following.

There are literally thousands of applications for used equipment in each of our hometown areas, and many of them are equally deserving of attention; there is simply no room here to list them all, but a few will get your minds moving in the right direction. Rigs and associated equipment of appurtenances are sorely needed by schools, camps, Courage Handi-hams, Civil Defense, FEMA, DSA, National Weather Service, Fire and Police Departments, and our many clubs with active Novice classes, among countless others. Perhaps your donation of usable and serviceable equipment now will be just what is needed to get new hams on line or to provide that equipment needed by present-day hams to provide that vital service to the public that will keep this hobby active and thriving.

Think about it now, while you can still do something about it, and before the spouse cleans house for you, or a good piece of equipment self-destructs on your shelf!

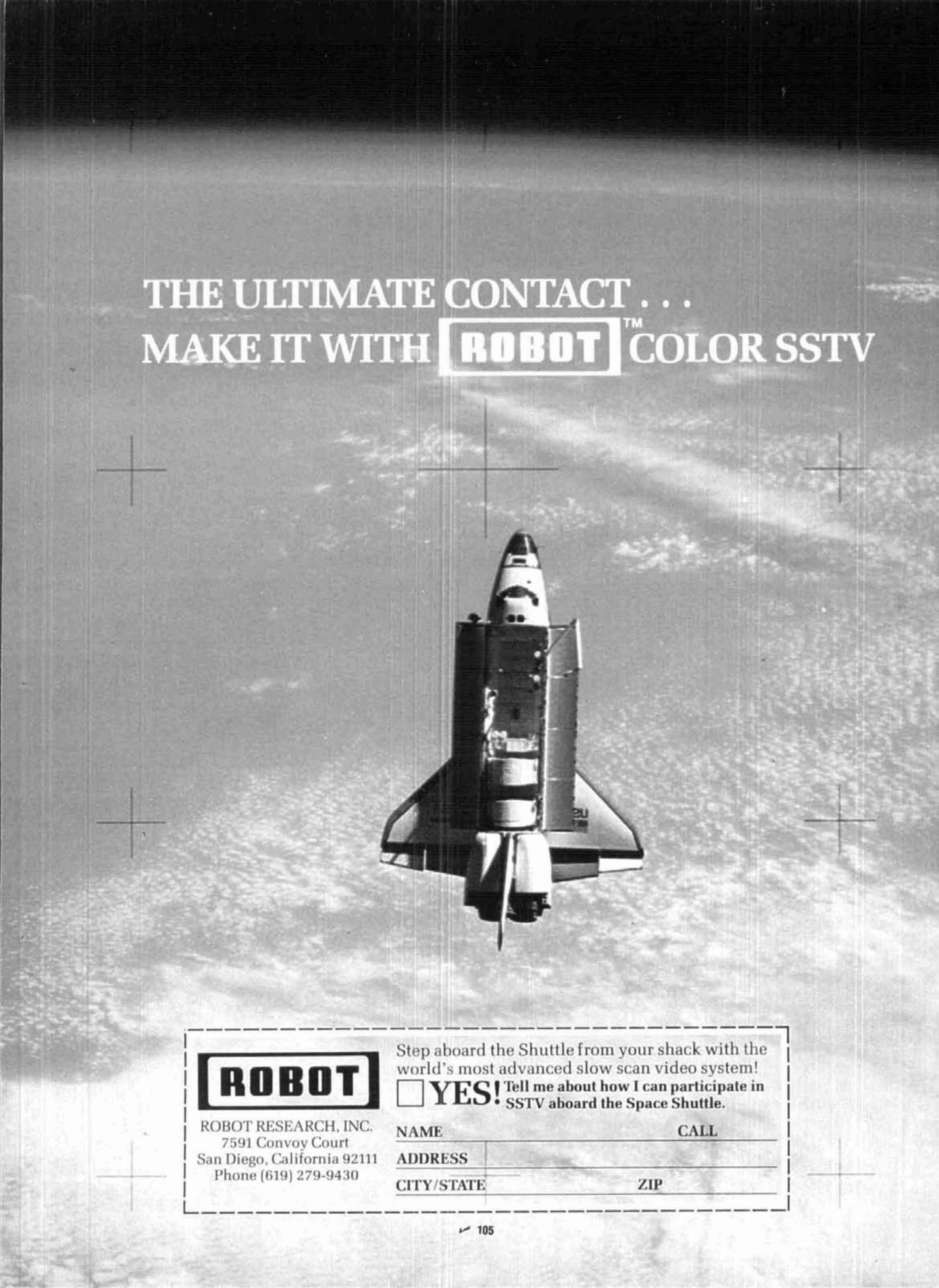
Jerry Murphy, K8YUW
Lakewood, Ohio

off and on

I recently saw a 12 VDC to 110 VAC power inverter that was switched on and off on demand by the load, without extra switches or wires.

Do any of your readers have information on how this is done?

Sam Popkin, K2DNR/7
Mesa, Arizona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passive audio filter design
part 1: development and analysis

Circuits using miniature preferred-value components are adaptable to printed-circuit boards

A recent article in *ham radio*[1] was the latest of a long series by W3NQN on the subject of elliptic lowpass audio filters suitable for Amateur constructors. It is mainly through the efforts of W3NQN that these filters have remained in the Amateur literature despite the proliferation of designs for active audio filters using operational amplifiers.[2-5]

It is surprising that active filters have become so popular considering the complexity required to equal the performance of passive designs and the disadvantages associated with active elements. They require power, produce noise, have a limited ability to handle large signals and have a limited upper operating frequency unless expensive, high-frequency devices are used. These disadvantages usually don't apply when using a passive circuit containing inductors.

Probably the main reasons for the decline of passive filters are the misunderstandings surrounding the selection of components for them. Some of these misunderstandings can be explained by:

- The lack of published designs using preferred-value inductors and capacitors.
- The belief that highly accurate inductance and capacitance values must be used to obtain acceptable results.
- The belief that only high-Q inductors are suitable for use in filters.
- Ignorance of the fact that ready-wound, standard-value inductors are available easily and inexpensively.
- A general phobia of winding inductors, especially ones with several hundred turns of wire.

W3NQN has avoided these problems by using telephone-line loading coils in his designs. These loading coils are relatively high-Q components. Specialized designs have been developed which make use of the inductance values included in these coils, or by slight modifications to the inductors by removing turns.[6]

In general, the capacitance values required in a passive filter are non-preferred and are obtained either by connecting several preferred value capacitors in parallel or by measuring capacitors and selecting the required value. Designs have been published in which some[7,8] or all[9,10] of the capacitors are preferred value, but these are intended for RF applications in which the non-preferred value inductors are not too difficult to wind and will have a relatively high Q value.

The question of what effect the inductor Q has on a filter response does not seem to have been addressed in the United States Amateur literature. Only two references that consider this question could be found,[11,11A] but non-preferred values of capacitance and inductance were used. The results from this investigation were encouraging, with only a slight degradation in the flatness of the passband and rounding in the cut off region of the Butterworth, Chebyshev, and Bessel filters considered.

objectives

One aim of this series of articles is to describe my investigations into the use of miniature preferred value inductors and capacitors in several types of audio filter. My goal was to use a single, unselected, inexpensive component for each inductance and capacitance value so that passive filter construction (and design, if the reader so wishes) can be simple for even the most inexperienced Amateur. Filters using these components are extremely compact and suitable for construction on printed circuit boards in modern equipment — which, unfortunately, designs using the telephone line loading coils are not.

The investigations were carried out using computer

By Stefan Niewiadomski, 29 MacKinley Avenue, Stapleford, Nottingham, NG9 8HU, England

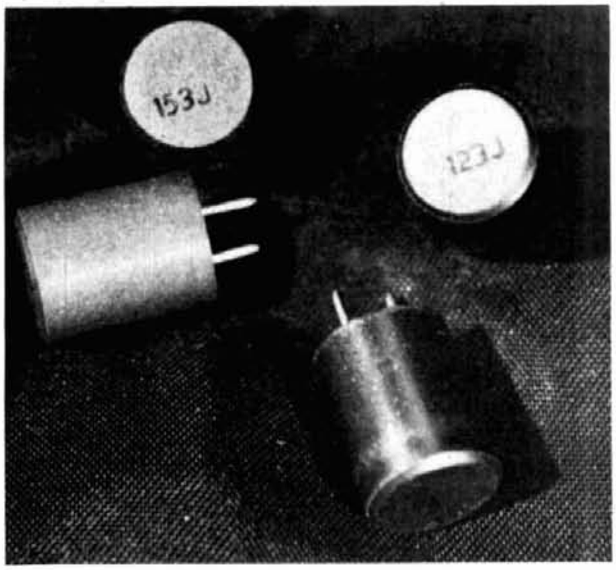


fig. 1. The Toko inductors used in the author's filter studies.

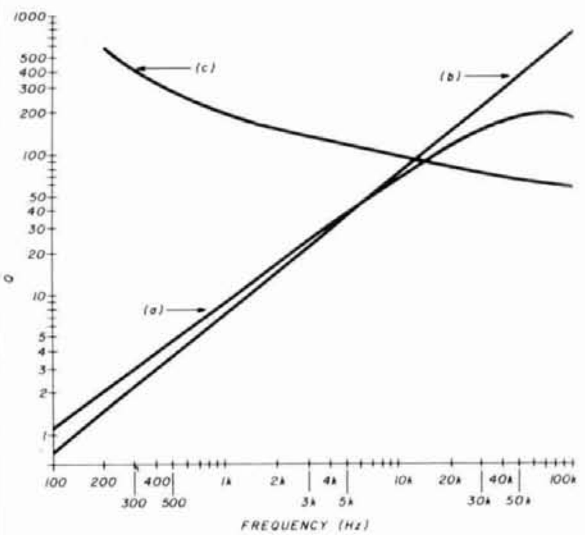


fig. 2. Plot of Q versus frequency for (*a*) 22-mH Toko 10RB inductor; (*b*) ideal 27-mH inductor and 22 ohm resistor; and (*c*) Siemens 0.22-μF capacitor.

simulations and practical tests. The simulations were performed on an Apple II microcomputer, using a BASIC circuit analysis program.[12] Circuit simulation programs that run on several home computers are now available.*

The major advantage of using circuit simulation in this field is that the effects of altering component values and using low-Q inductors can be isolated from each other and investigated separately. This contrasts with an experimental approach, in which the combined effects of non-exact component values and low-Q inductors would have to be accepted unless a large number of inductors of various values and Qs could be wound — which is obviously impractical for the Amateur.

I will also discuss attenuation equalizers and show how these comparatively simple circuits can improve the responses of filters made from low-Q inductors. I believe this is the first time these networks have been described in a practical way in the Amateur literature.

Also discussed in this series of articles are some methods of incorporating an audio filter into an audio path to ensure correct matching of the filter. Other topics tackled are the question of how much passband ripple is acceptable in an audio filter used in an Amateur receiver, and how passband ripple and stopband attenuation can be traded off to produce improved overall performance.

components

The inductors used in this study are the Toko 10RB range, manufactured from 1 mH to 120 mH with 5 percent tolerance. Another range, the 10RBH, is available from 150 mH to 1500 mH with 10 percent tolerance.† These two inductor types have identical case styles. They are cylindrical with a diameter of 10.5 mm and a height of 14 mm (see **fig. 1**). Leads are radial with a 5-mm pitch, enabling an extremely compact PCB layout.

Examination of a 47-mH inductor after removing its outer ferrite casing revealed a wire size of approximately No. 40 AWG. For most of the 10RB range, the Q quoted[13] is a minimum of 100 at a test frequency of 50 kHz. The recommended operating frequency range for these coils is from 100 kHz to approximately 170 kHz[14] over which they have a sufficiently high Q to be considered as almost ideal inductances.

The Q at audio frequencies is much lower and was measured for a 27-mH coil from 100 Hz to over 100 kHz using a Hewlett Packard 4192A LF Impedance Analyzer. **Figure 2** shows the results obtained. At 100 Hz, the Q is 1.1, rising to about 9 at 1 kHz, 24 at 3 kHz, and more than 50 at 7 kHz. At frequencies above 80 kHz, the Q begins to tail off, as the maximum operating frequency of the ferrite is approached and skin effects in the wire become appreciable.

Also shown in **fig. 2** is a plot of the Q of an ideal inductor of 27 mH with a 22-ohm resistor in series, which is the quoted DC resistance of the 27-mH Toko inductor. This model seems to be accurate at about

*One available in the UK is sold by Number One Systems, 9A Crown Street, St. Ives, Huntingdon, Cambs, England. Versions are available for the BBC model B and Sinclair Spectrum 48K computers.

†To order, contact Toko America, Inc., 1250 Feehanville Drive, Mt. Prospect, Illinois 60056 (312 297-0070).

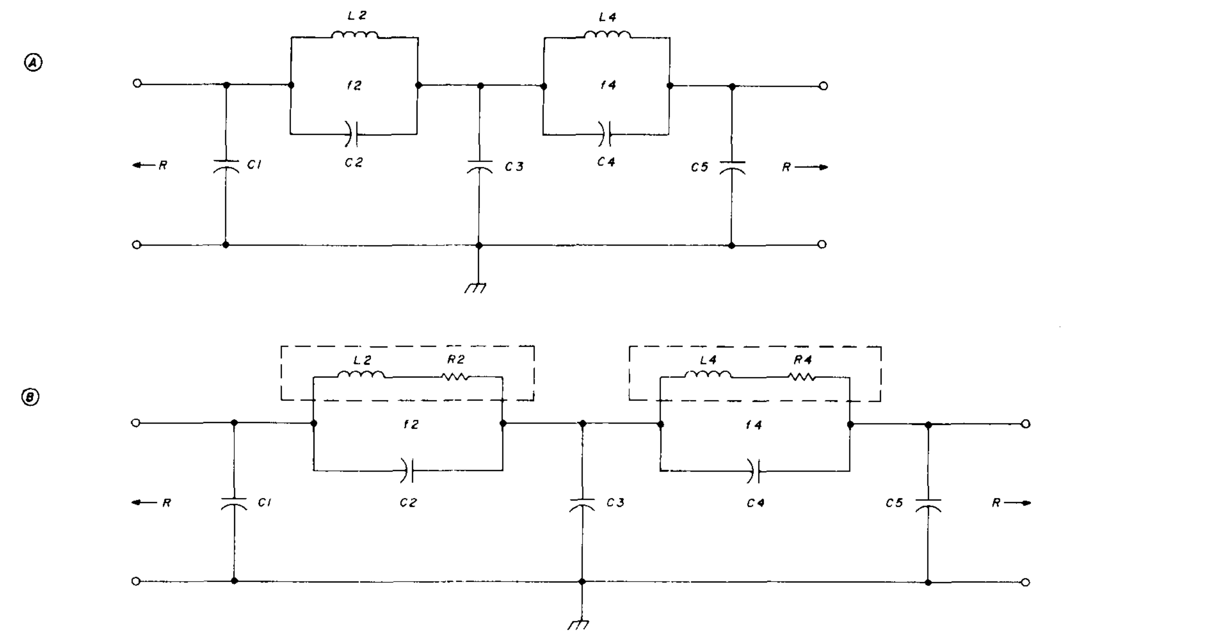


fig. 3. Elliptic 5-branch low-pass filter. (*A*) Schematic of filter with ideal inductors, and (*B*) schematic of filter with real inductors.

6 kHz, giving worse results below 6 kHz and better results above 6 kHz.

Ideally, to accurately model these inductors, a plot of Q versus frequency should be obtained for each value of inductor and the series resistance determined which most closely follows this plot. For the simulations presented here, the inductors were modeled with a series resistor equal to the manufacturer's quoted DC resistance, considering that this will give slightly worse results than in practice.

The DC current flowing through these coils, particularly in the 10RBH range, should be kept to a minimum to avoid heating and core saturation. In fact, to be completely safe, it is better to keep the DC current at zero. In most applications, this is achieved by inserting a DC blocking capacitor in series with the input of the filter in which the inductors are used when there is a direct DC path to a potential different from the input source. This also has the advantage of obviating the danger of interaction between the DC conditions of the driving and terminating circuits. In most applications a capacitor of 100 μF will avoid modifying the response of a filter, but the value can be chosen to have beneficial effects, which will be discussed later.

There are many types of capacitors suitable for use in audio filters. The ones I prefer are the Siemens B32560/1/2 metalized polyester layer type, which are available in a wide range of values and are very compact for their capacitance*. The variation of Q with

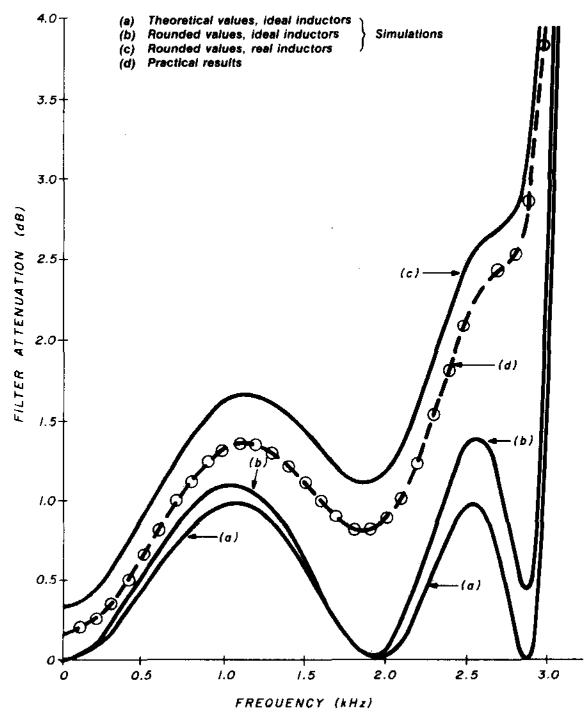


fig. 4. Passband response of 1-dB/50-dB 5-branch 3-kHz elliptic low-pass filter, showing simulation and practical results.

*Panasonic capacitors, available from Digi-Key Corp., P.O. Box 677, Thief River Falls, Minnesota 56701, (1-800-344-4539) may be substituted. —Ed.

frequency of a 0.22μF B32560 capacitor is also shown in **fig. 2**. This capacitor maintains a Q of more than 100 at frequencies up to 10 kHz and can be accurately modeled as a pure capacitance at audio frequencies. These capacitors can be obtained with a 5-percent tolerance and 7.5-mm lead pitch. These are used here.

low-pass filters

The most popular filter for audio low-pass applications is the elliptic or Cauer filter, named for the German network theorist who developed the mathematics associated with its characteristics. An excellent introduction to elliptic filters is given in reference 15, but many of W3NQN's articles include descriptions of the terminology of these filters and their fundamental characteristics. A brief resume of these points is given in the **Appendix**.

The first design considered here is the five-branch low-pass whose circuit is shown in **fig. 3**. **Figure 3A** shows ideal inductors and **fig. 3B** shows a resistor in series with each inductor to simulate their losses. The specification for this filter is:

passband ripple (A_p)	1dB
stopband minimum attenuation (A_s)	50 dB
ripple cutoff frequency (f_{A_p})	3000 Hz
start of stopband frequency (f_{A_s})	4221 Hz
source impedance	500 ohms
load impedance	500 ohms

From now on, I will refer to this filter as the 1-dB/50-dB filter, indicating its passband ripple and minimum stopband attenuation; this terminology will also be used for the other low-pass filters described later.

Table 1 shows the component values for the 1-ohm, 1-rad/sec prototype,[16] the exact values for the filter scaled to 500 ohms and 3 kHz, and the rounded values both with and without resistors to simulate the lossy real inductors. Each capacitor and inductor has simply been rounded to its nearest E12 series preferred value.*

The simulation and practical results for this filter are shown in **figs. 4, 5,** and **6**. Three sets of graphs have been plotted so that the axes for each set can be chosen to show the maximum detail in the passband,

*Capacitors are commercially available in several series of preferred values, two of which have designations of E12 (with a 10 percent tolerance) and E24 (with a 5 percent tolerance), (16A). The reciprocal of the E-number is the power to which 10 is raised to give the step multiplier for that particular series. For example, for the E12 series, the step multiplier is 10^(1/12) or 10^0.083333 = 1.2115. The sequence of the series is therefore 10, 10 • 1.2115 = 12, 12 • 1.2115 = 15, 15 • 1.2115 = 18, 18 • 1.2115 = 22. 22 + 1.2115 = 27, etc. – **Ed.**

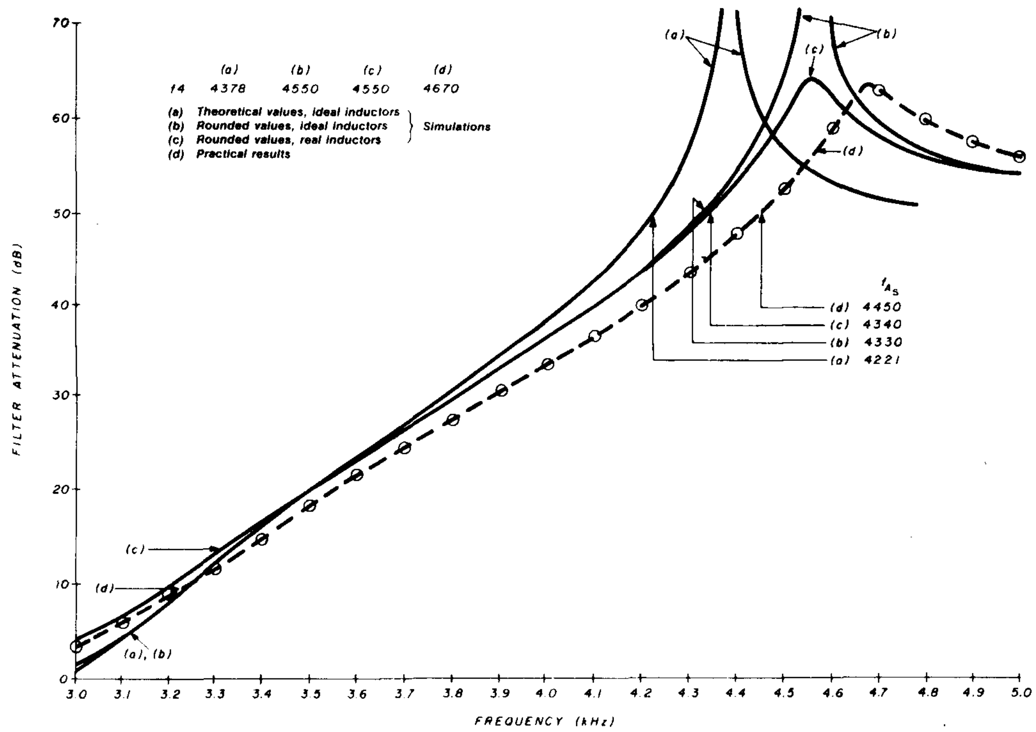


fig. 5. Transition band (and part of stopband) response of 1-dB/50-dB 5-branch 3-kHz elliptic low-pass filter, showing simulation and practical results.

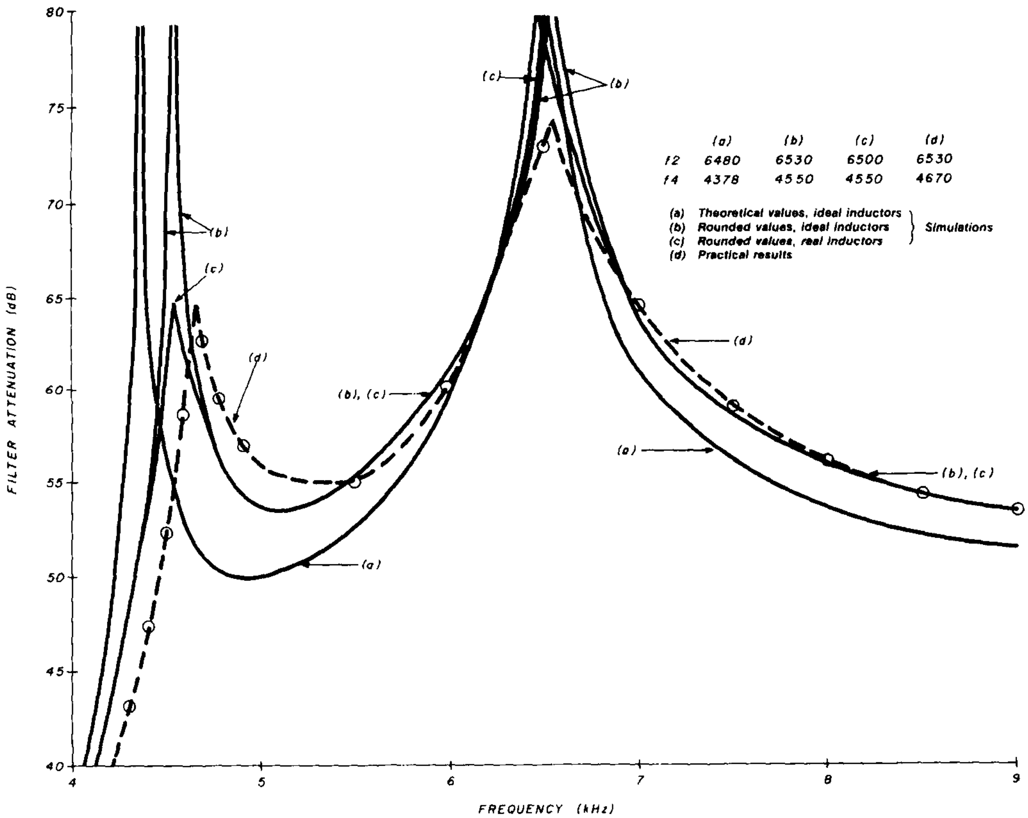
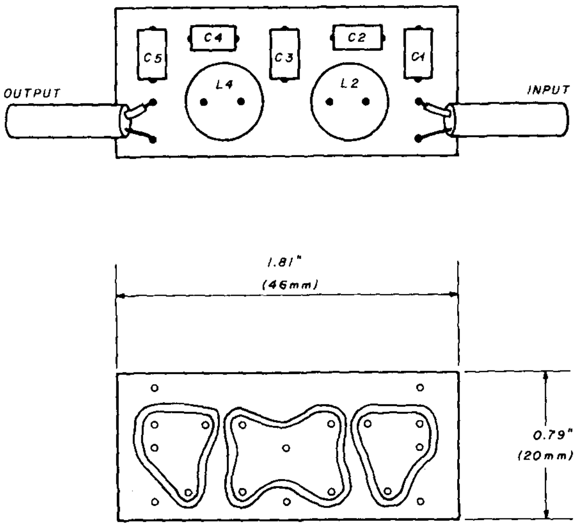


fig. 6. Stopband response of 1-dB/50-dB 5-branch 3-kHz elliptic low-pass filter, showing simulation and practical results.

transition band and stopband. I have used the term "transition band" to describe the response between the ripple cutoff frequency (f_{A_p}) and the start of stopband frequency (f_{A_s}). Many authors include this region in the stopband, but it was convenient for me to divide the total response into three regions, and the middle region seems most appropriately to be described as the transition band.

Curve *a* on **figs. 4, 5,** and **6** is the simulated response of the filter with theoretical values and ideal inductors (**table 1**, column 2). The response meets the 1-dB passband ripple (A_p), 3-kHz ripple cutoff frequency (f_{A_s}), 4221-Hz start of stopband frequency (f_{A_s}) and 50-dB minimum stopband attenuation (A_s) specifications. The calculations carried out to scale the 1-ohm, 1-rad/sec values (**table 1**, column 1) to 500 ohms, 3 kHz (**table 1**, column 2) are therefore correct. The frequencies of infinite attenuation in the stopband, f2 and f4, are 6480 Hz and 4378 Hz. These are the resonant frequencies of the parallel tuned circuits L2/C2 and L4/C4 respectively.

Curve *b* in **figs. 4, 5,** and **6** is the simulated response of the filter with rounded values (**table 1**, column 3). The passband ripple has increased, but by less than



Components for 1-dB/50-dB five-branch elliptic low-pass filter:

C1	0.22 μF Siemens metallized polyester 5 percent
C2	0.022 μF Siemens metallized polyester 5 percent
C3	0.27 μF Siemens metallized polyester 5 percent
C4	0.068 μF Siemens metallized polyester 5 percent
C5	0.18 μF Siemens metallized polyester 5 percent
L2	27 mH Toko 10RB
L4	18 mH Toko 10RB

fig. 7. PCB foil pattern and component placement for 5-branch elliptic low-pass filter.

table 1. Component values of 1-dB/50-dB five-branch elliptic low-pass filter. 500 ohm, 3-kHz values obtained by multiplying 1 ohm, 1 rad/sec values by 1.061×10^{-7} for capacitors and 2.653×10^{-2} for inductors.

component	column 1 1 ohm, 1 rad/sec value	column 2 500 ohm, 3 kHz theoretical value, ideal inductors	column 3 500 ohm, 3 kHz rounded value, ideal inductors	column 4 500 ohm, 3 kHz rounded value, real inductors
C1	1.933 F	0.2051 μF	0.22 μF	0.22 μF
C2	0.223 F	0.0237 μF	0.022 μF	0.022 μF
C3	2.392 F	0.2538 μF	0.27 μF	0.27 μF
C4	0.626 F	0.0664 μF	0.068 μF	0.068 μF
C5	1.635 F	0.1735 μF	0.18 μF	0.18 μF
L2	0.963 H	25.5 mH	27 mH	27 mH
L4	0.750 H	19.9 mH	18 mH	18 mH
R2	—	0 ohms	0 ohms	22 ohms
R4	—	0 ohms	0 ohms	17 ohms

0.5 dB; there has also been a slight decrease in the ripple cutoff frequency. In the transition band, close agreement with the unrounded value response is found. The frequency at which the stopband minimum attenuation is first achieved (f_{A_S}) is now 4330 Hz rather than the original 4221 Hz. The frequencies of infinite attenuation are now 6530 Hz and 4550 Hz, reflecting the change in resonant frequencies of L2/C2 and L4/C4 because of their value changes. One interesting result of the component changes is that the minimum stopband attenuation is now approximately 53 dB, rather than 50 dB. Though not shown in **fig. 6**, this value is maintained beyond 10 kHz. This increase in stopband attenuation seems to be a result of the increase in passband ripple, since these two parameters can be traded off at the design stage.

Curve *c* in **figs. 4, 5,** and **6** is the simulated response of the filter with rounded values and real inductors (**table 1**, column 4). The filter now exhibits non-zero insertion loss at all frequencies (having a value of about 0.3 dB at 100 Hz) and increased passband ripple. Other effects of the low-*Q* inductors are the smoothing of the final passband ripple and a gradual, rather than a sharp, transition from the passband into the transition band. The frequencies of high attenuation in the stopband are the same as those of the rounded values, ideal inductors' response (curve *b*), but the attenuations are no longer infinite. They are approximately 63 dB at 4550 Hz and 78 dB at 6530 Hz. The minimum stopband attenuation is similar to that shown by curve *b*, being approximately 53 dB.

Curve *d* in **figs. 4, 5,** and **6** shows the measured response obtained from the real filter constructed with the values of **table 1**, column 4. These results were obtained using a Hewlett Packard 3585A Spectrum Analyzer, which enables filter response measurements to be made very easily. Curve *d* shows close agreement with curve *c*, indicating that the simulation method was largely valid. The passband response is slightly better than simulations indicated, probably because the inductors have a higher *Q* than the simple simulation model produces. (Remember, this was seen from the measured *Q* values plotted in **fig. 2**.) Differences in the transition band and stopband response are probably because of the real components having values slightly different from their nominal values. The value of high attenuation attained by the practical filter at 4670 Hz is similar to that of the simulated filter (approximately 63 dB), but is approximately 5 dB less than the simulated filter at 6530 Hz. Minimum attenuation in the stopband is still a healthy 53 dB. This attenuation has been measured beyond 10 kHz, and remains at greater than 50 dB to more than 30 MHz.

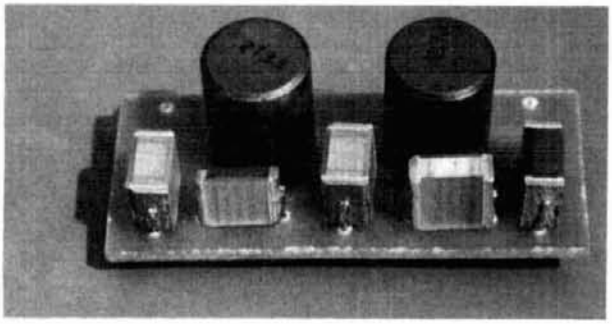


fig. 8. Experimental five-branch elliptic low-pass filter.

Before I comment on the significance of the changes in performance between the theoretical and the final, practical filter, I would like to show the method used to construct this filter and the results obtained from a more complex low-pass design.

Figure 7 shows the PCB foil pattern and component layout used for this practical filter. The layout follows the schematic of the filter, with the output as far from the input as possible. A good ground plane

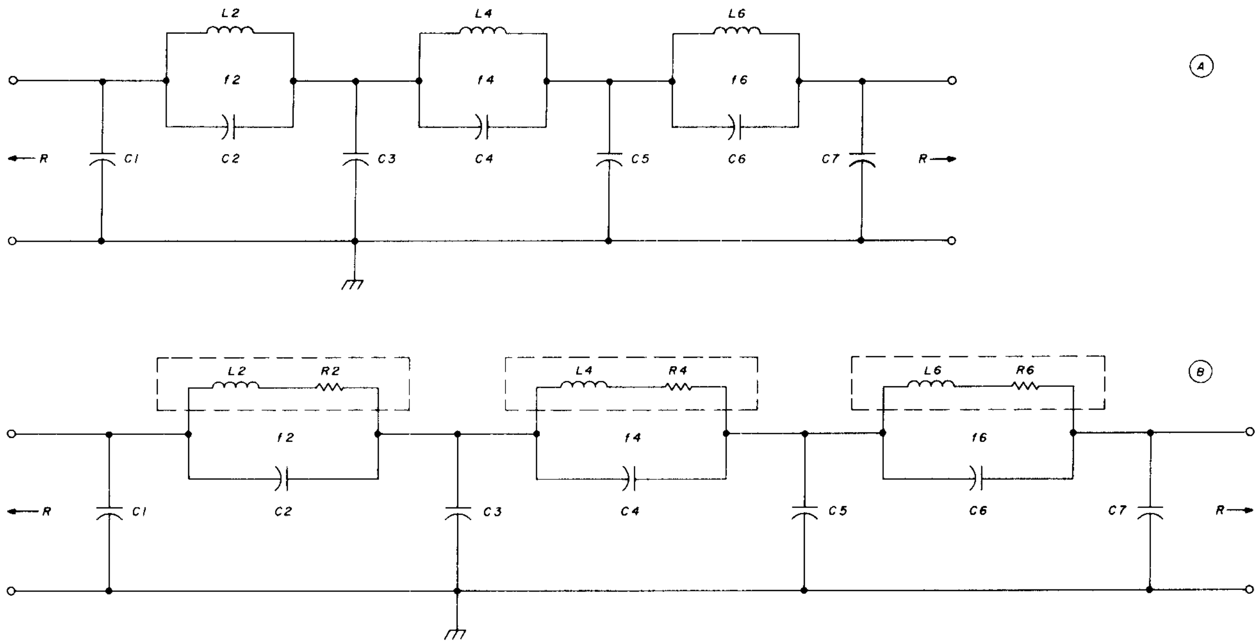


fig. 9. Elliptic 7-branch low-pass filter. (*A*) schematic of filter with ideal inductors, (*B*) schematic of filter with real inductors.

is maintained by etching away only the minimum amount of copper possible. The small amount of extra capacitance between each circuit node and ground is insignificant when compared with the capacitors. The ground plane gives low-impedance ground return paths and helps isolate the output from the input. If required, the filter can be made even more compact than my layout indicates. The ferrite caps over the Toko coils are such that they can be positioned very close to each other without any coupling effects. Stripboard can also be used for construction without any drastic effects on performance. **Figure 8** shows a photograph of this filter.

Figure 9 shows the schematics for a seven-branch elliptic low-pass filter, with and without the resistors to simulate the real inductors. The specification for this filter is:

passband ripple (A_p)	0.18 dB
stopband minimum attenuation (A_s)	50.1 dB
ripple cutoff frequency (f_{A_p})	3000 Hz
start of stopband frequency (f_{A_s})	3500 Hz
source impedance	500 ohms
load impedance	500 ohms

Table 2 shows the component values for the 1-ohm, 1-rad/sec prototype;[17] the exact values scaled to 500 ohms, 3 kHz; and the rounded values both with and without resistors to simulate the lossy real inductors. Again, each component has been rounded to the nearest E12 preferred value. Note that in the case of C4 and L4, both have been rounded downward, so we should expect a larger than average shift in the f4 frequency. If the peaks in stopband attenuation are being used in a particular application to obtain more than

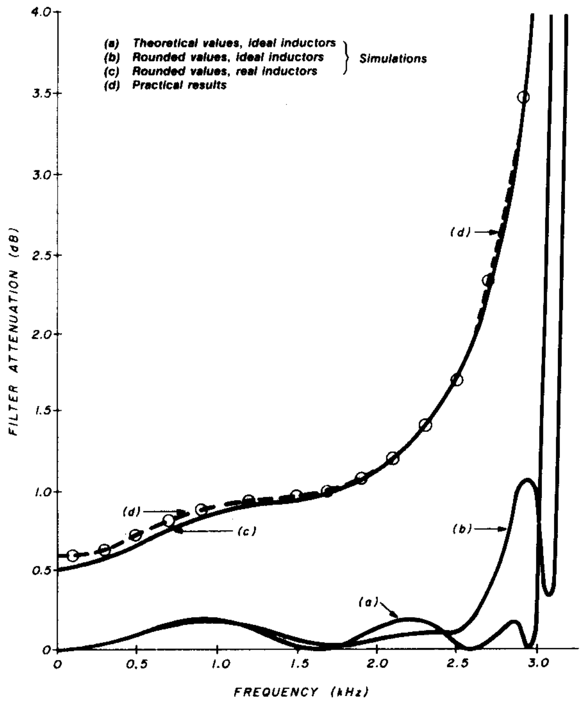


fig. 10. Passband response of 0.18-dB/50.1-dB 7-branch 3-kHz elliptic low-pass filter, showing simulation and practical results.

the minimum stopband attenuation at particular frequencies, then it is best to round the tuned circuit elements in the filter in opposite directions. The frequencies of these peaks can be placed accurately by rounding only the inductor values and then selecting or paralleling capacitors to obtain the desired resonances.

The simulation and practical results for this filter are shown in **figs. 10, 11,** *and* **12.** I will not describe the responses in as much detail as for the 1-dB/50-dB low-

table 2. Component values of 0.18-dB/50.1-dB seven-branch elliptic low-pass filter. 500 ohm, 3-kHz values obtained by multiplying 1 ohm, 1 rad/sec values by 1.061 × 10^{-7} for capacitors and 2.653 × 10^{-2} for inductors.

component	column 1 1 ohm, 1 rad/sec value	column 2 500 ohm, 3 kHz theoretical value, ideal inductors	column 3 500 ohm, 3 kHz rounded value, ideal inductors	column 4 500 ohm, 3 kHz rounded value, real inductors
C1	1.183 F	0.1255 μF	0.12 μF	0.12 μF
C2	0.1853 F	0.0197 μF	0.018 μF	0.018 μF
C3	1.535 F	0.1629 μF	0.15 μF	0.15 μF
C4	0.9576 F	0.1016 μF	0.1 μF	0.1 μF
C5	1.307 F	0.1387 μF	0.15 μF	0.15 μF
C6	0.6755 F	0.0717 μF	0.068 μF	0.068 μF
C7	0.8543 F	0.0906 μF	0.082 μF	0.082 μF
L2	1.203 H	31.92 mH	33 mH	33 mH
L4	0.7482 H	19.85 mH	18 mH	18 mH
L6	0.8217 H	21.80 mH	22 mH	22 mH
R2	—	0 ohms	0 ohms	26 ohms
R4	—	0 ohms	0 ohms	17 ohms
R6	—	0 ohms	0 ohms	19 ohms

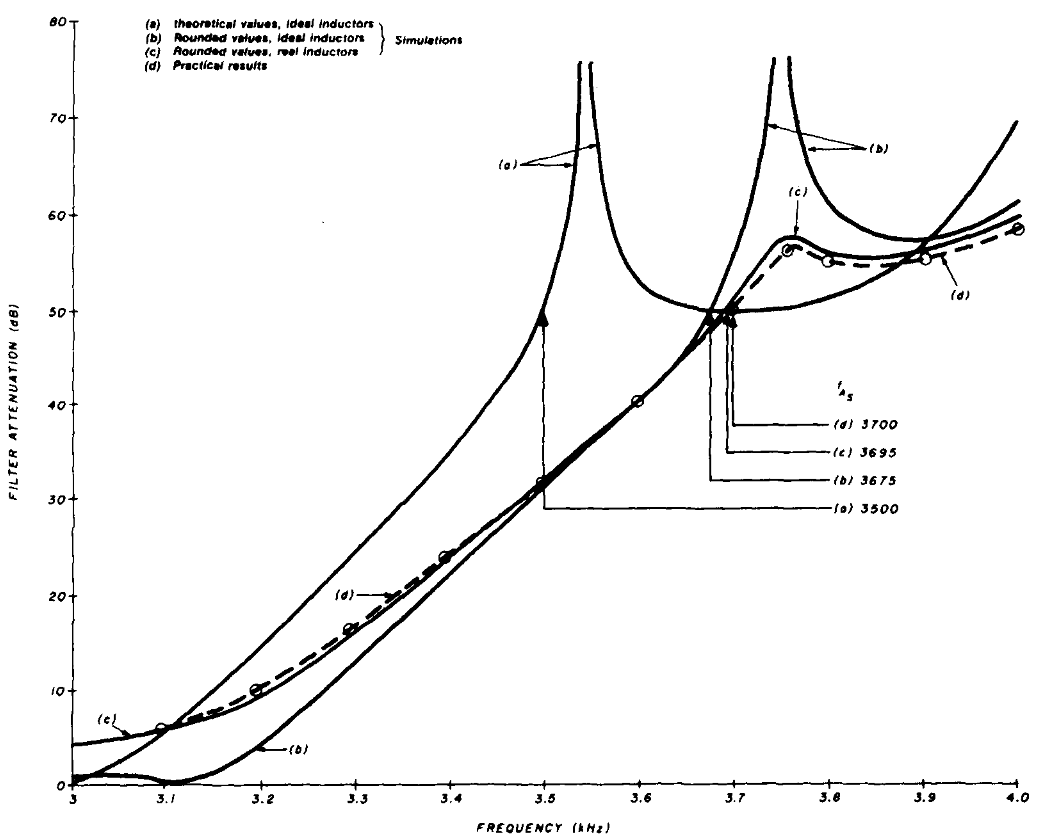


fig. 11. Transition band (and part of stopband) response of 0.18-dB/50.1-dB 7-branch 3-kHz elliptic low-pass filter, showing simulation and practical results.

pass filter; the graphs speak for themselves. The scaled, theoretical value response meets the filter specification exactly. As before, the rounded values, ideal inductor response is very similar to that of the the theoretical values apart from an increase in passband ripple (especially close to the cutoff frequency), a shift in the f2 frequency from 3500 Hz to 3751 Hz, and a corresponding shift in the initial 50.1-dB attenuation frequency (f_{A_S}). The minimum stopband attenuation is approximately 52 dB.

table 3. Component values of 0.18-dB/81-dB seven-branch elliptic low-pass filter. 500-ohm, 3-kHz values obtained by multiplying 1 ohm, 1 rad/sec values by 1.061 × 10^{-7} for capacitors and 2.653 × 10^{-2} for inductors.

component	column 1 1 ohm 1 rad/sec value	column 2 500 ohm, 3 kHz theoretical value, ideal inductors	column 3 500 ohm, 3 kHz rounded value, real inductors
C1	1.280 F	0.1358 μF	0.15 μF
C2	0.065 F	0.0690 μF	0.0068 μF
C3	1.943 F	0.2062 μF	0.22 μF
C4	0.3079 F	0.0327 μF	0.033 μF
C5	1.837 F	0.1949 μF	0.18 μF
C6	0.2183 F	0.0232 μF	0.022 μF
C7	1.145 F	0.1215 μF	0.12 μF
L2	1.321 H	35.05 mH	33 mH
L4	1.183 H	31.38 mH	33 mH
L6	1.157 H	30.70 mH	33 mH
R2	—	0 ohms	26 ohms
R4	—	0 ohms	26 ohms
R6	—	0 ohms	26 ohms

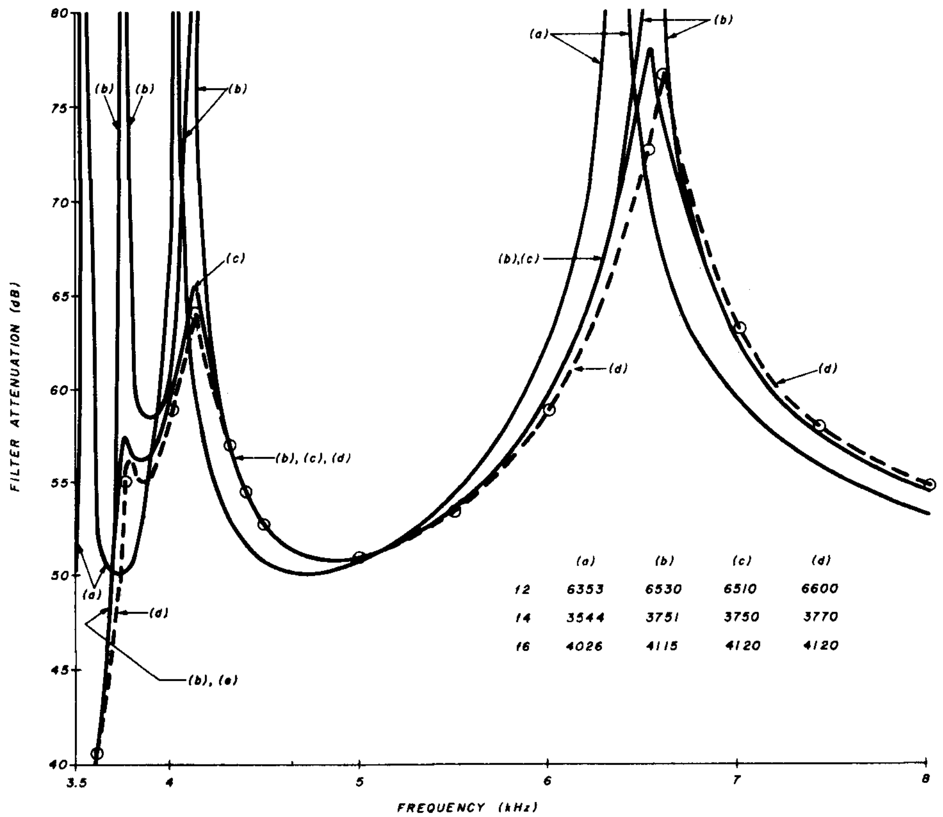
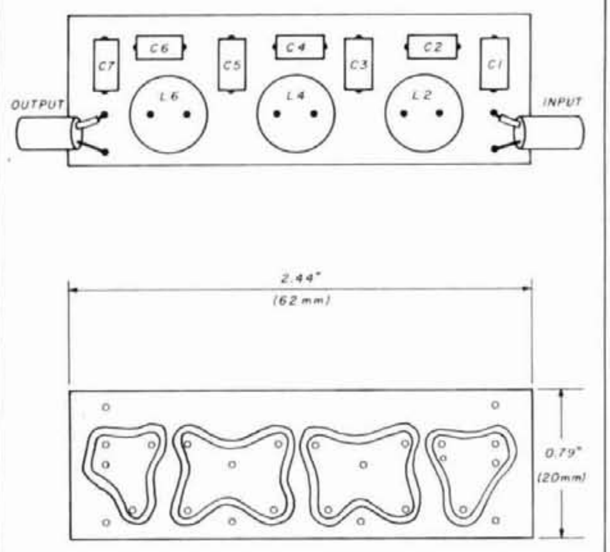


fig. 12. Stopband response of 0.18-dB/50.1-dB 7-branch 3-kHz elliptic low-pass filter, showing simulation and practical results.



Components for 0.18-dB/50.1-dB seven-branch elliptic low-pass filter:

C1 0.12 μF Siemens metalized polyester 5 percent
C2 0.018 μF Siemens metalized polyester 5 percent
C3 0.15 μF Siemens metalized polyester 5 percent
C4 0.1 μF Siemens metalized polyester 5 percent
C5 0.15 μF Siemens metalized polyester 5 percent
C6 0.068 μF Siemens metalized polyester 5 percent
C7 0.082 μF Siemens metalized polyester 5 percent
L2 33 mH Toko 10RB
L4 18 mH Toko 10RB
L6 22 mH Toko 10RB

fig. 13. PCB for foil pattern and component placement for 7-branch elliptic low-pass filter.

