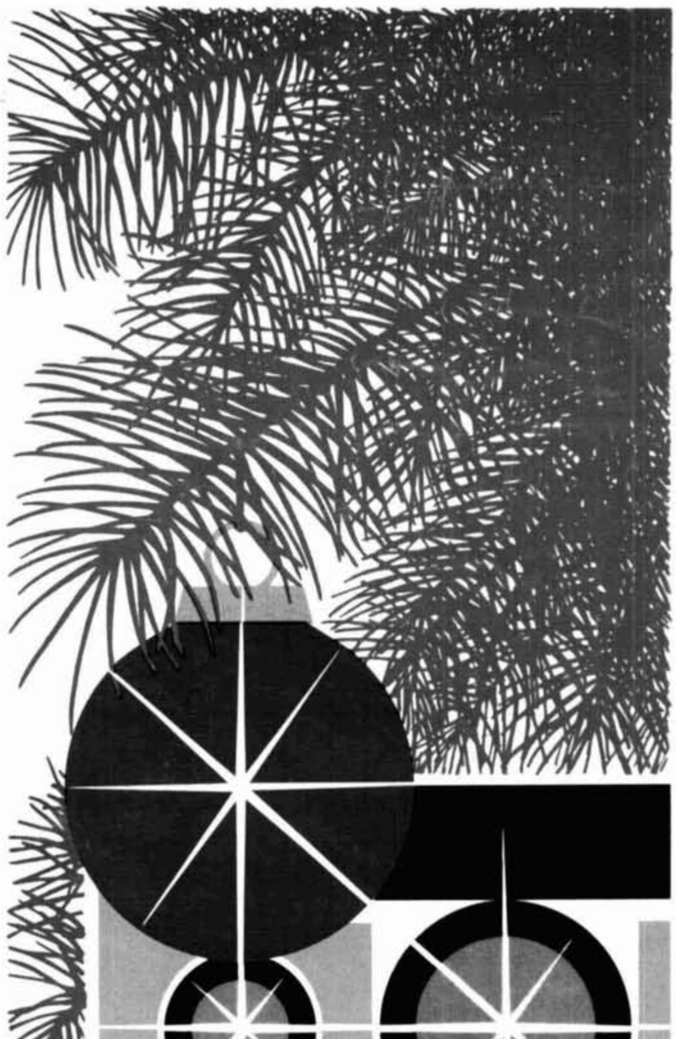
$1.50

ham radio

magazine

DECEMBER 1977



WE DON'T KNOW OF ANOTHER TRANSCEIVER OFFERING ALL THESE FEATURES AS STANDARD EQUIPMENT

- **Hybrid digital frequency presentation . . . built-in**
- **AC and DC VDC power supplies . . . built-in**
- **CW filter . . . built-in**
- **High performance noise-blanker . . . built-in**
- **VOX and semi-break in CW keying . . . built-in**
- **Speaker . . . built-in**
- **Cooling fan . . . built-in**
- **Microphone . . . included**

When you buy the Tempo 2020 you don't have to spend a bundle on accessories . . . just hook up to a power source and an antenna and you're on the air. A truly fine transceiver at a modest price.

The Tempo 2020 features a phase lock-loop (PLL) oscillator circuit that minimizes unwanted spurious responses. It is an advanced solid-state unit with only 3 tubes, including 2 rugged 6146-B final amplifier tubes. It covers all bands 80 through 10 meters, USB, LSB, CW and AM. Additional features worth noting is the 2020's crystal calibrator and WWV receiving capability, dual RIT control, fixed channel crystal control on two available positions, RF attenuator, adjustable ALC action, phone patch in and out jacks, separate PTT jack for foot switch, extraordinary receiver sensitivity (.3u S/N 10 db) and oscillator stability (100 Hz 30 min. after warm-up).

The **TEMPO 2020**	**$759.00**
Model 8120 external speaker	**$29.95**
Model 8010 remote VFO	**$139.00**

Send for descriptive information on the fine transceiver, or on the time proven Tempo ONE transceiver which continues to offer reliable, low cost performance. Both are available at select dealers throughout the U.S.

Henry Radio

11240 W. Olympic Blvd., Los Angeles, Calif. 90064 213/477-6701
931 N. Euclid, Anaheim, Calif. 92801 714/772-9200
Butler, Missouri 64730 816/679-3127

ham radio
magazine

DECEMBER 1977
volume 10, number 12

T. H. Tenney, Jr., W1NLB
publisher

James R. Fisk, W1HR
editor-in-chief

editorial staff

Charles J. Carroll, K1XX
Alfred Wilson, W6NIF
assistant editors

Patricia A. Hawes, WA1WPM
Thomas F. McMullen, Jr., W1SL
Joseph J. Schroeder, W9JUV
associate editors

Wayne T. Pierce, K3SUK
cover

publishing staff

Harold P. Kent, WA1WPP
assistant publisher

Fred D. Moller, Jr., WA1USO
advertising manager

James H. Gray, W1XU
assistant advertising manager

Therese R. Bourgault
circulation manager

ham radio magazine
is published monthly by
Communications Technology, Inc
Greenville, New Hampshire 03048
Telephone: 603-878-1441

subscription rates

U.S. and Canada: one year, $12.00
two years, $22.00
three years, $30.00

Europe, Japan, Africa:
(via Air Forwarding Service)
one year, $25.00
two years, $45.00

North America, South America, Australia and Asia (except Japan):
(via Surface Mail)
one year, $18.00
two years, $34.00

foreign subscription agents

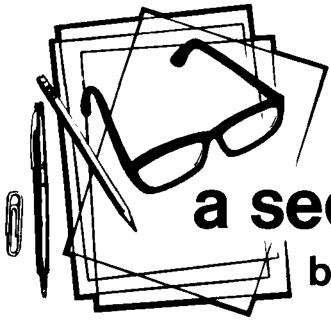
Foreign subscription agents are listed on page 113

Microfilm copies
are available from
University Microfilms, International
Ann Arbor, Michigan 48106
Order publication number 3076

Cassette tapes of selected articles from *ham radio* are available to the blind and physically handicapped from Recorded Periodicals
919 Walnut Street, 8th Floor
Philadelphia, Pennsylvania 19107

Second-class postage
paid at Greenville, N.H. 03048
and at additional mailing offices
Publication number 23340

contents



a second look

by Jim Fisk

During the holiday season it's customary to take stock, to look back over the past year, and to make our resolutions for the next — resolutions, no doubt, which will be forgotten by the time the snow melts from the landscape and the trees begin to show their buds. The long winter nights are also a good time to plan that new antenna system or to dream about some new station equipment. With the snow swirling up to the window sills and the cold winds howling down from the north, perhaps it's a good idea to take some time to think about where amateur radio has been, and where it's going.

With the World Administrative Radio Conference (WARC) of 1979 now less than two years away, I can't help wondering what our amateur bands will look like in the 1980s. Will amateurs be given some of the additional high-frequency bands requested by the WARC planning committees, will the width of the amateur bands be pared down, or will we lose much or all of our high-frequency allocations? Nobody will know the answer to that until the final votes are tallied in 1979, but I suspect it will fall somewhere between the two extremes.

There are some who would have you believe there will be *no* high-frequency amateur bands after 1980, and very little vhf spectrum either, but I'm more optimistic than that. Optimism, unfortunately, leads to apathy and that, my friends, is our worst enemy. Perhaps it's best to prepare for the worst and approach WARC '79 with cautious optimism.

It must be remembered that the last international conference which had much effect on the high-frequency spectrum was held in 1947 when the United States and our Allies had considerable influence on the 50 member countries of the United Nations. Radio amateurs were highly regarded by our government for the part they played in war-time communications — not as amateurs, but because they provided a pool of trained technicians and communicators. To a lesser extent the same thing was true in Britain and the Soviet Union. Radio Amateurs were also the backbone of the communication networks set up by the resistance movement in Europe, and of the coast watchers in the South Pacific.

Governments which had severely curtailed amateur radio before the war now recognized its great potential as a national resource. Amateur radio was no longer considered a nuisance to be tolerated, but an activity which should be encouraged. Part of that encouragement was a new, exclusive 15-meter band. Old timers will hasten to point out that bits were shaved off the top ends of 10 and 20 meters, and 160 meters was dominated by Loran, but most amateurs agreed that 15 meters more than made up for the losses.

By the time the next ITU conference on high-frequency allocations was convened in 1959, the United States' sphere of influence had decreased and it looked like amateur radio was in serious trouble; the foreign broadcasters wanted big chunks of 40 and 80 as well as portions of 20 and it was uncertain if we could rally enough votes to save amateur radio. Fortunately some of the nations who weren't particularly friendly toward the United States but supported amateur radio came to the rescue, with the result that the amateur bands in the Western Hemisphere came through unscathed (amateurs in other parts of the world lost 50 kHz of shared space on 40 meters).

In general, the United States and other governments which were supportive of amateur radio in 1959 still are, but in the 20 years since that last conference the balance of power has changed; the emerging nations are now in the majority and they are not altogether in favor of amateur radio — a few ban it outright. Many of these nations have few amateurs, so to them the amateur bands represent wasted space — space they feel should be allocated to a radio service that better serves their national interest. These are the same countries which often oppose the policies of the rich western nations simply because it's in the vogue to do so.

Nevertheless, there's still hope, because many of the questions to be asked at WARC '79 will be answered on the basis of their scientific merits. There's bound to be a certain amount of political arm twisting, but if the delegates from the emerging nations can be made to see the value of an amateur radio service to the technological development of their nation, perhaps they can be persuaded to vote in favor of increased amateur spectrum.

Jim Fisk, W1HR
editor-in-chief

That's all, Folks!

All you need for All Mode Mobile, that is.

All Mode Mobile is now yours in a superior ICOM radio that is a generation ahead of all others. The new, fully synthesized **IC-245/SSB** puts you into FM, SSB and CW operation with a very compact dash-mounted transceiver like none you've ever seen.

- **Variable offset:** Any offset from 10 KHz through 4 MHz in multiples of 10 KHz can be programed with the LSI Synthesizer.
- **Remote programing:** The **IC-245/SSB** LSI chip provides for the input of programing digits from a remote key pad which can be combined with Touch Tone* circuitry to provide simultaneous remote program and tone. Computer control from a PIA interface is also possible.

* a registered trademark of AT&T.

- **FM stability on SSB and CW:** The **IC-245/SSB** synthesis of 100 Hz steps make mobile SSB as stable as FM. This extended range of operation is attracting many FM'ers who have been operating on the direct channels and have discovered SSB.

The **IC-245/SSB** is the very best and most versatile mobile radio made: that's all. For more information and your own hands-on demonstration see your ICOM dealer. When you mount your **IC-245/SSB** you'll have all you need for All Mode Mobile.

SPECIFICATIONS

FREQUENCY COVERAGE	*144.00 to 149.00MHz
MODES	FM (F3) *SSB (A3J), CW (A1)
SUPPLY VOLTAGE	DC 13.8V ± 15%
SIZE (mm)	90H x 156W x 230D
WEIGHT	2.7
TRANSMITTER Tx OUTPUT	F3 10W *A3J 10W (PEP), A1 10W
CARRIER SUPPRESSION	40 dB OR BETTER
SPURIOUS RADIATION	60 dB BELOW CARRIER
MAXIMUM FREQUENCY DEVIATION	±5KHz
MICROPHONE IMPEDANCE	600 OHMS
RECEIVER SENSITIVITY	*A3J, A1 0.5 MICROVOLT INPUT GIVES 10 dB S+N/N. F3 0.6 MICROVOLT OR LESS FOR 20 dB QUIETING. S+N+D/N+D AT 1 MICROVOLT INPUT 30 dB
SQUELCH THRESHOLD	8 dB OR LESS (F3)
SPURIOUS RESPONSE	60 dB OR BETTER
SYNTHESIZER FREQUENCY RANGE	144 MHz to 148 MHz
STEP SIZE	5 KHz for FM *100 Hz or 5 KHz for SSB
STABILITY	PER C IN THE RANGE OF −10 TO +60C, ±0.0000145%

*VALID WITH SSB UNIT ONLY

More Details? CHECK—OFF Page 150

presstop

ARRL'S "CODE OF ETHICS" has been challenged in a formal written complaint filed with the Federal Trade Commission's Bureau of Competition.

Specific Complaints are that the Code will violate anti-trust laws by restraining trade, constitutes a "deceptive practice" as defined by the FTC, violates the First and Fourteenth Amendments to the Constitution, and that vendors who sign the ARRL pledge will become accessories after the fact in the above violations.

FCC'S DROPPING OF DOCKET 19759, the proposal that the 220-MHz Amateur band provide a home for a new CB service, doesn't mean that the band won't still become the new CB home. It does remove the immediate threat to the band, however, and many opinions have it that the longer the decision on where CB should go is delayed, the less likely 220 becomes as a choice.

In Announcing Its Termination of Docket 19759 the Commission pointed out that so many changes in related circumstances have occurred since several thousand comments were filed on it back in 1973, those comments were now obsolete. However, the question of a new CB band and where to put it is still very much alive, and 220 will undoubtedly be one of the options when the Commission considers the issue again in a future rulemaking.

A PETITION FOR RECONSIDERATION of the FCC's Report and Order on repeater deregulation (Docket 21033, *Presstop*, November), is being prepared by the ARRL. In it three issues will be emphasized: restoration of the WR-prefixed callsigns for repeaters, restoration of repeater licenses, and the need for formal consideration of the needs of the so-called "weak signal" vhf/uhf operations.

Plenty Of Support for the League position appears likely, as many repeater groups already oppose the dropping of repeater callsigns and licenses. In addition, reservations over the repeater sub-band expansion and even the proposed new bandplan for 144.5 - 144.5 MHz is starting to build among FM users as well as various SWOT and other VHF/UHF user groups.

AMATEUR LICENSING IRREGULARITIES will receive a full-fledged investigation run by an FCC Administrative Law Judge. The decision to go all-out on such a probe was reached at a closed meeting of the Commission, when information was presented that some Amateurs had apparently paid for the issuance or upgrading of their licenses or for special callsigns; that some of the same abuses may have occurred without payment; and that some Amateur callsigns have been issued inconsistent with normal FCC procedures.

ARTHUR C. CLARK, the noted science-fiction writer, was made an honorary AMSAT member in ceremonies attended by most of the AMSAT brass — Clark's honor came in recognition of his predictions of communications satellites and synchronous satellites in a 1945 *Wireless World* article.

1978 Orbital Prediction Booklets for OSCAR 7 only will be available shortly from Skip Reymann, W6PAJ, Box 374, San Dimas, California 91773. They're free to AMSAT Life members who request them; $3 to AMSAT Annual members and $5 to non-members — be sure to include AMSAT membership number and an self-addressed label with orders.

OSCAR 7's Mode Schedule will be changed effective January 1 to two days in Mode B for every day in Mode A, and the new schedule will be shown in W6PAJ's orbital calendar coming out in December. Ample Mode A operations will be provided by the Russian's "RS" spacecraft and AO-D, and OSCAR 7 is considerably more sensitive in Mode B than it is in Mode A.

A New Satellite Bandplan is also going into effect January 1 which will place CW only on the bottom third of the satellite downlink, mixed CW/SSB in the center third, and SSB only operation on the top third — the reverse of current practice.

OSCAR 6's Fifth Birthday was October 15, but revival efforts from VE3SAT failed to bring any response from it. RIP.

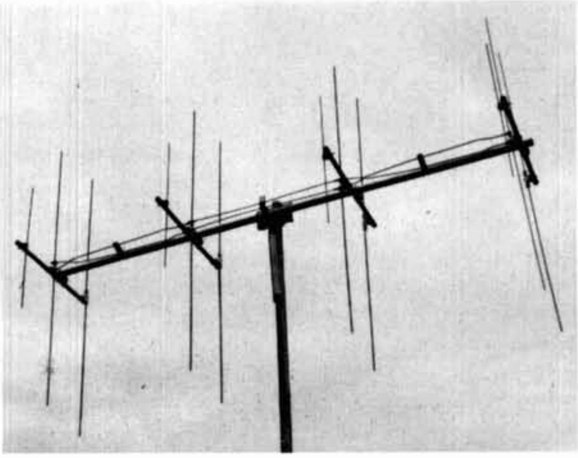
The Amateur Space Program made the Congressional Record in October when K7UGA lauded it during a Senate discussion of Sputnik's 20th anniversary.

THOSE PACIFIC AND CARIBBEAN prefix changes may not be as drastic as originally announced. FCC's news release announcing the change has now been "cancelled," and while it appears that prefix changes will still be made they'll be done in such a way that the resulting callsigns should identify the individual islands or island groups (*Presstop*, November).

FCC'S "GAG" ON DISCUSSIONS of current matters will remain in place as a result of the Supreme Court's decision not to review the Court of Appeals decision in the "Home Box Office" case (*Presstop*, June).

WESTINGHOUSE SCIENCE TALENT SEARCH is open to any high school student in the United States and Puerto Rico who'll graduate before October 1, 1978. Teachers who have an outstanding student who'd qualify for one of the many scholarships and awards must request entry materials from Science Service, 1719 N. Street, Washington, D.C. 20036 — entries are due by December 17, 1977.

VHF DX

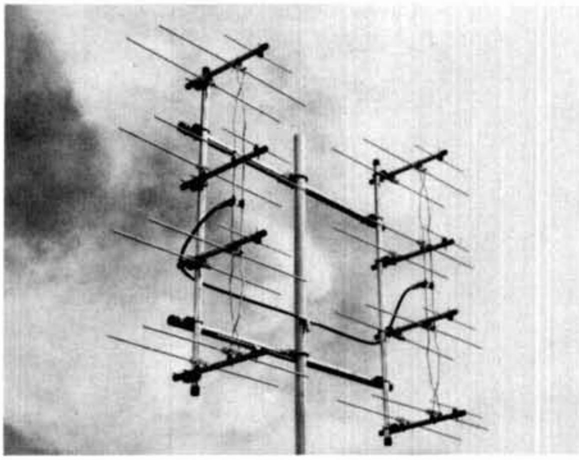


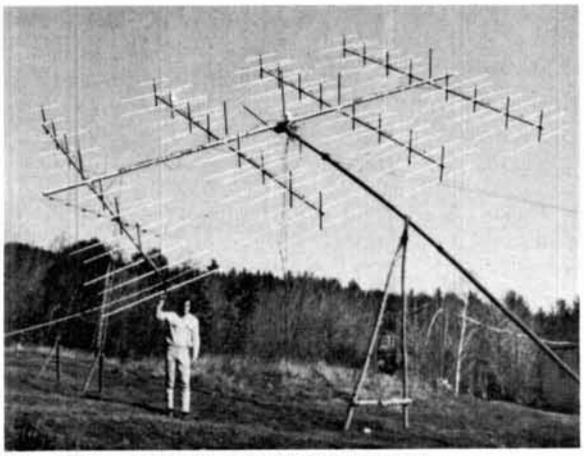
FM —

Enjoy the thrill of dependable long distance contacts on simplex or thru remote repeaters. The 20 element co-linear DX-Array offers a precise pattern with large capture area. This vertically polarized, horizontally stacked array provides a narrow beamwidth for the discriminating FM user. Wide impedance and gain bandwidths make the DX-Array a natural choice for the serious FM'er. A vertical polarization bracket, model DX-VPB, is required (support boom and mast not supplied). Seek out new horizons with DX-Array!

SSB/CW —

Discover reliability in long-haul communications with VHF SSB and CW. The Cush Craft DX-Array also gives low angle, high gain performance for many exotic propagation modes — tropo, aurora, sporadic-E, and meteor scatter. Horizontally polarized DX-Arrays may be used singly or combined in pairs (twice Effective Radiated Power) or quads (4 x ERP). Each DXK stacking kit is complete with stacking frame and phasing harness (vertical mast not supplied). This year has seen some spectacular VHF band openings — Don't miss the next one!





Dave Olean, K1WHS, with his 160 Element DX-Array and Polar Mount EME System

EME —

Many VHF experimenters have found excitement in conquering the formidable Earth-Moon-Earth (EME) path. 2-meter moonbouncers have achieved outstanding success using eight stacked DX-Arrays. Impedance and gain characteristics of this antenna permit stacking without the critical detuning problems inherent in large arrays of Yagis. Enlarging system size will yield a more uniform gain increase with DX-Arrays than with many other large antennas. The physical configuration alleviates mounting and phasing/tuning problems. EME enthusiasts are setting new records — So can you!

DX-ARRAY LEADS THE WAY!

	144 MHz.		220 MHz.		432 MHz.	
Description:	Model:	Price:	Model:	Price:	Model:	Price:
20 Element DX-Array	DX-120	$42.95	DX-220	$37.95	DX-420	$32.95
Frame & Harness (40 E.)	DXK-140	$59.95	DXK-240	$54.95	DXK-440	$39.95
Frame & Harness (80 El.)	DXK-180	$109.95	DXK-280	$89.95	DXK-480	$79.95
1-1 52-ohm Balun	DX-1BN	$12.95	DX-2BN	$12.95	DX-4BN	$12.95
Vert. Pol. Bracket (20 El.)	DX-VPB	$9.95	DX-VPB	$9.95	DX-VPB	$9.95

IN STOCK WITH DISTRIBUTORS WORLDWIDE

cushcraft

THE ANTENNA COMPANY

P.O. BOX 4680, MANCHESTER, N.H. 03108

More Details? CHECK—OFF Page 150

present-day receivers

— some problems and cures

Some thoughts on and cures for problems encountered in modern amateur communications receivers

The modern-day communications receiver is going through a continuous evolution that has brought about significant improvement in certain operating features. Among these are greatly improved frequency stability and setability, better selectivity, a slow and consistent tuning rate from band to band, and a wide-range automatic gain control system that functions on CW and single sideband. At the same time, unfortunately, the design philosophies which have made the above advances possible have also reduced the typical receiver's ability to simultaneously handle weak desired and strong undesired signals. This absolute reduction in receiver dynamic range has occured at the same time the number of high-power signals on the amateur bands has been increasing.

Insufficient dynamic range in a receiver can result in one or more stages being over-driven into nonlinearity by undesired strong signals. The result is internally-generated intermodulation distortion (IMD) products. These undesired products can occur in any mode of operation, but are easiest to identify on CW. Two CW signals which are overdriving a receiver will generate IMD products, but only when both stations are transmitting simultaneously. In the extreme situation, not only may IMD occur, but one signal alone can block, deaden, or desensitize the receiver.

In a pileup or contest situation, many strong CW stations can cause serious receiver overload, intermodulating with each other, and resulting in multiple phantom signals; it will appear as if several operators are randomly tapping their keys, or that you are listening to the Novice band with a diode detector without a BFO.

Two or more ssb signals with the correct frequency relationship can also intermodulate with each other and result in IMD products on top of the station you are listening to. The interference, however, will be unintelligible. IMD can also occur from a single ssb station on an adjacent channel as the individual speech frequencies mix with their own harmonics. Generally speaking, transmitted IMD from an rf power amplifier will be worse than that internally generated in the receiver, with the result that the transmitted IMD may cover up a receiver's shortcomings. An operator may never be certain whether the unintelligible signals he hears are being generated within his receiver, or coming from the outside — there is enough rf interference to contend with without the receiver creating its own!

The improvements mentioned in the first paragraph have been generally obtained by using a double- or triple-conversion scheme, plus a non-bandswitched master oscillator (PTO or VFO). Depending on the design technique, the first i-f may have a bandwidth of as much as 500 kHz, as in the Heath SB-104, or as narrow as 6 kHz in the Drake R-4B. Assuming that most of a receiver's selectivity occurs at the second intermediate frequency, you might think that the wider the bandwidth of the first i-f, the greater the chance of picking up more strong signals which could overload the second mixer. Of greater importance than this bandwidth, however, is the *net gain* between the antenna and the mixer that drives the narrow crystal or mechanical filter.

The Collins R-390A, for example, has three mixers and two separate gain stages ahead of its mechanical

By J. Robert Sherwood, WBØJGP, and George B. Heidelman, K8RRH, Sherwood Engineering, Incorporated, 1268 South Ogden Street, Denver, Colorado 80210

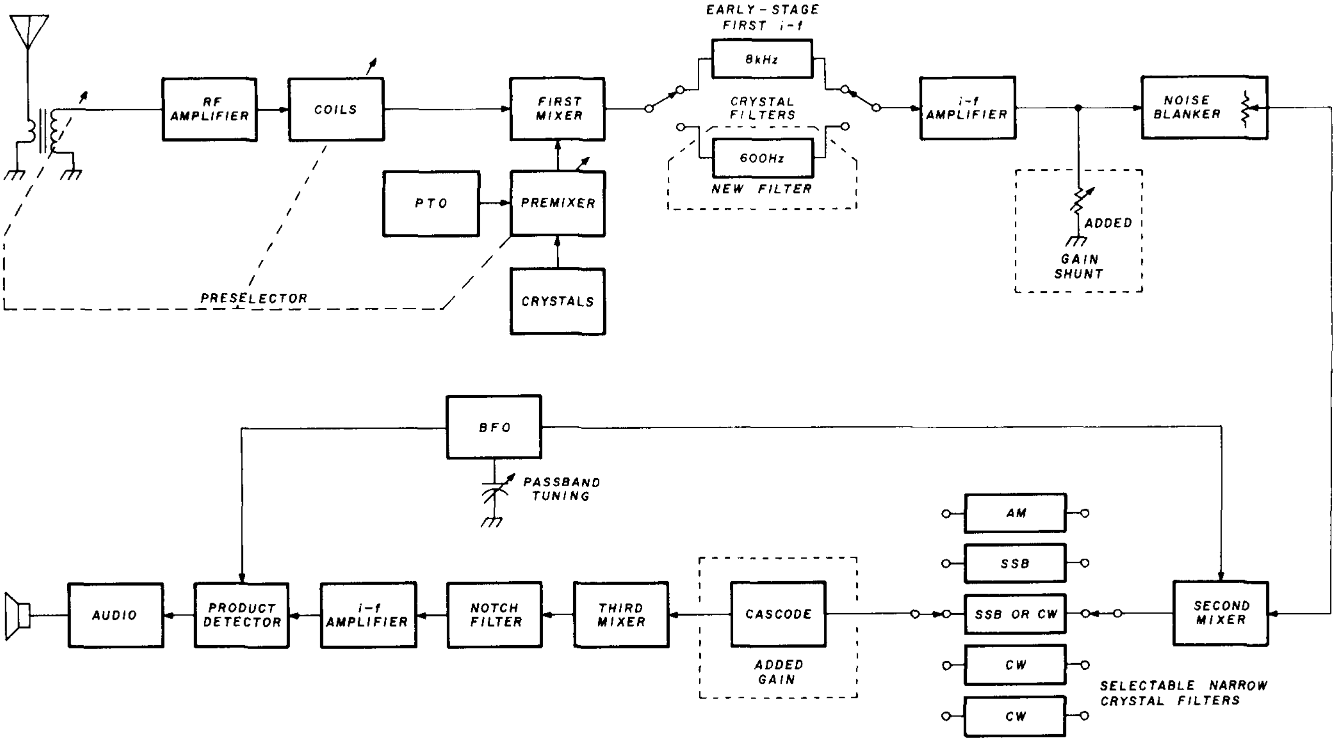


fig. 1. Block diagram of the Drake R4C receiver showing the gain redistribution. A shunt across the first i-f amplifier will reduce its gain the same amount as is added after the narrow i-f filters.

filters; it also has a set of elaborate, mechanically-tracked tuned circuits which have high *Q* and high insertion loss. Thus the net gain from the antenna to the major selectivity-determining elements is low enough to maintain good dynamic range.

Another receiver, the Heath SB-303, has a 500-kHz wide first i-f *window*, but unlike the R-390A, it has little selectivity ahead of its narrow filters and too much gain. This results in higher susceptibility to overload from strong signals anywhere in the band, which then cause undesired IMD products to be generated within the receiver.

At the opposite end of the bandwidth scale is the Drake R-4C with its 8-kHz wide first i-f filter at 5645 kHz. This four-pole crystal filter does an excellent job of keeping most of the undesired signals in the band from passing on to a second high-gain mixer. However, any undesired strong signals that *do* pass through this 8-kHz *window* can proceed to the second mixer with disasterous results. The net gain from the antenna to the narrow second i-f crystal filter can be as high as 50 dB when a desired weak signal (S1) is being received; this puts an impossible demand on the i-f stages, since the 1-dB compression point of the second mixer output has occured with any signal 30 dB over S9. An undesired signal, outside the narrow selectivity but inside the first i-f *window*, that is S9 + 40 dB (−33 dBm or 5 mV across the 50-ohm antenna input) for example, would have to be linearly amplified to a level of +17 dBm (1.58 volts across the 50-ohm narrow-filter input) and then be rejected by the filter. To supply this power level to the filter, the high-impedance plate of the second mixer would have to linearly swing more than 40 volts to yield a signal that is as great as 15

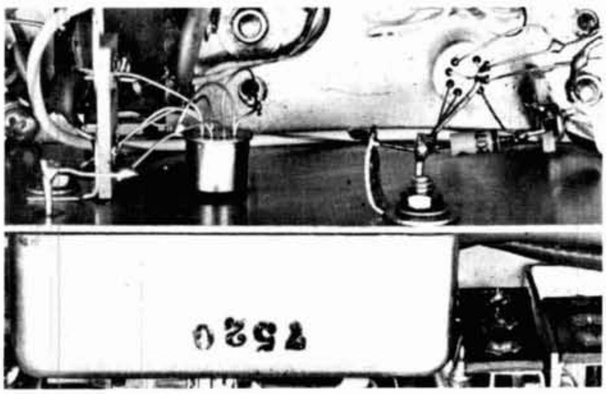
One topic that has received considerable attention by amateurs in recent years has been that of receiver performance and design. Many approaches have been covered, from the initial design of the "super receiver" to modification of existing equipment; but to the person with just a casual interest, the reasons behind some designs may not be readily apparent. In fact, the problems themselves may not be noticeable to the ordinary amateur. This article is another in a continuing series that shows you how to recognize the problems in typical modern receivers; in addition, it discusses modifications applied to one receiver and the motives behind these changes.

Of major importance is the reason for the modification. The intent of this article *is not* to prove that one particular receiver is superior to another for whimsical reasons, but to realistically and fairly compare different receivers by presenting test results on comparable circuits. On the basis of the test results, design changes were made in one receiver in an attempt to improve overall performance. You will notice while reading the article that the results are given in very specific terms; this will help you to better understand the basics of receiver performance standards. With this knowledge, *you* will be able to judge the merits of the different receivers on the market and choose one according to your own needs. **Editor** volts rms; even if this level could be produced in a low noise mixer, which is highly unlikely, the filter could be damaged.

What actually results when there are two undesired signals at S9 + 40 dB with the correct frequency relationship, over loading the second mixer, is a spurious third-order IMD signal that is greater than S9 in strength. This would certainly be strong enough to obliterate the desired weak signal!

One possible reason why such net-gain design errors are overlooked is our present method of testing receiver dynamic range. This subject has received considerable attention lately in *ham radio*[1,2,3] and *QST*.[4] An increasingly popular method of testing for dynamic range has been developed by Wes Hayward, W7ZOI, and is used by the ARRL.[5] Basically, it consists of applying two *well-isolated*, equal-strength signals, 20-kHz apart, to a receiver's input and then adjusting their level so that the undesired third-order IMD products generated within the receiver are just equal to the noise floor of the receiver. The difference in level between the noise floor and the test signals gives the receiver's dynamic range. The higher the receiver's dynamic range, the better it can handle both desired weak and undesired strong signals at the same time.

The choice of 20-kHz spacing for the two test signals is arbitrary and in many cases satisfactory. In a receiver which has all its significant selectivity far down the i-f chain, this signal spacing is relatively unimportant. If the early-stage bandwidth is narrower than the test signal spacing, however, its selectivity will partially or completely reject one or both of the test signals, resulting in a highly inflated dynamic range reading. We feel these measurements should cover worst-case conditions since real-life interference on the amateur bands may be spaced less than 20 kHz.



Installation of the 600-Hertz first i-f filter. The filter is installed on a vertical shield near the original 8-kHz filter. The devices with 8 leads are TO-5 size relays that are used to select the appropriate filter.

Third-order IMD products, with 20-kHz spacing, will occur 20 kHz below the low frequency test signal and 20 kHz above the high frequency test signal. When the receiver is tuned to a third-order internally-generated spurious IMD signal, the test signals are 20 and 40 kHz up or down the band. The 25-kHz-wide crystal filter in the first i-f of the Signal-One transceiver, to name just one example, will greatly attenuate the test signals before they can reach the following stages. Thus, 20-kHz spacing will test only the front end and first mixer. What is needed is spacing narrow enough so that both test signals can pass through any selectivity prior to the narrow filter. We feel a spacing of 2 kHz will satisfy this requirement, and at the same time be wide enough so the narrow filter will adequately reject the test signals when the receiver is tuned to an IMD product.*

The Drake R-4C, with its 8-kHz-wide first i-f filter, shows an inflated 20-kHz dynamic range of 83 dB. This reading has remained quite consistent over several receivers, including one we tested at the ARRL laboratory.† When the test signals are placed 2 kHz apart, however, so they *both* pass through the 8-kHz filter, the dynamic range drops to around 58 dB.

improving receiver performance

There are three ways to improve a receiver's dynamic range. If the second mixer cannot handle the required level, one option is to replace it with a mixer that will do the job. Unfortunately, as WB4ZNV discovered,[6] the process of replacing an active mixer with the superior passive double-balanced mixer is a laborious task, even if it does improve the receiver's overload characteristics. Oscillator injection levels and impedances are usually not compatible with existing circuitry.

Another remedy is to redistribute the gain in the receiver, reducing it ahead of the overloaded stage and building it up again after the narrow filter. A third method is to insert more early-stage selectivity into the receiver so strong interfering signals are not as likely to get past the first mixer. We chose to inves-

*When performing a 2-kHz IMD test, one very important factor must be taken into consideration: the noise sidebands of the signal generators. General test equipment, oscillators, or VFOs are more than adequate for testing, until a receiver's dynamic range nears 100 dB. At this point it will be impossible to accurately measure true receiver IMD products if the signal generators are producing excessive low-level spurs and noise. At this time there are only two or three generators that have the necessary sideband suppression; one manufactured by Hewlett-Packard and another by Rohde and Schwartz.

†The ARRL laboratory uses a pair of AN/URM-25 signal generators to perform IMD tests. A 2-kHz IMD test produced results within 2 dB of those obtained by the authors while using the high quality, low-noise sideband Rohde and Schwarz XUA signal generator.

tigate the latter two options, using our own R-4Cs.

The initial gain redistribution began with a 20-dB reduction of the signal level as seen by the second mixer. This gain loss was then restored after the narrow filters at the high-impedance grid of the third mixer. The original amplifier used a single jfet plus a step-up transformer to provide the necessary gain, but the circuit suffered from instability problems and noise. It was then decided to relocate the added gain outboard from the receiver and insert it at a convenient 50-ohm point, the output of the switchable second i-f crystal filters (see **fig. 1**).

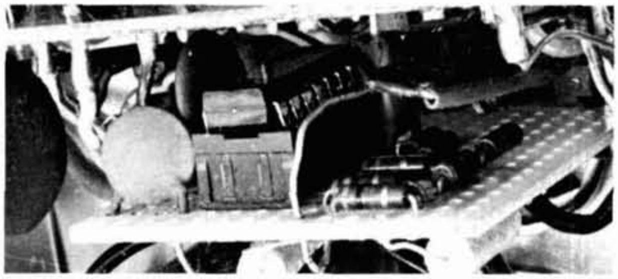
A cascode jfet amplifier, with 50-ohm input and output impedances (**fig. 2**), was built and inserted into the i-f chain just prior to T-6. The coax cable that connects T-6 and the mode switch was lifted at the switch end; two lengths of miniature coax (RG-174/U) were then run out through a slot in the rear of the receiver. The first length is connected to the lugs on the mode-switch wafer, while the second is spliced into the cable that feeds the transformer.

This amplifier can possibly be located inside the receiver. Regardless of its location, it should be mounted in a metal box or other well-shielded enclosure. Two toroidal transformers provide the necessary impedance changes, their associated trimmer capacitors forming resonant circuits. While both trimmers can simply be peaked for maximum signal, the input may be fine-tuned for the best compromise signal-to-noise ratio among the switchable narrow filters. (The 2N5950 and 2N5953 jfets may be purchased from G. R. Whitehouse Company, Amherst, New Hampshire 03031).

We found the best way to attenuate the signal level into the second mixer was to swamp the output of the first i-f amplifier Q1 (V3/6BZ6 in early receivers). A miniature 5000-ohm multi-turn trimmer, from noise blanker socket pin 4 to ground, made a convenient way to adjust this level. Simply adjust the trimmer to drop the calibrator signal 20 dB on the S-meter; then adjust the gain pot on the cascode amplifier to restore the S-meter to its previous level. On certain receivers it may be necessary to peak T-6 to obtain 20 dB of gain from the cascode amplifier; always readjust both cascode trimmers after making a gain change.

If the noise blanker is installed in the receiver, significant IMD products can occur in its stages, too. Due to noise limitations, however, the blanker cannot be starved a full 20 dB. Instead, after replacing blanker resistor R1 with a 0.001 μF disc capacitor, reduce the gain to the blanker about 12 dB, and then turn down the blanker output pot 8 dB to achieve the 20 dB reduction at the second mixer. Alternately, the gain of blanker transistor Q2 can be decreased by reducing its emitter resistor bypass capacitor, rather than readjusting the blanker output pot.

Take care not to use too much cascode amplifier or blanker gain; otherwise amplified 5645-kHz oscillator leakage can degrade system performance. With the antenna disconnected and the top and bottom covers of the receiver in place, make sure the S-meter does not kick upward more than one-quarter S-unit when the passband tuning is slowly turned through its range. In some receivers it may be necessary to jumper the cable-braid ground point of the Q4 oscillator board with a short clip lead to the shield tray on which the blanker board rests to reduce this oscillator leakage to an acceptable level. It might also be necessary to insulate the frame of the rear carrier-oscillator jack from the chassis ground.



The new product detector is installed next to the audio transformer and behind the variable capacitor used for passband tuning. The entire assembly is mounted on a 1-3/4 x 1-5/8 inch (4.5x4.1cm) board.

Also, if the cascode amplifier breaks into oscillation when the mode switch is between detent positions, reverse the leads of a high impedance winding of one of the toroids.

Proper operation of the gain redistribution circuits provided greatly reduced susceptibility to IMD overload problems on both CW and ssb, as was visibly demonstrated with strong nearby DX contest signals; yet the receiver was still able to meet its sensitivity specification. Agc attack distortion was also reduced somewhat. Dynamic range improved from 58 dB to around 70 dB, while using our 2-kHz spacing test method.

i-f filters

As an additional CW remedy we chose to increase the selectivity (possibly on a switchable basis) following the output of the first mixer; the bandwidth is presently determined by an 8-kHz wide four-pole crystal filter. This bandwidth is needed on phone to pass an upper and/or lower sideband signal. A bandwidth of at least this magnitude is also required to pass undistorted noise pulses to the blanker. A noise blanker's usefulness, however, is marginal at best with one or more strong nearby signals, due to its agc greatly increasing the blanking threshold, or possible false triggering. Thus, the need for narrowing first i-f selectivity ahead of the noise blanker, which reduces blanker effectiveness, occurs under conditions which are usually unfavorable to blanking in the first place.

Circumstances could occur where blanking would be necessary at all times, such as when you suffer from a continuous very high level of blankable noise. In these cases, the 8-kHz first i-f filter must remain ahead of the blanker. Then a properly-terminated narrow filter could be inserted just *after* the blanker, but before the second mixer. The signal path can be switched between the narrow filter and an attenuator equal to its loss. While the chance of second mixer overload is greatly reduced with this arrangement, there is no such narrow bandwidth IMD protection for the blanker; this limits the receiver's potential dynamic range considerably below what is otherwise obtainable. It is therefore mandatory to use the cascode gain redistribution system with this special, optional filter arrangement. With this arrangement close-in dynamic range will be in the high 70s.

We decided that the first i-f CW selectivity should be equal to the widest desirable under contest conditions. We then designed a new 600-Hz six-pole filter, keeping in mind package size limitations and insertion loss requirements. We've also developed a miniature relay system which allows instant interchange of our internally-mounted, CW-bandwidth, first i-f filter with the existing 8-kHz phone unit.

The project of minimizing overload in the R-4C was now complete and totally successful. When measured using our worst-case 2-kHz test method, the receiver's dynamic range jumped from an original unacceptable 58 dB to a final excellent 85 dB. This value ranks with the best of the commercially-available amateur gear on the market today, and

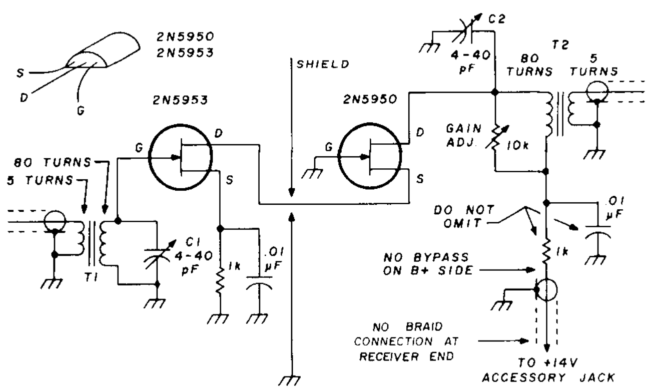


fig. 2. Schematic diagram of the cascode amplifier used for the gain redistribution. There is only one ground return on the circuit, through the input coax cable. The braid on the output coax cable goes to the primary of T6 which is not grounded at that point. T1 and T2 are wound on Micromet-als T-50-2 toroidal cores. The high-impedance windings are 80 turns of no. 30 AWG (0.25mm) while the low-impedance windings are 5 turns of no. 24 AWG (0.5mm).

should be more than adequate for most practical situations. As a side note, a similar arrangement of first i-f filter switching can be used on ssb by inserting a set of 2.6 or 2.3-kHz phone filters in the first i-f for improved phone selectivity.

simple receiver testing

While we made use of a considerable amount of test equipment during this project to measure dynamic range, you can make comparative tests using only a crystal calibrator and transmitter vfo, *loosely* coupled into the receiver. Comparative noise floor measurements, with no antenna connected, can be made by measuring the preselector noise peak (above later stage noise) with an ac voltmeter connected to the audio output line.

When making gain redistribution or selectivity changes, adjust the receiver to maintain its original net gain by measuring the calibrator level on some specific frequency. We use 7.2 MHz as our reference frequency. Here the calibrator level should read about 15 to 20 dB over S9 with nothing connected to the antenna input. (Don't readjust the S-meter sensitivity pot.) Two strong test signals, accurately set to a specific S-meter level, will produce a repeatable reference IMD that can also be measured on the S-meter. As improvements are made the IMD, read on the S-meter, will drop. We made our 2-kHz tests at S9 + 40 dB, and ended up reducing the IMD from greater than S9 to less than S3.

filter rejection

The 600-Hz first i-f filter, in addition to greatly reducing the chance of overload, had the extra benefit of eliminating the annoying signal leakage around the narrow second i-f filters. This problem of not being able to realize the ultimate rejection capabilities of a well-designed filter is one that plagues all equipment that, to our knowledge, is presently on the market. It is really quite difficult to even design a test fixture to correctly measure the ultimate rejection of a filter. Obtaining adequate ultimate attenuation, which should be in excess of 100 dB for an eight-pole filter in a receiver or transceiver, requires tedious attention to detail. Current ground loops and stray capacitive coupling are the main problems that must be eliminated. We have had many frustrated amateurs ask us to provide a filter for their receiver or transceiver which would not leak like the factory installed units. Unfortunately, some of the limitations were in the receiver and not the filter. Although replacing or adding to an existing *late* narrow filter can often considerably improve skirt selectivity, the only way to eliminate the last traces of these leakage problems, in existing popular receivers, is to add a filter earlier in the set with a bandwidth closer to that of the main filter. The early filter should preferably be on a different frequency from the later one, such as in the R-4C or 2B.

We tested one all-solid-state American transceiver that had so much leakage around the CW filter that a 2-kHz dynamic range test could barely be made. The IMD was masked by the test signal leakage until special audio filtering was employed.

While discussing filters, we would like to emphasize the importance of a great variety of bandwidths being available to the operator. Most of the equipment on the market has just one standard phone bandwidth, with one CW filter available as an option, and when installed it must be used at all

with this trade-off, there is an additional insertion loss of 5 to 7 dB compared to the phone filter, and relatively poor skirt selectivity.

As a minimum, the receiver net gain should be designed around the lossiest filter, with the losses of the other filters increased to that constant level. Another school of thought suggests that the noise integrated by each of the filters should be the same, requiring increasing gain (or decreasing insertion loss) as narrower filters are selected. To our knowledge, no amateur equipment manufacturer is currently keeping the integrated noise constant, and only the R-4C provides for constant insertion loss with narrow bandwidth filters.

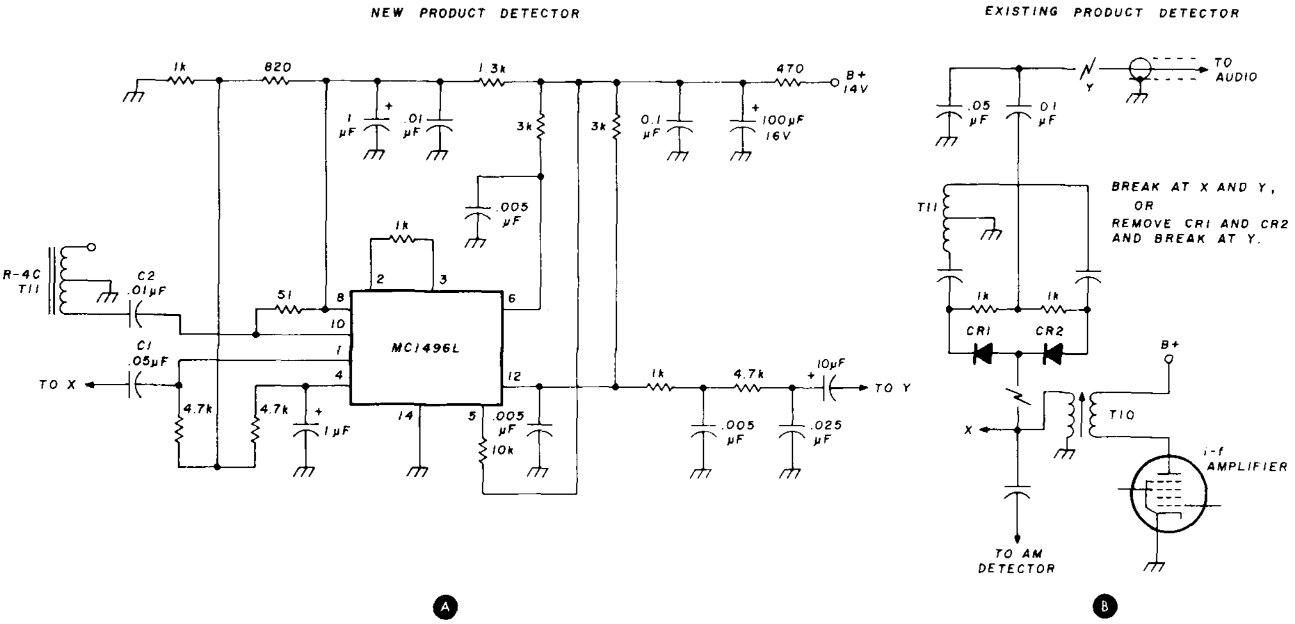


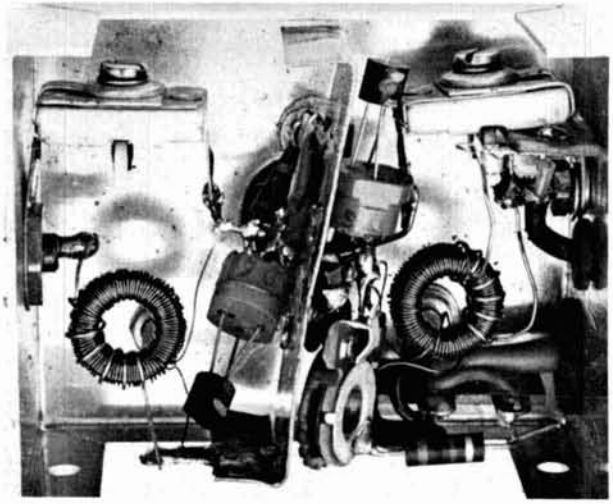
fig. 3. The MC1496L can be used as a product detector as shown in A. The IC plus associated components are mounted on a small circuit board which is installed next to the audio transformer in the receiver. C1 and C2 are critical values and should not be substituted. For smaller size, the 1-μF capacitors may be tantalum. B shows the interconnections between the detector and the receiver.

times for that mode. Many of the imported rigs are examples of these limitations. The Yaesu FT-101B has only a six-pole 600-Hz filter, and the Kenwood TS-820 is limited to only a six-pole 500-Hz unit.