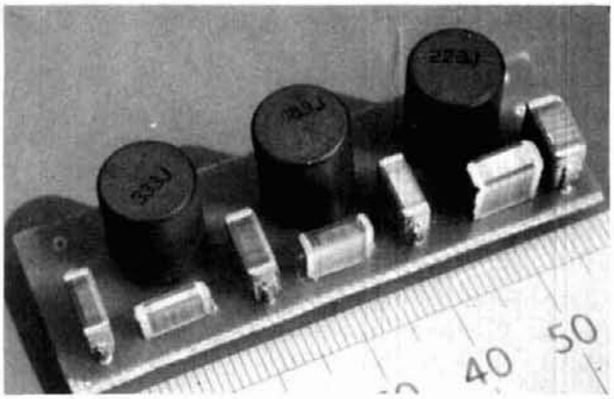


fig. 14. Experimental seven-branch elliptic low-pass filter.

There is close agreement between the simulated rounded values, real inductors' filter response, curve *c*, and the practical results, curve *d*, indicating accurate modeling of the circuit. Insertion loss at 100 Hz is approximately 0.6 dB. Rounding of the passband edge because of the low-Q inductors can clearly be seen. The maximum in stopband attenuation at approximately 3760 Hz is now barely perceptible. Minimum stopband attenuation is approximately 52 dB (compared to the theoretical value of 50.1 dB). With this filter, the stopband attenuation reaches a minimum at a frequency above 10 kHz then increases again to more than 70 dB at 30 MHz.

Figure 13 shows the PCB foil pattern and component layout used for this filter, and **fig. 14** is a photograph of my prototype. Again, if required, this filter can be made considerably smaller.

high stopband attenuation low-pass filters

The two low-pass filters considered so far were specified to have a minimum stopband attenuation of 50 dB and achieved that figure. In theory, at the points of maximum attenuation in the stopband, these filters should have infinite attenuation, but the finite Q of the inductors causes this attenuation to be reduced to typically 55-75 dB, depending on which attenuation peak is considered. Can, therefore, filters with high stopband attenuation be constructed with these inductors?

To answer this question, a 0.18-dB passband ripple, 81-dB minimum stopband attenuation seven-branch elliptic low-pass filter was selected[18] and scaled to 500 ohms, 3 kHz. **Table 3** shows the component values for this filter. The expected start of stopband frequency (f_{A_S}) is 4872 Hz, corresponding to a

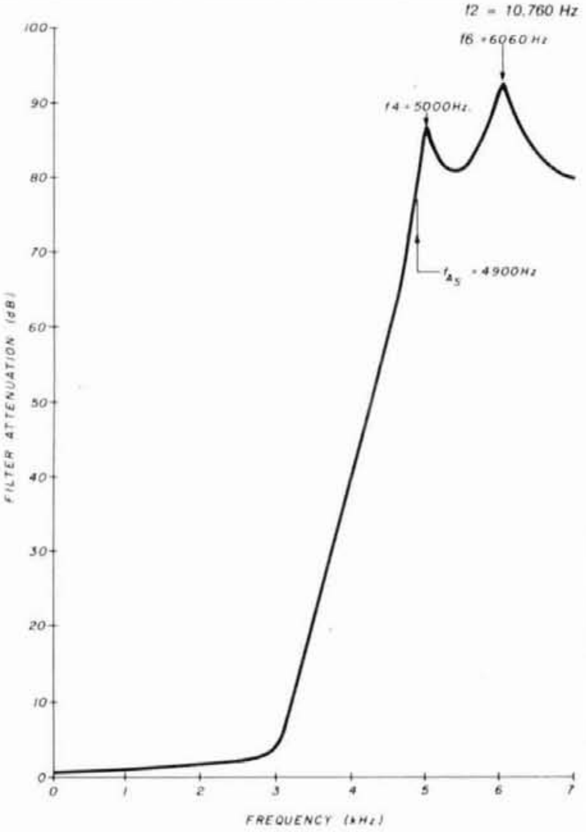


fig. 15. 0-7.5 kHz response of 0.18-dB/81-dB 7-branch elliptic low-pass filter showing practical results only.

normalized start of stopband *angular* frequency of 1.624 *radians/second.*

Detailed simulation results for this filter are not given here and I have only shown the practical results when the layout of **fig. 13** was used. These results are shown in **fig. 15.**

As we expected, the actual passband response has greater ripple (exceeds the 0.18 dB theoretical value) and has rounded corners. The insertion loss at 100 Hz is approximately 0.4 dB. Stopband attenuation shows a minimum of approximately 80 dB above the measured (f_{A_S}) of 4900 Hz. The two maxima of stopband attenuation below 10 kHz occur at approximately 5000 Hz and 6060 Hz, with values of 86 and 92 dB respectively. A further maximum of 93 dB occurs at 10,760 Hz.

This example shows that despite the use of low-*Q* inductors, high stopband attenuation can still be obtained if required in a particular application.

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appendix
elliptic low-pass filter terminology

The schematic of a five-branch elliptic low-pass filter is shown in **fig. A1(A).** The ideal response of this filter is shown in **fig. A1 (B).**

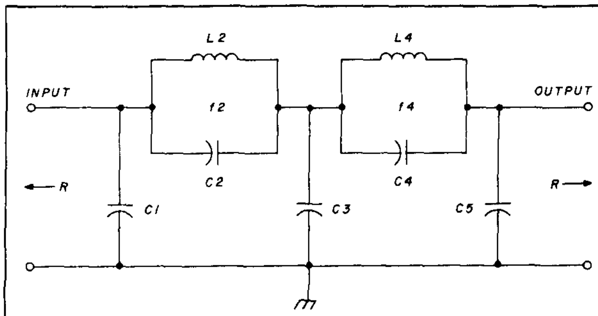

fig. A1(A). Schematic diagram of a 5-branch elliptic low-pass filter.

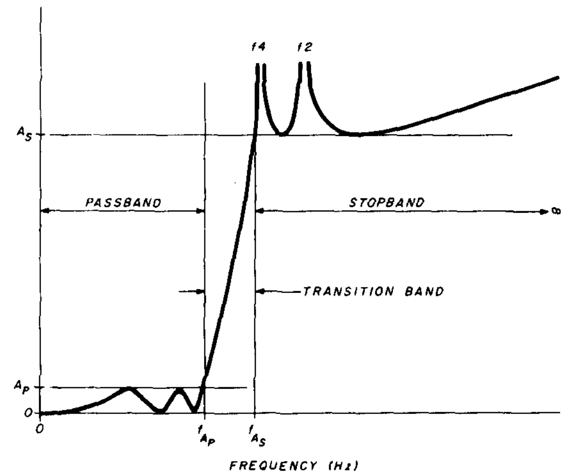

fig. A1(B). Ideal response of a 5-branch elliptic low-pass filter.

Some of the terms used in describing elliptic filters are explained below.

- **Passband ripple.** A variation in the passband attenuation between zero and some maximum value, A_p. The number of half cycles of ripple is equal to the number of branches of the filter.
- **Minimum stopband attenuation.** The value of stopband attenuation, designated A_s, below which the attenuation never falls having once achieved this value.
- **Maxima in stopband attenuation.** Frequencies within the stopband region, designated f2 and f4, at which the attenuation is infinite due to the resonances of L2/C2 and L4/C4 respectively.
- **Ripple cutoff frequency.** The frequency, designated f_{A_p}, at which the attenuation first exceeds the A_p value.
- **Start of stopband frequency.** The frequency, designated f_{A_s}, at which the attenuation first exceeds the A_s value.

Tables of component values for filter designs usually give normalized values; that is, values which produce a filter with source and load impedance values of 1 ohm and a cutoff frequency (angular) of 1 rad/sec. To obtain practical component values for impedance of R ohms and a cutoff frequency of f Hz, multiply all inductor values by $\frac{R}{2\pi f}$ and all capacitor values by $\frac{1}{2\pi f R}$.

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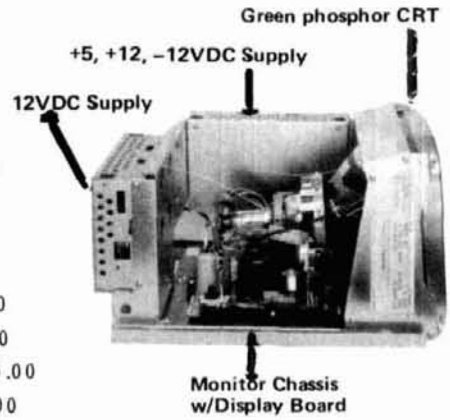

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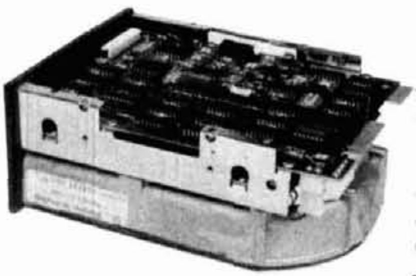

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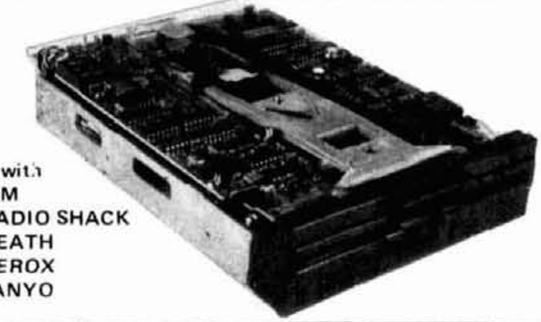

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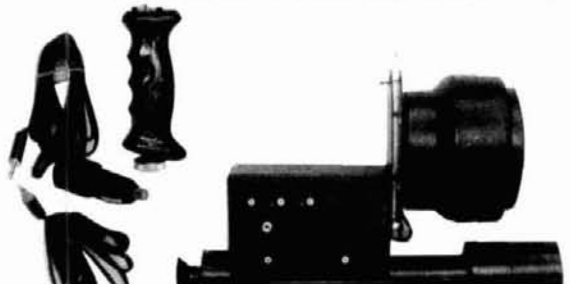

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adjusting SSB amplifiers

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How many times have you had your on-the-air conversations interrupted by someone who's more than 5 kHz from the frequency you're using? I can't remember how many times this has happened to me.

Splatter is rude and unnecessary. It *ought* to be against FCC rules — but it isn't. Part 97 of the Amateur Radio Rules states, in 97.73, (under "purity of emissions," paragraph *d*) that spurious radiation causing harmful interference to the reception of another radio station is against the rules, and that the licensee responsible for it may be required to eliminate the interference. At first this sounds good, but there's a note that explains that they're only talking about the garbage that slips outside of the Amateur band. In other words, if an operator on 14,275 kHz splatters ±50 kHz, he's in compliance with Part 97 because his spurious emissions *inside* the Amateur Radio bands are specifically exempted by the note that follows paragraph *d*. If the same splattering station were to move up to 14,310 kHz, the splatter would extend beyond the Amateur band and a violation of the rules would occur.

It seems, then, that the only way to avoid stations who splatter would be to operate near the band edge with a clean signal. Dirty stations operating in this area are likely to spill over the band edge and receive FCC citations.

The most common cause of splatter is a mis-adjusted "linear" amplifier. Linear amplifiers are far from foolproof; in fact, they're easy to operate non-linearly. There are many different settings of the tune and load controls, and only one combination will represent the best compromise between linearity and power output.

Without a doubt, the two-tone test, used in conjunction with an oscilloscope, is the best method of adjusting a linear amplifier. Unfortunately, the two-tone generator and a good oscilloscope cost more than many linear amplifiers.

A second method is the single-tone test. This involves inserting a single frequency — usually with the CW mode on the transmitter, or transceiver — at the maximum carrier level, and adjusting the linear amplifier for maximum power output by alternately adjusting the plate-tune and load controls. This method can be improved if the loading control is increased (for less capacitance) slightly beyond the point where the power peaks. At this point the linearity will be improved and the power output drops, just perceptibly. But this method places a terrible strain on the amplifier tubes and power supply. If the operator makes an error during this procedure, the tubes are likely to be damaged because the duty cycle is 100 percent.

Another problem with the single-tone test is that the average amplifier power supply is not designed to supply the 2500 watts of key-down power needed for the legal output of 1500 watts, assuming a typical efficiency of 60 percent. The average table-top 1500 watt output linear amplifier appears to have a 600 watt CCS plate transformer. This is completely satisfactory in SSB service, but it is not intended for full throttle single-tone tune-up.

Reducing the carrier level on tune-up would reduce the strain, but reduced carrier level results in reduced peak plate current in the amplifier tubes. Because peak plate current and peak AC plate voltage determine the plate load impedance, altering one would upset the

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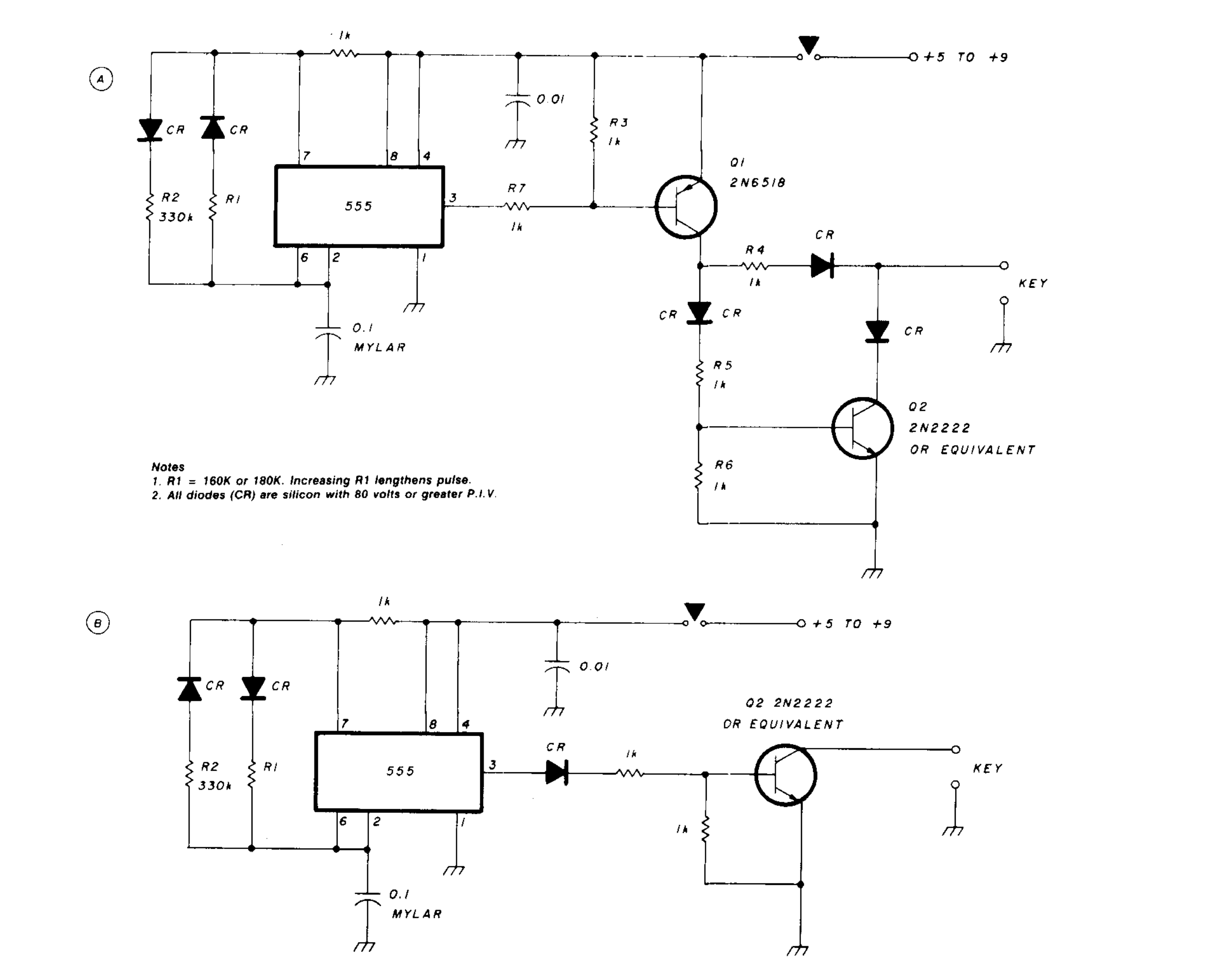

fig. 1. Schematic of a tuning pulser circuit. (A) for positive or negative keyed transmitters, and (B) for positive-keyed transmitters only.

adjustment, since the plate tune and load controls would be set to match a different plate load than will be encountered on voice peaks. This mis-adjustment method will make the amplifier splatter and beat up the grids of the common grounded-grid, class AB_2 amplifier because of excessive grid current.

Yet another problem with the single tone, or A-zero (AØ) tune-up is that it's not permitted, except for short periods below 51 MHz — but the chance of being cited for AØ emission is probably slim in comparison to the chance of experiencing a melt-down.

So the problem is how to tune-up a linear amplifier, linearly and safely, without spending a lot of money. The solution is obviously some device that will produce maximum peak plate current with a human voice duty-cycle, which is about 33 percent on the average. For ease of adjustment, the device must also produce steady meter indications.

The circuit shown in **fig. 1A** is a solution to the problem. It consists of a 555 timer and two transistor switches, one for positive keyed transmitters and the other for negative keyed transmitters. The 555 timing resistors have steering diodes so that the charge and discharge times are different by the ratio of 2:1. This produces a duty cycle of 0.3333, or one-third. The output of the 555 is high for about 24 ms and low for about 12 ms. When the base of Q1 goes low, it is forward biased and conducts collector current through R5 and the base of Q2, whose collector is then switched on. During the 24 ms high interval, the base-to-emitter voltage of Q1 is zero, which turns Q1 off, which then turns Q2 off. This causes the amplifier to work hard for 12 ms, then rest for 24 ms, alternately working and resting until the tuning process is complete.

The circuit shown in **fig. 1B**, which will key positive voltages only, requires fewer parts than the previously described circuit. (Most transceivers built today are positive-keyed.)

The pulser should be enclosed in a metal box or open-button metal chassis. (I used a 3 × 5 × 1 inch/7

× 12 × 2.5 cm open bottom chassis.) The keying lead to the transceiver should be shielded. These precautions will help to keep RF, which would interfere with proper operation, out of the pulser.

A good method of powering the pulser is to use four AA penlight batteries. There's plenty of room in the box for a four-cell AA holder, and the added milliampere hour capacity advantage over a 9-volt battery makes the AA cells a good choice.

Either circuit can be built on a piece of perfboard in less than one hour, so it isn't worth the trouble of making a printed circuit board unless you're going to make several tuning pulsers for Christmas presents.

using the tuning pulser

Set the transceiver to CW. Turn on the pulser and advance the carrier control until you have some ALC. If your exciter has an individual band tune feature, adjust it for maxiumum relative output.

Now turn on your amplifier and set the plate voltage to SSB. Key the pulser again and tune for maximum relative output on the plate tune and load controls. Sometimes a slight improvement in linearity can be had by loading the amplifier past the peak in output until the relative output drops about 2 percent.

Normal readings of plate current using the tuning pulser should be approximately one-third of what you would see with a steady carrier. Average-reading RF wattmeters are good for relative indications only, when tuning with the pulser. The indicated wattage cannot be simply multiplied by 3 to find the peak power because the time constant of the meter is unknown.

If you own a linear amplifier that uses sweep tubes, which are easily damaged by normal tune-up methods, a tuning pulser could provide increased tube life.

Another use for the tuning pulser is in locating loose hardware (such as clotheslines, rain gutters, or rusty guy-wires), that may be causing TVI by metal-oxide diode-rectification. Such problems usually occur only at or near the peak-power level. Running the typical amplifier key-down for the length of time needed to locate the fault is risky. With the tuning pulser, the amplifier can generate full peak power with little risk of damage, even for lengthy periods of time. A harmonic "sniffing" device is then used to determine the location of the fault. (Normal operating courtesies still apply; check the frequency first with your receiver, keep the tests short, and try to make your tests when the band is dead. — Ed)

ham radio

understanding telephones

Everybody has one. But what makes it work?

Although telephones and telephone company practices may vary dramatically from one country to another, and even from one locality to another, the basic principles underlying the way they work remain unchanged.

Every telephone consists of three separate subassemblies, each capable of independent operation. These assemblies are the *speech network*, the *dialing mechanism*, and the *ringer* or *bell*. Together, these parts — as well as any additional devices such as modems, dialers, and answering machines — are attached to the *phone line*.

the phone line

A telephone is usually connected to the telephone exchange by about three miles (4.83 km) of a twisted pair of No. 22 (AWG) or 0.5 mm copper wires, known by your phone company as "the loop." Although copper is a good conductor, it does have resistance. The resistance of No. 22 AWG wire is 16.46 ohms per thousand feet at 77 degrees F (25 degrees C). In the United States, wire resistance is measured in ohms per thousand feet; telephone companies describe loop length in kilofeet (thousands of feet). In other parts of the world, wire resistance is usually expressed as Ohms per kilometer.

Because telephone apparatus is generally considered to be current driven, all phone measurements refer to current *consumption*, not voltage. The length of the wire connecting the subscriber to the telephone exchange affects the total amount of current that can be drawn by anything attached at the subscriber's end of the line.

In the United States, the voltage applied to the line to drive the telephone is 48 VDC; some countries use 50 VDC. Note that telephones are peculiar in that the signal line is also the power supply line. The voltage is supplied by lead acid cells, thus assuring a hum-free supply and complete independence from the electric company, which may be especially useful during power outages.

At the telephone exchange the DC voltage and audio signal are separated by directing the audio signal through 2 μF capacitors and blocking the audio from the power supply with a 5-Henry choke in each line. Usually these two chokes are the coil windings of a relay that switches your phone line at the exchange; in the United States, this relay is known as the "A" relay (see **fig. 1**). The resistance of each of these chokes is 200 ohms.

We can find out how well a phone line is operating by using Ohm's law and an ammeter. The DC resistance of any device attached to the phone line is often quoted in telephone company specifications as either 600 or 900 ohms; this will vary from one country to another. But the resistance may, in fact, vary from 300 to 1,000 ohms.

Using these figures you can estimate the distance between your telephone and the telephone exchange. In the United States, the telephone company guarantees you no lower current than 20 mA — or what is known to your phone company as a "long loop." A "short loop" will draw 50 to 70 mA, and an average

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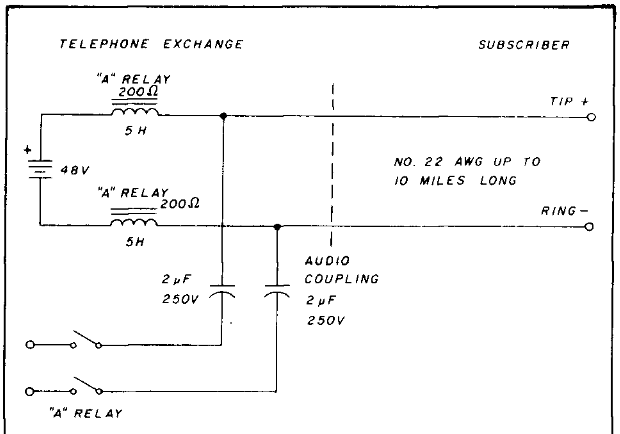

fig. 1. The phone line.

loop, about 35 mA. Some countries will consider their maximum loop as low as 12 mA. In practice, United States telephones are usually capable of working at currents as low as 14 mA. Some exchanges will consider your phone in use and feed dial tone down the line with currents as low as 8 mA, even though the telephone may not be able to operate.

Although the telephone company has supplied plenty of nice clean DC direct to your home, don't assume you have a free battery for your own circuits. The telephone company wants the DC resistance of your line to be about 10 Megohms when there's no apparatus in use ("on hook," in telephone company jargon); you can draw no more than 5 microamperes while the phone is in that state. When the phone is in use, or "off hook," you can draw current, but you'll need that current to power your phone. Any current you might draw for other purposes would tend to lower the signal level.

The phone line has an impedance composed of distributed resistance, capacitance, and inductance. The impedance will vary according to the length of the loop, the type of insulation of the wire, and whether the wire is aerial cable, buried cable, or bare parallel wires strung on telephone poles. For calculation and specification purposes, the impedance is normally assumed to be 600 or 900 ohms. If the instrument attached to the phone line should be of the wrong impedance, you'd get a mismatch, or what telephone company personnel refer to as "return loss." (Radio Amateurs will recognize return loss as SWR.) A mismatch on telephone lines results in echo and whistling, which the phone company calls "singing" and owners of very cheap telephones may have come to expect. A mismatched device can, by the way, be matched to the phone line by placing resistors in parallel or series with the line to bring the impedance of the device to within the desired limits. This will cause some signal loss, of course, but will make the device usable.

A phone line is a balanced feed, with each side equally balanced to ground. Any imbalance will introduce hum and noise to the phone line and increase susceptability to RFI.

The balance of the phone line is known to your telephone company as "longitudinal balance." If both impedance match and balance to ground are kept in mind, any device attached to the phone line will perform well, just as the correct matching of transmission lines and devices will ensure good performance in radio practice.

If you live in the United States, the two phone wires connected to your telephone should be red and green. (In other parts of the world they may be different colors.) The red wire is negative and the green wire is positive. Your telephone company calls the green wire "Tip" and the red wire "Ring." (In other parts of the world, these wires may be called "A" and "B".) Most installations have another pair of wires, yellow and black. These wires can be used for many different purposes, if they're used at all. Some party lines use the yellow wire as a ground; sometimes there's 6.8 VAC on this pair to light the dials of Princess® type phones. If you have two separate phone lines (not extensions) in your home, you'll find the yellow and black pair carrying a second telephone line. In this case, black is "Tip" and yellow is "Ring."

The above description applies to a standard line with a DC connection between your end of the line and the telephone exchange. Most phone lines in the world are of this type, known as a "metallic line." In a metallic line, there may or may not be inductance devices placed in the line to alter the frequency response of the line; the devices used to do this are called "loading coils." (Note: if they impair the operation of your modem, your telephone company can remove them.) Other types of lines are party lines, which may be metallic lines but require special telephones to allow the telephone company to differentiate between subscribers. Very long lines may have amplifiers, sometimes called "loop extenders"on them. Some telephone companies use a system called "subscriber carrier," which is basically an RF system in which your telephone signal is heterodyned up to around 100 kHz and then sent along another subscriber's "twisted pair."

If you have questions about your telephone line, you can call your telephone company; depending on the company and who you can reach, you may be able to obtain a wealth of information.

the speech network

The speech network — also known as the "hybrid" or the "two wire/four wire network" — takes the incoming signal and feeds it to the earpiece and takes

the microphone output and feeds it down the line. The standard network used all over the world is an LC device with a carbon microphone; some newer phones use discrete transistors or ICs.

One of the advantages of an LC network is that it has no semiconductors, is not voltage sensitive, and will work continuously as the voltage across the line is reduced. Many transistorized phones stop working as the voltage approaches 3 to 4 volts.

When a telephone is taken off the hook, the line voltage drops from 48 volts to between 9 and 3 volts, depending on the length of the loop. If another telephone in parallel is taken off the hook, the current consumption of the line will remain the same and the voltage across the terminals of both telephones will drop. Bell Telephone specifications state that three telephones should work in parallel on a 20 mA loop; transistorized phones tend not to pass this test, although some manufacturers use ICs that will pass. Although some European telephone companies claim that phones working in parallel is "technically impossible," and discourage attempts to make them work that way, some of their telephones *will* work in parallel.

While low levels of audio may be difficult to hear, overly loud audio can be painful. Consequently, a well designed telephone will automatically adjust its transmit and receive levels to allow for the attenuation — or lack of it — caused by the length of the loop. This adjustment is called "loop compensation." In the United States, telephone manufacturers achieve this compensation with silicon carbide varistors that consume any excess current from a short loop (see **fig. 2**). Although some telephones using ICs have built-in loop compensation, many do not; the latter have been designed to provide adequate volume on the average loop, which means that they provide low volume on long loops, and are too loud on short loops. Various countries have different specifications for transmit and receive levels; some European countries require a higher transmit level than is standard in the United States so a domestically-manufactured telephone may suffer from low transmit level if used on European lines without modification.

Because a telephone is a duplex device, both transmitting and receiving on the same pair of wires, the speech network must ensure that not too much of the caller's voice is fed back into his or her receiver. This function, called "sidetone," is achieved by phasing the signal so that some cancellation occurs in the speech network before the signal is fed to the receiver. Callers faced with no sidetone at all will consider the phone "dead." Too little sidetone will convince callers that they're not being heard and cause them to shout, "I can hear you. Can you hear *ME?*" Too much sidetone causes callers to lower their voices and not be heard well at the other end of the line.

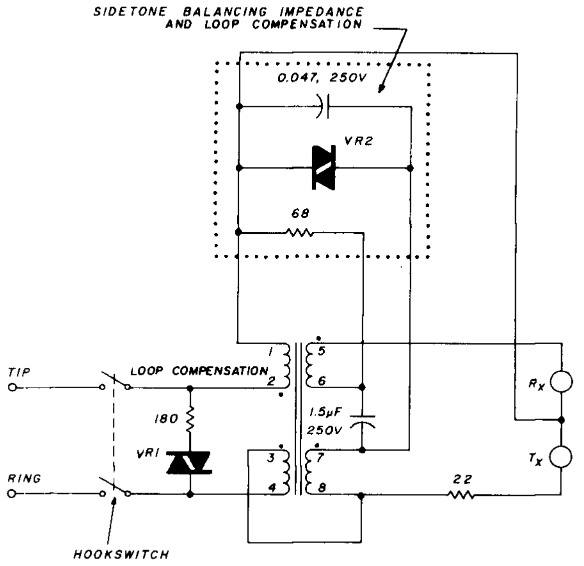

fig. 2. Telephone speech network. (Note: while *ham radio* designates varistors as *CR*, telephone companies customarily use the designation *VR*. — Ed.)

A telephone on a short loop with no loop compensation will appear to have too much sidetone, and callers will lower their voices. In this case, the percentage of sidetone is the same, but as the overall level is higher the sidetone level will also be higher.

the dial

There are two types of dials in use around the world. The most common one is called pulse, loop disconnect, or rotary; the oldest form of dialing, it's been with us since the 1920's. The other dialing method, more modern and much loved by Radio Amateurs is called Touchtone Dual Tone Multi-Frequency (DTMF) or Multi-Frequency (MF).

Pulse dialing is traditionally accomplished with a rotary dial, which is a speed governed wheel with a cam that opens and closes a switch in series with your phone and the line. It works by actually disconnecting or "hanging up" the telephone at specific intervals. The United States standard is one disconnect per digit, so if you dial a "1," your telephone is "disconnected" once. Dial a seven and you'll be "disconnected" seven times; dial a zero, and you'll "hang up" ten times. Some countries invert the system so "1" causes ten "disconnects" and 0, one disconnect. Some add a digit so that dialing a 5 would cause six disconnects and 0, eleven disconnects. There are even some systems in which dialing 0 results in one disconnect, and all other digits are *plus one*, making a 5 cause six disconnects and 9, ten disconnects.

Although most exchanges are quite happy with rates of 6 to 15 Pulses Per Second (PPS), the phone company accepted standard is 8 to 10 PPS. Some

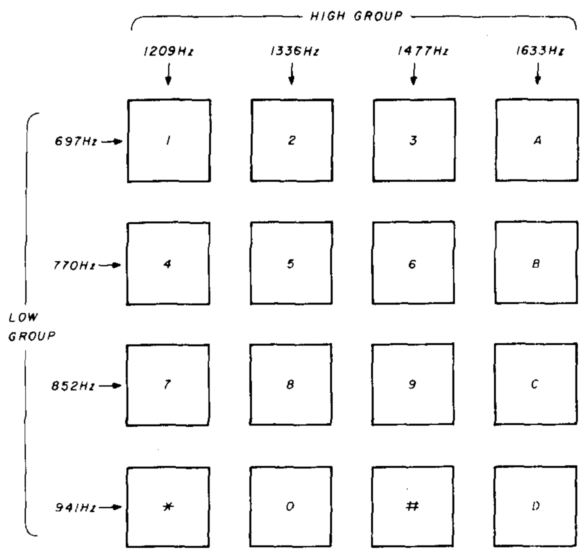

fig. 3. Standard DTMF pad and frequencies.

modern digital exchanges, free of the mechanical inertia problems of older systems, will accept a PPS rate as high as 20.

Besides the PPS rate, the dialing pulses have a make/break ratio, usually described as a percentage, but sometimes as a straight ratio. The North American standard is 60/40 percent; most of Europe accepts a standard of 63/37 percent. This is the pulse measured at the telephone, not at the exchange, where it's somewhat different, having travelled through the phone line with its distributed resistance, capacitance, and inductance. In practice, the make/break ratio does not seem to affect the performance of the dial when attached to a normal loop. Bear in mind that each pulse is a switch connect and disconnect across a complex impedance, so the switching transient often reaches 300 volts. Try not to have your fingers across the line when dialing.

Most pulse dialing phones produced today use a CMOS IC and a keyboard. Instead of pushing your finger round in circles, then removing your finger and waiting for the dial to return before dialing the next digit, you punch the button as fast as you want. The IC stores the number and pulses it out at the correct rate with the correct make/break ratio and the switching is done with a high-voltage switching transistor. Because the IC has already stored the dialed number in order to pulse it out at the correct rate, it's a simple matter for telephone designers to keep the memory "alive" and allow the telephone to store, recall, and redial the Last Number Dialed (LND). This feature enables you to redial by picking up the handset and pushing just one button.

Because pulse dialing entails rapid connection and disconnection of the phone line, you can "dial" a telephone that has lost its dial, by hitting the hookswitch rapidly. It requires some practice to do this with consistent success, but it can be done. A more sophisticated approach is to place a Morse key in series with the line, wire it as normally closed and send strings of dots corresponding to the digits you wish to dial.

Touchtone, the most modern form of dialing, is fast and less prone to error than pulse dialing. Compared to pulse, its major advantage is that its audio band signals can travel down phone lines further than pulse, which can travel only as far as your local exchange. Touchtone can therefore send signals around the world via the telephone lines, and can be used to control phone answering machines and computers. Pulse dialing is to touchtone as FSK or AFSK RTTY is to Switched Carrier RTTY, where mark and space are sent by the presence or absence of DC or unmodulated RF carrier. Most Radio Amateurs are familiar with DTMF for controlling repeaters and for accessing remote and auto phone patches.

Bell Labs developed DTMF in order to have a dialing system that could travel across microwave links and work rapidly with computer controlled exchanges. Each transmitted digit consists of two separate audio tones that are mixed together (see **fig. 3**). The four vertical columns on the keypad are known as the high group and the four horizontal rows as the low group; the digit 8 is composed of 1336 Hz and 852 Hz. The level of each tone is within 3 dB of the other, (the telephone company calls this "Twist"). A complete touchtone pad has 16 digits, as opposed to ten on a pulse dial. Besides the numerals 0 to 9, a DTMF "dial" has *, #, A, B, C, and D. Although the letters are not normally found on consumer telephones, the IC in the phone is capable of generating them.

The * sign is usually called "star" or "asterisk." The # sign, often referred to as the "pound sign." is actually called an *octothorpe*. Although many phone users have never used these digits — they're not, after all, ordinarily used in dialing phone numbers — they are used for control purposes, phone answering machines, bringing up remote bases, electronic banking, and repeater control. The one use of the octothorpe that may be familiar occurs in dialing international calls from phones in the United States. After dialing the complete number, dialing the octothorpe lets the exchange know you've finished dialing. It can now begin routing your call; without the octothorpe, it would wait and "time out" before switching your call.

When DTMF dials first came out they had complicated cams and switches for selecting the digits and used a transistor oscillator with an LC tuning network to generate the tones. Modern dials use a matrix switch and a CMOS IC that synthesizes the tones from a 3.57 MHz (TV color burst) crystal. This oscillator runs only during dialing, so it doesn't normally produce QRM.

Standard DTMF dials will produce a tone as long as a key is depressed. No matter how long you press, the tone will be decoded as the appropriate digit. The shortest duration in which a digit can be sent and decoded is about 100 milliseconds (ms). It's pretty difficult to dial by hand at such a speed, but automatic dialers can do it. A twelve-digit long distance number can be dialed by an automatic dialer in a little more than a second — about as long as it takes a pulse dial to send a single 0 digit.

The output level of DTMF tones from your telephone should be between 0 and −12 dBm. In telephones, 0 dB is 1 milliwatt over 600 ohms. So 0 dB is 0.775 volts. Because your telephone is considered a 600 ohm load, placing a voltmeter across the line will enable you to measure the level of your tones.

the ringer

Simply speaking this is a device that alerts you to an incoming call. It may be a bell, light, or warbling tone. The telephone company sends a ringing signal which is an AC waveform. Although the common frequency used in the United States is 20 Hz, it can be any frequency between 15 and 68 Hz. Most of the world uses frequencies between 20 and 40 Hz. The voltage at the subscriber's end depends upon loop length and number of ringers attached to the line; it could be between 40 and 150 volts. Note that ringing voltage can be hazardous; when you're working on a phone line, be sure at least one telephone on the line is off the hook (in use); if any are not, take high voltage precautions. The telephone company may or may not remove the 48 VDC during ringing; as far as you're concerned, this is not important. *Don't take chances.*

The ringing cadence — the timing of ringing to pause — varies from company to company. In the United States the cadence is normally 2 seconds of ringing to 4 seconds of pause. An unanswered phone in the United States will keep ringing until the caller hangs up. But in some countries, the ringing will "time out" if the call is not answered.

The most common ringing device is the gong ringer, a solenoid coil with a clapper that strikes either a single or double bell. A gong ringer is the loudest signaling device that is solely phone-line powered.

Modern telephones tend to use warbling ringers, which are usually ICs powered by the rectified ringing signal. The audio transducer is either a piezoceramic disk or a small loudspeaker via a transformer.

Ringers are isolated from the DC of the phone line by a capacitor. Gong ringers in the United States use a 0.47 μF capacitor. Warbling ringers in the United States generally use a 1.0 μF capacitor. Telephone companies in other parts of the world use capacitors between 0.2 and 2.0 μF. The paper capacitors of the past have been replaced almost exclusively with capacitors made of Mylar film. Their voltage rating is always 250 volts.

The capacitor and ringer coil, or Zeners in a warbling ringer, constitute a resonant circuit. When your phone is hung up ("on hook") the ringer is across the line; if you've turned off the ringer you've merely silenced the transducer, not removed the circuit from the line.

When the telephone company uses the ringer to test the line, it sends a low-voltage, low-frequency signal down the line (usually 2 volts at 10 Hz) to test for continuity. The company keeps records of the expected signals on your line. This is how it can tell if you've added equipment to your line. If your telephone has had its ringer disconnected, the telephone company cannot detect its presence on the line.

Because there is only a certain amount of current available to drive ringers, if you keep adding ringers to your phone line you'll reach a point at which either all ringers will cease to ring, some will cease to ring, or some ringers will ring weakly. In the United States the phone company will guarantee to ring five normal ringers. A normal ringer is defined as a standard gong ringer as supplied in a phone company standard desk telephone. The value given to this ringer is *Ringer Equivalence Number (REN) 1.* If you look at the FCC registration label of your telephone, modem, or other device to be connected to the phone line, you'll see the *REN* number. It can be as high as 3.2, which means that device consumes the equivalent power of 3.2 standard ringers, or 0.0, which means it consumes no current when subjected to a ringing signal. If you have problems with ringing, total up your RENs; if the total is greater than 5, disconnect ringers until your REN is at 5 or below.

Other countries have various ways of expressing REN, and some systems will handle no more than three of their standard ringers. But whatever the system, if you add extra equipment and the phones stop ringing, or the phone answering machine won't pick up calls, the solution is disconnect ringers until the problem is resolved. Warbling ringers tend to draw less current than gong ringers, so changing from gong ringers to warbling ringers may help you spread the sound better.

Frequency response is the second criterion by which a ringer is described. In the United States most gong ringers are electromechanically resonant. They are usually resonant at 20 and 30 Hz (±3 Hz). The FCC refers to this as *A* so a normal gong ringer is described as *REN 1.0A.* The other common frequency response is known as type B. Type B ringers will respond to signals between 15.3 and 68.0 Hz. Warbling ringers are all type B and some United States gong ringers are type B. Outside the United States, gong ringers appear to be non-frequency selective, or type B.

Because a ringer is supposed to respond to AC waveforms, it will tend to respond to transients (such as switching transients) when the phone is hung up, or when the rotary dial is used on an extension phone. This is called "bell tap" in the United States; in other countries, it's often called "bell tinkle." While European and Asian phones tend to bell tap, or tinkle, United States ringers that bell tap are considered defective. The bell tap is designed out of gong ringers and fine tuned with bias springs. Warbling ringers for use in the United States are designed not to respond to short transients; this is usually accomplished by rectifying the AC and filtering it before it powers the IC, then not switching on the output stage unless the voltage lasts long enough to charge a second capacitor.

conclusion

This brief primer describing the working parts of a telephone is intended to provide a better understanding of phone equipment. Note that most telephone regulatory agencies, including the FCC, forbid modification of anything that has been previously approved or attached to phone lines.

ham radio

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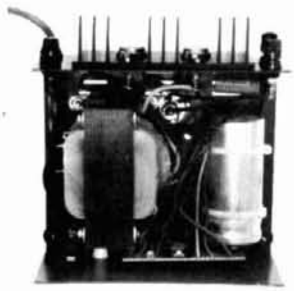

INSIDE VIEW — RS-12A

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MODEL RS-50A

MODEL RS-50M

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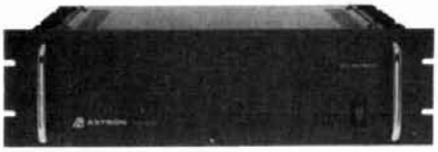

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Model	Continuous Duty (AMPS)	ICS* (AMPS)	Size (IN) HXWXD	Shipping Wt. (lbs.)
RM-35A	25	35	5¼ × 19 × 12½	38
RM-50A	37	50	5¼ × 19 × 12½	50
RM-35M	25	35	5¼ × 19 × 12½	38
RM-50M	37	50	5¼ × 19 × 12½	50

RS-A SERIES

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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

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MODEL VS-20M

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- 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

More Details? CHECK—OFF Page 158

✓ 170

a DTMF controller for repeaters

This multifunctional, expandable decoder uses high quality components — but doesn't cost a fortune to build

Remote control of the various functions of a repeater is usually accomplished through the use of dual-tone multifrequency (DTMF) signals generated in a pushbutton touchtone pad. These signals can also be generated in computer-controlled synthesizers, but the end result is always the same — a series of tone-encoded signals that must be detected and decoded to perform the intended function. Over the years a number of articles have appeared in Amateur publications concerning the decoding of the DTMF signal, but what to do with the decoded signals has often remained in question. The circuit described in this article may help to answer that question and perhaps encourage repeater technical committees whose members are thinking about modernizing or expanding their control circuitry.

This multifunctional, expandable decoder features full DTMF decoding, multi-digit coding, latching output, multi-source reset and a separate auxiliary output, for use by system logic. It's DC coupled to greatly reduce falses from noise, and expandable. No adjustments are necessary; no tedious alignment or periodic tweaking are required. Its circuits detect the sequence in which the decoded DTMF signals are received and, if the, sequence is correct, provide a latched open-collector output that can be used to activate the intended function.

circuit description

Two basic circuits comprise the DTMF controller: a DTMF decoder and a sequence detector (see **fig. 1**). For practical repeater control it may be preferable to locate these two circuits on separate PC boards. However, for purposes of explanation, consider them to be located on one subassembly.

The heart of the DTMF decoder is the SSI-201, manufactured by Silicon Systems, Inc. I won't go into details of the chip's operation, except to say that it represents a quantum leap beyond the traditional 567 decoder and exhibits central-office quality with respect to immunity to talk-off and noise falsing. This circuit was described in *ham radio* by KC9C[1] and is esentially lifted from the data sheet* provided by the manufacturer.

One addition that I made was to add the low-pass filter consisting of R1, R2, C1, and C2 (see **fig. 2**), which significantly improved the chip's tolerance to different pads in the field. No problems were encountered when the DTMF tones were generated in a Western Electric Series 35 pad, or equivalent. However, the vagaries of synthesized DTMF generators found in a variety of HTs and DTMF microphones made the decoder a little fussy — some pads would work, while others would not. Since the addition of the LPF, none of the pads used to access the decoder has failed to produce the correct outputs.

When the correct tone pair is received at pin 12 of U1, a hexadecimal output is generated on pins 1, 20, 21, and 22. These four data lines are applied directly

*Data sheet available from Silicon Systems, Inc., 14351 Myford Road, Tustin, California 92680.

By Terry Simonds, WB4FXD, PO Box 1558, Edgartown, Massachusetts 02539

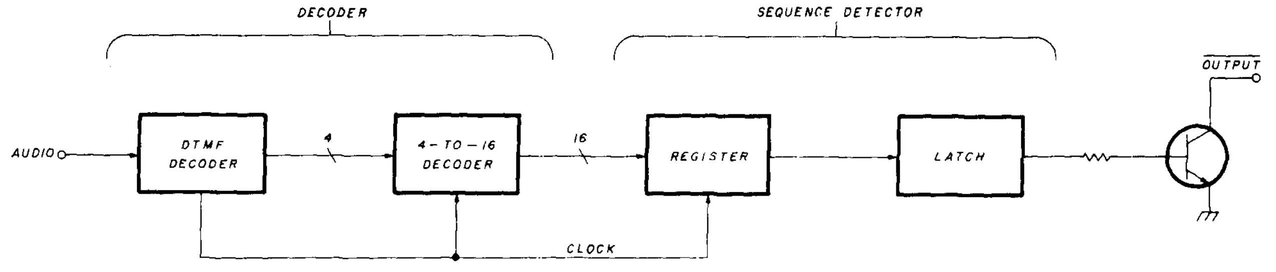
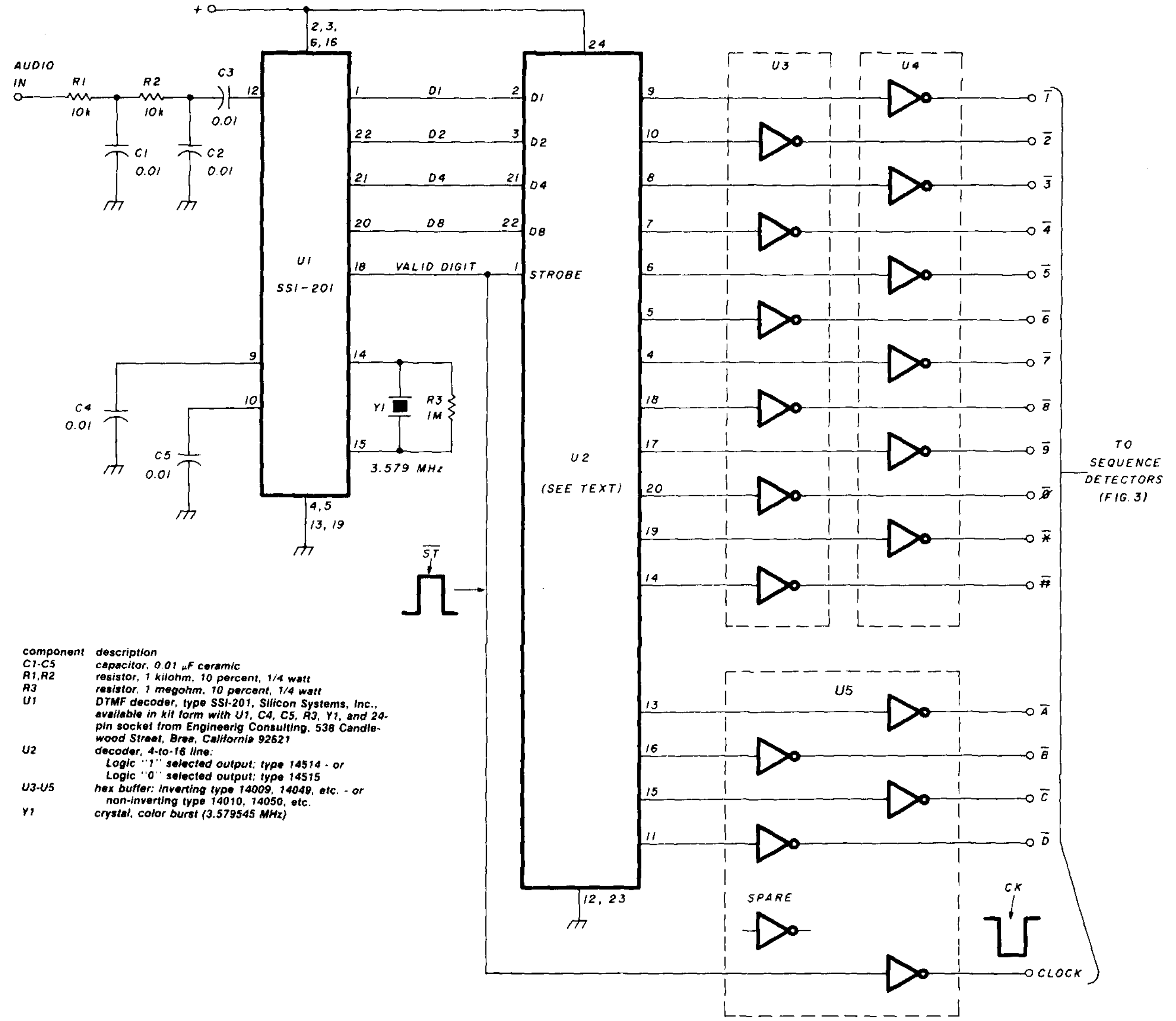


fig. 1. DTMF controller block diagram.



component	description
C1-C5	capacitor, 0.01 μF ceramic
R1,R2	resistor, 1 kilohm, 10 percent, 1/4 watt
R3	resistor, 1 megohm, 10 percent, 1/4 watt
U1	DTMF decoder, type SSI-201, Silicon Systems, Inc., available in kit form with U1, C4, C5, R3, Y1, and 24-pin socket from Engineerig Consulting, 538 Candlewood Street, Brea, California 92621
U2	decoder, 4-to-16 line: Logic "1" selected output; type 14514 - or Logic "0" selected output; type 14515
U3-U5	hex buffer: inverting type 14009, 14049, etc. - or non-inverting type 14010, 14050, etc.
Y1	crystal, color burst (3.579545 MHz)

fig. 2. DTMF decoder schematic diagram. Buffers U3-U5 may be omitted by substituting for U2 (see text).

to U2, a 4- to 16-line decoder. Pin 18 of U1 produces a positive-going "valid-digit" pulse if both DTMF tones have been received and decoded. This pulse is applied directly to U2 as a strobe for that chip's operation and is inverted and applied to the sequence detector as a clock.

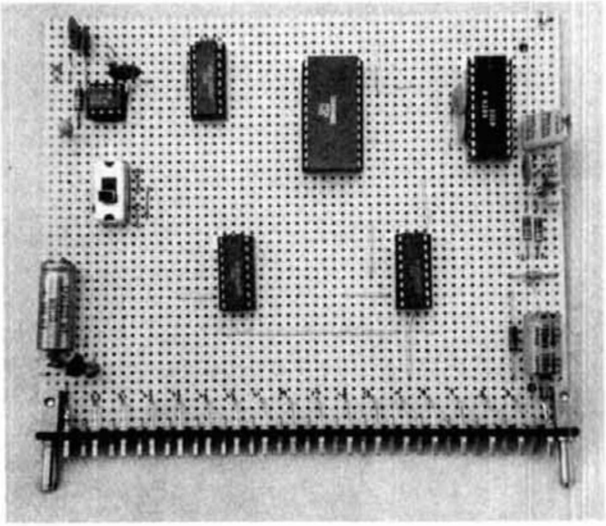


fig. 4. Decoder card. The heart of the decoder is the 24-pin chip — the SSI-201. Several components shown here are not required for basic decoder operation, but are used in other repeater-control functions.

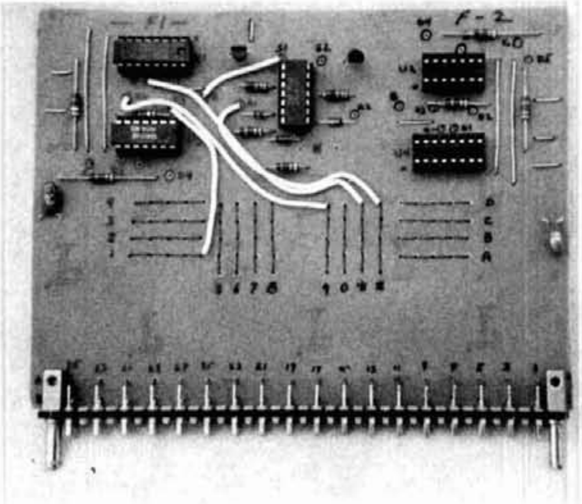


fig. 5. Sequence-detector card. The left half of the card has been programmed with the code **97*. The right half is uncoded at the present. The vertically oriented chip at the top center is the output latch shared by the two sequence detectors on the card.

The resulting output from U2 is logic *1* latched on one of its 16 output lines. By appropriately labeling these lines, one arrives at a unique output that corresponds to the button that was pressed on the pad.

Each output line from U2 is buffered and inverted in three hex inverter/buffers, U3-U5, for presentation to the sequence detector that follows. Note that these buffers are shown in the dashed box illustrated in **fig. 2**. When I was designing the control system for our repeater, I was unsure of the number of stages that would follow the decoder, for reasons that will become apparent later. I therefore chose the 14514 decoder, which has a decoded "1" output and inverted this in the buffer. If it's known in advance what the load will be, it may be possible to substitute a 14515 for U2 and eliminate U3-U5 (the 14515 presents a decoded "*0*" on its output line).†

The purpose of the sequence detector is to produce a latched output if, and only if, the sequence of *0*'s received from the decoder coincides with a preprogrammed sequence of digits for the desired function. **Figure 3** shows the schematic diagram of the sequence detector, which consists of a register and a latch. The register, made up of quad-D flip-flop U1 and quad-OR U2, has applied to its $\overline{\text{DIGIT-1}}$ through $\overline{\text{DIGIT-5}}$ inputs the desired decoded digit lines from the decoder in the sequence that corresponds to the desired code. Also applied to the register at U1-9 is the clock signal from the decoder.

As DTMF signals from the repeater receiver are decoded, *0*'s are momentarily placed on various of the 16 lines to the sequence detector. At the same time, a clock signal is generated for each decoded digit. The first digit line in the code is connected to $\overline{\text{DIGIT-1}}$, the second to $\overline{\text{DIGIT-2}}$, and so on. The first *0* received on $\overline{\text{DIGIT-1}}$ is clocked through U1A to its Q output, where it is stored and presented to OR gate U2A. The second decoded digit, presented to the other input to U2A, produces a *0* at the output of U2A which, upon receiving the second clock pulse, is passed on the the Q output of U1B. The third *0* in the sequence is OR'ed in U2B to produce a *0* at U2-3. It can be seen that a logic *0* is then passed along from output to output of the register as the correct code is punched into the pad. Note that there are output lines from the register corresponding to codes of two, three, four, and five digits. Any of these outputs can be used, depending on the number of digits in the code. If an incorrect digit appears in the code, a *1* will be clocked into the register at that point because there would not be a "desired digit line" as an input. This will cause the corresponding $\overline{\text{OUT}}$ line to remain high. The valid sequence is thus lost, and must be entirely re-entered.

The *0* from the appropriate $\overline{\text{OUT}}$ line is applied to $\overline{\text{SET}}$ input of conventional R-S flip-flop U3, configured as a dual-output latch. The Q output (pin 3) saturates transistor Q1 through R7, thereby pulling its collector to ground to actuate the selected function. The $\overline{\text{Q}}$ output from the latch (pin 4) can be used as an auxiliary output if desired. A typical application would be as an interlock signal for the repeater controller logic. If an auxiliary output is not wanted, omit diode CR3.

There are several ways that the latch can be reset and the function turned off; each requires that a logic *0* be placed on the latch $\overline{\text{RESET}}$ line.

†The nominal fan-out capability of a CMOS chip is 50.

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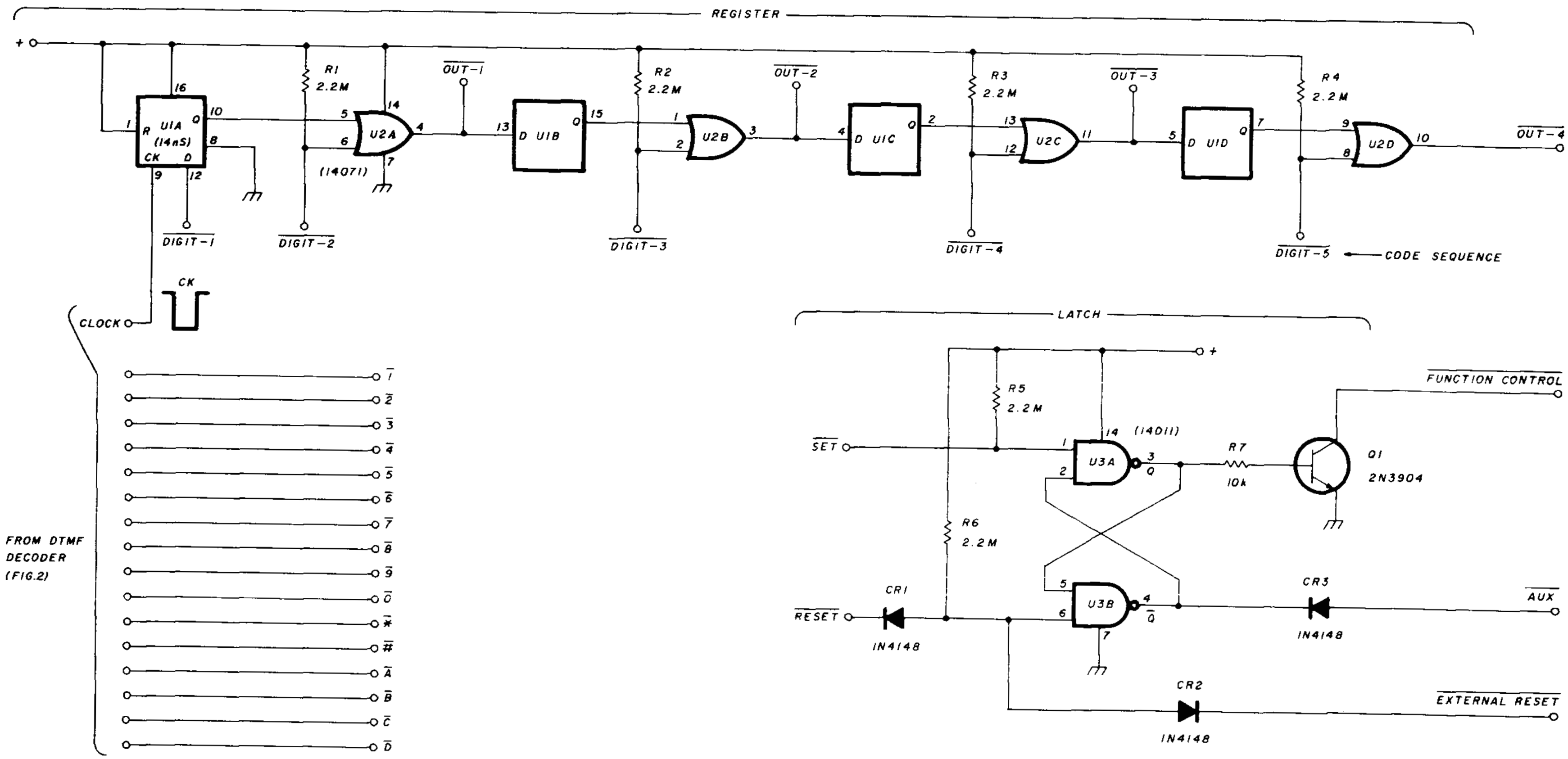

component*	description
CR1-CR3	diode, silicon, 1N4148 or equivalent
R1-R6	resistor, 2.2 megohm, 10 percent, 1/4 watt
R7	resistor, 10 kilohm, 10 percent, 1/4 watt
U1	quad-D flip-flop type 14175 or equivalent
U2	quad 2-IN OR gate type 14071 or equivalent
U3(1/2)	quad 2-IN NAND gate type 14011 or equivalent

*per detector — 2 detectors per card.

fig. 3. Sequence detector schematic diagram. Resistors R1-R5 and diode CR3 may not be required; see text.

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Single-digit reset. If one of the digit lines from the decoder is connected to $\overline{\text{RESET}}$, the latch will be reset when that digit is received. The most common would be #.

External reset. A logic *0* applied through diode CR2 will reset the latch. For example, if the function selected were autopatch, a negative-going pulse from the autopatch time-out timer could be connected here to reset the latch so that the patch would not be immediately brought back up after time-out. If external reset is not needed, omit diode CR2.

Multi-digit coded reset. If it is desired to provide a coded reset function, such as enabling the repeater transmitter after it has been "put to sleep," then $\overline{\text{SET}}$ is connected to an $\overline{\text{OUT}}$ line higher in number than that used to enable the function. For example, suppose the code *7539 were to be used to disable the transmitter. The five digit lines corresponding to that code would be connected to $\overline{\text{DIGIT-1}}$ through $\overline{\text{DIGIT-5}}$ in the code sequence and $\overline{\text{OUT-4}}$ would be connected to the $\overline{\text{SET}}$ line of the latch. The $\overline{\text{OUT-2}}$ line from the register would be connected to the $\overline{\text{RESET}}$ line of the latch. When the disable code *7539 is received, the latch is set and the output *0* is used to disable the transmitter, for example, by holding the receiver COR line low. To enable the transmitter, the code *75 would be used and the latch would be reset allowing the COR to operate the transmitter. This is not a particularly secure coding system, but it allows turning a function on and off with the same hardware and with a code that the average repeater user would not be able to "guess." Perhaps this is an acceptable tradeoff in component count and reliability.

Another very practical application of single- and multi-digit reset would be in the restriction of certain types of calls made on the repeater autopatch. For toll restriction, use the single-digit approach. Toll calls can only be made by dialing a *0* or a *1* after you have received dial tone. Assume a three-digit autopatch-access code. Connect the digit lines from the decoder in the correct sequence to the sequence detector $\overline{\text{DIGIT}}$ inputs and connect the $\overline{\text{OUT-2}}$ line to the $\overline{\text{SET}}$ line of the latch. Then diode-OR digits *1* and *0* to $\overline{\text{DIGIT-4}}$ and connect $\overline{\text{OUT-3}}$ to $\overline{\text{RESET}}$. When you now try to dial *1* or *0* as the first digit after the patch has been brought up, it will be immediately disconnected. To restrict calls to certain central offices, diode-OR the first two digits of the prohibited offices to $\overline{\text{DIGIT-4}}$ and $\overline{\text{DIGIT-5}}$ and connect $\overline{\text{OUT-4}}$ to $\overline{\text{RESET}}$. This latter method may be particularly attractive to repeater groups whose telephone billing is based on message unit systems.

Note resistors R1-R5. These are pull-ups to hold the gate inputs high if there is not a digit line or output line connected. This is necessary to prevent possible instability due to floating gate input. R6 performs the same function in the latch. Since this gate input is diode-coupled, R6 must be installed at all times.

construction details

The DTMF controller for our repeater was built as several subassemblies; the decoder and its associated circuits occupy one 4.5 × 6 inch (11 × 15 cm) perfboard, while two sequence detectors are located on each of several identically sized PC cards. **Figure 4** shows the decoder card. The 555 timer in the upper left corner is not required for decoder operation. Its function in the repeater controller is to mute the DTMF tones to the transmitter so that they are not retransmitted. This affords increased security of repeater codes, and somewhat calms the nerves of the control operators. The slide switch is used to select muting or non-muting of the tones and is also not required. The transistor, seen near the lower left corner, is not shown on the schematic. It functions as a power-up sequencer for the card, required because of different logic voltages used in the repeater controller logic system, but is not necessary for decoder operation.

Figure 5 shows one of the sequence-detector cards used in the repeater controller. This card is shown with jumpers installed for control code *91 and the diode installed for an auxiliary output for that function. When the photo was taken, the right half of the card was not required and was therefore left blank. Another function has since been added, jumpers have been appropriately arranged, and the necessary chips installed in their sockets.

expansion and change

As every repeater operator knows, there's no such thing as a finished machine. There are always changes to be made, more functions to be added, and codes to change for one reason or another. With the controller described here, this becomes a relatively simple task.

For example, if an access code is to be changed, all that has to be done is to move a few jumpers around. If you want to add a new function and all the sequence-detector cards are in use, it's a simple matter to fabricate another one, code it, and install it in the controller card cage. If the digit and clock lines from the decoder are "daisy-chained" to a reasonably large number of "dedicated-spare" sockets, together with V_{DD}, ground, and reset, then backplane wiring in the card cage at the time of addition would be significantly reduced. All that would be required would be to connect a $\overline{\text{FUNCTION ON}}$ line and the $\overline{\text{AUX OUT}}$ line if desired.

Because, at the time of design, I did not know what functions were to be included in the final configuration of the repeater, I buffered the digit and clock lines from the decoder card. So configured, the DTMF decoder should be able to drive all the sequence detectors or other loads required by the wildest imagination of any repeater technical committee!

conclusion

The simple circuit described here has been in operation for several months in the Vineyard Amateur Radio Association's 220-MHz machine on Martha's Vineyard. It has performed according to design in all respects and has afforded control of our machine's various functions without fail. Barring a near hit by lightning or a catastrophic failure in the power supply, it should remain operative for years. While not providing the flexibility over control functions that a micro-based system could, this control system comes close and is considerably simpler and less expensive to build.

reference

1. Mark Forbes, KC9C, "A State-of-the-Art Touchtone Decoder," *ham radio*, April, 1983, page 27.

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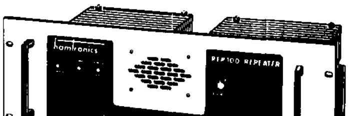

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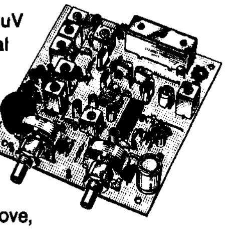

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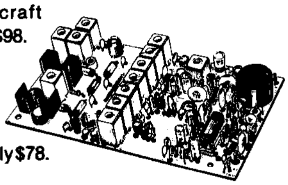

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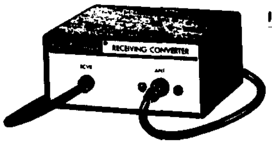

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144-146	28-30
145-147	28-30
144-144.4	27-27.4
146-148	28-30
144-148	50-54
220-222	28-30
220-224	144-148
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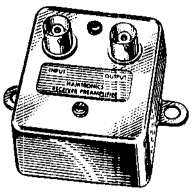

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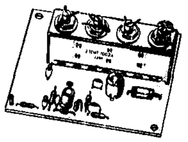

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designing and building loop Yagis

Antennas are always an exciting subject. Even more exciting is the introduction of a new type of design.

The loop Yagi is one new design that's become quite a performer, especially on 23 and 13 cm (1296 and 2304 MHz). However, its design parameters have not been widely available (especially in North America) and are often confusing.

Recently I had a call from Vern "Rip" Riportella, WA2LQQ, who wanted to know if the loop Yagi would work well on OSCAR 10, Mode "L." "Of course it will work," I told him, and pointed out that several stations were already using them. "But how do I build one?" he asked. Well, that got things rolling.

At Rip's suggestion, I moved this article a few months ahead on my planned schedule so that more stations could take advantage of the loop Yagi, especially on OSCAR 10. When you finish reading this month's column you should have all the material necessary on loop Yagis performance and know how to design and construct one of your own.

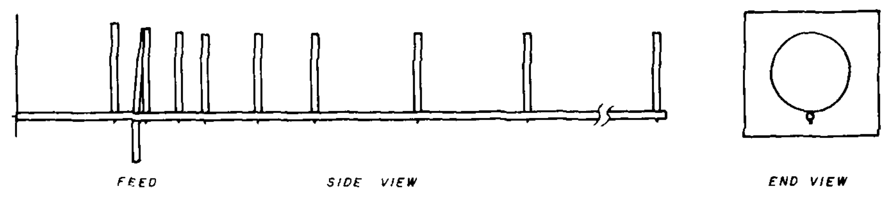

fig. 1. The original G3JVL loop Yagi. Note the plane reflector. The feed passes through the boom rather than through the driven element.

development of the loop Yagi

The loop Yagi, as we know it, came into existence in the back yard of Mike Walters, G3JVL, in 1974. Mike was trying to obtain high gain at 23 cm on a single long boom instead of using a parabolic dish. He tried and discarded many combinations of wire loops similar to quad elements; tuning was always critical and the gain was far less than expected.

Then Mike tried using thin (0.028 inch or 0.7 mm) flat strips of aluminum 0.1875 inch (4.8 mm) wide mounted on a 1/2-inch (12.7 mm) diameter boom. Gain was almost immediately realized. Using the heuristic (cut-and-try!) approach and a large box of different length loops, he moved the elements around to various positions on a boom to optimize gain as indicated on a signal strength meter.

What finally evolved was a 24-director loop Yagi on an 81-inch (206-cm) boom with one driven element and two reflectors, as shown in **fig. 1.**[1] One reflector was a regular loop placed close behind the driven element. The second reflector consisted of a rectangular perforated aluminum sheet measuring 4-1/2 by 5-1/2 inches (11.5 × 14 cm) and mounted on the rear of the boom. The driven element is fed directly at the top with a short length of 0.141 inch (3 mm) diameter 50-ohm semi-rigid coax.

Yagi versus loop Yagi

You may ask, "Why all the fuss about loop Yagis?" The answer lies mainly in their mechanical design. Really long Yagis (over 10 wavelengths long) with high gain (over 18 dBi) were not readily available until the 1980's.[2] Furthermore, long Yagi dimensions are very critical if optimum gain and low side lobes are desired. UHF and microwave designs are even more critical. For instance, at 23 cm the typical Yagi tolerance should be within ±0.003 wavelengths, with 0.001 wavelength preferred.[3] This equates to a 23 cm tolerance of 0.027 and 0.009 inches (0.069 and 0.023 mm), respectively — and these tolerances are quite difficult to maintain.

Metallic boom Yagis also require a correction factor to be applied to each element. (This area is still quite controversial.) Add this to the problems of conductivity to the boom or the capacitive and inductive effects of through the boom mounting with insulated elements and you have a tall order to fill.

Don't overlook the feed system in a Yagi antenna. For a good match, you must have a good mechanical assembly that can tune out variations in the design, and the antenna should preferably be fed with a balanced feed system. This implies the use of a balun, another item requiring good tolerances and construction techniques.

Many of the previously mentioned items were designed out or improved in the G3JVL loop Yagi designs. Mechanical duplication is straightforward. For instance, elements are mounted on top of the boom and connected with just one screw. Various boom diameter corrections are quite well documented, as we shall shortly see. Similarly, the loop length, width and thickness have been carefully tabulated with correction factors for different sizes and frequencies. Finally, a unique driven element feed system with a built-in balun was developed. Thus the loop Yagi is relatively easy to duplicate.

By now you must be asking what the disadvantages must be. Well, the main problem is that there just aren't a lot of recipes. In fact, there have

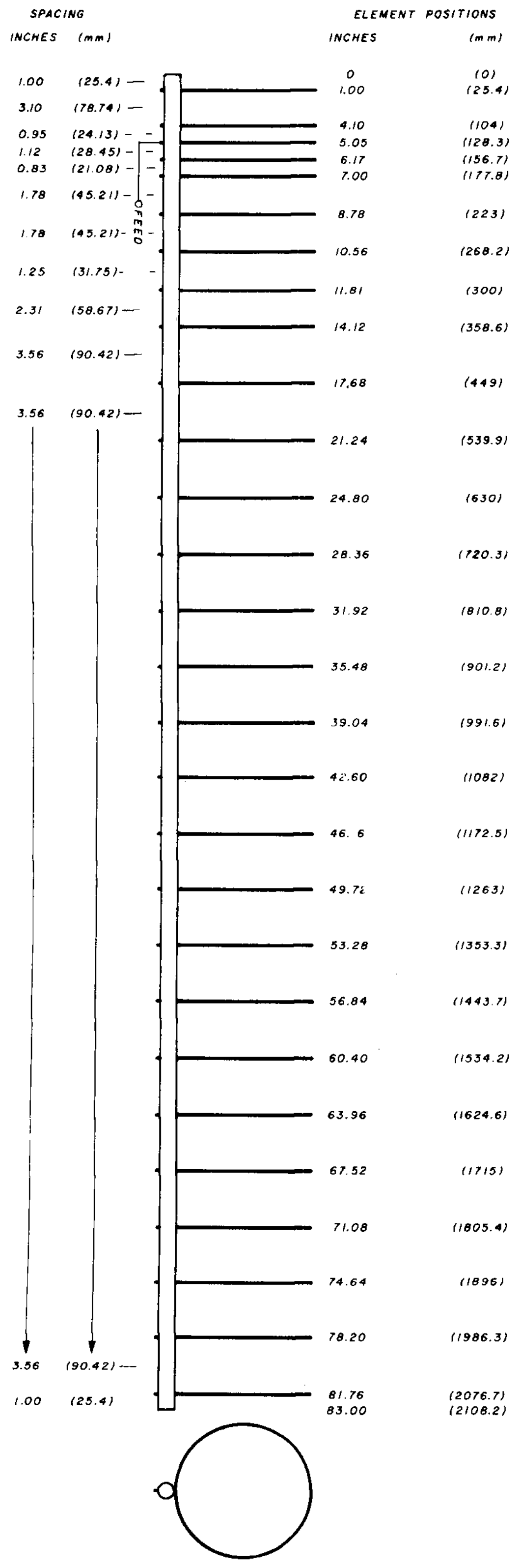

fig. 2A. The basic 28-element loop Yagi, with mechanical dimensions based on 1296 MHz. When constructing a 38 or 45-element loop Yagi, add additional loops as required, spacing them each 3.56 inches (90.42 mm) further down the boom as described in text.

been only three major designs published for 28, 38, and 45 elements.[1,4,5] Even these designs could probably use some improvements to reduce the first side lobe levels.

The loop Yagi also has a fair wind load. Several years ago Rick Commo, K1LOG, and I set out to build a 70 cm (432 MHz), 28-element loop Yagi. It looked truly inspiring and had very good gain when we measured it on my backyard antenna range. But plans to install it at K1LOG's QTH had to be abandoned halfway up the tower, because even in a 10 mph (16 km) wind, holding on to the antenna was like holding on to a large sail! So loop Yagis simply aren't practical below about 900 MHz.

Another loop Yagi headache is large birds since they can easily bend or flatten the loops if they decide to roost on them. G3JVL solved most of this problem by mounting his loop Yagi antennas upside down!

A third problem is deterioration of the joints after long exposure to the elements. This, however, is quite manageable, as we shall see.

loop Yagi variations and improvements

Many of the disadvantages mentioned above have been solved or circumvented and the loop Yagi — still a high-performance antenna — is widely accepted on OSCAR 10 and the 23 and 13 cm bands. If you're looking for an antenna that's relatively easy to duplicate and provides high gain on 23 cm and up, this may be the one for you.

Soon after the original design was published, several persons built models and frequency-swept the response.[1] Some dips in gain were noted, especially below the frequency of interest. Although this isn't normally a problem, it can be if tolerances vary. The first improvement was the addition of another director between directors 4 and 5 of the original design.[4] This also broadened bandwidth and increased gain by about 0.5 dB.

Shortly after I built my first loop Yagi in 1978, I became disillusioned with the plane reflector. It was difficult to fabricate and has a wind load that caused it to act like the tail end of a weather vane! But removing the plane reflector caused the gain to drop as much as 1 dB. I tried a variety of substitutes and finally settled for a second reflector loop, identical to the first one (just behind the driven element) but placed at the rear of the boom. It had far less wind load than the plane reflector and was easier to fabricate; the only perceptible change noted was perhaps a 0.1 dB drop in forward gain, a small penalty for the simplification it yielded.

Since the original design was conceived, the feed system has been improved. Originally the semirigid coax passed to the rear of the driven element and through the boom as shown in **fig. 1**. G3JVL found that if you pass the same coax directly through the lower portion of the driven element and correctly shape the element, a quarter-wave type of balun is formed.[4]

Other improvements made by G3JVL included higher gain for the original design, longer boom models, and correction factors for changing loop thickness and width as well as boom diameter. The latter makes frequency scaling the loop Yagi a breeze.[5]

how to design a loop Yagi

Let's look at the designs available. The improved original design now uses 28 elements with two different director lengths as shown in **fig. 2** and **table 1**. *All the loop lengths shown in* **table 1** *are based on the original design with a boom diameter of 1/2 inch (12.7 mm) and loops made from flat aluminum strips 3/16 inches (4.76 mm) wide and 0.028 inches (0.71 mm) thick. This will be the reference point for all other designs*. Also note that the length of the loops is equal to the distance between the mounting holes. An extra 0.25 inch (6 mm) should be added to each end.

I immediately found these sizes to be unacceptable. First, the elements were too narrow and would often break at the screw holes when they were tightened to the boom. This problem was overcome by using a wider (0.25 inch or 6.35 mm) strip. Also the 0.028 inch (0.71 mm) aluminum is not commonly available in the United States but 0.032 inch (0.81 mm) material is. Finally, the 1/2 inch (12.7 mm) diameter boom is too flimsy in areas where snow and ice are common. Adding extra support struts helps, but a larger diameter boom is still recommended.

Calculating these changes becomes very simple with the correction factors that G3JVL later derived.[5] This information is shown on individual graphs in **fig. 3** (the correction factor for boom diameter changes) and **figs. 4** and **5** (correction factors for different loop widths and thicknesses, respectively).

Let's work through an example. I prefer to use a 3/4 inch (19 mm) boom and loops that are 1/4 inch (6.35 mm) wide and 0.032 inch (0.081 mm) thick. Looking at **figs. 3**, **4**, and **5**, we see that corrections are +0.9, −0.3, and +0.04 percent, respectively. Adding these corrections together, we get a net change of +0.64 percent. This means that if we select new sizes of materials, all we have to do is increase the sizes of all directors and reflectors shown in **fig. 2** by 0.64 percent. Therefore, the scaled directors will now be 8.303 inches (211 mm) and 8.051 inches (205 mm), respectively. The reflectors will measure 9.732 inches (247 mm).

other designs

The compact 28-element has a gain equivalent to that of a 35-inch (90-cm) *dish*. But if you want a model with a higher gain, you may want to build a 38 or 45-element loop Yagi — roughly equivalent to a 39-inch (1 meter) and 43-inch (1.1-meter) dish, respectively — instead.

Table 1 shows the lengths of the 38 and 45-element designs. *Again, these are based on the original boom diameter and loops as noted above.* Note

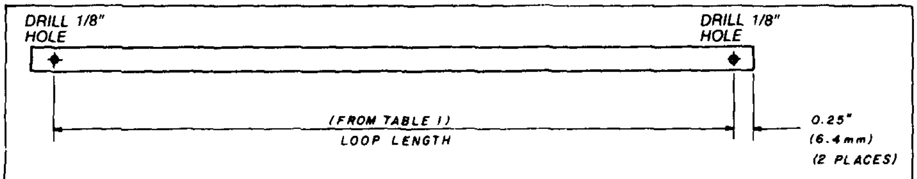

fig. 2B. Loop length is measured from hole to hole. Note that an extra 0.25 inch (6.4 mm) of aluminum strap should be provided at both ends of each loop for mechanical stability.

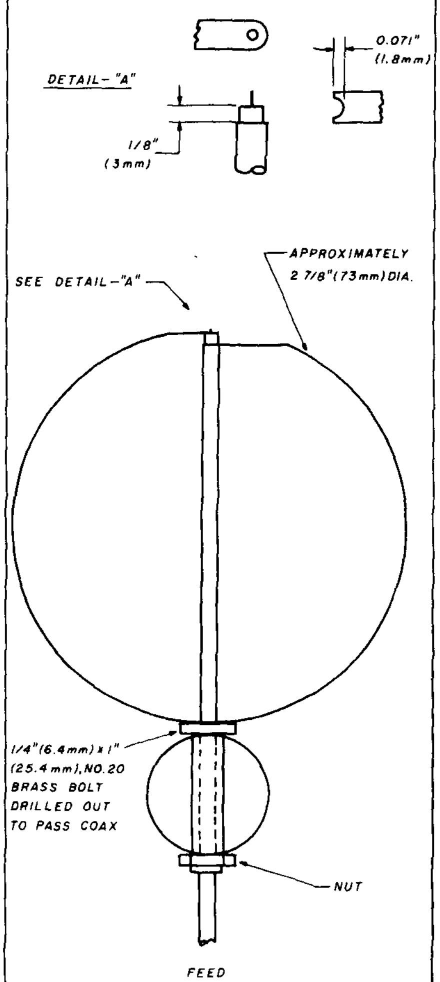

fig. 2C. The driven element is constructed as shown using a brass or copper strap 0.25 inch (6.35 mm) wide and 0.032 inch (0.81 mm) thick. The length is shown in *table 1* and is the distance between the center of the attachment holes. See text for final checkout.

table 1. 1296 MHz loop-Yagi element lengths.

design	28 elements inches	28 elements mm	38 elements inches	38 elements mm	45 elements inches	45 elements mm
reflector 1 & 2	9.67 (9.732)	246 (247)	9.67 (9.732)	246 (247)	9.67 (9.732)	246 (247)
driven element	9.23 (9.292)	234 (236)	9.23 (9.292)	234 (236)	9.23 (9.292)	234 (236)
directors 1-11	8.25 (8.303)	209 (211)	8.25 (8.303)	209 (211)	8.25 (8.303)	209 (211)
directors 12-18	8.00 (8.051)	203 (205)	8.00 (8.051)	203 (205)	8.00 (8.051)	203 (205)
directors 19-23	8.00 (8.051)	203 (205)	7.70 (7.749)	196 (197)	7.75 (7.800)	197 (198)
directors 24-25	8.00 (8.051)	203 (205)	7.70 (7.749)	196 (197)	7.65 (7.699)	194 (196)
directors 26-35			7.70 (7.749)	196 (197)	7.65 (7.699)	194 (196)
directors 36-42					7.50 (7.548)	191 (192)

The numbers shown above are the reference element lengths for designing a loop Yagi at 1296 MHz. These dimensions are based on a 0.5 inch (12.7 mm) boom diameter with 3/16 inch (4.76 mm) wide by 0.028 inch (0.71 mm) thick loops. The lengths shown in parenthesis are for use of a 3/4-inch (19 mm) boom and loops that are 1/4 inch (6.35 mm) wide and 0.032 inch (0.81 mm) thick. Other size material can be used if scaled as discussed in the text.

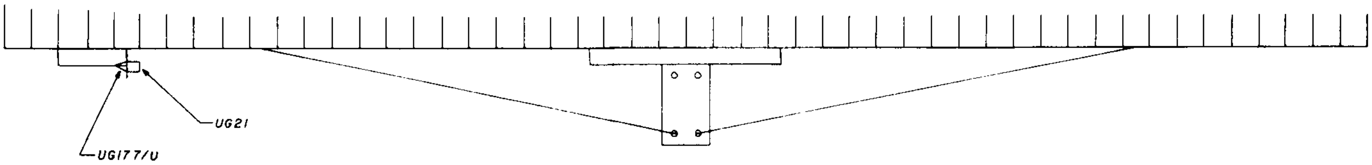

fig. 2D. Overall assembly showing connector mounting, mast bracket (per *fig. 7*) and the recommended supporting bars. The feed system shown may not be desired if stacking is used as described in text.

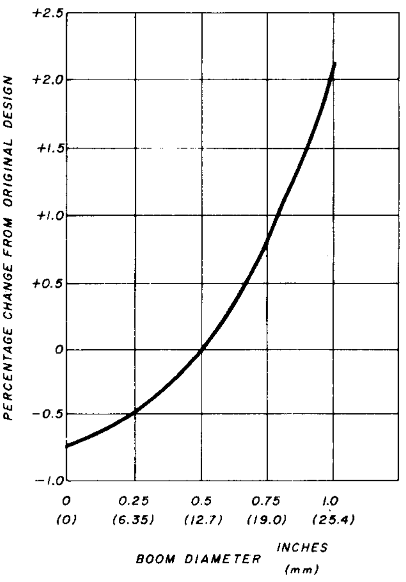

fig. 3. Use this graph to determine correction factors for booms other than 0.5 inch (12.7 mm) in diameter.

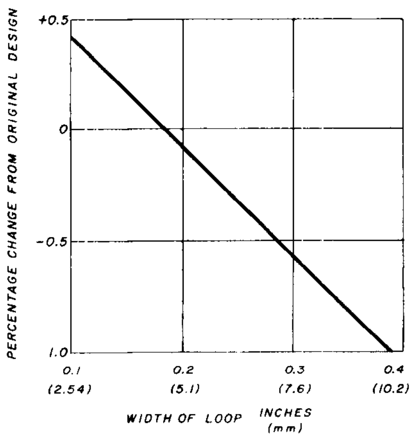

fig. 4. Use this graph to determine correction factors for loop widths other than 0.188 inch (7.76 mm).

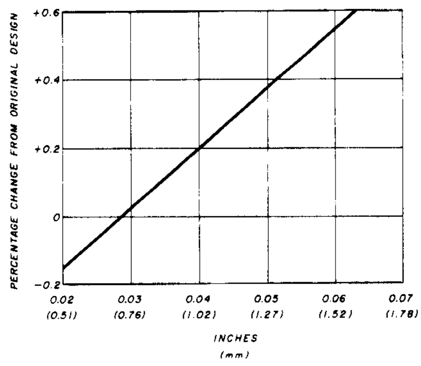

fig. 5. Use this graph to determine correction factors for loop thickness other than 0.028 inch (0.7 mm).

that all new directors on the longer boom designs are moved out an additional 3.56 inches (9.04 cm). However, the diameter of the loops varies with a slightly different tapering schedule.

For those who don't want to go through the scaling exercise, I've listed, in **table 1** (in parentheses), the recommended sizes for the 28, 38, and 45-element designs using a 3/4 inch (19 mm) boom and loops that are 0.032 inch (0.91 mm) thick and 1/4 inch (6.35 mm) wide. Different sizes can also be used, but you'll have to work out the new values yourself!

frequency scaling

If you want to operate at a frequency other than 1296, how do you perform the scaling? It actually isn't that complicated. All it requires is a hand calculator, some scratch paper and some thought! All data can be found on the scaling charts.

For example, suppose you want to make an optimized OSCAR Mode L design. 1269 MHz is actually only table 2. Specifications and stacking information for the 28, 38, and 45-element loop Yagi designs discussed in the text.

design	boom length (in λ)	gain* (dBi)	equivalent dish size* (inches)	equivalent dish size* (meters)	BW* (degrees)	stacking distance in λ (E plane)	stacking distance in λ (H plane)
28-element	9.0	19.0	35	0.9	18.0	2.50	2.30
38-element	13.2	20.0	39	1.0	16.5	2.75	2.55
45-element	15.7	20.7	43	1.1	15.0	2.85	2.65

*Approximate

about 2 percent lower in frequency that 1296 MHz. In reality, the models shown work quite well even though they're made for 1296 MHz, since the bandwidth of a typical Yagi type structure is usually good for at least −2 to +1 percent. But let's say you really want to optimize the design without compromise.

In order to exactly duplicate the performance, *all element dimensions and spacings must be increased by 2 percent* (1296-1269/1296). The spacing is easy. Just make all spacings 2 percent or 1.02 times the values shown in the figures and the table.

Then scale the new boom diameter. Let's say you want to use a 3/4 inch (19 mm) boom at 1269 MHz. First you have to design the boom as if it were 2 percent smaller in diameter at 1296. For example, if we have a boom 0.735 inches (18.67 mm) in diameter at 1296, it will be equivalent to 0.750 inch (19 mm) in diameter at 1269 MHz. The correction factor for 0.735 inch (19 mm) at 1296 is approximately +0.8 percent.

The elements are done in the same fashion; they're shortened by 2 percent at 1296 MHz and looked up in **figs. 4** and **5**. Then the changes are added to the boom correction for the final correction. If the frequency is above 1296, the boom correction and element parameters must be lengthened by the equivalent percentage at 1296. Proceed in the same way as already described.

construction

The loop locations should be marked carefully on the boom as shown in **fig. 2**. *This is a very important procedure that should not be taken lightly*. Because spacings are quite close for the first directors, a build-up tolerance could occur. I've therefore shown all dimensions referenced from the rear of the boom to prevent tolerance buildup.

For best symmetry, the boom should be drilled while supported in either a "V" block or a Porta Vise.™ After the first element hole is drilled, a dummy element should be fastened in place. This will provide a reference point for drilling successive holes so that they'll all be located in the same plane. Admittedly, this is less of a problem on a loop Yagi than a conventional Yagi since the elements can be leveled by pushing them sideways for alignment. Finally, drill out the larger hole for the driven element mounting screw.

Next, center-punch each loop for the proper length as shown in **fig. 2**, leaving about 0.25 inches (6.35 mm) of extra material on each end. Make sure the punch is centered on the loop width since any sideways skewing will weaken the joint. Also, use the smallest possible drill to just pass the screw shank.

The loops can be pre-formed by rolling them on a piece of tubing or dowel. Next insert the screw while drawing the two ends together, inserting the screw through the boom in the correct location and securing it with a lock washer and nut. *Do not overtighten; this will deform the loop material.*

Assembling the driven element is a little tricky. It must first be soldered together as a sub-assembly as shown in **fig. 2**. Then pass the mounting screw through the boom and secure it with the nut. (Suitable semi-rigid transmission line can be purchased from Microwave Components, WB8EUU, 11216 Cape Cod, Taylor, Michigan 48180, for approximately $2.00 per foot.)

Now add the connector. For maximum strength, rigidity, and reliability, it should be mounted on a small right angle plate attached to the boom. This simple, low-cost assembly with the shield, suggested to me by Bob Johnson, K9KFR, has worked well on the four loop Yagis I presently use.

Alternatively, a type OSN™* male "N" cable connector can be attached directly to the semi-rigid transmission line. This method offers an advantage if you're going to stack your antennas. You can use a transmission line the proper length required to reach the power splitter (more on this later).

other variations

Other loop widths can be used on this design if they're properly scaled by the methods already discussed. For instance, if some of the elements are widened, it may be possible to use a uniform length loop on the shorter model.

As mentioned earlier, the simplicity of the element attachment to the boom is one of the selling points of this design. But the place at which the loop attaches to the boom is a high current point. Therefore, if the elements are not tightened properly, the joints can corrode, resulting in increased loss in the future.

Several methods have been used to circumvent this problem. One is to coat the joints with an epoxy or sealant type of material after assembly. A second, more complex mounting method is to rotate all the elements 90 degrees.

First, a single screw, washer, and

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nut hold the loop ends together. Then a second hole is drilled one-fourth the distance between the end mounting holes in each loop. Finally the loops are attached with another screw to the boom. This locates the point at which the loops are attached at a voltage node.

Remember that all sizes given, including sizes on the scaling charts, are based on mounting loops exactly as shown. Any deviations will upset the correction factors and possibly degrade performance. Several years ago, for example, a number of these loop Yagis were distributed in kit form by a midwest Amateur. Although the design was satisfactory, the instructions recommended, for mechanical reasons, that a lock washer be placed between the loop and the boom rather than between the boom and the nut. The effect of this instruction was subtle. Since the element was now further removed from the boom, the boom correction was diminished, and the elements therefore resonated at a slightly lower frequency. The net result was a 0.5 to 0.75 dB gain decrease and higher side lobes. Removing the washer, cleaning up the surfaces, and then placing the washer on the other side of the boom instantly restored the antenna's original design performance.

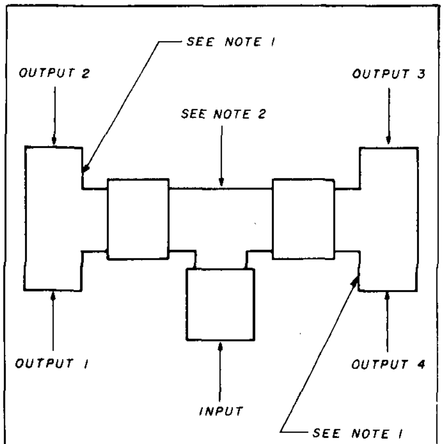

fig. 6. This is a simple power splitter using three type "N" coaxial Tee adapters. *Note 1:* Type UG 107A/U recommended but UG 107B/U is usable with slightly higher VSWR. *Note 2:* Either a UG 107B/U or UG 28A/U are usable.

stacking loop Yagis

The designs given in this month's column will work fine by themselves. However, there's always somebody who wants more gain. Since loop Yagis have lower wind loss than dishes (one of the prime reasons for using this design), they're often stacked to obtain higher gain.

Recommended stacking distances and configurations are discussed in references 6 and 7. **Table 2** lists electrical parameters to follow for proper stacking on all three models just discussed. Generally speaking, the spacings shown may seem too close, but they were confirmed at my QTH by a series of tests using both a signal source and on-the-air test.

When stacking antennas at such high frequencies, phasing harness losses and phase lengths are very important. Four matched phasing lines can be brought to the mast where a power splitter is attached — or you can use an identical length of the same amount of semi-rigid coax as mentioned earlier. You can then use short phasing lines with the back plane feed method as discussed.

Any suitable two-way or four-way in-phase power divider can be used.[7] One simple and usually inexpensive power divider can be made for 23 cm operation by combining three UG 107A/U type N Tee adapters as shown in **fig. 6**.[8] The longer (and older) type UG 107A/U is recommended because it's closer to the desired phase length. However, the newer UG 107B/U will work with slightly higher VSWR. These coax adapters are readily available at flea markets.

Loop Yagis are usually mounted on brackets similar to the one shown in **fig. 7**. These brackets are then attached to a mast or a stacking frame. If two- or four-loop Yagis are stacked vertically, it's often more convenient to turn the lower ones upside down so that the mast doesn't have to pass through the boom or loops. In this case, remember to invert the feed on the upside down antennas so that they're not fed out of phase.[7]

You may ask whether the mast can be placed through a loop Yagi as is typically done on Yagi antennas. The answer is yes, but the diameter should be kept reasonable and the mast should preferably pass midway between two loops. Tests conducted by G3JVL showed a slight gain reduction

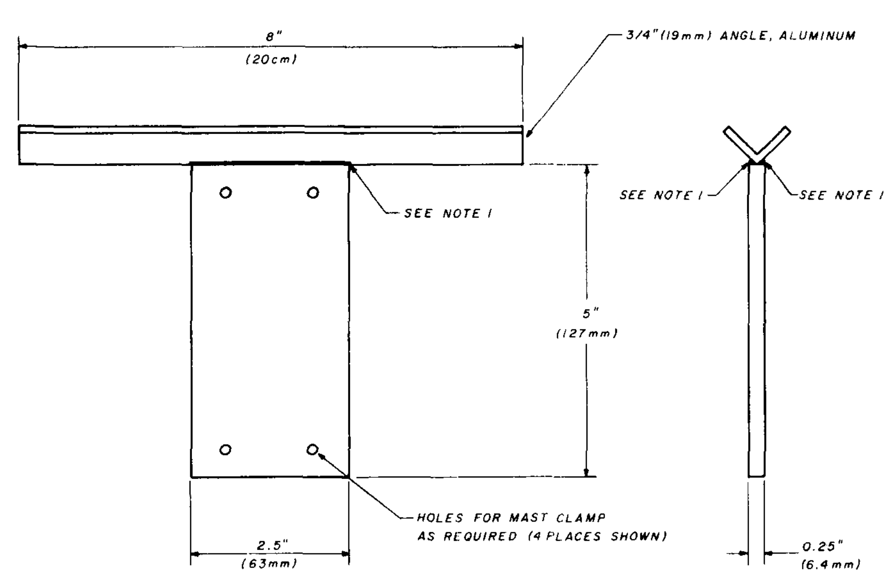

fig. 7. A recommended mast to boom mounting bracket. Material is aluminum. *Note 1:* Heliarc the angle aluminum and plate together at this point. Most local welding shops can provide this service.

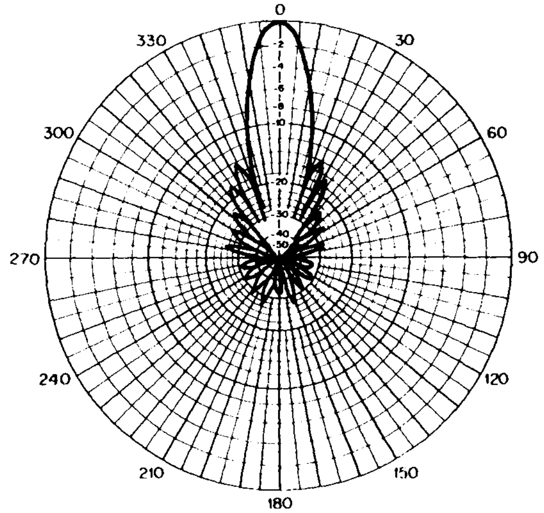

fig. 8. This is a polar plot of the typical "E" plane of a 45 element loop Yagi. Other designs will have similar patterns but with wider half-power beamwidth as shown in *table 2*.

(approximately 0.25 dB) when a large (2 inch or 51 mm) diameter boom was passed through the plane of a 23-cm loop Yagi.