By today's standards a six-pole 500-Hz filter is quite broad and has a poor shape factor. One possible reason for offering only these filters is that the design of the equipment was based on the use of an ssb filter having an insertion loss of only 2 to 4 dB. Unless a manufacturer employs special technology in building, say, an eight-pole 350-Hz filter that is more advanced than required for a phone filter, the insertion loss will rise to an unacceptable 14 to 16 dB. It is quite undesirable to have the signal drop 12 dB when the CW filter is used; a compromise is made, and the six-pole filters mentioned above are offered. Even

We have noted with interest the comments from some of our Japanese and German filter customers about American rigs such as the R-4C and T-4XC. The cost of these units in their home countries, due to import duties, is 30 to 50 per cent higher than here in the United States, but the discriminating foreign amateur is willing to pay that premium partly because of the excellent filters which are available. Compared with the typical filter in the average set, the Drake eight-pole 250-Hz and the Sherwood eight-pole 125-Hz CW filters are valuable assets. Similarly, an optional 1500 to 1800-Hz ssb filter* can make the dif-

*Drake also offers the FL1500, a 1500-Hz filter. Though publicized as an RTTY filter, it provides exceptional performance, especially under difficult phone contest conditions. **Editor.**



Cascode amplifier used for gain redistribution is installed in a small enclosure. The shield must be in place between the stages of the amplifier.

ference in being able to hold a contact under heavy interference and contest conditions.

It takes some practice to become proficient at using a narrow i-f filter, just as in learning to tune with the wide-skirted audio filters. But during crowded band conditions a 250-Hz filter can often be too broad! One CW operator used the 125-Hz filter in his R-4C almost exclusively during the hectic 160-meter contests.

The entire line of filters for the R-4C is excellent and can be adapted to any receiver or transceiver. A construction article in the 1977 ARRL *Handbook*[7] describes a method of adding bandpass tuning to a receiver lacking this feature. This circuit uses 455-kHz filters and is inserted in the receiver i-f chain by converting down to 455 kHz and back up again. This basic idea can be used with any pair of filter and receiver intermediate frequencies.

You could convert from 3395 kHz up to 5695 kHz and back down again, for example, or down from 9 and up again. As the difference between the two i-f frequencies becomes smaller, the difficulty of the conversion process increases. A Drake R-4B owner who wishes to add R-4C filters to his receiver has to cope with a conversion frequency difference of only 50 kHz. Howard Sartori, W5DA, has developed a circuit for use in his R-4B which can be adapted to any i-f by simply changing one crystal oscillator. It has been used on intermediate frequencies as low as 50 kHz and as high as 30 MHz with excellent results. His circuit is described on page 20 of this issue of *ham radio*. One precaution, when adapting the *Handbook* circuit or W5DA's i-f converter to a transceiver: make sure the transmitted signal does not have to pass through the added filters. Otherwise, with use of the two narrowest filters (the FL-250 and CF-125/8), the transmitter carrier offset frequency adjustment would become quite critical, and keying on the transmitted signal could be too soft.

The Kenwood TS-820, which we have in the lab, has a noise floor and dynamic range in the ssb mode that is virtually identical to that of the Drake R-4C. Both units perform very well on phone; when you want to dig out a weak CW signal on a quiet band, however, the R-4C is significantly better. The R-4C's gain remains constant when a CW filter is switched in, but the TS-820's drops off 5 to 6 dB. Even if a weak received signal is above the noise floor, this gain reduction increases the agc threshold to the point where it may become necessary to manually ride the gain control. The Yaesu FT-101B we tested had a dynamic range, at any test signal spacing, as bad as the unmodified R-4C when measured with the *worst-case* 2-kHz test method. The bulk of the problems in the FT-101B were caused by a bipolar transistor in the noise blanker which was being overdriven.

A receiver's maximum net gain from the antenna to the detector can change significantly from band to band without having much effect on the measured sensitivity. Two sets with similar signal requirements for a given signal-to-noise ratio can have vastly different capabilities in handling weak, fluctuating signals, especially on the 10- and 15-meter bands. As the net gain falls off, more and more signals will fall below the agc threshold. The R-4C, for instance, holds a much more consistent net gain from 80 to 10 meters than the TR-4C. The TS-820 increases the net gain on 10 meters compared to 20 and 15 by changing a capacitive tap on the rf amplifier drain. Its gain, however, is too high on 160 meters, resulting in a higher susceptibility to overload by broadcast stations. When connected to a nearly self-resonant 160-meter vertical antenna at our lab in Denver, the TS-820 grossly overloads with the eighteen local broadcast stations, developing more than 1 volt across its antenna input. Without the 20-dB rf attenuator switched in, the 160-meter band is nothing but a solid mass of S9 + 30 dB IMD products.

The TS-820's front end is not selective enough to cope with this admittedly unusual receiving situation. On 1.8 MHz, the preselector attenuates signals that are 100 kHz off frequency by 18 dB. In comparison, the R-4C attenuates these same signals by 38 dB. On 3.6 MHz, the TS-820's front end is down 8 dB at 100 kHz off frequency, the TR-4C by 12 dB, and the R-4C by 24 dB. When tested on 10 meters, the *500*-kHz attenuation is 8 dB on the TS-820, 8 dB on the TR-4C, and 15 dB on the R-4C.

One way to eliminate the need for a sharp preselector is to use an up-conversion scheme, with the first i-f above 40 MHz. The input may only need a bandpass filter that rejects signals below 1.8 and above 30 MHz. Then image signals would fall above 80 MHz and be virtually eliminated by the bandpass filter. The first mixer must have a much greater signal-handling capability than in present receivers, however, because it would see all stations between 1.8 and 30 MHz. Two strong local signals, one on 14 and the other on 21 MHz, could produce a 7-MHz IMD product.

The R-4C and the TS-820 show a 20-kHz test-signal-spacing dynamic range in the ssb mode of about 80 dB when tested on 20 meters. At this frequency, the preselectors do not significantly enter into the dynamic range test, since they will not attenuate the test signals more than 1 dB. This is not the case on 160 meters, especially with the R-4C. Here, its high-*Q* front end attenuates the 20-kHz signals enough to raise the dynamic range by 12 dB. On the other hand, some receivers have too much gain on 80 and 160 meters which, even with sharp preselectors, could yield a dynamic range no better (or even worse) than on 20 meters.

While the 20-kHz dynamic range of the R-4C improves on the lower frequencies because of its preselector, the 2-kHz dynamic range measurement remains quite constant at just under 60 dB. Similarly, it is consistently above 83 dB with the 600-Hz first i-f filter that cures its *window* overload problem. The TS-820 does not have this *window* problem since it is a single-conversion design and has no overloadable stages between the wide noise blanker filter and its narrow filter. Any improvement in dynamic range with increasing frequency separation of the test signals can only be attributed to its preselector.

A detailed review of the TS-820 in *CQ-DL*,[8] far more comprehensive than anything published in this country, showed a 6-dB improvement in dynamic range as the test signal spacing was increased from 2 to 50 kHz. It is interesting to note that *CQ-DL* also feels that a close-in 2-kHz spacing is necessary for proper evaluation.*

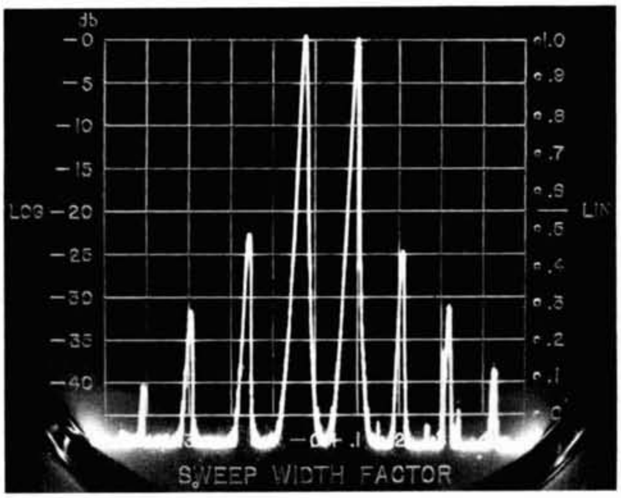
The Atlas 210X, without its noise blanker operational, has a better than average dynamic range of about 90 dB, which would be even better if its double-balanced mixer were properly terminated above the i-f frequency.[2] This could be accomplished with the use of a diplexer, as described by Wes Hayward,[4] or with a power jfet, as related by Ulrich Rohde.[2,3] There is one limitation in the 210X that cannot be easily remedied, however; its potential strong-signal handling capabilities cannot be fully realized due to its noisy conversion oscillator. Since this oscillator has noise sidebands that are only 65 dB down 10 kHz on each side of its center frequency, all the signals passing through the mixer will take on similar noise sidebands. Consider a strong station near a desired signal that is weaker in amplitude. Reciprocal mixing of oscillator noise can cause noise sidebands to be transferred to the strong nearby station and cause interference to the desired signal. Thus, even if the i-f filter's ultimate rejection is actually realized in the receiver circuitry, which is doubtful in practice, this high level of rejection can be negated by wide-band mixer noise. So while it takes two strong signals to cause IMD which can interfere with weak signal reception, a noisy oscillator and one strong signal can cause the same unfortunate results.[9]

The noise blanker in the Atlas 210X also degrades its dynamic range, diminishing the advantage of the double-balanced passive mixer. The 210X transceivers we tested had a dynamic range of between 73 and 81 dB, depending on the band selected. When the blanker was turned on, these numbers dropped by 3 dB.

There is little reason for a noise blanker to include additional gain stages which can degrade receiver performance. The TS-820 has only a 4-diode balanced blanker gate in its i-f chain; therefore, it does not reduce the overload capability or significantly increase the noise floor. Alternately, a balanced mixer or push-pull i-f stage can be gated for noise blanking; this requires no additional gain stages in the signal path.

product detectors

Another area that could use additional work is that of the product detector. As the name implies, its output should be the product of the two input signals. If



IMD generated at the output of the R-4C second mixer by two 5 mV signals at the antenna input. The signal spacing was 2 kHz. The receiver was tuned so that the narrow second i-f filter was positioned away from any test signals or IMD products. Therefore, with no signal reaching the AGC, the receiver gain is at maximum and the S meter reads S1.

*A recent independent measurement by DJ2LR showed the intercept point of the TS820 to be − 12 dBm.

BFO injection is removed, output should go to zero. If this is not the case, as in the Heath HW series, envelope detection is also occurring, which causes audio distortion. On the other hand, the 6GX6 product detector in the Drake R-4, TR-4, and TR-4C, and the 6BE6 in the Drake 2A and 2B, works very well.

Other extraneous outputs can occur even if the detector is acting solely as a product mixer. A detector should be a double-balanced, or other arrangement, which provides good isolation between input and output. The two-diode detector in the R-4B and R-4C is not a double-balanced design and allows the detected audio to leak back and envelope modulate the last i-f stage. This resultant signal is detected in the agc, which then tries to follow it at an audio rate, especially (but not only) when the faster time constants are in use. This audio output sounds slightly distorted, and is noticeable on ssb as well as CW. In addition, BFO injection is marginal, causing additional distortion on AGC attack.

We decided to replace the product detectors in our R-4C receivers, but wanted to use a device that was compatible with the existing drive and impedance levels. The MC1496L active double-balanced mixer looked like a good choice, and with minor circuit changes from the data sheet, was installed in the receiver. The modulation of the i-f by the detected audio was eliminated, resulting in cleaner sounding audio. AGC attack distortion was further reduced.

The MC1496's main drawback is its high number of associated components. Eleven 1/4-watt resistors, nine capacitors, and the IC had to be squeezed on a 1-3/4 by 1-5/8 inch (4.5x4.1cm) board which was nestled between the audio output transformer and the adjacent PC board (see **fig. 3**). All R-4C owners, whether they change product detectors or not, should add a 0.0015 μF capacitor across R83 in the audio amplifier. This corrects a phase error in the feedback circuit, and eliminates an undesirable peak in the audio frequency response which accentuates harmonic distortion. The Kenwood TS-820 and the Atlas 210X both use a double-balanced diode product detector that works quite well, and needs considerably fewer parts, but they are low-impedance devices not easily adapted to some circuitry.

conclusions

We have discussed several popular receivers and noted some of their strengths and weaknesses. Some problems can be corrected in the field, while others go beyond the scope of a weekend project. We've also investigated two ways to improve a receiver's susceptibility to overload, so that it can better handle today's high-level rf environment: redistributing the gain and increasing the early-stage selectivity with an additional filter. The importance of having a wide choice of adequate narrow filter selectivity, without leakage, was also mentioned. While most of our circuit changes have been applied to one specific popular receiver, the Drake R-4C, the ideas can be extended to other sets. A method of checking a receiver's overload capabilities which requires no test equipment was also described. Thus receiver changes can be evaluated as to their effect on dynamic range.

The real key to how a receiver performs is its net gain distribution, particularly in relation to the location of selectivity determining elements. A receiver must have a great deal of gain from its antenna to the speaker to be able to receive weak signals. But if too much gain is placed ahead of a narrow filter, the receiver is bound to overload and generate interference of its own.

How a receiver will perform in real-life situations can be determined in the lab, but only if it is tested in a manner that approximates the real world. We feel that the present 20-kHz signal-spacing method can be quite misleading, and should be augmented with our 2-kHz test procedure. If the two readings are significantly different, then further investigation is warranted.

As we stated at the beginning of this article, receivers have improved in many ways, especially over the past 15 years; at the same time, dynamic range has diminished. Amateur radio operators should be demanding excellence in this critical parameter. Improvements in receiver versatility need not reduce system performance, as we have so often observed. Potential problems can be eliminated in new equipment by state-of-the-art design or by retrofitting existing receivers. All that will be lost is some internally-generated rf interference!

references

1. James R. Fisk, W1HR, "Receiver Sensitivity, Noise Figure and Dynamic Range," *ham radio*, October, 1975, page 8.
2. Ulrich L. Rohde, DJ2LR, "High Dynamic Range Receiver Input Stages," *ham radio*, October, 1975, page 26.
3. Ulrich L. Rohde, DJ2LR, "High-Frequency Receiver Design," *ham radio*, October, 1976, page 10.
4. Doug DeMaw, W1FB, "His Eminence — the Receiver," *QST*, June, 1976, page 27.
5. Wes Hayward, W7ZOI, "Receiver Dynamic Range," *QST*, July, 1975, page 15.
6. Alex J. Burwasser, WB4ZNV, "Reducing Intermodulation Distortion in High-Frequency Receivers," *ham radio*, March, 1977, page 16.
7. Anthony Dorbuck, W1YNC, editor, *The Radio Amateur's Handbook*, American Radio Relay League, Newington, Connecticut, 1977, page 271.
8. Thomas Moiere, DL7AV, "Testbericht: Transceiver TS820," *CQ-DL*, (Germany) April, 1977, page 130.
9. Wes Hayward, W7ZOI, "A Competition-Grade CW Receiver," *QST*, March, 1974, page 19.

ham radio

Compare the Atlas 350-XL with other transceivers . . .

TYPE	ALL SOLID STATE			HYBRID (VACUUM TUBE P.A.)			
MODEL	ATLAS 350-XL	TEN TEC	YAESU FT-301	DRAKE TR4-CW	HY-GAIN 3750	KENWOOD TS-820	TEMPO 2020
INPUT POWER	350 WATTS	200	200	300	200	200	180
BANDS	10-160M	10-80M 160M OPT	10-160M	10-80M	10-160M	10-160M	10-80M

. . . and see why it's your best buy!

Above is a chart comparing leading HF Transceivers that fall in approximately the same price range as the Atlas 350-XL. The Drake TR4-CW is least expensive, while the HY-Gain 3750 is the highest. Rated power input (SSB) and bands covered are listed in the chart, but below is a discussion on a number of other interesting comparisons which will help you choose the right transceiver for your station.

1. STATE-OF-THE-ART, ALL SOLID STATE

The first 3 transceivers listed above are all solid state. The real designs of the future! Having manufactured and sold over 12,000 of our little 210x/215x's, we can attest to the high performance and reliability of all solid state design. Tubes for the driver and P.A., with their tuning circuits and high voltage power supplies are rapidly becoming obsolete. As a result their resale value will be declining.

2.POWER RATING.

The higher power rating on the 350-XL provides you with a comfortable edge over the others. Running barefoot you can easily ride over the competition. If you're driving a linear you don't have to *strain for every bit of drive from the transceiver.* It can loaf along with ease. The 350 watt input rating is really very conservative. Typical input power runs upwards of 400 to 450 watts without flat-topping. Considerably more than the others.

3. BAND COVERAGE

Not only does the 350-XL cover the 10 through 160 meter bands (including all of 10 meters in four 500 kHz segments), but one of its exclusive features is that you can install up to 10 auxiliary 500 kHz ranges anywhere from 2 to 5 MHz, and from 6 to 23 MHz. This gives you great flexibility for MARS operation and possible future amateur bands. Crystals for Auxiliary Ranges are installed internally. In addition, the 350-XL provides reception of WWV at 5, 10, and 15 MHz, without having to add any auxiliary range crystals.

4. DIGITAL FREQUENCY READOUT

On the 350-XL, the optional Digital Dial can be installed, and you still retain the conventional analog dial, with the option of switching the digital dial off if you wish. With the Ten-Tec or Yaesu 301, you lose the analog dial if you purchase the digital dial model, making you totally dependent on the digital dial.

5. FULL BREAK-IN CW

Only two rigs offer this feature; the Atlas 350-XL and the Ten-Tec ! The others are all "semi-break-in". And the Atlas includes CW sidetone with pitch and volume adjustments.

6. NARROW BAND CW FILTER

This is another standard feature in the Atlas, optional on the Ten-Tec , Yaesu, and Kenwood. Ours is an *I.F. filter with 500 Hz bandwidth, and shape* factor of better than 3 to 1.

7. A.F. NOTCH FILTER

This 350-XL standard feature permits nulling out heterodynes and other interference. The Yaesu, Hy-Gain and Kenwood include a similar feature.

8.SPEECH COMPRESSION

The standard Atlas ALC system provides up to 20 dB of R.F. compression which increases your talk power and at the same time reduces "flat-topping" and splatter. An optional speech processor to pro*vide up to 20 dB additional A.F. compression will be* available soon for installation in the AC supply. The *Hy-Gain, Kenwood, and Yaesu also provide some* form of speech processing.

9. AUXILIARY VFO

All of the rigs listed offer an optional second VFO for split frequency operation. But Atlas is the only one with an Auxiliary VFO that is not an add-on box. The Atlas Auxiliary VFO plugs right into a space provided in the upper right hand corner of the front panel. Although miniature in size it tunes the same 500 kHz as the primary VFO, and does it smoothly with coarse and fine controls that have 10:1 planetary drives. Green, yellow, and red LED's let you know which VFO you have set up for receiving and transmitting. Very neat, and all self-contained.

An option to the Model 305 Auxiliary VFO is the Model 311 crystal oscillator that provides up to 12 crystal controlled channels. It also plugs into the front panel just like the 305. Vernier controls provide fine tuning of the crystal frequency.

10. MOBILE/PORTABLE OPERATION

The Atlas, Ten-Tec , and Yaesu, being solid state, are unique in that they will operate mobile or portable directly from a 12-14 volt DC battery. Also, the solid state rigs are considerably smaller and lighter weight than the hybrid rigs. The Atlas is unique in having a very handy plug-in mobile bracket for the 350-XL that makes it a simple matter to plug-in and go mobile.

11. OTHER 350-XL STANDARD

FEATURES include R.I.T., VOX, Crystal Calibration, ANL, and Noise Blanker.

Compare the Atlas 350-XL SSB-CW Transceiver with the others, and we think you'll agree the Atlas has everything you'll ever need in a transceiver. *And it's made in America.*

And let us not forget to mention Our Customer Service which is second to none. Just ask the ham who owns one.

★ **MADE IN AMERICA** ★

We're very proud that every Atlas transceiver is made right here in America, (as are the Ten-Tec and Drake). ***We think the American worker, and our employees in particular, are the most*** **talented, industrious people in the world. The quality and versatility of our transceivers are proof of this.**

And by using this American quality workmanship, advanced value engineering in design and ***manufacture, and rigid quality control,*** **the Atlas transceiver is not only competitively priced with the imports, but is actually a better value!**

★ ★

Merry Christmas and Holiday Greetings from all the gang at Atlas!

Model 350-XL (less options) . . . $995.
Model DD6-XL Digital Dial . . . . $229.
Model 305 Auxiliary VFO . . . . . $155.

ATLAS RADIO INC.

417 Via Del Monte, Oceanside, CA 92054
Phone (714) 433-1983
Special Customer Service Direct Line
(714) 433-9591

More Details? CHECK—OFF Page 150

an up/down filter converter — matches any bandpass filter to any receiver i-f

Design and construction of an up/down converter that will interface any crystal filter with any receiver i-f. A design example shows how to add a 125-Hz filter to the Drake R-4B

Ultimate receiver performance is viewed by most amateurs as a moving target, with increasing cost just one factor that keeps the target out of reach. New inventions and techniques are constantly being announced by the fast-moving electronics industry; yesterday's dream of an ideal receiver becomes history long before the final receiver payment is due. Giant strides in IC technology have made receivers comfortable and easy to use through the addition of synthesizers, diode switches, and frequency counters. However, most *real* receiver performance improvements, in terms of signal-handling capability and selectivity, are still to be made. The name of the game is picking the weak signal out of the interference caused by many nearby strong signals. Then receiver performance specifications such as third-order intercept point, dynamic range, receiver desensitization, and mixer overload suddenly come to mind.

One goal of modern high-frequency receiver design is to process the desired signal through the narrowest available filter, with the smallest number of active components. Maintaining a credible noise figure, however, tends to legislate against throwing out all of the active front-end components except the mixer.* While giant strides have been made in semiconductor development, filter technology has been advancing rapidly, too.

This article will discuss the use of available crystal filters and will show you how to easily add high-performance filters to receivers without facing the frustrations of mixer design — frequency conversion, loss of sensitivity, and degradation of dynamic range.

filter characteristics

A complete line of filters optimized at the same center frequency for CW, RTTY, ssb, and a-m, particularly the i-f in your receiver, is hard to find at a price you can afford, especially from a single manufacturer. Many receivers place the ultimate selectivity (that filter which passes the information bandwidth, such as a 2.4 kHz ssb filter) in the second i-f stage, or further down the active component chain than is desirable.

Frequently a receiver manufacturer does not offer filters which are optimized for RTTY or CW. If you find a filter with the desired response characteristics, chances are that it won't match the receiver i-f.

If you look to filter manufacturers who specialize in only crystal filters, you'll find that, within the past year or two, excellent crystal filters have become available that will optimize filtering for any mode of radio communications. The first stumbling block is the wide variety of filter center frequencies, typically

*Recent developments in solid-state mixer design actually permit the omission of all active stages prior to the mixer. It is now possible to obtain a mixer noise figure of 10 dB or less on the high-frequency bands. This will be sufficient for all but the most demanding reception requirements, such as OSCAR 7, Mode A on 10 meters. **Editor**

By Howard Sartori, W5DA, 721 James Drive, Richardson, Texas 75080

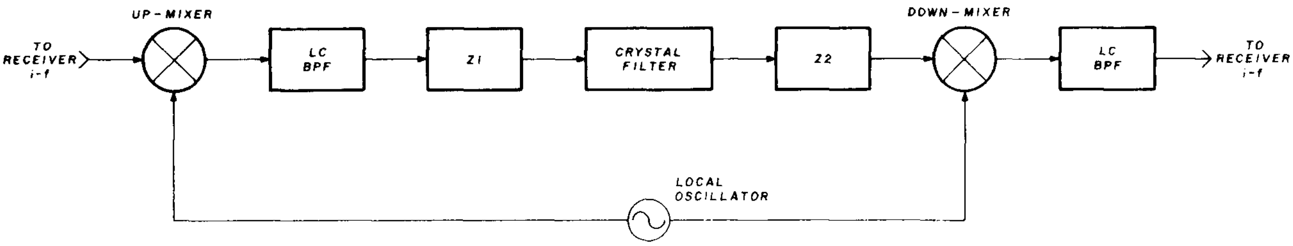


fig. 1. Block diagram of the up/down frequency converter for adding an additional filter to a receiver. Z1 and Z2 represent the impedance matching networks necessary to interface the mixers and filter.

in the range from 5 to 11 MHz. Rarely does one manufacturer produce a complete line of filters, optimized for the information bandwidth of each of the operating modes used by amateurs.

Cost has been a major factor in the past, but crystal filter production techniques have vastly improved and costs have turned downward. To put cost into perspective, and to consider the effects of inflation, excellent 8-pole crystal filters, with signal rejection *floors* below 100 dB, are now available for about the same price level as 4- and 6-pole crystal filters were about 5-10 years ago.

Describing a crystal filter by its shape factor, normally defined as the ratio of the 6-dB to 60-dB bandwidths, doesn't tell the whole story. This measure of squareness is typically 1.7 to 2.2 for a good quality ssb filter, the slope of the response curve in a simple filter is determined by the characteristics of the crystals. For a 2.4 kHz ssb filter with a shape factor of 1.75, for example, the attenuation/Δ frequency of the filter slope would be 54 dB/900 Hz. When narrower filters were designed, the bandwidth between corners was reduced but the slope remained essentially the same; a 500 Hz filter had a shape factor greater than 4.0. In fact, the bandwidth of the slope itself on one side of the ssb filter was wider than the 60 dB bandwidth of an optimized CW filter!

Eventually new fabrication techniques, such as mounting all crystals on the same header, permitted development of high-performance crystal filters. In some filters the entire passband may move as much as 2 Hz/°F, but this is not objectionable when the entire filter shape moves. To further illustrate the tremendous achievements in crystal filter technology that have occurred during the past several years, consider the 125-Hz CW filter now on the market. At one time, not too many years ago, 125-Hz crystal filters were a novelty of the laboratory. Today CW filters with 125-Hz bandwidths and shape factors of 2.5 are available for approximately $125.

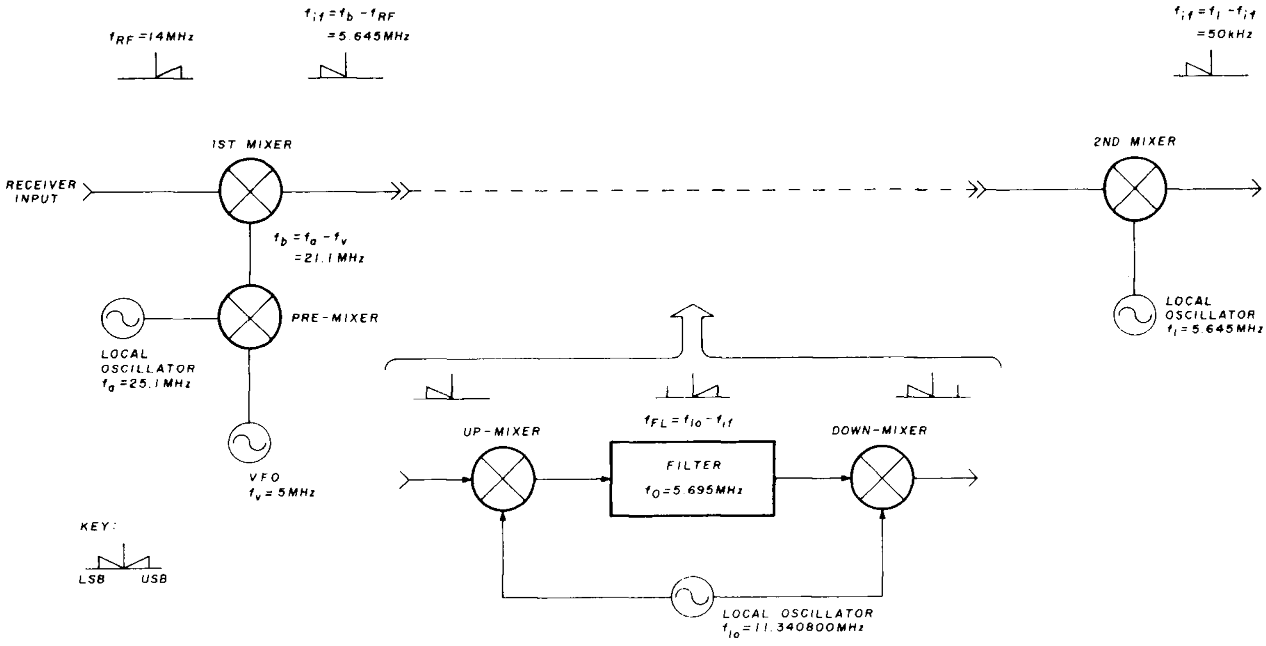


fig. 2. Block diagram of the Drake R-4B showing the receiver frequency conversion scheme. The conversion is necessary for the additional filter inserted between the first and second mixer. This diagram can be used to check for any sideband inversion.

By using the newer 8-pole crystal filters, receiver performance can be imoroved in the following ways:

1. Filters are optimized for the information bandwidth.

2. Signal-to-noise ratios are improved.

3. Filters placed as close to the front end as possible improve dynamic range.

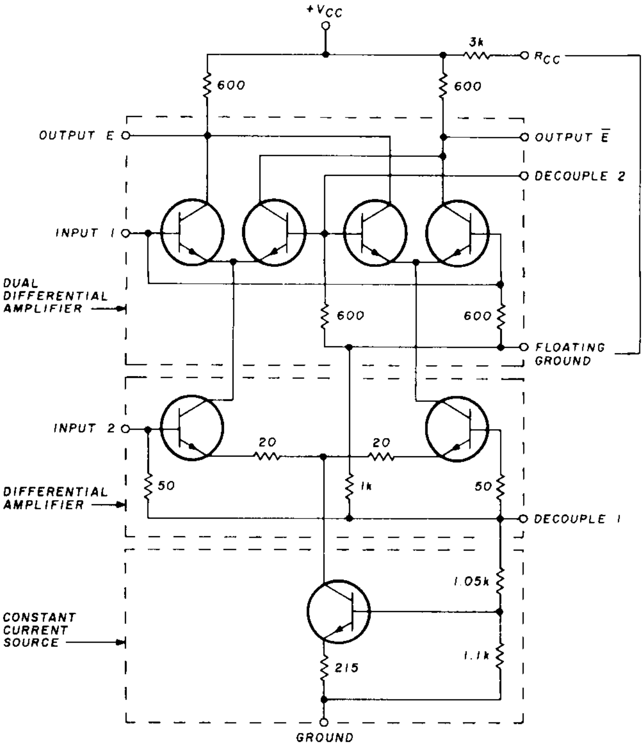


fig. 3. A representative schematic diagram of the Texas Instruments TL442 doubly balanced mixer IC. Input 1 has an input impedance of 600 ohms, while input 2 is 50 ohms. The output can be connected for 600 or 1200 ohms output impedance, depending whether the supply voltage is connected to $+V_{cc}$ or OUTPUT E.

4. Cascading with an existing filter to achieve better filter skirt and out-of-band performance.

When you optimize filters, you not only reduce susceptibililty to interference — you also reduce listener fatigue. Improved signal-to-noise ratios are particularly noticeable on the low bands for several reasons. First, if only an ssb filter is available for CW, when a 125-Hz bandwidth filter is switched into the circuit, the bandwidth improvement ratio will be 10 log 2400/125 or 12.8 dB. Even if a 500-Hz CW filter were available, a 125-Hz filter would improve the signal-to-noise ratio by 6 dB. In addition, by the very nature of impulse and static noise, the filter will prevent overloading the following stages; this means that the signal-handling ability of the receiver has been improved.

Some receivers have a nominal 2- or 4-pole filter in the first i-f, and the final selectivity in the second or last i-f stage. Obtaining all the needed selectivity at one i-f is difficult, however, because of signal radiation and leakage (even with the best shielding). By placing a high-performance crystal filter in the first i-f, overload of the second mixer can be greatly reduced. Further, spreading the selectivity over several stages is an excellent way to improve ultimate signal rejection.

Since the crystal filter you want to use will probably not agree with your receiver i-f, to say nothing of the input and output impedances, a convenient method is required to interface additional filters. Many receivers have a simple general purpose filter in the first i-f with an output impedance of 500 to 1000 ohms. This is an ideal place to add an outboard crystal filter.

Designing a conversion scheme can be a complicated process; consider all the variables. **Fig. 1** shows a block diagram of the general approach for heterodyning the first i-f signal up or down to a high-performance crystal filter, and then heterodyning back to the receiver. The first mixer (up converter) can easily overload; the down-mixer is not nearly as susceptible to overload. In addition, the local oscillator can act as a source of spurious radiation for birdies in the amateur bands. Since only one local oscillator is generally used for the two mixers, it may serve as the leakage path for the signal around the filter. Or, the local oscillator signal could feed through the down-mixer into the next i-f stage. And consider the fact that since almost all commercial crystal filters are in the 5 to 11 MHz frequency range, the receiver i-f and the crystal filter frequency should be very close.

Having both the receiver i-f, f_{if}, and the filter, f_{FL}, at nearly the same frequency is probably the leading cause for abandoning the project. Mixers not only mix; they can amplify. Therefore, if f_{if} cannot be filtered out by the LC bandpass filter (BPF) at the output of the up-mixer, overload may eventually become a problem because both signals could be substantially amplified. To make matters worse, the conversion process usually results in some loss of desired signal; as much as 30 or 40 dB difference between the two mixer output signals, f_{if} and f_{FL}, is not uncommon. As a result, the filter signal rejection floor is greatly diminished. If the two frequencies are within several hundred kilohertz, the isolation of f_{FL} by the bandpass filter may be as big a task as manufacturing the high-performance crystal filter in the first place.

Finally, the filter must be very carefully matched to the up-mixer output and the down-mixer input. These matching networks are shown in **fig. 1** as Z1 and Z2.

Selecting a frequency conversion scheme should be done with care. **Fig. 2** shows the first i-f signal, filter i-f, and local oscillator frequencies. It is well to consider the particular sideband, too, since sideband reversal may not be desirable. **Fig. 2A** shows the complete receiver conversion scheme, with the Drake R-4B used as an example. The sideband slope diagrams show the relative sideband with respect to the incoming rf signal.

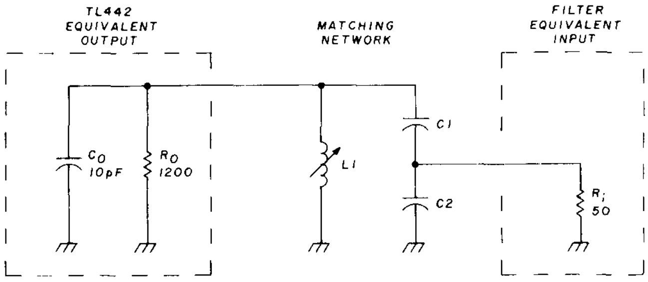
Fig. 2B shows how the up/down filter converter is integrated into the receiver's first i-f. Using the filter's center frequency, the required local oscillator frequency can be determined from $f_{LO} = f_{FL} \pm f_{if}$. The Sherwood Engineering CF-125/8* CW filter center frequency is 5695.0 kHz. Assuming an 800-Hz tone, the incoming frequency, f_{if}, would be 5645.0 +0.8 = 5645.8 kHz; the local oscillator frequency would be 5695.0 +5645.8 = 11340.8 kHz (or 5695.0 − 5645.8 = 49.2 kHz). The 11340.8 kHz frequency is, fortunately, not in any amateur band; but the 49.2-kHz local oscillator signal would fall within the passband of the receiver's second i-f! Therefore, 11340.8 kHz will be used as the local-oscillator frequency.

solving the problems

The close proximity of the receiver's first i-f and the crystal filter frequencies was the toughest problem to solve. Convenience and easy-to-do were words which guided this design project for more than six months. Building the LC filter at the output of the up-mixer, shown in **fig. 1**, however, was anything but easy. Combining it with the impedance matching network, Z1, was complicated and certainly not repeatable without diligent tuning. Doubly balanced mixers were considered, but many of them required large numbers of external components and even null adjustments.

Finally, a doubly balanced mixer IC was found that provides internal preset nulls in excess of 30 dB, for

*Sherwood Engineering, 1268 South Ogden Street, Denver, Colorado 80210.



$$R_i = \frac{R_O}{\left(\frac{C2}{C1} + 1\right)^2} \text{ OHMS}$$

$$Q_u > \frac{R_S}{2\pi f L} \qquad Q_L = \frac{R_S}{2\pi f L}$$

$$C_T = \frac{C1\ C2}{C1 + C2} + (C_O) \qquad L_1 = \frac{1}{(2\pi f)^2 C_T}$$

fig. 4. The capacitive tap-down network is used to match the up-mixer to the crystal filter. It can also be used to match a high-impedance first i-f stage to the 600-ohm input of the TL442 mixer IC.

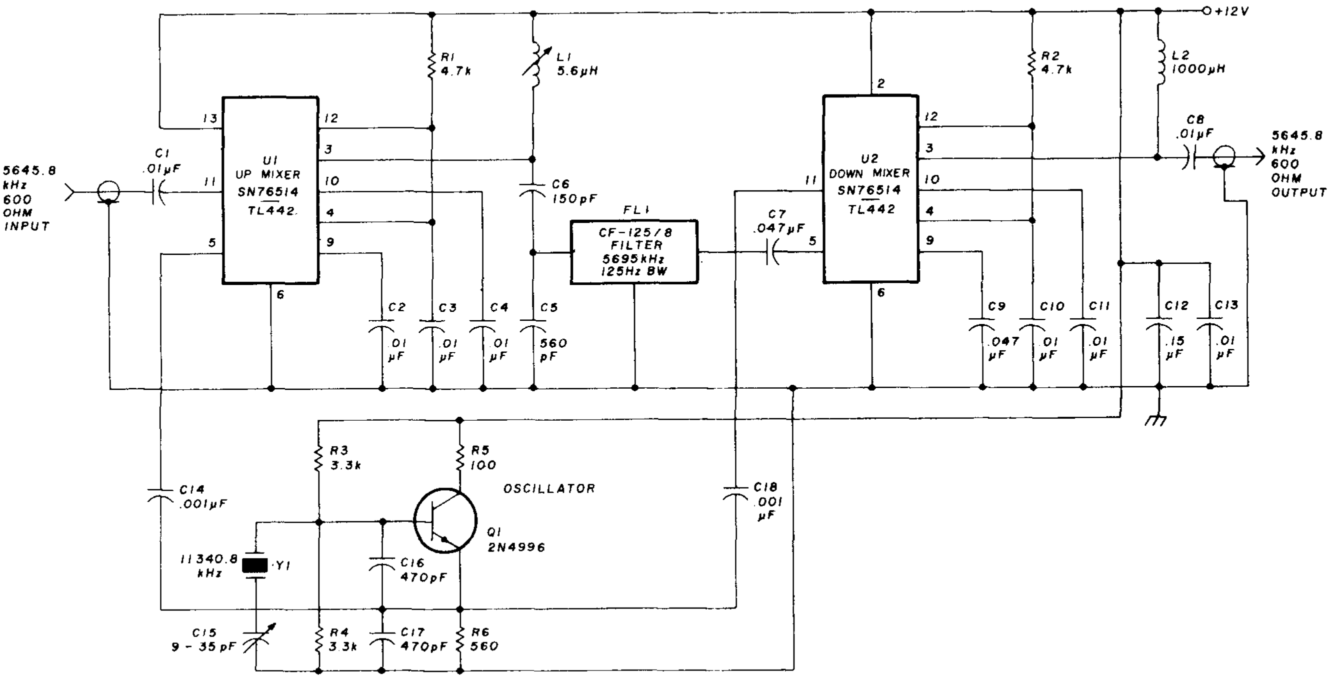


fig. 5. Schematic diagram of the up/down converter. All resistors are ¼ watt, 10 per cent. The TL442 pin-out is shown for the dual in-line package. The active devices can be obtained from Texas Instruments Supply, 6000 Dentron Drive, Dallas, Texas 75235.

both the input and the local oscillator signal. **Fig. 3** shows a diagram of the Texas Instruments TL442 (old designation SN76514). This circuit was designed specifically for radio receiver applications. Its features include

1. Flat frequency response to 100 MHz; with tuning usable to 300 MHz, $C_i = 3\text{-}5$ pF; $C_o = 10$ pF

2. 50 and 600 ohms input impedances and 600/1200-output impedance

3. Factory-tuned null adjustments for both signal and local oscillator

4. Single- or double-ended voltage source

5. Differential amplifier with large signal-handling capability

6. Low-level local oscillator requirement

7. Noise figure of approximately 6 dB

8. Typical conversion gain of 14 dB

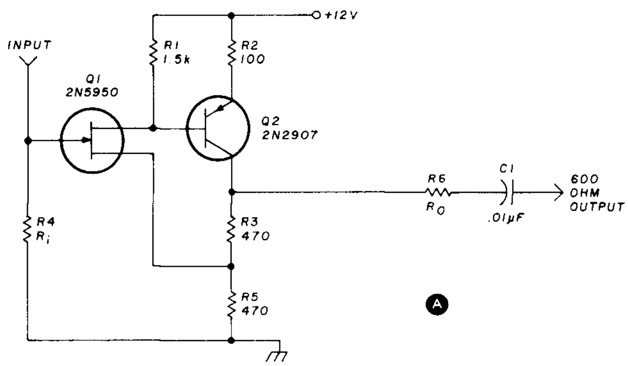
In the TL442 IC, uhf transistor chips are matched and the resistors are etch-trimmed in the manufacturing process to achieve balance. The IC actually consists of two cross-coupled differential amplifiers whose emitters are driven by a third differential amplifier. A constant-current source is connected to the third differential amplifier emitter. This device works best with 250 mV local-oscillator injection, and performs without significant overloading, up to about 300 mV of rf signal. Hence, the signal-handling characteristics of the TL442 are as good as or better than most vacuum-tube converters in current receiver designs.

An excellent description of the TL442 is also available from Texas Instruments.[1] Cost of the doubly balanced mixer is $2.40, an excellent trade-off when you consider that no external components are required. With more than 30 dB separation between the desired f_{FL} signal and the nearby f_{if} signal, the remainder of the high-performance crystal filter converter design is downhill.

Impedance matching, or the lack of it, is a big benefit of using the TL442. The fixed 600/1200-ohm output required no LC network, and only the most simple matching circuit to match the 50-ohm crystal filter. Going from the filter to the down-mixer does not require matching when using the 50-ohm input of the mixer! With isolation between the local oscillator and the output port of more than 30 dB, the local oscillator signal will have only minimal impact upon the receiver, and will provide more than 60-dB protection against signal leakage across the filter.

The gain/loss in the conversion process is also worth planning. The Sherwood CF-125/8 filter has a typical loss of 9 dB (maximum 11 dB). Another factor is the bandwidth reduction loss from 2.4 kHz to 125 Hz, which was shown to be about 13 dB. I like background noise to remain constant rather than to keep the signal strength constant when switching between the two filters; the noise floor is always a ready reference and a 13 dB drop in the noise floor is a noticeable deadening of the receiver! If the TL442 is connected for a 1200-ohm output impedance, about three S-units of excess gain can be provided to slightly more than account for loss of background noise due to bandwidth reduction.

Designing the matching network, from the TL442's 1200-ohm output impedance to the CF-125/8 crystal filter's 50-ohm input impedance, is based upon the capacitive tap-down network shown in **fig. 4**. The IC output impedance is 1200 ohms in parallel with 10 pF of source capacitance. L1 is used to resonate this 10 pF and the series connected tap-down capacitors, C1 and C2. **Fig. 4** shows the relationships between the network components and the termination parameters. As discussed before, one of the advantages of the TL442 is that the crystal filter will directly match the 50-ohm input of the second TL442 mixer.



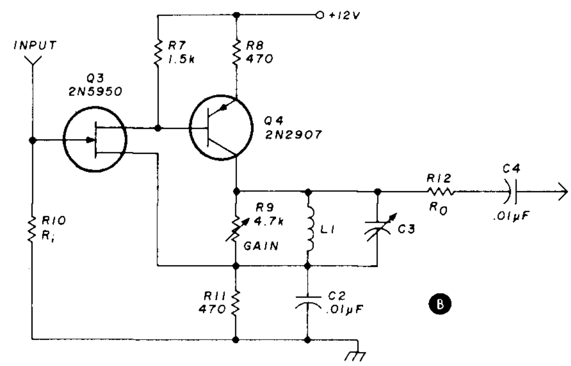


fig. 6. The 1:1 line isolation amplifier is shown in *A*, while the amplifier with the variable ratio is shown in *B*. This design is capable of handling large signals with low cross-modulation.

All that's needed to complete the converter are three semiconductor devices and one tuned circuit. **Fig. 5** shows the schematic. Both mixer ICs are configured in the same manner. Rf ground potentials are carefully bypassed with monolithic capacitors using short leads. The TL442 outputs are single ended, and the impedance is raised to about 1200 ohms by applying the supply voltage to pin 13. The constant-current source resistor network derives its voltage from the 3k resistor connected from pin 12 to pin 4; an additional 4.7k resistor is connected to pin 4 to increase gain. At the signal input, the 600-ohm input

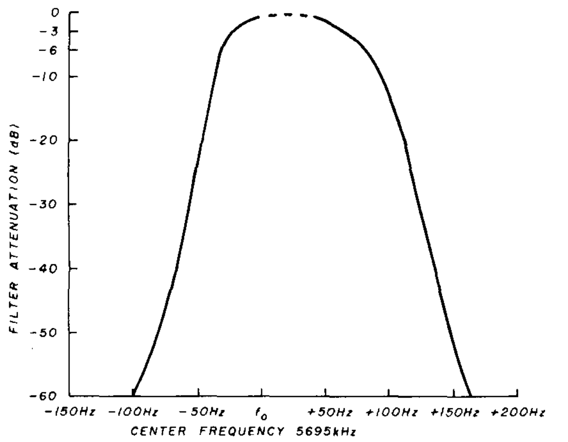


fig. 7. Frequency response of the Sherwood Engineering CF-125/8 crystal filter.

(pin 11) is used for the receiver first i-f signal because matching to 600 ohms is convenient.

The local oscillator was carefully designed to provide as much decoupling from the supply voltage as possible and also to provide a very low output impedance. A T-pad attenuator between the two mixers further decreases the possibility of signal leakage from the signal input through the input mixer, oscillator, and through the output mixer.

The capacitive tap-down network from the upmixer, U1, to the crystal filter, FL1, is composed of L1, C6, and C5. Depending upon the *Q* of L1, and any other filter impedance, C5 and C6 can be adjusted to give the proper ratio for a good filter match. This occurs at or near maximum signal strength without objectionable ripple in the passband or out-of-band ripples.

Retune L1 each time C5 or C6 are changed; the adjustment is straightforward and noncritical. C15 provides a fine-tuning adjustment for the crystal.

line amplifiers

When the output impedance of the receiver's first i-f is greater than one or two thousand ohms, a matching circuit will be required. Again, the capacitance tap-down network will work well for ratios of 24:1 or more. Further, there is sufficient gain in the TL442 IC mixers to recover a few dB of circuit loss. When excessive loss is encountered, a line amplifier (**fig. 6**) will help recover gain, or match extremely high-impedance circuits to low-impedance circuits. This circuit features several S-units of gain while exhibiting very large signal-handling capabilities with low cross-modulation distortion. The output impedance is 1200 ohms, untuned, and should be easy to match to the second-mixer circuit in any receiver.

construction

The whole system was built on a double-sided printed circuit board that fits over the pins on the CF-125/8 crystal filter. The filter is securely grounded to the back plane of the printed-circuit board to reduce signal leakage around the filter. A piece of double-stick *Scotch* mounting tape was used to attach the entire up/down crystal filter converter assembly to an unused panel inside the receiver. One word of caution: always place a metal shield between the input wafer and the output wafer of the crystal filter switch to minimize signal leakage.

results

True single-signal reception with the CF-125/8 crystal filter in tandem with an ssb filter is most gratifying. **Fig. 7** shows the frequency response of the CF-125/8 crystal filter by itself. Other crystal filters give equally impressive results. My R4-B receiver is equipped with a 1:1 line amplifier which drives the Drake ssb filters from the 2-crystal filter in the first i-f stage. The output from the ssb filter drives the line driver (adjusted to make up the 6 dB filter loss) and then the second mixer. The up/down crystal filter converter is switched in between the ssb filter and the second line amplifier. The tandem combination of filters does not ring, and 40 word-per-minute CW copy is possible. The noise and static effects that were so bothersome when a 125-Hz audio filter (shape factor 3) was used are now annoyances of the past.

If you are lucky enough to find crystal filters that are on the same frequency as your receiver's first i-f, all that is needed is a line isolation amplifier to buffer the filter, a matching network, and a line amplifier to make up the gain of the return signal.

reference

1. *Balanced Mixer Application Note*, Section 6.6 SN76514/TL442, Linear Circuits Application Department, Mail Station 964, Dallas, Texas 75222.

ham radio

how to select TTL sub-series ICs for different digital designs

The popular TTL family of digital ICs is widely used in amateur applications, but low-power, high-speed, and Schottky TTL have been largely neglected — here's how to select the best TTL sub-series for your own designs

Through the years, as the 7400 series of ICs has become the mainstay of TTL logic designers, more and more devices have been added to the family. In the last few years, both Fairchild Semiconductor and Texas Instruments have increased their commitment to the market by introducing expanded lines of high speed, low power, and Schottky-clamped devices. At the same time, extensive use of foreign production facilities has allowed a 50 per cent drop in prices, which distributors are now beginning to pass along to the consumer. Where does that leave you when you decide to build that new keyer or frequency counter? Consider the popular 7400 quadruple 2-input NAND gate, for example. There are five versions: the 7400, 74H00, 74L00, 74LS00, and 74S00. Which version is best suited for your purposes? What advantages does one version have over another?

Actually, each 7400 sub-series (H, L, LS, and S) has clear cut strengths and weaknesses which make the choice a lot easier than it may appear. The two major differences between each sub-series are speed (maximum operating frequency) and power consumption. In general, to gain speed, power consumption must be increased. This speed-power trade-off would probably settle the matter because you would pick the lowest power version that meets the required speed and stop right there, but a third factor comes into play: cost. To either increase speed or decrease power, the cost at least doubles over that of the standard (and the least expensive) version. A good rule of thumb is to use these special devices *only* when the standard 7400-series chips can't do the job.

performance comparison

Let's go back to the 7400 quad 2-input NAND gate and look at the differences between each version and set down some general characteristics for each sub-series.

The 7400 typically operates from dc to 35 MHz, as will the remainder of the 7400 series. This is a *typical* specification and does not hold true in devices of higher complexity such as the Texas Instruments SN74144, which contains a BCD counter, a four-bit latch, and a BCD to seven-segment decoder-driver. The SN74144 is intended to be a one-chip replacement for the popular SN7490A counter, SN7475 latch, and SN7447 decoder-driver combination. Because of the high component density in the SN74144 (an equivalent of 86 gates on one chip), however, the typical counting frequency only extends to 18 MHz. Some of the earlier devices were equally slow. There was a time, not too long ago, when it was sometimes necessary to go through a handful of 7490 counters before you could find one that would work to 30 MHz. Therefore, it's wise to buy only devices with current date codes, unless the application isn't critical. Problems shouldn't pop up with any major suppliers, like those who advertise in *ham radio*, because the turnover is too high for 1973 chips to be still floating around in the open market.

Digressing a moment, the date code is a three- or four-digit number standardized by the EIA (Electronic

By Ian MacFarlane, WA1SNG, 102 Columbus Avenue, Greenfield, Massachusetts 01301

Industries Association). It is stamped on every integrated circuit, usually, but not always, after inspection. Contrary to what you might think, you can get an untested IC with all the same markings as a first-rate unit. If the number has four digits, the first two represent the year of manufacture, such as 75, and the next two stand for the calendar week, such as 38, which would mean the thirty-eighth week of 1975 (the third week in September). If the number has three digits, the first is the year of manufacture (in the example above, the year would be cropped to 5), and the last two digits refer to the calendar week.

The typical low power 74L00 version will operate to 3 MHz, making it somewhat slower than the CMOS family. Every other sub-series is faster than the original type. Below is a list in terms of *typical* speed:

74L	3 MHz
74LS	45 MHz
74H	50 MHz
74S	125 MHz

These figures represent the highest typical clock rate for flip-flops. Once again, remember that each device must be considered on a one-by-one basis where speed is concerned, with the higher-density units having lower maximum frequencies than their less complicated brothers.

Power consumption is often compared using the power dissipation per gate for each series. This information is given in **table 1**, along with all other comparative figures, but in this case it is based on the average supply current, per gate, assuming a 50 per cent duty cycle. The average supply current data is readily available for individual devices, whereas power dissipation is generalized for all gates in the series. The difference in consumption will hold true, when comparing more complicated devices, so long as it is treated as an approximate ratio. In other words, if the average supply current for one gate of a 7400 is 2 mA, and the average supply current, per gate, of a 74L00 is 0.2 mA, then it is fair to say that *any* standard 7400 series device will require approximately ten times the amount of power than an L-series unit does. In practice, the actual ratio may be more or less.

To take several cases, the power ratio is 7.25 for the SN7490A, SN74L90 combination, and 13.15 for the SN7473, SN74L73 flip-flop pair. The average supply current values for the remainder of the devices are: 4.5 mA for the 74H00, 0.4 mA for the 74LS00, and 3.75 mA for the 74S00. Thus, if the 7400 is used to establish the standard unit of power consumption (2 mA = 1 unit), then the relative standings are 0.1, 0.2, 1.9, and 2.3 for the L, LS, S, and H sub-series, respectively.

selecting a sub-series

There are three variables that must be considered when choosing the proper series: price, speed, and power. In general, the first and deciding requirement is that the chip will work up to the desired frequency. It is possible to approach the choice from a power consumption standpoint, but if power conservation is critical, it would be a good idea to see what can be done with a very low power series like the RCA CD4000 COS/MOS family. On a cost-effective basis the low-power 74L00 series is not as good as the COS/MOS family, which has a much lower power-cost product; COS/MOS will also work at higher frequencies (5 MHz for counters, 10 MHz for gates and flip-flops).

This brings us to the method for selecting the best sub-series once the speed requirements have been fulfilled: the *power-cost product*. Since both cost and power are to be minimized, it is easier to multiply the two figures together and deal with one variable instead of two. The lower the power-cost product, the more performance you get for your money. In practice, the product is calculated by multiplying the average current per gate (in mA) for the series, by the average increase in price of the series over that of the standard 7400 series (given as a multiple, such as 3.1 times cost). Data is provided in **table 1**. This is a method for standardizing the selection process, or a mathematical replacement for common sense.

As an example of how to use the chart, suppose you are planning to built a 10-MHz frequency standard. The 10-MHz specification puts everything in the running except the L series. If cost effectiveness is the object, a look at the lowest power-cost product reveals that the LS series is your best bet. Sheer

table 1. Comparison of the various TTL sub-series showing clock, rate, power dissipation, propagation delay, relative cost, and power-cost product

series	maximum flip-flop clock rate	power dissipation per gate	gate propagation delay time	average cost increase over standard series	power-cost product
74L00	3 MHz	1 mW	33 ns	3.1	0.62
7400	35 MHz	10 mW	10 ns	1.0	2.00
74LS00	45 MHz	2 mW	9.5 ns	1.4	0.57
74H00	50 MHz	22 mW	6 ns	1.9	8.49
74S00	125 MHz	19 mW	3 ns	3.4	13.07

low cost, providing that a husky power supply is available, would be provided by a switch to the standard series. Not all device selections are that simple.

Let's assume you are designing a frequency counter. The goal is to build a model capable of counting to the highest frequency and requiring the least possible power, and using only the TTL series (no CMOS or ECL integrated circuits); price is no object. In case the design goal will not be met by using only one 7400 sub-series, the lowest power version having the necessary speed will be selected. Excess speed margins, when not needed, will be sacrificed for power conservation. Starting with the 10 MHz oscillator, choose a 7400. The 74LS00 and other sub-series chips have a reputation for not performing well in oscillator service. A key to this problem is the different biasing requirements for each sub-series. It is impossible to just simply remove a 7400 from an oscillator circuit and plug in a 74LS00 without changing external resistor values. There are many proven oscillator circuits based on the 7400, but little published information about biasing for oscillator service, so sticking to the well trodden path will assure success.

The first divider must be able to toggle up to 10 MHz; a 74LS90 will require the lowest power. All remaining dividers operate at 1 MHz or below, making the 74L90 the best bet. The counter control circuitry, which generates the count enable, strobe, and reset pulses functions at a very low rate, since most counters can make no more than 10,000 counts per second, so L-series devices can be used. The gate must pass the highest counted frequency, as must the first decade counter, and this application calls for Schottky ICs such as a 74S00 for the gate, and a 74S196 for the first counter. The second decade counter must be LS to count up to 12.5 MHz, but the remaining counters may be L versions. Latches and decoder drivers can also be chosen from the L series.

It is important to note that no standard series TTL logic was used in this circuit. Only when performance can be sacrificed in favor of price is standard TTL a wise choice. Price is almost always important, which explains my rule of thumb which suggests that the standard series be used exclusively, except when it just won't do the job. It's less expensive to build a higher current power supply than to purchase twenty-five special ICs at three times the cost of their standard TTL equivalents.

TTL sub-series compatibility

One of the original design objectives for the different TTL sub-series was compatibility. All have the same maximum supply voltage rating of 7 volts, except for the L series, which is 8 volts. This gives plenty of leeway above the typical 5.0 V supply voltage, which is common to all sub-series. Operating temperature range extends from 0 to 70°C (32 to 158°F). The maximum input voltage for the L series is 7 volts, with 5.5 volts as the limit for all others. Because of these similarities, mixing devices from different sub-series will produce no problems so long as fan-out limits are observed.

Fan-out (the number of inputs a single output can drive) is figured only on the basis of outputs driving inputs from the same sub-series. The standard fan-out is 10 loads, except for the L and LS series, where it is 20. Mixing of devices is permitted as long as the output can source (provide) or sink (absorb) the *total* current to or from all inputs.

The high- and low-state input requirements are shown in **table 2** along with output sink capabilities.

table 2. Input and output data for the various TTL sub-series. Note that the L series had two different standard inputs; assume highest input current when calculating output requirements. Negative signs represent current flow out of terminal

series	input current (high state)	input current (low state)	maximum output sink current	maximum output source current
74L00	10/20 μA	−0.18/ −0.8 mA	3.6 mA	−200 μA
7400	40 μA	−1.6 mA	16 mA	−400 μA
74LS00	20 μA	−0.4 mA	8 mA	−400 μA
74H00	50 μA	−2.0 mA	20 mA	−500 μA
74S00	50 μA	−2.0 mA	20 mA	−1000 μA

From these figures it's easy to check to see whether a particular output can handle its loads. Just add up the low-state currents for all loads (inputs), and then check that the totals fall within the maximum sink limit for the output. The negative values of input current represent a flow out of the terminal, back into the output. If the output can sink the required current, it will always be able to source enough current for the loads.

conclusion

While the use of standard and LS series TTL ICs has certainly caught on for amateur projects, the H, L, and S series have been largely neglected. As so often happens with new products, this is due more to insufficient information than it is to a lack of applications. It is hoped that this article has provided enough information to generate more interest in using the various TTL sub-series ICs in future designs.

ham radio

If you're ever
DX-ing
on an island so small that
the only things resembling coconuts
are the traps on your beams—
You'll be glad you're
using a Drake C-Line...
KP6BD
KINGMAN REEF
1977
N9NM WB9KTA
K4SMX K6NA
R.L. Drake Company
Miamisburg, Ohio
1977 DXpedition Group
Palmyra / Kingman Reef
A DXpedition to Kingman Reef requires the operators to have an uncommon amount of faith in their equipment. For this reason we chose the Drake C-Line.
Our two C-Lines were subjected to what we feel were some of the most adverse conditions possible:
1. Temperatures were 150° plus in the engine room of our chartered boat for 17 days.
2. Generator voltage was low due to running 1 kW amplifiers. (Typically 100 volts)
3. AC-4 power supplies were sitting in water on several occasions due to severe rains.
4. During one rain storm, water was actually coming out of the R-4C headphone jack.
5. Numerous small lizards and spiders were crawling in and out of the C-Lines.
Despite all these adversities, the two Drake C-Lines were in operation for over 145 hours; the only "off time" was during the six hour trip from Palmyra Island to Kingman Reef. A total of over 16,000 contacts were made from KP6AL Palmyra and KP6BD Kingman Reef without a single transmitter or receiver failure.
I know that customer satisfaction has been the cornerstone of R.L. Drake Co. for 34 years. Let me say that as far as we are concerned, that cornerstone is firmly in place. Thank you for making a very reliable product.
Barry J. Fairfax
Barry J. Fairfax WB9KTA,
operator: KP6AL Palmyra Island
KP6BD Kingman Reef
Received 7/15/77 by:
R. L. DRAKE COMPANY
DRAKE
540 Richard St., Miamisburg, Ohio 45342 • Phone: (513) 866-2421 • Telex: 288-017
Western Sales and Service Center, 2020 Western Street, Las Vegas, Nevada 89102 • 702/382-9470

500-watt regulated power supply

Introducing
Dragon One —
a power source
with built-in safety features
for your
high-power equipment

With solid-state devices making advances in the vhf and uhf spectrum, more powerful transmitters are made available to radio amateurs. Solid-state transmitters and linear amplifiers in the 150-200-watt range are not uncommon. Although most of the equipment is made to operate in automobiles using car batteries, many amateurs want to operate their higher-power solid-state devices in their homes. But here the power supplies become a problem, unless of course, you wish to purchase an auto battery and a battery charger as accessories for the modern equipment. Even then, the battery has a finite life, and the sulphuric acid in the battery is hazardous inside living quarters.

the dragon one supply

This article describes a power supply system that delivers a whopping 500 watts of clean, regulated power. The regulation is better than 1 per cent from no load to full load, with a ripple voltage of less than 10 mV peak-to-peak. Safety features such as current limiting, overvoltage shutdown, and short-circuit protection are all built in. Optimum regulator efficiency is approximately 65 per cent at an output of 450 watts.

Fig. 1 shows the regulated-power supply schematic. Transformer T1 steps down the line voltage to 22 volts, which is rectified by full-wave bridge rectifier CR1. Filtering is by C1, which is a computer-grade electrolytic capacitor having a capacitance of 18,000 μF. R1 discharges C1 after the power supply is turned off.

Regulation is provided by U1, the popular 723 regulator IC. The 12-15-volt voltage adjustment is by R4. C5 ensures oscillation-free operation of regulator

By C. C. Lo, WA6PEC, 5414 Barrett Avenue, El Cerrito, California 94530

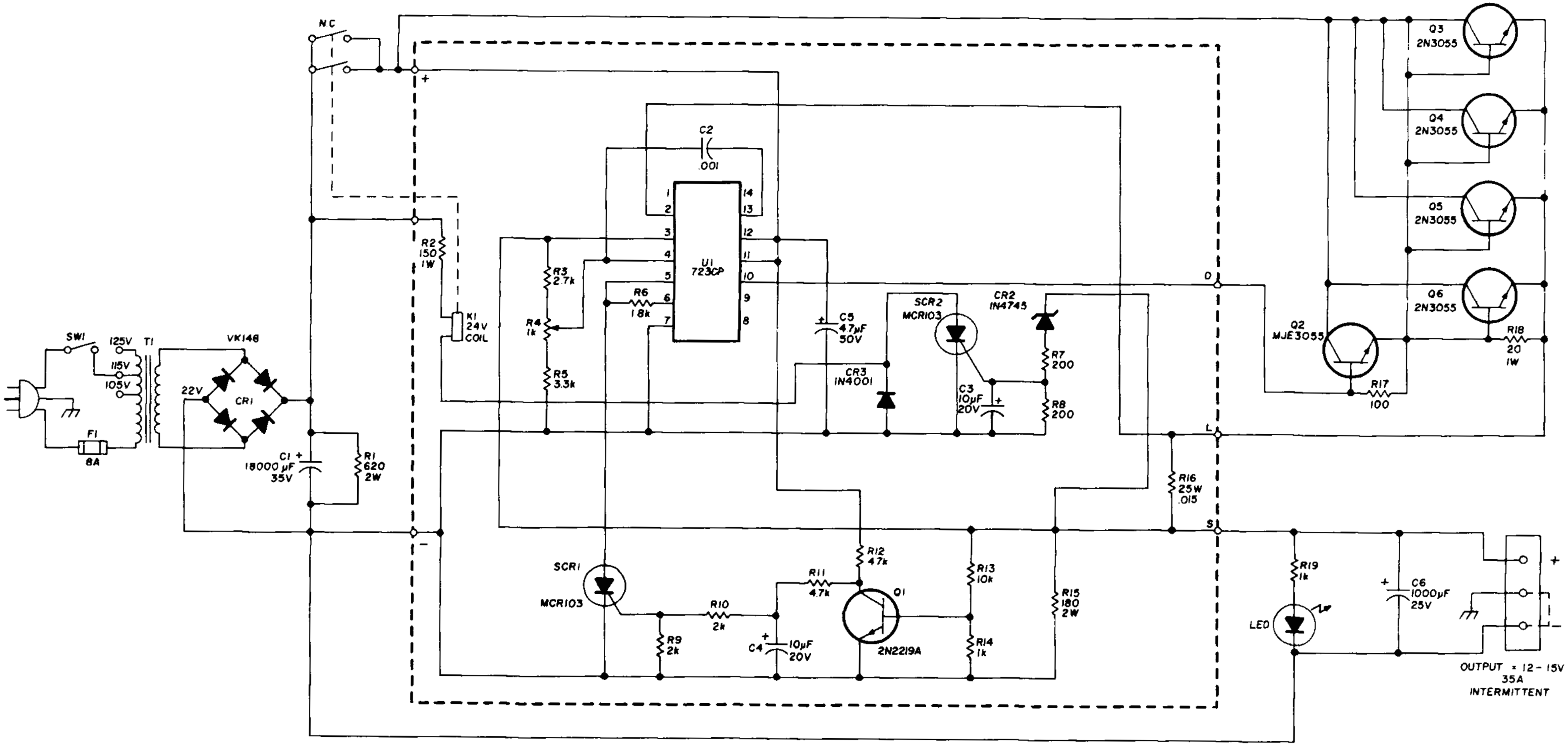


fig. 1. Power-supply schematic. All resistors, unless otherwise marked, are ½ watt, 10 per cent.

table 1. Parts list for the 500-watt regulated supply.

CR2	16V zener 1W, 1N4745 or equivalent
CR3	diode 50V 1A
LED	red light-emitting diode
T1	transformer Lotronics T2230
CR1	bridge rectifier Varo VK148 or equivalent
C1	electrolytic capacitor - 18,000 µF, 35V
Printed circuit board Lotronics PC723SO	
Heat sinks	10″ x 6″ (254x152mm) Lotronics H10-6, one piece 4″ x 6″ (102x152mm) Lotronics H4-6, two pieces
R16	resistor 15 milliohm Lotronics R15M
Chassis	7″ x 8″ x 10″ (178x203x254mm) steel box
K1	relay 24V coil dpdt, contacts rated at 10A 125V each
U1	723 regulator DIP package
SCR1, SCR2	MCR103 or equivalent (50V 200µA gate current)
F1	fuse holder and 8A fuse
SW1	toggle switch dpst on-off
Miscellaneous wire, screws, washers, terminal block, line cord.	

The following parts are available from Lotronics, Box 975, El Cerrito, California 94530:

Items 1-9	Dragon One major component kit — $129.50 Dragon One complete component kit — $169.50 Dragon One assembled and tested — $209.50

For all above add $10 for shipping, insurance, and handling. California residents add 6 per cent tax. Instructions included.

723. U1 output drives Q2, an MJE3055, which in turn, drives Q3-Q6, 2N3055s. Current sensing is by R16, a special 15-milliohm resistor. The two output terminals are isolated from chassis ground. Grounding is achieved by connecting the positive or negative output terminal to the ground terminal with a jumper. A light-emitting diode indicates the presence of dc output voltage. R3, R4, and R5 make up the output voltage sensing divider; the voltage control signal is connected to U1 inverting input.

To protect the power supply from burning itself up in case of excessive load current, the short-circuit shutoff is done in conjunction with the current limiting provided by the regulator through R16. As load current exceeds 35 amps, the output voltage starts to drop. When the voltage drops below 8 volts, Q1 turns off and SCR1 turns on, pulling the regulator noninverting input close to ground potential, thus turning off the output power. This condition remains until the power supply is turned off and SCR1 unlatches.

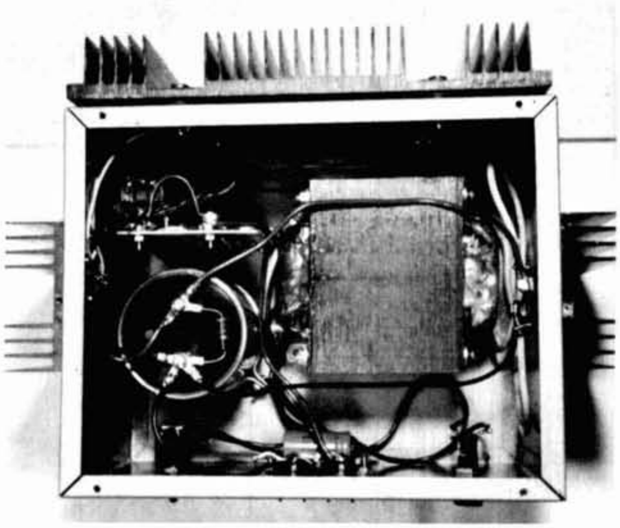
Overvoltage shutdown is designed into the system to protect your expensive transceivers and linear amplifiers. If anything should happen to the regulator or any of the series transistors, chances are one of these devices will short out, putting the full voltage across C1 at the output. This could be disastrous to transceivers and amplifiers. Relay K1, together with CR2 and SCR2 ensure that this will not happen, even if all the pass transistors and regulator are shorted. As the voltage exceeds 16 volts, CR2 starts to conduct, supplying gate current to SCR2, which turns on and activates K1. In doing so, the main dc supply is cut off and will remain off for as long as the power is on and the defect has not been corrected. This special feature is valuable and its additional cost is well justified, although the overvoltage shutdown feature may never be needed in the lifetime of the power supply.

construction

All components are packaged in a 7 x 8 x 10-inch (178x203x254mm) steel chassis box. Three heatsinks are used (photo).

All components shown inside the dotted line in the schematic diagram are mounted on the printed circuit board. Since this circuit is a high-current power source, no. 12 (2.1mm) wire should be used for all high-current paths. However, no. 16 (1.3mm) wire can be used for interconnections from the two relay contacts, which are wired in parallel to the individual transistor collector and from the individual emitter to point L or R16. R19 and C6 are mounted behind the output terminal block. Holes are punched on the top and bottom panels for ventilation purpose.

Output voltage can be adjusted between 12-15 volts dc. Load current is rated at 35 amps intermittent, and 22 amps continuous duty. For prolonged operation at high current and low output voltage (below 13 volts), a small external fan is recommended for cooling the heat sinks. However, the power supply can deliver 22 amps continously without forced-air cooling if ambient temperature is below 77°F (25°C). The temperature of the pass bank tran-



Underchassis view of the power supply. Three heatsinks are used. The heatsink mounted on the rear of the chassis box is isolated from chassis ground. The four 2N3055s (Q3 - Q6) are mounted directly on the heatsink. The heatsink on the right-hand side is for bridge rectifier CR1; the other heatsink is for Q2. Heatsink compound was used for mounting Q2 - Q6.

sistor under this condition stabilizes at around 221°F (105°C). With a 25-30 cfm ($7 \times 10^5 - 8 \times 10^5$ cm^3/minute) fan blowing at the rectifier and the transistor heatsinks, the transistor heatsink temperature stabilizes at 122°F (50°C) with 30 amps continuous load current operation for one hour. Regulation is below 1 per cent from no load to full load (35 amps). The taps on transformer T1 are for optimum efficiency operation. It's obvious that if the line voltage is high, the unregulated dc voltage will also be high, making the voltage drop across the pass bank transistor high. That means higher power dissipation and lower system efficiency. Hence, if the input line voltage is connected to the proper tap, an optimum system efficiency is achieved.

bibliography

1. *Voltage Regulator Handbook*, National Semiconductor, Santa Clara, California, May, 1975.

2. *Fairchild Voltage Regulator Application Handbook*, Fairchild Semiconductor, Mountain View, California, March, 1974.

ham radio

HEATHKIT: The name in Amateur radio...and now computers!

SB-104A Amateur Transceiver

The world-famous SB-104 with significant improvements. We've increased the sensitivity to 0.5 μV on all bands and included a fully assembled and tested receiver front end circuit board for reduced assembly time. The optional 400 Hz filter is independently selectable for CW operation. We've maintained the features that made it famous too — totally broadbanded, all solid-state, digital frequency readout and more. Make the SB-104A the "heart" of your station.

Only $669.95

HW-2036 2-Meter Mobile Transceiver

Our value-standard 2-meter rig offers true digital frequency synthesis in 5 kHz steps and a built-in tone encoder to access most repeaters! Also features built-in simplex, + and − 600 kHz offsets, and an aux. position that lets you add your own crystal for any other offset crystal you may want. The HW-2036 has 0.5 μV receiver sensitivity and a transmitter that can operate into an infinite VSWR without damage! Come on up to 2-meters with one of the best mobile rigs you can get.

Only $269.95

LA36
DEC
Writer II
Keyboard Printer
Terminal at Heath's
SPECIAL LOW PRICE:
$1495 Assembled

New The personal computer products you've been waiting for.

And the ones to which all others will be compared. Total computing systems for home, hobby, educational and business applications. Powerful, comprehensive software to get you up and running fast. Unequalled documentation and product support services coupled with low Heath prices make the difference.

New Self-Instruction Course in Microprocessor Operation and Application

Another addition to Heath's famous Continuing Education Series. Learn microprocessor operation, interfacing and programming. Hardware and software experiments let you get hands-on experience using the ET-3400 Microprocessor Trainer.

FREE!

HEATHKIT CATALOG

Nearly 400 kits for you to build! Whatever your interest — *hi-fi, television, automotive, marine, home appliances, test gear* — it's all in our big new catalog.

Send Today! ▶

HEATH
Schlumberger

Heath Company, Dept. 122-360
Benton Harbor, Michigan 49022

Please send me my FREE Heathkit Catalog.
I am not on your mailing list.

Name ____________________

Address ____________________

City __________ State __________ Zip __________

AM-356

Prices are mail order net F.O.B. Benton Harbor, Michigan.
Prices and specifications subject to change without notice.

the latest gear for the VHF enthusiast

Gamber-Johnson Deluxe slide mount
$17.88

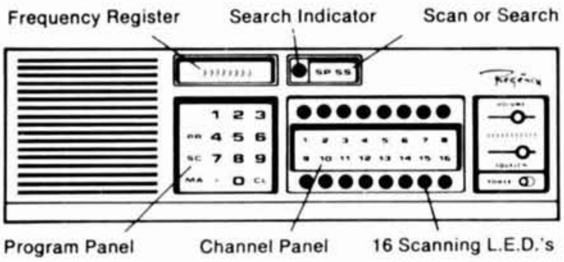
- Solid snap in design
- Attaches to radio mtg bkt (or directly to radio)
- Four molex pins for power and external speaker
- BNC RF slide connector
- pigtail UHF (SO-239) connections to radio and antenna
- designed for commercial use thru 1000 MHз

Gamber-Johnson Console floor mount
$31.50

- utilizes deluxe slide mount
- built in speaker
- mount attaches securely to floor

extra slide mount base **$8.40**
stationary half of deluxe slidemount allows use of radio in second car or location

Regency



Regency Digitally Programmable Scanner with Keyboard Entry **special $299**

Model ACT-T-16K

Frequency Range:
Lo VHF .. 30- 50MHz
Hi VHF . 146-174 MHz
UHF . 440-512 MHz

Sensitivity:
(20 DB quieting)
Lo VHF .... 0.5 μ V
Hi VHF .... 0.6 μ V
UHF .... 0.7 μ V

Selectivity
$\pm$ 7 KHz (min.) @ 6 DB
$\pm$ 15 KHz (max.) @ 60 DB

Squelch: (threshold)
Lo VHF .... 0.4 μ V
Hi VHF .... 0.5 μ V
UHF .... 0.6 μ V

Search Scan Range:(max)
Lo VHF 4000 channels
Hi VHF 5600 channels
UHF 5760 channels

WESTCOM

Westcom VHF Amplifiers

Model	Band	Emission	P in	P out	Price
2M 3x30	144MHz	FM	1 - 4	30	72.95
2M 3x30L	144MHz	CW-FM-SSB/AM	1 - 4	30	82.95
2M 10x40	144MHz	FM	2 - 10	40	77.95
2M 15x80	144MHz	FM	5 - 15	80	129.95
2M 15x80L	144MHz	CW-FM-SSB/AM	5 - 15	80	139.95

Ruggedized DC Power Supplies
Ideal for VHF Transceivers and Amplifiers

- 105-125 VAC, 50/60 Hz
- Fold back current limiting
- 13.8 VDC $\pm$ .05V
- UL listed & computer grade components
- One year warranty
- 5 mV peak-peak max ripple

Astron RS-6A $49.95
4.5 ADC Continuous
6.0 ADC Intermittant
Recommended for up to 30 W amp's & xcvrs

Astron RS-20A $89.95
16 ADC Continuous
20 ADC Intermittant
Recommended for up to 120 W amp's

Astron RS-10A $74.95
8 ADC Continuous
10 ADC Intermittant
Recommended for up to 70 W amp's

Astron RS-35A $129.95
25 ADC Continuous
35 ADC Intermittant
Recommended for up to 180 W amp's

Larsen Electronics

Larsen mobile antennas
⅝ wave, 3dB gain, 200 W rating

LM-150-K	2M roof mount	$30.20
LM-150	w/magnetic mount	$38.45
LM-150	w/trunk lid mount	$37.90

for Motorola NMO type mount add $5.25
220 MHz and 450 MHz available at same price

Master Charge & B of A
We ship prepaid in USA
Calif. residents add 6% tax
Check with order or COD

10 day money back guarantee
full satisfaction guaranteed
Factory warranty on all items

WESTCOM
COMMUNICATIONS DIVISION 1320 Grand Ave. San Marcos, CA. 92069 (714) 744-0728

More Details? CHECK—OFF Page 150

voice-operated gate

to replace voice-operated relays for carbon microphones

Presenting a circuit using four ICs plus a couple of transistors and diodes to replace the old voice-operated relays in ssb transceivers

VOR is an acronym for what is often called the "voice-operated-relay" or "squawk-to-talk" circuit, as used in many modern ssb and fm transceivers. "Voice-operated-relay" was an adequate description when tubes and relay circuitry were used, but it's rather unusual to find such relays in today's all-solid-state designs. And so now we have the Voice Operated Gate, or VOG.

The VOG described here used four ICs plus a couple of transistors and diodes to accomplish pre-amplification, bandpass filtering, and audio gating. A logic output also comes out of the VOG (choice of **1** or **0** for *gate-on*), to serve as a turn-on signal for other sections of the system being voice controlled.

Incorporated in the VOG is a lowpass and highpass filter pair providing the equivalent of a 300-3000 Hz bandpass filter with 40 dB per decade rolloff at each edge. These filters are of the active type, built around operational amplifiers. Only the audio passing through the filters can actuate the gate (and thereby pass through the VOG); this helps to discriminate against ambient noise.

VOG circuit

A diagram of the VOG is shown in **fig. 1**. The first section is a microphone preamp with an fet constant-current source for a carbon microphone. The carbon microphone is a variable resistance, so the injection of a constant-current into it causes the voltage across it to be representative of the variations in resistance of the microphone. The op amp that forms

By Hank Olson, W6GXN, P.O. Box 339, Menlo Park, California 94025

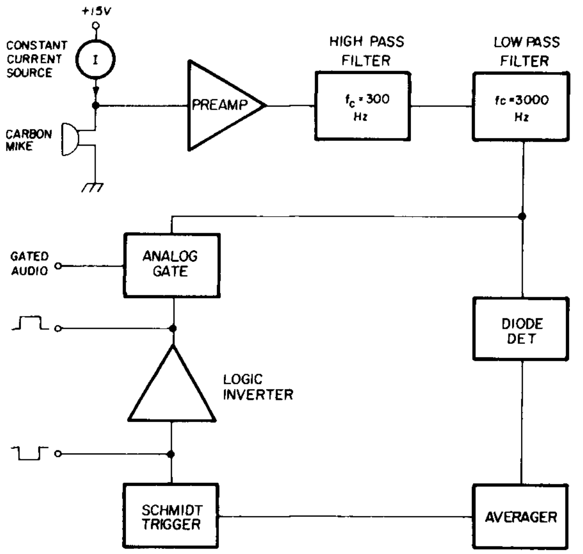


fig. 1. Voice-operated-gate (VOG) circuit block diagram. The circuit is a replacement for the old voice-operated relay systems prevalent in many modern ssb and fm transceivers.

the microphone preamp has a voltage gain of 100, which provides a voltage output of about 3 volts rms for usual carbon microphones during average close-talking use.

Following the microphone preamp is the highpass active filter followed by the lowpass active filter, each consisting of one section of the same quad op amp (U1) that's used as the preamp (see **fig. 2**). The last section of U1 is used as an *active* diode detector CR1, CR2, in which the op amp *linearizes* the detector. The diode detector is arranged to furnish the negative polarity of rectified audio.

The rectified audio from CR1, CR2 is then averaged by U2. Since the averager (U2) is also an inverter, the negative rectified audio is inverted and averaged to become a smoothed, long, positive pulse of the duration of the audio burst originally delivered by the microphone. This positive pulse is processed by U3, a Schmitt trigger, which sharpens the pulse leading and trailing edges and makes it

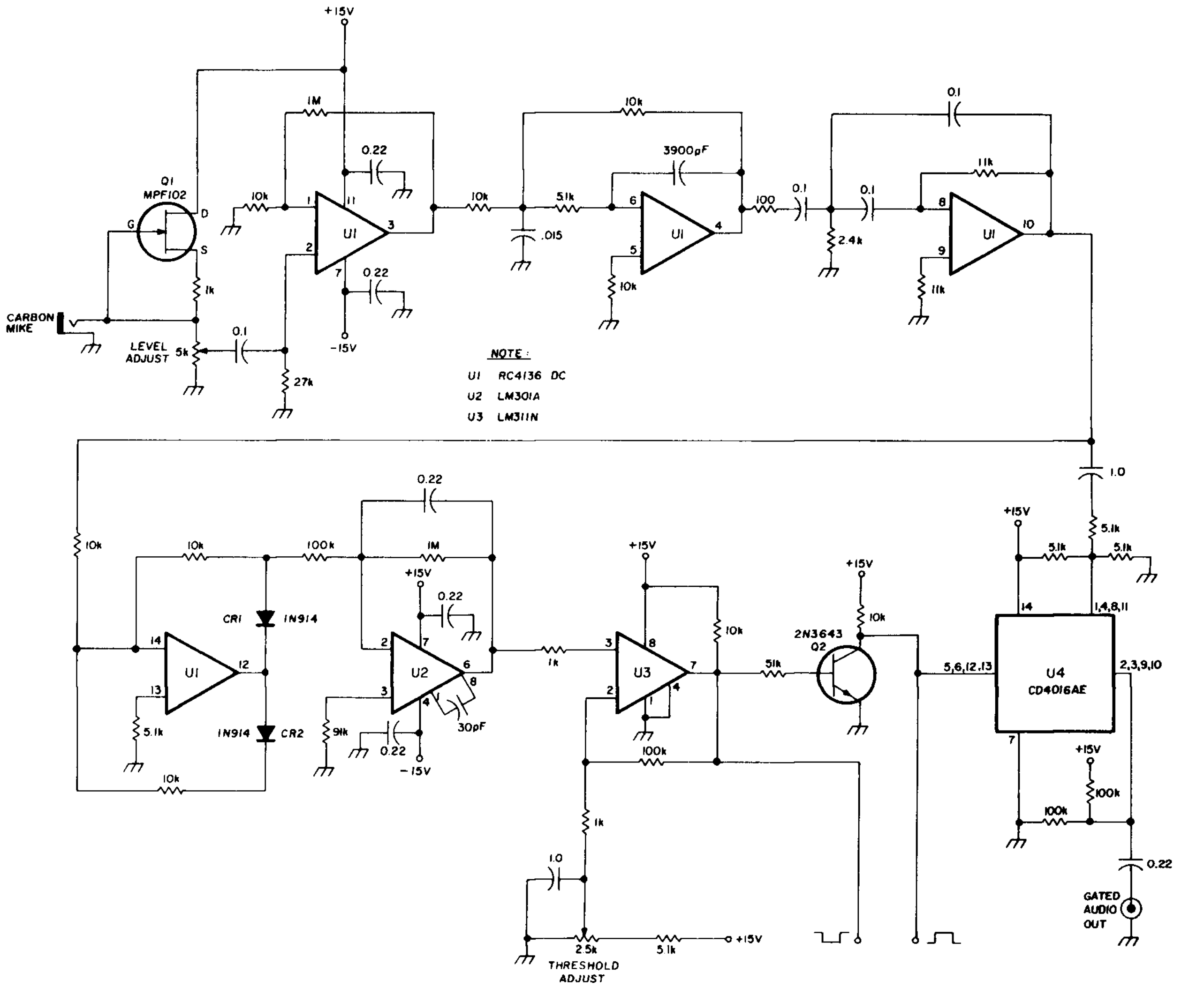


fig. 2. Schematic showing the carbon microphone preamp, bandpass filter, and voice-operated gate (VOG). Note that U1 is the equivalent of four μA741 op amps and could be replaced by four such ICs.

CMOS-logic compatible. The Schmitt trigger also inverts the pulse and adds an effect called hysteresis. That is, U3 output (pin 7) will go from **1** to **0** at an input level (set by the threshold-adjust pot) of say, 2 volts. U3 output will not return from **0** to **1** until the input voltage has dropped substantially *below* 2 volts. This hysteresis action prevents noise on the audio and minor voice level wavering from causing a chopping effect.

After the Schmitt trigger comes Q2, a simple transistor inverter, which inverts the audio-derived pulse to provide the proper polarity to turn on analog gate U4 when an audio signal is present. The inverter output and the Schmitt trigger output provide both **0** to **1** and **1** to **0** logic-level outputs, which can be used to actuate the turn-on function of the transmitter. Both polarities are handy, because this unit may be used with a number of transmitter designs.

The analog gate, U4, is a member of the RCA CD4000 CMOS logic family, which makes it much less expensive than some of the hybrid analog gates on the market. U4 consists of four analog gates. Since we need only one, all four sections have been wired in parallel. The CD4016 doesn't tolerate very large ac voltages without distortion, so the (filtered) audio input is attenuated at a ratio of 3:1 by a voltage divider at the analog input.

adjustment and testing

Setup of the VOG is simple. Connect it to a carbon microphone and a ±15-volt supply. Connect a scope or ac VTVM to U1 pin 3 of U1. Talk into the microphone and adjust the LEVEL pot (**fig. 2**) until about 3 volts rms is seen, then adjust the THRESHOLD pot until about +2 volts is seen at its wiper arm. Connecting a scope or ac VTVM to the output should now show a pulse of audio when speaking into the microphone. A dc voltmeter at U3 pin 7 should jump from +15V for "no talking" to near zero for "talking". The same dc voltmeter at the Q2 collector should react in the opposite way: near zero for "no talking" and +15 volts for "talking."

closing remarks

This VOG circuit was originally designed to replace one of the special-purpose ICs made by a large linear IC manufacturer. It surpasses the device it replaces in every way.

Note that U1 is the equivalent of four μA741 op amps and could be replaced by four such ICs. Also, two μA747s (dual μA741 op amps) or two MC1458s could also be used. U2 is best left as an LM301A, since the requirement here is for low input bias currents. When using other-than-called-for ICs, however, pin changes will have to be made.

ham radio

accurate low power rf wattmeter for high frequency and vhf measurements

How to build an accurate low-power wattmeter that measures up to 10 mW from 1 to 500 MHz — it uses small lamps as barretters

A pair of subminiature lamps used as an rf power detector make up the heart of a simple but accurate rf power meter, which can be calibrated directly from dc measurements. The instrument described in this article can be used to accurately measure rf power from 10 mW down to about 0.2 μW, over a frequency range from 1 MHz to 500 MHz. Its high sensitivity makes it useful for a host of purposes including antenna gain measurements, local oscillator measurements, and vswr or filter response measurements in conjunction with low-power signal generators. Its maximum power capability can be extended to any level through the use of external calibrated attenuators or directional couplers. In addition, homebrew attenuators and directional couplers can themselves be calibrated using the power meter.

The rf power detecting element in the wattmeter consists of a pair of incandescent lamps used as barretters. Barretters have been used for many years in commercial wattmeters and have been discussed in several previous articles.[1,2]

A barretter is a wire element whose resistance increases with temperature. Suppose a barretter is heated to a specific resistance (say 50 ohms) by a variable power source whose level is known. As long as the total power dissipated and the ambient temperature remain constant, the barretter resistance will remain at 50 ohms. Now suppose the barretter is also heated with power from a separate source (an rf generator in this case) whose level is unknown. The resistance of the barretter will increase. If the power supplied from the known source is then reduced until the barretter resistance returns to 50 ohms, the amount of power reduction from the known source will equal the power supplied by the unknown source. The unknown power level is thus measured by metering the decrease in the known power source.

The known power source can be adjusted automatically to maintain constant barretter resistance by using a bridge circuit in a closed loop with an amplifier. In many commercial microwave power meters the closed loop forms a self-balancing audio oscillator so that the known power source is an ac signal (in combination with some dc which is also applied). The oscillator technique has the advantage of eliminating dc offset drift errors in the balancing and metering circuits. In the power meter described here, however, the known power source is pure dc. The dc approach was chosen for ease of calibration and testing, for circuit simplicity, and to allow a wide rf frequency range. (The relatively large rf coupling capacitor required for low-frequency response would introduce excess phase shift and upset the balance

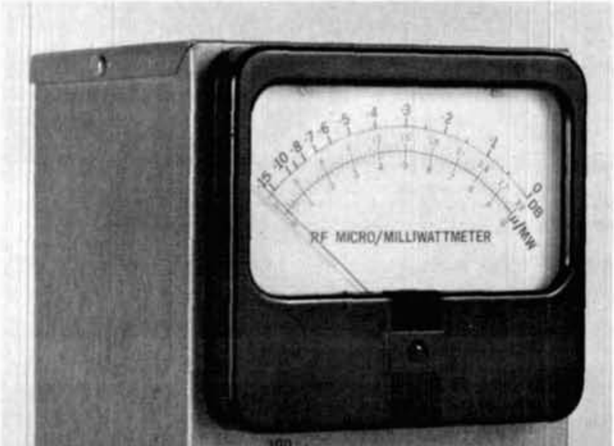
By James H. Bowen, WA4ZRP, 6500 Carefree Lane, Apartment B1-21, Roanoke, Virginia 24019

in an ac balanced bridge, depending on the low-frequency impedance of the rf source.)

circuit description

The circuit diagram of the rf wattmeter is shown in **fig. 1**. The design philosophy was to explore what useful sensitivity could be achieved in a simple circuit without the use of special low-drift components or special schemes for drift compensation. The experimenter who wishes to build his own version of the wattmeter is encouraged to try his hand at improvements.

The incandescent lamps, I1 and I2, used in the rf sensor are subminiature T-3/4 types obtained at a hamfest flea market. The lamps have wire leads and the glass envelopes are 0.187 inch (5mm) long by 0.094 inch (2.5mm) in diameter. Their dc characteristics indicate they are similar to Chicago Miniature types CM2, CM30, or CM3102. **Fig. 2** shows the measured current-voltage (I-V) characteristic of one of the lamps. Note the non-linear nature of the plotted data which indicates changing lamp resistance. This general characteristic is typical of all incandescent lamps with tungsten filaments. **Fig. 3** shows the same data plotted as dc resistance, V/I, versus power dissipated, VI. At rf frequencies, the resistance of the lamp during any rf cycle remains constant and equal to the dc resistance because one rf cycle is much shorter than the minimum thermal response time of the lamp filament (skin effect does not appear to seriously alter the resistance of the small diameter, high resistivity filament over the frequency range of interest).



The author's completed power meter.

In order to simultaneously feed dc and rf to the lamps over a wide bandwidth, the lamps are connected in series for dc and in parallel for rf. Chip capacitors C1 and C2 perform the functions of rf coupling and bypassing, respectively, with low impedance over a wide frequency range. If chip capacitors are not available, small ceramic disks with zero lead length may be used. For good uhf measurement accuracy, construction of the rf sensor must be based on good uhf construction practices, with emphasis on minimizing parasitic inductances by keeping all leads short. The rf paths through C1, either lamp, and C2 to ground must be as short as possible.

The rf sensor is built on a small piece of double-clad glass-epoxy printed-circuit board 1/16 inch (1.5mm) thick as shown in the photograph. Both sides of the board were soldered directly to the rear of a BNC connector, with the connector center pin soldered to a pad approximately 0.105 inch (2.5mm) wide. This pad forms a 50-ohm microstrip transmission line leading to chip capacitor C1. One lead of both I1 and I2 is soldered to a small pad connected to the other end of C1. A small hole is drilled through the board at the ground lead of I2 so this lead can be soldered to the ground plane on both sides of the board. The opposite lead of I1 is soldered to the pad in the upper right hand corner in the photo. A dc feed wire is also soldered to this pad and chip capacitor C2 is soldered from the point of attachment of I1 across a gap to the ground plane.