Supports or trusses should be used to stabilize and strengthen the boom, especially where ice and snow are prevalent. This can easily be done by attaching a piece of tubing between a point about two thirds the distance out on the boom and the bottom corner of the mounting plate shown in **fig. 7**. This tubing can have the same or slightly smaller diameter as the boom.

final performance evaluation

Once the loop Yagi is completely assembled, it should be mounted on a mast in a clear area and pointed away from any local objects. Then the VSWR should be measured. If it is not below 1.5:1, bend the first reflector or the first director closer or further away from the driven element for a better match. Sometimes even the second director can be bent slightly to enhance VSWR., If all else fails, shorten or lengthen the driven element slightly.

After the antenna is mounted in its final resting place, the pattern can be tested. The beamwidth is narrow as shown in **table 2**. The first side lobes should be at least 10 dB and usually 13 or so dB below the main lobe. If not, you may have scaled your dimensions improperly.

For reference, see **fig. 8**, in which a pattern adapted from an equivalent 13 cm (2304 MHz) 45 element loop Yagi is shown. The initial data for this pattern was done on a professional antenna range and supplied to me by N3CX. The 2304 MHz loop Yagi will be covered in a paper I'll be presenting at the First Annual 1296/2304 MHz conference in Estes Park, Colorado from September 20 to 22 (see end of column). Note that the nulls between the main beam and the side lobes can be easily used to determine beamwidth, as described in reference 9.

summary

The loop Yagi is an exciting and relatively new antenna design that has been well received as a true performer. In this month's column I've tried to provide some overall background information on its design along with procedures for modifying the design for other frequencies and material sizes to suit the builder.

This antenna isn't a panacea, nor does it necessarily offer any more gain than a well-designed Yagi. However, it's easily reproduced and has much less wind load than an equivalent dish of the same gain. Models have been made to frequencies as high as 3 cm (10 GHz) with equivalent performance.

acknowledgements

This design would not have been possible without the many hours of trials and testing by Mike Walters, G3JVL. I'd like to thank him for all the encouragement and information supplied to me over the years so that I too could obtain the gain claimed. Also, thanks to N3CX for providing the pattern data of the 45-element loop Yagi shown in **fig. 8**.

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9. Joe Reisert, W1JR, "VHF/UHF World: Determining VHF/UHF Antenna Performance," *ham radio*, May, 1984, page 110.

important VHF/UHF events

September 7-8:	*International Region 1 VHF Contest*
September 14-16:	ARRL VHF QSO Party
September 16:	EME Perigee
September 20-22:	*First Annual 1296/2304 MHz Conference, Estes Park, Colorado (Contact WØPW)*
October 5-6:	*Mid-Atlantic States VHF Conference, Warminster, Pennsylvania (Contact WA2OMY)*
October 5-6:	*International Region 1 UHF/SHF Contest*
October 9:	*Peak of Draconids Meteor Shower predicted at 0300 UTC*
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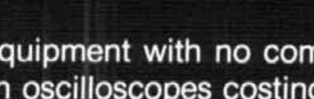

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by Joe Carr, K4IPV

now that the warranty has expired. . .

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But sooner or later, long after the initial euphoria has worn off, you're going to have to consider what we all dread: repairing the rig. Repairing electronic equipment is like buying insurance; most of us never give it a moment's thought until something catastrophic happens. A little planning in this regard can make the difference between quick success or being off the air for weeks while the rig moves through the repair "pipeline."

The first time to think about repairs is while you're unpacking the new rig: should it have to be shipped back to the manufacturer's or importer's repair shop, that original packing carton is probably the best shipping container available. Unpack carefully, taking care not to destroy the carton in your eagerness to get to the goodies.

You think that's a bit extreme? After all, who has room to store that enormous cardboard shipping crate? I called the repair shop service manager for a major mail order seller of ham gear; he told me that all too often, improper packing results in shipping damage, often hidden, that must be repaired at the owner's expense *before* the warranty problem can be examined. Sometimes the shipping damage completely masks rightful warranty repairs — for example, a broken printed circuit board track.

An old grocery carton and three inches of newspaper are not proper shipping materials! Nor is it prudent to use a single wrap of masking tape to seal the carton; rigs have been "lost in the mail" because of inadequate sealing of perfectly adequate shipping containers. Use *two* runs of broad nylon filament tape, wrapped around the carton in both directions. Top this off with plastic film tape or paper packing tape (the kind you have to moisten). Tape a card with your name, callsign, address, and telephone number directly to the rig, just in case your rig becomes separated from its packaging.

It's not prudent to ship more than one item per container. My contact told me of one fellow who shipped an in-warranty Kenwood TS-120S in the same substandard carton as the 12-volt DC, 20-ampere AC power supply that powers the rig. That heavy power supply bounced around that newspaper-lined cardboard box like a cannonball and mashed the TS-120S to bits! Unfortunately, because the damage was caused by improper packing, neither the shipper nor the manufacturer could cover the damage.

In general, it's wise to not ship items such as external power supplies, microphones, telegraph keys, loudspeakers, headphones and other accessories unless told to do so by the repair shop. Twenty years of working in various repair shops left me with many memories of lost customer property. If your transceiver is bad, then ship *only* the transceiver. Keep the other stuff at home. You can be certain that an authorized repair shop will have an adequate DC power supply, speaker or microphone on hand for testing the equipment.

do you really have a problem?

In one shop where I worked, our service jobs ran about 40 percent "NFF" — No Fault Found — although some of the technicians had a more vulgar way of putting it. That means that the user diagnosed a fault when none existed, and the unit was out of service for no reason at all.

Eliminating the NFF takes a little common sense. If you suspect a malfunction, check all connections, accessories, and switch settings. Consult the troubleshooting chart in the owner's manual. I know it sounds dumb, but many a "probable blown fuse" complaint results from the AC power cord's being disconnected from the wall socket.

You'd be surprised to know how often a "won't transmit" complaint is traced to a broken PTT wire in the microphone connector. If your unit won't transmit, try several operating modes. If the rig won't "push to talk," but does work on CW mode, then it's a fair bet that the microphone is faulty. Similarly, if your rig will work on VOX but not on PTT, then the PTT wire is probably at fault. A little common sense goes a long way.

I prefer to keep certain accessories on hand to check my rig; for example, I normally have a spare microphone. Because I'm rarely fond of the standard handheld microphones that come

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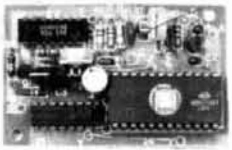

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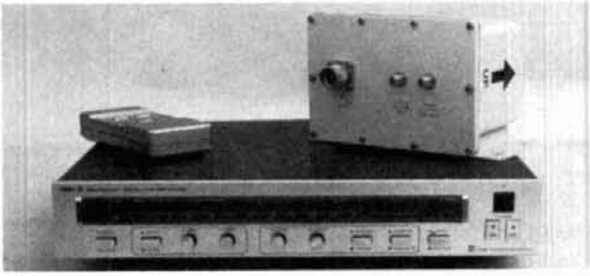

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with new rigs, I buy another model — either a desk mike for the home rig or a touchtone mike for the 2-meter mobile rig. It's a simple matter to squirrel away the original mike, or I would buy a standby replacement mike, to use in troubleshooting problems later.

Other useful items to have on hand are a dummy load and RF wattmeter. Although I now use a Bird Model 43, a simple $30 VSWR meter is also handy for troubleshooting. In the latter case, however, the reading is relative only, so it helps to make a record of readings and knob settings when the rig is known to be working properly. Take the readings with the rig driving a dummy load, and then record the readings and the knob settings that created them. A deflection of 50 to 80 percent of full scale is suitable.

what to fix

Although some "old timers" like me, with 25 or more years in Amateur Radio behind us, loathe the idea of not being able to repair our own rigs, it's nonetheless necessary to recognize that some problems will inevitably be "Beyond Capability of Maintenance" (BCM). If the rig is BCM, then it needs to go the service shop.

You have to decide what repairs you're willing (and able) to undertake. Part of this decision will depend on the design of the rig, while part will be based on the capabilities of your workshop test equipment. Another factor is your personality: if you're fearful of breaking into your rig, then it's probably best to leave that job to others.

Of course, it's also possible to reduce the fear factor by working under the supervision of an "Elmer" who has repair savvy.

In general, the repair of purely mechanical problems with minor controls (for example, toggle switches or potentiometers), visible solder joint problems on printed circuit boards, and DC power supply problems should be well within the capability of most Amateurs. It's also possible to add digital displays to the list above. If the design of your transceiver is such that most assemblies are on removable PCBs, then swapping boards is also on the list of "can do's."

Problems with electronic equipment tend to recur in individual sets within a model group. Because professionals see the same problems again and again, they soon develop a "sense" for the symptoms. During my college years, I worked part-time in an auto radio shop that supposedly didn't hire part-time help. I'd gone into the shop to talk to the owner, who tried to ignore me while he worked on a Delco radio. As we talked, I recognized the problem and told him — without touching the radio myself — to go get a 7281933 trimmer capacitor and replace the LO capacitor. My point in telling this story is to encourage you to call the repair technicians at the manufacturer's or importer's facility, describe the symptoms, and take their advice. Whatever your problem is, they've probably seen it before, and they'll most likely be willing to help you.

While you have a technician on the line, ask whether there are any updates, retrofits, or engineering changes that would normally be incorporated into your rig if it were on the bench right now. You'd probably be surprised to know how often manufacturers and importers will update equipment returned for repair at little or no cost to the owner. Such a courtesy can often eliminate future problems.

tools and supplies

If you don't have a certain minimum assortment of tools, don't even think about attempting the repair of your radio. If you decide to proceed, perhaps the first thing you'll need will be the screwdrivers required for removing the covers. Be sure to have the correct size screwdrivers; improperly sized screwdrivers will tear up both the screw heads and the screwdriver — or pop out of the heads and scratch the cabinet's paint job.

Many rigs are made in Japan. Because the bevel angle of Phillips screws on many Japanese products differs from that of American-made Phillips screws, American-made tools will turn improperly inside the screw slots and tear up the screws. This is one instance in which cheap two-for-a-buck imported "tool barrel" screwdrivers work better than classy $3 models.

You'll also want to have a couple of soldering devices on hand. For small work (and PCB repairs), use a 25-watt to 75-watt pencil iron; for larger jobs (and wire antennas), use a 250-watt soldering gun. (My own *Weller D-440* has served for 20 years.)

The choice of solder and desoldering aids are as important as the soldering iron you select. The only type of solder to use is *resin core* solder marked for radio, TV, or electronic use. I know many experienced hands will smirk, claiming that this advice is a useless restatement of the obvious, but it's necessary nonetheless: every shop I know occasionally sees a set that is ruined from the use of the wrong solder. Don't use an acid core solder, "plumber's solder" or "industrial solder." All these products use an acid core that will corrode your equipment into the junkyard! Use only resin core solder marked for radio, TV, or electronic uses. (I prefer either *Kester* or *Ersin Multicore* brands in either 50/50 or 60/40 lead/tin mixtures.)

Solder size is also somewhat important. For light work on things like IC pins or other PCB points, I prefer a No. 22, No. 24, or even No. 26 solder. Larger work or wire antennas require a No. 14 to No. 20 size. I keep rolls of No. 14, No. 18, and No. 24 solder in my toolbox. Solder isn't cheap, by the way — so either learn to use it sparingly or get rich and foolish.

Desoldering is a workbench skill that is just as important as soldering, but is all too often ignored in Amateur circles. Several aids available for desoldering, especially on printed wiring boards: desoldering tips, solder suckers, and solder wick.

• **Desoldering tips** are special soldering iron (or gun) tips that are shaped like the pin pattern for the device being

meet Joe Carr, K4IPV

Licensed since 1959, Joe Carr has written more than 221 magazine articles and 41 books on a wide variety of subjects including Amateur Radio, computers and computer programming, electronics, mathematics, and biomedical equipment repair.

Joe began his lengthy and diversified career as a techician, working in mobile and biomedical electronics, communications, and both radio and television broadcasting. He won ISCET certification in consumer and communications electronics in 1971 and 1973, respectively, and was co-recipient, in 1977, of that organization's Technician of the Year Award.

He holds an MSEE from George Washington University (1981) and is currently employed as an electronics engineer in avionics.

Joe's recent books include *Interfacing Your Microcomputer to Virtually Anything*, *Designing and Building Electronic Gadgets (with Projects)*, *104 Weekend Electronics Projects*, *CMOS/TTL: A User's Guide (with Projects)*, and *The Complete Handbook of Radio Transmitters*, as well as *The Complete Handbook of Radio Receivers*, all published by Tab Books, Inc. Other titles — published by Reston Publishing Company, a division of Prentice-Hall — include *Elements of Microcomputer Interfacing*, *Designing Microprocessor-Based Instrumentation*, and *Elements of Electronic Instrumentation and Measurement*.

Five additional books have been completed and are awaiting publication, and six more are "in the works."

ham radio welcomes K4IPV aboard.

desoldered. For example, there are tips that fit over all 14 or 16 pins of a DIP integrated circuit. The tip is chucked up in a soldering gun so that all pins can be heated simultaneously.

• **Solder suckers** are vacuum tools that, when used in conjunction with a soldering iron, suck melted solder from a joint. Really fancy (high dollar) systems are available; these use a vacuum pump and a pneumatic plumbing system that's an integral part of the soldering iron. Such tools are suitable for commercial shops or industrial users. Amateurs and most other users can get away with less elaborate solder suckers.

There are at least two types of solder suckers that are practical for Amateur applications. One type is a rubber squeeze ball (something like those little ear irrigating syringes you can buy at the drug store) with a nylon or teflon desoldering nozzle. The other type of solder sucker is a spring-powered piston device. The operator cocks it by engaging the spring, then places the tip against the molten joint and presses the spring release trigger. The solder zips up into the tool, leaving a clean joint. If you buy one of these devices, be sure to also buy a spare tip. Worn out tips tend to splash solder around the PCB a little bit. A small file or penknife does wonders in repairing worn-out tips, but a spare tip is nice to have on hand.

A small collection of other hand tools is also necessary. You should have a small pair of diagonal sidecutters, small longnose pliers, mid-size longnose pliers, wire strippers, several sizes of nutdrivers, and some alignment tools suitable for the type of radio set that you own. With this last comment I feel compelled to issue a stern warning: ALIGNMENT ADJUSTMENTS ARE *NEVER* USED IN TROUBLESHOOTING! The mark of a neophyte servicer is the use of the "diddle stick" in troubleshooting. So-called alignment problems do not occur suddenly, but typically occur over a very long period. When alignment shifts suddenly, it isn't an "alignment problem" at all, but rather a component failure. Alignment causes a certain amount of wear and tear trauma, so constant tweeking is likely to add more faults than it may correct.

You might also want to keep a small supply of certain service chemicals on hand. Repair and maintenance jobs sometimes require cleaning of switches and potentiometers, so a spray can of cleaner (*Blue Stuff*, for example) is handy. You'll also need a small tube of either silicone grease or white grease (*Lubriplate* is a popular brand), some heat transfer grease for power transistors, and a freeze spray for locating intermittents. For that really professional touch on equipment with PCBs, buy a bottle of PCB cleaner designed to remove solder resins. Cleaning cabinets can be done with special cleaners, but they're expensive, so I always use modest amounts of soapy water on soft sponges or cloths.

I also recommend that you order the shop manual for your rig. Most rigs come with a manual that's fine for operating (it may even contain a schematic diagram), but not much good for troubleshooting. The shop manual must be purchased separately. Some rigs include a postcard or order form with the rig's documentation to make ordering a shop manual easier. In other cases, you'll have to write to the manufacturer or importer and ask about the availability of the manual. You should also consider buying service aids such as PCB card extenders, which allow you to operate PCBs out of the rig for troubleshooting, as well as patch cords and other items the company offers to professional servicers.

conclusion

Repairing commercially made electronic equipment is not always a difficult matter better left to professional repair services. The Amateur with enough knowledge to pass a General or Advanced class license examination should be able to learn the job of trouble-shooting and repair — even if under a friendly "Elmer" the first time.

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a detailed look at probes

From simple to exotic, these devices invariably affect circuits

Although it's admittedly difficult to get excited about probes, this article may offer insight into, and perhaps even respect for, these devices. Despite their uncomplicated appearance, they're really much more than "just a piece of wire with a handle."

probes load down circuits

Most low- to medium-frequency oscilloscopes have a 1-Megohm impedance shunted by 8 to 50 pF of capacitance. Some scopes above 200 MHz have a 50-ohm or both a 1 Megohm and 50-ohm input impedance that is switch-selectable. In either case, when a scope's probe is attached to the circuit under test, this impedance loads the circuit and may alter its proper operation or even cause it not to work.

Figure 1 shows an attenuator probe and scope input. An attenuator probe contains a built-in voltage divider. Most typical values of these types of probes are 10:1 and sometimes even 100:1.

How does the probe affect the input signal? First, consider what happens to square wave and sinewave inputs. (With sinewave inputs we're especially concerned with amplitude and phase distortion.) Referring again to **fig. 1**, note that the probe and scope input essentially form an RC divider. Since R1C1 must equal R2C2 for equal attenuation at all frequencies, as R1 increases C1 must decrease. The capacitance at the probe tip can be reduced by going to higher values of attenuation.

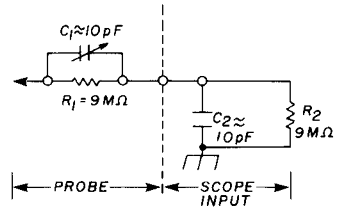

fig. 1. Illustration of a probe and scope's input circuitry.

Note: All figures courtesy Tektronix, Inc., unless otherwise noted.

measuring pulsed signals

Referring to **fig. 2A**, note that if R_s = 200 ohms and if C_s = 20 pF, then t_{r1} would be limited by the integration network of R_sC_s and would be equal to 2.2 $R_s \cdot C_s$ or 8.8 nanoseconds in this case. Using a typical passive probe such as the P6053B (**fig. 3**) with a 9.5 pF and 10 Megohm impedance then results in the circuit shown in **fig. 2B**. (R_p has been disregarded because it is much greater than R_s.) Looking at the risetime as 2.2 R_s (C_s + C_p) we obtain 13 nanoseconds. Mathematically

$$\frac{t_{r2}-t_{r1}}{t_{r1}} \times 100 = \frac{13\ ns - 8.8\ ns}{8.8\ ns}$$

and $$\frac{C_p}{C_s} \times 100 = \frac{9.5\ pF}{20\ pF} = 48\ percent$$

Next, let's look at what happens when we use a P6048 probe (**fig. 4**) with its 1 pF, 10 kilohm characteristic. Referring to **fig. 2C**, note that by using Thévenin's theorem that t_{r3} = 2.2 R_2 (C_s + C_p) = 7.7 nanoseconds now. This percentage change is dramatically less than that caused by the P6053B. Mathematically,

$$\frac{7.7\ ns\ -\ 8.8\ ns}{8.8\ ns} \times 100 = 12\ percent\ change$$

Interestingly, though, by not degrading the signal by slowing its risetime, the probe actually modified the source resistance to decrease the risetime, making it faster than it should be. This, however, was at the expense of output amplitude, which decreased to 83.3 percent. Recall that in the first example there was no change in signal source amplitude when the probe was applied.

By Vaughn D. Martin, 114 Lost Meadows, Cibolo, Texas 78108 and Billy W. Davis, 8914 Rich Quail, San Antonio, Texas 78251

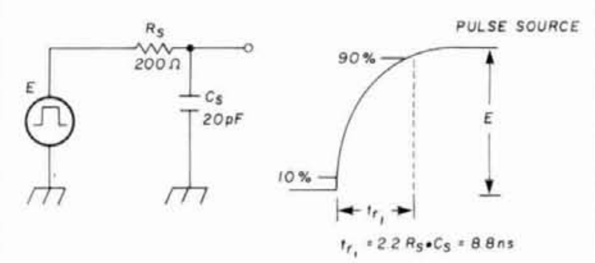

fig. 2A. Typical pulsed signal source.

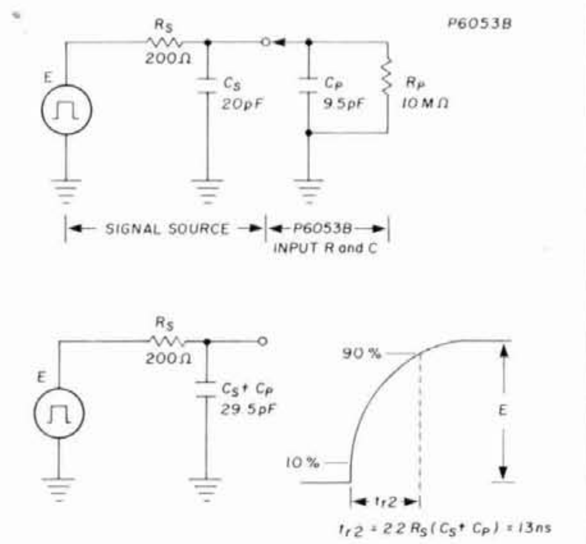

fig. 2B. A P6053B probe added to this typical signal source.

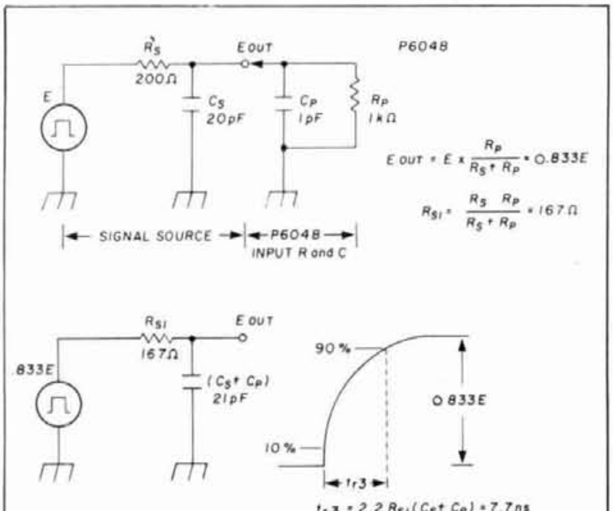

fig. 2C. A P6048 probe added to this typical signal source.

These two examples demonstrate that when measuring pulsed or square wave signals, low capacitance is desired when measuring risetime, but *high resistance* is more important when measuring amplitude. Also, selecting a low impedance test point in a circuit is best when measuring both risetime and amplitude.

Using the same probes and the same circuit, let's see how amplitude and phase relationships are affected when the signal source is a sinewave oscillator. Refer to **fig. 5** and note that we now have a 10 MHz source; at these higher frequencies, the X_p and R_p of the P6053B probe change (**see fig. 6**). Applying the P6053B probe to the source, the output voltage drops to 94 percent of the generator voltage. This represents a 3 percent drop from the 97 percent output voltage normally obtained from the source.

Applying a P6048 probe to the same circuit causes an output voltage of 81 percent of the generator's open circuit voltage and 16 percent from the unloaded voltage condition (**fig. 7**).

Because all probes contain a capacitive element, phase relationships or shifts will naturally occur. Refer to **fig. 8** and consider an amplifier driven from a 10 MHz, 50 ohm source and having an output impedance

fig. 3. P6053B high-impedance probe.

fig. 4. P6048 low-capacitance probe.

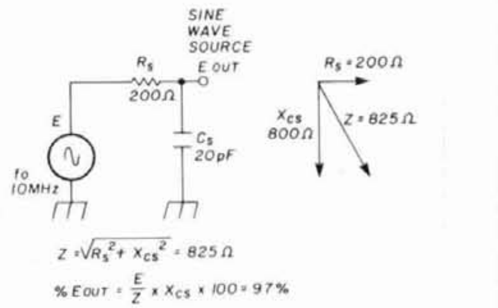

fig. 5. A typical sine wave signal source.

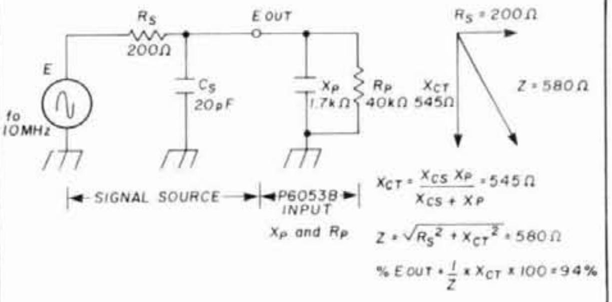

fig. 6. A P6053B probe applied to this typical source.

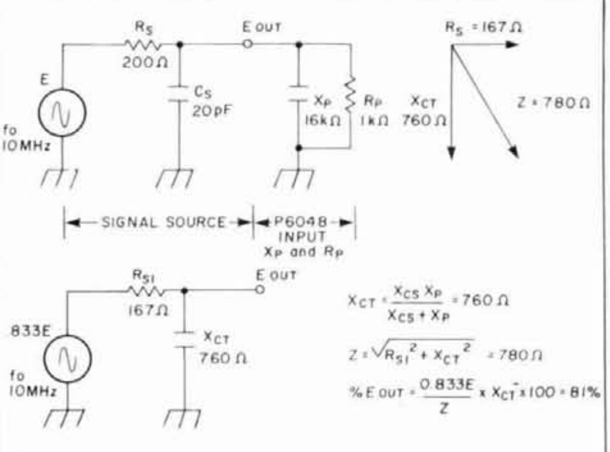

fig. 7. A P6048 probe applied to this typical source.

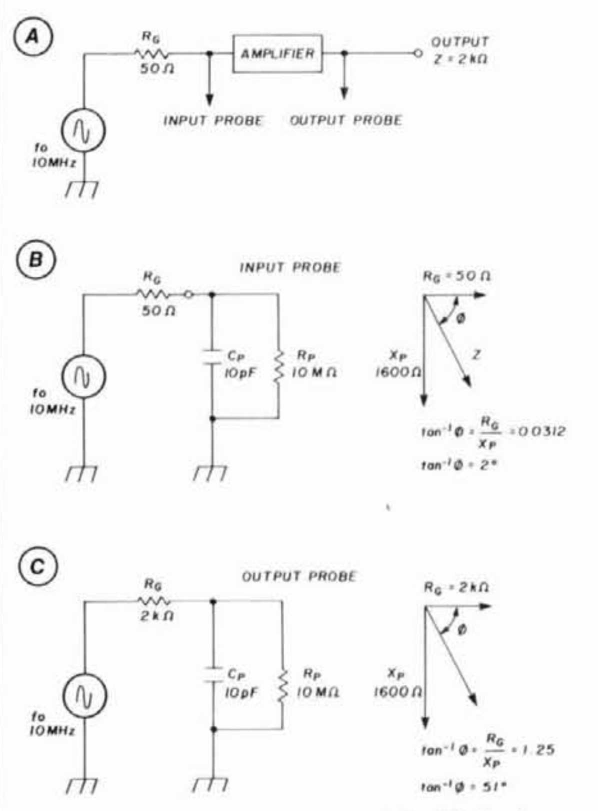

fig. 8. (A) Typical amplifier circuit with differing input and output impedances. (B) Phase shift caused by applying P6053B probe to the amplifier input. (C) Phase shift caused by applying P6053B to amplifier's output.

of 2 kilohms. Examining the input and output using two 10 Megohm 10 pF probes graphically shows a 49 degree phase shift difference in the points in the circuit being examined.

Next, refer to **fig. 9**. Note that with 1 kilohm, 1 pF probes the phase difference is now only 2 percent. But the price paid for this is an attenuation in signal — it's only 67 percent of the original amplitude.

application determines probe needed

Here are some general guidelines to follow when making measurements with a passive scope probe.

- Always check the probe compensation on the oscilloscope being used to make the measurement.
- Choose the lowest *impedance* test point possible to view the signal.
- When making risetime measurements:

  Choose a probe with R and C values as low as possible.

  Scope and probe risetime should be short relative to the signal risetime.

  - Observed risetime is approximately equal to the square root of the sum of the squares of all risetimes in the system. These risetimes include that contributed by the signal source, the probe and the scope.
- When making amplitude measurements:

  For sine wave measurements, choose a probe that has the highest input impedance at the frequency of interest. Remember, loading error changes with frequency.

  For pulse measurements, choose a probe that has a large input resistance relative to the source impedance. Input C is of no concern if pulse duration is about five times longer than the input RC.

active probes

Two prime advantages of active probes include the following: isolation (provided between the measurement point and the probe cable and scope, allowing high input resistance and low capacitance to be achieved) and full bandwidth (obtainable without input signal attenuation).

Most active probes are compatible with either 1 Megohm or 50 ohm scope inputs without using external adapters. When working in the 50 ohm mode, a 50 ohm cable can be used to extend the probe length without increasing capacitive loading. However, longer cables will slow the risetime.

A typical active probe such as the Tektronix P6201 in **fig. 10** has a probe bandwidth of from DC to 900 MHz with a risetime of 0.4 nanosecond.

To show how much better an active probe is than a passive probe, let's go back to the same circuits we've been comparing and see what happens to the circuit once the active probe is connected to it (see **fig. 11**). Realizing that the P6201 has a 1.5 pF capacitance, its loading effect is only 8 percent, increasing the pulse risetime from 8.8 ns to 9.5 ns or mathematically:

$$\frac{t_{r3}-t_{r1}}{t_{r1}} \times 100 = \frac{9.5\text{-}8.8}{8.8} = 8 \text{ percent}$$

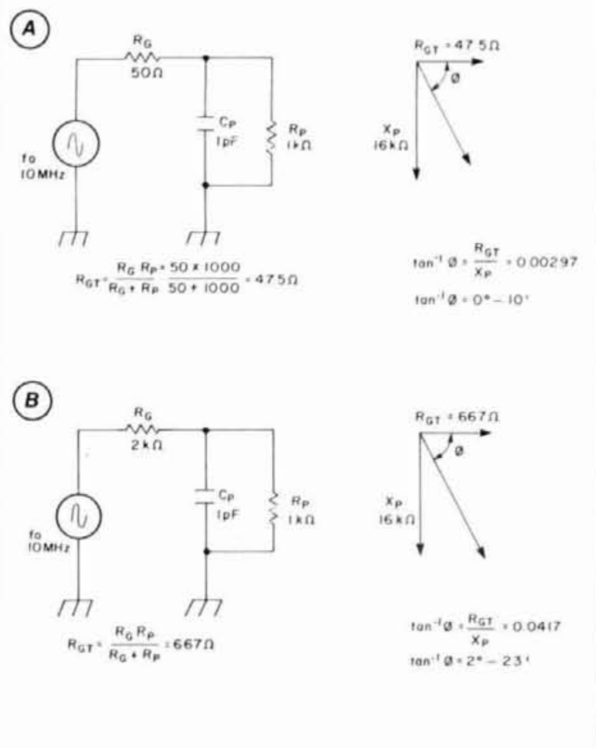

fig. 9. Phase shift caused by applying a P6048 probe to an amplifier's (A) input and (B) output.

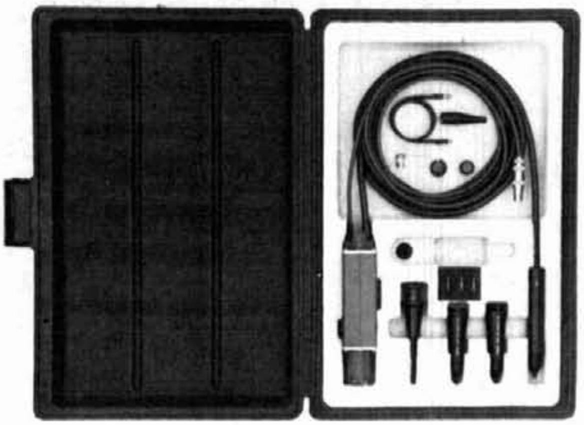

fig. 10. A typical active probe, the Tektronix P6201.

This 8 percent value is a marked improvement over the 48 percent increase in risetime caused by a 10x high impedance *passive* probe like the P6048.

measuring low-level signals

One prime advantage of an active probe is full bandwidth at 1x attenuation with minimum circuit loading. **Figure 12** shows that the active probe increased the risetime from 8.8 ns to 10 ns for a 14 percent change. Although somewhat greater than the 8 percent change

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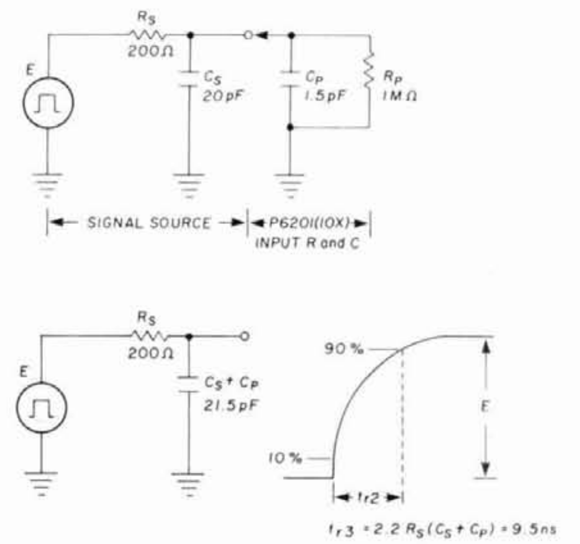

fig. 11. A P6201 (10X) active probe added to a typical pulse source.

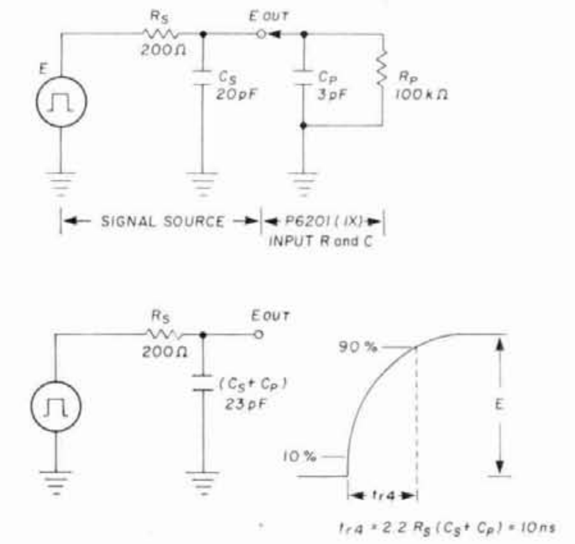

fig. 12. A P6201 (1X) active probe added to a typical pulse source.

of the P6201 (10x), it virtually had no effect at all on the signal amplitude. But in fairness to the passive probes, it must be noted that at lower values of source impedance or with slower risetimes the small difference in measurement error may not justify the difference in cost between the active and passive probes. But in the final selection process it might be advisable to observe the following general guidelines:

• Full bandwidth is provided with no signal attenuation using the 1X configuration.

• The active nature of the probe provides the high input impedance characteristics of most passive probes and the low input capacitance of passive probes designed to work into 50 ohm inputs. These features yield the best features of both — minimum risetime and minimum pulse-amplitude error.

• Impedance selection to permit use with either 50 ohm or 1 Megohm inputs is usually provided.

• Probe length can be extended through the use of a 50 ohm cable without increasing probe loading.

• Over-voltage capability is typically provided. However, to minimize the likelihood of over-voltage, the highest attenuation configuration should always be used when probing unknown voltages.

• Dynamic signal range of the active probe is not as great as that of a passive probe. For example, the P6201 (1X) can handle signals up to ±600 mV. This can be extended to ±60 volts using the 100X attenuator. DC offset provides a measurement window of ±5.6 volts using the probe alone, with the range extended to ±200 volts using the 100X attenuator.

fig. 12A. The P6042 current probe and accessories.

the current probe

Now let's turn our attention to a measurement tool often overlooked — the current probe. Current probe measurements are particularly applicable for high impedance measurement points where the voltage probe would significantly alter the circuit characteristics.

The current probe offers the lowest circuit-loading of any available probe. There is, however, an insertion impedance reflected into the circuit under test, which consists of a series resistance shunted by a small

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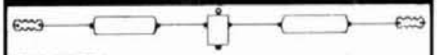

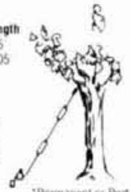

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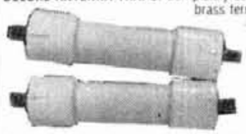

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1412	144-148	160	30	-	-
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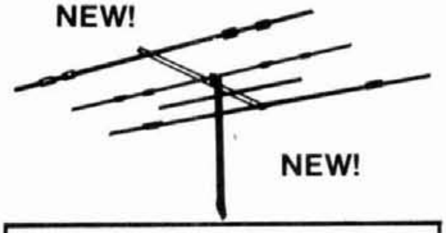

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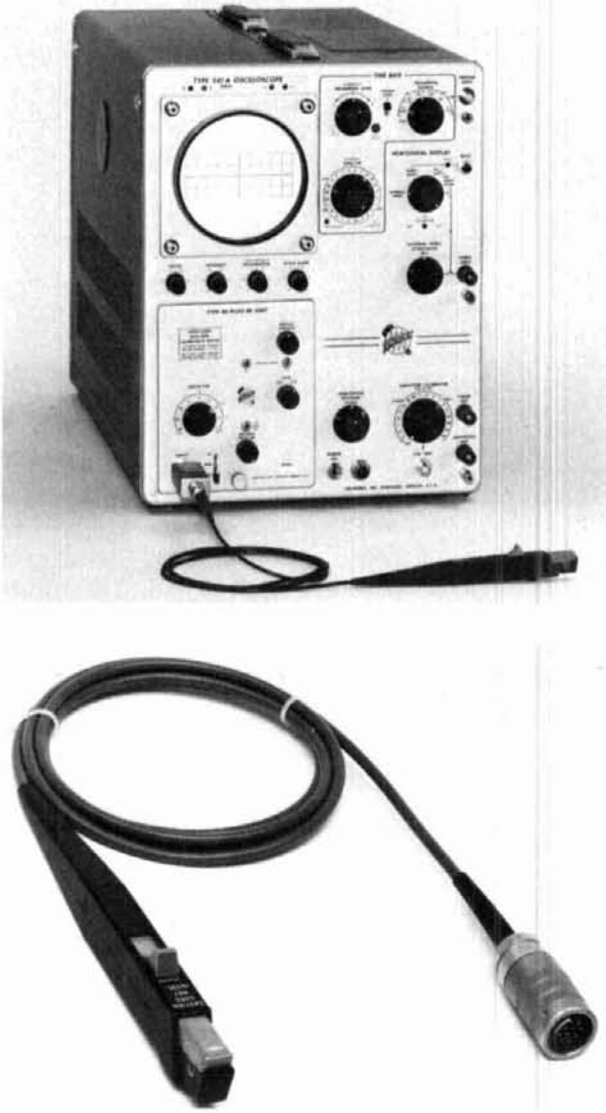

fig. 13A. Examples of closed-core head current probes.

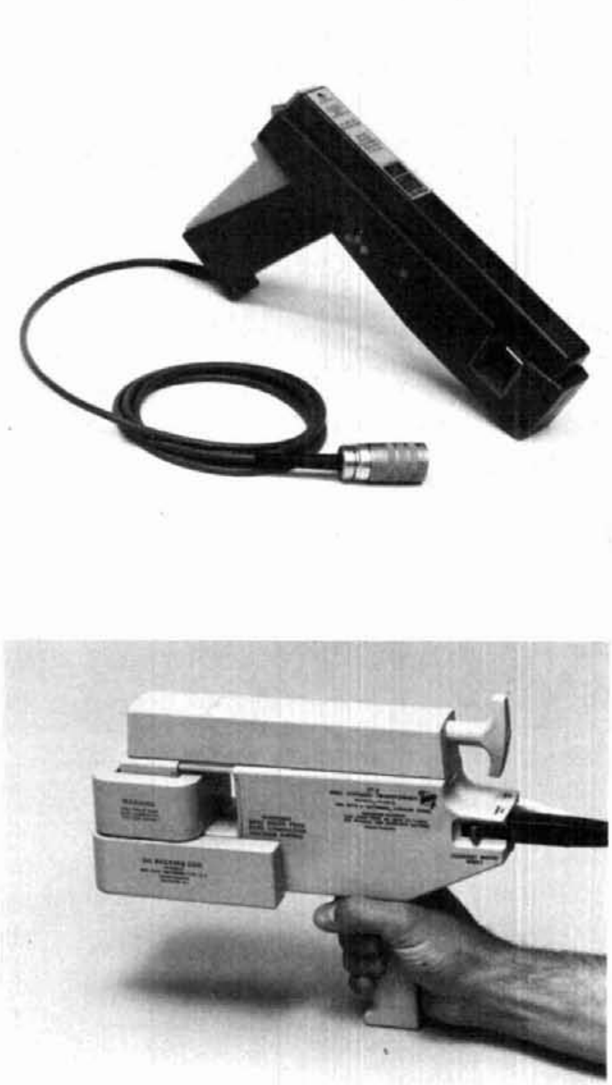

fig. 13B. Examples of split-core head current probes.

inductance which is associated with the inserted impedance of the current-sensing unit in the probe head. The P6042 current sensing probe is a DC to 50 MHz device with insertion impedance of 0.1 ohms at 5 MHz, (**fig. 12A**). Therefore, to realize an amplitude measurement error of no greater than 2 percent the signal source impedance should be 50 times the insertion impedance or 5 ohms in this case. But let's take a closer look at this head. It uses a Hall Effect* device to yield tilt-free display of the current waveform. This also supplies the DC and low frequency information to the P6042 amplifier. In this amplifier, this low frequency information is combined with the high frequency component of the signal to yield the output.

Another consideration in using current probes is the capacitive loading from the probe to the circuit. The coupling — the only shunt loading placed on the circuit by the probe — will vary according to the size and type of wire or current conductor. For example, while a No. 20 AWG wire will show approximately 0.6 pF, a No. 14 wire will have approximately 1.5 pF. The majority of capacitance occurs between the shielding and the current sensing unit. This can be minimized by using the probe ground lead when working with large voltage swings of high-frequency signals.

There are two types of current probes (**figs. 13A** and **13B**): the *closed-core unit*, in which the wire is

*The Hall Effect describes the phenomenon of what happens when a conductor through which a current is flowing is placed in a magnetic field: a difference in potential (the Hall voltage) is generated between the two opposite edges of the conductor in the direction perpendicular to both the field and the current.

threaded through the head and the *split-core unit*, which provides for a portion of the core to slide back, allowing the current-carrying lead to be inserted without breaking the circuit.

A different set of terms is used to describe the operational characteristics of a current probe than is used with a voltage probe. The most important parameter is the Amp-Second Product, which is directly related to the flux saturation of the transformer core. Effectively, the Coulomb* charge (one volt is the potential difference between two points in an electric circuit when the energy involved in moving one coulomb of electric charge from one point to the other is one joule) under one pulse is integrated to determine whether it will place the current transformer into saturation.

The following are general considerations related to current probe use:

- The current probe can be considered complementary to the voltage probe in that while the voltage probe requires low impedance points for accurate measurements, the current probe requires higher impedance points.
- The current probe exhibits lower loading than any voltage probe. This generally implies minimum signal amplitude attenuation and minimum risetime inaccuracies.
- Where information on current supply requirements is needed, primarily current into capacitive elements, the current probe is almost a necessity.

a more exotic probe

The last type of probe to be considered is the sophisticated, cleverly designed HP5363B time interval probe (**fig. 14**).

An electronic counter works on a simple principle in the time interval mode. First, any frequency counter has a main gate that when opened, allows pulses from an extremely accurate quartz crystal oscillator to be counted and accumulated in a counting register. The main gate remains open and the register keeps counting the crystal's frequency as long as a measurement is being made. In the time interval mode, there is a finite elapsed time between two events. These two events, the START and STOP events, take the form of the two independent inputs on a frequency counter. The problem arises when the two channels (the START and STOP inputs) have unequal delays through their probes, cabling, and input circuitry. Also, a counter's input circuitry has been designed for optimum performance at detecting zero crossings. This makes the measurement of risetimes, propagation delays and slow rates very difficult because its limited

fig. 14. The HP5363B time-interval probe. (*Photo courtesy Hewlett-Packard.*)

trigger range is typically ±1 volt or less. A slight uncertainty or ambiguity in the exact triggering point results.

The HP5363B time interval probe can be very useful in this situation. The user goes through a procedure that basically involves grounding the probe to be calibrated and pressing a front panel switch. This action causes the reference voltage, V_r, to move up or down in a stair-step fashion in very precise 1 mV steps until the device triggers. Knowing the exact value of V_R helps and the dynamic range of this probe is +9.99 volts to −9.99 volts and is presettable in 1 mV steps by the thumbwheel switches on the front panel. This probe eliminates the need for attenuators and allows more accurate measurements nearer the top and bottom of waveforms than would be possible without this device. The probe also has a pullable engaging type switch that adds 10 nanoseconds to the measurement to compensate for less than ideally matched input channels. Naturally, though, this 10 nanoseconds has to be added to the final reading if you engage this feature on the time interval probe.

conclusion

The judicious selection of a probe results in more accurately derived readings, and this enhanced accuracy will be evident in both more precise amplitude and phase measurements with a passive scope probe and more accurate current measurements with an active current probe. And if you have to make very precise time interval measurements (stop-to-start intervals, for example,) between events using a frequency counter, you now know of an accessory for the frequency counter's probes that minimizes and nulls out the differences in each channel's probe and its input circuitry.

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*A Coulomb is mathematically equal to $\frac{W}{V}$ or one joule divided by one volt.

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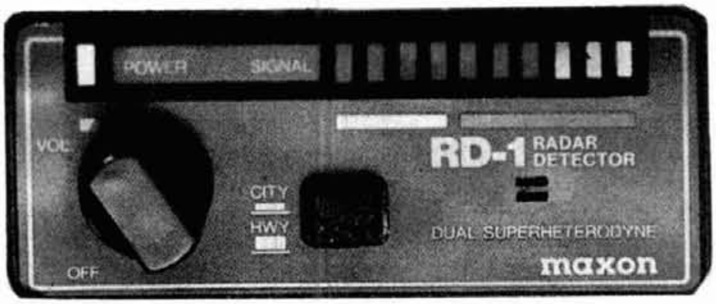

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ham radio TECHNIQUES

Bill Orr, W6SAI

"I have seen the future — and it works"*

It may be that Amateur Radio is undergoing a technical revolution as great as those revolutions brought about by the switch to single sideband and to VHF repeaters. Both developments changed the face of Amateur Radio within a few short years. Amateurs of the 1940s would be astounded if they were magically transported through time to visit a modern Amateur Radio station.

The microcomputer is leaving its mark on Amateur Radio today. Last winter, for example, the first 20-meter SSB computer controlled contacts were made via a VHF/UHF repeater and remote link (**fig. 1**). The heart of this unique communication circuit was the newly-developed Shackmaster® station control unit (**fig. 2**) developed by Ed Ingber, WA6AXX, and his associates at Advanced Computer Controls, Inc., of Cupertino, California.

The Shackmaster is a station accessory that permits remote control of a home station via digital command given over the air or via a telephone line. In the case I'm talking about, N6IPE (Don Melchoir), controlled his 14 MHz SSB station via a remote VHF radio link. And this is *complete* — receiver and transmitter band scanning, mode changing, band changing and on/off control — just as if the operator were sitting at the station console!

*John M. Reed, 1920.

crossband linking

Imagine yourself driving along the highway. Your vehicle is equipped with two FM transceivers, one on the 440-MHz band and the other on the 1296-MHz band. At the moment you're listening on 443.875 MHz, which is the output frequency of the hill-mounted repeater. The down-link is 443.875 MHz, and an FM receiver at the 20-meter home station is listening to

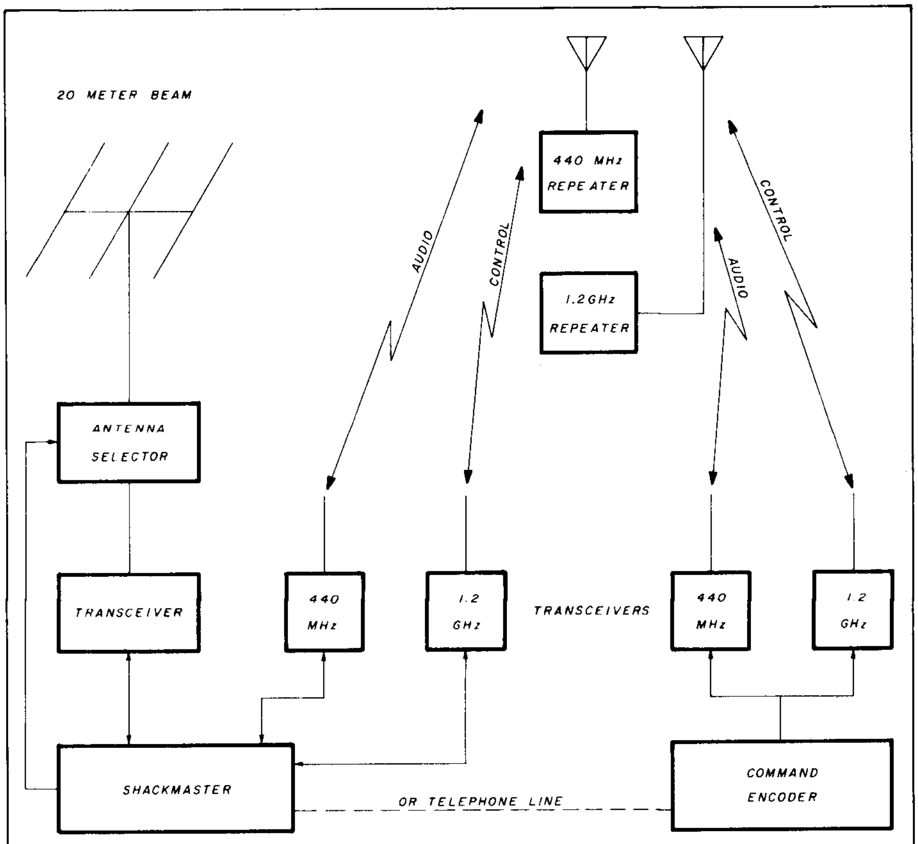


fig. 1. The Shackmaster supports voice, frequency and mode control of 20-meter transmitter via two UHF links through repeaters. In the N6IPE experiments an ICOM-751 computer-controlled HF transceiver was used. Instructions are loaded into memory circuits of transceiver. DX to date includes Guam, Kwajalein, and Venezuela.

fig. 2(A). Shackmaster 100 Station Controller® allows operator to control home station over the air or over the phone lines. Unit ties together home equipment and allows deposit of electronic messages in its "mailbox."

this channel. This link provides the two-way voice channel. The 1296-MHz channel is provided for frequency control of the home station and for transmit-receive control. Everything's ready for operation.

Via the 1296-MHz link, you key the command "HF LISTEN" by sending your individual code number plus *74*. You now key in *3* and the "SCAN UP SLOW" command starts the transceiver to slowly tune up the band. To "STOP SCAN," you key in *2* and to scan down, you key in *1*. Other commands allow fast scan up or down, and frequency jumps of 20, 100, and 500 Hz. The keyed command *5* allows you to shift to the auxiliary VFO, which can be programmed separately.

Now you've tuned in the signal you wish to call. As soon as the opportunity presents itself, you pick up the 440 MHz mic, key in **75* and call. To return to listen, you key in *5*.

When the contact is finished, you

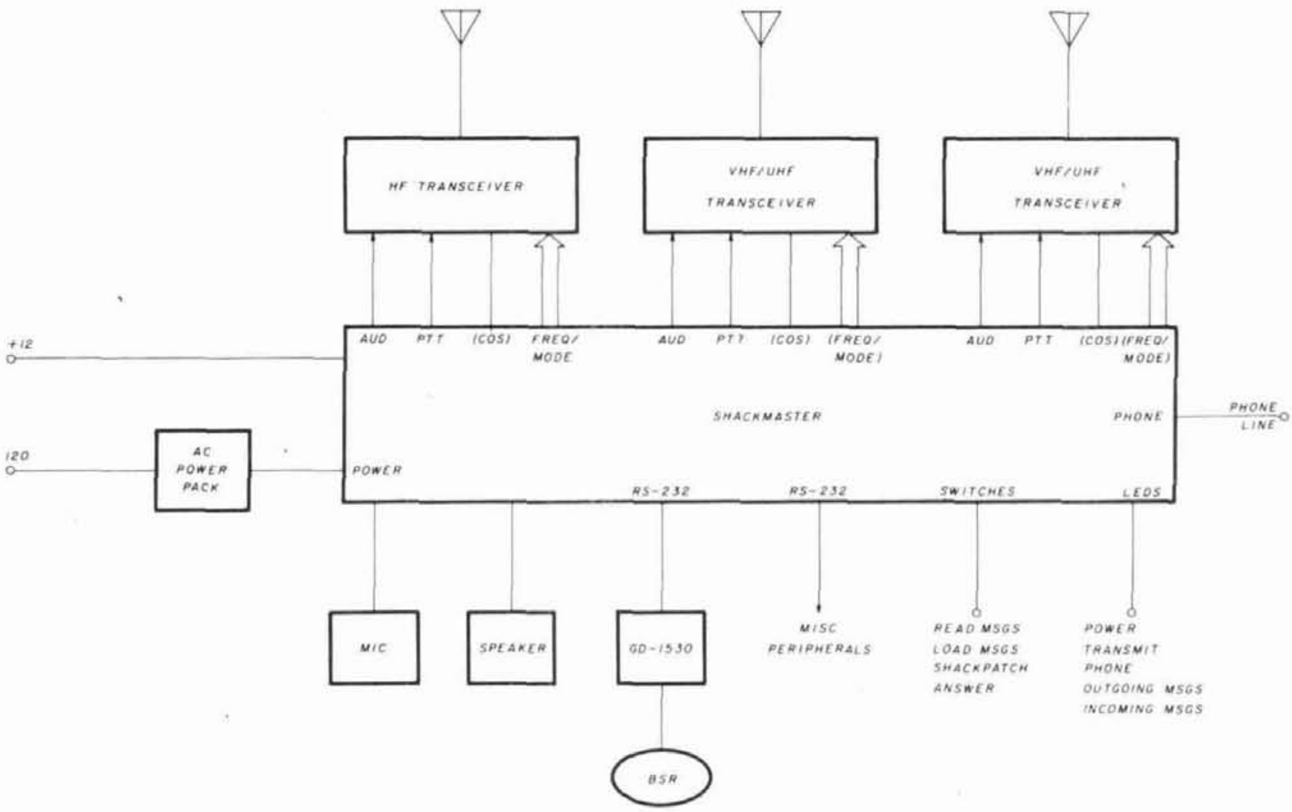
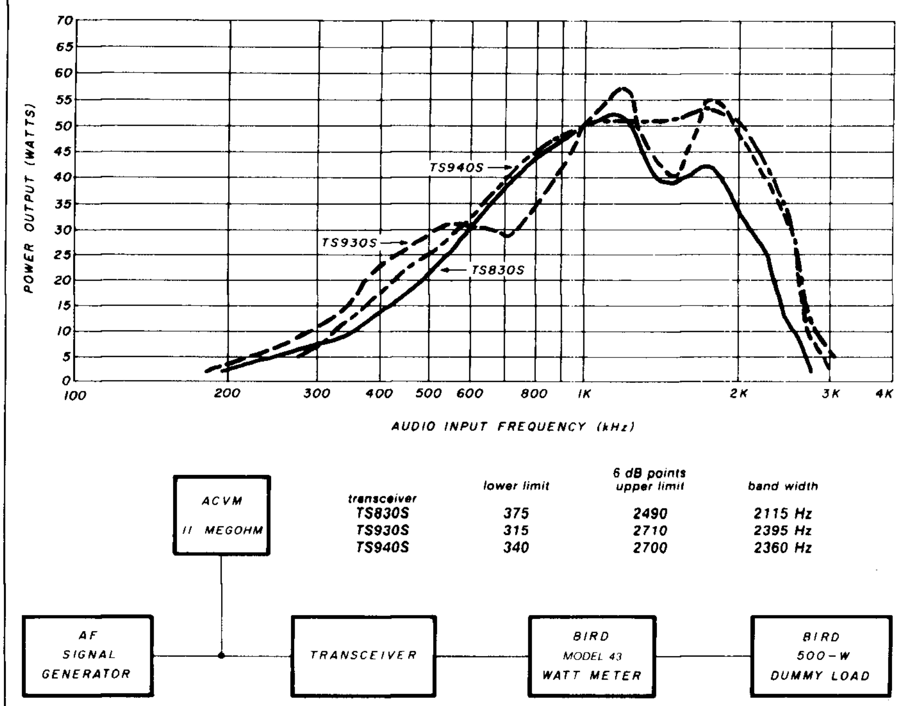


fig. 2(B). Block diagram of Shackmaster.



transceiver	lower limit	6 dB points upper limit	band width
TS830S	375	2490	2115 Hz
TS930S	315	2710	2395 Hz
TS940S	340	2700	2360 Hz

fig. 3. Test setup for measuring audio response of transceiver.

decide you want to see what's coming in from the west. A beam heading of 270 degrees will do the job. You key in **4* to actuate the rotator, followed by *270*. Your antenna is now aimed west.

All this may sound very complex and confusing at first, but it quickly becomes second nature and provides an enormous amount of control capability with a touchtone pad.

The home station makes use of a computer-controlled transceiver, broadband linear amplifier and computer-controlled antenna tuner. In the case of N6IPE, the transceiver was an ICOM-751, the linear amplifier was an ICOM 2KL solid state, broadband device, and the antenna tuner was an ICOM-AT500. The IC-751 was run in the memory mode and the various commands were loaded into the memory.

As you become experienced with the system, you can query the Digital Voice Synthesizer, which will tell you the frequency the 20-meter equipment is tuned to. The capabilities are infinite. Too much QRM on 20 meters? Key *72400* on the touchtone pad and you've instantly QSY'd to 7.240 MHz.

And finally, when you get to your destination and leave your mobile rig, you can still activate your home station via the telephone line!

Well, it all sounds like lots of fun. No doubt you'll be hearing more and more remote-controlled, computer operated stations on the HF and VHF bands during the coming months. The day when two computers talk to each other is not far away in the amazing world of Amateur Radio.

audio response revisited

In my April column I discussed some of the variations in the audio response curve of some representative SSB transceivers. The conclusion was that the passband of some of them left much to be desired. Recently Tiff, W6GNX, had the opportunity to run an audio passband check on three more HF transceivers: the Kenwood TS-830S, the TS-930S, and the new TS-940S. The test was accomplished by injecting an audio tone into the "phone patch" port and measuring the power

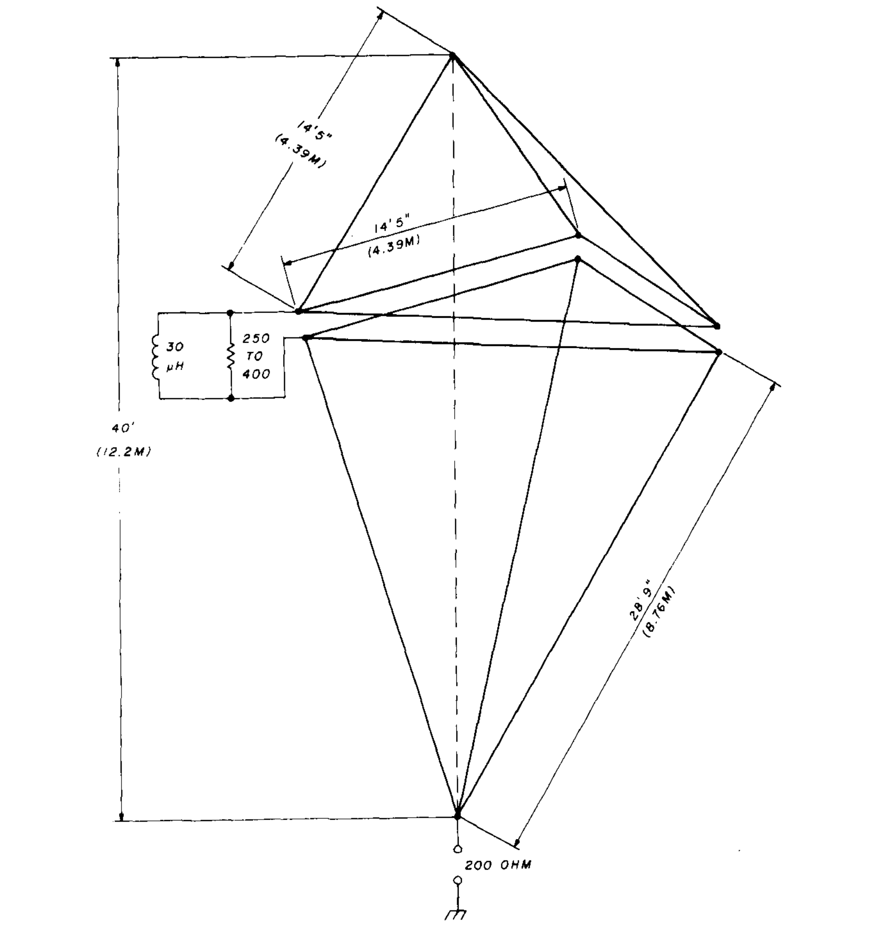


fig. 4. The modified Australian monopole covers 3.5-17.5 MHz. Original design used 377-ohm resistor in RL network.

output of the transceiver as the tone was swept across the audio passband. Sufficient instrumentation was used so that the tone level was constant and the transceiver always operated in the linear mode. The results are shown in **fig. 3.**

The TS-830S and TS-930S both exhibit the characteristic "bumpy" audio response common to that derived from a multi-pole filter that controls the passband. (Compare the curves with that run on the FT-980, as shown in the April column).

Now observe the passband curve of the TS-940S; it's nearly devoid of the filter "humps" and shows a nearly flat frequency response from about 700 Hz to 2300 Hz (less than 1 dB variation). Of interest, too, is the enhanced high-frequency response of both the TS-930S and TS-940S, as compared to the TS-830S.

On-the-air tests of all three transceivers over a period of time showed that it was easy to distinguish the TS-830S from the other two transceivers. It just didn't sound as clear and penetrating, even though the same microphone was used for all tests.

It was even more difficult to differentiate the TS-930S from the TS-940S. I could do it because I knew what Tiff's voice sounded like in person. But the on-the-air difference was marginal.

In any event, the audio passband of the TS-940S is a step in the right direction. As AG6K said, "Perhaps we can now stop sounding like Donald Duck on the air!"

More Details? CHECK—OFF Page 158

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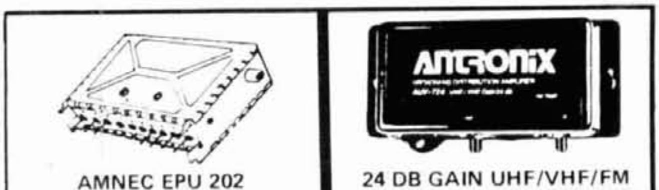

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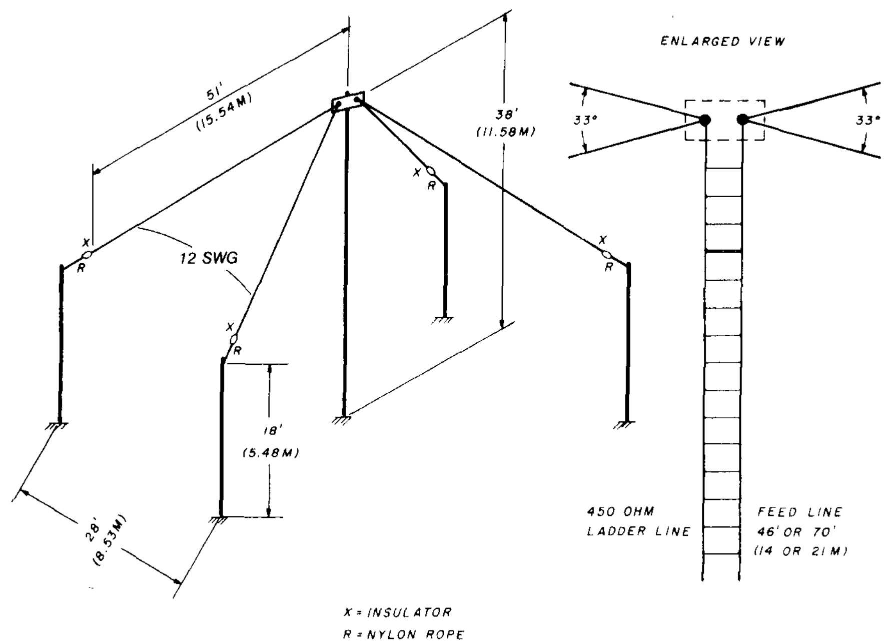

fig. 5. "All-band" antenna patterned after G5RV design. Angles between wires is not critical.

the "Australian monopole"

In my April, 1984, column I described a wideband monopole antenna. Recently I received a letter from Tom, KA2APX, who has built and used it. He says, "I've had several hundred hours operating time on the antenna and am very pleased with the results. I've seen a received signal increase between 12 to 15 dB, as measured on an SP-600 S-meter as compared to an inverted-V at resonance. Incoming signal strength has been good overall, with VK and ZL signals running reasonably well above the noise floor on 75 and 160 meter SSB."

Tom is using a 100-watt, 250-ohm resistor in the antenna network and a 60 inch diameter cage instead of a 72 inch one. He concludes, "Many stations, whom I regularly contact, have indicated an interest in the antenna because of its compact length, radiation efficiency, and bandswitching ease."

Recently *Amateur Radio*, the publication of the *Wireless Institute of Australia* described a new version of this interesting wideband antenna. The description was written by Ron, VK3AFW; the general layout of the antenna is shown in **fig. 4**. It's a kite-shaped, three-dimensional affair, about 40-feet high, that could be suspended from a single pole with crossarms to support the widest part of the structure.

The upper and lower portions of the antenna are connected with a simple R-L network. Experience has shown that the resistor should be noninductive and have a power rating equal to about 10 percent of the power output of the transmitter.

The feed point resistance of the antenna is about 200 ohms, so a 4:1 balun is used to match a 50-ohm transmission line. The frequency range of the antenna is 5:1, so this design should presumably cover the range of 3.5 MHz to 17.5 MHz. Ron has found that bumps in the SWR response curve can be moved about or eliminated by varying the value of the shunt resistor in the antenna network.

As with any vertical antenna, a good ground system is required, although VK3AFW reports good results when using only a single 6-foot ground rod.

The whole family of so-called "Australian" antennas (dipole and monopoles) was covered in a technical paper, "Low Profile Radiator for HF Surface and Skywaves," by R.R. Treharne, published in the *IRRECON Digest* (Melbourne, Australia, August, 1981).

It would seem to me that an antenna of this type — one that could be packaged like an umbrella, capable of being opened and erected by one person — would make an excellent portable antenna for military or commercial use, and represent an interesting challenge in experimental design for Radio Amateurs.

a simple "all-band" antenna

In my February column I discussed the so-called G5RV multiband antenna, which is very popular in Europe but not as well-known in the States. In brief, it's a 102-foot (31.09 meter) wire, center-fed with tuned feeders and a Transmatch,® or other form of antenna tuner.

I understand many of the dedicated QRP stations use this antenna and the design has recently resurfaced in the fine QRP Column hosted by George Dobbs, G3RJV, in *Radio Communication*, the flagship publication of the *Radio Society of Great Britain*. The basic design is shown in **fig. 5**. It consists of two G5RV antennas, 33 degrees apart, fed in parallel by an open-wire transmission line. It's an ideal antenna to mount above a single-family residence, with the apex supported on a pole strapped to the chimney.

Both 300-ohm ribbon line and 240-ohm oval line have been used with this interesting antenna (taking into account the propagation factor of the line). A center height of 38 to 45 feet (11.58 to 13.71 meters) is recommended and end heights of 14 to 18 feet (4.26 to 5.48 meters) are satisfactory. And, as G3RJV says, "The antenna is cheap, simple and can, because of its inverted-V nature, fit into a surprisingly small space." That's not bad for an antenna that covers 3.5 to 28 MHz and exhibits some power gain on the higher frequency bands.

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4.916 Bd. Rate	1.25
5.000000	1.50
5.0688	2.50
5.616	1.59
6.000	2.49
6.176	1.49
7.164112	1.00
7.3728	1.49
8.000	1.49
9.000	1.49
9.90000	1.25
10.69425	2.50
10.8864	1.49
10.920	1.49
11.088	1.59
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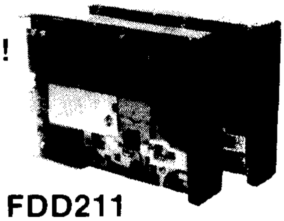

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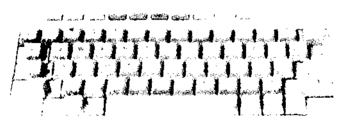

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This unit features azimuth and elevation memory storage, manual or clock control, digital readout and a 24-hour clock

a digitally-controlled satellite tracker

Photo A. Controller mounted in a BUD cabinet. The RUN-PROGRAM/MANUAL toggle swich shown here has since been changed to a 3-position rotary switch.

For satellite tracking *two* rotators are required for pointing the antennas in both azimuth and elevation. But constant adjustment as the satellite moves across the sky — which can be especially troublesome when you're trying to track the fast-moving, low orbit, Russian satellites — is, in fact, not necessary at all.

This system provides 1-degree tracking resolution. The unit (**Photo A**) includes a 24-hour clock and a memory for azimuth, elevation and time data. A small keyboard loads data for storage so that hands-off tracking can be accomplished by loading data before starting operations. Manual control is provided for positioning the antennas for start-up or manual tracking if desired.

the rotator

The most common rotator available is the U-100 TV rotator fròm Alliance. It has a double-field coil for forward and reverse, coupled through gears to the mast shaft. Every ten cycles of the 60-Hz power line turns the mast shaft 1 degree. A disc in the gear train mechanically closes a set of contacts every 10 degrees of rotation; this signal steps the control box. While 10-degree increments are a bit coarse for satellite tracking, the unit is inexpensive and readily available. A minor modification must be made to the rotator gear train, as explained later.

To get the rotators to turn with 1-degree resolution I use a counter clocked by the 60-Hz power line, which counts up or down as the rotator turns. Due to start up drag and antenna load, parity between mechanical position and readout cannot be maintained, and the 10-degree rotator signal is used to update the counter. Therefore, should the counter count ahead or behind, it is mechanically corrected by presetting the units counter to 5. For instance, when the counter has reached 14, mechanically the rotator is at 15 degrees. The rotator signal presets the counter to 15. Continuing on, the correction occurs again at 25 degrees, or every 10 degrees.

operating controls

The keyboard is used to load the memory with azimuth, elevation, and time data. The button in the lower right corner of the keyboard is the ENTER key and enters the data into memory. The memory program counter, clock and antenna aiming data are displayed. Azimuth is expressed in degrees from north; elevation in degrees from horizontal. Each seven-segment readout has an extra LED, which is normally used for the decimal point.

Some of these LEDs show internal functions. The A = B LED indicates that the data entered from the keyboard has successfully entered the memory. The START LED indicates the starting position for loading keyboard data.

Data is entered into the PROGRAM mode as follows: Depress the PROGRAM START pushbutton; the START LED lights momentarily. The first keyboard entry will load into the ten's hour bit of the clock. The next key will load into the unit's hour bit and so on across the program counter, AZ display and EL display. When all the data has been loaded, press the ENTER key to load data into memory. The A = B LEDs light to show successful memory loading. Press PROGRAM START again and we can load the next

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

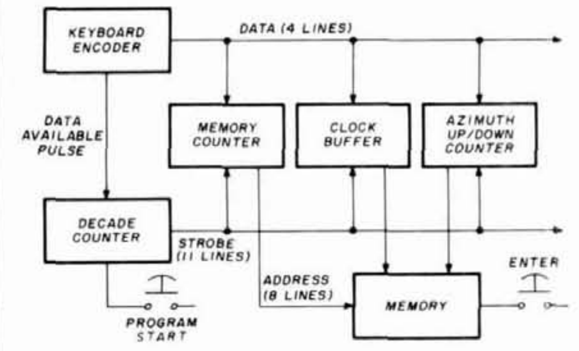
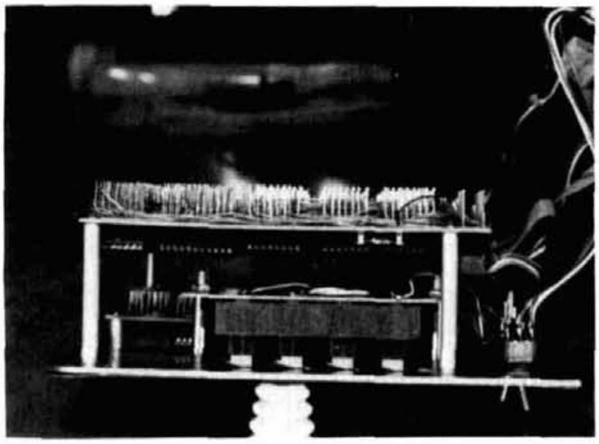


fig. 1. Diagram showing data logic when system is in PROGRAM mode.



Side view of front panel showing keypad mounting.

table 1. Typical data loading schedule for OSCAR 10 satellite. (December 21, 1984.)

universal *time*	*azimuth*	*elevation*
1747	267	10
1754	264	18
1800	261	26
1810	258	34
1823	252	43
1843	245	51
1944	230	57
2203	230	47
2316	235	38
0028	238	28
0141	238	19
0253	232	08

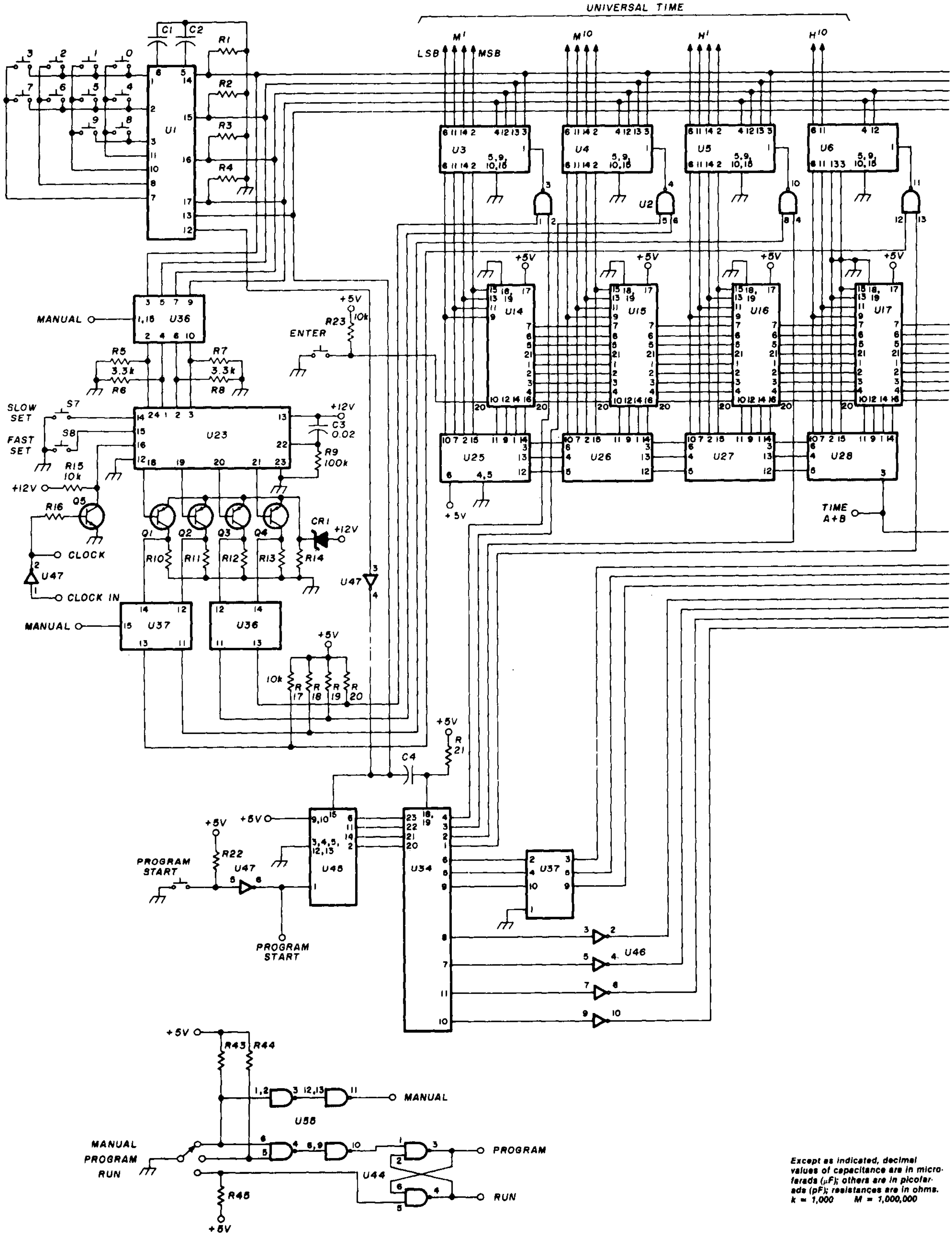
Programming the satellite tracker with antennas parked at 260-degrees azimuth and 80 degrees elevation:

	time	memory	azimuth	elevation	
PROGRAM	1747	01	260	80	ENTER
Program Start	1754	02	267	10	ENTER
Program Start	1800	03	264	18	ENTER
Program Start	1810	04	261	26	ENTER
Program Start	1823	05	258	34	ENTER
Program Start	1843	06	252	43	ENTER
Program Start	1944	07	245	51	ENTER
Program Start	2203	08	230	57	ENTER
Program Start	2316	09	230	47	ENTER
Program Start	0028	10	235	38	ENTER
Program Start	0141	11	238	28	ENTER
Program Start	0253	12	238	19	ENTER
Program Start	2600	13	232	08	ENTER
Program Start	0000	00	000	00	ENTER
RUN					

Note: The time value of 2600 at step 13 prevents turning by the rotators at the end of a run.

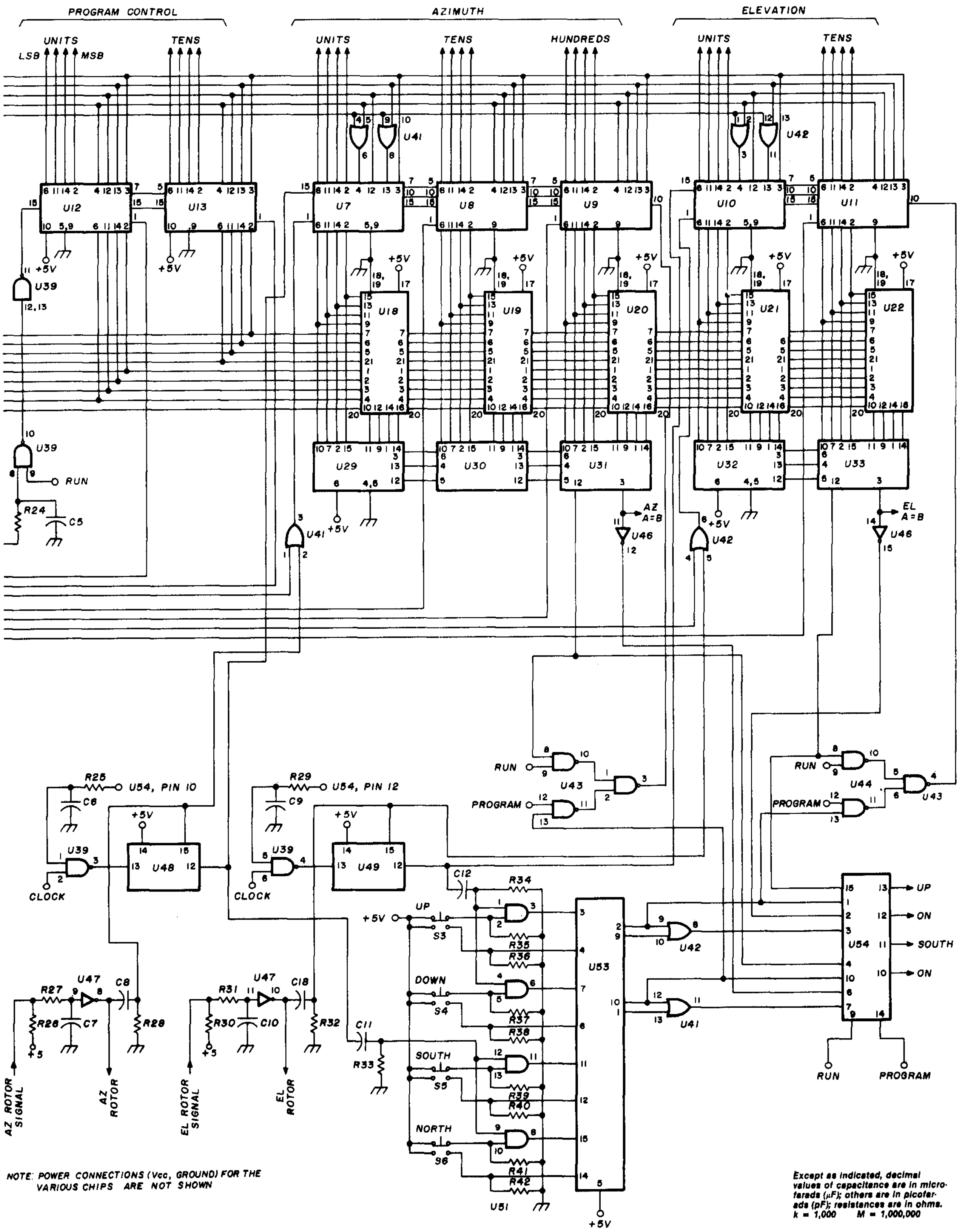
batch of data. Start with 01 in the memory counter and increment by 1 for a possible 99 steps.

Table 1 shows a typical loading schedule for OSCAR 10. The ROTOR LEDs show the closing of the cam switch in the rotator heads for every 10 degrees of rotation. They can be monitored for possible rotor jamming. In the RUN mode, time in memory is compared with the clock. When equal the program counter is incremented, and the rotators move to the new azimuth and elevation data. In MANUAL mode the



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. 2 (part 1). Satellite tracker schematic diagram shows keyboard encoder, universal timer,



program counter, and azimuth/elevation counters.

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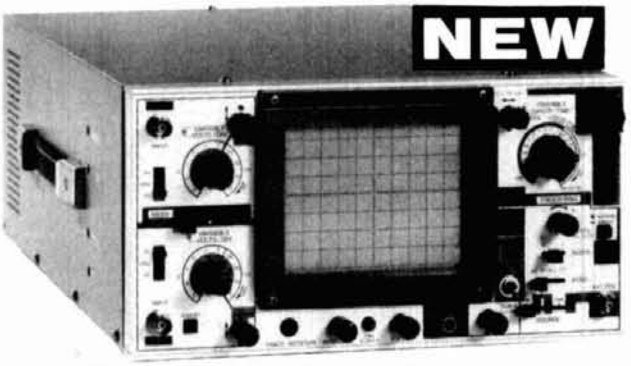

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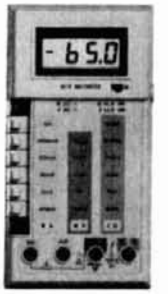

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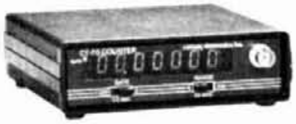

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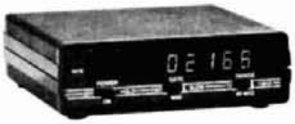

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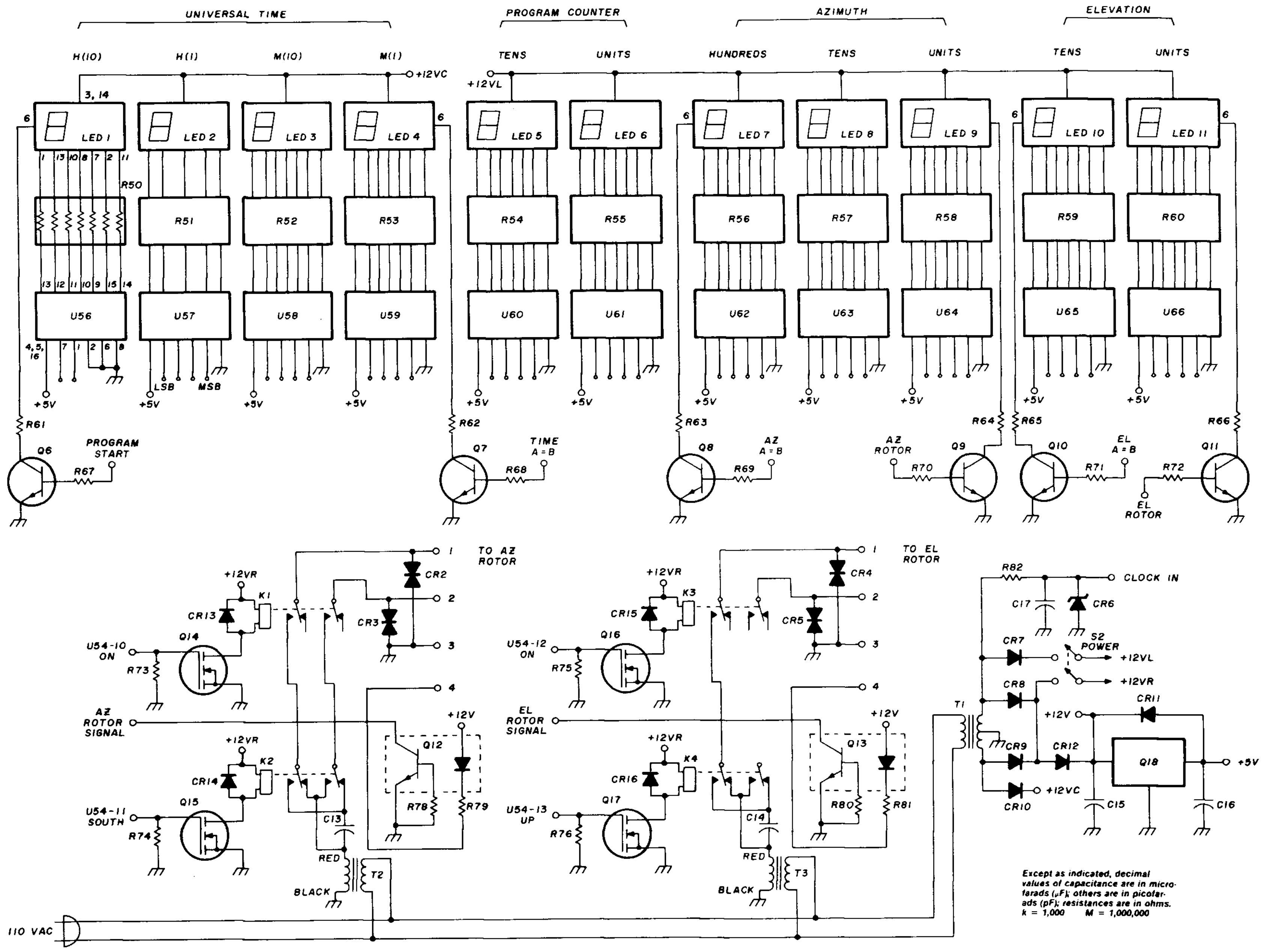

fig. 2 (part 2). Satellite tracker shows universal timer, program counter, azimuth and elevation display, and power supply.

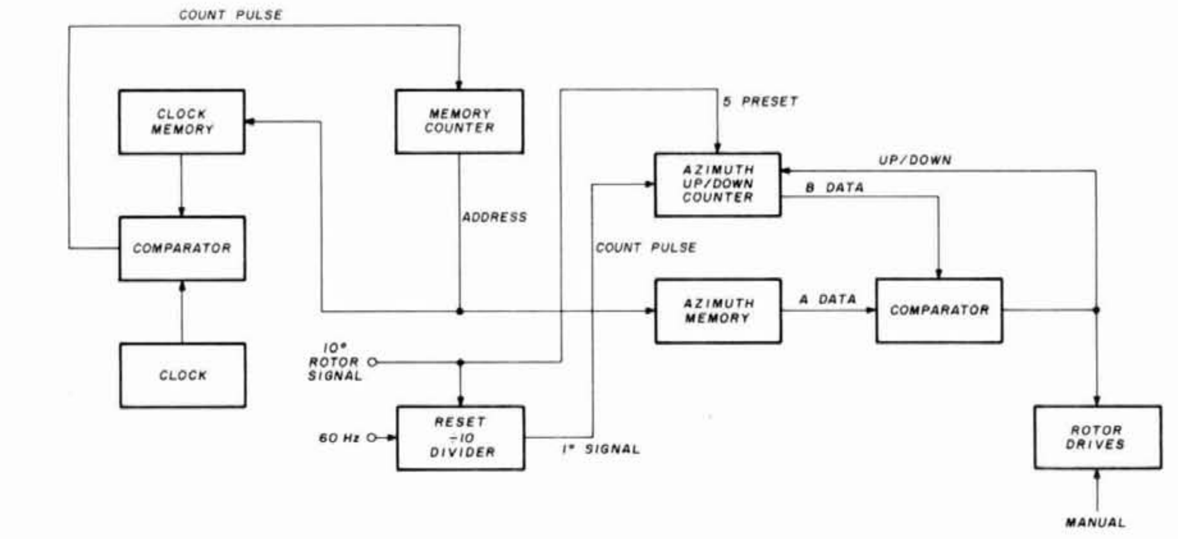

fig. 3. Data routine when in the RUN mode.

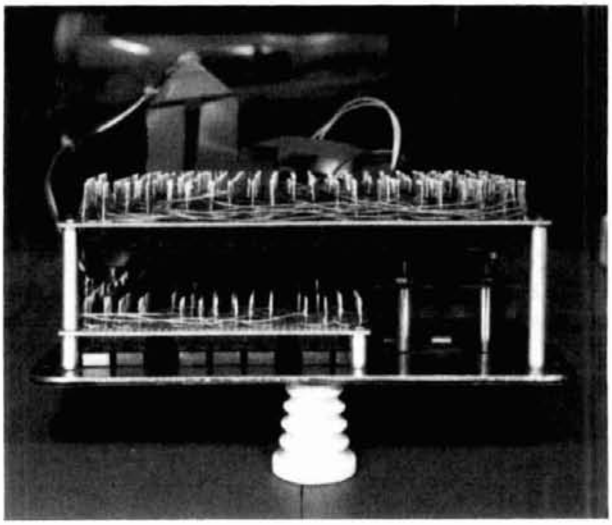

Photo B. Top view of front panel. Note keypad mounted on spacers.

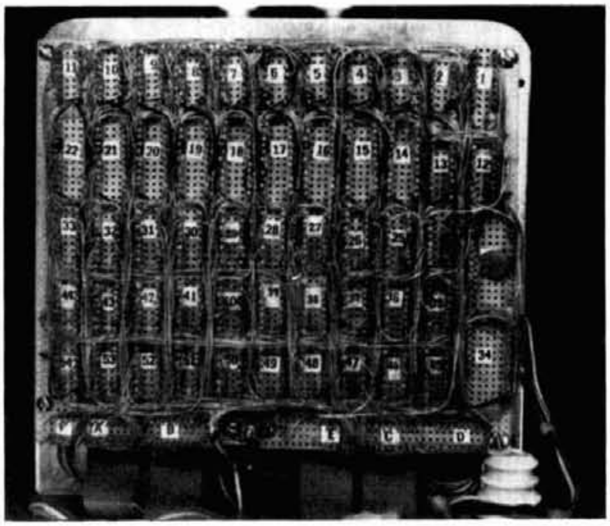

Photo C. Main circuit board showing wire-wrap. The numbers indicate ICs. Parts are mounted on DIP headers. Letters indicate sockets for interconnecting cables.

manual pushbuttons are available for positioning the rotators. A FAST and SLOW pushbutton is available to set the clock to universal (or Greenwich Mean Time) in the MANUAL mode.

basic operation

For simplicity the elevation circuitry will not be included. It is exactly the same as the azimuth circuitry.

• **Loading data from the keyboard (PROGRAM MODE), (fig. 1)**. The key encoder (U1) encodes a keyboard array and outputs the binary value on four data lines (see **fig. 2**). This data presets the clock, AZ-EL and memory counters (U3 through U11). The key encoder also outputs a data-available pulse each time a keyboard entry is made. This pulse steps decade counter U45, U34. The output of the decade counter strobes each data counter sequentially until the data is loaded. We are now ready to store the information. The output from the memory address counter becomes the address for the memories (U14 through U22). The clock and AZ-EL counters provide the data input for the memories. Data is stored when the ENTER key is depressed.

• **Tracking the satellite automatically (RUN**

mode, fig. 3). During RUN mode the program counter is stepped by the output of the clock comparator (U25 through U28). When real time from the clock equals the time stored in memory the program counter increments to the next address. New AZ-EL data from memory (U18 through U22) is compared with the data in the AZ-EL counters (U7 through U11). Three signals are available from the AZ comparator (U29 through U31). If Data A = Data B, the data in both memory and counter is the same and the rotator will not move. If Data A is smaller than Data B, the rotator is turned on in reverse and the UP/DOWN counter is placed in the down mode.

A 1-degree pulse steps the counter until A = B and the rotator stops. If Data A is larger than Data B then the rotator is turned on forward, the UP/DOWN counter is placed in the up mode and again the 1-degree pulse steps the counter until A = B. The 1-degree signal comes from a decade divider (U48) which is clocked from the 60-Hz power line.

When the rotators are turning the counters are corrected every 10 degrees by a rotator strobe, which forces U7 to a count of 5 through OR gate U41 (pin 3). The decade divider is also reset by the rotator strobe from the Schmitt trigger U47 (pin 8).

• **Manual Mode.** In MANUAL mode the rotators are directly energized. The memory and comparator are not used. The manual pushbuttons each set a flip-flop (U53). Reset of each latch is synchronous with the zero count of the decade divider. This ensures manual operation in 1-degree steps. The select gate (U54) either routes MANUAL or RUN commands to the rotators. During the MANUAL mode the clock is also operational.

construction

A complete parts list is provided in **table 2**. All control circuitry was wirewrapped on the two boards. The board behind the front panel has the LED displays and drivers U56 through U66. The dropping resistors are DIP with seven resistors. The keyboard, purchased from Jameco, came mounted on a PC board, which was removed and the assembly remounted on a blank circuit board (**photo B**). The unit was then rewired to conform to the U1 keyboard decoder. Because the right row of switches is not used, the pushbuttons should be removed. (I have since used another keyboard sold by Herbach and Rademan, Inc. This keyboard doesn't have to be modified.)

The main circuit board contains all logic circuits in wirewrap sockets (**photo C**). Both boards are mounted to the front panel of a BUD cabinet with spacers. All interconnections were made with flat ribbon cable DIP plugs (**photos B, D**). Some care must be exercised in wiring the V+ and ground to the chips.

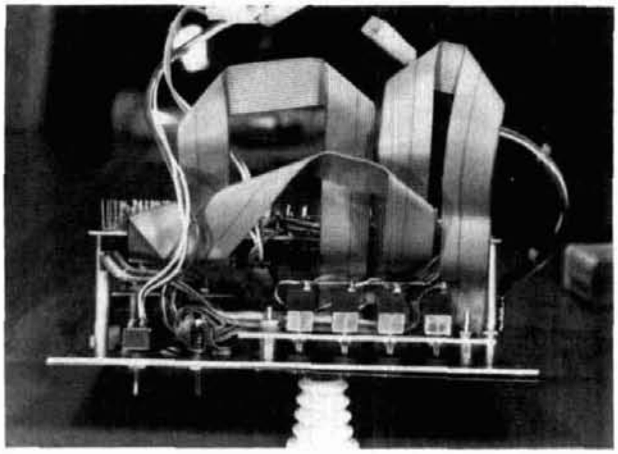

Photo D. Bottom view of front panel. Pushbuttons are mounted on a spacer. Note flat ribbon interconnect cables.

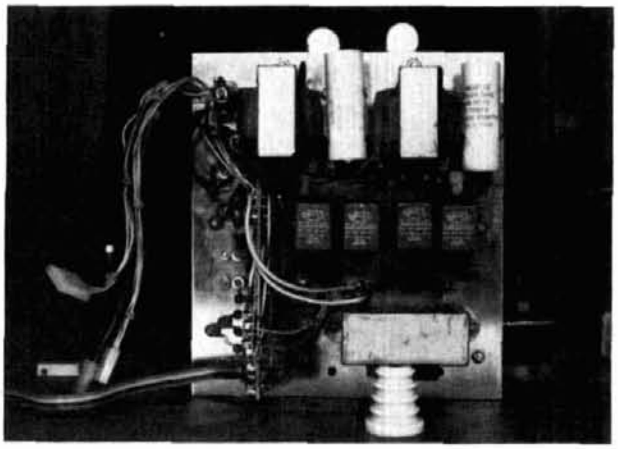

Photo E. Power supply chassis mounted in rear of BUD cabinet. Top transformers and capacitors are from original rotator drive. Small board to the left contains relay drivers, optical couplers and power supply. The +5 volt regulator is mounted on the chassis for cooling.

Each row was daisy-chained, and each chain was provided with a 0.01 μF bypass capacitor; all were then run to a common connection on the board. Two No. 18 wires with Molex plugs connect to the power supply. The power supply, rotator transformer, and control relay circuitry were mounted on the chassis back plate.

The rotators are very noisy when starting and stopping. Each output has a varistor (CR2 through CR5), which takes care of some of the noise, but good ground housekeeping is a must. Lead dress is especially important.