On the ground side of C2, another hole is drilled through the board and a wire is soldered through this hole to form a direct connection to the ground plane on the back of the board. The use of small filament lamps with low parasitic inductance, and this method of construction ensure good performance into the uhf portion of the spectrum. (**Warning**: chip capacitor ends must be soldered quickly with minimum heat; otherwise tin-lead solder will rapidly leach away the metallization from the ends of the capacitors.)

The layout of the remaining dc portion of the wattmeter circuit is not particularly critical and was built on a Vector DIP padboard mounted on the meter terminals. The unit is housed in a 4 x 5 x 6 inch (10.2 x 12.7 x 15.2cm) minibox.

The lamps are operated at sufficient dc current to bring their series resistance to 200 ohms. If the lamps are reasonably well matched, the resistance of each lamp will be about 100 ohms, making the parallel rf resistance equal to 50 ohms. If two lamps identical to the one plotted in **fig. 3** are used, each will dissipate about 7 mW at a resistance of 100 ohms, for a total dissipated power of 14 mW. Thus, 14mW is the maximum rf power which can be measured in a 50-

ohm system with two such lamps. A highest scale of 10 mW was therefore chosen for the wattmeter. Random drift establishes a practical limit of 10 μW for the most sensitive scale.

To maintain their series resistance at 200 ohms, the lamps are operated in a bridge circuit consisting of R1, R2, R3, and the rf sensor. For best accuracy, R1, R2, and R3 should all be selected to be as close as possible to 200 ohms with R1 and R2 selected for best match, and R3 selected closest to 200 ohms.

The voltage difference between the two legs of the bridge is sensed and amplified by U1, a μA741 or similar type op-amp IC. The capacitors in the feedback loop of U1 form an integrator for very high dc gain and good stability. The output of U1 passes through diode CR1 to transistor Q1, the bridge current driver. Q1 is connected as an emitter follower, and supplies the necessary current to bring the bridge to a balanced condition. The 10k resistor across Q1 feeds a small residual positive bias to the bridge to ensure that the bridge will always come to balance with a positive potential, even though U1 may initially turn on with a negative output. Diode CR1 prevents emitter-base breakdown of Q1 if U1 turns on with a negative output.

Following turn-on, the output of U1 will quickly become positive in response to the residual positive bias on the bridge. The voltage at the output of U1 will continue to increase until enough current flows through the rf sensor to bring its resistance to 200 ohms, at which point equilibrium is achieved. In practice, the bridge comes to balance within a second or two of turn-on, with some overshoot due to the thermal lag of the lamps.

The equilibrium voltage at the top of the bridge, V_B, (3.50 volts in the unit shown) is fed to the metering circuit made up of U2A, U2B, and associated components. Range switch S2A selects one of the calibration resistors, R4 through R10. A method for calculating the values of these resistors is covered in the calibration section.

Op-amp U2A compares the voltage selected by S2A to a reference voltage established at pin 3 of its input. Since the full-scale voltage change in V_B is only 1.1 mV for the 10 μW scale, the reference voltage supply must be extremely stable and minutely variable. To establish a stable reference voltage, fet Q2 is connected as a constant-current source feeding zener diode, CR2. Any fet having an I_{DSS} of 3 mA or more could be used for Q2. Alternatively, a 5-volt, three-terminal regulator IC could probably be used instead of Q2 and CR2.

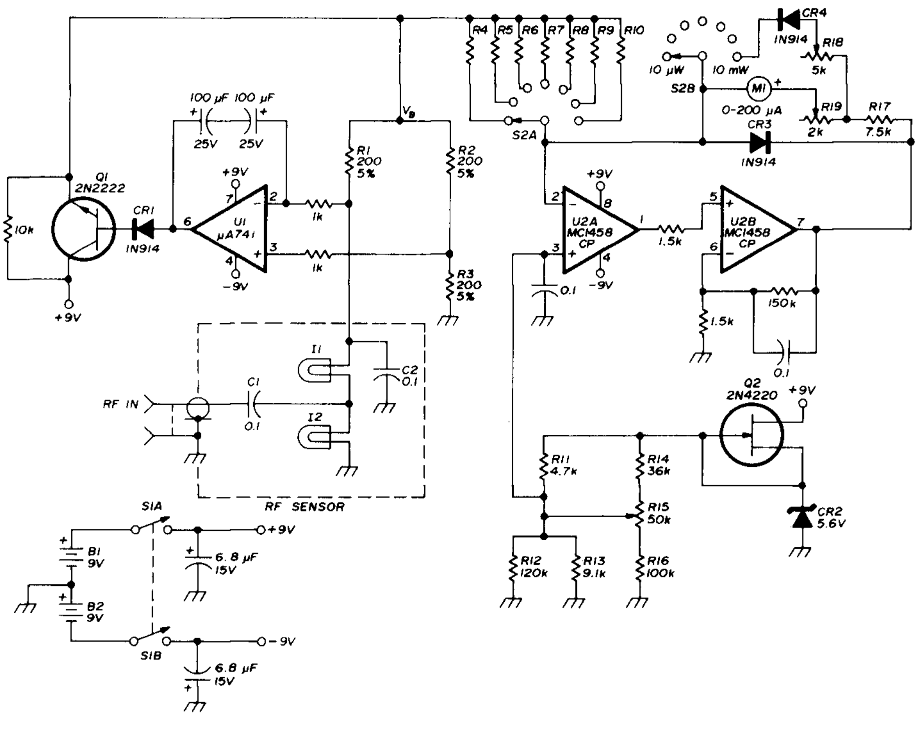


fig. 1. Schematic diagram of the rf wattmeter for 1 to 500 MHz. Fixed-value capacitors are disk ceramic except as noted; polarized capacitors are electrolytic or tantalum; resistors are ¼ or ½ watt carbon composition types.

C1, C2 0.1 μF chip capacitor or miniature leadless ceramic discap

I1, I2 subminiature T-3/4 incandescent lamp (Chicago Miniature type CM2, CM30, or CM3102)

J1 BNC jack, flange mount

R15 miniature 50k 10-turn pot

R18 5k trimmer

R19 2k trimmer

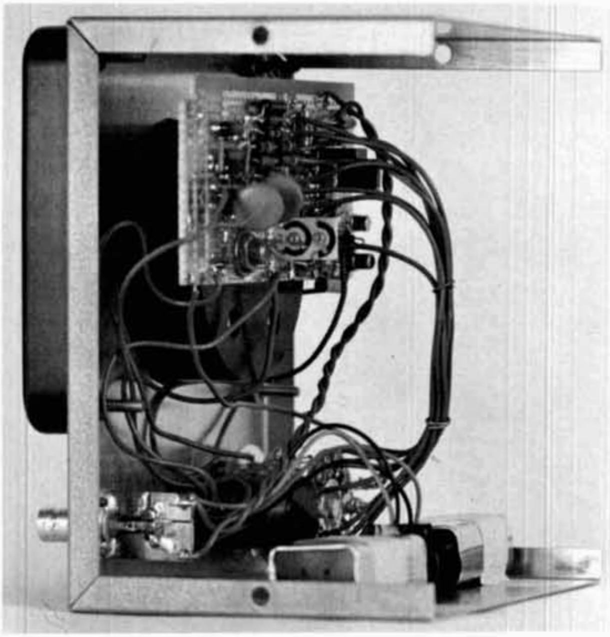
R4-R10 (see **table 1** of text)

S1 dpst toggle switch

S2 2-pole, 7-position rotary wafer switch

Resistor network R11 through R16 divides the zener voltage down to the value required to match V_B. To get the required voltage resolution with a reasonable adjustment range, a miniature 10-turn pot was used at R15. If a 10-turn pot is not available, then both a coarse and a fine adjust pot must be used. Resistors R11 through R14 and R16 reduce the adjustment range of R15; this increases resolution. Resistors R11 through R13 are chosen to establish a reference voltage close to V_B with the wiper of R15 disconnected. Resistors R11 through R13 also serve to maintain a fairly low impedance for the reference voltage. Resistors R14 and R16 are selected to reduce the adjustment range of R15, and to establish a residual voltage close to V_B on the wiper of R15 when the wiper is set at mid-range.

Since the specified minimum open-loop gain of a single μA741 op amp is marginally low for proper operation of the metering circuit, two op amps are connected in cascade. Op amp U2B supplies an additional gain of 100 to the open-loop gain of U2A. A dual op amp, the MC1458CP, was used for U2A and U2B, though two μA741s could have been used or a quad 741 could have been used for the entire unit.



Interior of the rf power wattmeter. All active circuits are installed on the perf board mounted on the meter terminals. The two incandescent lamps are mounted on the small section of printed-circuit board soldered to the BNC jack (lower left).

The meter, M1, is connected in the feedback path of U2. Meter M1 is a 200 μA meter removed from an old vacuum-tube voltmeter. The action of U2 is to supply enough current through the feedback path to maintain the voltage at pin 2 of U2A equal to the reference voltage at pin 3. Since the current flowing in pin 2 of U2A is negligible, the current in the feedback circuit continues through the calibration resistor, R_{CAL}, selected by S2A. This current has no effect on V_B because it is automatically compensated for by U1. By Ohm's law, the feedback current is equal to $\Delta V/R_{CAL}$, where ΔV is the difference between the reference voltage and V_B. On all scales except the 10 mW scale, all feedback current normally passes through meter M1. Diode CR3 conducts when the feedback current is negative, preventing M1 from pinning hard in the negative direction when the circuit is negatively unbalanced. Resistor R17 prevents M1 from being severely overloaded in the positive direction when the circuit is unbalanced positively. Resistor R17 is selected so that M1 reaches full scale somewhat before the output of U2B saturates in the positive direction. Resistor R18 and diode CR4 shunt some feedback current past M1 on the high end of the 10 mW scale to linearize the reading.

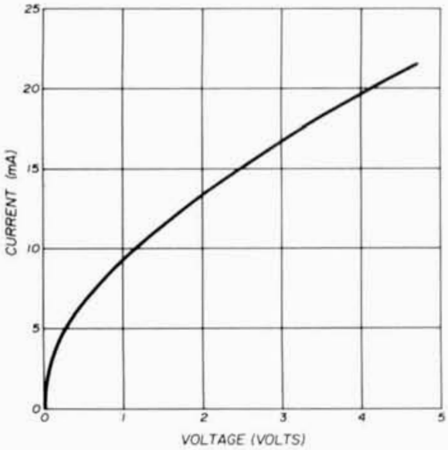


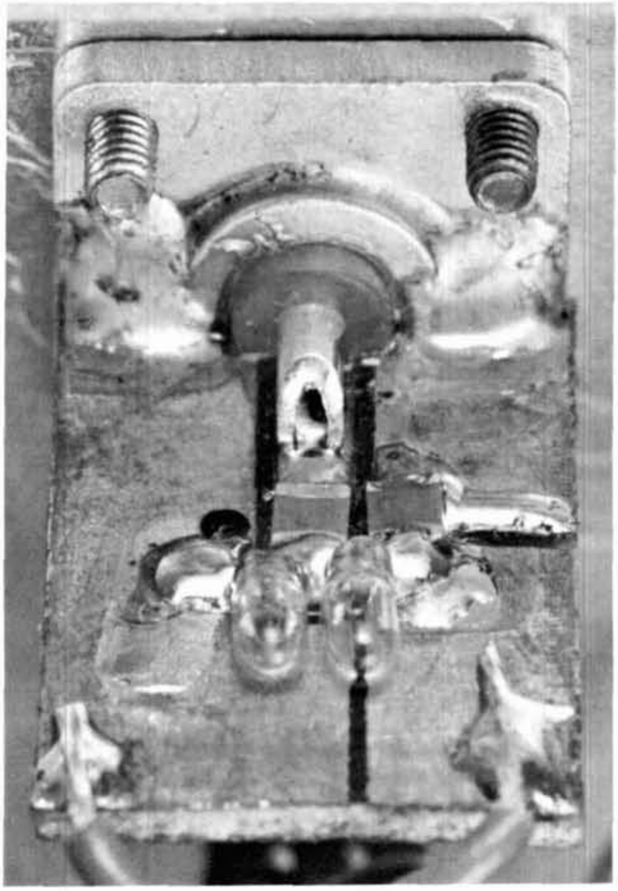
fig. 2. Current-voltage (I-V) characteristic of an incandescent lamp of the type used in the rf power meter.

To allow portable operation, the unit is powered by two 9-volt batteries. Battery voltage *sag* following turn-on contributes some additional drift to the circuit. The miniature transistor radio batteries shown in the photograph sagged excessively and have been replaced by larger 9-volt batteries (Eveready 246). For enhanced stability, somewhat higher battery voltage could be used followed by electronic regulators to 9 or 12 volts. If it is desired to power the unit from the ac line, regulated dc supplies are a must.

The value of calibration resistance, R_{CAL}, for any scale is determined by calculating ΔV, the change in V_B for a given applied rf power level. The total dc power dissipated in the bridge is given by V_B^2 divided by 200 ohms, the series-parallel combination bridge resistance. Since each leg of the bridge has equal resistance, the dc power dissipated in the rf sensor is 1/4 the total dc power dissipated in the bridge. The rf power applied to the sensor, P_{rf}, is equal to the difference in dc power dissipated in the sensor with no rf applied and the dc power dissipated in the sensor with rf applied, as expressed by

$$P_{rf} = \frac{1}{4}\,\frac{V_{BE}^2}{200} - \left(\frac{1}{4}\right)\frac{(V_{BE} - \Delta V)^2}{200} \qquad (1)$$

where V_{BE} is the equilibrium voltage at the top of the bridge with no rf applied and ΔV is the change in



Construction of the rf sensor showing the two incandescent lamps and chip capacitors C1, C2. Components are mounted on a small section of double-clad PC board which is soldered to the rear flange of the BNC connector.

bridge voltage following application of rf. Solving the above equation algebraically for ΔV results in the following solution:

$$\Delta V = V_{BE} - \sqrt{V_{BE}^2 - 800P_{rf}} \qquad (2)$$

A given desired full-scale rf power is used in **eq. 2** to determine a corresponding ΔV. The required value

table 1. Calculated values for calibration resistors for the rf power meter (V_{BE} = 3.5 volts, I_{FS} = 200 μA).

P_{rf}	ΔV	R_{CAL}
10 μW	1.143 mV	R4 = 5.715 ohms
30 μW	3.430 mV	R5 = 17.15 ohms
100 μW	11.450 mV	R6 = 57.25 ohms
300 μW	34.460 mV	R7 = 172.30 ohms
1 mW	116.200 mV	R8 = 581.10 ohms
3 mW	361.500 mV	R9 = 1808.00 ohms
10 mW	1.438 V	7192 ohms (see text)

of R_{CAL} for proper full-scale reading is determined by dividing ΔV by I_{FS}, the full-scale value of meter current. **Table 1** shows the calculated values for the meter shown. Similar calculations should be made when duplicating the wattmeter, using the measured values of V_{BE} and I_{FS}.

The equation for ΔV is the equation of a parabola. Thus, the meter current varies parabolically instead of linearly with rf power. On the low-power scales, however, the voltage varies over such a small sector of the parabola that for all practical purposes it is linear. On the highest scale, the deviation from linear becomes significant, and is such that when the meter is calibrated for an accurate full-scale reading, the indicated power will be less than the actual applied power at levels below full scale. **Table 1** shows that a resistance value of 7192 ohms is needed for proper full-scale calibration of the meter on the 10 mW scale. For accurate calibration near the bottom of the 10 mW scale, a resistance 1000 times the value of the calibration resistor for the 10 μW scale, or 5715 ohms, would be required. Therefore, without some form of compensation, readings made near the bottom of the 10 mW scale will be only 79 per cent of the actual value, or 1 dB low.

To avoid lettering a special nonlinear 10 mW scale on the meter face, I used a compensation network. A compromise value of the calibration resistor R10 was selected at about 6000 ohms to reduce the error at the low end of the 10 mW scale. On the same scale, switch S2B connects the series combination of CR4 and R18 across M1 and R19. Toward the high end of the 10 mW scale, CR4 begins to conduct, shunting the excess current past M1. Variable resistor R18 determines the amount of current shunted away from M1, and variable resistor R19 determines the point at which diode CR4 begins conducting.

Before adjusting R18 and R19, an accurate voltmeter is connected from the top of the bridge (at V_B) to the reference voltage at pin 3 of U2A to read ΔV. A value of ΔV corresponding to a full-scale reading of 10 mW (1.438 volt in the meter shown) is artificially established by adjusting the reference voltage level. Then R18 is adjusted for a full-scale reading of the power meter. A ΔV corresponding to a reading of 6 mW (0.7705 volt in the meter shown) is then set and R19 is adjusted for a reading of 6 mW.

Since these two adjustments interact, they should be repeated several times until the meter reads both 10 mW and 6 mW. Linearization is now complete and the meter should be found to be quite accurate at all power levels.

The adjustment of R19 has no effect on the calibration of the other scales, provided the output of U2B is not at saturation for full-scale deflection of

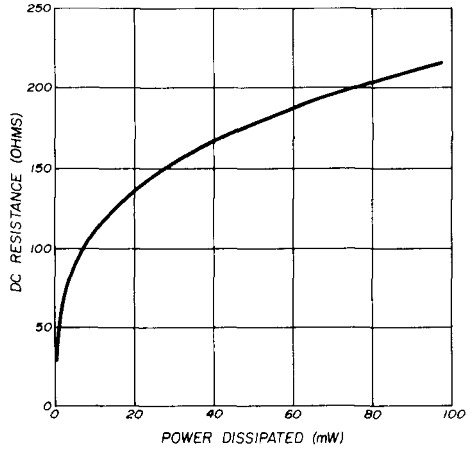


fig. 3. Plot of lamp resistance vs power dissipated in the lamp.

M1. Since the nonlinearity on the 3 mW scale is such that readings on the low end of this scale are only 5 per cent low (−0.23 dB), no linearization was deemed necessary for this and lower scales.

For most accurate results, the values of R_{CAL} used for the lower scales should be as close to the calculated values as possible. Junk box resistors within a per cent or two of the desired values were selected using a digital ohmmeter. Where a proper value could not be found, a series or parallel combination was used.

The dB scale was added to the meter face so power could be read directly in dBm (dB with respect to a milliwatt) and so that losses and gains could be read out directly in dB. The scale position corresponding to each dB mark is given by

$$P = \frac{1}{antilog_{10}(0.1X)} \quad \textbf{(3)}$$

where P is the relative scale position (with 1 = full scale) and X is the number of dB below full scale.

procedure for use

Following turn-on, the meter is allowed to stabilize and the desired scale is selected. In the meter shown, stabilization is almost immediate on the higher power scales; several minutes are required on the 10 μW scale before warm-up drift ceases. Once the meter has sufficiently stabilized, the zero adjust pot, R15, is adjusted for zero reading. The rf power is then applied and readings are made. Provided the lamps are not burned out, the meter will not be damaged by exceeding the maximum power for the scale selected. Since the lamps can safely dissipate 200 mW, a considerable margin of safety exists. Random drift is significant on the 10μW scale; thus the meter zero should be checked between readings for greatest accuracy when using that scale.

measured performance

Following calibration as described, the rf wattmeter was connected through one foot (30cm) of RG-58/U coaxial cable to the calibrated output of a Wavetek 3001 rf generator. Over the frequency range from 1 to 500 MHz, the generator power setting agreed to within 0.3 dB of the wattmeter reading at full scale on all wattmeter scales. The good agreement cannot be taken as a claim for wattmeter accuracy, however, because the specified worst-case generator power error on the most accurate power range is only 1.25 dB.

At 432 MHz, the input swr of the wattmeter was measured at 1.6:1. When measuring power from a 50-ohm source at 432 MHz, the resulting reading is calculated to be 0.24 dB low, due to reflected power. If the impedance of the source is adjusted to conjugately match the load presented by the wattmeter and interconnecting low-loss cable, this source of error is eliminated. On lower frequencies, the swr and resulting mismatch loss are expected to be even less because the parasitic reactance of the lamps and fixtures will be lower.

The wattmeter sees nearly constant use in testing rf circuits and devices of all types. Used directly, or with attenuators, it measures gains and losses. Used with directional couplers, hybrids, or rf bridges, it measures reflected power, return loss, and standing wave ratio. Since the lamps are a high temperature 50-ohm load, the wattmeter is also used as a noise generator for receiver rf amplifier tuneup and testing. In the few months since its construction, the wattmeter has become a virtually indispensable addition to my test bench.

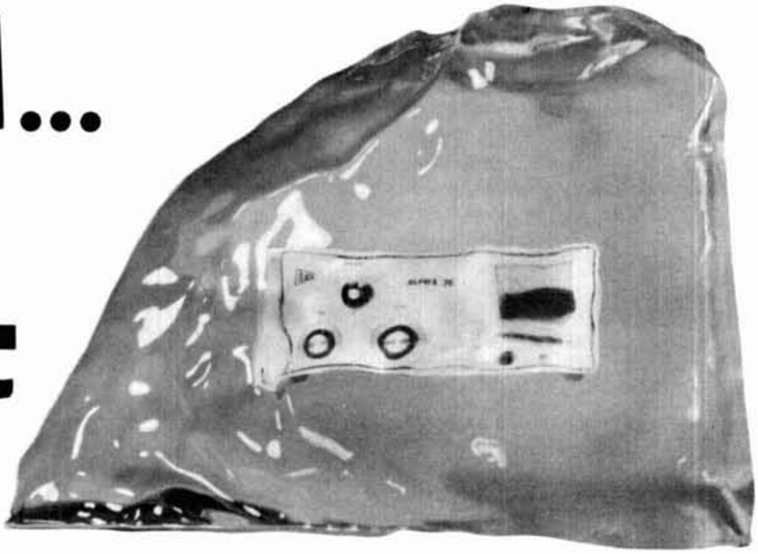
references

1. Robert S. Stein, W6NBI, "How to Use the Lab-Type Rf Power Meter," *ham radio*, April, 1977, page 44.

2. Bruce Clark, K6JYO, "RF Power Detecting Devices," *ham radio*, June, 1970, page 28.

ham radio

ALPHA...
The Cool Kilowatt



It's no trick to make a compact linear amplifier that'll put out a kilowatt or two . . . for a while.

What distinguishes **ALPHA** amplifiers from the rest is their ability to operate *indefinitely* at a full kilowatt average—2 KW PEP—*and stay cool.*

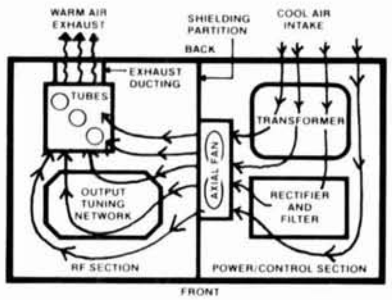
Every professional designer knows that heat is the arch-enemy of high power components. The keys to reliable amplifier performance are, therefore . . .

- Robust, conservatively-rated parts
- Efficient operational design
- Carefully engineered cooling

Short-cutting even one of these areas practically guarantees major failures!

Every **ALPHA** is engineered around ETO's exclusive and highly efficient 'ducted air' cooling system. Cool air is circulated around the power transformer and throughout the cabinet, then ducted through the tube cooling fins and directly out of the cabinet at the rear.

SIMPLIFIED DIAGRAM, ALPHA 374
DUCTED-AIR COOLING SYSTEM
(TOP VIEW)



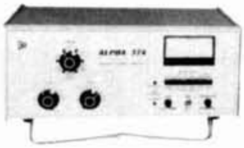
The standard **ALPHA 76** that ran key-down for 18 days at 1000 watts d-c input was finally shut down for inspection. It was in perfect shape, ready to go on indefinitely.

26,000 minutes key-down at full ratings! That typical **ALPHA** performance illustrates why *every* model—including the value-packed **ALPHA 76** and the No-Tune-Up **ALPHA 374**—can carry both a No-Time-Limit (NTL) full-power rating *and* an 18 month factory warranty!

(In shopping for a linear, it pays to investigate very carefully. Most manufacturers *do not* provide positive cooling for critical power supply or plate circuit components. Some widely-distributed models have their transformers located in virtual 'heat chambers'—with even natural air convection cut off—and blow heated air (from the tubes) over other circuitry before exhausting it *forward!*)

Buying or home-brewing, either way you may pick up useful do's and don'ts from ETO's guide, "Everything You Always Wanted To Know About (Comparing) Linears . . ."—It's yours free for the asking.

ALPHA: Sure you can buy a cheaper linear . . . but is that *really* what you want?



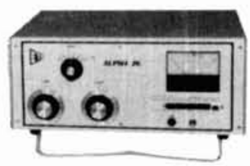
ALPHA 374
- No Tune Up, 80-10 meters!
- 2 KW PEP, 1 KW avg., *NTL*
- RF output typically 1200+ watts PEP into 1.5:1 SWR
- Harmonics −50db; IMD −30 db
- 0.9 cu. ft.; 52 pounds

18 MONTH WARRANTY

ALPHA/VOMAX

New split band speech processor can boost your "talk power" 10db or more when conditions get rough. Very low distortion, easy to install and use with any rig.

18 MONTH WARRANTY



ALPHA 76
- 2 KW PEP, 160-10 meters
- 1000 watts average, *NTL*
- Full pi-L; harmonics −52db
- Nominal efficiency over 60%
- Just 1 cu. ft.; 70 pounds. (Lightweight option, 50 lb.)

18 MONTH WARRANTY

CALL OR WRITE YOUR DEALER—OR ETO DIRECT—FOR DETAILED LITERATURE AND FAST SERVICE ON THESE AND ALL **ALPHA** PRODUCTS

ETO Ehrhorn Technological Operations, Inc.

P.O. Box 708 · Cañon City, Colorado 81212 · (303) 275-1613

drift-correction circuit

for free-running oscillators

If you're bothered by warmup drift in your transceiver, here's a circuit that provides automatic compensation and uses readily available components

The principle of drift correction of an oscillator can be used in receivers or transmitters to compensate for warmup drift. The principle can also be used in new designs using simple free-running oscillators instead of the more complex types that use heterodyne mixing or phase-locked loops.

The idea is simple and straightforward. It can be best explained if you consider the operation of a frequency counter in which an oscillator frequency is measured. If the counter gate time is one second, and if sufficient displays are present, a 14-MHz signal could be displayed as 14.012.345 MHz. If, after the next measuring period, the least-significant digit changes from 5 to 7, for example, the oscillator frequency will have drifted 2 Hz high during that period. To counteract the drift, you could manually tune the oscillator back to its original frequency after each measurement. *But there's a better way — read on.*

In the system described here, oscillator drift is compensated automatically. Only the last digit of the counter display is inspected after a measurement period. It is checked if the number is above or below a fixed value (5 in the example above). For values of 6, 7, 8, or 9, a voltage on a varicap in the oscillator reduces the frequency; for values of 0, 1, 2, 3, and 4, the reverse action occurs.

From this simple example it can be seen that:

1. The oscillator frequency always varies at a slow rate around a fixed value.

2. Stable points occur within 10 Hz from each other over the vfo tuning range.

3. Drift and short-term stability of the oscillator must be within limits. In the example cited, the drift must not exceed a few Hertz per second, otherwise the circuit can't compensate for the drift.

4. The automatic correction should be *very light*. If, after one correction period, the frequency overshoots too much, the remedy is worse than without the system.

For proper operation the correction-circuit time constant must be rather long (but also short enough to counteract the "natural" drift). Because of the long time constant, tuning feels quite normal. After a manual frequency adjustment, the frequency will creep to its nearest "stable" point (actually an unstable point) and will remain there. Because these points are closely spaced you don't notice the operation of the system by listening to a CW or ssb signal.

Note that, for correct operation of the system, the time base frequency doesn't have to be exactly 1 Hz, but the time base must be very stable. Thus the time base must be derived from a crystal oscillator. Counting can be in binary instead of binary-coded decimal format.

circuit description

The circuit is shown in **fig. 1**. Only one stage of a counter is required. A 74LS93 binary counter (U1) counts the oscillator frequency that is to be stabilized. This stage is preceded by a 2N709 transistor

By **Klaas Spaargaren, PA0KSB,** Ruischenstein 29, Amstelveen, Holland

(Q1) to obtain sufficient sensitivity. About 100 mV of input signal is required.

After each counting period, the value of the 2^3 output (Q_C, pin 8, of U1) is stored in a D-type flip-flop, U2, (half of a CD4013) at the rising edge of the time base signal. The flip-flop output drives an integrator (U3) up or down, which in turn drives a varicap in the oscillator to correct the frequency.

The time base frequency that actually determines system stability is derived by dividing the frequency of a crystal oscillator. A 1-MHz crystal oscillates with one input gate of a CD4060, (U4), which also contains 14 binary dividers. In combination with a CD4020, (U5), these two circuits divide the 1-MHz frequency by 2^{18} to about 3.81 Hz, so the stabilization points are spaced at 3.81 times 8 Hz, or 30.5 Hz.

I found that FT241 crystals between 400 and 500 kHz oscillate very well in this circuit. The total dividing factor should be 2^{17} in that case, which can be obtained by using output pin 2 of U4 instead of pin 3, as shown in **fig. 1**.

The counter counts almost continuously. Just after the transfer of the state of the Q_C output to the D-type flip-flop (U2), a short reset pulse is generated by the other half of the flip-flop (U6). To achieve this action, the clock input signal of U6 is delayed by R1C1. After the Q output is set, the flip-flop resets itself because the Q output is connected through R2C2 to its own reset input. The resulting positive-going pulse is about 0.5 microsecond duration (line 3, **fig. 2**). This pulse resets the 74LS93 counter to zero which starts counting again immediately thereafter.

Worth mentioning is the long time constant of the integrator, which is formed by R3 and C3 (**fig. 1**). Capacitor C3 must be a low-leakage type, not an electrolytic. A polystyrene or polycarbonate type will do.

The switches labeled UP and DOWN (**fig. 1**) serve a dual purpose. First, after circuit switch-on, the integrator output can be brought into its range manually; but also, small frequency variations can be made by pushing the UP or DOWN button. So a push-button-controlled fine tuning is obtained, which is convenient if, for example, a CW signal slowly drifts out of a narrow CW-filter passband. (With this system installed you can be sure it's the other station that drifts.)

The CA3140, a very convenient operational amplifier, is used because of its high fet input impedance. The integrator output signal can be monitored on a meter to verify that it's still within its operating range. The action of the varicap in the oscillator must be such that a 10-volt output variation of the integrator shifts the frequency about 3 kHz.

construction

The circuit was built onto a piece of *Vero* board and installed in my CW transceiver. A double-balanced diode mixer is used in my rig, so a high-level oscillator signal was available.

The UP and DOWN pushbuttons were mounted on the transceiver front panel. The control signal was monitored in a particular position of the transceiver meter switch.

Several prototype circuits were built using different construction methods, such as mounting all components on a copper-clad board with the ICs in sockets, but mounted upside down so that the socket pins could be wired directly. All these prototype circuits worked well, so the layout shown shouldn't be too critical. Just make sure that you avoid long wires between the ICs.

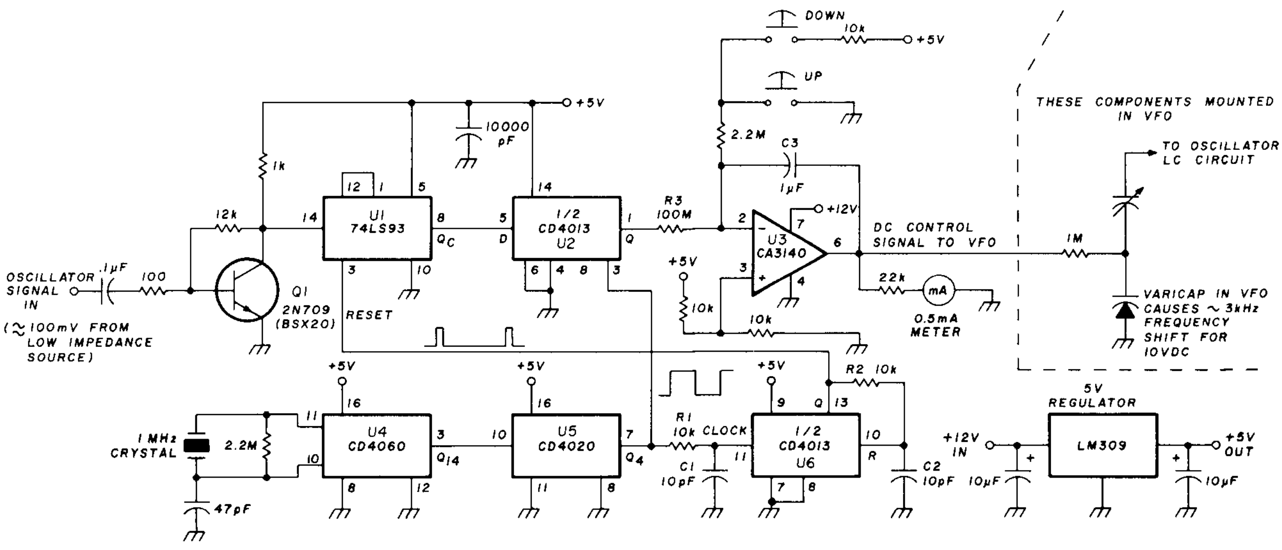


fig. 1. Circuit for vfo stabilization.

The circuit shown has been used for quite some time in my transceiver, which has a free-running oscillator on all bands. The highest frequency is 21 MHz, but the circuit has been used experimentally with oscillators operating to 40 MHz.

Within one minute after switch-on, the transceiver has crystal-quality stability on all bands. The 30-Hz frequency spacing between stabilization ponts is more than adequate for CW and ssb work. Also, during transmission, with about 200 watts to the antenna, a jump to another stabilization point has never occurred.

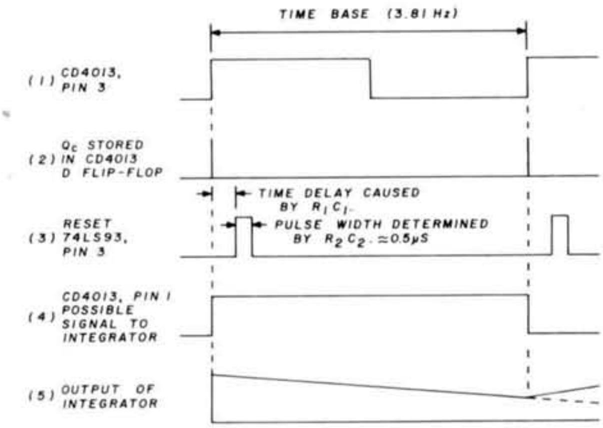


fig. 2. Timing sequency of signals in the circuit of fig. 1. The time base is 3.8 Hz.

A kind of proportional control system was tried instead of the constant-speed system described above. In this system, the corrective action depended on the *offset* value. Although the control could be measured (to be more effective), I believe this idea is really not worth the more complex electronic circuitry. Reason: with both systems a vfo becomes virtually drift-free, and both systems are not noticed during operation.

conclusion

The system described here doesn't turn a bad vfo into a good one but helps to make a good one even better. Especially where a low-noise oscillator is important, as for local oscillators in high dynamic-range front ends for receivers to obtain low reciprocal mixing, I believe this technique could be applied successfully at least for hf-band applications.

Synthesized oscillators appear to be noisier than good free-runnng types so if this system is used in combination with a digital frequency read out, on a well-designed, free-running oscillator, a much simpler system results than is possible with fully synthesized oscillators, giving at least the same or better results.

ham radio

SPECSCAN-S Programmable Scanner

.. . The ONLY Digital Scanner made for the IC-22S. It adds a whole new dimension to 2M FM. If any other accessory can make your IC-22S as versatile as the SPECSCAN-S does, Buy It!

- Scans the entire 146-147 MHz Band in 15 kHz steps, automatically, or manually
- Automatically reads out your other 21 channels when they are used.
- Can be used as a remote programming unit with the radio hidden under the seat, etc.
- Exclusive VARI-SCAN™ control allows full control of scan rate *in either direction*!
- Full compatibility with the duplex mode.
- Uses state of the art CMOS logic.
- Low current drain. Less than 500 mA.
- RF immune. Unaffected by nearby equipment and in high RF areas.
- Large LED display lets you see every channel at a glance.
- Manual mode features lets you scan past any portion of the band and manually select a desired channel.
- Easy installation. Uses only one matrix position leaving the other 21 useable for manual programming.
- Plugs into 9 pin accessory socket.
- Adjustable scan delay feature.
- 90 day limited warranty.

ONLY **149.95** Amateur Net

Send S.A.S.E. for more SPECSCAN info.

Send S.A.S.E. for more SPECSCAN information

arma
amateur radio manufacturer's association

Our 1977 Convention Season is over, and we would like to thank the thousands who visited our booths.

We have some new display units at reduced prices. Most of these were opened and shown at a convention and put back in their boxes. All are new units and carry factory warranty.

	List	Display
ATLAS		
Model 210X, less blanker	$679	$579
BRIMSTONE		
144, no warranty	$650	$349
DENTRON		
160-10L/572B amplifier	$574	$499
DRAKE		
SSR-1 gen. cov. rcvr.	$350	$259
MN-4 Antenna tuner	$120	$105
TR-4CW w/RIT xcvr	$799	$619

	List	Display
ICOM		
IC-22S	$299	$249
IC-202	$259	$220
IC-502	$249	$210
IC-215	$229	$189
KLM		
Multi 2700	$756	$666
SWAN		
700CX	$649	$549
TEN-TEC		
Triton IV	$699	$599

Terms of Sale: Cash, no trade. You may use your **MASTERCHARGE** or **VISA**. Many items are one-of-a-kind. We suggest your calling first to assure getting the unit you want.

Midland 13-510

- PLL Synthesized
- Switchable: 25W or 1W
- LED Frequency Indication
- 10kHz Steps Plus 5kHz Shift
- Compact: 2-5/8" x 6-3/4" x 9-5/8"

$359 Cash;
No-Trade Special
List Price $399.00

See us at the **SAROC Convention**, Las Vegas, Nevada, **January 5-8, 1978.**

Thanks for your great response to our 1977 Buyers Guide. The **78 Buyers Guide** will be available soon. Watch our ads to get your NEW BUYERS GUIDE.

Model 43
$120 + shipping

BIRD

. . . If you have been having difficulty locating the Wattmeter or element just right for you. . . . You may have been looking in the wrong places. Our large inventory of most common elements lets you get what you want when you need it. Give us a call first for your BIRD needs.

SPECTRONICS, INC.

1009 GARFIELD
OAK PARK, IL. 60304
312-848-6777
TELEX 72:8310

HOURS

STORE HOURS:
Mon-Thurs 9:30-6:00, Fri. 9:30-8:00
Sat. 9:30-3:00, Closed Sun. & Holidays.

master charge — BankAmericard

More Details? CHECK—OFF Page 150

active bandpass filters — some staggering thoughts

Here's a rundown on stagger-tuned filters using op amps as active devices — great idea for many amateur applications

Applications for active bandpass filters in the audio-frequency range can be found in every part of amateur radio. Audio selectivity for CW, speech processing for ssb, tone-detector filters for RTTY, and control-tone separation for fm repeaters are only a few of the uses. In this article you'll learn an easy way to design and build stagger-tuned operational-amplifier active filters to fit your requirements. All you need is one of the readily available hand-held scientific calculators (or some other method for calculating square roots and logarithms).

Perhaps you've seen other types of *active filters* or filter designs using LC components. Why use stagger-tuned filters, and why use active filters? It's easy to build very narrowband audio filters by cascading, one after another, several identical simple filter sections. This may be adequate for some tasks but can often leave a lot to be desired in terms of transient response (*ringing*), peaked or *narrow-nosed* amplitude response, and poor skirt selectivity (*shape factor*). Conventional circuits using inductors can give excellent performance *if well designed, which is* often done with complex computer-aided design programs. But inductors are often large and hard to tune. Many amateurs have been discouraged by the need to add or remove turns from the 88-mH toroidal inductors common in RTTY use.

features

The filters described here offer many advantages. They give amplitude response with flat or slightly rippled characteristics in-band. Out of band, they have excellent skirt selectivity and a shape factor that improves directly as more filter sections are added. As a bonus, the transient response is usually much better than narrow-nosed filters. Best of all, each stage can be tuned separately with no measurable interaction or detuning of the other stages — this is a real plus for experimenters.

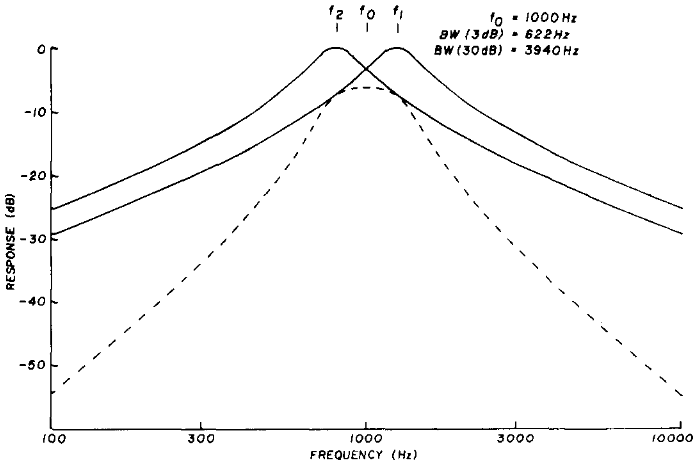


fig. 1. Typical stagger-tuned response. By choosing the correct peak frequency, f_n, and Q for each stage we get the response shown.

Now the bad news (which isn't really too hard to take). Stagger tuning requires that each stage provide enough gain so that the sum of the stage gains is *greater than that of the overall filter*. This is because of *staggering loss*, of which you'll see more shortly. With op amp ICs and their large open-loop (no feedback applied) gain, this parameter turns out to be of little concern. Another problem is that if one

By **Terry A. Conboy, WB6GRZ**, 1231 Crestview Drive, San Carlos, California 94070

of the stages is out of tune, the filter response can be poorer than in designs that purposely introduce interaction between filter sections, as in most LC designs or in *leapfrog* active filters, which are much more difficult to design.

description

The stagger-tuned filter is made of two or more stages, each having a different peak frequency, f_n, with an associated Q (which *may* be the same as the Q of *one* of the other stages), and a certain amount of gain, G. The sum, in dB, of the gains versus frequency can be arranged to give a flat response over the band of interest. **Fig. 1** shows how this happens. In the area between the two peaks one response rises as the other falls. By choosing the right f_n and Q for each stage, we get the response shown. Note that, at the center frequency of the overall response f_O (where the stages have equal loss), the net loss is *twice* as much (in dB). This is the stagger loss, S, which must be made up by the sum of the individual stage gains to give unity gain overall. Compare **figs. 1** and **2**. **Fig. 2** shows a two-stage nonstaggered or "synchronously tuned" filter response with the same 3-dB bandwidth. Note the poorer skirts and the much rounder passband.

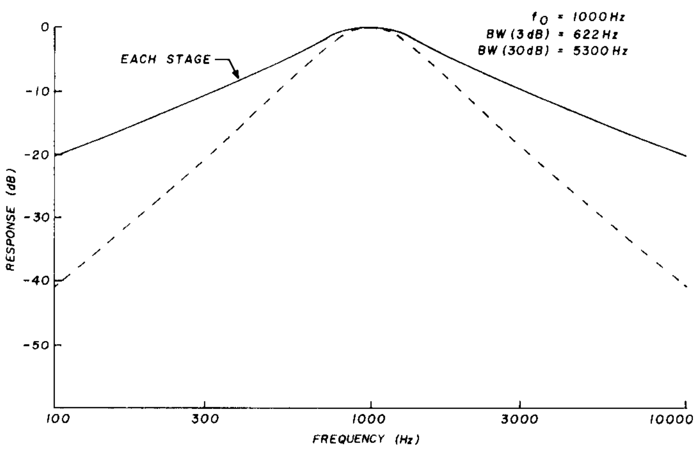


fig. 2. Response of a two-stage synchronously tuned filter (compare with the response in fig. 1).

In the stagger-tuned filter, the shape of each stage response is of the classic single-resonator shape (the same as that generated by a single parallel LC circuit with a shunt resistance to define the Q). The amplitude response is defined mathematically (for those of you itching to use your HP-25) as follows:

$$\frac{V_{out}}{V_{in}} = -\ 10 \log_{10} \left[1 + Q^2\left(\frac{f}{f_n} - \frac{f_n}{f}\right)\right]^2 \qquad \textbf{(1)}$$

Eq. 1 is of interest only and is not necessary for designing a filter. It can be used for analysis, however. You can find the response of each stage then add all responses together to find the overall filter response. One thing that's important to note is that the curve has *geometric symmetry*. All this means is that if the upper (x) dB-down point is two times the center frequency, then the lower (x) dB point will be at one-half f_n. This relationship is expressed by

$$f_n = \sqrt{f_L f_H} \qquad \textbf{(2)}$$

where f_L is a frequency below f_n with the same attenuation as f_H, which is higher than f_n. Note that f_n is *not* the arithmetic average of f_L and f_H. The resultant overall filter response will exhibit the same type of symmetry as the stages of which it is composed. So **eq. 2** holds for the complete filter, where n is zero.

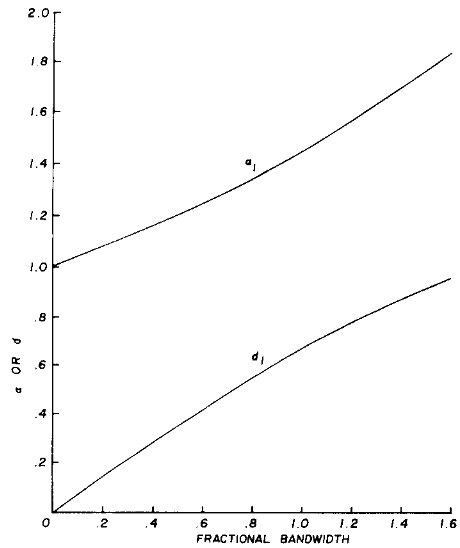


fig. 3. A two-stage Butterworth filter showing α or d as functions of fractional bandwidth, δ.

Design procedure. In designing the filter, the first thing is to decide what type of filter is wanted. The Butterworth, or maximally flat filter, provides the flattest passband and a good skirt shape. The Chebychev or equal-ripple filter gives ripples in the passband (1 dB in the designs to follow), but in turn, it has very rapid cutoff of the band. Many other filter types are in use, but these two will serve you well.

Next you must determine how many stages you want. This requirement is determined by the required shape factor, with the other consideration being how much circuitry you want to build. High Qs and more precise tuning of the stages are also requirements of the higher-performance designs.

Shape factor. To refresh your memory, shape

table 1. Shape factors for Butterworth and Chebychev filter designs.

number of stages	butterworth 3/30 dB	butterworth 6/60 dB	1-dB chebychev 3/30 dB	1-dB chebychev 6/60 dB
1	31.60	577.00	31.60	577.0
2	5.62	24.00	4.70	20.8
3	3.16	8.33	2.30	6.6
4	2.37	4.90	1.75	3.5
5	1.99	3.57	1.60	2.5
6	1.78	2.89	1.30	2.0

factor (also called *selectivity ratio*) is the ratio of bandwidth at a higher attenuation to the bandwidth at a lower attenuation. Most common is the 6 - 60-dB

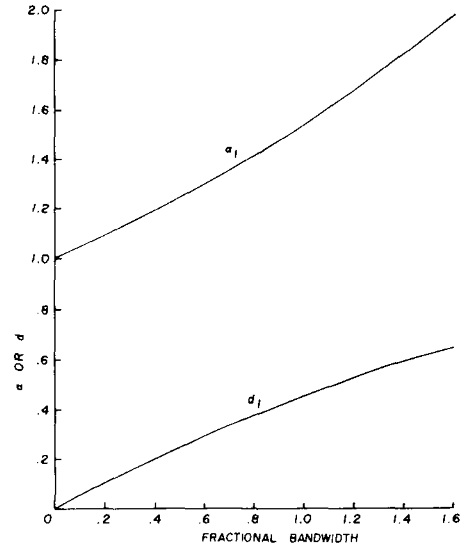


fig. 4. Three-stage Butterworth filter showing α or d versus fractional bandwidth, δ.

shape factor. **Table 1** shows this shape factor versus the number of stages for Butterworth and 1-dB-ripple Chebychev filters. Also given is the 3 - 30-dB shape factor.