Coupling between rotators and circuitry is kept to a minimum by using relays and VMOS drivers for isolation (**photo E**). Optical couplers Q12 and Q13 are used for the rotator signal, and the 60-Hz clock signal is filtered through R82, C17 at the power transformer.

table 2. Parts list for the digital satellite tracker.

item	description
C1	10μF 10 volt tantalum
C2,7,10	0.1 μF 5 volt disc
C3	0.02 μF 5 volt disc
C4,6,8,9,11,12,18	0.01 μF disc
C5	1 μF 10 volt tantalum
C13,14	see text
C15	1000 μF 24 volt electrolytic
C16	50 μF 10 volt electrolytic
C17	0.2 μF 5 volt disc ceramic
CR1	3.3 volt zener
CR2 thru CR5	24 volt varistor GE V47ZA1
CR6	5 volt zener
CR7 thru CR16	1N4002
K1 thru K4	DPDT 12 volt coil
Q1 thru Q4	2N3905
Q5 thru Q11	2N3904
Q12,13	MCT-2 (4N25, LIT-1)
Q14 thru Q17	VN10KM (Radio Shack 276-2070)
All resistors are 10 kilohm, 1/4 watt except the following:	
R5,6,7,8	3.3 kilohm
R9	100 kilohm
R10,11,12,13,14	4.7 kilohm
R26,30	1 kilohm
R50 thru R60	470 DIP
R61 thru R66	470
R73 thru R76,78,80	68 kilohm
R79,81	620
R82	22 kilohm
S1	SP3T rotary miniature
S2	2PST toggle
S3 thru S6	SP2T momentary
S7,8,9*	SPST momentary N.O.
T1	24 VCT 2A (Stancor P-6377)
T2,3	see text
U1	74C922
U2,43,44,55	CD4011
U3 thru U13,45	CD4029
U14 thru U22	5101 RAM
U23	MM5312
U25 thru U33	74C85
U34	74C154
U36,37	74LS368
U39	CD4093
U41,42	74C32
U46	CD4049
U47	74C14
U48,49	CD4017
U51	74C08
U53	CD4043
U54	CD4019
U56 thru U66	74LS247
keyboard	Jameco K-19 TM23K222 (Herback & Rademan, Inc., 401 E. Erie Ave., Philadelphia, PA 19134)
displays	common anode, RHDP, LHDP (Hewlett-Packard HDSP-4030 or equivalent)

*"Slow-set" clock, "fast-set" clock, "program start."

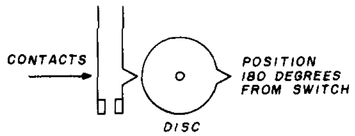

fig. 4. Repositioning the switch contact disc for 5-degree set in the Alliance rotator controller.

I have not experienced any problems with everything mounted in one unit, but keep in mind that CMOS is high impedance and will react to low-frequency noise.

Three separate pairs of wires supply +5 volts to the circuit boards. One pair is for the main logic card, one pair for the front panel LED circuitry and a final pair for the manual pushbuttons, mode switch and ENTER buttons. All three pairs originate at the regulator chip Q18. Since continuous power is needed for the clock, no switch is provided for it in the power supply. The +12 volts is turned off to most of the display (except the clock) and power to the relays is turned off for safety. The +5 volts remains on. Transformers T2 and T3 and capacitors C13 and C14 were removed from the Alliance rotator controllers.

mods to rotators

One small modification must be made to the rotators. Before removing the transformers and capacitors, connect the rotators to the Alliance control box and check to make sure they work properly. Turn the knob counter-clockwise until the rotator runs into the stops. Now open the rotator housing, but try not to disturb the gears. Tabs on the main shaft move a T-slug stop. Make sure the rotator has gone into the stop at full counter-clockwise rotation. Note the disc which activates the switch contacts; this produces the 10-degree signal. Carefully remove the snap ring, lift the gear, and position the disc as shown in **fig. 4**. Replace the snap ring and reassemble the body.

It probably would be a good idea to clean the contacts and lubricate the gears at this time. This disc is now at the 0-degree point and will produce a signal at every 5-degree set. I used a cable with 3 pairs of wires in aluminum foil wrap to connect the digital controller to the rotators. The two ground wires were used for AC return. Both rotator signals were brought down in one pair with the bare wire grounded at the controller.

A simplified version (manual operation, AZ-EL readout only) of the KA8OBL satellite tracker is available from the author. Send SASE to Rudolph Six, KA8OBL, 30725 Tennessee, Roseville, Michigan 48066

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Figure 1 shows what happens if, for example, random 4-volt and 2-volt CW signals are fed to a 1-volt limiter. For clarity, a filter that passes signal *B* and rejects the frequency of signal *A* is assumed. The unfiltered output of the limiter contains signals *A* and *B* plus harmonics and cross-products — a real mess.

Despite the poor quality of signal *B* at the limiter/filter output, experienced "brass pounders" can often get solid copy because of our fantastic ear-brain coordination capabilities. But comprehension is made more difficult, not easier, by the limiter's action. Moreover, if signal *A* is initially three or four times the amplitude of signal *B*, then copying *B* becomes very unlikely. Finally, even copying one signal can become a problem if heavy limiting is used. In this case, noise would come up to fill the spaces between code elements.

In addition to the suppression factor, if one or more signals above the limit threshold are fed to a limiter,

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

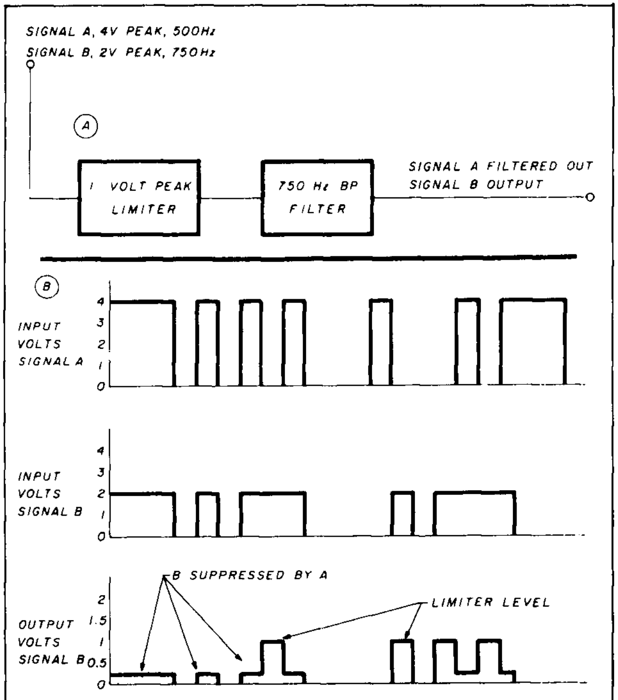


fig. 1. (*A*) limiter/filter circuit model; (*B*) impact of strong signal on weaker signal by limiter action. (Idealized peak envelope shown for clarity.)

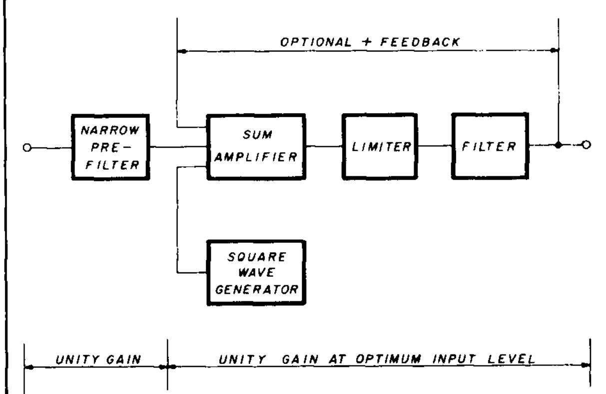


fig. 2. Basic requirements of a carrier activated limiter.

a squared-off waveshape, which contains a considerable amount of harmonic energy, is produced. In a recent article, a limiter was shown in front of a narrowband CW filter.[2] The article stated that locating the limiter in front prevents harmonics generated by the limiter action from reaching the power amplifier, prevents overload of the following power amplifier by strong signals, and makes up for AGC problems with CW. This is true as far as it goes, but it does nothing for the suppression problems illustrated above. In addition, it doesn't prevent sub-harmonics of the filter frequency from entering the limiter which, in turn, creates harmonics that appear as false signals in the filter passband.

To eliminate the problem with sub-harmonics and mitigate the suppression effect, a narrow filter must be added in front of the limiter. This practice prevents lower frequency signals that are sub-harmonically related to the output filter frequency from getting to the limiter and reduces the number of signals with which the limiter is likely to be confronted. But even with the addition of filters surrounding the amplitude limiter, because of the isochronal* nature of CW, the signal-to-noise ratio is worse when using a limiter than for the linear case. The S/N for the limiter case can, however, approach linear performance if a received signal can be adjusted to an amplitude level where limiting is just about to begin. (In this case, S/N refers to the ratio of the coded signals; ON response to the noise response during the coded signals' OFF state.) If the input level is made high enough so that receiver noise is at or above the limit level, then the effective S/N for any received CW signal will be 0 dB — usually an undesirable condition.

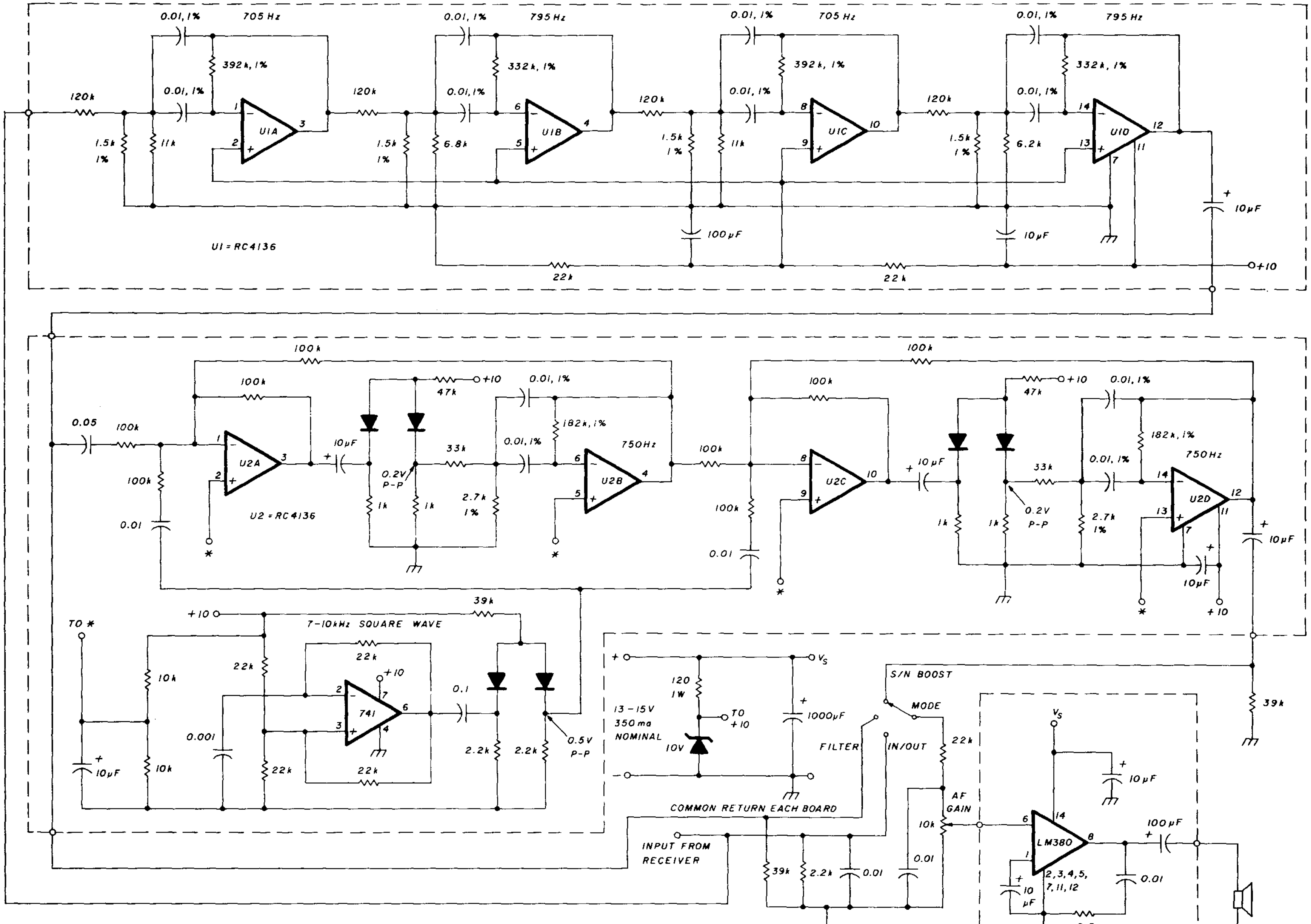
At this point one may wonder whether or not a limiter is worth the bother. Not only is the system no longer simple, but the input signal amplitude adjustment is very fussy, even if you're trying to get an S/N only nearly as good as would exist in the linear case — where the limiter could just be thrown out altogether. Fortunately something can be done — with just a little more hardware — that will tilt the S/N ratio more than 14 dB in favor of the limiter case.

the super-CW model 10: a carrier-activated limiter

Figure 2 shows a block diagram of what must be added to the basic Filter-Limiter-Filter combination in order to obtain the S/N enhancement. The basic concept recognizes that the noise floor, which is present between the coded elements, must be treated as a particular case. To accomplish control of this noise, a nominal 10-kHz squarewave carrier is linearly summed with the output from the pre-filter and fed to a low level limiter. The amplitude level of this carrier is made large enough to fully capture the basic limiter under no-signal conditions.

For a simplified explanation of operation, when a receiver's input to the system is set at a level where the noise floor output from the pre-filter is below the voltage amplitude of the carrier, the noise is suppressed *by* the carrier — remember, survival of the fittest. Then when a signal voltage appears that is above

**isochronal* — occurring at equal intervals of time



All resistors are 1/4 watt, 5% except as noted.
All capacitor values are nominal except as noted.
All diodes are 1N4148 or equivalent.

fig. 3. Complete system including pre-filter and a cascade of two carrier activated limiters with positive feedback and a power amplifier. (Patent applied for on part of this system.)

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IC-271H 100w 2m FM/SSB/CW xcvr	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 xcvr	1099.00	**969^{95}**
AG-35 Mast mounted preamplifier*	84.95	

For a Limited time!
With the purchase of IC-271A/H or IC-471A/H get the matching Preamp* for just $1.00 extra.

Common accessories for 271A/H and 471A/H		
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}**
CF-1 Cooling fan for PS-15	45.00	
EX-144 Adaptor for PS-15/CF-1	6.50	
SM-6 Desk microphone	39.00	
EX-310 Voice sythesizer	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		
IC-290H 25w 2m SSB/FM xcvr, TTP mic	549.00	**479^{95}**
IC-490A 10w 430-440 SSB/FM/CW xcvr	649.00	**579^{95}**

VHF/UHF/1.2 GHz FM	Regular	SALE
IC-27A Compact 25w 2m FM w/TTP mic	369.00	**319^{95}**
IC-27H Compact 45w 2m FM w/TTP mic	409.00	**359^{95}**
IC-37A Compact 25w 220 FM, TTP mic	449.00	**299^{95}**
IC-47A Compact 25w 440 FM, TTP mic	469.00	**419^{95}**
UT-16/EX-388 Voice synthesizer	29.95	
IC-3200A 25w 2m/440 FM w/TTP	549.00	**489^{95}**
UT-23 Voice synthesizer	29.95	
IC-120 1w 1.2 GHz FM transceiver	499.00	**449^{95}**
ML-12 10w amplifier	339.00	**299^{95}**

6m portable	Regular	SALE
IC-505 3/10w 6m port. SSB/CW xcvr	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	
SP-4 Remote speaker	24.95	

Hand-held Transceivers

Deluxe models	Regular	SALE
IC-02AT for 2m	349.00	**289^{95}**
IC-04AT for 440 MHz	379.00	**289^{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

Shortwave receiver	Regular	SALE
R-71A 100 kHz-30 Mhz digital receiver	$799.00	**659^{95}**
RC-11 Wireless 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	

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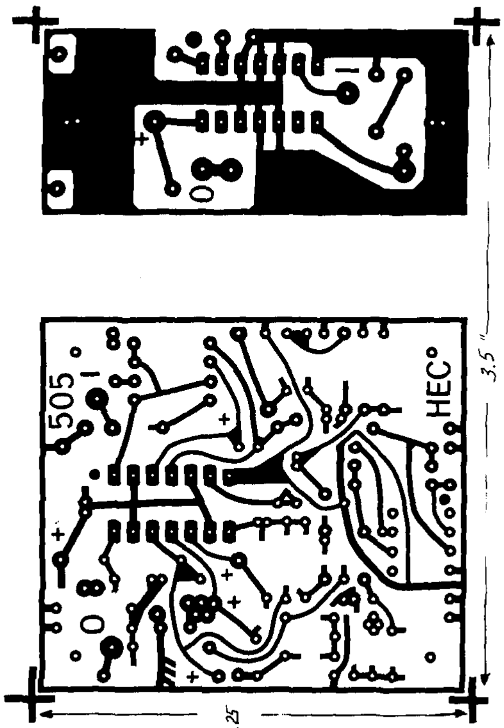

fig. 3A. PC boards 505 and 103, containing the carrier-activated limiter and the power amplifier (component side).

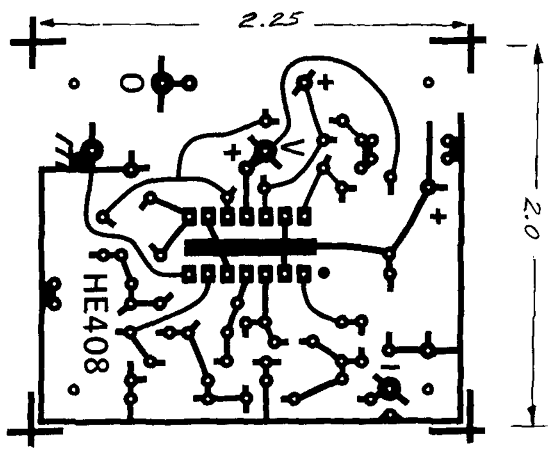

fig. 3B. PC board 408, the Butterworth filter board (component side).

the carrier amplitude, the signal suppresses the carrier. Moreover, *the instantaneous signal and carrier* voltages add to suppress coincident noise. The filter following the limiter removes harmonics created by the limiter as well as the 10-kHz squarewave carrier.

By designing the op-amp summer, limiter and op-amp active filter so that the gain is unity from input to output for the desired signal, identical stages may be cascaded for a *multiplied S/N enhancement* in a manner similar to that of a quality FM communication system. A complete system, including a narrow pre-filter and two stages of carrier activated limiters, which seems to provide just about the right amount of S/N enhancement for excellent operating "feel," is shown in **fig. 3**.

The input filter is an 8th-order Butterworth two-pole cascade with a 100-Hz bandwidth centered at 750 Hz. This design provides minimal ringing and much better skirt rejection than can be obtained from synchronously tuned filters or others of the Gaussian class. The summing amplifiers are designed to linearly add three inputs: the signal, the carrier, and a resistive controlled positive feedback, which assists the S/N enhancement of each stage. Circuit constants of the in-line limiters provide limiting levels of 0.2 volts peak-to-peak. The same limiter design is used to control output from the 10-kHz carrier, but in this case components are selected to make a 0.5 volt peak-to-peak limiter. Because of the light loading presented by the op-amp summer design, only one 10-kHz carrier generator/limiter combination is required to drive both carrier activated limiter stages. Identical 2nd order filters with a nominal 175-Hz bandwidth centered at 750 Hz are used following each carrier activated limiter. Output from the last filter is fed through an L network and volume control to drive an LM380 power amplifier. A mode control switch is included to enable selecting the input from a receiver, output from the linear pre-filter, or output from the complete carrier activated limiter system for input to the power amplifier.

system performance

With this system, S/N enhancement has essentially reached its maximum of a little over 14 dB when the S/N out from the pre-filter is +10 dB and enhancement declines smoothly toward zero as the S/N from the pre-filter approaches zero dB. As a relative comparison, this means that a received signal at about 4.5 dB *below* the noise in a typical 3 kHz bandwidth would yield a +10 dB S/N from the pre-filter and a +24 dB S/N from the carrier activated limiter system. **Figures 4A** and **B** *illustrate generalized performance.*

In addition to reducing the noise by 14 dB, the system can also suppress the ringing residues from the pre-filter by the same amount. Since the ringing residue amplitudes from a Butterworth filter are more than 10 dB below the ON elements of a CW signal that triggers them, the final effect is reduction of ringing residues to *more than 24 dB below the desired signal.*

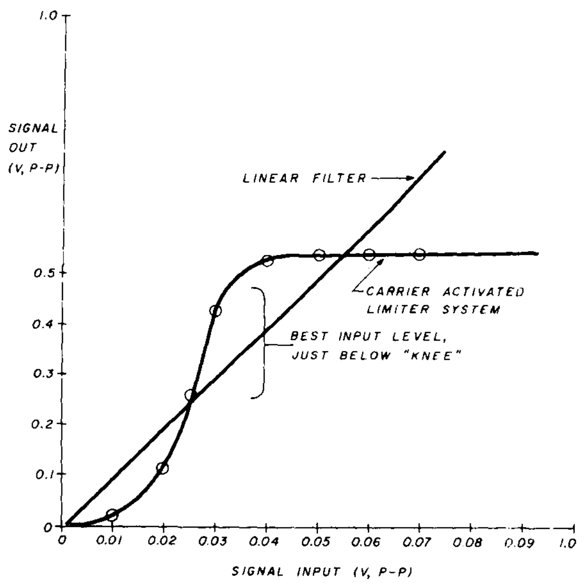

fig. 4A. S/N out versus S/N at input. Curve is analagous with S/N enhancement curves for FM systems, but better because this system has no detection losses.

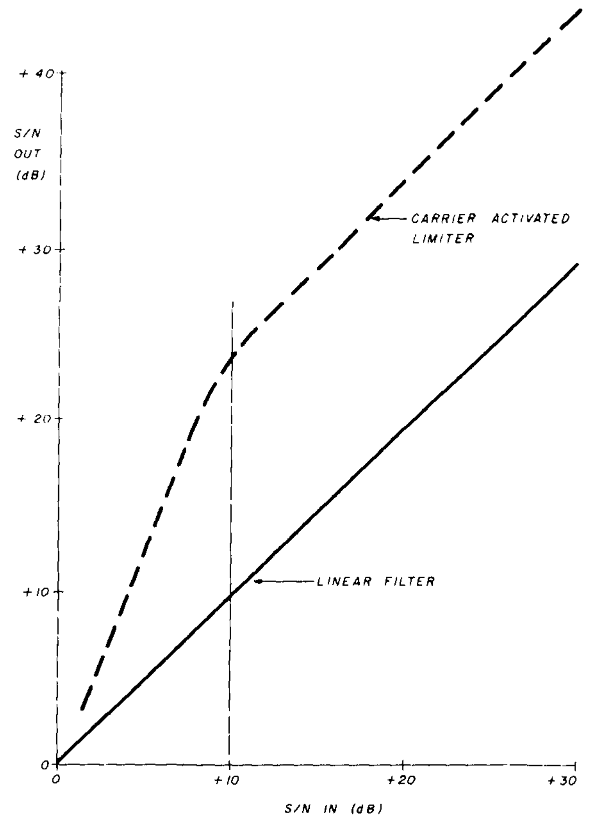

fig. 4B. Signal output characteristic as signal input level is varied. A nomianl 14 dB S/N ratio enhancement is available over the range from 0.2 to 0.5 volt p-p input with a peak boost of 18 dB when input is set at 0.3 volt peak-to-peak.

Also, because filter ringing increases in duration rather than amplitude as bandwidth decreases, this makes possible the use of sharper filters — down to 25 Hz or so for a CW signal at 20 WPM.[3] And this can be done without the need for a complicated synchronous detection system. However, to make use of this very narrow bandwidth and assure comfortable operation, many existing receivers would need better bandspread tuning control than they now have. Even the 100-Hz bandwidth used in this system requires relatively stable oscillators on the part of a received signal and the receiver as well as very careful tuning.

Since the limiter/filter system effectively holds the signal output level constant, the sound pressure listening level cannot exceed that selected by the AF gain control. This feature, present for any signal or noise pulse received, guards against damage to the listener's hearing. This protection is lost, however, when switching to the IN/OUT or Filter positions.

Other methods of S/N enhancement include those techniques that develop a voltage from a received signal to operate an electronic switch to turn an audio oscillator on and off, or to drive a digital system. In general, these methods are fine when a CW signal has a good S/N, but they usually don't perform well with threshold signals. However, the electronic switch method, where it must be used, can be improved by driving it from the carrier activated limiter system.

Finally, the system is designed to operate from a low input level to avoid the requirement of moderate to high receiver gain when listening to weak signals. This reduces the possibility of receiver saturation — unplanned limiting with all of its ramifications as shown in the beginning — by strong signals that may exist in a receiver outside of the pre-filter bandpass.

operating with the model 10

The nominal signal input voltage requirement is from 0.25 to 0.5 volt peak-to-peak at 700 to 800 Hz. Input termination is resistive at 2.2 kilohms, which enables the unit to be driven from either a receiver's speaker or phones output, or an op-amp. Output from the power amplifier is low impedance to enable driving a speaker of from 4 to 8 ohms. If headsets are used, connection to the output should be made through a nominal 100 ohms to avoid possible damage to ears or headset.

The MODE control has three postions. In the IN/OUT position, no filtering takes place, but the variable gain from the AF GAIN control is in effect. In the FILTER position, the 8th order Butterworth pair cascade is inserted between the input and the power amplifier. In the S/N BOOST position, the cascade of carrier operated limiters is connected between the FILTER output and the power amplifier.

To make the best marriage with a receiver, disable the AGC, use a low RF/IF gain, and set the audio level from moderately high to maximum. In a receiver that does not have an AGC ON/OFF capability, AGC action is effectively defeated by a reduced RF/IF gain setting. A little experience with the system will make this clear.

With the preliminaries completed, listen to the system with your receiver set at a point on its dial where no signal is present and with Model 10's AF GAIN set at mid scale. Then, switching through the three positions, you should hear broadband noise in the IN/OUT position, reduced noise in the FILTER position and still further reduced noise in the S/N BOOST position. As a quick reference, you can put Model 10 in its S/N BOOST position, then adjust your receiver's RF/IF gain control to obtain a weak noise background. Tune in a moderate-to-weak signal. Now, when adjusting your receiver's gain up and down, you'll notice a "knee" (see **fig. 4B**) where the signal remains constant in level for increased input and where the signal falls off very sharply as gain is reduced. In the region of the knee, your receiver's gain control is adjusted for optimum S/N ratio enhancement. At this point, switching the MODE control to any of its three positions will result in about the same signal output level — which confirms an optimum receiver input level.

In the S/N BOOST position, tuning is even sharper than in the FILTER position. The BOOST position suppresses skirt responses and residual ringing in the same manner as it reduces the noise floor, which enables clean high speed copy with a narrow filter.

In normal operation you simply adjust receiver gain for input level and Model 10's AF GAIN for desired sound pressure level.

Don't want to build it yourself? The super-CW Model 10 is available preassembled. Contact the author at Hildreth Engineering, P. O. Box 60003 Sunnyvale, California 94088, for details.

references

1. Elie J. Baghdady, Sc. D., *Lectures on Communication System Theory*, McGraw-Hill, New York, 1961, page 494-498.
2. Doug DeMaw, "A Second Look at Magnetic Cores," *QST*, June, 1984, page 19.
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DX FORECASTER

Garth Stonehocker, KØRYW

equinoctial DX propagation brings change, excitement

This season's propagation is characterized by change and excitement resulting from the fewer number of daylight hours as winter approaches. In addition the MUF diurnal curve will no longer exhibit summer's typical low, flat response but will instead show a pronounced peak in the afternoon and a downward dip in the predawn hours. Short-skip sporadic E openings will become scarce, giving way to long skip, including many long one-hop transequatorial openings, particularly towards the south in the evening. Shortwave broadcasters must anticipate these changes by planning for frequency changes after each of the two-month periods, (March/April and September/October). The change is slower during the other two periods, which comprise four-month intervals (May through August and November through February).

During the equinoctial period the geomagnetic field exhibits the greatest variability. The magnetosphere (geomagnetic field) acts as a source of high latitude electrons and accounts for ionospheric movement. During equinox — when the earth's equatorial plane intersects the sun — solar wind particles feed down through the magnetosphere into both polar regions of the ionosphere. The variability, both in speed and density, of the solar wind stream is transferred to the geomagnetic field and ionosphere. Geomagnetic field control of the ionosphere is strong at this time; consequently we can look to it as a measure of what the ionosphere's reaction will be. Recall the large geomagnetic disturbances of last spring's equinox in April; the A index, which was 77 on April 21, was again up to 40 the following week, on April 28. Remember what propagation conditions were like then?

But what is meant by geomagnetic data? The A index is a measure of the amount of change, with time (minutes to hours), of the geomagnetic field from a normally (average) quiet day at that station. The larger the A index (one number per day) or K index (every three hours or 8 per day), the more the ionosphere is moving around. The eight K numbers are summed and multiplied by a factor that converts it into the daily single A index. (The number is further manipulated to calibrate the data from each measuring station.) Large changes in the ionospheric layers take place with K's above 6, especially for paths along or across the auroral zone (65 to 75 degrees north latitude). A K of 4 to 5 indicates moderate movement with its accompanying signal strength variation, QSB.

When listening on the bands during various degrees of geomagnetic disturbance, you'll notice something like this: with K's of 0 to 2 the band will be full of signals from just about every direction; with K's of 3 to 5, the accompanying absorption and some QSB will cut out some of the stations you hear. When the K's are 6 and 7, signals you hear will be coming from unusual, less frequently heard directions. For even higher K's, all signals are lost in the absorption and QSB. Don't despair — when the K drops slightly from the previous high, we're back in the "unusual direction" K category.

last-minute forecast

The third week of September is expected to be the best for working DX on the 10 through 30 meter HF bands, coincident with a higher solar flux. To confirm that this situation is occurring, monitor radio station WWV on 2.5, 5, 10, 15, and 20 MHz at 18 minutes after each hour. If the flux is up, expect transequatorial openings to occur to South Africa, South America, and especially Australia. These will be enhanced openings during a geomagnetic-ionospheric disturbance indicated by an A index of 20 to 40, which is likely at this equinoctial season of the year. The lower bands should greatly improve through the month with lower atmospheric noise levels and higher signal strengths. The MUF will be lower on east-west paths during disturbed conditions, with QSB noticed on the signals. Under these same circumstances, expect to hear DX from some unusual locations.

A full moon will occur on September 29th and its perigee on the 16th. The autumnal equinox will be on the 23rd at 0207 UTC. No significant meteor showers are expected this month to enhance meteor burst DXing.

band-by-band summary

Six meters may have a few sporadic E openings around local noon, but don't count on them. This month should be the last chance for E_s until next summer's season begins.

Ten, twelve, and fifteen meters should provide a few short-skip E_s openings and many long-skip openings during any solar flux peaks to most southern areas of the world during daylight. Some of these openings will result from transequatorial propagation, especially during the disturbed conditions.

SEPTEMBER

WESTERN USA

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	
PDT	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	40	40	30	30	30	30	40	40	40	40	40	30	30	30	20	20	20	20	20	N
EUROPE	30	30	20	20	20	20	20	20	20	20	20	20	30	40	40	40	40	40	30	40	40	40	40	40	NE
S. AFRICA	20	15	15	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	15	12	10	SE
ANTARCTICA	12	12	12	12	15	15	15	20	20	30	30	30	30	30	30	30	30	20	20	15	15	15	15	12	S
NEW ZEALAND	10	10	12	12	15	15	20	20	20	20	20	20	20	20	20	15	15	12	12	10	10	10	10	10	SW
OCEANIA AUSTRALIA	10	10	12	15	15	20	20	20	20	20	20	20	20	20	15	15	15	12	10	10	10	10	10	10	W
JAPAN	15	15	15	20	20	30	40	40	30	30	40	40	40	30	30	30	30	30	20	20	20	15	15	15	NW

MID USA

MDT	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	
ASIA FAR EAST	30	30	40	40	40	40	40	30	30	20	20	20	20	20	20	40	40	40	40	40	30	30	30	20	N
EUROPE	30	30	20	20	20	20	20	20	20	20	20	20	20	30	40	40	40	40	40	40	40	40	40	40	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	15	12	10	SE
ANTARCTICA	15	15	12	12	15	15	15	15	20	20	30	30	30	30	30	30	30	30	30	20	15	15	15	15	S
NEW ZEALAND	10	10	12	12	15	15	20	20	20	20	20	20	20	20	20	20	20	20	15	12	12	10	10	10	SW
OCEANIA AUSTRALIA	10	10	12	12	15	20	20	20	20	20	20	20	20	20	20	20	20	20	20	15	12	10	10	10	W
JAPAN	20	15	20	20	20	30	40	40	40	40	30	30	30	30	40	40	40	30	30	30	30	20	20	20	NW
CDT	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	

EASTERN USA

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

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

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

Twenty, thirty, and forty meters will support propagation from most areas of the world during the daytime and into the evening hours almost every day, either long-skip to 2500 miles (4000 km) or some short-skip E_s to 1250 miles (2000 km) per hop.

Thirty, forty, eighty, and one-sixty meters are all good for nighttime DX. The bands will be open in the east soon after sundown, swing toward the south about midnight, and end in the Pacific areas during the hour or so before dawn. On some nights these bands will be as good as the winter DX season. Some nights, noise (QRN) from thunderstorms (airmass and fronts of fall weather storms) will be a problem. However, high signal levels that occur during short-skip E_s propagation conditions may overcome the static.

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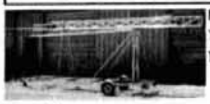
Crank-ups to 100 ft.

EXCELLENT FOR AMATEUR COMMUNICATIONS



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Mobile Truck Type

Over 36 types aluminum and steel towers made—specials designed and made—write for details

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Four Section 50 Ft.
Van Mounted Crank-Up
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Fixed Base

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$69.95 NEW LOW PRICE! Plus $3.00 Shipping & Handling

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MODEL VS 300A ANTENNA TUNER $69.95

MATCH MOST ANTENNA-FEEDLINE COMBINATIONS TO YOUR RIG

MATCHES: dipoles, inverted vees, beams, quads, verticals, mobile whips, random wire, etc. that are fed by coax, balanced line or single wire
MAXIMUM POWER: 300 watts RF
INPUTS (selectable from front panel):
3-coax: 1-direct, 2-direct or thru tuner
1-balanced line (4:1 balun inc.) or single wire
IN-LINE CALIBRATED WATTMETER INCLUDED

1985-86 CATALOG 50¢

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RADIOKIT
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IC-R71A, IC-751, IC745, IC-27A/H, IC-37A, IC-47A, IC-1271A, IC-271A/H, IC-3200A, IC-471 A/H, IC-735

KENWOOD
R-600, R-1000, R-2000, TS-940 S/AT
TS 430S, TR-3600A, TR 7950,
TW-4000A, Kenwood Service/Repair.
TH21/31/41AT., TM-211A/411A & TS-711A/811A

Antennas: A-S, Cushcraft, Hustler, KLM, METZ, Mini-Products, Mosley

YAESU
FT-ONE, FT-980, FT-757GX, FRG-8800
FT-726R, FRG-9600, FT-270RH, FT-2700RH

YAESU	ICOM	Land Mobile H/T
FT-1/2/703R	IC2AT	Midland/Standard
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FTC-1903	IC-04AT	Yaesu FTC 2203, FT 4703
		Icom IC M12 (Marine) M700
		Tempo M-1

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WELZ
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Yaesu FTR-2410, Wilson
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ICOM IC-RP 1210 (1.2 GHz)

SANTEC
ST-222/UP
ST-142/UP
ST-442/UP
HT-7

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JBC soldering line in stock

Soldering Station, 48 Watts, $68

Computer Interfaces stocked: MFJ-1224
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ETO ALPHA AMPLIFIERS

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GLB ELECTRONICS

151 Commerce Pkwy., Buffalo, NY 14224
716-675-6740 9 to 4

GLB products include high quality components and prewound coils. Circuit boards are made from G-10 epoxy and are silk-screened and solder-masked for easy construction.

High performance and affordability are featured throughout the GLB product line. All products carry a 90-day warranty.

Our design capabilities offer cost-effective solutions for special applications from HF to microwave, with production support for large quantities.

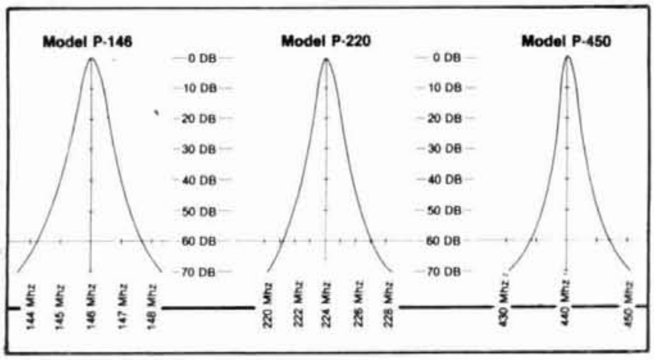
Contact us with your requirements—amateur, commercial, and military.

GLB PRESELECTOR - PREAMP

THE SOLUTION TO MOST INTERFERENCE, INTERMOD & DESENSE PROBLEMS.

FANTASTIC REJECTION!

Typical rejection:
±600 Khz @ 144 Mhz: −28dB
±1.6 Mhz @ 220 Mhz: −40dB
± 5 Mhz @ 450 Mhz: −50db



Typical Selectivity Curves

Bipolar w/RCA jacks $89.95, Commercial $109.95
GaAs fet option (200 Mhz & up) $20.00

Connector options:
N $10.00, UHF $6.00, BNC $5.00

Custom tuning is available when maximum selectivity is required. Gain is then controlled to 2-3 db.

Special order— $10.00

- LOW COST
- 40 - 1000 Mhz - tuned to your frequency
- 5 Large Helical Resonators
- LOW noise - HIGH overload resistance
- 8 db Gain - Ultimate Rejection 80 db
- 10 to 15 Volts DC Operation
- 5-10 ma Current Drain
- Cast Aluminum Enclosure
- Small size - 1.6 x 2.6 x 4.75" exc. connectors

DESIGN OBJECTIVES

The function of a preselector is to provide additional filtering against undesired signals. The design objective in this product line is to achieve the highest possible selectivity with carefully controlled gain. Very sharp selectivity is produced through five helical resonators which can benefit receivers in many instances where intermod and cross-band interferences occur. The "nose" of the selectivity curve is extremely sharp, so the unit must be tuned to the exact frequency used.

Easy installation of our "add on" preselector can be the low-cost cure for problems which until now could only be accomplished by improving the dynamic range of the receiver itself.

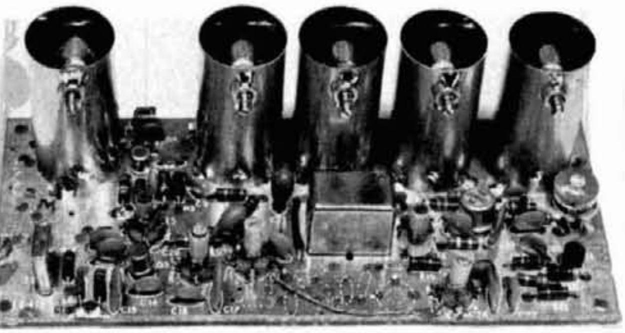
Custom units are available on special order. Write or call for quotations.

GALLIUM ARSENIDE VERSION

Better performance is obtained with GaAs transistors. The higher gain these transistors provide is traded off for still better selectivity. GaAs transistors also offer greater resistance to overload and improved noise figure.

TOP QUALITY MODULES

HIGH PERFORMANCE HELICAL FRONT END

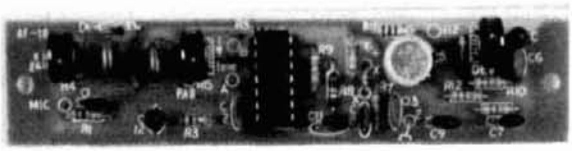


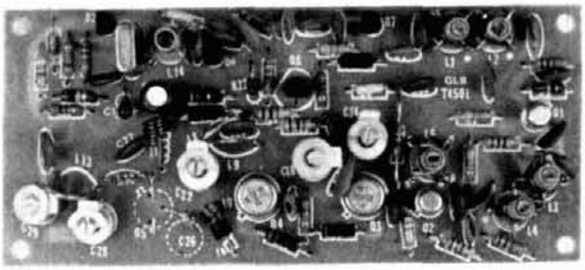
- Designed for any application requiring state-of-the-art performance
- *Five large helical resonators*
- 8-pole Crystal Filter
- On-board crystal oscillator
- Typical sensitivity: .29 @ 20 db
- Over 100 db adjacent channel rejection
- Image rejection well over 80 db
- *Over 105 db dynamic range*
  (no desense below 100,000 uv)
- Front end bandwidth less than 1 Mhz
  (wider bandwidths available on special order)
- Dimensions - 5.25 x 2.25 x 1.75 inches
- 12V DC operation

Model 415	- 144 to 148 Mhz (pictured)	$139.95
Model 415 A	- 220 to 225 Mhz	$149.95
Model 415 C	- Commercial Hi-Band	$179.95

* Now Available - 420 to 1000 Mhz w/GaAs Fet - Call

UHF TRANSMITTER





- Direct FM capability or AM for ATV
- On-board crystal oscillator
- Typical output - 2 Watts
- Spurious down 55 db
- 12V DC operation
- *On-board keying circuit* for push-to-talk
- Includes AF-10 audio processor
  (see description above)
- Dimensions - 2 x 4.5 x 0.8 inches
  AF-10 - 1 x 4.5 x 0.8 inches

Model T450L Kit	$59.95
Wired/Tested	$99.95

Add $10.00 out of ham band

✓ 285

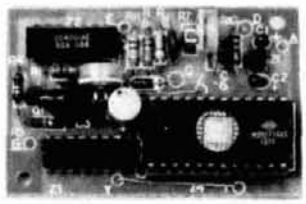
10.7 FM IF/AF

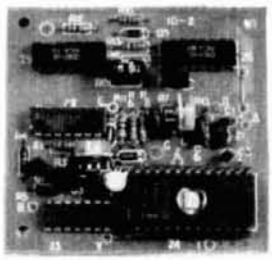
- Fantastic squelch - can be set to open on signals you can't even hear! "Chop" resistant and there is no "pop" when it opens or closes!
- Temperature stable squelch & audio levels
- Hard FM limiting
- 2 Watts of audio output power
- Fully compatible with GLB front ends (or yours)
- 12V DC operation
- Dimensions - 2 x 4.5 x 0.8 inches

Model R107 Kit	$39.95
Wired/Tested	$64.95

AUTOMATIC CW IDENTIFIERS

The alternative to troublesome diode programming
Model ID-2 w/2-10 min. interval timer.





- Enormous capacity - Up to 8 reprogrammable, 2,000 bit messages. (Approx. 2.5 minutes each at 20 WPM!)
- Size: ID-1 2.5 x 1.7 x 0.7" ID-2 2.5 x 2.75 x 0.7"
- Adjustable audio, speed, and interval timer (ID-2). (30 sec. to 1 hr. intervals spec. order)
- Simple installation - +7 to +15 volts, DC
- Automatic operation. Mode 1 - trigger input starts message cycle - terminates at end of message. A "hold" signal is provided to maintain transmission until cycle is completed. Mode 2 - message starts when power is applied - cycles continuously until power goes off. (repeats about *every 2.5 min. @ 20 WPM*).
- Message switching w/jumper wires. A multi-tap switch or logic gates can be used.

INCLUDE message(s). Print or type with exact spacing, punctuation, etc., clearly.

Model ID-1	$49.95	Wired, tested
Model ID-2	$69.95	and programmed

GLB ELECTRONICS

151 Commerce Pkwy., Buffalo, NY 14224 716-675-6740

DIGI-KEY CORPORATION

1-800-344-4539

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VISA

NEW! **256K (262,144 x 1) DRAM 150NS $5.70/1; $39.95/9**

Factory Firsts

MasterCard

INTEGRATED CIRCUITS

1% METAL FILM RESISTORS

¼ Watt • Temperature Coefficient ± 100 ppm/°C
Max. RC WV: 250V Max. Voltage: 500V
Dielectric Withstanding Voltage: 500V
Standard Resistor Values from 10 to 1.00M ohms

STANDARD RESISTOR VALUE TABLE

STANDARD RESISTOR VALUE							(E-96 Series)
10.0	13.3	17.8	23.7	31.6	42.2	56.2	75.0
10.2	13.7	18.2	24.3	32.4	43.2	57.6	76.8
10.5	14.0	18.7	24.9	33.2	44.2	59.0	78.7
10.7	14.3	19.1	25.5	34.0	45.3	60.4	80.6
11.0	14.7	19.6	26.1	34.8	46.4	61.9	82.5
11.3	15.0	20.0	26.7	35.7	47.5	63.4	84.5
11.5	15.4	20.5	27.4	36.5	48.7	64.9	86.6
11.8	15.8	21.0	28.0	37.4	49.9	66.5	88.7
12.1	16.2	21.5	28.7	38.3	51.1	68.1	90.9
12.4	16.5	22.1	29.4	39.2	52.3	69.8	93.1
12.7	16.9	22.6	30.1	40.2	53.6	71.5	95.3
13.0	17.4	23.2	30.9	41.2	54.9	73.2	97.6

How To Order: Take any standard resistor value (2.32K) and add an "X" (2.32KX), this is the DIGI-KEY part number. Order by quantity and price listed below.

	5 for	100 for	1,000 for
¼ Watt 1% Metal Film	50¢	$3.80	$30.00

For large quantities and prices as low as $9.25/M, contact DIGI-KEY.

5% Carbon Film Resistors

Specifications:

Rating Wattage	¼ W	½ W
Max. Working Voltage	250V	350V
Rated Ambient Temp.	70°C	
Operating Temp. Rge.	-55°C to +155°C	
Resistance Range	2.2Ω to 5.1MΩ	
Resistance Tolerance	±5%	
Series	E24	

Dimensions:

Style		¼ W	½ W
Body	Length (L)	6.5±0.4	9.5±0.5
	Diameter (D)	2.3±1.0	3.7±0.2
Lead-Wire	Length (H)	28±1.0	28±1.0
	Diameter (d)	0.6	0.7

5% Carbon Film Resistor Values in Ohms

TI I.C. SOCKETS

Body — 94 V-0 polyester with Copper Alloy contacts. Accommodates standard IC leads up to .014" thick and .025" wide. Contact is designed and oriented to the insulator to grasp the broad "face" of the IC lead, allowing for low insertion and high retention forces. Socket is designed to achieve maximum density on boards.

SOLDER TAIL DIP SOCKETS

- Single beam
- Low profile
- YOUR CHOICE: TIN OR GOLD* (Minimum .30 microinch gold inlay on gold sockets)

TIN PLATED SOLDER TAIL Min. 200 Microinches Tin, -40° to +70°C

Part No.	Description	1	10	100
C8908	8 pin solder tail, tin	.13	1.15	10.50
C8914	14 pin solder tail, tin	.15	1.45	12.00
C8916	16 pin solder tail, tin	.17	1.60	13.00
C8918	18 pin solder tail, tin	.20	1.90	17.00
C8920	20 pin solder tail, tin	.23	2.10	20.00
C8922	22 pin solder tail, tin	.25	2.25	21.00
C8924	24 pin solder tail, tin	.28	2.60	24.00
C8928	28 pin solder tail, tin	.32	2.90	27.00
C8940	40 pin solder tail, tin	.46	4.20	39.00

GOLD INLAY SOLDER TAIL Min. 30 Microinches Gold, -40° to +125°C

Part No.	Description	1	10	100
C9808	8 pin solder tail, gold	.34	3.20	30.00
C9814	14 pin solder tail, gold	.44	4.20	40.00
C9816	16 pin solder tail, gold	.50	4.70	45.00
C9818	18 pin solder tail, gold	.57	5.40	52.00
C9820	20 pin solder tail, gold	.63	5.90	57.00
C9822	22 pin solder tail, gold	.70	6.60	64.00
C9824	24 pin solder tail, gold	.76	7.20	70.00
C9828	28 pin solder tail, gold	.79	7.50	73.00
C9840	40 pin solder tail, gold	1.12	9.90	97.00

WIRE WRAP DIP SOCKETS

- Standard profile
- Universal mounting and packaging capabilities
- Contacts accommodate .015" through .021" rec. or round dual-in-line leads.
- Wire wrap posts held to true position of .015" providing a true position of .020" on boards for efficient automatic wire wrapping*
- YOUR CHOICE: TIN OR GOLD*
- TEXAS INSTRUMENTS QUALITY

TI EDGEBOARD CONNECTORS

H4 SERIES .100" x .200" EDGEBOARD CONNECTORS

H4 SERIES .125" x .250" EDGEBOARD CONNECTORS

H4 SERIES .156" x .200" EDGEBOARD CONNECTORS

ELECTRONIC HARDWARE KIT

Electronic Hardware Kit contains:

100 – 2-56x¼ Machine Screws
100 – 2-56x½ Machine Screws
100 – 4-40x¼ Machine Screws
100 – 4-40x½ Machine Screws
100 – 6-32x¼ Machine Screws
100 – 6-32x½ Machine Screws
100 – 8-32x3/8 Machine Screws
100 – 6-32x5/8 Machine Screws
100 – 2-56 Hex Nuts
100 – 4-40 Hex Nuts
100 – 6-32 Hex Nuts
100 – 8-32 Hex Nuts
100 – No. 2 Internal Tooth Lock Washers
100 – No. 4 Internal Tooth Lock Washers
100 – No. 6 Internal Tooth Lock Washers
100 – No. 8 Internal Tooth Lock Washers

CAT. NO. 1600-KIT **$14.95**

PANASONIC ELECTROLYTIC KIT

100 CAPACITORS Cat. No. P6200-Kit ONLY **$39.95**

ASSORTMENT OF 15 POPULAR CAPACITORS

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PANASONIC V SERIES

DISC CAPACITORS

For Complete Specs on Physical Size and Electrical Characteristics, consult your FREE DIGI-KEY Catalog.