After deciding the type and complexity of the filter, specify the lower 3-dB point, $f_L(3\ dB)$, and the

table 2. Approximations for fractional bandwidth, δ, equal to or less than 0.3 for Butterworth and Chebychev active filters.

Butterworth

two-stage

$\alpha_1 = 1 + 0.365\delta$ $\qquad$ $d_1 = 0.707\delta$

three-stage

$\alpha_1 = 1 + 0.450\delta$ $\qquad$ $d_1 = 0.500\delta$

four-stage

$\alpha_1 = 1 + 0.485\delta$ $\qquad$ $d_1 = 0.380\delta$

$\alpha_3 = 1 + 0.195\delta$ $\qquad$ $d_3 = 0.920\delta$

Chebychev (1-dB ripple)

two-stage

$\alpha_1 = 1 + 0.365\delta$ $\qquad$ $d_1 = 0.433\delta$

three-stage

$\alpha_1 = 1 + 0.450\delta$ $\qquad$ $d_1 = 0.220\delta$

upper 3-dB point, $f_H(3\ dB)$. Then use **eq. 2** to find f_O. Next find δ, the fractional bandwidth.

$$\delta = \frac{(f_H - f_L)}{f_0} \tag{3}$$

This parameter, δ, is the main design factor. It's used to find tuning data for each stage. Refer to **figs. 3, 4,** or **5** for Butterworth filters of two, three, or four stages respectively. For a 1-dB Chebychev filter of

table 3. Design equations for two-, three-, and four-stage filters. Parameter α is the ratio of resonant to filter center frequency.

for two-stage filters

$f_1 = (f_0)(\alpha_1)$ $\qquad$ $f_2 = f_0/\alpha_1$

$Q_1 = 1/d_1$ $\qquad$ $Q_2 = 1/d_1$

$G_1 = G_2 = (S + G_0)/2$

for three-stage filters

$f_1 = (f_0)(\alpha_1)$ $\qquad$ $f_2 = f_0$ $\qquad$ $f_3 = f_0/\alpha_1$

$Q_1 = 1/d_1$ $\qquad$ $Q_2 = 1/\delta$ $\qquad$ $Q_3 = 1/d_1$

$G_1 = G_2 = G_3 = (S + G_0)/3$

for four-stage filters

$f_1 = (f_0)(\alpha_1)$ $\qquad$ $f_2 = (f_0)(\alpha_3)$ $\qquad$ $f_3 = f_0/\alpha_3$ $\qquad$ $f_4 = f_0/\alpha_1$

$Q_1 = 1/d_1$ $\qquad$ $Q_2 = 1/d_3$ $\qquad$ $Q_3 = 1/d_3$ $\qquad$ $Q_4 = 1/d_1$

$G_1 = G_2 = G_3 = G_4 = (S + G_0)/4$

two or three stages, see **fig. 6** or **7** respectively. From the appropriate figure, obtain α_1 and d_1 (and α_3 and d_3 for a four stage Butterworth). If your filter has a δ 0.3, **table 2** offers approximations for α and d, which usually give better accuracy than reading from the graph. Decide what overall gain, G_O, in dB you want from the filter, then use **table 3** to find the tuning frequency, the Q, and the gain for each stage.

It's a good idea to organize the stages as given, with the highest-frequency stage first. (This mini-

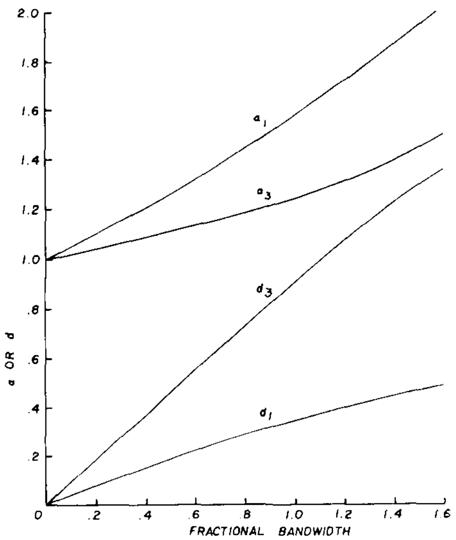


fig. 5. Four-stage Butterworth, with α or d as functions of fractional bandwidth, δ.

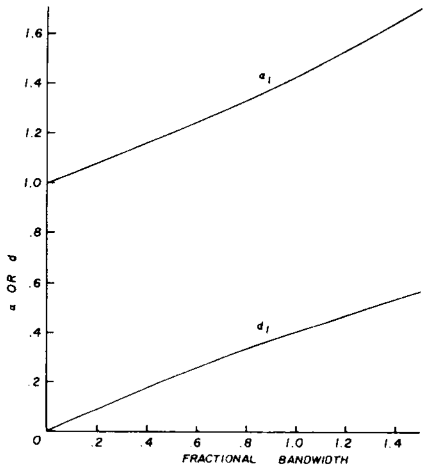


fig. 6. A Chebychev two-stage filter (1-dB ripple) showing α or d as functions of fractional bandwidth, δ.

mizes harmonic distortion for the overall filter.) The higher-frequency stages have the lowest open-loop gain, which means that feedback will be less effective in reducing the distortion in these circuits than in the lower-frequency stages. Putting the low-frequency stages last gives maximum attenuation to any harmonics generated by the higher frequency stages.

Multiple-feedback circuit. Now that you know what the stages must do, the only thing remaining is to design circuits with the required f_n, Q, and G. For stages with low Q (less than 10), the multiple feedback (MFB) circuit in **fig. 9** performs well. Almost any op amp will work here, but depending on its bandwidth, limitations exist on maximum Q and maximum f_n.

The upper limit on Q for the MFB circuit is given by the smaller of

$$Q_{max} \cong \sqrt{f_T/(5f_n)}, \qquad \textbf{(4)}$$
$$Q_{max} \cong 10$$

where f_T is the frequency at which the op-amp gain equals zero dB (unity gain). The frequency, f_n, should be limited to about 1 per cent of f_T (10 kHz for a 1-MHz f_T amplifier, such as the type 741).

These restrictions minimize the effects of amplifier gain on f_n and Q, which ensures accurate calculation of these parameters and freedom from drift because of amplifier gain changes with temperature.

The component values in the MFB circuit can be found easily. Choose convenient value of capacitor, C. The resistors are:

$$R3 = \frac{Q}{\pi f_n C} \qquad \textbf{(5)}$$

$$R1 = \frac{R3}{2 \cdot 10^{(G/20)}} \qquad \textbf{(6)}$$

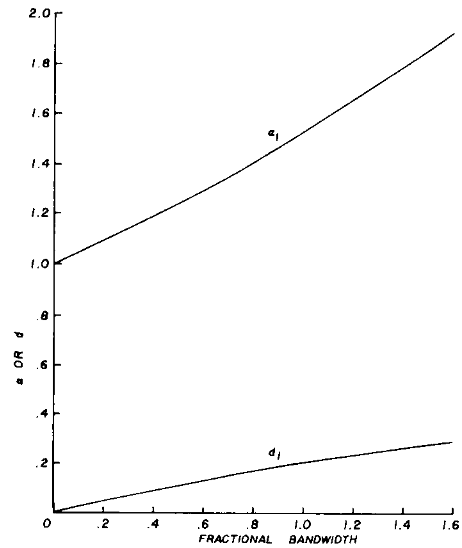


fig. 7. Chebychev filter with three stages (1-dB ripple) showing α or d versus fractional bandwidth, δ.

$$R2 = \frac{1}{[(2\pi f_n C)^2 R3 - (1/R)]} \qquad \textbf{(7)}$$

Note that $[10^{(G/20)}$ equals $antilog_{10}(G/20)]$, where G is the gain, as described previously.

State-variable design. The limitations of the MFB circuit require that a higher-performance circuit be used in some cases. The state-variable circuit in **fig. 10** can do some amazing things. It can provide very high Qs (over 100) and is hard to beat for stability and lack of sensitivity to passive component drift. However, it does take two more op amps and four more resistors than the MFB design.

There are several degrees of freedom in this design. Choose C, $R2$, and $R4$ for convenience.* The remaining resistors are found from

$$R1 = R_2 Q/(10^{\,G/20}) \qquad \textbf{(8)}$$

$$R3 = \frac{1 - \frac{f_n}{f_T}}{2\pi f_n C} \qquad \textbf{(9)}$$

$$R5 = \frac{R4}{\left[\dfrac{2Q + (10^{G/20})}{\left[1 + \dfrac{4Q + (10^{G/20})}{\frac{f_T}{f_n}}\right]}\right] - 1} \qquad \textbf{(10)}$$

*A "convenient" capacitor is one as small as possible that doesn't require overly large resistors. Choosing resistors too much above 100k (for 741s or similar op amps) can lead to excessive dc offsets because of input-bias currents. Fet input op amps have extremely small bias currents and will tolerate resistors in the tens of megohms.

For the MFB circuit, capacitors with about 10 kilohms of reactance are in the ballpark. For instance, at 1500 Hz, a 0.01 μF capacitor is suitable. In the state-variable circuit, capacitors of about 100k ohms of reactance can be used, such as 0.001 μF at 1500 Hz. A reasonable value for $R2$ or $R4$ is between 10k - 100k.

Both circuits can be impedance-scaled if the calculations of component values reveal one or more values that are out of the desirable range. This means that all resistor values may be changed so long as all change by the *same ratio*, and the capacitors change by the *reciprocal* of that ratio. For example, if you find a 300k resistor where you'd like to have 100k, you can change it by making all the resistors one-third of their original value and by making the capacitors three times as large. In the state-variable circuit, $R4$ and $R5$ may be changed independently of the other resistors so long as the ratio R4:R5 is constant.

design example

The design procedure is used to create an input prelimiter filter for an RTTY demodulator (TU). We'll

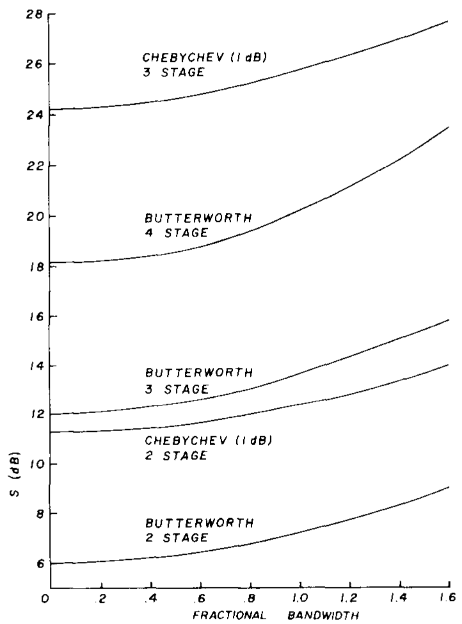


fig. 8. Loss due to staggering, S, as functions of fractional bandwidth, δ, for various active filters.

choose an overall gain of 30 dB to provide adequate drive to the limiter from normal speaker signal levels. To give flat response in-band and reasonable delay distortion (associated with the transient response), we'll choose a Butterworth design. For good selectivity a four-stage configuration will be used. For 170-Hz shift and 45.45 Baud (standard 60 wpm), the

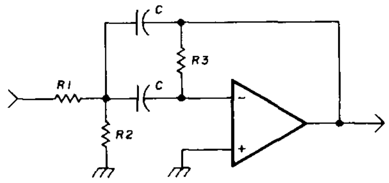


fig. 9. Schematic showing the MFB, or multiple-feedback circuit.

CCIR formula shows the bandwidth to be 246 Hz. To allow for tuning error and drift, a 300-Hz bandwidth at the 3-dB points will be used. The mark frequency is 2125 Hz; the space frequency is 2295 Hz. Thus the passband should be from $f_L = 2060\ Hz$ to $f_H = 2360\ Hz$. **Eq. 2** gives

$$f_o = \sqrt{(2060)\,(2360)} = 2205\ Hz$$

From **eq. 3** we obtain the fractional bandwidth

$$\delta = \frac{(2360 - 2060)}{2205} = 0.1361$$

Since δ is less than 0.3, use the approximations in **table 2.**

$$\alpha_1 = 1 + (0.485)\,(0.1361) = 1.066$$
$$d_1 = (0.38)\,(0.1361) = 0.0517$$
$$\alpha_3 = 1 + (0.195)\,(0.1361) = 1.0265$$
$$d_3 = (0.92)\,(0.1361) = 0.1252$$

From **fig. 8** the loss due to staggering, $S_r = 18.2$ dB and from **table 3** we have

$$f_1 = (2205)(1.066) = 2351\ Hz \qquad Q_1 = 1/0.0517 = 19.3$$
$$f_2 = (2205)(1.0265) = 2263\ Hz \qquad Q_2 = 1/0.1252 = 8.0$$
$$f_3 = 2200/1.0265 = 2148\ Hz \qquad Q_3 = 1/0.1252 = 8.0$$
$$f_4 = 2205/1.066 = 2068\ Hz \qquad Q_4 = 1/0.0517 = 19.3$$

and $G = (18.2 + 30)/4 = 12.05\ dB$ (per stage).

It's apparent that the state-variable circuit must be used for the first and fourth stages ($Q > than\ 10$). At 2351 Hz a 741-type op amp is capable of

$$Q_{max} \approx \sqrt{\frac{10^6}{5(2351)}} = 9.2$$

Since the second and third stages have Qs less than this, the MFB circuit is usable.

Let the capacitors in the state-variable stages be 0.001 μF and the capacitors in the MFB stages be 0.01 μF. Let R2 and R4 be 100k in stages 1 and 4. From **eqs. 8, 9,** and **10** we obtain the values for the first state-variable stage:

$$R1 = (100k)\,(19.3/10^{12.05/20}) = 482k$$

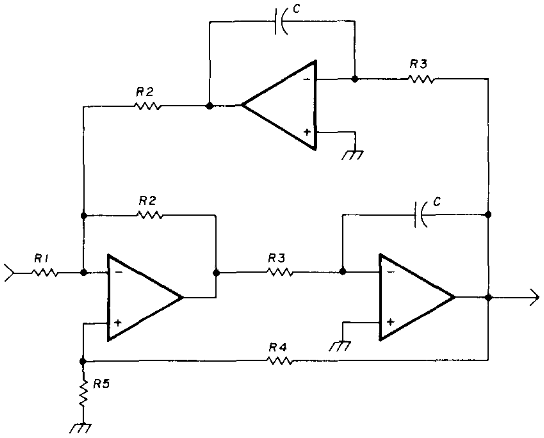


fig. 10. Schematic of the state-variable stage.

$$R3 = \frac{1 - \left[\frac{2351}{10^6}\right]}{(2\pi)(2351)(10^{-9})} = 67.54k$$

$$R5 = \frac{10^5}{\left[\frac{(2)(19.3 + 10^{12.05/20})}{1 + \frac{(4)(19.3 + 10^{12.05/20})}{\frac{10^6}{2351}}}\right] - 1} = 2686 \ ohms$$

Similarly, for stage four, we find

$$R1 = 482k \ ohms$$
$$R3 = 76.8k \ ohms$$
$$R5 = 2626 \ ohms$$

Now for stage two, using **eqs. 5, 6,** and **7,**

$$R3 = 8/\pi(2263)(0.01 \times 10^{-6}) = 112.5k \ ohms$$

$$R1 = 112.5k/(2)(10^{12.05/20}) = 14.05k \ ohms$$

$$R2 = \frac{1}{[2\pi(2263)(0.01 \times 10^{-6})]^2 \ [112.5k - \left(\frac{1}{14.05k}\right)]} = 439.6 \ ohms$$

And in the same fashion, for stage three, we have

$$R3 = 118.6k \ ohms$$
$$R1 = 14.8k \ ohms$$
$$R2 = 462.9k \ ohms$$

construction

The filter was constructed using two MC3303 quad op amps. Combinations of one per cent resistors were used to give the calculated values within 0.5 per cent or less, nominally. Polystyrene capacitors, 1 per cent tolerance, were used in all sections.

The measured response of the filter before tuning is shown in **figs. 11** and **12**. The calculated response which is given for comparison, was generated using **eq. 1** for each stage and then adding the four responses.

Normally, filter sections will need trimming for frequency and/or Q. In many low Q filters (δ 0.3), 5-per cent tolerance resistors will give quite satisfactory results without trimming. The only penalty may be slight center frequency error and perhaps a small amount of skew in the passband frequency response.

For the narrowband filters, and especially those with three or four stages, an audio generator, ac voltmeter, and frequency counter will help in trimming each stage independently to the required parameters. In the state-variable circuit, adjust both R3 values to set the center frequency, then use R5 to fix the Q. Remember Q is the 3-dB bandwidth divided by f_n. For an MFB stage, adjust R3 to give the desired 3-dB bandwidth. Then adjust R2 to set f_n. Varying R2 has virtually no effect on the bandwidth, which means the Q changes at the same rate as f_n. After tuning the RTTY demodulator input filter, the overall response was essentially indistinguishable from the calculated response.

components

Generally, components should be the best you can get. Metal-film resistors and polystyrene or mylar capacitors are hard to beat, but may be *overkill.* Stay away from capacitors designed for bypass or coupling use; their tolerance is poor, as is their stability. Carbon resistors are usually adequate in all but the narrowest filters. For op amps, 741s are suitable (as are the 1458 dual versions and the quads like the

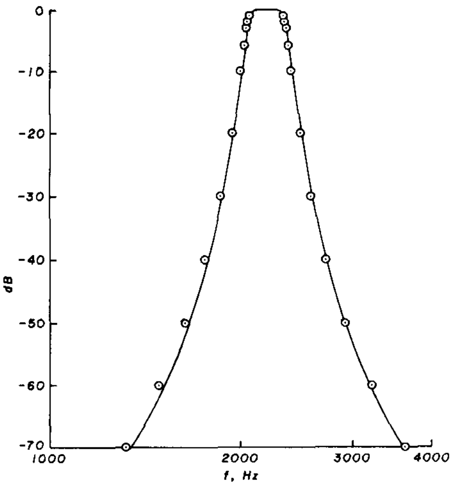


fig. 11. Response as a function of frequency for an RTTY input filter. Solid line: calculated; dots: measured data before tuning.

3303), when used within the limitations given above. The LM318 op amp gives much greater freedom from Q drift (in the state-variable circuit) and f_n drift (in the MFB circuit). Some of the new wideband fet-input op amps, such as the LF356, should be excellent performers. When external frequency compensation is required, use the values specified for unity gain amplifiers.

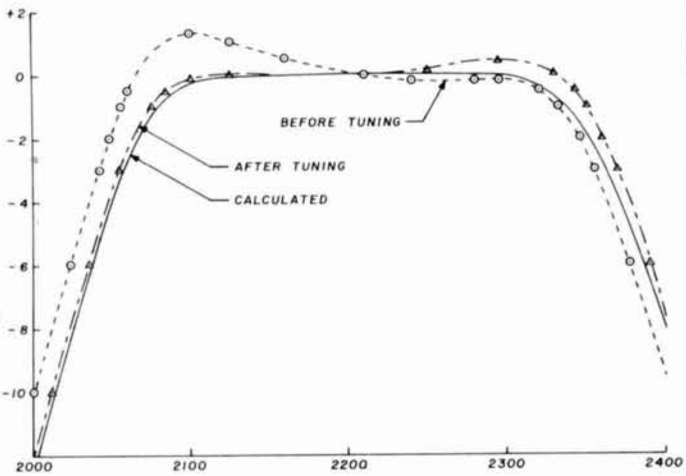


fig. 12. Passband response of an RTTY input filter.

When interfacing active filters, take care that the source impedance driving the filter is very low, i.e., less than 1 per cent of R1 in either circuit. Another op amp or a voltage follower provides an excellent driver. If the requirement for a low impedance can't be met, deduct the source resistance from the value of R1 in the first stage.

You've seen an easy-to-use method for designing stagger-tuned active filters to your own needs, and have learned to avoid some of the possible pitfalls. Now you can replace that filter you borrowed from someone else's circuit that never did work exactly the way you wanted.

bibliography

1. G.E. Valley and H.T. Wallman, *Vacuum-Tube Amplifiers* (Stagger-tuned Butterworth filters), *MIT Radiation Laboratory Series*, 1948, pages 180-191.

2. J.M. Pettit and M.M. McWhorter, *Electronic Amplifier Circuits* (Butterworth and Chebychev filters), McGraw-Hill, New York, 1961, pages 221-229.

3. *Reference Data for Radio Engineers*, ITT, 1975, (necessary bandwidth, page 1-23; filter shapes, page 8-5; MFB stage, page 10-12).

4. Lee Schaeffer, "Op Amp Active Filters — Simple to Design Once You Know the Game," *EDN*, April 20, 1976, pages 79-84 (state-variable filters).

5. Leonard H. Anderson, "Top-Coupled Bandpass Filter — a Chebychev Design," *ham radio*, June, 1977, pages 37-40.

ham radio

On most 4, 5 and 6-element antennas, only 3 elements at any one time on any one band are working. The rest are goofing off.

So counting elements is no way to judge an antenna.

This 3-bander uses every one of its 4 elements all the time for maximum forward gain and maximum front-to-back ratio.

And that adds up to an antenna that works harder. With no idle elements to increase windage and bulk.

A good reason why the TB-4HA is known both for performance *and* toughness.

In fact, all of Swan's beam antennas share a reputation for working harder for every dollar you invest in them.

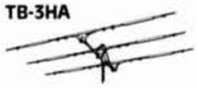
Swan beams are precision engineered for a full 2000-watt PEP rating and a VSWR of 1.5:1 or better at resonance. And besides optimum gain and front-to-back ratio, they're easy to install and tune.

Order a Swan beam today. Use your Swan credit card. Applications at your dealer or write to us. Who needs antennas that goof off?

TB-4HA

Heavy-duty, four-working-element antenna for 10, 15 and 20 meters. $259.95

TB-3HA

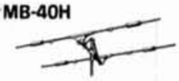


Heavy-duty, three-working-element antenna for 10, 15 and 20 meters. $199.95

TB-2A

Light-weight, two-working-element antenna for 10, 15 and 20 meters. $129.95

MB-40H



Heavy-duty, two-working-element antenna for 40 meters. $199.95

SWAN BEAM ANTENNA SPECIFICATIONS. For 52-ohm coaxial feedlines.

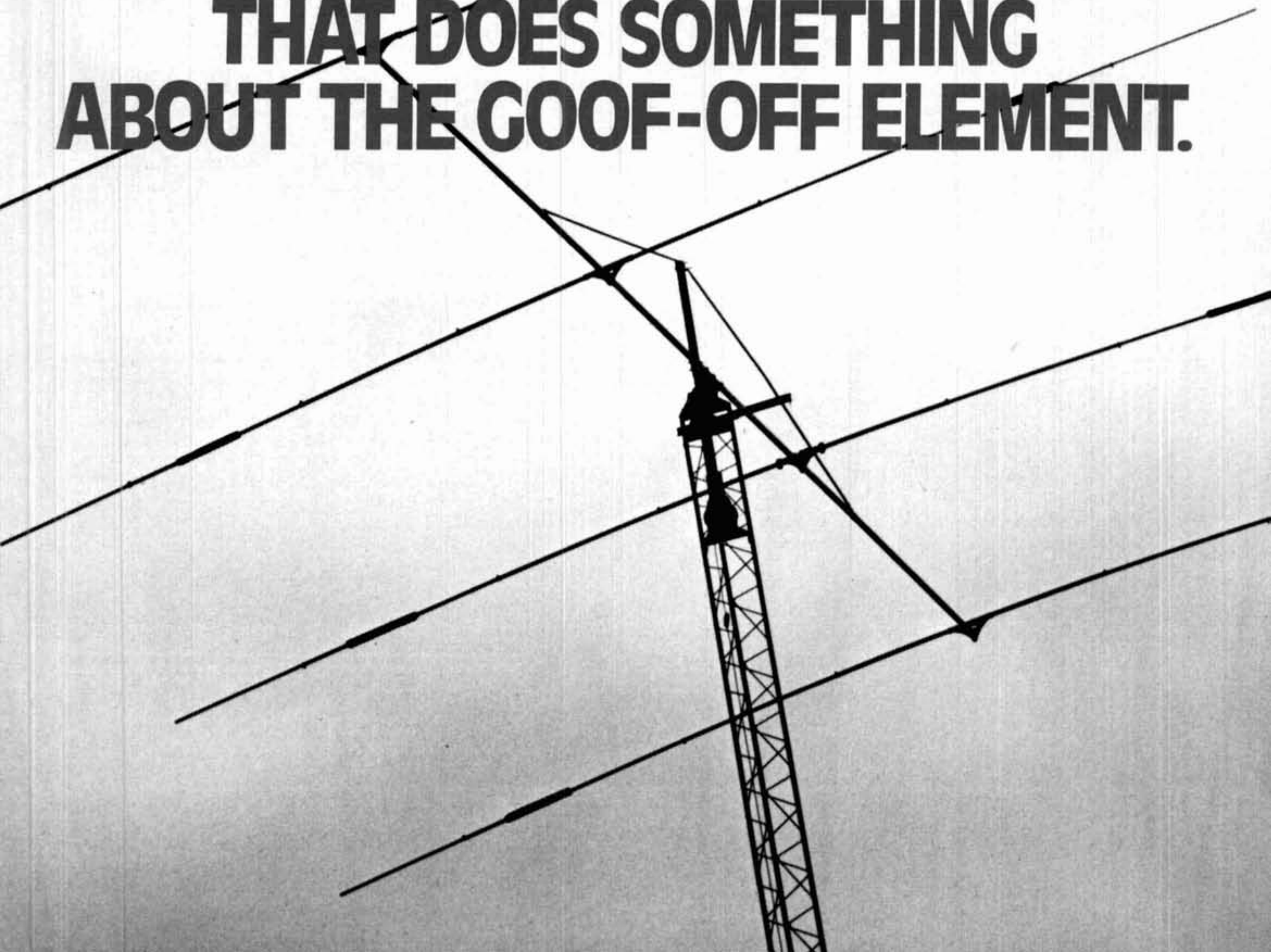
Antenna Model Number	Boom Length & Diameter	Longest Element	Turning Radius	Maximum Wind Survival	Wind Load @ 80 MPH	Wind Surface Area	Net Weight
TB-4HA	24' x 1.5"	28'-10"	18'-6"	100 mph	148 lbs.	6 sq.ft.	54 lbs.
TB-3HA	16' x 1.5"	28'-2"	16'	100 mph	110 lbs.	4 sq.ft.	44 lbs.
TB-2A	6.5' x 1.5"	27'-8"	14'-3"	80 mph	60 lbs.	1.8 sq.ft.	18 lbs.
MB-40H	15.75'x1.5"	30'-4"	17'-6"	100 mph	80 lbs.	2.5 sq.ft.	40 lbs.

(Prices FOB Oceanside, CA)

Dealers throughout the world or order direct from

SWAN® ELECTRONICS
A subsidiary of Cubic Corporation
305 Airport Road, Oceanside, CA 92054
(714) 757-7525

SWAN TB-4HA. FINALLY, A BEAM ANTENNA THAT DOES SOMETHING ABOUT THE GOOF-OFF ELEMENT.



Our new 4010V expandable 4-band antenna is designed for the operator who wants to straddle continents at a down-to-earth price.

One reason the 4010V saves you money is because it's simpler. For example, it doesn't need a counterpoise. And it's easy to install.

The new 2000-watt PEP trap vertical comes in short lengths complete with mounting plate. So with easy set-up and no ground radials to contend with, you can't beat it for getting on the air fast when you're in the great outdoors.

And it's also ideal for mobile homes and apartments.

Then when you feel like exploring 75 meters, expand your 4010V to five bands with the Swan 75 AK kit and you're into a whole new world.

75 AK 75-meter kit

1040V Vertical Antenna.

But if you're interested in a more permanent installation with one of the most effective verticals made, check out our 1040V.

The rugged 4-band 1040V trap vertical for 40 through 10 meters is well-known for completeness.

When you open your 1040V box what you see is what you need.

Like copper wire to make two counterpoise radial wires for each band, egg insulators and a base mounting plate.

And when you're ready for 75 meters you can expand to five bands with the Swan 75 MK kit. Which is noted for the same attention to completeness as the 1040V.

Buy a Swan 4010V or 1040V expand-a-band-later vertical today.

75 MK 75-meter kit

Use your Swan credit card and pay later, too. Applications at your dealer or write to us.

4010V 4-band trap vertical antenna.	\$ 74.95
75 AK 75-meter kit.	\$ 39.95
1040V 4-band trap vertical antenna.	\$122.95
75 MK 75-meter kit.	\$ 39.95

(Prices FOB Oceanside, CA)
Dealers throughout the world
or order direct from

SWAN® ELECTRONICS
A subsidiary of Cubic Corporation
305 Airport Road, Oceanside, CA 92054
(714) 757-7525

NEW 4010V VERTICAL ANTENNA.

IT LOOKS AS GOOD TO YOUR POCKETBOOK AS IT DOES TO YOUR TRANSCEIVER.

crystal-controlled phase-locked receiving converter

Circuit details and construction information for a converter that receives signals between 0-28 MHz when used with a receiver that tunes from 28 to 29 MHz

Over the years many amateurs have traded their old, general-coverage receivers for shiny new "ham-band-only" models. We've gained in stability, sensitivity, selectivity, dial accuracy, and many other attributes; but we've lost on frequency coverage. Except for a few narrow windows to the outside world, we can listen only to each other. Those with interests outside the amateur bands have had to use a second receiver (frequently an old general-coverage job) and put up with drift, bulk, and lack of accurate calibration. The *XPL Converter*, described here, is designed to work with a modern receiver to give the best of both worlds — extremely broad frequency coverage together with crystal stability and calibration accuracy. The converter receives all frequencies between 0 and 28 MHz when used with a receiver tuning 28 to 29 MHz. Construction is simple, straightforward, and inexpensive thanks to integrated circuits.

description

The *XPL Converter* consists of a wide-range tuned input circuit, 60 kHz to 28 MHz; a local oscillator with injection frequency switch-selectable in 1-MHz steps from 29 to 56 MHz; and a mixer circuit with output 28 to 29 MHz feeding the receiver as a tunable i-f amplifier. A block diagram is shown in **fig. 1**. Local oscillator output is taken from a vfo (vco), which is phase locked to a 100-kHz reference oscillator through a counter chain preset by thumbwheel switches for band selection. The various sections are described in more detail later.

An example may help clarify the frequency conversion technique employed in the *XPL*. If the vco is set at, say, 38 MHz, the tunable i-f range of 28 to 29 MHz will allow reception of signals from 38-29 = 9 MHz to 38-28 = 10 MHz. A 9330-kHz signal in this range would be received at 38-9.33 = 28.67 MHz. The receiver tunes *backwards*, in that the low-frequency end of each range will be received at 29 MHz and the high end at 28 MHz. This turns out to be only a minor operating annoyance, however. Low-side injection could be used for forward tuning but only at the sacrifice of tuning range at the upper end.

The vco is phase locked to the reference crystal, so the local oscillator is of crystal quality as far as accuracy and stability are concerned. Any input frequency can be precisely located and will be stable within the accuracy and stability of the receiver on the 10-meter range. For most modern receivers, this means 1-2 kHz accuracy and a few hundred hertz drift on warmup. What a difference from the old general-coverage boat anchors!

input circuitry

Input-circuit details are shown in **fig. 2**. A single-tuned circuit provides input selectivity for the *XPL*. Six switch positions cover 60-150 kHz, 150-450 kHz, 450-1400 kHz, 1.4-4.5 MHz, 4.5-10 MHz, and 10-30 MHz. The four high-frequency ranges use a commercially available coil set having high-impedance balanced antenna windings. On the two low-frequency ranges pi-section single-ended input circuits are used with rf chokes for the inductors. Tuning is by a miniature broadcast superhet variable capacitor having a total capacitance of about 560 pF with the two sections in parallel.

Two input traps are used: a balanced lowpass filter to eliminate TV/fm pickup and a series-resonant

By Keith H. Sueker, W3VF, 110 Garlow Drive, Pittsburgh, Pennsylvania 15235

trap to eliminate overload from any one broadcast station. Additional suppression measures may be required in unusual situations.

There's no need to conform to the input circuit shown. In fact, the antenna tuning section from a scrapped general-coverage receiver could be used to

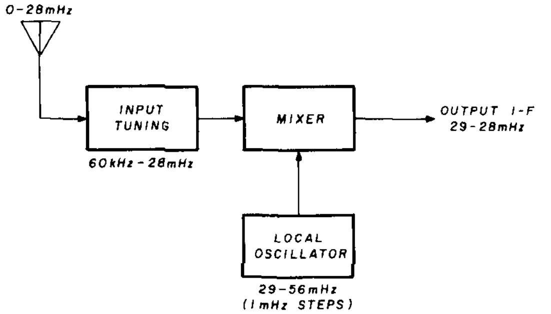


fig. 1. Block diagram of the *XPL* converter.

handle the high-frequency end of the range. The low end can be extended with larger inductors, but the tuning range for each band will be quite limited because of distributed capacitance in the coils. Two additional coils, however, will allow tuning to about 15 kHz.

local-oscillator system

The heart of *XPL* is the local oscillator. This circuit consists of a voltage-controlled oscillator (vco), programmable divider chain, crystal-reference oscillator, and phase comparator. A block diagram is shown in **fig. 3.**

Phase-locked-loop operation has been well described in the literature, but a quick review may be worthwhile. A phase-locked loop is a feedback control system that measures the phase difference between two frequency sources and generates an error voltage that changes the frequency of one frequency source until the two sources are in phase synchronism. For continuing phase errors, the phase detector will function on frequency difference and steer the system into phase lock.

Two basic systems can be used to generate a selectable series of integrally related frequencies. If the phase comparator is sensitive to reference-oscillator harmonics, the controlled oscillator can be directly locked to a selected harmonic by first tuning it manually to a nearby frequency, then allowing the phase detector to lock up. This is the system used in several commercial receivers. The only objection from a construction point of view is that it requires a manually variable oscillator with dial calibration sufficient to resolve adjacent harmonics. A lock indication is also useful in identifying the proper harmonic.

A more direct way of generating the integrally related frequencies is to divide the controlled-oscillator frequency by programmable digital dividers before phase comparison to the reference frequency. If the oscillator frequency is divided by, say, 24 before the comparison is made, the effect is to lock the oscillator to the 24th harmonic of the reference frequency. In *XPL*, a fixed divide-by-ten and two programmable divide-by-n counters are used to enable lock from the 290th harmonic to the 560th harmonic of the 100-kHz reference frequency in steps of 1 MHz.

oscillator and phase comparator

Fig. 4 is the schematic for the reference oscillator and phase comparator. A 7400 quad NAND gate is used with a 100-kHz crystal to generate the reference frequency. There's no special merit to this scheme other than simplicity, and any convenient oscillator circuit could be used so long as it provides TTL output levels. In the circuit shown, the 0.0047 μF capacitor at the input to the last gate was necessary to eliminate a double-pulsed output to the phase comparator.

A Motorola MC4044P phase-lock chip was chosen because it offers TTL logic, a nonharmonic-sensitive

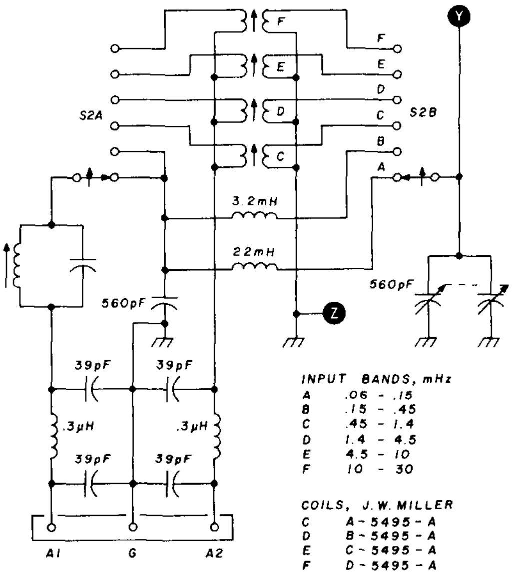


fig. 2. Input-circuit schematic.

comparator, and some internal auxiliary transistors. Also, its use in synthesizers has been described in recent articles.

Output from the MC4044P is buffered by an external 2N5457 fet follower and the internal emitter followers. The comparator has unity gain from the phase detector to the output. An active filter is backed up by two poles of rolloff for loop stability and high 100-kHz ripple attenuation. The reference oscillator and phase comparator are supplied from an on-board regulator that provides both isolation and filtering.

voltage-controlled oscillator

The voltage-controlled oscillator in the *XPL* (**fig. 5**) uses a Motorola MC1648L ECL chip designed for this service. Spectral purity requirements preclude a voltage-controlled multivibrator, so this chip was used with an external high-Q toroidal inductor and a Motorola MV1401 variable-capacitance diode or varicap. Since ECL has a very low logic swing, an

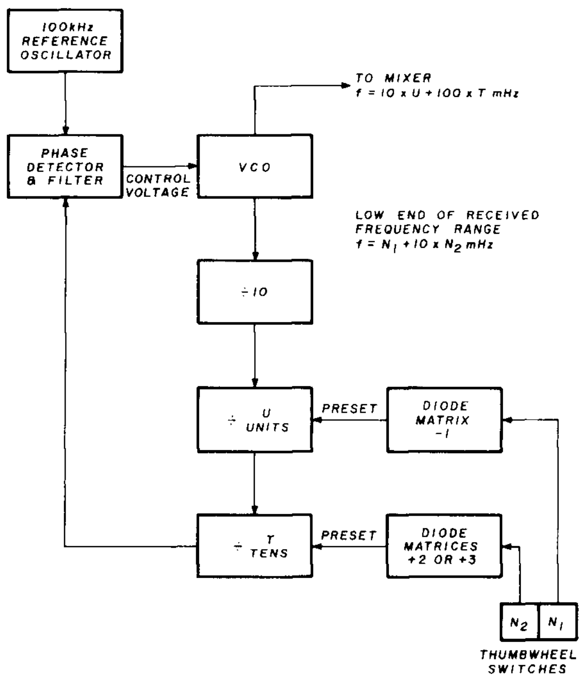


fig. 3. Local-oscillator block diagram.

output translator, 2N4403, is used to regenerate the TTL signal level. At this point you might ask whether the ECL chip is worth the effort. The answer is a qualified "Yes," since it functions from a two-terminal tank circuit and eliminates the need for fussing with feedback in a transistor oscillator.

The MV1401 varicap is rather expensive (in the $9.00 range), but it has a guaranteed 3:1 tuning range and high Q. This application requires only a 2:1 range, but allowances for temperature variation component tolerances, and other considerations make it necessary to have some overrange. Less-expensive limited-range diodes could be used, but they would require changing fixed capacitors to cover the tuning range for the vco. The inductor is a T-25 mix 6 toroid with four turns of no. 22-28 AWG (0.6-0.3mm) enameled wire.

An output to the mixer is taken directly from the 50 ohm vco output at pin 3. For the TTL counters, however, the swing is wrong. The sum of one diode drop and a base-emitter drop from the 5-volt-supply rail places the 2N4403 base voltage in the ECL logic voltage range. The 2N4403 collector voltage swings from 0.5V to about 3.5V to drive the counter. A 22-ohm base-emitter resistor aids junction recovery and cleans up the output waveform.

The entire vco section is quite susceptible to hum and modulation disturbances. For this reason, a separate voltage regulator is again used. The vco should be located well away from transformer fields or ac power wiring.

programmable counters and translators

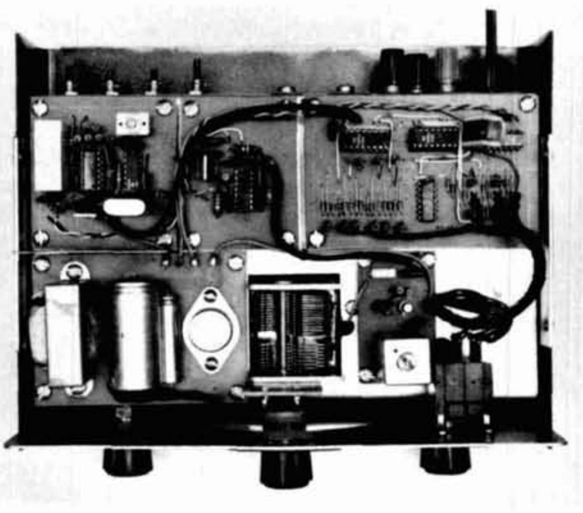
This circuit is shown in **fig. 6**. Before getting into counter details, a related matter must be considered. The count set into the preset counters must always be 29 (MHz) higher than the bottom end of the input tuning range, so that the switches can read input range directly. This requirement leads to the necessity of translating switch settings to the counters. **Table 1** summarizes the required relationships. If decimal switches are used, the offset of minus 1 in the units digit can be provided by simply rewiring into the decimal-to-BCD diode matrix, as shown in **fig. 6**. Note, for example, that a switch indication of 4 is translated to BCD 1+2=3, which is 4 minus the required one unit. The 390-ohm resistors establish a TTL logic zero for open-switch positions.

The tens digit is somewhat more messy. Switch indications must be translated up by 3 *except* when the units position is zero, which requires an up-translation of only 2. Thus, 00 goes to 29, 01 goes to 30, 10 goes to 39, 11 goes to 40, and so on. Since a zero-units digit is translated to a 9 in the output, the presence of this 9 can be used to change the tens digit to an output lower by one integer.

Two sections of a 7400 quad NAND are used to accomplish this magic. A decimal-to-BCD diode matrix with an offset of +3 is used in conjunction with a second matrix with offset of +2. The proper matrix

table 1. Relationship between switch settings and counters.

input range	switch readings ten	switch readings units	counter presets ten	counter presets units
0-1	0	0	2	9
1-2	0	1	3	0
2-3	0	2	3	1
9-10	0	9	3	8
10-11	1	0	3	9
11-12	1	1	4	0
12-13	1	2	4	1
19-20	1	9	4	8
20-21	2	0	4	9
21-22	2	1	5	0
27-28	2	7	5	6



Looking down on the *XPL* converter. Components and wiring are shown on top of the chassis.

is chosen by clamping diodes from the two 7400 outputs. If a units 9 is present, the 9 bus is high and the 9 bus is low. Under this condition, the +3 matrix diodes are clamped low, and the +2 matrix diodes are released. For units digits other than 9, the situation is reversed.

Those familiar with counter techniques may immediately conclude that this is the long way around the barn, and so it is. A simpler solution to the translation would be to use a precounter set to 29 to delay activation of the programmable counters until the first 29 counts have passed. However, this requires two more counter chips, involves a clock gate, and is more difficult to troubleshoot if problems develop. The approach shown was devised with the less-experienced builder in mind, since troubleshooting of the diode matrices can be done with a vtvm.

Returning now to the counters, a high-speed 74196/8290 is used as a divide-by-10 prescaler to get the signal into TTL frequency range. This unit has a typical toggle frequency of 75 MHz and handles the 56-MHz maximum input with little effort. The programmable counters, 74192s, are preset by their respective diode matrices. Both are operated in the countdown mode and are cascaded and loaded through the borrow outputs.

Counter operation is as follows: The C_0 output of the 74196/8290, pin 2, goes high once every ten input pulses from the vco. Each output pulse causes the units 74192 to count down by one count. When the count reaches zero, the borrow output goes low between pulses and causes the tens 74192 to count down by one count. It, too, generates a borrow pulse after reaching zero, and it is this pulse that's used to reset the system. The borrow pulse from the tens counter is used to load the preset number into each counter.

As an example of operation, suppose the thumbwheel switches are set to 08 (8-9 MHz range). The units counter will be preset to a count of 7 (8-1) and the tens counter to 3 (0+3). Following a reset pulse, the units counter will count down one count every ten vco cycles and first generate a borrow pulse after 70 vco cycles.

After this first 70 cycles from the reset pulse, the counter will again generate a borrow pulse every 100 vco cycles. Each of these borrow pulses causes the tens counter to count down by one count from its preset of 3 and to generate its own borrow pulse after 70 + 100 + 100 + 100 vco cycles. The tens counter borrow and reset pulse thus occurs 370 vco cycles *after* the first reset and then immediately resets the counters again.

The tens counter borrow output frequency is equal

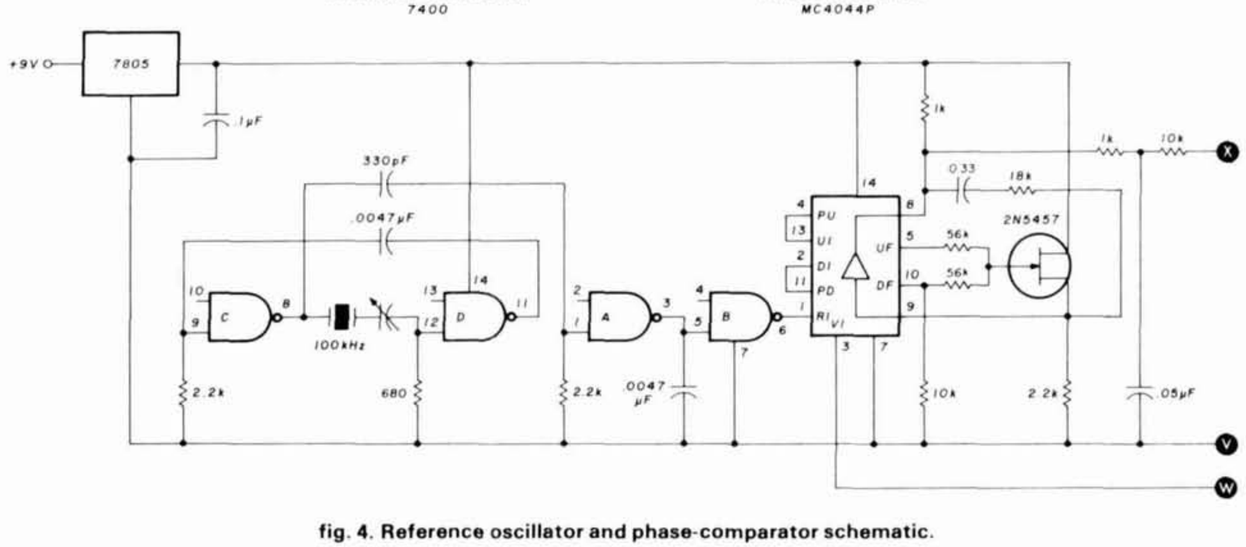


fig. 4. Reference oscillator and phase-comparator schematic.

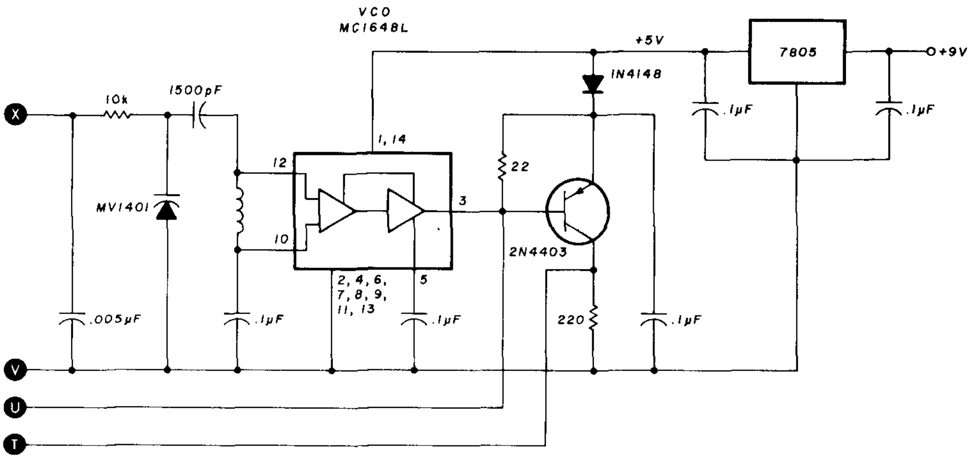


fig. 5. Voltage-controlled oscillator schematic.

to the vco frequency divided by (10xU + 100xT), where U and T are the units and tens presets respectively (7 and 3 in our example).

The tens-counter borrow output is also used to feed the phase comparator so that the vco frequency is locked to 10x7 + 100x3 = 370 times the reference frequency of 100 kHz. The vco is thus locked at 37 MHz, which is the required local-oscillator injection frequency for receiving 8 MHz with a 29-MHz i-f.

Resistor values shown for the diode matrices are fairly critical. Germanium diodes would provide more margin, but the circuit works well as shown. If the same nominal values are used, no problems should be experienced. Power for the counters and translators is provided by still another 5-volt regulator. This system draws several hundred milliamperes and may need a regulator heat sink.

mixer

A dual-gate, diode-protected mosfet is used for the mixer (**fig. 7**). The 40673 has good intermodulation characteristics and is simple to use. Output from the drain is taken through an output transformer, broadly resonant at 28.5 MHz, which provides a low impedance output to the receiver. This stage is powered directly from the 9-volt power supply, since decoupling is not a problem. An output switch pole allows the receiver input to be connected to the converter or to a high-frequency antenna. A second pole is used to ground the high-frequency antenna to minimize pickup when the *XPL Converter* is in use.

power supply

All operating power for the *XPL* is derived from a 12-volt transformer and bridge rectifier at about 10 volts (**fig. 8**). A 2N3055 is used as an active filter to reduce ripple. This transistor is much larger than required, but it's cheap, readily available, and needs no heatsink. If the 9-volt rail is not reasonably clean, the received signal may be hum modulated. Ac input is switched by a third pole of the IN-OUT switch, and a pair of 0.02 μF capacitors are used for line bypassing. Note that these capacitors should have 600-volt ratings.

construction

Each circuit section was built on a separate printed-circuit board for easy testing and debugging. There's no real need to do this, however, and a single PC board might be easier to handle mechanically. The layout shown is also more compact than necessary. The entire unit could be built on perf board if generous ground conductors are used.

Coax cable should not be used for interconnecting circuits except for the vco output to the mixer, mixer output to the receiver, and input from the hf antenna. Other leads should be run in twisted pairs of no. 22-26 (0.6-0.4mm) hookup wire to minimize shunt capacitive loading on the TTL gates and to reduce inductive pickup in the phase-comparator circuitry. Coax cable should not be used in the input circuit, since the high capacitance of this cable could appreciably decrease the tuning range.

The 28.5-MHz output coil was a junk-box relic of unknown parentage. Any coil with a turns ratio of about 5:1 with a slug capable of resonating at 28.5 MHz will do. An inductance of about 3μH is required.

Most of the parts for the *XPL* are available from surplus houses or other *ham radio* and *QST* advertisers. The MC4044P, MC1648L, and MV1401, however, will probably have to be ordered from a franchised Motorola distributor. Total cost is about $20 for these items.

The individual regulators were Motorola types, but various National LM-series are equally satisfactory and widely available. The 2N4403 transistor can be replaced with almost any high-frequency pnp transistor. Similarly, the 2N5457 can be replaced by other N-channel jfet devices, such as the MPF102 series.

All signal diodes should be 1N4148/1N914 or similar silicon computer diodes. As mentioned earlier, germanium diodes can be used in the diode matrices if desired. Power diodes are low voltage, plastic-lead-mounted types.

Capacitors can be ceramic units except for the antenna input capacitor (560 pF) and the vco 1500-pF capacitors which should be of low-loss polystyrene or mica construction.

The entire counter and phase-lock system could be designed around CMOS circuitry except for the vco and the prescaler. CMOS chips are not widely available in surplus outlets but are rather inexpensive when purchased new. Power supply current could be considerably reduced by shifting to CMOS, and the diode translators could be run at a much higher impedance level.

adjustments and troubleshooting

The power supply forms a logical first item if the *XPL* is built in steps. Output voltage must be at least

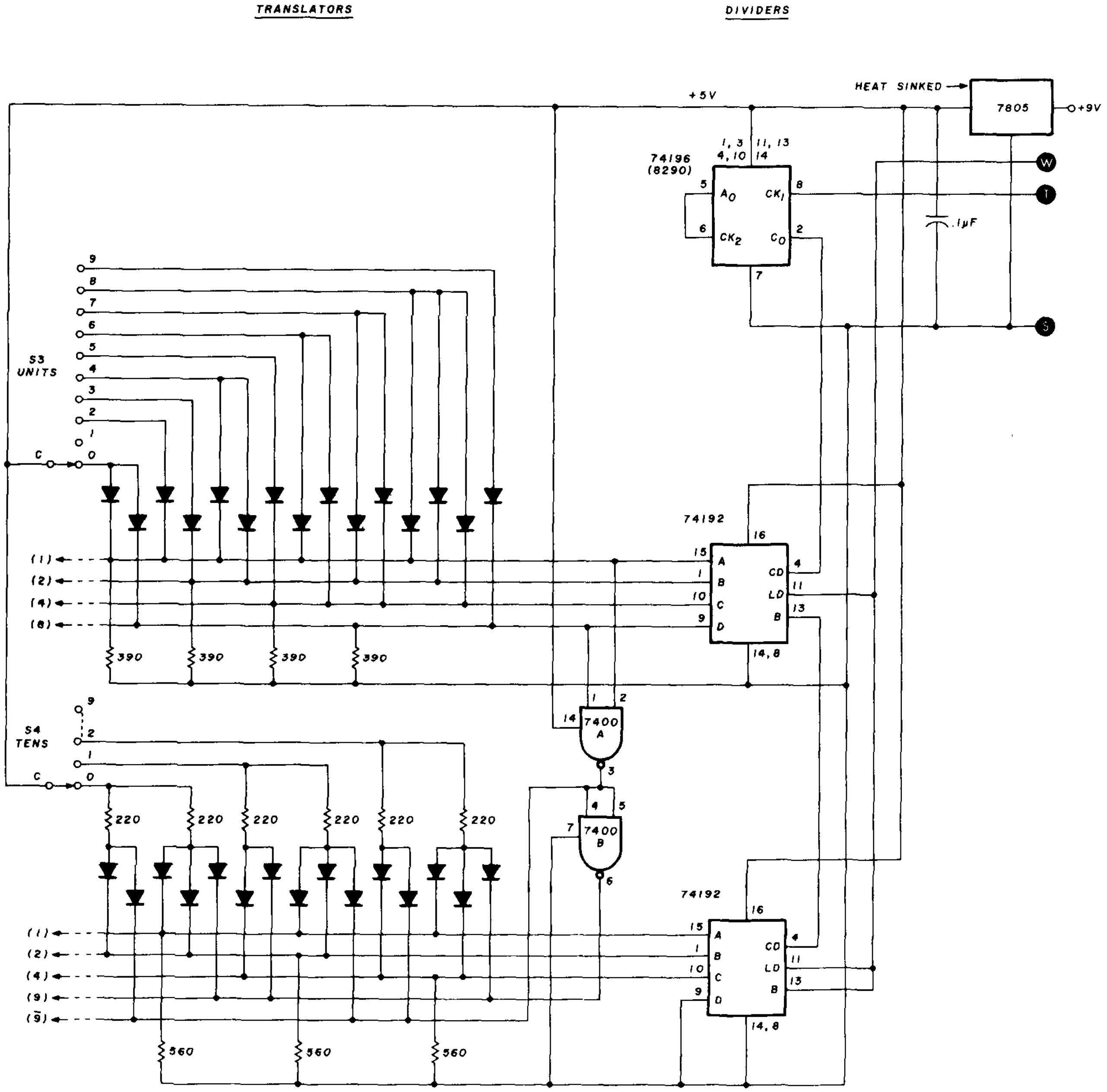


fig. 6. Schematic of the *XPL* programmable counters and translators.

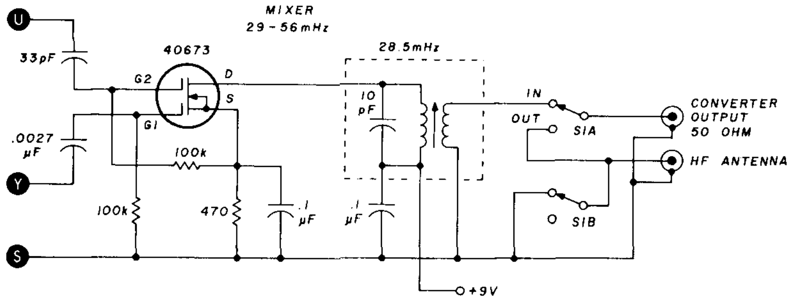


fig. 7. Mixer schematic.

7 volts to allow the individual regulators their required 2-volt input margin over 5-volt regulated output voltage. Frequency calibration of the reference oscillator can be done by zero beating with WWV or with WCFL, Chicago, on 1000 kHz. The vco should be checked for range by coupling a grid-dip oscillator to the toroidal coil. An input of 0.5 to 3.5-volts positive, derived from a separate source, should drive the vco from 25 to 60 MHz or so. If the frequency range is off, toroid turns may be trimmed or the 1500-pF capacitor value changed to suit. Input-coil slugs should be adjusted to allow coverage of all input frequencies with a bit of overlap.

Operation of the translators can be checked with a vtvm. Logic zero must be 0.8 volt or less, and logic 1 must be 2.4 volts or more — standard TTL levels. Preset counter operation can be checked with a triggered oscilloscope and a low capacitance (10X) probe. The 74196 output pulses will be visible on most inexpensive scopes.

operation

For best results, a good antenna system should be used with the *XPL*. One of the best is an 80-meter inverted V or dipole with open-wire feeders. Except for those few frequencies at which the antenna happens to be an odd number of quarter wavelengths long, its impedance will be quite high. Thus, the high capacitance of a grounded coax antenna feeder would result in serious signal attenuation. A simple long-wire antenna can be used if the end is brought directly to the *XPL* input terminals. If a separate antenna system isn't available, any ungrounded antenna feeder system can be used by connecting either lead to the **A1** antenna terminal. Terminal **A2** should be grounded for single ended inputs.

The input circuit should be calibrated at least roughly so you can be sure the desired signal is being peaked. The input circuit provides the only rejection for 10-meter signals present on the antenna. Above about 15 MHz, this rejection may be inadequate to prevent strong 10-meter signals from coming directly through the mixer to the i-f. A resonant trap or a loosely coupled input circuit can be added if this problem proves troublesome. A balanced mixer would reduce the feedthrough, but the added complication seemed unnecessary. I suggest this as an alternative approach for those interested in experimentation.

final remarks

The *XPL Converter* has been fun to use. Broadcast stations pop up exactly where they are supposed to be. The *Selected Cities Weather Summary*, broadcast from Miami on RTTY has been interesting to print and peruse. WWV is available on all frequencies for calibration or a check on propagation conditions.

Aviation weather and general information is broadcast on the local low-frequency range station. Every international shortwave band can be received. International air-route traffic control from Miami and New York can also be monitored. And, near the top end, you can even listen to CB operations.

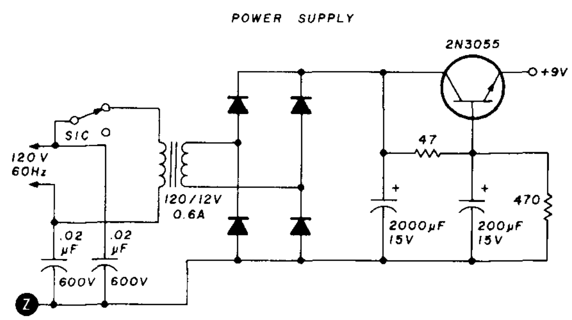


fig. 8. Power-supply schematic.

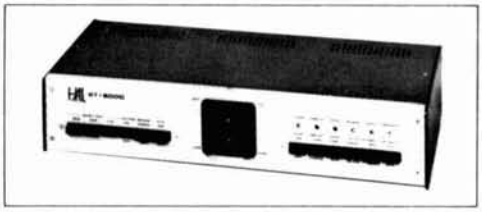
bibliography

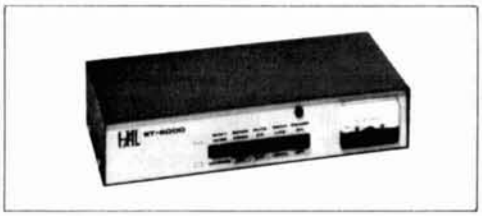
1. R. W. Wilmark, W1MCR, and W. R. Wade, K1IJZ, "Synthesized Two-Meter FM Transceiver," *ham radio*, January, 1976, page 10.
2. K. W. Robbins, W1KNI, "Six Meter Frequency Synthesizer," *ham radio*, March, 1974, page 26.
3. P. J. Bertini, K1ZJH, and R. Van Hooft, WB2MBI, "A Practical Approach to Two Meter Frequency Synthesis," Part 1, *QST*, June, 1973, page 31; Part 2, *QST*, July, 1973, page 34.
4. *Motorola Application Notes AN-535, AN-533, and AN-564*, Motorola, Inc., Technical Information Center, P. O. Box 20912, Phoenix, Arizona 85036.

ham radio

RTTY Can Be Easy!

Have You Wondered . . .
What Owning a RTTY Station Would be Like?
Have You Thought . . .
About Finding Out but Didn't Know Who to Ask?





ASK THE GUYS AT HAL!

Our sales and service staff will be happy to assist you in your choice of RTTY equipment, answer questions about RTTY, and provide assistance if problems do arise. In addition, all HAL amateur RTTY equipment manuals can be purchased for $10.00 each for an advance look (applicable to future purchase of that unit).

Answers to common RTTY questions are featured in the center fold of our new amateur radio catalog. Such questions as "What do I need?", "How do I hook it up?", and "What frequencies do I use?" are discussed. Technical points concerning RTTY pulses, FSK and AFSK, and high-tones vs low-tones are covered.

Write today for HAL'S new catalog and RTTY guide and discover how much fun RTTY can be.

HAL COMMUNICATIONS CORP.
Box 365
Urbana, Illinois 61801
217-367-7373

For our European customers see HAL equipment at:
Richter & Co., Hannover
I.E.C. Interelco, Bissone
Primetek Systems, Handen, Sweden
Radio Shack of London

More Details? CHECK—OFF Page 150

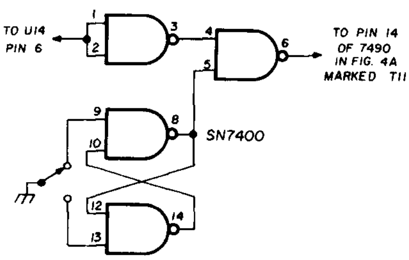
short circuit

RTTY time/date printout

An important point was missed in **table 1** of the RTTY printout article which appeared in June, 1976, *ham radio*. Pin 4 of U15 should not be grounded but should have the appropriate BCD information for the tens of minutes digit.

As shown, the ten, minutes digit will only display up to 39 minutes instead of 59 minutes. In **fig. 4A**, pins 6 and 7 of the 7490s must be grounded; otherwise the circuit will only print the 19th as the date.

Advancing the date by moving the clock is a very tedious process. Overshooting will mean doing the entire thirty days over again. The diagram below shows a circuit that will permit



you to advance the date by one day with the flip of the switch. When the date resets at the end of the month, flipping the switch will advance the clock to Ø1, much easier than advancing the digital clock a complete 24-hour period. Note that this advance circuit is designed to work with a low input so the date advance must be done before 2000 hours.

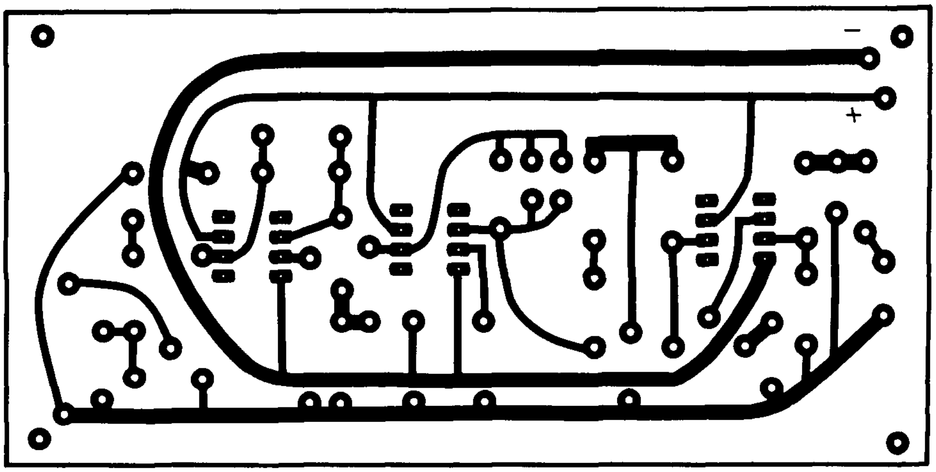
pi network design and analysis

Eq. 8 in the pi network design article, September, 1977, *ham radio*, should not have the radical sign on the right hand side of the expression; it should read

$$R1 \text{ (at minimum point of } X_{C1} \text{ curve)} = R_{1B} = \frac{2X_L^2}{R_2} \qquad (8)$$

Also, **eq. 12** should read as follows:

$$X_L = (R1 + R2)\ \frac{Q_o^2 + \sqrt{Q_o^2 - (Q_o^2 + 4)\left(\frac{R2 - R1}{R1 + R2}\right)^2}}{Q_o^2 + 4} \qquad (12)$$



direct output synthesizer for two meters

In **fig. 4** of the direct output synthesizer in August, 1977, *ham radio*, the lines connected to pins 10 and 8 of U3C have been transposed. For correct operation, pin 10 is connected to the pin 9s of the 74161s, and pin 8 of U3C is connected to pin 1 of U2B. On U1, pin 2 is the input from U3D and pin 1 should be connected to the junction of the 100 and 360 ohm resistors. U1 may exhibit some temperature and voltage sensitivity at times causing the divide-by-21 function to become a divide-by-22. This problem can be cured by either of two methods: putting a 330 pF capacitor from pin 2 of U1 to ground or replacing U3 with a 74L00 instead of the 7400. U8 is a 7483, not a 7473. In **fig. 6**, the 0.1 μF capacitor connected to pin 2 of U18 should be a 0.01 μF disc capacitor. Also, the 40k-ohm resistor on the output of U18B should be 10k.

serial converter for 8-level teleprinters

The serial converter in August, 1977, *ham radio*, uses a 74121 for U16, not a 7474.

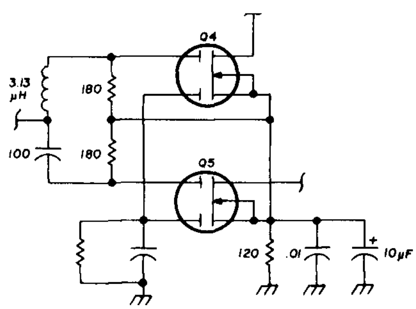
audio frequency speech processing

The circuit board layout for the audio speech processor in August, 1977, *ham radio* was missing several connections. The diagram above shows the correct circuit board layout. The output is taken from the center of R13 and not as shown in **fig. 5** in the article. The numbering for the pins of the ICs in the schematic diagram should be changed to correspond with the 8-pin mini DIPs used on the finished board.

fig. 3	change to
5	3
4	2
6	4
10	6
11	7

phasing-type single-signal detector

In **fig. 2**, page 72 of October, 1976, *ham radio*, the two 180-ohm resistors should be connected between gate 2 and the source of the dual-gate mosfet as shown below. Also, gate number 1 is not connected to the source.



spectrum analyzer

There are several errors in the spectrum analyzer construction article which appeared in the June, 1977, issue. The 75.1 ohm resistor in the rf attenuator should be 71.5 ohms; the six 69.1 ohm resistors should be 61.9 ohms (**fig. 10**). The i-f attenuator should have three, *not two*, 20 dB sections (like the rf attenuator).

The mixer diodes used by the author are Hewlett-Packard part number 5082-2900; most any hot-carrier diodes should work if they are all the same type.

The crystal in the second local oscillator is 150 MHz ±2 MHz; the crystal in the third local oscillator is 39.3 ±1 MHz. The 10k resistor associated with CR401 should go to switch S601A, the 250 kHz position; the same for the 10k resistor associated with the second crystal filter, Y401 (**fig. 11**). The 2.4k resistor in series with CR402 should go to switch S601A, the 10 kHz position. The coil located near CR403, and the switch contacts near R402, are parts of the same relay.

Large size Xerox copies of the top and bottom chassis photographs are available from *ham radio*, and will be sent to interested readers upon receipt of a self-addressed, stamped envelope.

reducing IMD in high-frequency receivers

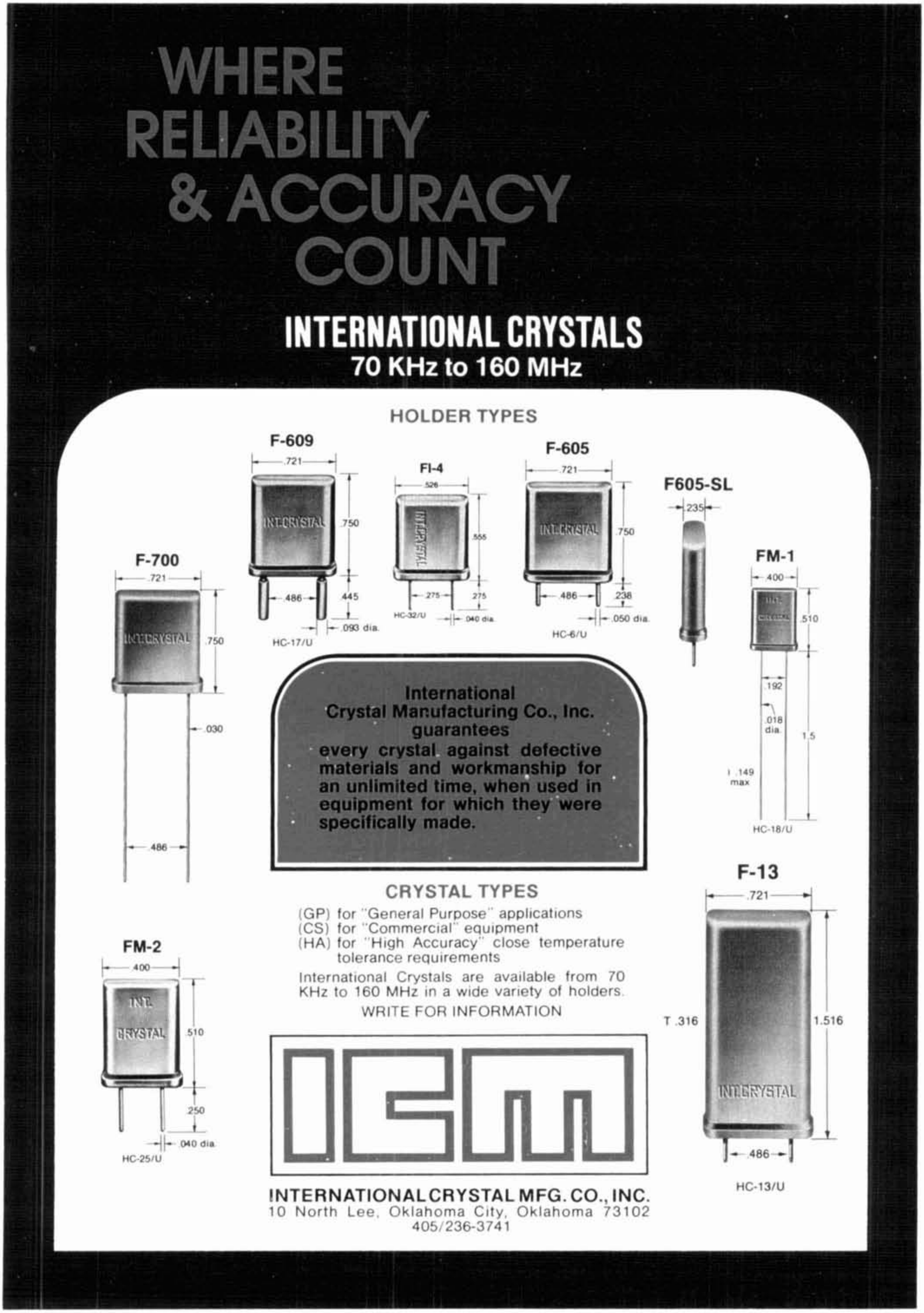
The 3-dB pad between the local oscillator input and the balanced mixer, in **fig. 6** on page 30 of the March, 1977, issue of *ham radio*, should have the values transposed (the series resistor should be 18 ohms, the shunt resistor 300 ohms.)

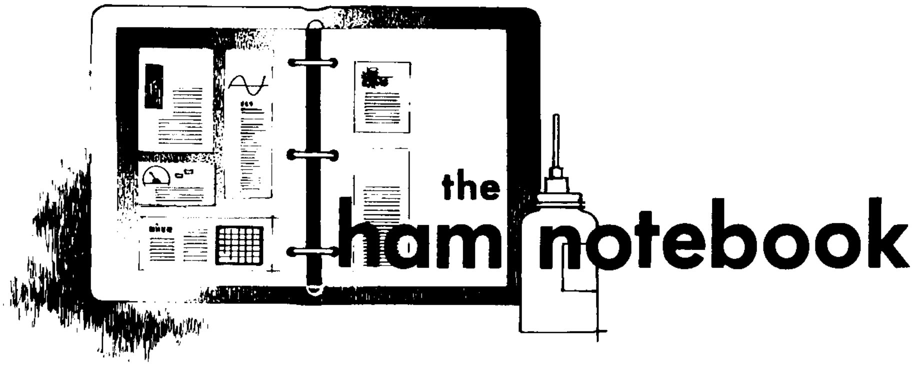
bandspreading techniques for resonant circuits

In **eq. 19** on page 49 of the February, 1977, issue of *ham radio*, the term C_r should not be included under the radical sign. The equation should read:

$$C_p = \frac{\sqrt{C_q + C_r{}^2}}{2V} - C_r$$

More Details? CHECK — OFF Page 150


WHERE RELIABILITY & ACCURACY COUNT
INTERNATIONAL CRYSTALS
70 KHz to 160 MHz
HOLDER TYPES
F-609
.721
.750
.445
.486
.093 dia.
HC-17/U
FI-4
.526
.555
.275
.275
HC-32/U
.040 dia.
F-605
.721
.750
.238
.486
.050 dia.
HC-6/U
F605-SL
.235
F-700
.721
.750
.030
.486
FM-1
.400
.510
.192
.018 dia.
1.5
.149 max
HC-18/U
International Crystal Manufacturing Co., Inc. guarantees every crystal against defective materials and workmanship for an unlimited time, when used in equipment for which they were specifically made.
CRYSTAL TYPES
(GP) for "General Purpose" applications
(CS) for "Commercial" equipment
(HA) for "High Accuracy" close temperature tolerance requirements
International Crystals are available from 70 KHz to 160 MHz in a wide variety of holders.
WRITE FOR INFORMATION
FM-2
.400
.510
.250
.040 dia.
HC-25/U
F-13
.721
T .316
1.516
.486
HC-13/U
INTERNATIONAL CRYSTAL MFG. CO., INC.
10 North Lee, Oklahoma City, Oklahoma 73102
405/236-3741



simple formula for microstrip impedance

In many amateur vhf and uhf applications strip transmission lines etched on printed-circuit board are used for impedance matching and as components in tuned resonant circuits. Although several methods are available for calculating the characteristic impedance of microstrip transmission line, the formula derived by Sobol[1] is the most popular. It has been widely publicized in Motorola Semiconductor's application notes and appeared recently in *QST*[2]. Sobol's equation:

$$Z_o = \frac{120\pi h}{\sqrt{\epsilon_r}\; w(1 + 1.735\epsilon_r^{-0.0724}\; w/h^{-0.836})}$$

where w is strip width, h is the dielectric thickness, and ϵ_r is the relative dielectric constant of the substrate.

Sobol's equation gives Z_o as a function of microstrip geometry, but in practical applications you usually need to know what size microstrip is required for a given impedance. Since the equation can't be solved directly for w/h, an interactive trial-and-error solution is necessary. This can be done rather quickly with a high-speed computer, but an iterative solution with a programmable calculator such as the HP-25 may require a minute or more — an iterative solution with a non-programmable calculator is impractical.

Some time ago N6TX (ex WA6UAM) sent me an iterative HP-25 program for Sobol's microstrip equation which provided acceptable accuracy for most design work. This program begins at $w/h = 1$ and iterates out to the required value. Therefore, for low and high values of Z_0 a solution requires considerable calculation time. To reduce calculation time I decided to see if I could develop a simple equation for an approximate value of w/h which could then be refined with the HP-25 program. My first step was to rewrite Sobol's equation as

$$Z_o = \frac{120\pi}{\sqrt{\epsilon_r \frac{w}{h}}} \left[\frac{1}{1 + 1.735\,\epsilon_r^{-0.0724}\;\; w/h^{-0.836}}\right]$$

By inspection, to a first approximation Z_0 is equal to the first term on the right-hand side of the equal sign; the term inside the parenthesis is a modification term which is a function of both ϵ_r and w/h. Designating the quantity $(1.735\epsilon_r^{-0.724} w/h^{-0.836})$ as K, **eq. 1** was rewritten as

$$\frac{120\pi}{Z_0\sqrt{\epsilon_r}} = \frac{w}{h}\,(1 + K) = \frac{w}{h} + K \cdot \frac{w}{h}$$

All that remained was to find a value for $K \cdot w/h$ which satisfied varying values of ϵ_r and w/h. After calculating several tables of values, it was ap-

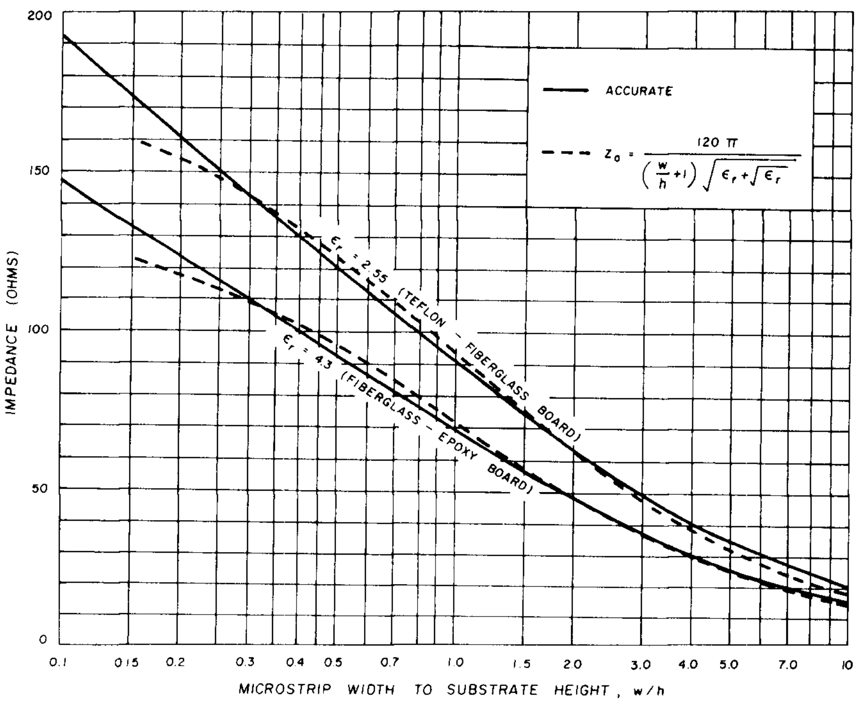


fig. 1. Microstrip impedance calculated with simple formulas developed by W1HR (dashed lines), as compared to actual impedance (solid line). For $\epsilon_r > 4$, accuracy is very good for w/h > 0.2.

1. H. Sobol, "Extending IC Technology to Microwave Equipment," *Electronics*, March 20, 1967, page 112.
2. R. Olsen, N6NR, "Designing Solid-State RF Power Circuits," *QST*, September, 1977, page 15.

parent that $K \cdot w/h = 1$ would give the desired results. Substituting and rearranging terms yielded the expression

$$\frac{w}{h} \approx \frac{120\pi}{Z_o \sqrt{\epsilon_r}} - 1 \qquad (3)$$

When this equation was plotted on graph paper and compared to a graph of Sobol's equation, the similarity was much closer than I expected — the curve had essentially the correct shape, but all values were slightly larger than those given by Sobol's formula. This was the desired result; rewriting the HP-25 program around **eq. 3** considerably reduced calculation time.

Later it occurred to me that it might be possible to further factor **eq. 3** to obtain a more accurate formula for microstrip impedance. After calculating numerous tables of Z_o vs w/h and ϵ_r, and inspecting the values, I found that the impedance of microstrip etched on a substrate with $e_r > 4.0$ could be approximated within a few per cent by the following equations:

$$\frac{w}{h} \approx \frac{120\pi}{Z_o \sqrt{\epsilon_r + \sqrt{\epsilon_r}}} - 1 \qquad (4)$$

$$Z_o \approx \frac{120\pi}{(\frac{w}{h} + 1)\sqrt{\epsilon_r + \sqrt{\epsilon_r}}} \qquad (5)$$

For microstrip etched on glass-epoxy circuit board ($\epsilon_r = 4.8$), these equations can be reduced to

$$\frac{w}{h} \approx \frac{142.6}{Z_o} - 1 \qquad Z_o \approx \frac{142.6}{\frac{w}{h} + 1}$$

For Teflon-fiberglass circuit board ($\epsilon_r = 2.55$) the simplified expressions are

$$\frac{w}{h} \approx \frac{185.1}{Z_o} - 1 \qquad Z_o \approx \frac{185.1}{\frac{w}{h} + 1}$$

The dielectric constant of Teflon-fiberglass is below the value recommended for these equations, but accuracy is still acceptable for many applications.

These formulas can be solved quickly by hand (or with a simple four-function calculator), and should be a big help to amateurs who want to design their own microstrip circuits. They can also be used to determine the approximate impedance of circuit traces for digital logic boards (for best results the V_{CC} and ground lines for TTL should have low impedance).

The accuracy of these simplified equations is surprisingly good. As shown in **fig. 1**, for $w/h > 0.2$, the simplified formulas are within a few per cent of the impedance calculated with more accurate equations; this covers the microstrip impedance range most commonly used in radio communications work. With fiberglass-epoxy board the formulas are within about 1 ohm of the exact expression for all values of Z_o below 60 ohms. The values for Teflon-fiberglass board are somewhat less accurate, but are still acceptable for most amateur work.

James R. Fisk, W1HR

improved (vfo) stability for the Atlas 180

Early versions of the Atlas 180 transceiver have exhibited poor vfo stability with a varying dc supply voltage. In some cases, the vfo will actually be frequency modulated at dc input voltages below 13 volts. Atlas owners can check for this condition by listening to a signal or the calibrator beat note and adjusting the dc supply from about 11.5 volts to 14.5 volts. A 500-milliampere supply is more than ample to operate the receiver. The test can also be made in the car by first setting up the beat note with the engine off and then starting the engine. After a few moments the battery system will come up to full-charge voltage of 14.5 volts. Any change in pitch during this time indicates poor vfo power supply regulation. The units in which this is most likely to occur are those which use a 10-volt regulator circuit consisting of a transistor with a 10-volt Zener on the base.

The solution to the problem is to remove the 27-ohm decoupling resistor (R401 in my Atlas 180) on the vfo board (PC-400), and replace it with a 78L08ACP low-power 8-volt regulator. The wire that previously connected to the 10-volt bus is then reconnected to the 13-volt bus. After making this change, retuning is unnecessary for dc inputs of 11.5 volts to 14.5 volts, and there are no reports of frequency modulation when operating mobile without the engine running. There is no other noticeable change in the operation of the vfo due to the 8-volt rather than 10-volt supply.

Dave Sargent, K6KLO

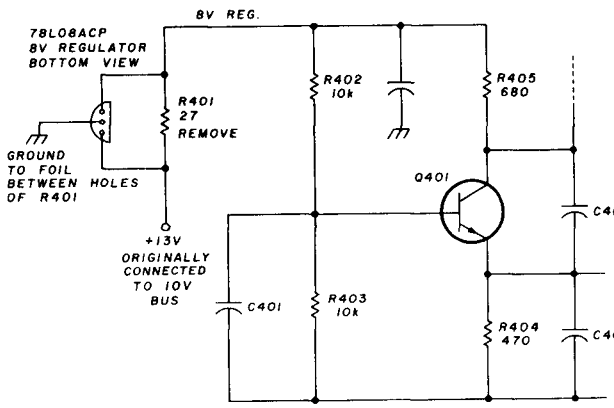


fig. 1. Modification to the Atlas 180 vfo power supply to prevent any frequency modulation due to voltage changes. The 78L08ACP voltage regulator is used to prevent voltage changes. It is fed from the normal 12.6-volt dc supply.

KENWOOD
...pacesetter in amateur radio

TS-520S
AND DG-5 DIGITAL FREQUENCY DISPLAY

The TS-520S combines all of the fine, field-proven characteristics of the original TS-520 together with many of the ideas and suggestions for improvement from amateurs worldwide.

FULL COVERAGE TRANSCEIVER

The TS-520S provides full coverage on all amateur bands from 1.8 to 29.7 MHz. Kenwood gives you 160 meter capability, WWV on 15.000 MHz., and an auxiliary band position for maximum flexibility. And with the addition of the TV-506 transverter, your TS-520S can cover 160 meters to 6 meters on SSB and CW.

DIGITAL DISPLAY DG-5 (option)

The Kenwood DG-5 provides easy, accurate readout of your operating frequency while transmitting *and* receiving.

OUTSTANDING RECEIVER SENSITIVITY AND MINIMUM CROSS MODULATION

The TS-520S incorporates a 3SK35 dual gate MOSFET for outstanding cross modulation and spurious response characteristics. The 3SK35 has a low noise figure (3.5 dB typ.) and high gain (18 dB typ.) for excellent sensitivity.

NEW IMPROVED SPEECH PROCESSOR

An audio compression amplifier gives you extra punch in the pile ups and when the going gets rough.

VERNIER TUNING FOR FINAL PLATE CONTROL

A vernier tuning mechanism allows easy and accurate adjustment of the plate control during tune-up.

FINAL AMPLIFIER

The TS-520S is completely solid state except for the driver (12BY7A) and the final tubes. Rather than subsitute TV sweep tubes as final amplifier tubes in a state of the arı amateur transceiver, Kenwood has employed two husky S-2001A (equivalent to 6146B) tubes. These rugged, time-proven tubes are known for their long life and superb linearity.

HIGHLY EFFECTIVE NOISE BLANKER

An effective noise blanking cricuit developed by Kenwood that virtually eliminates ignition noise is built into the TS-520S.

RF ATTENUATOR

The TS-520S has a built-in 20 dB attentuator that can be activated by a push button swich conveniently located on the front panel.

PROVISION FOR EXTERNAL RECEIVER

A special jack on the rear panel of the TS-520S provides receiver signals to an external receiver for increased station versitility. A switch on the rear panel determines the signal path . . . the receiver in the TS-820 or any external receiver.

The VFO-520 remote VFO matches the styling of the TS-520S and provides maximum operating flexibility on the band selected on your TS-520S.

The TS-520S is completely self-contained with a rugged AC power supply built-in. The addition of the DS-1A DC-DC *converter (optional)* allows for mobile operation of the TS-520S.

The TS-520S has 2 convenient RCA phono jacks on the rear panel for PHONE PATCH IN and PHONE PATCH OUT.

The CW-520-500 Hz filter can be easilly installed and will provide improved operation on CW.

The AGC circuit has 3 positions (OFF, FAST, SLOW) to enable the TS-520S to be operated in the optimum condition at all times whether operating CW or SSB.

The TS-520S retains all of the features of the original TS-520 that made it tops in its class: RIT control • 8-pole crystal filter • Built-in 25 KHz calibrator • Front panel carrier level control • Semi-break-in CW with sidetone • VOX/PTT/MOX • TUNE position for low power tune up • Built-in speaker • Built-in Cooling Fan • Provisions for 4 fixed frequency channels • Heater switch.

TS-520 *Specifications*

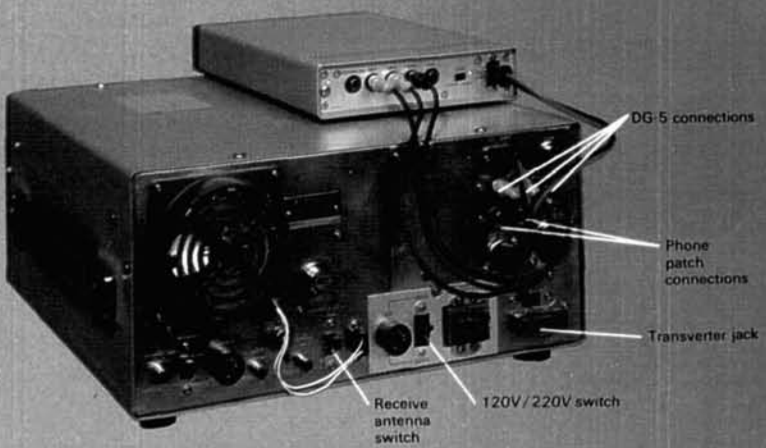
Amateur Bands: 160-10 meters plus WWV (receive only)
Modes: USB, LSB, CW
Antenna Impedance: 50-75 Ohms
Frequency Stability: Within ±1 kHz during one hour after one minute of warm-up, and within 100 Hz during any 30 minute period thereafter
Tubes & Semiconductors:
- Tubes . . . . 3 (S2001A x 2, 12BY7A)
- Transistors 52
- FETs 19
- Diodes 101

Power Requirements: 120/220 V AC, 50/60 Hz, 13.8 V DC (with optional DS-1A)
Power Consumption: Transmit: 280 Watts Receive: 26 Watts (with heater off)
Dimension: 333(13⅛) W x 153 (6-0) H x 335(13- (13-3/16) D mm(inch)
Weight: 16.0 kg(35.2 lbs)

TRANSMITTER
RF Input Power: SSB: 200 Watts PEP CW: 160 Watts DC
Carrier Suppression: Better than -40 dB
Sideband Suppression: Better than -50 dB
Spurious Radiation: Better than *-40 dB*
Microphone Impedance: 50k Ohms
AF Response: 400 to 2,600 Hz

RECEIVER
Sensitivity: 0.25 uV for 10 dB *(S+N)/N*
Selectivity: SSB:2.4 kHz/-6 dB, 4.4 kHz/-60 dB
Selectivity: CW: 0.5 kHz/-6 dB, 1.5 kHz/-60 dB (with optional CW-520 filter*)*
Image Ratio: Better than 50 dB
IF Rejection: Better than 50 dB
AF Output Power: 1.0 Watt (8 Ohm load, with less than 10% distortion)
AF Output Impedance: 4 to 16 Ohms

DG-5
SPECIFICATIONS
Measuring Range: 100 Hz to 40 MHz
Input Impedance: 5 k Ohms
Gate Time: 0.1 Sec.
Input Sensitivity: 100 Hz to 40 MHz . . . 200 mV rms or over, 10 *kHz to 10 MHz . . 50 mV or over*
Measuring Accuracy: Internal time base accuracy ±0.1 count
Time Base: 10 MHz
Operating Temperature: -10° to 50° C/14° 122° F
Power Requirement: Supplied from TS-520S or 12 to 16 VDC (nominal 13.8 VDC)
Dimensions: 167(6-9/16) W x 43(1-11/16) H x 268(10-9/16) D mm(inch)
Weight: 1.3 kg(2.9 lbs)



DG-5

The luxury of digital readout is available on the TS-520S by connecting the DG-5 readout (option). More than just the average readout circuit, this counter mixes the carrier, VFO, and heterodyne frequencies to give you your exact frequency. This handsomely-styled accessory can be set almost anyplace in your shack for easy to read operation . . . or set it on the dashboard during mobile operation for safety and convenience. Six bold digits display your operating frequency while you transmit and receive. Complete with DH (display hold) switch for frequency memory and 2 position intensity selector. The DG-5 can also be used as a normal frequency counter up to 40 MHz at the touch of a switch. (Input cable provided.)
NOTE: TS-520 owners can use the DG-5 with a DK-520 adapter kit.

KENWOOD

. . . pacesetter in amateur radio

TS-820S

WITH DIGITAL FREQUENCY DISPLAY

We told you that the TS-820 would be best. In little more than a year our promise has become a fact. Now, in response to hundreds of requests from amateurs, Kenwood offers the TS-820S* . . . the same superb transceiver, but with the digital readout factory installed. As an owner of this beautiful rig, you will have at your fingertips the combination of controls and features that even under the toughest operating conditions make the *TS-820S the Pacesetter that it is.*

Following are a few of the TS-820S' many exciting features.

PLL • The TS-820S employs the latest phase lock loop circuitry. The single conversion receiver section performance offers superb protection against unwanted cross-modulation. And now PLL allows the frequency to remain the same when switching sidebands (USB, LSB, CW) and eliminates having to recalibrate each time.

DIGITAL READOUT • The digital counter display is employed as an integral part of the VFO readout system. Counter mixes the carrier VFO, and first heterodyne frequencies to give *exact* frequency. Figures the frequency down to 10 Hz and digital display reads out to 100 Hz. Both receive and transmit frequencies are displayed in easy to read, Kenwood Blue digits.

SPEECH PROCESSOR • An RF circuit provides quick time constant compression using a true RF compressor as opposed to an AF clipper. Amount of compression is adjustable to the desired level by a convenient front panel control.

IF SHIFT • The IF SHIFT control varies the IF passband without changing the receive frequency. Enables the operator to eliminate unwanted signals by moving them out of the passband of the receiver. This feature alone makes the TS-820S a pacesetter.

*The TS-820 and DG-1 are still available separately.

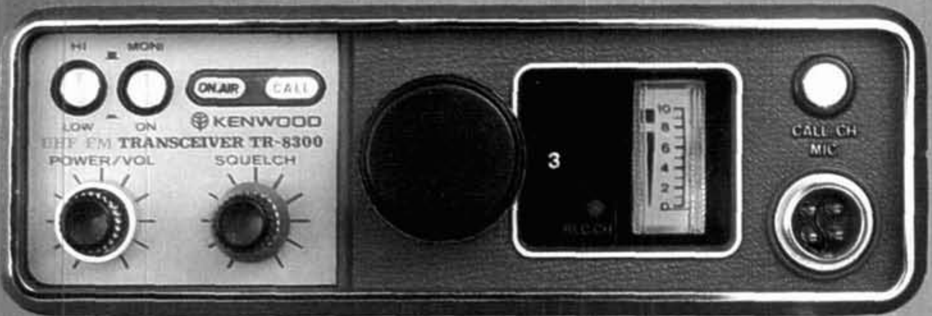
TS-600

TV-506

An easy way to get on the 6 meter band with your TS-520/520S, TS-820/820S and most other transceivers. Simply plug it in and you're on . . . full band coverage with 10 watts output on SSB and CW.