310 DISC CAPACITORS CAT. NO. DH-KIT ONLY **$24.95**

Metallized Polyester Capacitors

PANASONIC POLYESTER KIT

170 METALLIZED POLYESTER CAPACITORS CAT. NO. E-KIT **$54.95**

PLESSEY MINI BOX

140 CAPACITORS CAT. NO. 3050P-Kit ONLY **$37.95**

ASSORTMENT OF 14 POPULAR "MINI-BOX" CAPACITORS

TANTALUM CAPACITORS

PANASONIC TANTALUM KIT

180 TANTALUM CAPACITORS CAT. NO. E-KIT ONLY **$54.95**

PANASONIC TSW SERIES

Part No.	Working Voltage	Cap.	1	10	100
P6520		4700	3.46	26.61	240.00
P6521		6800	4.20	32.38	291.00
P6522	100	470	1.44	11.14	100.00
P6523		1000	2.43	18.76	169.00
P6524		2200	3.91	30.11	271.00
P6525	200	220	1.91	14.70	132.34
P6526		330	2.89	22.20	200.00
P6527		470	3.38	25.91	233.00
P6528	250	150	2.58	19.88	179.00
P6529		220	2.60	20.00	180.00
P6530		330	3.02	23.26	209.00
P6531		470	3.90	30.00	270.00

AMP Champ Connectors

Digi-Key Part No.	No. of Pins	Receptacle or Plug	Mounting Description	Price
A1500	24	P	Cable Screw Lock	$3.45
A1501	36	P	Cable Screw Lock	3.70
A1502	24	P	Cable Bail Lock	3.57
A1503	36	P	Cable Bail Lock	3.80
A1504	24	R	Cable Screw Lock	3.45
A1505	36	R	Cable Screw Lock	3.70
A1506	24	R	Cable Strain Relief	1.68
A1507	36	R	Cable Strain Relief	1.69
A1508	24	R	Panel, Screw, Bail	3.57
A1509	36	R	Panel, Screw, Bail	3.80
A1529			T-Handle Wire Insertion Tool	5.30
A1510	24	R	PC Board Vertical	7.25
A1511	36	R	PC Board Vertical	8.02
A1512	24	R	PC Board Edge	7.92
A1513	36	R	PC Board Edge	8.65
A1514	24	R	PC Board Right Angle	6.37
A1515	36	R	PC Board Right Angle	6.88

Latch Type Connectors

Digi-Key Part No.	No. of Pins	Receptacle or Plug	Mounting Description	Price
A1550	24	P	Screw Lock	$8.52
A1551	24	P	Bail Lock	8.72
A1552	36	P	Screw Lock	9.42
A1553	36	P	Bail Lock	9.62
A1554	24	R	Screw or Bail	8.52
A1556	24	R	Panel, Screw, Bail	8.72
A1557	36	R	Screw or Bail	9.42
A1558	36	R	Panel, Screw, Bail	9.62

Mounting Hardware Available Separately.

4116 200 nsec 16,384x1 D Ram

Part No.	8	32	128	512	1024
4116N-ND	15.12	57.12	215.00	806.40	1397.75
6290N-ND	15.12	57.12	215.00	806.40	1397.75
Price Each	1.89	1.785	1.68	1.575	1.365

MN4164-15 64K DRAM 150NS $2.95/1; $17.50/9

1 AMP SILICON RECTIFIERS

Part No.	Description	Pkg.	10	100	1,000	10,000
1N4001	50 PIV	DO-41	.80	7.00	60.00	515.00
1N4002	100 PIV	DO-41	.80	7.00	60.00	540.00
1N4003	200 PIV	DO-41	.80	7.50	64.00	563.00
1N4004	400 PIV	DO-41	.80	7.90	68.00	588.00
1N4005	600 PIV	DO-41	1.00	9.00	74.00	625.00
1N4006	800 PIV	DO-41	1.00	9.00	80.00	661.00
1N4007	1000 PIV	DO-41	1.50	12.00	100.00	710.00
1N4148	Ultra Fast Switching Diode	DO-41	.60	5.00	29.58	211.25

3 AMP SILICON RECTIFIERS

Part No.	Description	Pkg.	1	10	100	1,000
1N5400	3 Amp 50PIV	Plastic	.28	2.56	22.80	199.50
1N5401	3 Amp 100PIV	Plastic	.30	2.70	24.00	210.00
1N5402	3 Amp 200PIV	Plastic	.31	2.83	25.20	220.50
1N5404	3 Amp 400PIV	Plastic	.33	2.97	26.40	231.00
1N5406	3 Amp 600PIV	Plastic	.35	3.15	28.00	245.00
1N5407	3 Amp 800PIV	Plastic	.40	3.60	32.00	280.00
1N5408	3 Amp 1000PIV	Plastic	.50	3.60	32.00	280.00

Silicon Transistors

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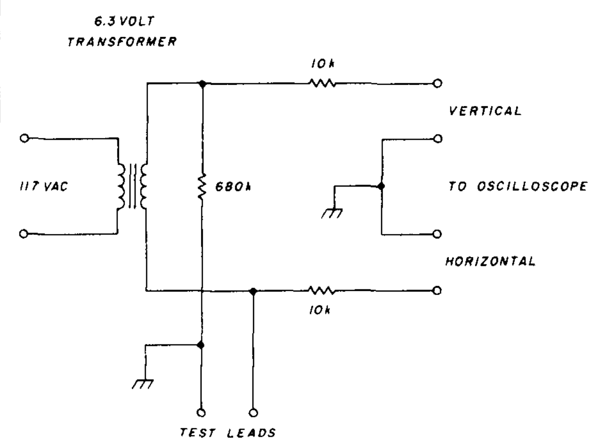


fig. 1. The "octopus."

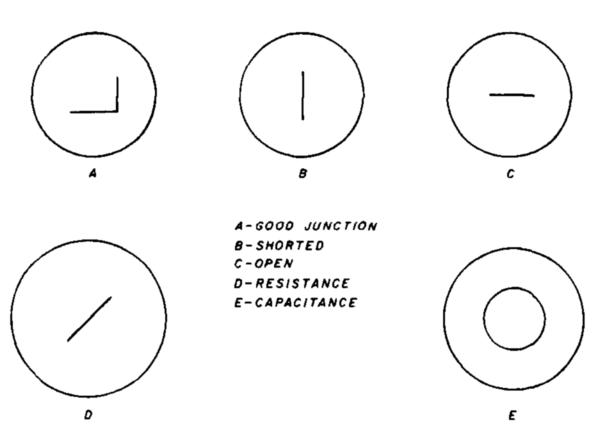


fig. 2. Octopus presentations.

A United States Navy training manual once described a circuit — affectionately known as the "octopus" — for examining semiconductor junctions, capacitors, and comparing printed circuit boards similar to the circuit shown in **fig. 1**. Through the years, I have run across several other versions of the octopus differing only in the methods of attaching the many wires connecting the instrument to the oscilloscope, power source, and device under test. The octopus is useful in pointing out problem nodes and providing fast go/no-go tests on a variety of components. Oscilloscope patterns obtainable are combinations of those depicted in **fig. 2**.

While ferreting out the cables and cords necessary to hook up a particularly elaborate octopus, it occurred to me that I would not be wasting time looking for a power cord if the octopus were battery powered. After locating the power cable, I determined that elimination of the required oscilloscope would also be necessary because every available oscilloscope was hopelessly buried under other people's ongoing calibration setups.

circuit description

As a result of my decision to eliminate both the power cord and the oscilloscope, the circuit shown in **fig. 3** was developed. The circuit illustrates a 555 timer operating as a minimum-parts astable oscillator. The ceramic sounder provides an aural indication of resistance. The diode bridge steers current through the ceramic sounder with the correct polarity, and the dual color LED (light emitting diode) provides a visual indication of current flow and polarity information. The tapped power source provides a node that is negative when the 555 timer is conducting and positive when the timer is not conducting. Current through the LED and the device under test is limited to a nondestructive value by the internal resistance of the ceramic sounder.

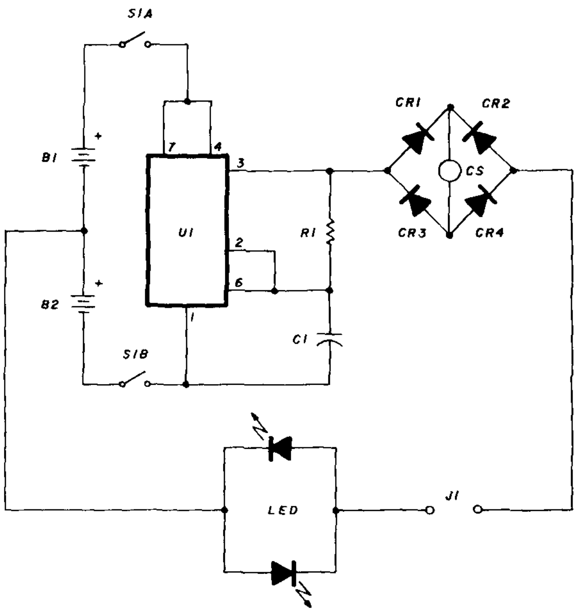
By Robert R. Frahm, WD6GMB, Box E, American Embassy, APO Miami 34002

directions for use

With the junction tester turned on, a *shorted* condition is indicated by a steady tone and by the alternately blinking red and green LED. This condition can be observed by holding the test probes together. The tone should be steady — i.e., there should be no change in volume.

An *open* condition is indicated by silence and the absence of color in the LED. A clicking noise may be heard if the test probes are held close together due to capacitance between the probes.

A good junction is indicated by a beeping sound and either a blinking red or blinking green LED when the test probes are placed across the junction. If the test probes are reversed, the same sound will be heard, but the LED will blink in the opposite color! For ex-



B1,B2	9-volt battery, RS No. 275-1546
C1	2.2 μF 50-volt capacitor RS No. 272-997
CR1,2,3,4	1N914 diode, RS No. 276-1620
CS	ceramic sounder, RS No. 273-060 or No. 273-065
J1	female banana jacks, RS No. 274-725
LED	XV-5491 LED (dual color), RS No. 276-035
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R1	33 kilohm, 1/4-watt resistor, RS No. 271-1341
S1	DPDT switch, RS No. 275-1546
miscellaneous	box, RS No. 270-222 alligator clip, RS No. 270-347 test probes, RS No. 278-704 printed circuit board, RS No. 276-168 IC socket, RS No. 276-1995

Note: RS = Radio Shack

fig. 3. Junction tester.

ample, if a beeping sound and blinking red LED indicate a good junction, then a beeping sound and blinking green LED indicate that the test probes are reversed. Take note of this relationship, since it helps to determine the polarity of the junction.

The junction tester may be used both in and out of the circuit (with the power off), but parallel resistances may complicate interpretation of the results. Comparing the results of testing printed circuit boards known to be good can facilitate interpretation of the results of testing boards of unknown status.

Low current pulses (10 Hz at 18 volts peak-to-peak) are available at the test probe tips. These signals are useful when implementing signal or pulse injection techniques.

A slight change in volume while the test probes are shorted may indicate that the batteries are "out-of-balance." This condition may be corrected by interchanging or replacing the batteries. Since the junction tester draws current from the batteries whenever it is turned on, be sure to turn it off after use.

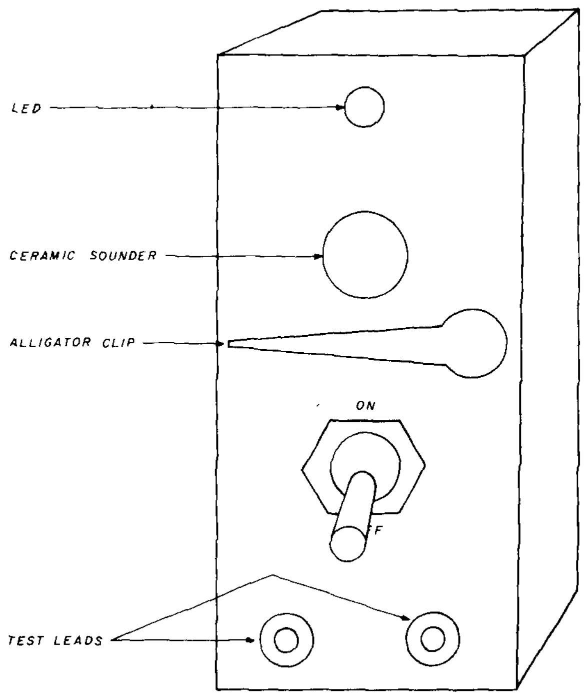

fig. 4. Panel layout.

construction details

Circuit layout is not critical. A socket is recommended for the 555 timer to simplify replacement. The low current (CMOS) 555 timer version is unforgiving of inductive loads and not recommended, particularly on modified junction testers that may include a switch to bypass the ceramic sounder and LED. A suggested panel layout is presented in **fig. 4**. The total cost of parts is about $20.00 if they're purchased new.

conclusion

An alligator clip secured to the panel holds a loose transistor, sparing me the bother of chasing the transistor around the bench with the test probes. (Since building the junction tester, I still find myself searching for it because other technicians are always carrying it away.)

I've often found faulty parts while demonstrating the junction tester. Once I used it to "wring out" a problem extender board that had been tested with an ohmmeter, but showed no apparent defects. Using the tester, I found a staked terminal where oxidation had developed between it and the printed circuit, turning the mechanical connection into a diode!

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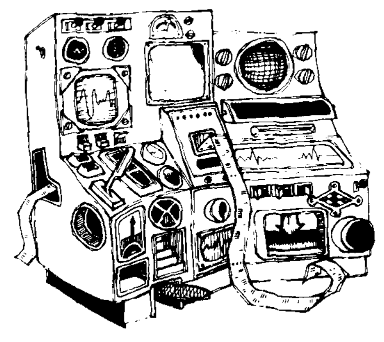

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9.0USB/CW 6 pole 2.7KHz wide at 6dB. Impedance 680ohms 7pf In/300ohms 8pf out. CW-1599Hz	19.99

KOKUSAI ELECTRIC CO. Mechanical Filter #MF-455-ZL/ZU-21H

455KHz at Center Frequency of 453.5KC. Carrier Frequency of 455KHz 2.36KC Bandwidth.

Upper sideband. (ZU)	19.99
Lower sideband. (ZL)	19.99

****

CRYSTAL FILTERS

NIKKO	FX-07800C	7.8MHz	$10.00
TEW	FEC-103-2	10.6935MHz	10.00
SDK	SCH-113A	11.2735MHz	10.00
TAMA	TF-31H250	CF 3179.3KHz	19.99
TYCO/CD	001019880	10.7MHz 2pole 15KHz bandwidth	5.00
MOTOROLA	4884863B01	11.7MHz 2pole 15KHz bandwidth	5.00
PTI	5350C	12MHz 2pole 15KHz bandwidth	5.00
PTI	5426C	21.4MHz 2pole 15KHz bandwidth	5.00
PTI	1479	10.7MHz 8pole bandwidth 7.5KHz at 3dB, 5KHz at 6dB	20.00
COMTECH	A10300	45MHz 2pole 15KHz bandwidth	6.00
FRC	ERXF-15700	20.6MHz 36KHz wide	10.00
FILTECH	2131	CF 7.825MHz	10.00

****

CERAMIC FILTERS

AXEL	4F449	12.6KC Bandpass Filter 3dB bandwidth 1.6KHz from 11.8-13.4KHz	10.00
CLEVITE	TO-01A	455KHz+-2KHz bandwidth 4-7% at 3dB	5.00
	TCF4-12D36A	455KHz+-1KHz bandwidth 6dB min 12KHz, 60dB max 36KHz	10.00
MURATA	BFB455B	455KHz	2.50
	BFB455L	455KHz	3.50
	CFM455E	455KHz +-5.5KHz at 3dB , +-8KHz at 6dB , +-16KHz at 50dB	6.65
	CFM455D	455KHz +-7KHz at 3dB , +-10KHz at 6dB , +-20KHz at 50dB	6.65
	CFR455E	455KHz +-5.5KHz at 3dB , +-8KHz at 6dB , +-16KHz at 60dB	8.00
	CFU455B	455KHz +-2KHz bandwidth +-15KHz at 6dB, +-30KHz at 40dB	2.90
	CFU455C	455KHz +-2KHz bandwidth +-12.5KHz at 6dB , +-24KHz at 40dB	2.90
	CFU455G	455KHz +-1KHz bandwidth +-4.5KHz at 6dB , +-10KHz at 40dB	2.90
	CFU455H	455KHz +-1KHz bandwidth +-3KHz at 6dB , +-9KHz at 40dB	2.90
	CFU455I	455KHz +-1KHz bandwidth +-2KHz at 6dB , +-6KHz at 40dB	2.90
	CFW455D	455KHz +-10KHz at 6dB , +-20KHz at 40dB	2.90
	CFW455H	455KHz +-3KHz at 6dB , +-9KHz at 40dB	2.90
	SFB455D	455KHz	2.50
	SFD455D	455KHz +-2KHz , 3dB bandwidth 4.5KHz +-1KHz	5.00
	SFE10.7MA	10.7MHz 280KHz +-50KHz at 3dB , 650KHz at 20dB	2.50
	SFE10.7MS	10,7MHz 230KHz +-50KHz at 3dB , 570KHz at 20dB	2.50
	SFG10.7MA	10.7MHz	10.00
NIPPON	LF-B4/CFU455I	455KHz +-1KHz	2.90
	LF-B6/CFU455H	455KHz +-1KHz	2.90
	LF-B8	455KHz	2.90
	LF-C18	455KHz	10.00
TOKIN	CF455A/BFU455K	455KHz +-2KHz	5.00
MATSUSHIRA	EFC-L455K	455KHz	7.00

****

SPECTRA PHYSICS INC. Model 088 HeNe LASER TUBES

POWER OUTPUT 1.6MW.	BEAM DIA. .75MM	BEAM DIR. 2.7MR	8KV STARTING VOLTAGE DC
68K OHM 1WATT BALLAST	1000VDC +-100VDC	At 3.7MA	$59.99

ROTRON MUFFIN FANS Model MARK4/MU2A1

115 VAC 14WATTS 50/60CPS IMPEDENCE PROTECTED-F 88CFM at 50CPS $ 7.99
105CFM at 60CPS THESE ARE NEW

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RF TRANSISTORS

TYPE	PRICE	TYPE	PRICE	TYPE	PRICE	TYPE	PRICE
2N1561	$25.00	2N5920	$ 70.00	40608 RCA	$ 2.48	BFY90	$ 1.50
2N1562	25.00	2N5921	80.00	40673 RCA	2.50	BLW60C5	15.00
2N1692	25.00	2N5922	10.00	40894 RCA	1.00	BLX67	12.25
2N2857	1.55	2N5923	25.00	60247 RCA	25.00	BLX67C3	12.25
2N2857JAN	4.10	2N5941	23.00	61206 RCA	100.00	BLX93C3	22.21
2N2857JANTX	4.50	2N5942	40.00	62800A RCA	60.00	BLY87A	7.50
2N2876	13.50	2N5944	10.35	62803 RCA	100.00	BLY88C3	13.08
2N2947	18.35	2N5945	10.00	430414/3990RCA	50.00	BLY89C	13.00
2N2948	13.00	2N5946	12.00	3457159 RCA	20.00	BLY90	45.00
2N2949	15.50	2N5947	9.20	3729685-2 RCA	75.00	BLY92	13.30
2N3118	5.00	2N6080	6.00	3729701-2 RCA	50.00	BLY94C	45.00
2N3119	4.00	2N6081	7.00	3753883 RCA	50.00	BLY351	10.00
2N3134	1.15	2N6082	9.00	615467-902	25.00	BLY568C/CF	30.00
2N3287	4.90	2N6083	9.50	615467-903	40.00	C2M70-28R	92.70
2N3288	4.40	2N6084	12.00	2SC568	2.50	C25-28	57.00
2N3309	4.85	2N6094	11.00	2SC703	36.00	C4005	2.50
2N3375	17.10	2N6095	12.00	2SC756A	7.50	CD1659	20.00
2N3478	2.13	2N6096	16.10	2SC781	2.80	CD1899	20.00
2N3553	1.55	2N6097	20.70	2SC1018	1.00	CD1920	10.00
2N3553JAN	2.90	2N6105	21.00	2SC1042	24.00	CD2188	18.00
2N3632	15.50	2N6136	21.85	2SC1070	2.50	CD2545	24.00
2N3733	11.00	2N6166	40.24	2SC1216	2.50	CD2664A	16.00
2N3818	5.00	2N6267	142.00	2SC1239	2.50	CD3167	92.70
2N3866	1.30	2N6304	1.50	2SC1251	24.00	CD3353	95.00
2N3866JAN	2.20	2N6368	30.00	2SC1306	2.90	CD3435	26.30
2N3866JANTX	3.80	2N6439	55.31	2SC1307	5.50	CD3900	152.95
2N3866JANTXV	4.70	2N6459	18.00	2SC1424	2.80	CM25-12	20.00
2N3866AJANTXV	5.30	2N6567	10.06	2SC1600	5.00	CM40-12	27.90
2N3924	3.35	2N6603	13.50	2SC1678	2.00	CM40-28	56.90
2N3926	16.10	2N6604	13.50	2SC1729	32.40	CME50-12	30.00
2N3927	17.25	2N6679	44.00	2SC1760	1.50	CTC2001	42.00
2N3948	1.75	2N6680	80.00	2SC1909	4.00	CTC2005	55.00
2N3950	25.00	021-1	15.00	2SC1945	10.00	CTC3005	70.00
2N3959	3.85	01-80703T4	65.00	2SC1946	40.00	CTC3460	20.00
2N4012	11.00	35C05	15.00	2SC1947	10.00	DV2820S	25.00
2N4037	2.00	102-1	28.00	2SC1970	2.50	DXL1003P70	22.00
2N4041	14.00	103-1	28.00	2SC1974	4.00	DXL2001P70	19.00
2N4072	1.80	103-2	28.00	2SC2166	5.50	DXL2002P70	14.00
2N4080	4.53	104P1	18.00	2SC2237	32.00	DXL3501AP100F	47.00
2N4127	21.00	163P1	10.00	2SC2695	47.00	EFJ4015	12.00
2N4416	2.25	181-3	15.00	A2X1698	POR	EFJ4017	24.00
2N4427	1.25	210-2	10.00	A3-12	14.45	EFJ4021	24.00
2N4428	1.85	269-1	18.00	A50-12	24.00	EFJ4026	35.00
2N4430	11.80	281-1	15.00	A209	10.00	EN15745	20.00
2N4927	3.90	282-1	30.00	A283	6.00	FJ9540	16.00
2N4957	3.45	482	7.50	A283B	6.00	FSX52WF	58.00
2N4959	2.30	564-1	25.00	A1610	19.00	G65739	25.00
2N5016	18.40	698-3	15.00	AF102	2.50	G65386	25.00
2N5026	15.00	703-1	15.00	AFY12	2.50	GM0290A	2.50
2N5070	18.40	704	4.00	AR7115	20.00	HEP76	4.95
2N5090	13.80	709-2	11.00	AT41435-5	6.35	HEPS3002	11.40
2N5108	3.45	711	4.00	B2-8Z	10.70	HEPS3003	30.00
2N5109	1.70	733-2	15.00	B3-12	10.85	HEPS3005	10.00
2N5160	3.45	798-2	25.00	B12-12	15.70	HEPS3006	19.90
2N5177	21.62	3421	28.00	BAL0204125	152.95	HEPS3007	25.00
2N5179	1.04	3683P1	15.00	BF25-35	56.25	HEPS3010	11.34
2N5216	56.00	3992	25.00	B40-12	19.25	HF8003	10.00
2N5470	75.00	4164P1	15.00	B70-12	55.00	HFET2204	112.00
2N5583	3.45	4243P1	28.00	BF272A	2.50	HP35821	38.00
2N5589	9.77	4340P3	18.00	BFQ85	2.50	HP35826B	32.00
2N5590	10.92	4387P1	27.50	BFR21	2.50	HP35826E	32.00
2N5591	13.80	7104-1	28.00	BFR90	1.00	HP35831E	30.00
2N5596	99.00	7249-2	10.50	BFR91	1.65	HP35832E	50.00
2N5636	12.00	7283-1	37.50	BFR99	2.50	HP35833E	50.00
2N5637	15.50	7536-1	30.00	BFT12	2.50	HP35859E	75.00
2N5641	12.42	7794-1	10.50	BFW16A	2.50	HP35866E	44.00
2N5642	14.03	7795	15.00	BFW17	2.50	HXTR2101	44.00
2N5643	25.50	7795-1	15.00	BFW92	1.50	HXTR3101	7.00
2N5645	13.80	7796-1	24.00	BFX44	2.50	HXTR5101	31.00
2N5646	20.70	7797-1	36.00	BFX48	2.50	HXTR6104	68.00
2N5651	11.05	40081 RCA	5.00	BFX65	2.50	HXTR6105	31.00
2N5691	18.00	40279 RCA	10.00	BFX84	2.50	HXTR6106	33.00
2N5764	27.00	40280 RCA	4.62	BFX85	2.50	J310	1.00
2N5836	3.45	40281 RCA	10.00	BFX86	2.50	J02000	10.00
2N5842	8.45	40282 RCA	20.00	BFX89	1.00	J02001	25.00
2N5847	19.90	40290 RCA	2.80	BFY11	2.50	J04045	24.00
2N5849	20.00	40292 RCA	13.05	BFY18	2.50	KD5522	25.00
2N5913	3.25	40294 RCA	2.50	BFY19	2.50	KJ5522	25.00
2N5916	36.00	40341 RCA	21.00	BFY39	2.50	M1106	13.75

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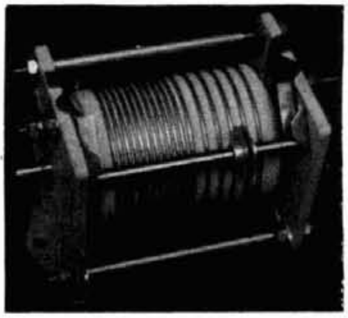
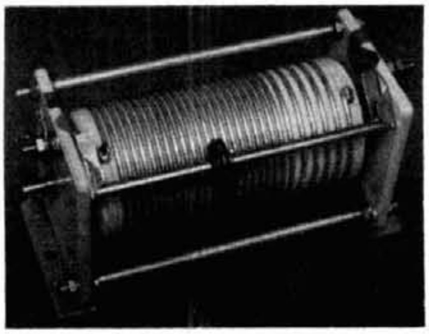
M1107	$16.75	MRF458	$20.70	NE02160ER	$100.00	SD1009	$15.00
M1131	5.15	MRF464	25.30	NE021350	5.30	SD1009-2	15.00
M1132	7.25	MRF466	18.97	NE13783	61.00	SD1012	10.00
M1134	13.40	MRF472	1.50	NE21889	43.00	SD1012-3	10.00
M9116	29.10	MRF475	3.10	NE57835	5.70	SD1012-5	10.00
M9579	6.00	MRF476	3.16	NE64360ER-A	100.00	SD1013	10.00
M9580	7.95	MRF477	20.00	NE64480 (B)	94.00	SD1013-3	10.00
M9587	7.00	MRF479	8.05	NE73436	2.50	SD1013-7	10.00
M9588	5.20	MRF492	23.00	NE77362ER	100.00	SD1016	15.00
M9622	5.95	MRF502	1.04	NE98260ER	100.00	SD1016-5	15.00
M9623	7.95	MRF503	6.00	PRT8637	25.00	SD1018-4	13.00
M9624	9.95	MRF504	7.00	PT3127A	5.00	SD1018-6	13.00
M9625	15.95	MRF509	5.00	PT3127B	5.00	SD1018-7	13.00
M9630	14.00	MRF511	10.69	PT3127C	20.00	SD1018-15	13.00
M9740	27.90	MRF515	2.00	PT3127D	20.00	SD1020-5	10.00
M9741	27.90	MRF517	2.00	PT3127E	20.00	SD1028	15.00
M9755	16.00	MRF525	3.45	PT3190	20.00	SD1030	12.00
M9780	5.50	MRF559	1.76	PT3194	20.00	SD1030-2	12.00
M9827	11.00	MRF587	11.00	PT3195	20.00	SD1040	5.00
M9848	35.00	MRF605	20.00	PT3537	7.80	SD1040-2	20.00
M9850	13.50	MRF618	25.00	PT4166E	20.00	SD1040-4	10.00
M9851	20.00	MRF626	12.00	PT4176D	25.00	SD1040-6	5.00
M9860	8.25	MRF628	8.65	PT4186B	5.00	SD1043	12.00
M9887	2.80	MRF629	3.45	PT4209	25.00	SD1043-1	10.00
M9908	6.95	MRF641	25.30	PT4209C/5645	25.00	SD1045	3.75
M9965	12.00	MRF644	27.60	PT4556	24.60	SD1049-1	2.00
MM1500	25.00	MRF646	29.90	PT4570	7.50	SD1053	4.00
MM1550	10.00	MRF648	33.35	PT4577	20.00	SD1057	10.00
MM1552	50.00	MRF816	15.00	PT4590	5.00	SD1065	4.75
MM1553	50.00	MRF823	20.00	PT4612	20.00	SD1068	15.00
MM1607	8.45	MRF846	44.85	PT4628	20.00	SD1074-2	18.00
MM1614	10.00	MRF892	35.50	PT4640	20.00	SD1074-4	28.00
MM1810	15.00	MRF894	46.00	PT4642	20.00	SD1074-5	28.00
MM1810	15.00	MRF901 3 Lead	1.00	PT5632	4.70	SD1076	18.50
MM1943	1.80	MRF901 4 Lead	2.00	PT5749	25.00	SD1077	4.00
MM2608	5.00	MRF902/2N6603JAN	15.00	PT6612	25.00	SD1077-4	4.00
MM3375A	17.10	MRF902B	18.40	PT6619	20.00	SD1077-6	4.00
MM4429	10.00	MRF904	2.30	PT6708	25.00	SD1078-6	24.00
MM8000	1.15	MRF905	2.55	PT6709	25.00	SD1080-7	7.50
MM8006	2.30	MRF911	2.50	PT6720	25.00	SD1080-8	6.00
MM8011	25.00	MRF965	2.55	PT8510	15.00	SD1080-9	3.00
MPSU31	1.01	MRF966	3.55	PT8524	25.00	SD1084	8.00
MRA2023-1.5	42.50	MRF1000MA	32.77	PT8609	25.00	SD1087	15.00
MRF134	10.50	MRF1004M	31.05	PT8633	25.00	SD1088	22.00
MRF136	16.00	MRF2001	41.74	PT8639	25.00	SD1088-8	22.00
MRF171	35.00	MRF2005	54.97	PT8659	25.00	SD1089-5	15.00
MRF208	11.50	MRF5176	24.00	PT8679	25.00	SD1090	15.00
MRF212	16.10	MRF8004	2.10	PT8708	20.00	SD1094	15.00
MRF221	10.00	MSC1720-12	225.00	PT8709	20.00	SD1095	15.00
MRF223	13.00	MSC1821-3	125.00	PT8727	29.00	SD1098-1	30.00
MRF224	13.50	MSC1821-10	225.00	PT8731	25.00	SD1100	5.00
MRF227	3.45	MSC2001	30.00	PT8742	19.10	SD1109	18.00
MRF230	2.00	MSC2010	93.00	PT8787	25.00	SD1115-2	7.50
MRF231	10.00	MSC2223-10	245.00	PT8828	25.00	SD1115-3	7.50
MRF232	12.07	MSC2302	POR	PT9700	25.00	SD1115-7	2.10
MRF237	3.15	MSC3000	35.00	PT9702	25.00	SD1116	5.00
MRF238	13.80	MSC3001	38.00	PT9783	16.50	SD1118	22.00
MRF239	17.25	MSC72002	POR	PT9784	32.70	SD1119	5.00
MRF245	35.65	MSC73001	POR	PT9790	56.00	SD1124	50.00
MRF247	31.00	MSC80064	35.00	PT31083	20.00	SD1132-1	15.00
MRF304	36.00	MSC80091	10.00	PT31962	20.00	SD1132-4	12.00
MRF306	50.00	MSC80099	3.00	PTX6680	20.00	SD1133	9.50
MRF313	11.15	MSC80593	POR	RE3754	25.00	SD1133-1	10.00
MRF314	29.21	MSC80758	POR	RE3789	25.00	SD1134-1	2.50
MRF315	28.86	MSC82001	33.00	RF35	16.00	SD1134-4	12.00
MRF316	55.43	MSC82014	33.00	RF85	17.50	SD1134-17	12.00
MRF317	63.94	MSC82020M	130.00	RF110	21.00	SD1135	10.25
MRF412	18.00	MSC82030	33.00	S50-12	23.80	SD1135-3	12.00
MRF420	20.12	MSC83001	40.00	S3006	15.00	SD1136	12.50
MRF421	25.00	MSC83003	82.00	S3007	10.00	SD1136-2	12.50
MRF422	38.00	MSC83005	70.00	S3031	22.00	SD1143-1	10.00
MRF427	17.25	MSC83026	POR	SCA3522	5.00	SD1143-3	17.00
MRF428	63.00	MSC83303	POR	SCA3523	5.00	SD1144	4.00
MRF433	12.07	MSC84900	60.00	SD345	5.00	SD1145-5	15.00
MRF449/A	12.65	MT4150	14.40	SD445	5.00	SD1146	15.00
MRF450/A	14.37	MT5126	25.00	SD1004	15.00	SD1147	15.00
MRF452/A	17.00	MT5596(2N)	99.00	SD1007	15.00	SD1188	10.00
MRF453/A	18.40	MT5768(2N)	95.00	SD1007-2	15.00	SD1189	24.00
MRF454/A	20.12	MT8762	25.00	SD1007-4	15.00	SD1200	1.50
MRF455/A	16.00	NE02136	2.00	SD1007-5	15.00	SD1201-2	15.00

E.F. JOHNSON ROLLER INDUCTORS





MODEL 229-0201-01
10UH at 3AMPS MAX. $36.99

MODEL 229-0202-01
18UH at 5AMPS MAX. $44.99

NI-CAD BATTERY CHARGERS

UNIVERSAL CHARGER $19.99

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UNELCO,SEMCO,ARCO METAL CLAD MICA CAPACITORS

Standard Size					Micro Size	
3.9	14	33	62	175	5	25
4.7	15	34	68	180	6	27
5	18	36	75	200	7	33
5.1	20	38	80	220	8	36
6.8	22	39	82	240	9	51
7	24	40	100	250	12	62
8.2	25	43	110	300	15	
9.1	27	44	120	360	16	
10	27.5	47	123	470	18	
11	28	50	125	500	20	
12	30	51	140	820	22	
13	32	56	150	1000	24	

********NOTE ALL VALUES LISTED IN PICO FARAD********

PRICE INFORMATION
1 to 10 $ .90ea. 11 to 51 $.80ea. 52 to 102 $.70ea.
103 and up call

MALLORY CHARGER $23.99

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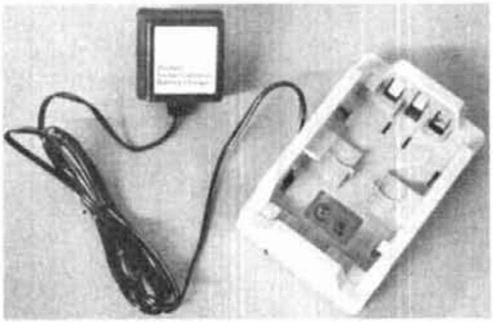
GOULD NI-CAD BATTERIES

AA size 1.25v at 500mahr	new	a	$ 1.99
D size 1.25v at 4 AMPHR	new	h	7.49

GENERAL ELECTRIC NI-CAD BATTERIES

AA size 1.25v at 500mahr	new	a	2.99
195194 3.75v at 100mahr	new		1.99
AA size 3.75v at 100mahr	new	a	2.99
AA size pack of 10 12.5v at 450mahr	used	a	5.99
Sub C Pack of 10 12.5v at 2.5Amphr	new	c	9.99



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SD1212-11	4.95	SD1307	3.00	SD1452-4	24.00	SRF1834	40.00	SD1263	15.00	SD1416	28.00	SD1542HI	170.00
SD1212-16	4.95	SD1308	3.00	SD1453HI	20.00	SRF2053-3	60.00	SD1263-1	15.00	SD1422-2	24.00	SD1544	26.00
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SD1219-5	15.00	SD1347-1	1.00	SD1484	1.50	SRF2265	100.00	SD1278	13.75	SD1429-5	15.00	SD1575	6.95
SD1219-8	15.00	SD1365-1	2.50	SD1484-5	1.50	SRF2281	5.00	SD1278-1	13.75	SD1430	12.00	SF4557	25.00
SD1220	8.00	SD1365-5	2.50	SD1484-6	1.50	SRF2371	15.00	SD1278-5	13.75	SD1430-2	18.00	SK3048	5.00
SD1220-1	9.50	SD1375	7.50	SD1484-7	1.50	SRF2347	50.00	SD1279-1	18.00	SD1434	28.00	SL501-59	15.00
SD1220-9	8.00	SD1375-6	7.50	SD1488	22.85	SRF2356	38.00	SD1279-3	18.00	SD1434-5	28.00	SL501-173	15.00
SD1222-8	16.00	SD1379	15.00	SD1488-1	28.00	SRF2378	16.00	SD1281-2	8.00	SD1434-9	28.00	SM7714	5.00
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SD1229-7	10.95	SD1408	25.00	SD1520-2	18.00	SRF2747	40.00	SD1289-1	15.00	SD1444-8	3.25	SRF887K3	2.50
SD1229-16	10.95	SD1409	18.00	SD1522-4	33.00	SRF2767H	40.00	SD1290-4	15.00	SD1444-9	3.25	SRF989K	15.00
SD1232	4.00	SD1410	18.00	SD1528-1	24.00	SRF2821	25.00	SD1290-7	15.00	SD1446	4.03	SRF1005	50.00
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product REVIEWS

world time clock

Azimuth Clock has just released its new World Time/Dual Zone clock. Using a large 1-7/16 × 2-1/2-inch LCD display, it's easy to read. And with large pushbuttons on the side, it's also easy to set. There's no need to fumble with a pen or pencil on tiny buttons recessed into the clock's mechanism.

To ensure accuracy, these clocks use a quartz crystal time base oscillator. The local time display shows time in the standard AM/PM format. The Universal Time clock display is in 24 hour/Zulu/military notation for instant logging accuracy. Both displays can be set to also flash the date, if desired. Both the UTC and local time clocks have been programmed to automatically determine the number of days per month and will require resetting only during leap years, or should the battery fail.

These clocks are set in a durable piece of extruded aluminum that has been beautifully silk screened. Azimuth also offers a 14-day satisfaction-guaranteed or your money-back offer: if you're not delighted with your Azimuth clock, simply return it within 14 days of purchase. The World Time dual zone clock retails for $29.95 but is currently specially priced at $24.95, plus $1.95 shipping and handling.

Toll-free numbers are available for ordering by credit card; call (800) 821-6842; in California, (800) 421-1061. Further information is available from Azimuth, 11030 Santa Monica Blvd., Suite 200, Los Angeles, California 90025.

Circle #307 Reader Service Card.

N1ACH

CMC's docking booster

Here's a really neat product for owners of handheld radios. The Docking Booster is a compact, self-contained power supply, a 16-dB gain GaAsMES FET receiver pre-amp, and a 30-watt RF amplifier (a 50-watt unit will be available soon), all in one package. Designed to integrate your portable radio into your car without sacrificing either portability or versatility, the Docking Booster is currently available for the IC-2AT, IC-02AT and Yaesu, Kenwood, and Standard radios.

When I unpacked the box, I was surprised that the unit is really quite small. Installation is quite simple. You just connect the unit to the car battery either directly or through the fuse block, slide the radio in, attach the external antenna and you're on the air!

The Docking Booster comes with a U-shaped bracket that can be attached to the door of most cars. (Unfortunately, our Dodge station wagon door is too deep, and the unit wouldn't fit there. I also found that both the power cord and antenna feedline tend to get in the way if you install the radio on the driver's door.) But I did find the perfect place to install the unit — right in the ashtray (I don't smoke). The U-clamp which fit perfectly, provides a stable, easy-to-reach mounting platform.

Now, trying to shout into the ashtray while you're driving down the road is bound to attract attention, if not cause an accident. So you'll want to add the optional ICOM handheld speaker mike.

The Docking Booster is simple to use, with only a high and low power switch for the 30-watt RF amplifier. There are no other switches, knobs, or dials to turn or set.

Here in Southern New Hampshire, I found the extra 30 watts to be helpful in accessing repeaters. The 16-dB pre-amp helped tremendously in hearing distant repeaters and weak mobile stations on simplex frequencies.

I did find one problem with the unit. You have to avoid long-winded transmissions because there's no heatsink for the RF amplifier. I don't yet have enough experience with the unit to tell whether this is going to be a problem or not, but in normal use, the Docking Booster did get warm to the touch. (The 50-watt unit does have a heat sink.)

The Docking Booster uses the latest Japanese power transistors in a stripline circuit for high, stable power output. Using a 1.5-dB NF GaAs FET device, the 16-dB receiver provides excellent weak signal reception over the full 2-meter band. Designed to run on 13.8 volts DC, the unit requires 4 amps maximum on transmit and supplies a stable 10 volt power source for the radio.

For more information on the Docking Booster, contact CMC Communications, 5479 Jetport, Tampa, Florida 33614.

N1ACH

Circle #305 on Reader Service Card.

NEW products

integrated packet terminal

Packeterm, a company specializing in packet radio technology, has announced release of the PACKETERM IPT. The IPT is a complete packet node controller and terminal in one compact unit. The IPT will interface with any popular FM or SSB rig, for use on both HF and VHF channels. The IPT can operate at 300 or 1200 baud. All that's required for operation is to connect the IPT to a transceiver and tune to one of the local packet frequencies.

The IPT uses Tuscon Amateur Packet Radio firmware for complete compatibility with existing packet networks. A built-in modem allows much greater tolerance for receiver audio level than previous available designs.

The IPT will also function as a general-purpose ASCII terminal. It features data rates from 110 to 19,200 baud, 7 function keys, 40 or 80 column display, and will drive an optional printer. Power required is 120 VAC at 1/2 ampere. For portable operation, a DC converter that uses a 13.8 VDC power source is available.

For further information, contact Packeterm, P.O. Box 835, Amherst, New Hampshire 03031.

Circle #303 on Reader Service Card.

ICOM IC-A2 air band handheld transceiver

ICOM has announced the IC-A2 5-watt PEP output aircraft handheld transceiver. Utilizing over 20 years of experience in synthesized communications equipment, the ICOM IC-A2 in-

cludes outstanding new features not available in other handhelds.

Standard features include all 720 COM and 200 NAV channels plus 720 additional COM channels and 200 NAV channels. Five watts PEP power output — an ICOM exclusive — and 1.5 watts operation capability for battery-saving low power operation are standard.

The unit features ten owner-programmable memory channels, with internal lithium cell memory backup.

The ICOM IC-A2 comes standard with an IC-CM7 rechargeable Nicad battery pack, charger, LC-14 soft leather case, and earphone. A wide selection of options and accessories are available, including the ICOM HS-10 headset and HS-10SA VOX unit or HS-10SB PTT switchbox.

The ICOM IC-A2 may be purchased only through authorized ICOM avionics dealers/distributors or FBO shops.

For further information, contact ICOM, 2380 116th Avenue N.E., Bellevue, Washington 98004.

Circle #306 on Reader Service Card.

packet radio relay power amplifier

With linking of packet radio stations on 220 MHz becoming popular, Hamtronics has announced a new version of their widely-used power amplifiers designed just for this service. Called the PPA-220, the new PA is similar to the Hamtronics LPA 2-40, except that it has increased gain (up to 50 watts out with 2 watts drive) and built-in PIN diode antenna switching to allow T/R transition in only a few milliseconds. The new PA can be used with the Hamtronics T51 or any other 2 watt, 220 MHz exciter. With the ultra-fast T/R switching, the PPA-220 is an ideal component for packet relay stations being constructed for inter-area ties at 9600 baud. The cost of the kit is $138.00.

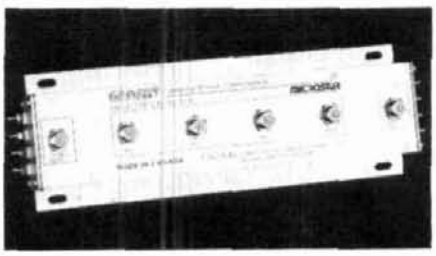
For more information on this and other products, such as transmitters, receivers, repeaters, and "202" type modulators and demodulators, contact Hamtronics, Inc., 65 Moul Road, Hilton, New York 14468-9535.

multi-tap V/H switch

The MTS-1200 is the first in Gensat's series of MICROSTAR® integrated block downconversion accessories. Incorporating all the circuitry required to independently operate up to four receivers from one dish, the MTS-1200 offers the easiest solution to most MTVRO system requirements.

The MTS-1200 is designed to operate with most block downconversion receivers operating at 950 to 1450 MHz. Each receiver can independently select the vertical or horizontal line from the block downconverters. No signal loss is introduced by the accessory.

The switching circuitry is driven from the polarizer output of the receiver. In order to ensure proper isolation between the horizontal and



vertical signal, the polarizer interface must be compatible with either a ferrite or pin diode polarizer.

Packaged in Gensat's standard weather-proof housing, this MICROSTAR® product can be mounted either indoors or outdoors.

For further information, contact Gensat, 951 Alness Street, Downsview, Ontario, Canada M3J 2J1.

Circle #308 on Reader Service Card.

NEW products

digital level meter

North American SOAR Corporation has announced the release of its Model 1700 digital level meter, which represents an entirely new concept in surface level measurements. Model 1700 was designed to assist the professional engineer or craftsman in making finite level or angular measurements quickly and accurately. Small and compact, the unit is sized 6-1/4 × 3-3/4 × 1-1/4 inches for portability. The Model 1700 has two 3-1/2 digit LCD readouts with annunciators, enabling the operator to observe the slope angle in degrees, the slope direction, and slop height in meters per meter from either the side or top. A buzzer can be activated to give an audible tone alarm when 0 degree (level) is attained. It contains a switchable LCD light for reading in dim light. Powered by two 1.5 volt "AA" batteries, the Model 1700 can be continuously operated for 500-800 hours. The measuring method employs an encoder and micro-computer, giving it a dynamic range of ±120 degrees with an accuracy of 1.0 degree and resolution to 0.5 degree. The Model 1700 is priced at $99.95 in small quantities.

For more information, contact North American SOAR Corporation, 1126 Cornell Avenue, Cherry Hill, New Jersey 08002.

Circle #310 on Reader Service Card.

transmitter kit

RF Kit Co. has developed a compact Amateur Radio transmitter kit that can be assembled in one evening and provide a solid 5-watt CW output on the 7, 10.1, and 14 MHz Amateur bands. This unit is crystal controlled and one crystal is included in the $39.95 price. Stock crystals available include: 7.035, 7.125, 10.108, 10.125, and 14.035 MHz.

This unit is suitable for home use with a simple dipole antenna or for portable and emergency power communications.

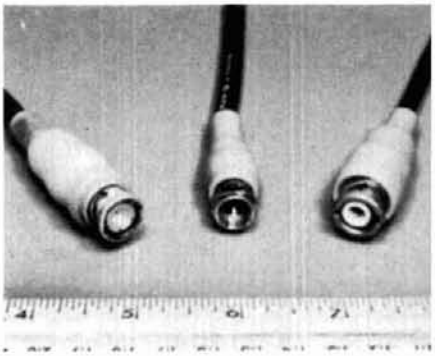
The electronic design is straightforward and may be easily modified for any Amateur band from 160 to 10 meters. The 3.5 × 2 × 1 inch size will allow the builder to custom-fit this transmitter into many surplus enclosures.

For further information, contact RF Kit Company, P.O. Box 27127, Seattle, Washington 98125.

Circle #302 on Reader Service Card.

weather boots

Kilo-Tec has announced a new custom weather boot for use with RG-58, RG-59, and RG-8X. Simply slip the weather boot over the



coaxial cable before soldering on the connector, then slide the boot over the connector for a good weather-tight seal — without the use of tape or rubber compounds.