Experience the excitement of 6 meters. The TS-600 all mode transceiver lets you experience the fun of 6 meter band openings.

This 10 watt, solid state rig covers 50.0-54.0 MHz. The VFO tunes the band in 1 MHz segments. It also has provisions for fixed frequency operation on NETS or to listen for beacons. State of the art features such as an effective noise blanker and the RIT (Receiver Incremental Tuning) circuit make the TS-600 another Kenwood "Pacesetter".



TR-8300

Experience the luxury of 450 MHz at an economical price.

The TR-8300 offers high quality and superb performance as a result of many years of improving VHF/UHF design techniques. The transceiver is capable of F_3 emission on 23 crystal-controlled channels (3 supplied). The transmitter output is 10 watts.

The TR-8300 incorporates a 5 section helical resonator and a two-pole crystal filter in the IF section of the receiver for improved intermodulation characteristics. Receiver sensitivity, spurious response, and temperature characteristics are excellent.

KENWOOD
...pacesetter in amateur radio

TS-700S
WITH DIGITAL FREQUENCY DISPLAY

Check out the new "built-ins": digital readout, receiver pre-amp, VOX, semi-break in, and CW sidetone! Of course, it's still all mode, 144-148 MHz and VFO controlled.

Features: Digital readout with "Kenwood Blue" digits • High gain receiver pre-amp • 1 watt lower power switch • Built in VOX • Semi-break in on CW • CW sidetone • Operates all modes: SSB (upper & lower), FM, AM and CW • Completely solid state circuitry provides stable, long lasting, trouble-free operation • AC and DC capability (operate from your car, boat, or as a base station through its built-in power supply) • 4 MHz band coverage (144 to 148 MHz) • Automatically switches transmit frequency 600 KHz for repeater operation. Simply dial in your receive frequency and the radio does the rest . . . simplex, repeater, reverse • Or accomplish the same by plugging a single crystal into one of the 11 crystal positions for your favorite channel • Transmit/Receive capability on 44 channels with 11 crystals.

VFO-700S

Handsomely styled and a perfect companion to the TS-700S. This unit provides you with the extra versatility and the luxury of having a second VFO in your shack. Great for split frequency operation and for tuning off frequency to check the band. The function switch on the VFO-700S selects the VFO in use and the appropriate frequency is displayed on the digital readout in the TS-700S. In addition a momentary contact "frequency check" switch allows you to spot check the frequency of the VFO not in use.

TR-7400A

Features Kenwood's *unique Continuous Tone Coded* Squelch system, 4 MHz band coverage, 25 watt output and fully synthesized 800 channel operation. This compact package gives you the kind of performance specifications you've always wanted in a 2-meter amateur rig.

Outstanding sensitivity, large-sized helical resonators with High Q to minimize undesirable out-of-band interferance, and give a 2-pole 10.7 MHz monolithic crystal filter combine to give your TR-7400A outstanding receiver performance. Intermodulation characteristics (Better than 66dB), spurious (Better than −60dB), image rejection (Better than −70dB), and a versatile squelch system make the TR-7400A tops in its class.

Shown with the PS-8 power supply

(Active filters and Tone Burst Modules optional)

TR-7500

This 100 channel PLL synthesized 146-148 MHz transceiver comes with 88 pre-programmed channels for use on all standard repeater frequencies (as per ARRL Band Plan) and most simplex channels. For added flexibility, there are 6 diode-programmable switch positions. The 15 KHz shift function makes these 6 positions into 12 channels. 10 watt output, ±600 KHz offset and LED digital frequency display are just a few of the many fine features of the TR-7500.

The PS-6 is the handsomely styled, matching power supply for the TR-7500. Its 3.5 amp current capacity *and built-in speaker make it the perfect companion for* home use of the TR-7500.

TR-2200A

The high performance portable 2-meter FM transceiver. 146-148 MHz, 12 channels (6 supplied), 2 watts or 400 mW RF output. Everything you need is included: Ni-Cad battery pack, charger, carrying case and microphone.

QSA 599

Amateur Radio Center
11 S. Morris, Mesa, AZ 85202
(602)833-8051

1.1 GHZ Portable Counter
PROFESSIONAL QUALITY BUT AFFORDABLE!

Specifications
No Pre-Scaler Needed
Calibrated to .0002%
Rechargeable Ni-Cd Pack Built In
Weight: 2 lb. 1 oz. Size: 4"x4.15"x7"
Front Panel FAA Approved Lettering
Guaranteed One Year Parts and Labor
Price: $599.95 postpaid

EIMAC Tubes
New with Guarantee

3-400Z	$67.00	4CX250B	$43.00
3-500Z	$67.00	4-400A	$74.00
3-1000Z	$165.00	4-1000A	$221.00
7289	$56.50	8874	$116.00
8873	$116.00	8877	$260.00

HY-GAIN

TH6DXX	$249.95	5 element, 2m	$16.95
TH3MK3	$199.95	14 element, 2m	$27.95
Hy Tower	$279.95	14RMQ	$28.95
18AVT/WB	$97.00	14AVQ/WB	$67.00

WILSON

1402SM	2.5W Handheld, 2m	$212.00
1405SM	1W/5W Handheld, 2m	$279.00
4502SM	1W/1.8W Handheld, 70cm	$349.00
WR-500	Rotor	$149.95
SY-1	Deluxe Triband Beam	$259.95

USED EQUIPMENT

AM-479/GR serial number 1, 5KW Amplifier; with MD-135/GR & 4 new 4-1000A's	$3400.00*
Ballantine 300HS/2 VTVM calibrated	$75.00*
Ballantine 300HS/2 VTVM uncalibrated	$35.00*
Kay Mega-Sweep Model 111A	$175.00*
Antenna Tuner TN-339/GR	$85.00*
Transmitter T-368A/URT	$185.00*
WU Desk-Fax	$20.00*
Model 15 Printer (Teletype)	$45.00*

MORE! Write for free list.

* Allow for shipping charges.

PARTS PARTS PARTS

Air Variable Capacitors ▪ Vacuum Variable Capacitors ▪ Roller Inductors ▪ New Tubes Used Tubes ▪ Transformers ▪ Miniductors Chokes ▪ Ceramic Standoffs ▪ RF Switches

MORE! Write for free list or quotes.

MAKE CW MORE ENJOYABLE

MVD-1000 MORSE VIDEO DISPLAY
- Enjoy Morse Code copy on your TV screen
- Displays letters, numbers, and punctuation
- 16 lines of 32 characters per page
- 2 page display with Recall feature
- Automatic scrolling
- Automatic or Manual speed control
- Copy Morse Code from 6-60 WPM
- Easily connects between receiver and TV set

ONLY $350

MK-1 REPROGRAMMABLE MEMORY KEYER

- Stores up to 100 characters
- Iambic keying, dot, dash memories
- Dual keyed outputs
- Operates on 120 VAC or 12 VDC

ONLY $169.95

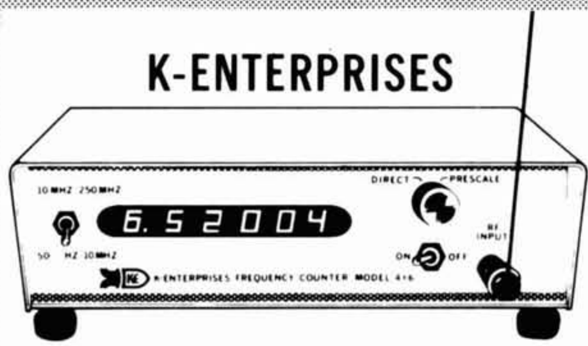
CMOS KEYER, ASSEMBLED PCB
ONLY $24.95

MORSE KEYBOARD COMING SOON

Wisconsin residents add 4% sales tax

DGM ELECTRONICS
787 BRIAR LANE, BELOIT, WISCONSIN 53511

K-ENTERPRISES



MODEL 4X6C
50 HZ—250 MHZ $270.00

300 and 500 MHZ PRESCALERS
FREQUENCY STANDARDS
MARKER and PEAKING GENERATORS
POWER SUPPLIES AMPLIFIERS

WRITE FOR FREE CATALOG

Your BANKAMERICARD welcome here

Phone:
918-676-3752

master charge THE INTERBANK CARD

K-ENTERPRISES
Box 410 (N.W. of town) FAIRLAND, OK 74343

More Details? CHECK—OFF Page 150

NEW products

For literature on any of the new products, use our *Check-Off* service on page 150.

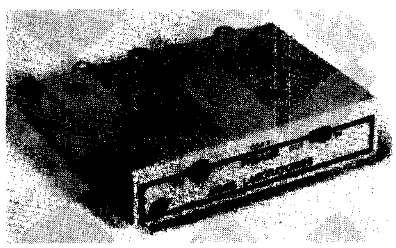
crystal filters

Sherwood Engineering has announced two new additions to their crystal filter line. As complements to the CF-600/6, the new CF-2.6K/8 or CF-2.3K/8 crystal filter sets will replace the normal 8-kHz wide first i-f filter in the Drake R-4C. Each set has two filters, USB and LSB, that must be switched for the correct sideband. The individual filters are 8-pole crystal-ladder filters.

The CF-2.6K/8 is a set of ssb-bandwidth filters that are approximately 200 Hz wider than the normal second i-f phone filter. This allows a limited amount of passband tuning, while still reducing the second i-f bandwidth from 32 kHz, at −60 dB, to approximately 4 kHz. The other phone filter pair is the CF-2.3K/8, which is slightly narrower (100 Hz nominally) than the second i-f filter. Having the new filter sharper than the normal filter produces the equivalent of a 2 to 2.1 kHz filter, with 16 poles distributed over two frequencies. The passband tuning is then used to align the center frequencies, of the two filters, for proper cascading. This narrow combination offers the ultimate in phone selectivity. The bandwidth using the CF-2.6K/8, with the normal phone filter, is 2.3 kHz, at −6 dB, and 3.1 kHz at −60 dB; the bandwidth for the CF-2.3K/8 is 2.1 kHz and 2.9 kHz, at the 6 and 60 dB points. The additional advantages gained by distributing selectivity over two i-f frequencies are: virtual elimination of the chance of overloading the second mixer, and elimination of off-frequency signals that leak around the normal second i-f filter.

In addition to offering the basic filters, Sherwood Engineering also sells switching kits for the first i-f filters. The simplest arrangement is for the operator who wants to switch only between the two ssb bandwidth filters (CF-2.3K/8 or CF-2.6K/8). Custom-designed kits are also available to permit switching of all first i-f filters, 8 kHz, 2.6/2.3 kHz, or 600 Hz. Prices for the new filters are $120. The basic switching kit is $29.00 with the cost increasing approximately $25.00 per additional filter switched. Exact price quotes are given based on an individual's needs. For more information, contact Sherwood Engineering, Incorporated, 1268 South Ogden Street, Denver, Colorado 80210.

two-meter preamplifier



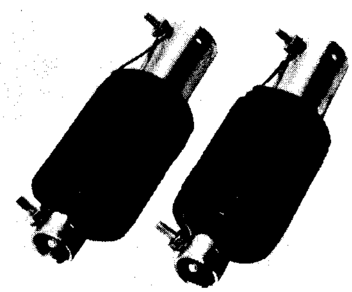
A new two-meter preamp has been introduced by Janel Labs. This preamp is specially designed to improve the sensitivity of transceivers and includes bypass circuitry for carrying transmit power through the unit. The preamp has a low noise figure, which gives excellent sensitivity for weak signals. An adjustable delay circuit (similar to that used in VOX circuits) allows for its use on all modes — f-m, ssb, am and CW.

The gain of the QSA 5 has been optimized for transceivers. It has a 15-dB gain level, which is sufficient to improve the sensitivity as much as practical but low enough to avoid creating overload problems.

A front-panel switch on the QSA 5 disables the preamp from the antenna line. This switch allows you to reduce gain on local signals and also allows experimentation on weak signals. A LED pilot light indicates when the preamp is in the line. This same LED also indicates when transmit power is being sensed.

The QSA 5 preamp is available from Janel Laboratories, 3312 S.E. Van Buren Blvd., Corvallis, Oregon 97330. The QSA 5 is available from stock at $39.95 plus postage. A full one-year warranty is provided. Specifications are available upon request.

multiband antenna coils (40 through 10 meters)



Microwave Filter Company announces a set of antenna coils that will convert an amateur antenna from a single-frequency band of limited operation to operation on all amateur hf bands (40-10 meters).

Known as Reyco antenna coils, they are designed to shorten the overall physical length of an original single-frequency-band antenna. Model numbers are KW-40, 20, 15, and 10. Used in pairs, the model KW-40 coils will give flexibility of operation on all five hf amateur bands. Ideal performance is obtained by using all four coil pairs (KW-40 through KW-10).

In today's crowded apartment and suburban communities, the shortened antenna using Reyco multiband coils provides flexibility in minimum space. For additional information, write Microwave Filter Company, 6743 Kinne Street, East Syracuse, New York 13057.

The New Sigma XR3000D Linear Amplifier Compare!

HOLIDAY SALE

$699

2 Day Air Shipment
Anywhere in U.S.
Airport to Airport $35
Alaska and Hawaii Slightly Higher

Features:

Custom computer grade commercial components, capacitors, and tube sockets manufactured especially for high power use—heavy duty 10Kw silver plated ceramic band switches • Silver plated copper tubing tank coil • Huge 4" easy to read meters—measure plate current, high voltage, grid current, and relative RF output • Continuous duty power supply built in • State of the art zener diode standby and operating bias provides reduced idling current and greater output efficiency • Built in hum free DC heavy duty antenna change-over relays • AC input 110V or 220V AC, 50-60Hz • Tuned input circuits • ALC-rear panel connections for ALC output to exciter and for relay control • Double internal shielding of all RF enclosures • Heavy duty chassis and cabinet construction and much, much more.

- Full band coverage 160-10 meters including mars.
- 2000 watts P.E.P. SSB input. 1000 watts input continuous duty, CW, RTTY & SSTV.
- Two Eimac 3-500Z conservatively rated finals.
- All major HV and other circuit components mounted on single G-10 glass plug in board. Have a service problem? (Very unlikely) Just unplug board and send to us.
- Heavy duty commercial grade quality and construction second to no other unit at any price!
- Weight: 90 lbs. Size: 9½" (h) x 16" (w) x 15¾" (d).

HOLIDAY INTRODUCTORY SPECIAL!

New! Sigma Model AF250L Deviation/Modulation Meter

Fully Certifiable for Commercial Use

HOLIDAY SALE

$169

Features:

Extremely stable local oscillator for easy measurement of HF, VHF, and UHF bands employing negative feedback to insure extremely high stability ● Easy to read, accurate linear scale ● Direct off the air signal measurement capability.

Specifications:

Frequency: 1.8MHZ-520MHZ/3 range select (A, B, C, EXT). A range: 26.5 MHZ-40MHZ, B range: 48MHZ-60MHZ, C range: 140MHZ-156MHZ, EXT. range: 1.8MHZ-520MHZ (Need Signal Generator) • Generous overranges • Input level: (1) Through type input level: IW-200W (RF Input Terminal) (2) Direct input level: More than 80db/50ohm impedance • Amplitude modulation degree: 0-100% • Frequency deviation: 0-20KHZ • Accuracy: +/-3% of full scale • Intermediate frequency: 10.7MHZ • Local input frequency (EXT Range) • Measuring frequency +/-10.7MHZ • RF Attenuator: 0-60db variable • Audio signal oscillator: (1) Audio Frequency—1,000HZ (1 KHZ), (2) Output level—More than 1V RMS • Power Source: AC117V • Dimensions: H-5½" (140mm), W-10¼" (260mm), D-7¼" (184mm) • Weight: 7 lbs.

SIGMA RF-2000 SWR & POWER METER

$29
Introductory Price

Cal PWR Scales 200W-2000W Freq Range 3.5-150 MHz. Please do not confuse the RF2000 with similar appearing lower priced units. RF2000 is an individually calibrated professional quality instrument. Unequaled at many times the price. Size 7" (w) x 2 1/3" (d).

SPECIAL SCANNER SALE

FOR KENWOOD TR-7400A

14 Channel Programmable
reg $109 — **$65**

FMSC-1 reg $169 — **$99**
7400 Scanner II Reg $189-$119

FMSC-1 Scanner for KDK FM 144 and 7400 Scanner II for Trio-Kenwood TR-7400A. ● Full scan 146 and 147 MHz consecutively or 1 MHz, or any MHz range ● Scan rate: 1 MHz/2 seconds (adjustable) ● Controls: Scan/Hold, Latch/Delay, 600 KHz offset (off, up, down), program 1 MHz ● Simple installation.

KDK SPECIAL SALE
FM 144 Accessories

FMTP-1	Touch Tone Pad	$59
FMTP-2	Touch Tone Pad with 10 Number Programmable Memory	$99
FMTD-1	Private Call Decoder for use with and Programmed by Any Touch Tone Pad	$75
SC-12A	Audible Tone Encoder Decoder	$65
FMSC-1	Scanner-Random Any Range	$99
MARS-CAP	Option Kit - Any Frequency, Any Split	$12
FMOF-1	Offset Option Kit - 2 Extra Positions, Crystals Required	$10
FMOF-2	1 MHz Offset Option Kit (No Crystals to Buy)	$10
FMTE-1	Sub Audible Tone (100 Hz-Adjustable 67-203 Hz)	$15
	Owners Manual (Extra)	$5

FM 2015R Accessories:

FMPS-4R	Regulated AC PS	$49
FMMC-1	Microphone with Built-in Touch Tone Pad	$49
MARS-CAP*	Option Kit - Any Frequency, Any Split	$6
FMAT-1	½ Wave Portable Antenna for Hotel, Motel or Apartment	$7.95
	Extra DC Cord & Plug	$3.50
	Service Manual	$2.00
	Mounting Bracket (Extra)	$6.00

Standard New 2 Meter FM Transceivers Model SRC 146A Special Sale

SRC 146A	$314
4 Xtals 34/94 and 94/94	NC
USA 2 Deluxe Base Charger	$47
PT3644 Leather Case	$12
AT 19 Rubber Ant and Whip	$10
N1-cads	$30
Reg.	$413

NEW!!! Touch Tone pad completely wired and ready to plug in-$69.00

Our Price **$289**

NEW! 6 METER FM50-10SXRII

51.00-53.995 MHz. 600 channels
Holiday Sale—Price $339

NEW CDE HAM III ROTATORS—
Reg. $159.95—$125

AMATEUR-WHOLESALE ELECTRONICS

Atlas 210X-215X and 350-XL
Please write for special bonus and package offers.

8817 S.W. 129th Terrace, Miami, Florida 33176
COURTEOUS PERSONAL SERVICE—SAME DAY SHIPMENT • Prices subject to change without notice.
Telephone: (305) 233-3631 • Telex 51-5628 • Store Hours: 10-5 Mon.-Fri.

BankAmericard master charge

More Details? CHECK—OFF Page 150

NEW!
THE FUTURE NOW!
FM2015R

KDK

Does Your Unit Cover The New Sub-band 144.5 - 145.5 MHz? The FM2015R Does, PLUS MARS-CAP!*

All Solid State-CMOS PLL digital synthesized - No Crystals to Buy! 5KHz steps - 144 - 149 MHz-LED digital readout PLUS MARS-CAP.*

• 5 MHz Band Coverage - 1000 Channels (instead of the usual 2MHz to 4MHz-400 to 800 Channels) • 4 CHANNEL RAM IC MEMORY WITH SCANNING • MULTIPLE FREQUENCY OFFSETS • ELECTRONIC AUTO TUNING - TRANSMIT AND RECEIVE • INTERNAL MULTIPURPOSE TONE OSCILLATOR • RIT • DISCRIMINATOR METER - 15 Watts Output - Unequaled Receiver Sensitivity and Selectivity - 15 POLE FILTER, MONOLITHIC CRYSTAL FILTER AND AUTOMATIC TUNED RECEIVER FRONT END, COMPARE! • Superb Engineering and Superior Commercial Avionics Grade Quality and Construction Second to None at ANY PRICE.

INTRODUCTORY PRICE

$399.00

Regulated AC/PS Model FMPS-4R . . . $49.00

FMMC-1 Microphone with Built-in Touch Tone Pad.

- LED indicator
- Adj. level and tone balance
- only 3-3/4" x 2"

$49.00

- **FREQUENCY RANGE**: Receive and Transmit: 144.00 to 148.995 MHz, 5Khz steps (1000 channels) INCLUDING NEW BAND 144.5-145.5MHz + MARS-CAP.*
- **LED DIGITAL READOUT.**
- **4 CHANNEL RAM SCANNER WITH IC MEMORY**: Program any 4 frequencies and reprogram at any time using the front panel controls-scan all or part of the memory-search for occupied (closed) channel or vacant (open) channels. Internal Ni-Cad included to retain memory (no diode matrix to wire or change).
- **MULTIPLE FREQUENCY OFFSETS**: Three positions A,B,C, provided for installation of optional crystals: EXAMPLE - 1 MHz offset. Duplex Frequency Offset Built in - 600 Khz PLUS or MINUS 5 KHz steps, plus simplex, any frequency.
- **INTERNAL MULTIPURPOSE TONE OSCILLATOR BUILT IN**: 1750Hz tone burst for "whistle on operation" and sub-audible tone operation possible by simply adding a capacitor across the terminals provided. Internal 2 position switch for automatic and manual operation, tone burst or sub audible tone PL - adjustable 60-203Hz (100 Hz provided).
- **AIRCRAFT TYPE FREQUENCY SELECTOR**: Large and small coaxially mounted knobs select 100KHz and 10KHz steps respectively. Switches click-stopped with a home position facilitate frequency changing without need to view LED's while driving and provides the sightless amateur with full Braille dial as standard equipment.
- **FULL AUTOMATIC TUNING OF RECEIVER FRONT END AND TRANSMITTER CIRCUITS**: DC output of PLL fed to varactor diodes in all front end RF tuned circuits provides full sensitivity and optimum intermodulation rejection over the entire band. APC (AUTO POWER CONTROL) - Keeps RF output constant from band edge to band edge. NO OTHER AMATEUR UNIT AT ANY PRICE has these features which are found in only the most sophisticated and expensive aircraft and commercial transceivers.
- **TRUE FM**: Not phase modulation - for superb emphasized hi-fi audio quality second to none.
- **RIT CONTROL**: Used to improve clarity when contacting stations with off frequency carrier.
- **MONITOR LAMPS**: 2 LED's on front panel indicate (1) incoming signal-channel busy, and (2) Transmit.
- **FULLY REGULATED INTEGRAL POWER SUPPLY**: Operating voltage for all 9v circuits independently regulated. Massive Commercial Hash Filter.
- **MODULAR COMMERCIAL GRADE CONSTRUCTION**: 6 Unitized modules eliminate stray coupling and facilitate ease of maintenance.
- **ACCESSORY SOCKET**: Fully wired for touch tone, phone patch, and other accessories. Internal switch connects receiver output to internal speaker when connector is not in use.
- **MULTI-PURPOSE METER**: Triple Function Meter Provides Discriminator Meter, "S" Reading on receive and Power Out on Transmit.
- **RECEIVE**: Better than .25uv sensitivity, 15 POLE FILTER as well as monolithic crystal filter and AUTOMATIC TUNED LC circuits provide superior skirt selectivity - COMPARE!
- **HIGH/LOW POWER OUTPUT**: 15 watts and 1 watt, switch selected. Low power may be adjusted anywhere between 1 and 15 watts. Fully protected-short or open SWR.
- **OTHER FEATURES**: Dynamic Microphone, Built In Speaker, mobile mount, external 5 pin accessory jack, speaker jack, and much, much more. Size 2½ x 7 x 7½. All cords, plugs, fuses, microphone hanger, etc. included. Weight 5 lbs.

Manufactured by one of the world's most distinguished Avionics manufacturers, Kyokuto Denshi Kaisha, Ltd. First in the world with an all solid state 2 meter FM transceiver.

AMATEUR-WHOLESALE ELECTRONICS

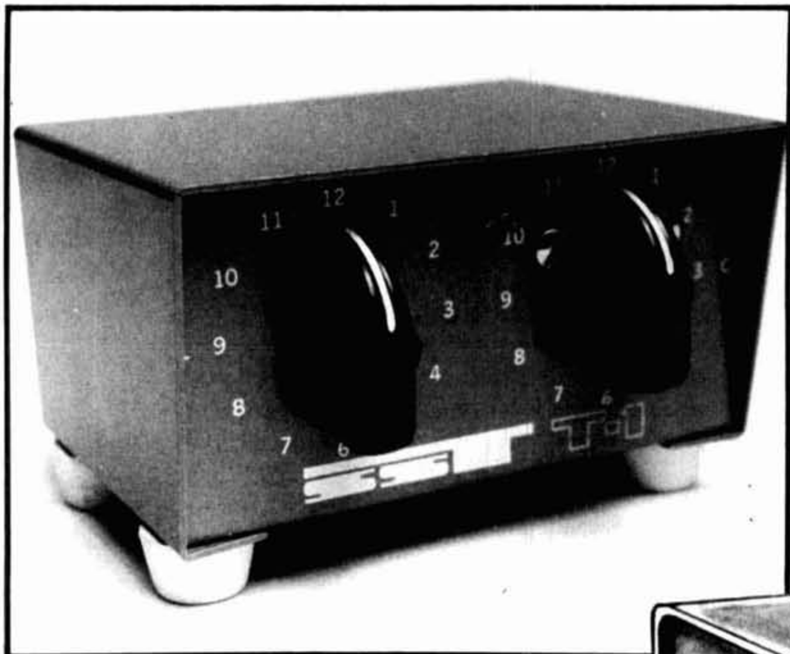
8817 S.W. 129th Terrace, Miami, Florida 33176
Telephone (305) 233-3631 • Telex: 51-5628
U.S. DISTRIBUTOR

DEALER INQUIRIES INVITED.

PLEASE ORDER FROM YOUR LOCAL DEALER OR DIRECT IF UNAVAILABLE.

Regional Sales & Service Centers:
Northeast: Buzzards Bay Electronics, Buzzards Bay, Mass. (617) 759-3376
East: Sanford Communications, Inc. Colonia, N.J. (201) 574-3003
Midwest: Universal Service, Columbus, Ohio (614) 221-2335

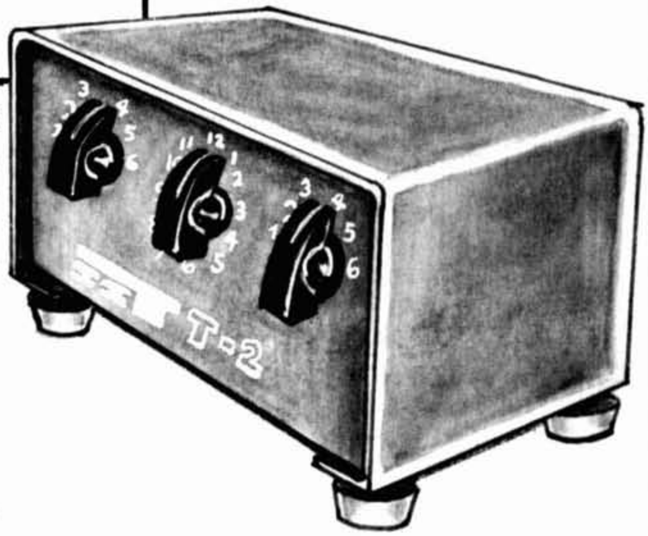
SST T-1 RANDOM WIRE ANTENNA TUNER



All band operation (160-10 meters) with any random length of wire. 200 watt **output** power capability—will work with virtually any transceiver. Ideal for portable or home operation. Great for apartments and hotel rooms—simply run a wire inside, out a window, or anyplace available. Toroid inductor for small size: 4-1/4" X 2-3/8" X 3." Built-in neon tune-up indicator. SO-239 connector. Attractive bronze finished enclosure.

only $29.95

sst t-2 ULTRA TUNER

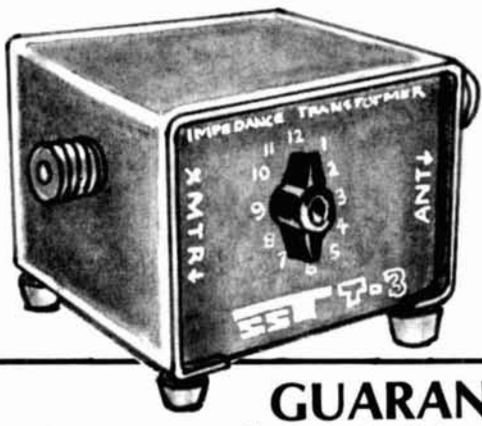


Tunes out SWR on any coax fed antenna as well as random wires. Works great on all bands (160-10 meters) with any transceiver running up to 200 watts power output.

Increases usable bandwidth of any antenna. Tunes out SWR on mobile whips from inside your car.

Uses toroid inductor and specially made capacitors for small size: 5¼" x 2¼" x 2½." Rugged, yet compact. Attractive bronze finished enclosure. SO-239 coax connectors are used for transmitter input and coax fed antennas. Convenient binding posts are provided for random wire and ground connections.

only $49.95



sst t-3 IMPEDANCE TRANSFORMER

Matches 52 ohm coax to the lower impedance of a mobile whip or vertical. 12 position switch with taps spread between 3 and 52 ohms. Broadband from 1-30 MHz. Will work with virtually any transceiver—300 watt output power capability. SO-239 connectors. Toroid inductor for small size: 2-3/4" X 2" X 2-1/4." Attractive bronze finish.

only $19.95

GUARANTEE

All SST products are guaranteed for 1 year. In addition, they may be returned within 10 days for a full refund (less shipping) if you are not satisfied for any reason. Please add $2 for shipping and handling. Calif. residents, please add sales tax. COD orders OK by phone.

SST ELECTRONICS

P.O. BOX 1 LAWNDALE, CALIF.
90260 · (213) 376-5887

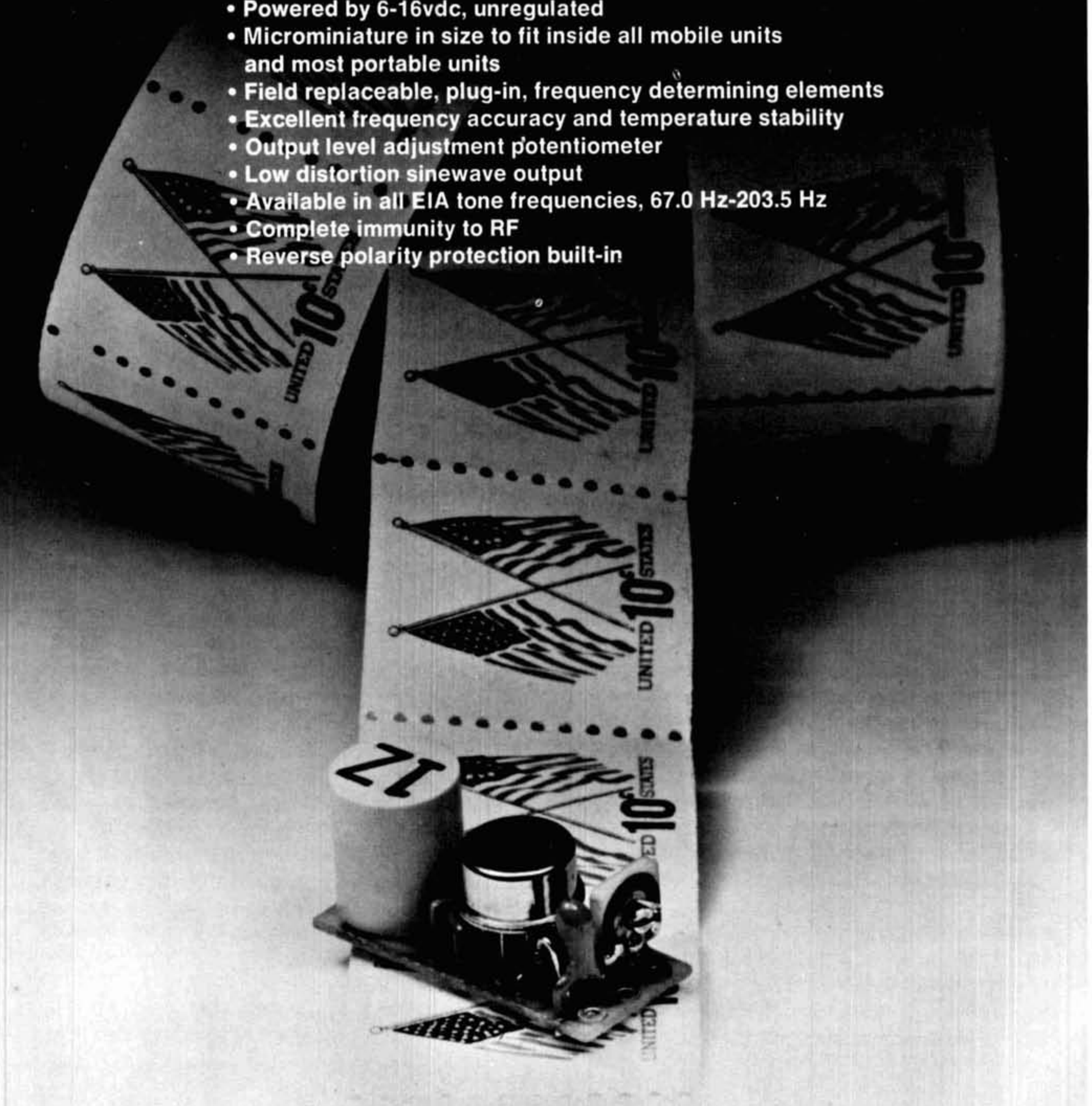
More Details? CHECK—OFF Page 150

More Details? CHECK—OFF Page 150

ME-3 microminiature tone encoder

Compatible with all sub-audible tone systems such as: Private Line, Channel Guard, Quiet Channel, etc.

- Powered by 6-16vdc, unregulated
- Microminiature in size to fit inside all mobile units and most portable units
- Field replaceable, plug-in, frequency determining elements
- Excellent frequency accuracy and temperature stability
- Output level adjustment potentiometer
- Low distortion sinewave output
- Available in all EIA tone frequencies, 67.0 Hz-203.5 Hz
- Complete immunity to RF
- Reverse polarity protection built-in



$29.95 each

Wired and tested, complete with K-1 element

communications specialists
P. O. BOX 153
BREA, CALIFORNIA 92621
(714) 998-3021

master charge

K-1 FIELD REPLACEABLE, PLUG-IN, FREQUENCY DETERMINING ELEMENTS

$3.00 each

More Details? CHECK — OFF Page 150

The Touch.

It's the best value available in scanners.

Searching Receiver

Touch SP, then enter the starting frequency of your choice. The Touch will search up through the action radio channels in the search band until it hears an active call. You'll probably discover "live" frequencies you never before knew existed.

Priority Receiver

Touch 2., then sit back. Any call coming in over the frequency you choose for channel one will automatically override calls on other channels. You'll never miss a call on your favorite frequency.

Search or Scan

Touch SS to Search the unknown. Touch SC to scan the known. You can either search through all bands for unknown frequencies, or listen to the stored frequencies you've selected for the sixteen scanning channels. There's so much versatility, and it's all at the tip of your finger.

Model ACT-T-16K

Frequency Range:
Lo VHF .. 30-50 MHz
Hi VHF .. 146-174MHz
UHF .. 440-512MHz

Sensitivity
(20 DB quieting)
Lo VHF .... 0.5 μ V
Hi VHF .... 0.6 μ V
UHF .... 0.7 μ V

Selectivity

± 7 KHz (min.) @ 6 DB
±15 KHz (max.) @ 60 DB

Squelch: (threshold)
Lo VHF .... 0.4 μ V
Hi VHF .... 0.5 μ V
UHF .... 0.6 μ V

Search Scan Range: (max)
Lo VHF 4000 channels
Hi VHF 5600 channels
UHF 5760 channels

Scanning Receiver

Touch PR, then enter the frequency you want as you watch it appear on the L.E.D. display. Next, touch the channel number you wish to use. Then touch SC, the scanning lights will begin the search for action.

REGENCY DIGITALLY PROGRAMMABLE SCANNER WITH KEYBOARD
SPECIAL $299

Master Charge & B of A
We ship prepaid in USA
Calif. residents add 6% tax
Check with order or COD

10 day money back guarantee
full satisfaction guaranteed
Factory warranty on all items

IN STOCK FOR IMMEDIATE DELIVERY

WESTCOM

COMMUNICATIONS DIVISION 1320 Grand Ave. San Marcos, CA. 92069 (714) 744-0728

More Details? CHECK—OFF Page 150

Don't play the numbers!

1-800-432-1234 1-800-233-0250 1-800-527-4634 1-800-645-9187 1-800-647-8660 1-800-228-4097

Just call us . . . Toll Free!

1-800-325-3636

FOR NEW OR USED AMATEUR RADIO GEAR . . . we're specialists and carry *in stock* most of the famous-brand lines. Or, we will talk trade.

FOR FAST, DOOR-STEP DELIVERY . . . give us a call. You'll be amazed: for we guarantee we'll ship your equipment the same day. Plus, most shipments are PRE-PAID.

TO SAVE MONEY . . . join thousands of our satisfied customers who buy from us as easily as from their local supplier. So, remember your call is *Toll Free*.

We welcome your Master Charge or VISA/BankAmericard.

HAM RADIO CENTER, INC.

8340-42 Olive Blvd. P.O. Box 28271 St. Louis, MO 63132

YOU'VE SEEN THE MAGAZINE ARTICLES

Here's what you can expect from the **DX ENGINEERING RF Speech Processor**

- 6 db INCREASE IN AVERAGE POWER
- MAINTAINS VOICE QUALITY
- IMPROVES INTELLIGIBILITY
- NO CABLES OR BENCH SPACE REQUIRED
- EXCELLENT FOR PHONE PATCH
- NO ADDITIONAL ADJUSTMENTS — MIKE GAIN ADJUSTS CLIPPING LEVEL
- UNIQUE PLUG-IN UNIT — NO MODIFICATIONS REQUIRED

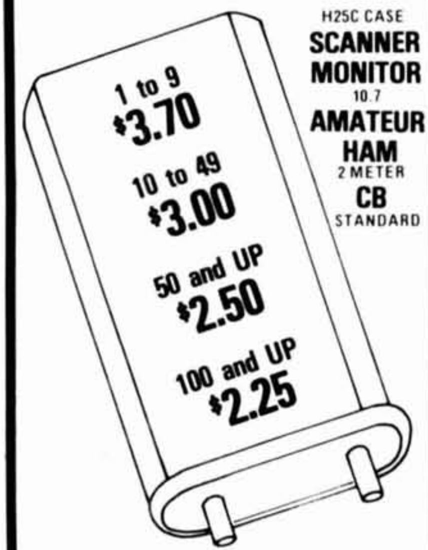
This is RF Envelope Clipping— the feature being used in new transmitter designs for amateur and military use.

Models Now Available
Collins 32S, KWM-2 ...... **$ 98.50 ea.**
Drake TR-3, TR-4, TR-6, TR-4C, T-4, T-4X, T-4XB, T-4XC **$128.50 ea.**
Postpaid — Calif. Residents add 6% Tax

Watch for other models later!

DX Engineering
1050 East Walnut, Pasadena, Calif. 91106

10's OF THOUSANDS OF CRYSTALS IN STOCK!



H25C CASE
SCANNER MONITOR
10.7
AMATEUR HAM
2 METER
CB
STANDARD

Immediate delivery on most frequencies!
OTHERS ARE SPECIAL ORDER

**CRYSTAL BANKING SERVICE
P.O. BOX 683
LYNNFIELD, MASSACHUSETTS
01940**

Radio Amateurs Reference Library of Maps and Atlas

WORLD PREFIX MAP — Full color, 40" x 28", shows prefixes on each country . . . DX zones, time zones, cities, cross referenced tables **$1.25**

RADIO AMATEURS GREAT CIRCLE CHART OF THE WORLD — from the center of the United States! Full color, 30" x 25", listing Great Circle bearings in degrees for six major U.S. cities; Boston, Washington, D.C., Miami, Seattle, San Francisco & Los Angeles. **$1.25**

RADIO AMATEURS MAP OF NORTH AMERICA! Full color, 30" x 25" — includes Central America and the Caribbean to the equator, showing call areas, zone boundaries, prefixes and time zones, FCC frequency chart, plus useful information on each of the 50 United States and other Countries **$1.25**

WORLD ATLAS — Only atlas compiled for radio amateurs. Packed with world-wide information — includes 11 maps, in 4 colors with zone boundaries and country prefixes on each map. Also includes a polar projection map of the world plus a map of the Antarctica — a complete set of maps of the world. 20 pages. Size 8¾" x 12" **$2.50**

Complete reference library of maps — set of 4 as listed above $3.75

See your favorite dealer or order direct.

Mail orders please include $1.25 per order for shipping and handling.

RADIO AMATEUR **callbook** INC.

WRITE FOR FREE BROCHURE!

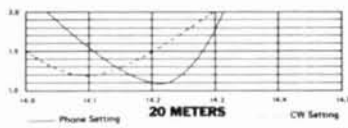
Dept. E 925 Sherwood Drive
Lake Bluff, Ill. 60044

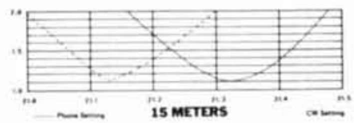
More Details? CHECK—OFF Page 150

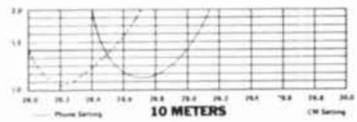
The new standard of performance for Tribanders is the Wilson System One!!! A DX'ers delight operating 20 meters on a full 26' boom with 4 elements, 4 operational elements on 20-15-10, plus separate reflector element on 10 meters for correct monoband spacing. Featured are the large diameter High-Q Traps, Beta matching system, heavy duty Taper Swaged Elements, rugged Boom to Element mounting . . . and value priced at $259.95. Additional features: • 10 dB Gain • 20-25 dB Front-to-Back Ratio • SWR less than 1.5 to 1 on all bands.

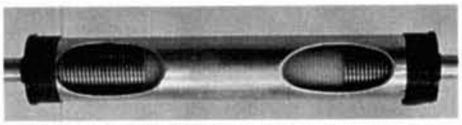
MODEL SY-1 SPECIFICATIONS:

Matching Method:	Beta	F/B Ratio	20-25 dB	Mast Diameter	2" O.D.
Band MHz:	14-21-28	Boom Length	26' (2" O.D.)	Boom Diameter	2" O.D.
Maximum Power Input:	Legal Limit			Surface Area	7.3 sq. ft.
Gain	10 dB	No. of Elements	5	Windload Area	146 lbs.
VSWR (at Resonance)	1.5 to 1	Longest Element	26' 7"	Shipping Weight	50 lbs.
Impedance	50 ohms	Turning Radius	18' 6"		

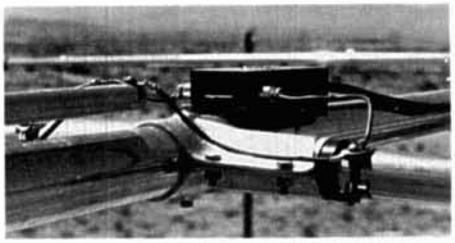




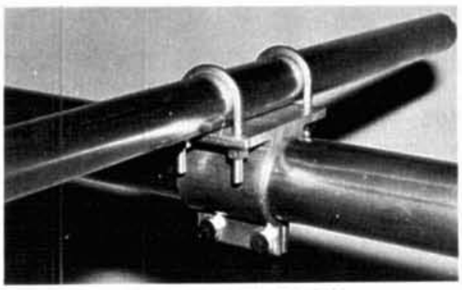




ADVANCED DESIGN LARGE DIAMETER HIGH-Q TRAPS FOR MINIMUM LOSS AND MAXIMUM POWER CAPACITY



INSULATED DRIVEN ELEMENT WITH PRECISION BETA MATCH AND HEAVY DUTY ELEMENT MOUNTS



HEAVY DUTY BOOM TO ELEMENT EXTRUSION

AMATEUR PRODUCTS DEALERSHIPS FOR MANY AREAS ARE AVAILABLE!!!
If you are interested in the profits you can make as a Wilson Dealer, contact us.

For complete specifications on the above products or a copy of our new Amateur Products Buyers Guide, write: Consumer Products Division

Wilson Electronics Corp.

P.O. BOX 19000 • LAS VEGAS • NEVADA • 89119 • (702) 739-1931 • TELEX 684-522

More Details? CHECK — OFF Page 150

State of the art by K.V.G.

CRYSTAL FILTERS and DISCRIMINATORS

9.0 MHz FILTERS

XF9-A	2.5 kHz	SSB TX	$31.95
XF9-B	2.4 kHz	SSB RX/TX	$45.45
XF9-C	3.75 kHz	AM	$48.95
XF9-D	5.0 kHz	AM	$48.95
XF9-E	12.0 kHz	NBFM	$48.95
XF9-M	0.5 kHz	CW (4 pole)	$34.25
XF9-NB	0.5 kHz	CW (8 pole)	$63.95

9.0 MHz CRYSTALS (Hc25/u)

XF900	9000.0 kHz	Carrier	$4.00
XF901	8998.5 kHz	USB	$4.00
XF902	9001.5 kHz	LSB	$4.00
XF903	8999.0 kHz	BFO	$4.00
F-05	Hc25/u	Socket Chassis	.50
F-06	Hc25/u	Socket P.C. Board	.50

Export Inquiries Invited

Shipping $1.25 per filter

LINEAR AMPLIFIERS

COMPATIBLE WITH OUR LOW POWER TRANSVERTERS.
10W DRIVE, 50Ω IN/OUT
EDL432, 50W (ILLUS.) **$129.95**

EDL432P, INCL. POWER SUPPLY/CABINET **$299.95**
EDL144, 100W 2M, IN CABINET, WITH 115V POWER SUPPLY **$299.95**

UPS Shipping at Cost

432 MHz SSB TRANSVERTERS

Use your HF Transceiver on the 432 MHz band with the addition of the MMt432 linear Transverter. The MMt432 operates on all modes; SSB, CW, AM, FM. It contains BOTH the linear transmit up-converter and the receive down-converter. An internal PIN diode T/R connects to your Transceiver T/R line. The MMt432 is FT101 and similar HF rig compatible. Add the 70/MBM48 MULTIBEAM and operate direct into OSCAR 7 mode B. Write for application note.

Specifications:

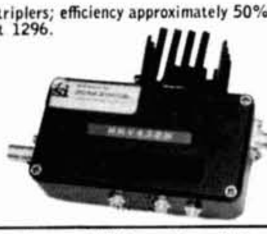
Output Power	10 W PEP
Drive, 10 meters	½ W max
Receiver N.F.	3.0 dB typ
Receiver gain	30 dB typ
Prime Power	12 V D.C.

Shipping: $3.50

MMt432-28 MK4	**$229.95**	**MMt144-28**	**$199.95**
MMt432-50	**$249.95**	**FMt440-146**	**$154.95**
MMt432-ATV	**$259.95**	**QMt432-144**	**$154.95**
MMt432-144	**$319.95**		

VARACTOR TRIPLERS

The low cost, easy way to operate on the 432 MHz and 1296 MHz bands. For OSCAR 7, mode B, drive the MMv432 family varactor tripler with your 2 meter transmitter. The wideband varactor triplers cover the full 2M/432 band without retuning.
NO power supply required for varactor triplers; efficiency approximately 50%.
Three models available at 432, two at 1296.



Model	Max Drive	
MMv432	30 W	$65.95
MMv432M	50 W	79.95
MMv432H	70 W	125.50
MMv1296	20 W	77.50
MMv1296H	35 W	99.95

Shipping $2.50

Send 26¢ (2 stamps) for full line catalogue of KVG crystal products and all your VHF & UHF equipment requirements.