The boots are manufactured with a flexible vinyl material that resists moisture and breakdown from the sun's rays.

Three new boots are available: Model KTBNC-59 for (F) BNC/RG-59 and RG-8X; Model KTBNC-58 for (F) BNC/RG-58; and Model KTBF-59 for (M) Type F/RG-59 and RG-8X. We also offer various models for PL-259 and type N. Boots for TNC are available on special order.

For more information, contact Kilo-Tec, P.O. Box 1001, Oak View, California 93022.

Circle #313 on Reader Service Card.

RF circuit design program

STAR 1.0 is a low-cost program written for circuit design using personal computers. It analyzes and optimizes electronic circuits including amplifiers, oscillators, filters, matching networks, hybrids, couplers and others. STAR 1.0 features include frequency domain analysis of circuits, optimization of any component values in circuit, file storage of circuits for easy recall or modification, and screen, printer, and plot outputs. The program disk includes 30 application examples. The program is available for IBM PC/XT/JR, APPLE II+IIc/IIe, Kaypro 2/2X/4/10 CP/M and the Commodore C-64.

For additional information, write Circuit Busters, P. O. Box 256, Lilburn, Georgia 30247.

Also available from Ham Radio's Bookstore — IBM and C64, $99; Apple and Kaypro, $89. Add $3.50 for shipping and handling.

Circle #309 on Reader Service Card.

new antennas

NCG Company has announced its new line of Amateur antennas. The line includes a 1.2 GHz antenna for base/repeater use (with a 12.5 dB gain) and a new mobile with a 7.5 dB gain.

Also available are the new 2-meter 70-cm antenna duplexer and 6-meter/2-meter antenna duplexer combinations. A quad band vertical for HF + VHF 40, 15, 10, and 6 meters is ideal for the limited roof areas.

Another new antenna is the new ground-plane vertical Tribander for the new 10, 12, and 18-MHz band.

For further information, contact NCG Company, 1275 North Grove Street, Anaheim, California 92806.

Circle #312 on Reader Service Card.

CoCo MORSE

The latest release from dataLOG Software allows you to send morse code from your Radio Shack Color Computer. "CoCo MORSE" requires 32K of RAM and a disk drive. It features a 320-character input buffer for type ahead that will keep up with the fastest typist. (The operator is usually not aware of the buffer limit because the buffer works in a circular fashion, allowing wrap-around when the 320 character limit is reached.) A split screen display shows input buffer and transmitted characters.

The program will allow operation from 5 to 80 words per minute and speed changes may be made during transmission. Up to five predefined message buffers can be created and saved to disk for increaed efficiency during contests or for that "brag" tape. The messages may be dumped into the transmit buffer, up to the buffer's limit, without effecting transmission speed or quality.

Included in the purchase price is an RS232 interface to connect the computer to the transmitter. The interface also provides the necessary isolation between the transmitter and computer. CoCo MORSE is written in machine language and is relocatable. Its documentation includes information for modifying the weight and duration of the transmitted code. A future release of the "dataLOG Logbook" program will allow combined operation of the morse program AND the log program for the dedicated CW operator. CoCo MORSE, including the interface sells for $39.00 plus $2.50 for shipping and handling.

For additional information, contact dataLog Software, P.O. Box 10531, Jacksonville, Florida 32247.

Circle #311 on Reader Service Card.

antique radios

Antique Radio Classified, a national publication for buyers and sellers of old radios and related items, is entering its second year of publication. The largest publication of its type, it caters to collectors interested in collecting radios

NEW products

built between 1905 and the 1940's. Although the emphasis is on "Wanted" and "For Sale" ads, many articles related to the hobby are included in each issue. Every subscriber is entitled to a free classified ad in each issue.

Antique Radio Classified is published 12 times a year in an attractive 5-1/2 × 8 inch size format.

For further information, contact Gary B. Schneider, publisher, Antique Radio Classified, 9951 Sunrise Blvd., Suite R-9, Cleveland, Ohio 44133. (Enclose SASE.)

Circle #315 on Reader Service Card.

'tenna hitch

Mounting mobile antennas on cars has always been a problem. Most people are reluctant to drill holes into the car body, and now that many bumpers are made of plastic, that relatively easy way out is no longer usable, either. However, DC Sales has come up with an idea that makes mounting antennas on cars equipped with trailer hitches as easy as 1, 2, 3!

The 'Tenna Hitch is designed to fit underneath the trailer hitch ball and is equipped with the standard 3/8-inch insulated mount. The 'Tenna Hitch is made from high strength, chrome plated steel and is designed to give years of trouble-free service. It will mount all currently available commercial mobile antennas.

For more information, contact DC Sales, 1602 Chestnut Ridge Road, Kingwood, Texas 77339.

Circle #314 on Reader Service Card.

2-meter RF amplifier

Hustler has announced the availability of its new model HVA-225 Class C Amplifier for 144-149 MHz 2-meter FM Amateur mobile use. Utilizing state-of-the-art broadband microstrip design, the amplifier exhibits components and manufacturing techniques found only in higher priced commercial units for superior performance and reliability.

The HVA-225 is conservatively rated at 25 watts with only 2 watts of drive while requiring only 4 amperes at 13.8 VDC for full output. Separate power and RF indicators, on-off switch, SO-239 connectors, reverse polarity protection, plus extra capacity heat sink for high temperature reliability and efficiency. The amplifier is housed in a black matte finish aluminum housing complete with gimble bracket and thumb screws for underdash mounting.

For more information on the HVA-225 amplifier, write Hustler, Inc., 3275 North "B" Avenue, Kissimmee, Florida 32758.

Circle #317 on Reader Service Card.

1000-call paging encoder

Communications Specialists has just announced the availability of its new PE-1000 desk-top paging encoder. The PE-1000 is capable of 100 or 1000 call paging capacity for two-tone sequential signaling. Five-tone sequential and REACH formats are also available. All features are included in every unit and fully field programmable through the front panel keyboard. A non-volatile memory retains the programming if a power loss occurs.

The PE-1000 includes all standard tone groups from 250.0 Hz to 4000.0 Hz and uses state-of-the-art microprocessor technology for high accuracy and stability of paging tones. The unit provides outputs for recording a hard copy print-out of all paging activity and an automatic self test is run each time the PE-1000 is powered up. The PE-1000 is protected by a full one-year warranty and is available for immediate shipment from factory stock. The price if $224.95.

For information, contact Communications Specialists, Inc., 426 West Taft Avenue, Orange, California 92665.

Circle #316 on Reader Service Card.

communications satellites

by Larry Van Horn

The first comprehensive directory of communication satellites and their radio frequencies is now available from Grove Enterprises.

Chapters cover spy and surveillance satellites, U.S. and Russian manned space missions, military tactical and scientific satellites, oceanographic and water satellites, navigational and communication satellites, and private and direct broadcast satellites.

This directory of space communications includes chapters on channelization band plans, transponder identification, international satellites, and a history of earth satellite development. An exhaustive frequency cross-reference allows quick identification of the source of unknown transmissions from space!

Illustrations and tables are included for better understanding of this space technology. Special chapters provide insight into satellite operation, much of which has never been revealed to the public.

The price is $12.95. Book-rate shipping by mail is free. (For shipping by UPS, add $1.50.)

To order, contact Grove Enterprises, P.O. Box 98, Brasstown, North Carolina 28902.

Also available through Ham Radio's Bookstore, $12.95 plus $3.50 shipping and handling.

Circle #301 on Reader Service Card.

✓ 208

NEW products

DeVry to coordinate nationwide VE program

The DeVry Technical Institute of Technology s planning to expand its VEC coverage from the ₹th call district to all 13 districts according to Jim Georgias, W9JUG, DeVry VE Coordinator. DeVry is looking for groups of three Extra Class Amateurs to set up "core groups" that will function as DeVry representatives in their local areas. DeVry will provide core group members with hree written exams per license class and a computer generated tape for code tests. The core groups will then be responsible for setting up, administering, and correcting of exams. DeVry equires that core groups comply with FCC Part 97, Subpart I rules and regulations.

Initially DeVry representatives will schedule exams at least every other month, though a once-monthly schedule is preferred.

If your club or group is interested in working with the DeVry Institute of Technology, call Jim Georgias at (312) 929-8500 between 9:00 A.M. and 4:00 P.M. (CDST) or write to him at DeVry nstitute of Technology, 3300 N. Campbell Avenue, Chicago, Illinois 60618.

Circle #318 on Reader Service Card.

Advanced terminal unit

Said to be the most advanced HF RTTY modulator-demodulator available, the ATU-1000 from AEA is designed for interconnecting a communications transceiver with a computer (or mechanical communications device) using appropriate computer communications software. Operation on Morse, Baudot, ASCII, Packet and AMTOR teletype is provided.

The heart of the demodulator system of the ATU-1000 is a pair of identical eight pole (0.5 dB ripple) Chebyshev filters. Twin oscillator-modulators mix the input tones to the filter's center frequency.

Both mark and space tones may be adjusted independently from 1000 to 3000 Hz, providing compatibility with all commercial and Amateur tone pairs. Adjustment of the tone frequencies is accomplished with ten turn potentiometers and the tone frequencies are indicated with a built in frequency counter. Adjustment of the filters is accurate to 1 Hz. For fixed tone pair operation, an optional eight-pole bandpass prefilter is selectable from the front panel. Selection of the normal channel bandwidth of 180 Hz or a narrow 100 Hz bandwidth is provided for optimizing the channel filters for the mode of operation.

The filter system is followed by twin full-wave detectors and twin four-pole low-pass filters with selectable cutoff frequencies corresponding to 50, 110, and 300 baud data rates. This is followed by a DC coupled threshold correction system that provides superior performance during selective fades and low signal conditions. In total, 32 poles of receive filter are provided in this system.

Operation using both normal mark-space comparison and mark only or space only is selectable during interference on one of the information channels.

Tuning is indicated with a discriminator style LED bar graph with selectable mark only, space only and summed mark and space operation. In addition, the tuning rate is selectable for quick initial tuning and precise final tuning.

For further information, contact Advanced Electronic Applications Inc., P.O. Box C-2160, Lynnwood, Washington 98036.

Circle #304 on Reader Service Card.

Heath TNC

The state-of-the-art HD-4040 Terminal Node Controller (TNC) from Heath is said to be the only RFI approved TNC on the market.

A version of the popular Tucson Amateur Packet Radio (TAPR) TNC, the Heath TNC allows communication using terminal or computer control of any Amateur Radio system. Packet radio insures error-free communication and greatly increases communication speed. The HD-4040 has a built-in 1200 baud modem, although Baud rates up to 9600 are possible with an external modem. Both AX.25 and VADCG protocols are used.

Three modes of operation are provided: a conversation mode that allows conversation with another operator, a command mode that allows configuration of the TNC and use of variety of operating commands, and a transparent mode that's used in transferring files from one computer to another. A 6809 processor and a 32K ROM and 8K RAM are featured. Both ROM and RAM can be expanded by adding up to 16K.

A built-in automatic beacon can be set to transmit a message at designated intervals determined by the operator. Any station can act as a digital repeater and up to eight such "linking" stations are allowed which greatly expands the operator's range.

For complete information and a free catalog of Heath products, write Heath Company, Dept. 150-525, Benton Harbor, Michigan 49022. (In Canada write Heath Company, 1020 Islington Avenue, Suite 3100, Toronto, Ontario, M8Z 5Z3.)

Circle #319 on Reader Service Card.

flea market

RATES Noncommercial ads 10¢ per word; commercial ads 60¢ per word **both payable in advance**. No cash discounts or agency commissions allowed.

HAMFESTS Sponsored by non-profit organizations receive one free Flea Market ad (subject to our editing) on a space available basis only. Repeat insertions of hamfest ads pay the non-commercial rate.

COPY No special layout or arrangements available. Material should be typewritten or clearly printed (**not** all capitals) and must include full name and address. We reserve the right to reject unsuitable copy. **Ham Radio** cannot check each advertiser and thus cannot be held responsible for claims made. Liability for correctness of material limited to corrected ad in next available issue.

DEADLINE 15th of second preceding month.

SEND MATERIAL TO: Flea Market, Ham Radio, Greenville, N. H. 03048.

CX7 REPAIRS. 415-549-9210.

LETTERING and text for QSL pasteup and label usage. Stamp brings circular. Labelcraft, PO Box 412, W. Sand Lake, NY 12196.

HOUSE READY FOR HAM. Beautiful mountain top all brick 4 bedroom, 3 full bath home and radio site on one acre landscaped, private, with huge inground pool. Located 55 miles from Washington, DC and 60 miles from Baltimore, easy commute by Amtrack or van pools. Extremely energy efficient brick home, full basement and other extra rooms, radio room. All cable, poles, antennas, fire alarm system and intercom system stay. Must see to fully appreciate. Call or write to receive free written details of all features, $250,000. (301) 371-7521. John Murray, Box 290, Jefferson, Maryland 21755.

ELECTRON TUBES — Radio & TV types 75% off list price. Huge inventory. Also industrial types. Send for free catalog today or call Toll Free (800) 221-5802. Box HC, Transleteronice, Inc., 1365 - 39th Street, Brooklyn, NY 11218. See our display ad in this issue.

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.

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RECLAIM SILVER from electronics scrap! Write RALTEC, 25884F Highland, Cleveland, OH 44143.

WANTED: Manual and schematics for military V.L.F. receiver R-1134/WRR-3. Tom Adams, K9TA, PO Box 5541, Madison, WI 53705.

NEW CW Word Copying Course. Easy to learn. Complete. QSO-Trainer™ Course. Send $16.95 (Indiana add 85¢). Money-back satisfaction guarantee (less $2.00 shipping and handling). Business-size SASE gets free information. AVC Innovations, Inc., Department HC, PO Box 20491, Indianapolis, IN 46220.

COMPUTERIZE Your IC-720 or R-70. Keyboard frequency entry, 64 memories, scanning (frequency, Memory, and mode). Many more features. Requires no interface, just cable, directions included. For Commodore 64. Cassette $14.75, disk $16.75, pdd. Cables also available. David Oliver, W9ODK, Rt. 2, Box 246, Shevlin, MN 56676.

WINDMILL & TOWER: 1978 Dunlite 2000 watt windmill, 110' Rohn 45G tower with new concrete anchors, 110V - 220 amp battery bank, converter, loading switch. Complete system only. $4,995.00. (518) 623-9951. Box 196, HCR-01, Warrensburg, NY 12885.

TRS-80 Model I/III/IV owners. HF antenna design program calculated dimensions for dipole, Yagi, and quad antennas. $14.95 (cassette) + $2.00 s&h to Cynwyn, Dept. H, 4791 Broadway, Suite 2F, New York, NH 10034.

MILITARY RADIOS: CPRC-26 Manpack Radio (described in March 1985 Ham Radio). Transceives 46-54 MHz, with battery box, antenna, crystal, handset: $22.50 apiece, $42.50/pair, good condition. R-390A Receiver, 5-32 MHz all modes, 4 mechanical filters, meters sealed (government removed, operation unaffected): $175 complete/checked; spair parts unit (80% complete, missing PTO/IF): $65. Info SASE. CPRC-26 add $4/unit shipping. R-390A shipping charges collect. Baytronics, Dept. HR, Box 591, Sandusky, Ohio 44870. 419-627-0460 evenings.

CLIMBING BELTS. OSHA certified nylon web belt with adjustable lanyard. $54.95 plus $3 UPS. John Limbach, K8NN, 7397 S. Platte Canyon Drive, Littleton, CO 80123.

MINT ROBOT 400. First sync modification. Instruction book and original box. I ship. $275 firm. Jim Valentino, KW2W, PO Box 438, Mastic Beach, NY 11951.

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.

CHASSIS and cabinet kits. SASE K3IWK.

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, NY 10538.

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.

RTTY-EXCLUSIVELY for the Amateur Teleprinter. One year $7.00. Beginners RTTY Handbook $8.00 includes journal index. P.O. Box RY, Cardiff, CA 92007.

OLD RADIO transcription discs wanted. Any size, speed. W7FIZ, Box 724 HR, Redmond, WA 98073-0724.

Coming Events

ACTIVITIES

"Places to go..."

OHIO: 43rd annual Findlay Hamfest sponsored by the Findlay Radio Club at the Hancock County Fairgrounds. Sunday, September 8, 6:30 AM to 5 PM. Advance tickets $3.00 by September 1. At the door $4.00. Tables $6.00 each. Outdoor flea market spaces $3.00 each. Talk in on 147.75/15. For more information write Findlay Radio Club, PO Box 587, Findlay, Ohio 45839.

CALIFORNIA: The Sonoma County Radio Amateurs' third annual Ham Radio flea market Saturday, September 21, 8 AM to 2 PM, Sebastopol Community Center, 390 Morris St., Sebastopol. Admission and parking free. Tables $6/door, $5/advance. Vendor setup 7 AM. Radio clinic, exhibits, refreshments. Noon auction. Talk in on 146.13/73. For tickets and information: SCRA, Box 116, Santa Rosa, CA 95402.

WYOMING: (Laramie-Cheyenne) The 6th annual High Plains Ham Roundup, September 6, 7, 8, Medicine Bow National Forest, Yellow Pine Campground, 14 miles east of Laramie on I-80. Sponsored by the Shy-Wy ARC, University of Wyoming ARC and Northern Colorado ARC. Saturday potluck supper — bring your favorite dishes. Swapfest, packet radio, musical entertainment and campfire sing-a-long. All hams and families welcome. No registration fees, small forest service charge for campers. Talk in on 22/82 and 25/85. For information: KØHRS, 2204 Vassar Ave., Fort Collins, CO 80525.

PENNSYLVANIA: York Hamfest, September 21 and 22, York Fairgrounds, Rt. 74. Seminars, tailgating, displays, banquet and FCC exams on Saturday. Tailgating and displays on Sunday. Registration $2/Saturday and $4/Sunday. $5/both days. XYL's and Jr. ops under 12 free. Saturday evening banquet $10.00 advance only. Tailgating $4 per day; $6 both days. Indoor tables $5 and up per day. Vendors setup 6 AM. Registration 8 AM both days. Ladies' activities. Special motel rates and overnight camping on grounds. Write York Hamfest, Box W, Dover, PA 17315.

TEXAS: Houston Com-Vention '85, September 20-22, Stouffer Greenway Plaza Hotel, SW freeway and Edloe St., 5 miles SW of downtown Houston. Friday night registration 5:00 PM, hospitality suites and HARC auction. Saturday 8 AM to 5 PM. Sunday 9 AM to 3 PM. Indoor flea market, exhibits, ladies' luncheon and forums, free parking. Saturday night Texas BBQ dinner. For information (713) 333-1466.

NEW YORK: Hall of Science Amateur Radio Club Hamfest, Hall of Science parking lot, Flushing Meadow Park, 47-01 111th Street, Corona, Queens. Sunday, September 8. Raindate September 15. 9 AM to 4 PM. Donation: buyers $3.00, sellers $5.00 per space. Talk in on 144.250 simplex link, 223.6000 repeat, 445.225 repeat. For information: John Powers, KA2AHJ, (718) 847-8007. Arnie Schiffman, WB2YXB, (718) 343-0172.

NEW YORK: Long Island Hamfair, Sunday, September 22, New York Institute of Technology, Rt. 25A, Northern Blvd., Old Westbury. General admission $3. Spouse, children, sweethearts free. Exhibitors $5 per car space. No reservations. Talk in on 146.85. Hank Wener, WB2ALW (516) 484-4322 or Bob Reed, WB2DIN (516) 221-8116 evenings.

OHIO: Lima Hamfest, October 13, Allen County Fairgrounds, Rts. 309 and 117. Advance tickets $3.00. Door $3.50. Tables $6.00; half tables $3.50. For reservations SASE and check to NOARC, PO Box 211, Lima, OH 45801. Amateur exams, Novice through Extra. Send completed FCC 610 with check for $4.00 payable to ARRL/VEC and photocopy of current license by September 13 to Amateur Exams, NC8F, PO Box 211, Lima, Ohio 45802. SASE required.

NEW YORK: The 1985 Ham-O-Rama, September 14, Niagara Falls International Convention Center, Niagara Falls. General admission $3.50/advance before August 24, $5.00/gate. Canadian money accepted at par for advance general admission tickets. Computer and equipment displays, tech programs, indoor/outdoor flea market, FCC exams Novice through Extra. Outside flea market $5.00, inside $15.00. Talk in on 146.31/91 and 146.52 simplex. For information: Nelson Oldfield, 126 Greenaway Blvd., Cheektowaga, NY 14225.

1985 BLOSSOMLAND BLAST, Sunday, October 6, 1985. Write "BLAST", PO Box 175, St. Joseph, MI 49085.

KENTUCKY: The 1985 ARRL National Convention, October 4, 5 and 6, Kentucky Fair and Exposition Center, Louisville. Exhibitors and flea market all air conditioned. ARRL forum, packet radio, AMSAT, FCC National weather service, ladies' programs and much more. Admission $5.00 advance; $6.00 at door. 12 and under free. For information contact The Greater Louisville Hamfest Assn., PO Box 34444, Louisville, KY 40232. (502) 368-6657.

OHIO: The annual Cincinnati Hamfest, Sunday, September 15, Stricker's Grove, Rt. 128, one mile west of Venice (Ross). Exhibits, food and refreshments, flea market, music, hidden transmitter hunt, awards and sensational air show. Admission and registration $5.00. For information: Lillian Abbott, K8CKI, 317 Greenwell Road, Cincinnati, OH 45238.

MICHIGAN: The L'Anse Creuse ARC presents the 13th annual Swap and Shop, September 15, L'Anse Creuse High School, Mt. Clemens. 0800-1500. Plenty of food and parking. Trunk sales $4.00 per space. Inside tables $8.00 each. Tickets $2.00 at door, $1.00 advance. Talk in on 147.69/.09 and 146.52. For tickets and table reservations: Maurice Schietecatte, N8CEO, 15835 Touraine Ct., Mt. Clemens, MI 48044. (313) 286-1843.

VIRGINIA: ARRL Virginia State Convention and 10th annual Amateur Radio-Computer Fair, Saturday and Sunday, September 21 and 22, rain or shine, Virginia Beach Pavilion. 9 AM to 5 PM. Advance tickets both days $5.00. $6.00/door. Flea market tables $5.00 one day, $8.00 both days. Displays, forums, computer equipment, ARRL license upgrading exams. For information and tickets: Jim Harrison, N4NV, 1234 Little Bay Avenue, Norfolk, VA 23503. (804) 587-1695.

MICHIGAN: The Central Michigan ARC and Lansing Civil Defense Repeater Association are sponsoring Ham Fair '85 at the National Guard Armory, 2500 S. Washington Avenue, Lansing, Sunday, October 13, 8 AM to 3 PM. Admission $3.00. Tables 75¢ per foot by reservation only. FCC exams at 1 PM registration by September 13. For information and reservations: Rowena Elrod, KA8OBS, 111 Lancelot Place, Lansing, MI 48906. (517) 482-9650.

NEW HAMPSHIRE: The Connecticut Valley FM Association's 9th annual Hamfest and Flea Market, September 29, 9 AM to 5 PM rain or shine, King Ridge Ski Area, Sutton. General admission $2.00. Dealers and flea market set up $3.00. Food available. Overnight camping for SC units (no hookups). Talk in on 146.76 or 146.52 simplex.

CONNECTICUT: The Candlewood Amateur Radio Association (CARA) annual Flea Market, Sunday, September 15, Edmond Town Hall, Main St., Newtown, 10 AM to 4 PM. Dealers 9 AM. Admission $2. Tables $7. Tailgating $5. Talk in on 147.72/12 or 52 simplex. For table reservations send check or MO to CARA, PO Box 143, Bethel, CT 06801. For information: Gene Marino, W1IDH, Valley View Rd., Newtown, CT 06470. (203) 426-8852.

ILLINOIS: The 10th annual New Berlin Hamfest sponsored by the Sangamon County Fair Association, Sunday, September 22, rain or shine, Sangamon County Fairgrounds. 7 AM to 3 PM. Admission and flea market setup free. Food and drink available. Talk in on 146.52 and 146.88. For information: Al Swettman, K9OFR, Box 2, Pleasant Plains, IL 62677 (217) 626-1634.

OHIO: Cleveland Hamfest & Computer Show, Sunday, September 22, Cuyahoga County Fairgrounds, Berea. General admission 8 AM to 5 PM, $3.50 at gate, $3.00 advance. Under 12 free. Special NASA displays, vendors, speakers, Packet Radio, FCC and more. Non-ham and ladies' activities. For tickets or information: Cleveland Hamfest Assn., PO Box 93077, Cleveland, OH 44101. Walk-in Amateur Radio license exams starting 9 AM. Bring original and copy of current license. Check for $4 payable to ARRL/VEC. For information: Dave Willemin, AI8M, 331 Courtland, Elyria, OH 44035. Ph: 324-4574. Saturday night Hamfest banquet. For reservations: Barbara Ernest, N8DAD, 327-3914.

CONNECTICUT: Annual Natchaug Amateur Radio Association Flea Market, Sunday, September 22, 9 AM to 4 PM, Elk's Home, 198 Pleasant Street, Willimantic. Advance reserved tables inside/outside $5.00 ea. At door $7.00 ea. Admission $2.00. Under 16 free. Free parking. Talk in on 52 direct or 147.30/.90. For informaion: Ed Sadeski, 49 Circle Drive, Willimantic, CT 06226. (203) 456-7029 after 4 PM.

GEORGIA: DXPO 1985, September 27, 28 and 29, Lanier Plaza Hotel, I-85 and Monroe Drive NE, Atlanta. Reservations: Grover Meinert, KC8BX, 720 Starlight Lane NE, Atlanta, GA 30342. Registration $49.50.

PENNSYLVANIA: Pack Rats (Mt. Airy VHF ARC) 9th annual Mid-Atlantic VHF Conference, Saturday, October 5, Warrington Motor Lodge, Rt. 611, Warrington. 14th annual Hamarama, Sunday, October 6, Bucks County Drive-In Theatre, Rt. 611, Warrington. Flea market admission $5.00. Selling spaces $8.00 each. Gates open 6 AM, rain or shine. Bring own tables. Advance registration for Conference $4.00. Send to Hamarama '85, PO Box 311, Southampton, PA 18966 or Lee A. Cohen, K3MXM (215) 634-4942.

NORTH CAROLINA: 1985 National QCWA Convention, September 26, 27 and 28, Hyatt Winston-Salem. Meetings, forums and interesting local tours.

OREGON: The Walla Walla Valley Radio Amateur Clubs' 39th annual Hamfest, September 21 and 22, Community Building, Milton-Freewater. Free registration. For flyers write Pat Stewart, W7GVC, 1404 Ruth Street, Walla Walla, WA 99362.

GEORGIA: The 12th annual Lanierland ARC Hamfest, September 22, 9 AM Gainesville Holiday Inn. Free tables and inside display area for dealers with advance registration. Large parking lot for flea market. Doors open 8 AM for dealer set up. Talk in Novice through Extra exams starting 9 AM. Talk in on 146.07/.67. For information/reservations: Paul Watkins, W4FDK, Route 11, Box 536, Gainesville, GA 30501 (404) 536-8280.

NEW YORK: The Elmira Amateur Radio Association's 10th annual International Hamfest, September 28, Chemung County Fairgrounds. Outdoor flea market, dealer display, breakfast and lunch available on premises. Gates open 6 AM to 5 PM. Tickets at gate or advance from Steve Zolksky, 118 East 8th Street, Elmira Heights, NY 14903.

NEW MEXICO: Northern New Mexico ARC's annual Hamfest, September 28 and 29, Camp Stoney, 8 miles east of Santa Fe. Saturday AM — ARRL/VEC exams. Free overnight camping, no hookups. Sunday, 8 AM to 3 PM, tailgate flea market, dealers, programs. Admission $3.75 adults; $1.75 kids includes lunch. Talk in on .52 and local repeaters. For information: SASE to NNMARC, Rt. 3, Box 95-15, Santa Fe, NM 87501.

ILLINOIS: Peoria Area Amateur Radio Club's Superfest '85, September 21 and 22, Exposition Gardens, W. Northmoor Rd., Peoria. Admission $3.00 advance, $4.00 gate. Children under 12 free. Amateur radio and computer displays, huge flea market, FCC exams Saturday. Free bus to Northwoods Mall on Sunday. Full camping facilities on grounds. Saturday night get-together at Heritage House Smorgasboard, 8209 N. Mt. Hawley Rd., Peoria. For information: SASE to Superfest '85, PO Box 3461, Peoria, IL 61614.

MARYLAND: The Columbia Amateur Radio Assocition's 9th annual Hamfest, Sunday, October 6, 8 AM to 3:30 PM, Howard County Fairgrounds, 15 miles west of Baltimore. Admission $3.00. Spouse and kids free. Outdoor tailgating $5.00. Tables $6.00. Indoor tailgating (payments by Sept. 30) $6.00. Food available. Talk in on 147.735/147.135, 146.52/146.52. For reservations and information: Mike Vore, W3CCV, 9098 Lampskin Lane, Columbia, MD 21045. (301) 992-4953.

NEW YORK: Yonkers Electronics Fair and Giant Flea Market, Sunday, October 6, 9 AM to 4 PM, Yonkers Municipal Parking Garage, Nepperhan Avenue & New Main Street. Rain or shine. Refreshments, free parking, unlimited free coffee all day. Giant auction 2 PM. Admission $3.00. Children under 12 free. Sellers $7.00 per parking space, admits one. Bring tables. For further information: (914) 969-1053.

CONNECTICUT: CQ Radio Club of Torrington will hold its annual Flea Market, Saturday, October 5, 9 AM to 3 PM, East Albert Street Recreation Building. Dealers $7.00 per table. Tailgaters $5.00. Admission $1.00. Talk in on 146.955. For information: Donald D. Taylor, KA1GKJ, PO Box 455, Watertown, CT 06795.

NEW JERSEY: The South Jersey Radio Association, the oldest radio club in continuous operation in the US (1916) will hold its 37th annual Hamfest, Sunday, September 15, Pennsauken High School, Hylton Road, Pennsauken. Table and tailgating sales in parking lot. Refreshments and food available. Gates open 8 AM. Tickets $2.50 advance, $3.00 at door. Tailgating $5.00 per space plus admission ticket. Talk in 145.29/144.69. Contact Fred Holler, W2EKB, 348 Bortons Mill Rd., Cherry Hill, NJ 08034. (609) 795-0577.

NEW HAMPSHIRE: Hosstraders annual Fall tailgate swapfest, Saturday, October 5, Deerfield Fairgrounds. Donation $2 per person sellers included. Profits benefit Shriners' Boston Burns Center. Our May Swapfest gave $6,960. Friday night camping at Nominal fee after 4 PM. Talk in .52 and 146.40-147.00. For information SASE to Norm, WA1IVB, RFD Box 57, West Baldwin, ME 04091.

NEW YORK: The Radio Amateurs of Greater Syracuse 30th RAGS Hamfest, Saturday, October 5, New York State Fairgrounds off Rt. 690. 9 AM to 6 PM. Flea market setup 7:30 AM. Flea market tables $6. Outdoor tailgating $3. Exhibitors and dealers. VE exams by pre-registration. Speakers, ARRL forum, free parking. Admission $3. Talk in on 31/91 and 90/30. For information: Viv Douglas, WA2PUU or Ed Swatiowski, WA2URK, PO Box 88, Liverpool, NY 13088.

RHODE ISLAND: The RI Amateur FM Repeater Service will hold its annual Fall Flea Market and Auction, Saturday, September 22, American Legion Fairmont Post 85, 870 River St., Woonsocket. Starts 9 AM. Spaces $5.00 each. Some other spaces available under pavilion. Auction noon to 5 PM. Admission free. Food and beverages available. Talk in on 34/94 and 52 simplex. For information: Richard Fairweather, K1KYI, 127 Sherman Farm Rd., Harrisville, RI 02830. (401) 568-3468.

MASSACHUSETTS: The Hampden County Radio Association will be giving exams for all classes of Amateur Radio licenses, Saturday, October 18, Hampden-Wilbraham Reg. High School, 621 Main Street, Wilbraham at 9 AM. Get Form 610 by writing to the club. For upgrading, bring original and copy of current license, check for $4 payable to ARRL/VEC. Send completed applications to Yorke Phillips, 235 Ames Rd., Wilbraham, MA 01036 or sign up that day. Sign up time 8:30 AM. Amateur radio classes will be held in the Fall. Send post card with name, address and phone number to Hampden County Radio Association, PO Box 482, West Springfield, MA 01090.

OPERATING EVENTS

"Things to do..."

Riding Radio Operators — Amateur Radio Motorcycle Club Net meets every Thursday night at 0300 UTC at 3888 kHz standard time and 7237.5 kHz daylight saving time. An eastern USA group meets one hour earlier at 3888 kHz year-round. Send business SASE to AG0N, Gary McDuffie, Rt. 1, Box 464, Bayard, NE 69334 and ask for net information.

September 21: Celebrate Connecticut's 350th anniversary with Connecticut DX Association and the Newington Amateur Radio League. Listen for KW1V operating from the grounds of the State Capitol in Hartford. For a special QSL card and official Connecticut Tourism map send business SASE with 39¢ to Dave Rose, KW1V, 13 Long Crossing Road, East Hampton, CT 06423.

September 18: The Little Brown Jug special event held by the Delaware Amateur Radio Association, W8QLS, at the Delaware County Fair. For a Delara QSL card SASE to W8QLS, Staff Stafford, 5987 Dublin Road, Delaware, OH 43015.

September 14: Members of the Utica-Shelby Emergency Communications Association (USECA) Utica, Michigan, will operate KA8KTV to celebrate the first air-to-ground public telephone service inaugurated between Chicago and Detroit 1957. For a certificate send large SASE to USECA, PO Box 291, Utica, MI 48087.

September 13: The Michigan Technological University ARC will operate special event station W8YY to celebrate the University's Centennial and the Club's Golden Anniversary. Help support young Amateur Radio students. For a commemorative certificate send QSL and large SASE to Debbie Parmer, c/o W8YY, W. Wadsworth Hall, MTU, Houghton, MI 49931.

September 10-14: The Southern Counties ARA will operate K2BR during the Miss America Pageant, Atlantic City, NJ. SASE via SCARA, Box 121, Linwood, NJ 08221.

September 29: Fall Classic Radio Exchange, 2000 UTC, Sunday to 0300 UTC, Monday. Object to restore, operate and enjoy older equipment with like-minded hams. Exchange name, RST, QTH, receiver and transmitter type. Same station may be worked with different equipment combinations, each band, each mode. CW call "CQ CX", phone "CQ Exchange". Send logs and SASE to Stu Stephens, K8SJ, 1407 Hollyrood Road, Sandusky, OH 44870.

September 14: The West Alabama Amateur Radio Society (WAARS) will operate special event station WD4DAT from the campus of the University of Alabama to commemorate the "Greatest College Football Coach in History" Paul 'Bear' Bryant. 1300Z to 2400Z. For a handsome commemorative certificate of the event send $1 and large SASE to WAARS, PO Box 1741, Tuscaloosa, AL 35403.

September 17: The Eagle Rock ARC of Idaho Falls will commemorate the 198th anniversary of the adoption of the Constitution of the United States with special event stations KX7C and N07B. For a special commemorative QSL SASE to Eagle Rock ARC.

September 21: The Paul Bunyan Wireless Association will operate a special event station from the site of the Paul Bunyan Festival near Brainerd, MN. For a commemorative QSL SASE to Paul Bunyan Wireless Assoc., PO Box 354, Pequot Lakes, MN 56472.

September 21: Minnesota QSO Party sponsored by the Paul Bunyan Wireless Association, 1700Z Saturday to 1700Z Sunday. Special awards for most contacts on phone, CW, mixed and QRP. Send logs to George Carleton, AD0S, PO Box 43, Merrifield, MN 56465.

September 12: The Columbiana County ARC will operate N8DKX to commemorate the annual Johnny Appleseed Festival. For a certificate send large SASE and QSL to N8DKX, 6008 Camp Blvd., Lisbon, OH 44432.

the ham notebook

solving a difficult TVI problem

Just when I thought I had the neighborhood TVI-proofed a new neighbor called to tell me my station was causing TVI to his cable service.

After many fruitless attempts to help him solve the problem, I told him that his situation was, in my opinion, due to the shoddy, run-of-the-mill converter that the cable company had provided. He didn't believe me and continued to write letters of complaint to the FCC.

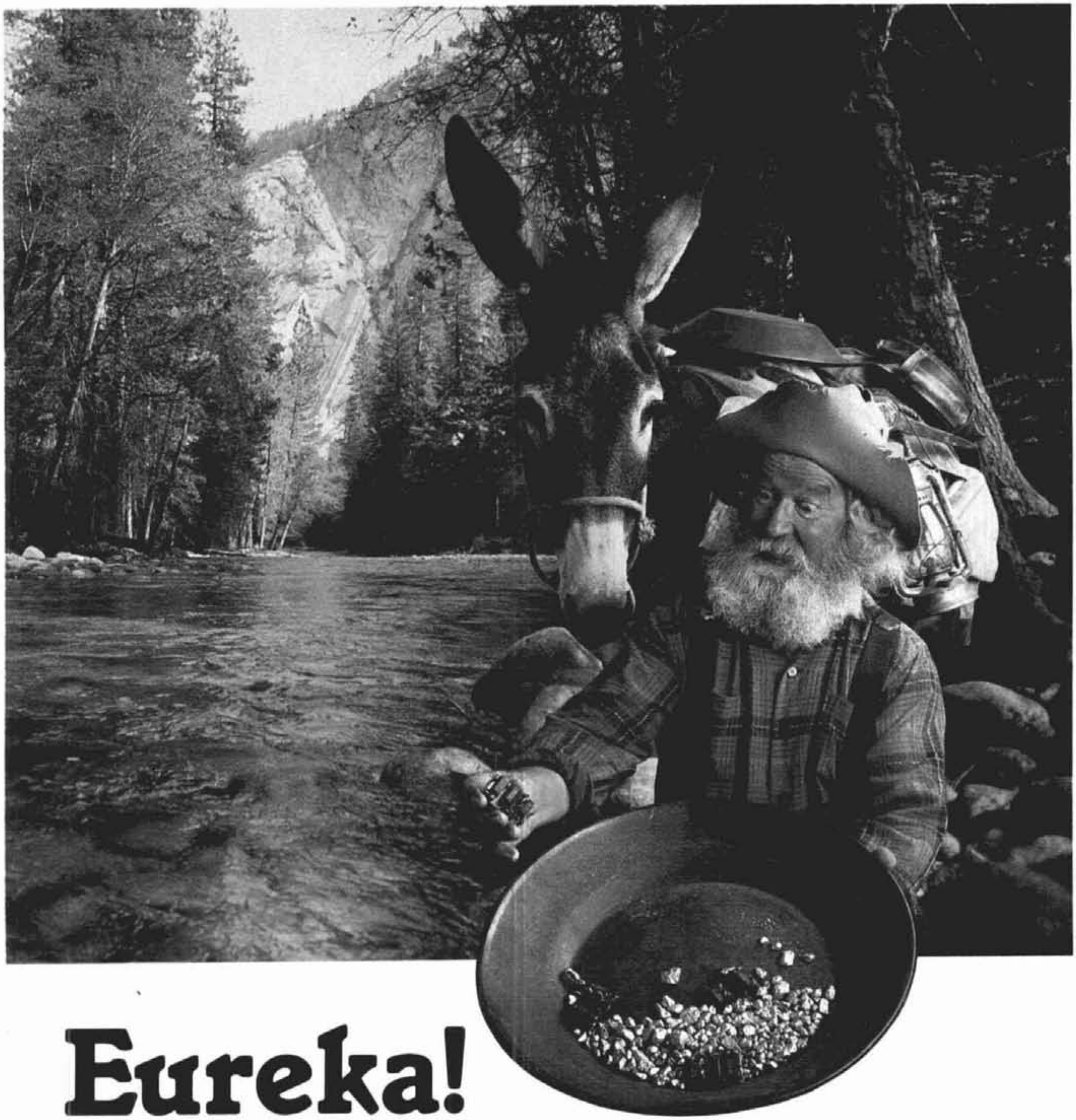
In due time two FCC field engineers from the New York City office came to my place, dragged a truckload of instruments into the house, made a number of tests, gave my station a clean bill of health, and told the neighbor the TVI problem was *his* baby. Again I told the neighbor to get a better converter.

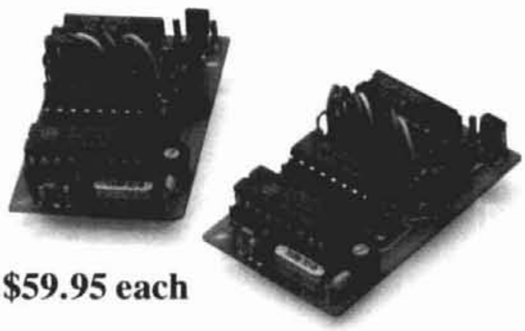
When the cable company did nothing about the problem, the neighbor bought a completely shielded state-of-the-art, crystal-controlled converter that cleared up most of the TVI.

We concluded that the residual interference may have been caused by reradiation from the neighbor's "Genie" automatic door units.

A call to the manufacturer was met not only with a sympathetic reception but also with quick action. The manufacturer's representative was familiar with the problem, which originated in the sequencer boards in the units. She said that even though the old units were out of warranty, the company would send new replacement boards at no charge provided the old boards were sent back. Installing the new boards (Alliance, Inc. Part No. 21277R) removed the last trace of TVI.

John Labaj, W2YW





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THE GUERRI REPORT

Ernie Guerri
W6MGI

?F power supplies achieve high efficiency

We have long come to expect the ower supply to be the one part of any ystem that is heavy and hot. Typical near power supplies have power den-ities of about 0.25 watt/inch³, and re about 35 percent efficient at con-erting AC line power to usable DC. n recent years, however, switching upplies have improved the situation y converting the AC line to square vaves at about 20 kHz. This higher fre-uency permits switching schemes sing pulse width modulation as a egulation mechanism, which in turn eeps the input-output differential cross the regulator quite small. The esulting supplies have power densities f about 1 watt/inch³, and efficiencies f more than 60 percent. But this im-rovement is not without a price. witching supplies generate consider-ble noise, and consequently require nore extensive filtering and shielding han linear supplies. Even so, their ef-iciency is excellent, and switching upplies are now the prevalent type in nost Amateur equipment.

Recently, National Semiconductor as made a significant advance in witching technology by developing a ower module (No. HS9151) that perates at 1 MHz. This integrated ackage operates directly from the 120 olt AC line and can deliver 5 volts at amperes with almost 80 percent effi-iency. Its small size gives it a power ensity of over 5 watts/inch³. As vould be expected, appropriate filtering is mandatory if you don't want to hear 1 MHz all over the spectrum. However, the high switching frequency makes filtering/shielding very manageable. This development surely signals the beginning of the end for bulky power supply components and frees valuable space in the new equipment designs for increased functionality.

receiver technology makes new strides

No matter what band we favor, part of our success or failure depends on the quality of the receiver we have working for us. Modern technology gives us the option to have nearly perfect receiving capability — if we choose. Sadly, much of today's excellent technology is not implemented in the latest production receivers.

It's nearly impossible to find a "professional" grade communications receiver whose front-end doesn't fall apart at the seams with input signals of only −10 dBm, and many do much worse. Yet we've had balanced JFET front-end designs with 3rd order intercepts of over +20 dBm for nearly 20 years! The incremental cost for incorporating these front-ends would be a few dollars in production. On the plus side, nearly all new VHF/UHF receivers incorporate GaAs FET input stages, which give good noise figures and can handle large, complex input signals.

Intermediate frequency and detector sections suffer similarly. The availability of monolithic crystal and ceramic filters has resulted in uniformly good performance at IF frequencies up to 45 MHz. However, few receivers offer multiple filters and all-mode detectors, even as options. Most of the necessary features are available in one or two ICs that could be added by the user if appropriate provisions were made during manufacture. Perhaps receiver designers could take a lesson from the computer people who leave empty card slots for expansion, or unpopulated sockets for memory expansion.

Thanks to the TV industry, frequency synthesis up to about 1 GHz is now relatively easy to achieve at modest cost. The Yaesu FRG-9600 is the first general coverage VHF/UHF receiver to use these low cost component assemblies in a versatile, reasonably priced package. These same techniques could be used to make high quality up-conversion (1st IF above the highest tuned frequency) receivers that would be image-free up through 450-500 MHz.

Just as ideas have been borrowed from the TV industry, we should soon see broader incorporation of computer technology into key receiver functions. The fact that most current equipment is microprocessor controlled makes the inclusion of an RS-232 port fairly easy, for example. Some manufacturers offer this feature now — but it (or something like it) will become almost a necessity as time goes by. Many of the advances now taking shape in the field of telecommunications are keyed to equipment that is computer controlled and highly adaptive.

ham radio

ADVERTISER'S INDEX AND READER SERVICE NUMBERS

Listed below are the page number and reader service number for each company advertising in this issue. To get more information on their advertised products, use the bind-in card found elsewhere in this issue, select the correct reader service number from either the ad or this listing, check off the numbers, fill in your name and address, affix a postage stamp and return to us. We will promptly forward your request to the advertiser and your requested information should arrive shortly. If the card is missing, send all the pertinent information on a separate sheet of paper to: *ham radio* magazine, Attn: Reader Service, Greenville, NH 03048.

READER SERVICE ✓ **PAGE ✓**

PRODUCT REVIEW/NEW PRODUCT

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Message Master™

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Now you can communicate vital information even when the station you are calling is not on the air — with Message Master. Message Master is a solid state voice recording system which can record messages just by listening to you speak, store messages in memory, and deliver messages on demand. If you can't be there to deliver your messages let Message Master deliver them for you - any messages in any language and in your own voice!

Message Master connects easily to any radio system for remote access: repeaters, base stations, even transceivers. It can even be connected to an autopatch device to exchange messages between your radio system and the telephone network.

Message Master is a multi-user system with mailbox style personalized message service for a hundred users. With 8 minutes of message storage it can store hundreds of messages simultaneously making it ideal for large, active repeater groups.

Would you like your callsign identifications, tail messages, and bulletin messages sent in real-voice? Message Master can send them too. Record several identification messages and it will even send a different ID each time. Almost like magic, Message Master knows when to send identifications and tail messages so it needs no special control signals from your base or repeater.

Call or write for further information before you make another wasted call.

Commercial users: Ask for a brochure on the Message Master Electronic Dispatcher with group and all call messaging.

- ***Create messages just by talking.* Message Master's 'real-voice' technique saves YOUR VOICE in digita memory to deliver messages in your own voice, lan guage and dialect.**
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For starters, each 757 includes an electronic keyer. 600-Hz CW filter. AM and FM modes. AF speech processor. And a 25-kHz marker generator. All at no extra charge.

And working the DX has never been easier with dual VFOs, single-button VFO/memory swap for split-frequency operation, eight memories, and push-button quick memory and band scan.

The 757 also lets you listen from 500 kHz to 30 MHz with its high-performance general coverage receiver. The transmitter covers 160 through 10 meters, including the new WARC bands, with 100 watts output on sideband, FM and CW.

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And of course, there's the 757's highly attractive price. It's the perfect way to get all the HF performance you desire, with money left over to apply toward other ham gear. Perhaps a power supply for base station use. An antenna or antenna tuner. Or whatever else makes your operation complete.

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212

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  Eliminate QRM with the IF shift and tuneable notch filter. A noise blanker supresses ignition noise. Squelch, RF attenuator, and RIT are also provided. *Optional IF filters may be added for optimum interference reduction.*
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  Solid state design permits input power of 250 watts PEP on SSB, 200 watts DC *on CW, 120 watts on FM (optional), or* 60 watts on AM. Final amplifier protection circuits and a cooling fan are built-in.
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  Eight memory channels *store frequency, mode* and band data. Channel 8 may be programmed for split-frequency operation. A front panel switch allows each memory *channel to operate as an* independent VFO or as a fixed frequency. A lithium battery backs up stored information.
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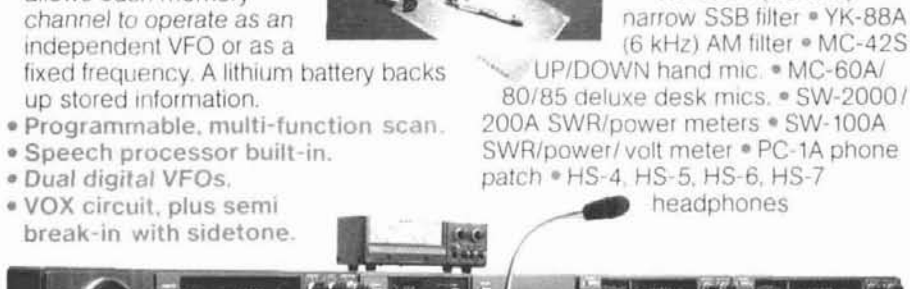

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