Pre-Selector Filters	Amplifiers	SSB Transverters
Varactor Triplers	Crystal Filters	FM Transverters
Decade Pre-Scalers	Frequency Meters	VHF Converters
Antennas	Oscillator Crystals	UHF Converters

si

Spectrum International, Inc.
Post Office Box 1084
Concord, Mass. 01742, USA

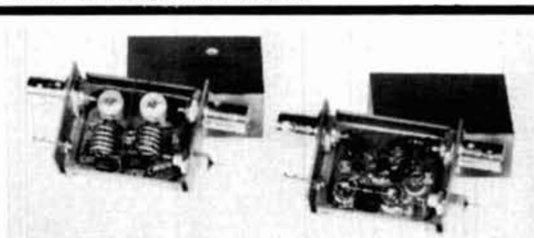
GREGORY ELECTRONICS
The FM Used Equipment People.

START THE NEW YEAR WITH A COPY OF GREGORY ELECTRONICS NEW 1978 CATALOG

GREGORY ELECTRONICS CORP.
245 Rt. 46, Saddle Brook, N.J. 07662
Phone: (201) 489-9000

PREAMPS from LUNAR

Originally developed by Chip Angle N6CA, the **"Anglelinear"** receiving preamplifiers meet the most demanding needs where low noise figure is important.



Model	Noise Figure	Gain	Bandwidth 3 dB	Bandwidth 10 dB	List Price
28N	1.25	15	1.3	4	34.95
28W	1.25	10	2.6	7	34.95
50	1.5	12	2.5	5	34.95
144N	1.5	12	2.5	8	34.95
144W	1.5	11	5	15	34.95
222	2.0	11	6	18	34.95
432-2	1.6	15	150	400	39.95
E432-3	1.0 ± .1	11	180	325	125.00
450-2	1.7	15	150	400	39.95
490-2	1.7	15	150	400	44.95

BNC Connectors standard, except E432-3 SMA only. Others, specify RCA Phono, TNC, etc.

New **"Anglelinear"** line products coming soon: Preamps thru 2.5 GHz, converters & transverters systems filters 28 MHz thru 2.5 GHz.

Write for descriptive brochure on all Lunar Products.
Please add $3.00 shipping/handling

California residents add 6%. Order today at your dealer or direct from:

LUNAR electronics
SUITE 10
2785 KURTZ ST.
SAN DIEGO, CA 92110
714-299-9740
Louis N. Anciaux WB6NMT

More Details? CHECK—OFF Page 150

Gift ideas from Vhf engineering

THE WORLD'S MOST COMPLETE LINE OF VHF-FM KITS AND EQUIPMENT

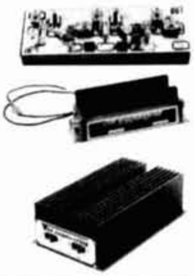
RECEIVERS

RX28C	28-35 MHz FM receiver with 2 pole 10.7 MHz crystal filter	$ 59.95
RX28C W/T	same as above–wired & tested	104.95
RX50C Kit	30-60 MHz rcvr w/2 pole 10.7 MHz crystal filter	59.95
RX50C W/T	same as above–wired & tested	104.95
RX144C Kit	140-170 MHz rcvr w/2 pole 10.7 MHz crystal filter	69.95
RX144C W/T	same as above–wired & tested	114.95
RX220C Kit	210-240 MHz rcvr w/2 pole 10.7 MHz crystal filter	69.95
RX220C W/T	same as above–wired & tested	114.95
RX432C Kit	432 MHz rcvr w/2 pole 10.7 MHz crystal filter	79.95
RX432C W/T	same as above–wired & tested	124.95
RXCF	accessory filter for above receiver kits gives 70 dB adjacent channel rejection	8.50
RF28 Kit	10 mtr RF front end 10.7 MHz out	12.50
RF50 Kit	6 mtr RF front end 10.7 MHz out	12.50
RF144D Kit	2 mtr RF front end 10.7 MHz out	17.50
RF220D Kit	220 MHz RF front end 10.7 MHz out	17.50
RF432 Kit	432 MHz RF front end 10.7 MHz out	27.50
IF 10.7F Kit	10.7 MHz IF module includes 2 pole crystal filter	27.50
FM455 Kit	455 KHz IF stage plus FM detector	17.50
AS2 Kit	audio and squelch board	15.00

TRANSMITTERS

TX50	transmitter exciter, 1 watt, 6 mtr	39.95
TX50 W/T	same as above–wired & tested	59.95
TX144B Kit	transmitter exciter–1 watt–2 mtrs	29.95
TX144B W/T	same as above–wired & tested	49.95
TX220B Kit	transmitter exciter–1watt–220 MHz	29.95
TX220B W/T	same as above–wired & tested	49.95
TX432B Kit	transmitter exciter 432 MHz	39.95
TX432B W/T	same as above–wired & tested	59.95
TX150 Kit	300 milliwatt, 2 mtr transmitter	19.95
TX150 W/T	same as above–wired & tested	29.95

POWER AMPLIFIERS



PA2501H Kit	2 mtr power amp–kit 1w in–25w out with solid state switching, case, connectors	59.95
PA2501H W/T	same as above–wired & tested	74.95
PA4010H Kit	2 mtr power amp–10w in–40w out–relay switching	59.95
PA4010H W/T	same as above–wired & tested	74.95
PA50/25 Kit	6 mtr power amp, 1w in, 25w out, less case, connectors & switching	49.95
PA50/25 W/T	same as above, wired & tested	69.95
PA144/15 Kit	2 mtr power amp–1w in–15w out–less case, connectors and switching	39.95
PA144/25 Kit	same as PA144/15 kit but 25w	49.95
PA220/15 Kit	similar to PA144/15 for 220 MHz	39.95
PA432/10 Kit	power amp–similar to PA144/15 except 10w and 432 MHz	49.95
PA140/10 W/T	10w in–140w out–2 mtr amp	179.95
PA140/30 W/T	30w in–140w out–2 mtr amp	159.95

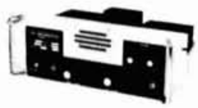
Blue Line . . . RF power amp, wired & tested, emission–CW-FM-SSB/AM

Model	BAND	Power Input	Power Output	
BLC 10/70	144 MHz	10W	70W	139.95
BLC 2/70	144 MHz	2W	70W	159.95
BLC 10/150	144 MHz	10W	150W	259.95
BLC 30/150	144 MHz	30W	150W	239.95
BLD 2/60	220 MHz	2W	60W	159.95
BLD 10/60	220 MHz	10W	60W	139.95
BLD 10/120	220 MHz	10W	120W	259.95
BLE 10/40	420 MHz	10W	40W	139.95
BLE 2/40	420 MHz	2W	40W	159.95
BLE 30/80	420 MHz	30W	80W	259.95
BLE 10/80	420 MHz	10W	80W	289.95

POWER SUPPLIES

PS15C Kit	15 amp–12 volt regulated power supply w/case, w/fold-back current limiting and overvoltage protection	79.95
PS15C W/T	same as above–wired & tested	94.95
PS25C Kit	25 amp–12 volt regulated power supply w/case, w/fold-back current limiting and ovp	129.95
PS25C W/T	same as above–wired & tested	149.95
PS25M Kit	same as PS25C with meters	149.95
PS25M W/T	same as above–wired & tested	169.95
O.V.P.	adds over voltage protection to your power supplies, 15 VDC max.	9.95
PS3A Kit	12 volt–power supply regulator card with fold-back current limiting	8.95
PS3012 W/T	new commercial duty 30 amp 12 VDC regulated power supply w/case, w/fold-back current limiting and overvoltage protection	239.95

REPEATERS



RPT50 Kit	repeater–6 meter	465.95
RPT50	repeater–6 meter, wired & tested	695.95
RPT144 Kit	repeater–2 mtr–15w–complete (less crystals)	465.95
RPT220 Kit	repeater–220 MHz–15w–complete (less crystals)	465.95
RPT432 Kit	repeater–10 watt–432 MHz (less crystals)	515.95
RPT144 W/T	repeater–15 watt–2 mtr	695.95
RPT220 W/T	repeater–15 watt–220 MHz	695.95
RPT432 W/T	repeater–10 watt–432 MHz	749.95
DPLA50	6 mtr close spaced duplexer	575.00
DPLA144	2 mtr, 600 KHz spaced duplexer, wired and tuned to frequency	379.95
DPLA220	220 MHz duplexer, wired and tuned to frequency	379.95
DPLA432	rack mount duplexer	319.95
DSC-U	double shielded duplexer cables with PL259 connectors (pr.)	25.00
DSC-N	same as above with type N connectors (pr.)	25.00

TRANSCEIVERS

TRX50 Kit	Complete 6 mtr FM transceiver kit, 20w out, 10 channel scan with case (less mike and crystals)	229.95
TRX144 Kit	same as above, but 2 mtr & 15w out	219.95
TRX220 Kit	same as above except for 220 MHz	219.95
TRX432 Kit	same as above except 10 watt and 432MHz	254.95
TRC-1	transceiver case only	19.95
TRC-2	transceiver case and accessories	39.95

SYNTHESIZERS

SYN II Kit	2 mtr synthesizer, transmitt offsets programmable from 100 KHz–10 MHz, (Mars offsets with optional adapters)	169.95
SYN II W/T	same as above–wired & tested	239.95
MO-1 Kit	Mars/cap offset optional	2.50
TO-1 Kit	18 MHz optional tripler	2.50

WALKIE-TALKIES

HT 144B Kit	2 mtr, 2w, 4 channel, hand held transceiver with crystals for 146.52 simplex	129.95
NICAD	battery pack, 12 VDC, ½ amp	29.95
BC12	battery charger for above	5.95
Rubber Duck	2 mtr, with male BNC connector	12.95

OTHER PRODUCTS BY VHF ENGINEERING

CD1 Kit	10 channel receive xtal deck w/diode switching	$ 6.95
CD2 Kit	10 channel xmit deck w/switch and trimmers	14.95
CD3 Kit	UHF version of CD1 deck, needed for 432 multi-channel operation	12.95
COR2 Kit	carrier operated relay	19.95
SC3 Kit	10 channel auto-scan adapter for RX with priority	19.95
Crystals	we stock most repeater and simplex pairs from 146.0-147.0 (each)	5.00
CWID Kit	159 bit, field programmable, code identifier with built-in squelch tail and ID timers	39.95
CWID	wired and tested, not programmed	54.95
CWID	wired and tested, programmed	59.95
MIC I	2,000 ohm dynamic mike with P.T.T. and coil cord	12.95
TS1 W/T	tone squelch decoder	59.95
TS1 W/T	installed in repeater, including interface accessories	89.95
TD3 Kit	2 tone decoder	29.95
TD3 W/T	same as above–wired & tested	39.95
HL144 W/T	4 pole helical resonator, wired & tested, swept tuned to 144 MHz ban	24.95
HL220 W/T	same as above tuned to 220 MHz ban	24.95
HL432 W/T	same as above tuned to 432 MHz ban	24.95

master charge

Vhf engineering

DIVISION OF BROWNIAN ELECTRONICS CORP.

BOX H / 320 WATER ST. / BINGHAMTON, N.Y. 13901 / Phone 607-723-9574

BANKAMERICARD

More Details? CHECK–OFF Page 150

More Details? CHECK — OFF Page 150

More Details? CHECK—OFF Page 150

PREAMPS

HIGH GAIN • LOW NOISE

30 dB power gain, 2.5-3.0 dB N.F. at 150 MHz, 2 stage, R.F. protected, dual-gate MOSFETS. Manual gain control and provision for AGC. 4-3/8" x 1-7/8" x 1-3/8" aluminum case with power switch and your choice of BNC or RCA receptacles. Available factory tuned to the frequency of your choice from 5 MHz to 350MHz with approximately 3% bandwidth. Up to 10% B.W. available on special order. Requires 12 VDC @10mA.

Model 201 price (5 200 MHz) $29.95
201-350 MHz $34.95

EXTRA LOW NOISE

Excellent for weather satellite reception and recommended by Dr. Ralph E. Taggart in his Weather Satellite Handbook. Less than 2 dB noise figure and approximately 17 dB gain. Uses a low noise J-FET in a common source neutralized circuit. Available factory tuned to your choice of frequency from 135 MHz to 250 MHz. Bandwidth approximately 4 MHz. Supplied in a 2-1/4" x 1-1/8" x 1-3/8" die cast aluminum weather-proof case with a filter for powering it through the antenna. Requires 12 VDC @ 5 mA. Choice of VHF, type "N", or BNC receptacles.

Model 102 PRICE $36.95

UHF

3 TO 5 dB MAX. N.F.

20 dB MIN. POWER GAIN

Uses 2 of TI's low noise J-FETS in our special circuit board design which gives a minimum of 20 dB power gain at 450 MHz. Stability is such that you can have mismatched loads without it oscillating and you can retune (using the capped openings in the case) over a 15-20 MHz range simply by peaking the maximum signal. Available tuned to the frequency of your choice between 300-550 MHz. 4-3/8" x 1-7/8" x 1-3/8" aluminum case with power switch and your choice of BNC or RCA receptacles. Requires 12 VDC @ 10mA.

Model 202 price $34.95

CONVERTERS

2 METERS

This converter has a minimum of 20 dB gain and a noise figure of 2.5-3.0 dB which assures you of a sensitivity of .1 microvolt or better. The circuit uses a dual-gate MOSFET R.F. stage and a dual-gate MOSFET mixer (thereby giving you a minimum of cross-modulation products), 6 tuned circuits, a bipolar oscillator and .005% crystal. Covers 144-146 MHz at 28-30 MHz output with one crystal included and 146-148 MHz at 28-30 MHz with an extra crystal (available for $6.00 more). The glass epoxy circuit board is enclosed in a 16 gauge aluminum case measuring 3-1/2" x 2-1/4" x 1-1/4" with your choice of either BNC or RCA receptacles. Also included is a power and antenna switch. Requires 12 VDC @ 15 mA. The converter is also available at other input and output frequencies. Call us for prices. PRICE: Model C-144-A available from stock at $39.95 with one crystal. Additional crystal $6.00 extra.

HF & VHF

40 dB GAIN 2.5-3.0 N.F. 150MHz

2 RF stages with transient protected dual-gate MOSFETS give this converter the high gain and low noise you need for receiving very weak signals. The mixer stage is also a dual-gate MOSFET as it greatly reduces spurious mixing products — some by as much as 100 dB over that obtained with bipolar mixers. A bipolar oscillator using 3rd or 5th overtone plug-in crystals is followed by a harmonic bandpass filter, and where necessary an additional amplifier is used to assure the correct amount of drive to the mixer. Available in your choice of input frequencies from 5-350 MHz and with any output you choose within this range. The usable bandwidth is approximately 3% of the input frequency with a maximum of 4 MHz. Wider bandwidths are available on special order. Although any frequency combination is possible (including converting up) best results are obtained if you choose an output frequency not more than 1/3 nor less than 1/20 of the input frequency. Enclosed in a 4-3/8" x 3" x 1-1/4" aluminum case with power and antenna transfer switch and your choice of BNC or RCA receptacles. Requires 12 VDC @ 25 mA.

Model 407A price:
5-200 MHz $54.95
201-350 MHz $59.95
Prices include .005% crystal. Additional crystals $8.95 ea.

UHF

20 dB MIN. GAIN

3 TO 5dB MAX. N.F.

This model is similar in appearance to our Model 407A but uses 2 low noise J-FETS in our specially designed RF stage which is tuned with high-Q miniature trimmers. The mixer is a special dual-gate MOSFET made by RCA to meet our requirements. The oscillator uses 5th overtone crystals to reduce spurious responses and make possible fewer multipliers in the oscillator chain which uses 1200 MHz bipolars for maximum efficiency. Available with your choice of input frequencies from 300-550 MHz and output frequencies from 14-220 MHz. Usable bandwidth is about 1% of the input frequency but can be easily returned to cover more. Requires 12 VDC @ 30 mA.

Model 408 price $59.95
.005% crystal included.

VHF RECEIVER

11 crystal controlled channels. Available in your choice of frequencies from 135-250 MHz in any one segment from 1-4 MHz wide. I.F. bandwidth (channel selectivity(available in your choice of ±7.5 kHz or ± 15 kHz. 8-pole quartz filter and a 4-pole ceramic filter gives more than 80 dB rejection at 2X channel bandwidth. Phase locked loop detector. Frequency trimmers for each crystal. .2 to .3 microvolt for 20 dB quieting. Dual-gate MOSFETS and integrated circuits. Self contained speaker and external speaker jack. Mobile mount and tilt stand.

Aluminum case, 6" x 7" x 1-3/8".
Model FMR 260-PL price:
135-180 MHz $149.95
181-250 MHz $159.95
Price includes one .001% crystal. Additional crystals $8.95 ea. This receiver is recommended in Dr. Taggart's Weather Satellite Handbook.

SYNTHESIZERS

FOR ALL TRANSCEIVERS

The STR series synthesizers are available for any transceiver operating from 20 MHz to 475 MHz that uses crystals in the 5 to 85 MHz range. It has a thumbwheel dial calibrated for your operating frequency plus a selectable transmit offset of plus or minus 600 kHz, plus or minus 1 MHz, and 2 spare offsets that you can add later. Frequency accuracy is .0005% and spurious outputs are 60 to 70 dB down. To process your order we must have the crystal formula of your transmit and receive crystals. If your transceiver uses 1 crystal for both transmitting and receiving (like the Motorola Metrum 11), you can use our receive synthesizer described to the right. Maximum tuning range per synthesizer is 10 MHz above 100 MHz and proportionally less at lower frequencies. Dial increments are in 1 kHz steps from 5 to 30 MHz and 5 kHz steps above.

Model STR synthesizer price:
5-150 MHz $259.95
151-475 MHz $279.95

FOR VHF RECEIVERS

This synthesizer has 8000 channels and can tune a continuous 40 MHz segment of your choice from 110-180 MHz in 5 kHz steps. This will satisfy most of your requirements in the VHF range and can save you hundreds of dollars in crystals plus a lot of time. Stock units are programmed for receivers with the crystal formula Fc = Fs -10.7 divided by 3 but we can program it to almost any other IF at no additional cost at the time of your order. It is supplied with an interface for plugging in to your existing crystal socket. Requires 12 VDC @ 1/2 amp which is easily obtainable from a low cost power supply. The synthesizer has 4 voltage regulators therefore the power supply need not be regulated. Phase noise is not detectable as the VCO is coarse tuned by a DAC thereby easing the requirements of the phase locked loop. Not affected by vibrations encountered in mobile use. Enclosed in an 8" x 3-7/8" x 1-1/2" aluminum case and supplied with a combination tilt stand/mobile mounting bracket.

Price: Model SR 140D-05 .... $179.95

NOTE: We can make any synthesizer from audio to 475 MHz. Call us for prices.

HOW TO ORDER: All items on this page are available only from Vanguard Labs. For receivers and converters state model, input and output frequencies, and bandwidth where applicable. For the fastest service call (212) 468-2720 between 9 AM and 4 PM Monday through Friday, except holidays. Your order can be shipped COD by Air Parcel Post.

BY MAIL: Send your order to Vanguard Labs, 196-23 Jamaica Avenue, Hollis, NY 11423 and include remittance by postal money order, cashiers check or certified check. Personal checks are also accepted, but banks now require 3 weeks for checks to clear, therefore this will delay your order. Include sales tax if you reside in New York State.

PURCHASE ORDERS: We accept purchase orders from US and Canadian government agencies, universities, and AAA rated corporations. Our terms are Net 30 days.

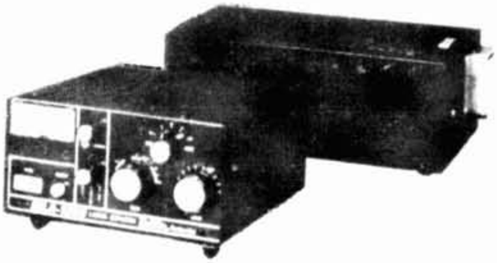
FOREIGN ORDERS: Must remit payment in full in US funds plus postage and insurance fees. If complicated customs forms are required, please forward your order to an import-export agent.

SHIPPING: We ship all our merchandise by insured parcel post or air mail. Special delivery is also available. Prices include shipping by regular parcel post if you remit with your order. For air mail shipping add $1.00. Postage will be added on all CODs, purchase orders, and foreign orders.

Vanguard Labs

196-23 Jamaica Ave.
Hollis NY 11423
(212) 468-2720

We have DenTron's New MLA-1200



The MLA-1200 is a compact KW designed to fill the gap between your barefoot transceiver or transmitter and a full power 2 KW amplifier. A single 8875 external-anode ceramic/metal triode, (the same revolutionary tubes that power the MLA-2500) yields 1200 Watts PEP SSB and 1000 Watts DC CW with as little as 70 Watts drive. (An automatic swamping circuit prevents damage to the final if more than 100 Watts drive is applied to the MLA-1200.) There are scores of features common to both the MLA-1200 and MLA-2500, like forced-air cooling, all-steel chassis construction with tight fitting black wrinkle finish cabinetry, a plug-in PC board for metering, ALC, and mandatory warm-up timing. The MLA-1200 is the same size as our Super Tuner (just 10" W x 6¼" H x 10" D), and weighs only 10 pounds! Twin outboard power supplies are available for AC or DC operation, with the MLA-1200's low filament current drain characteristics allowing for standard 6 foot cabling between units. Both supplies are constructed of high quality, high current components, and are designed for a lifetime of trouble-free operation.

MLA-1200 - $399.50

AC-1200 - $159.50 DC-1200 - $199.50

- 80 thru 10 meters
- 1200 Watts PEP input on SSB
- 1000 Watts DC input on CW, RTTY, or SSTV
- Forced Air Cooling System
- AC or DC Outboard Power Supplies (AC-1200, DC-1200)
- EIMAC 8875 external-anode ceramic/metal triode operating in grounded grid

WESTCOM

COMMUNICATIONS DIVISION
1320 Grand Ave. San Marcos, CA.
(714) 744-0728 92069

TEN-TEC ULTRAMATIC KEYER

MODEL KR50

- **SUPERLATIVE "FEEL" 5-50 GRMS PADDLE FORCE**
- **AUTOMATIC OR MANUAL WEIGHTING**
- **DIT AND DAH MEMORIES WITH SEPARATE DEFEATS**
- **"STRAIGHT KEY" OVERRIDE FOR QRS OR TUNE-UP**
- **GUARANTEED FOR LIFE BEARING PIVOTS**

A sparkling new keyer with a host of exciting features. A powerful aid to cleaner, more articulate CW that is relaxing to use and a joy to copy.

The paddle assembly will delight the CW purist as well as the recent graduate from a bug or hand key. The superlative "feel" is attained by a magnetic return force, instantly adjustable to exactly the right touch for you.

Weighting, the ratio of dit and dah (bits) lengths to the spacing between them, is either automatically or manually varied. In the automatic position, it is programmed to lengthen the bits at slow speed for enhanced smoothness and decrease them as you advance the speed, for highest articulation. Or, it can be adjusted to a constant value.

The KR50 is versatile. Dit and dah memories are provided for full iambic (squeeze) keying. Either dit or dah, or both, may be turned off for operation as a conventional type keyer. Self-completing characters at all times.

A convenient "Straight key" is built-in for QRS sending or tune-up. Also an internal side-tone and 115VAC/12VDC operation is provided.

The KR50 is designed to have a permanent place in your shack for the years, perhaps decades, ahead. An investment in the enjoyment of CW.

PRICE $110.00

KR20-A

Paddle has unique principle with excellent feel for rhythmic CW. Characters are self-completing. Bit weighting is optimized for normal speeds. Manual key button conveniently located for hand sending. Side tone signal, Reed relay. Plug-in circuit boards. 115VAC or 6 to 14 VDC. HWD 2½" X 4½" X 8¼", Wt. 2½ lbs.

PRICE $69.50

KR1-A

This is the paddle mechanism used in the KR50. Requires 6-14 VDC for adjustable electro-magnetic paddle return force. Adjustable contact spacing. For iambic or conventional keyers. "Straight key" button. Housed in an attractive metal case with cream front panel, walnut vinyl top. Size: 2" X 4" X 6", Wt. 1½ lbs.

PRICE $35.00

KR5-A

Similar to the KR20A but without monitor signal and AC power supply. A great value. For 6-14 VDC operation. Size HWD 2" X 4" X 6". Weight: 1½ lbs.

PRICE $39.50

KR2-A

The paddle used in the KR20A. Single paddle for non-iambic keyers. "Straight key" button conveniently located, cream aluminum case with walnut vinyl top. Size: 2" X 4" X 6", Weight: 1½ lb.

PRICE $17.00

TEN-TEC, INC.
SEVIERVILLE, TENNESSEE 37862
EXPORT: 5715 LINCOLN AVE., CHICAGO, ILL. 60646

ASTRAL ELECTRONICS CORP.
321 PENN. AVE. P.O. BOX 707
LINDEN, NEW JERSEY 07036
201 - 486-3365

PRIME QUALITY
TUBES • SEMICONDUCTORS • IC'S • LED'S

IF YOU DON'T SEE IT, SEND A SASE AND WE WILL QUOTE.

FAIRCHILD		4051	5/4.50	7489	1.35
VHF Prescaler		4071	10/1.60	7490	5/3.00
Chips	**Price**	4073	10/2.30	7493	10/4.45
95H90DC	8.90	**Tubes**	**Price**	74121	10/3.25
95H91DC	9.40	3-400Z	57.90	74132	10/6.60
11C01FC	15.35	3-500Z	57.90	74148	1.20
11C05DC	74.30	3-1000Z	156.00	74150	5/4.50
11C06DC	12.20	572B	24.50	74151	5/4.75
11C24DC	2.35	811A	10.70	74154	5/4.75
11C44DC	2.35	1625	3.00	74155	1.15
11C58DC	4.50	5894	39.50	74157	5/4.75
11C70DC	12.30	6146B	6.10	74163	5/3.00
11C83DC	29.15	6360	5.50	74164	5/4.75
11C90DC	14.90	6883B	6.60	74170	2.75
11C91DC	15.90	7094	58.00	74176	5/3.75
	Quantity/	8072	42.00	74190	1.15
Discretes	**Price**	8122	49.50	74192	5/4.25
1N270	5/1.00	8236	23.00	74193	5/3.50
1N914	10/1.50	8950	5.50	74197	5/3.75
1N4001	25/1.15	8560	52.00	74H71	10/3.00
	100/4.25	8643	87.50	74LS151	5/3.25
1N4002	20/1.10	8877	239.00		**Quantity/**
	100/5.25	**7400**	**Quantity/**	**Linear IC**	**Price**
1N4003	20/1.30	**Series IC**	**Price**	301AH	10/2.90
	100/5.70	7400	10/1.50	301 DIP	10/2.90
1N4004	20/1.50	7402	10/1.50	309K	2/1.90
	100/5.90	7404	10/1.60	340T-5	2/1.90
1N4005	20/1.60	7407	10/2.50	340T-6	2/1.90
	100/6.90	7408	10/1.70	340T-8	2/1.90
1N4006	20/1.80	7410	10/1.50	340T-12	2/1.90
	100/7.60	7414	10/6.20	340T-15	2/1.90
1N4007	20/1.90	7425	10/2.50	340T-18	2/1.90
	100/8.50	7430	10/1.50	340T-24	2/1.90
2N3055	2/1.65	7432	10/2.30	NE555V	10/3.40
2N3904	8/1.00	7438	10/2.00	565CN	5/4.75
2N3906	8/1.00	7441	10/7.00	566	1.75
CD/	**Quantity/**	7442	10/3.70	567	1.25
CMOS IC	**Price**	7447	10/7.90	709 TO5	10/2.50
4001	10/1.60	7453	10/1.50	723 DIP	10/4.00
4012	10/1.60	7454	10/1.50	741 TO5	10/3.00
4017	5/3.50	7470	10/2.60	741 MIN DIP	10/2.50
4028	5/3.75	7473	10/2.50	741 DIP	10/2.00
4043	5/2.25	7474	10/2.80	747 DIP	10/4.80
4049	10/3.50	7476	10/3.00	1458 MIN DIP	5/4.00
4050	10/3.50	7485	10/9.90	5558	5/4.00

Free Metric Converter With Each Order

FREE CATALOG WITH ORDER
WE PAY POSTAGE
N.J. RES. ADD 5% SALES TAX MINIMUM $10.00
SEND STAMP FOR FREE CATALOG

More Details? CHECK—OFF Page 150

More Details? CHECK—OFF Page 150

More Details? CHECK—OFF Page 150

2 METER FM

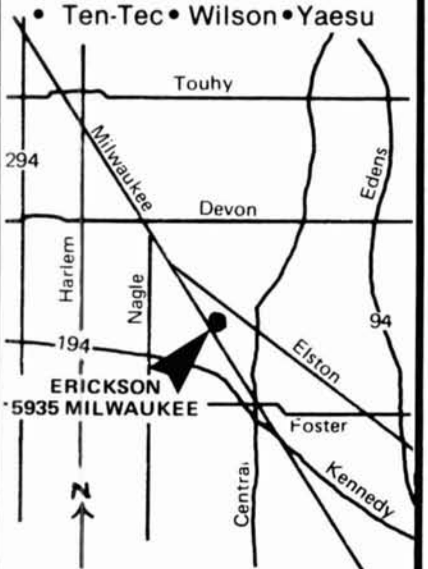
and HF too . . .

SATELLITE HEADQUARTERS

See Erickson for all your Amateur Radio needs!

WB9EBP, WB9JKT, WB9VIK serving you with . . .

- Ameco • ASP • Atlas
- Belden • Bird • CDE
- CES • Collins • Cushcraft
- Dentron • Drake • HAL
- Hy-Gain • Icom • KLM
- Kenwood • Larsen • MFJ
- Midland • Mosley • NPC
- Newtronics • Nye
- Regency • Shure • Swan
- Standard • TPL • Tempo
- Ten-Tec • Wilson • Yaesu



Hours: 9:30-9 Mon. & Thurs, 9:30-5:30 Tues, Wed. & Fri. 9-3 Sat.

ERICKSON COMMUNICATIONS
5935 N. Milwaukee Ave.
Chicago, IL 60646
(312) 631-5181

NEW!

DAVIS ELECTRONICS

Mini Counter

60 MHz
600 MHz
(with optional prescaler)

General Purpose Low Cost Counter Without the Sacrifice of Basic Performance

"Check the features we have that some other low cost counters don't have."

- All Metal Cabinet
- 8 Digit .4" LED Display
- Input Cable Included
- 12V Input Jack
- Crystal Time Base
- 115V or 12V Operation
- Push Button Controls
- Gate Light
- Completely Auto Decimal Point
- Selectible Gate Times (1 sec & .1 sec)
- State of the Art LSI Circuitry
- Sensitivity <10 MV

ORDER NOW
Call Toll Free
1-800-828-7422

7208 60 MHz Kit	$119.95	Assembled	169.95
7208A 600 MHz Kit ..	$149.95	Assembled	199.95

DAVIS

DAVIS ELECTRONICS 636 Sheridan Dr., Tonawanda, NY 14150 716/874-5848

DIPOLE ANTENNA CONNECTOR

HYE-QUE (HQ-1) dipole connector has coax SO-239 socket molded into glass filled plastic body to accept coax PL-259 plug on feedline. Drip-cap keeps coax fittings dry. Instructions included. Guaranteed. At your dealers or **$3.95 postpaid.** Companion insulators 2/$.99.

BUDWIG MFG. Co. PO Box 97H, Ramona, CA 92065

See our HAM MART listings to find the Amateur Radio dealers nearest you.

ALL-MODE VHF amplifiers

FOR BASE STATION & REPEATER USE

MODEL	INPUT	OUTPUT	PRICE
V70	10-20W	60-70W	$298
V71	1-5W	60-70W	$329
V130	25-40W	110-130W	$389
V131	1-5W	110-130W	$419
V135	5-10W	110-130W	$419
V180	10-15W	180-200W	$525
Universal 19" Rack Mount			$25

- ☆ 143-149 MHz No Tuning
- ☆ AM - FM - CW - SSB
- ☆ Low Harmonics
- ☆ Heavy Duty
- ☆ No Power Supply Needed
- ☆ Illuminated Panel Meter
- ☆ + 13.5V/3 Amp Socket
- ☆ 115 or 230V AC
- ☆ 60dB Spurious
- ☆ Fully Protected Output
- ☆ Internal T/R Switch
- ☆ U.S. Manufactured
- ☆ 19" Rack Panel Option
- ☆ Size 8-1/2 x 13 x 7" H

Only two things are needed to put this power house on the air with your handy-talky or mobile transceiver: a two foot piece of coaxial cable and a 115 or 230 volt AC outlet. That's all. You do not need anything else. The mobile transceiver can be powered directly from the accessory socket located in the rear panel of the RFPL amplifier. It puts out + 13.5 volts at 3 amperes. This is sufficient for powering most 15 watt transceivers.

DEALER INQUIRIES INVITED

RF POWER LABS, INC.

11013-118th Place N.E. • Kirkland, Washington 98033 • Telephone: (206) 822-1251 • TELEX No. 32-1042

More Details? CHECK—OFF Page 150

BULLET ELECTRONICS

P. O. BOX 19442 DALLAS, TEXAS 75219

* No COD'S.
* Send check or MO
* MasterCharge or VISA accepted.
* Texas Residents add 5% sales tax.
* Foreign orders add 10% (20% airmail)
* Catalog included with each order
* Orders over $50, take 10% discount.

PHONE ORDERS (214/823-3240) ON MASTERCHARGE & VISA

Did Somebody Mention Parts? Well, Here Are Just A Few Of The Items We Have. All Parts Are Prime & Guaranteed!

160W NPN Darlingtons

HOUSE NO. 2N6283 TO-3 Power Transistors with Hfe of over 5,000! 80V Vceo. Outperforms MJ3001.

Limited Qty.! - $1.00

PICK A PAIR!

8A Complimentary Darlington Power Transistors. MJ900 PNP, MJ1000 NPN. 90 Watts. Build high power audio amps.

Buy a Pair for $3.00!

ZENER Special!

ALL UNITS PRIME!
Overstocked on these units:
1N3030 1W 27 volt
House no. ½W 5.4V
House no. .4W 12.6V

9 for $1.00 (Same type)

MC1351P FM IF, Limiter, Discriminator & AF Pre-Amp

14 PIN IC. COMPLETE FM SOUND SUB SYSTEM USES MINIMUM EXTERNAL COMPONENTS. COMPLETE SPECS AND APPLICATIONS INFORMATION.

House # - 5/$1.00

General Purpose NPN

2N3569 Fairchild Vceo = 60V Hfe to 300. 800MW power, epoxy TO-5. Limited Qty!

6 for $1.00

Wideband AMP IC, High Gain

100Khz to over 20Mhz. Good for IF's and low frequency Complete Specs!

CA3011 50¢ each

MULTICOLORED 26 CONDUCTOR

Ribbon Cable No. 28 wire with a woven binder for easy seperation. Super flexiblity! Compare our price!
10' Roll $2.95
50' Roll $9.95

MC1469R

VOLTAGE REGULATOR IC

Versatile 500Ma regulator is adjustable with a single external resistor from 3 to 30 volts. Provisions for current limit and remote shutdown. Complete specs and application notes are included. $1.25 each or 10/$10. External series pass will provide currents to 20 amps.

Heatshrink Tubing

SPECIAL A very good assortment of 3/32", 1/8", 3/16", 1/4" and 7/16" heatshrink tubing 12 6" lengths for .75 Assorted colors

Quad Matched Diodes

Four closely matched 1N914 type diodes for balanced bridge or modulator circuits. One set – $1.00

2N5590

RF POWER TRANSISTOR

Just what you've been looking for: 10 Watts with 13.5VDC supply. Frequencies to 300 MHZ. Limited Quantity!

$3.95

PMOS Counter Chips

Single digit pre-settable up or down BCD counter with 7 segment decoded output/driver has internal latch. Requires +12, & +24VDC. Build counters, timers, etc. Complete specs. 24 Pin IC 4/$5.00

#30 Silver Plated

Wirewrap wire with Kynar® jacket. 4 colors available, 100 ft. of each color.

$4.95 (400')

BULLET LUCKY NUMBER! Starting next issue a number will be listed in our ad that corresponds to a number on one of our catalogs. The number is worth $100! Watch for the special number on your Bullet Catalog.

WE ALSO SELL A GROWING LINE OF QUALITY KITS. WE HAVE SHIPPED 1000's!

MINI GRANDFATHER CLOCK KIT

Just in case you have spent the last six months in Siberia, we will tell you one more time that **BULLET** has the **ONLY** Completely **Electronic Grandfather Clock Kit** in the world that has all the below listed features. The biggest problem we have is to try and describe how unique and fascinating this clock really is! The **Swinging LED Pendulum and Matching Tick-tock sound** are available only on our clock. In addition the electronic chime notes each hour (ie: 3 times for 3 o'clock). Housed in the optional **SOLID HARDWOOD CASE**, the unit makes a beautiful addition to any room as well as a great gift.

* ½" 4 digit LED readout
* Adjustable Tone & Duration on Chime
* AM/PM indicator
* Simulated swinging pendulum uses LEDS
* All CMOS construction
* All electronics, switches and transformer inc.
* Quality plated PC boards (2) 6.5" x 4.5"

MG-01 $39.95

BEAUTIFUL SOLID HARDWOOD CASE FOR MG-01: Case is cut, grooved and finished for clock. Includes Ruby front filter. Quick easy assembly requires only 4 screws (included) $19.95 **CHRISTMAS/HOLIDAY SPECIAL**: Buy an MG-01 at regular price and get the case for a low $12.95. Your total cost **$52.90**. **Good till 1/31/78.**

New! PS-14 HIGH CURRENT REGULATED POWER SUPPLY KIT

A low cost, no frills, heavy duty power supply. Designed for use and abuse!

12V @ 15A CONTINUOUS Less Case, meters & jacks

* Better than 200MV load & line regulation
* Foldback Current Limiting
* Short Circuit Protected
* Thermal Shutdown
* Adjustable Current Limiting
* Less than 1% ripple
* 15 amps 11.5 to 14.5V
* All parts supplied including heavy duty transformer
* Quality plated fiberglass PC board

$39.95 UPS SHIPPING PAID!

POWER SUPPLY ACCESSORIES

Quality 3½" Meters for PS-14 (0-25A; 0-15 VDC) Individually Packaged. Not Surplus $12.50/set

OVERVOLTAGE PROTECTION KIT

Provides cheap insurance for your expensive equipment. Trip voltage is adjustable from 3 to 30 volts. Overvoltage instantly fires a 25A SCR and shorts the output to protect equipment. Should be used on units that are fused. Directly compatible with the PS 12 and PS 14. All electronics supplied. Drilled and plated PC board. (Order OVP 1)

$6.95

MK-05 MINI MOBILE CLOCK

$12.95

With punched front aluminum case – $15.95

The smallest and best priced mobile clock kit on the market. Designed to be a mobile clock from the ground up. There has been no compromise on quality.

FEATURES:

* Quartz crystal timebase
* Toroid & zener noise & overvoltage protection.
* Magnified .15", 6 digit LED readout.
* Complete with presettable 24 hr. alarm
* 9–14 VDC @ 40 to 50 ma.
* Readouts can be suppressed
* EASY, QUICK ASSEMBLY
* All components required included (you supply the speaker).
* Top quality drilled and plated PC boards. Clock board: 2.6" x 2" Readout board: 2 3/8" x .75"

Small enough to mount in the instrument panel!

MK–06 CLOCK/CALENDAR AUTO/HOME CLOCK KIT

Nothing else to buy!
Can be panel mounted.
Great for Vans & RV's!

We designed this to be a SUPER CLOCK with ALL the features you want. Quality double sided PC boards make assembly easy. Mobile (12VDC) or home (12VAC)

* Large ½" LED Readout
* AM/PM Indication
* 28/30/31 day calendar displays automatically or manually
* Display can be dimmed or blanked
* Flashing Colon counts the seconds
* Intergal Timebase is adjustable
* Presettable Alarm with Snooze Feature.
* Noise and voltage protection circuits
* Single front mounted rotary switch selects all functions

Additional Options
24 hour format; Add $2.
12VAC XFMR for 110 operation add $1.75

$21.50 LESS CASE

POLY PAKS® IS THE WORLD'S LARGEST ELECTRONIC DISCOUNT SUPERMARKET

DEC. 77 HAM MAGAZINE SPECIALS

SANTA'S BARGAINS

CONDENSER MIKE "TIE-PIN" TYPE

It's a little giant in sound quality. Metal encased with built-in FET circuit, omni-directional, freq. resp. 20-12,000Hz. Less tie pin or lapel clip. 600 ohm impedance. 1.5VDC. No. 12H3178 **4.95**

7/16" x 7/8" long

"GEL-SEL" POWER PAK

Rechargeable! Perfect for back-up power for computers, alarms, and more. Sealed, spill-proof, leak-proof. Better than NI-CADS, recharges to 100% capacity. Compact, only 4" x 1⅞ x 2", stack 'em in series or parallel. Lead or lead/antimony gel (sorry, no choosing). Wt. 16 ozs. No. 12H4088 □ **$4.95**

6 V 1000 MILS

AM-FM-MPX TUNER AMP

- 4D Matrix for 2 & 4 speaker systems
- Wall/Console
- Contemporary design black and chrome front panel

The Philharmonic

SPECIFICATIONS: AMP: Pwr. our 5W x 2 RMS, both chan into 8 ohms, 40-20000 Hz. THD 0.9%. Freq. resp. 15-20,000±2db. S/N ratio 55db. FM: Sens 2.7 uV for 20 db S/N. Requires 115-VAC 60 Hz. Size: 8½ x 13½ x 3½". Wt. 7 lbs.

Solid state circuitry. 4D MATRIX simulates quad sound from stereo FM, tapes, and records. Gives feel of a live performance. Slide controls for VOLUME, BASS, TREBLE and BALANCE. Selector for PHONO, TAPE, AM, FM, FM-MPX. Rocker switches for POWER ON/OFF, AFC, STEREO/4D MATRIX. Also features stereo headphone jack, FM stereo indicator.

Cat. No. 12H4007 □ **$69.95**

In 5-12-15 volts! 1-AMP REGULATED POWER SUPPLY

New! Easy to assemble! Uses LM340K positive voltage regulator. Reverse leads for a negative supply. Buy 2 for a ± power supply! With transformer, regulator, PC board & all components. Complete kit, nothing else to buy. Wt. 4 lbs.

Cat. No.	Volts
□ 12H3854	5
□ 12H3857	12
□ 12H3858	15

2 for $15.95

□ Your choice KIT **$8.88** □

100 KHz* MARKER CRYSTALS

Build your own marker generator at 100, 200, 300 KHz etc. Calibrate receivers, ham rigs and more. Accuracy 0.001%, size 1½ x ½". With instructions for building marker generator. *100 KHz after trimming. Wt. 1 oz.

Order by Cat. No. 12H3896 □ **$2.95**

□ 104.067 KHz □ 105.000 KHz
□ 104.092 KHz □ 114.000 KHz

LAB-N-HOBBY TEST EQUIPMENT FACTORY OVERSTOCK

TRANSISTOR CHECKER DYNAMIC

Tests NPN, PNP, Powers and unknown semi's. Simple to use, both in-or-out of circuit. Automatically identifies polarity. Tests leakage, matches similar transistors. Use with VOM to test noise, dynamic leakage and more. Built-in quick test socket. Requires 1½V "D" cell. With instructions. 2½ x 2 x 5". Wt. 16 ozs.

Cat. No. 12H3933 □ **$14.95**

Transistorized SIGNAL TRACER

It's like having a third hand. Simplifies locating circuit troubles in AF, RF, and IF circuits. Easy to use, compact and lightweight, only 2½ x 2 x 5". Built-in speaker and gain control, with test leads. Requires 9V battery. 16 ozs.

No. 12H3934 □ **$12.95**

POLY PAKS "CHIPS" AWAY IC PRICES!

Order Cat. No. 12H4048 and Type No.

Type		Sale
□ ICM7205	Stopwatch	$14.95
□ AY3-8500-1	Six TV Games	9.95
□ MM5330	4½ Digit DVM	4.95
□ 8038C	Volt Control Osc	4.95
□ KR2376	Encoder ROM BCD	6.95
□ 95H90DC	350 MHz Prescaler	8.88
□ MC14410	Touch Tone Encoder	9.95
□ MK2002P	Char. Gen. (2513 equal)	3.95
□ 7207A/7208	Frequency Counter, pair	29.95
□ ICM7107	3½ Digit DPM	12.50
□ MM5316	Alarm Clock	2.95
□ 8080A	Microprocessor	14.95
□ 1702A	Erasable PROM	4.95
□ 2708	8K EPROM	22.88
□ 2102-1	1K RAM	1.39

STEREO TO QUAD ADAPTOR

Derives quad sound from stereo. Works with all models, all makes, hooks up in seconds. Gives the feel of a "live" performance. No power necessary. Inputs 2 RCA plugs, outputs 4 RCA jacks. Size: 3¼ x 2½ x 2". Wt. 14 ozs.

Cat. No. 12H3910 WESTINGHOUSE □ **$2.95**

69¢ EACH 6 for $2.50 SPECTROL "SKINNY-TRIMS"

3/8" square. Screwdriver shaft, 20% tolerance, ½ watt. Cermet construction, PC leads. Order by Cat. No. and Value.

□ 12H3863 25 Turn upright, type 64
□ 12H3864 25 Turn flat, type 64
□ 12H3866 Single turn flat, type 63

*Available in all types **Available in Cat. No. 12H3863 only.

OHMS: □ 10 ** □ 20 ** □ 50 ** □ 100 * □ 200 * □ 500 * □ 1K * □ 2K * □ 5K * □ 10K * □ 20K * □ 50K ** □ 100K ** □ 200K ** □ 500K ** □ 1 Meg**

upright flat

RCA "POCKET" VOM

- 1000 ohms per volt

Model WV-539A. Features 1% precision, movements diode protected against burnout. Measures DC volts 0-15-150-1000; AC volts 0-15-150-1000; DC current 0-150ma; resistance X1000. Sensitivity 1000 ohms/volt AC-DC. Uses penlite cell, not included. Size 2⅝ x 3½ x 1⅜". Wt. 5 ozs. Cat. No. 12H3921

$8.88 □

"CB" POWER SUPPLY

COMPLETELY WIRED

□ 3 AMPS **$16.88**
□ 4 AMPS **$19.95**

Ideal for CB's, Ham rigs, tape decks & more! Modern cabinet, 5 x 4½ x 2¼". With on/off switch, LED lamp, built-in circuit breaker. 115 VAC 60 Hz, Wt. 5 lbs. Cat. No. 12H3452

- Completely wired
- 12 VDC @ 3 Amps output
- Regulated, continuous duty

TTL'S We know we have the lowest prices!!

BUY 100 25% OFF
BUY 10 15% OFF

Order by Cat. No. 12H1981

Type	Sale
□ SN7400	$0.14
□ SN7401	.14
□ SN7403	.14
□ SN7404	.17
□ SN7405	.18
□ SN7406	.19
□ SN4707	.24
□ SN7410	.14
□ SN7411	.19
□ SN7413	.39
□ SN7414	.61
□ SN7416	.24
□ SN7417	.24
□ SN7420	.14
□ SN7423	.25
□ SN7427	.26
□ SN7430	.14
□ SN7432	.24
□ SN7437	.24
□ SN7438	.24
□ SN7440	.14
□ SN7441	.79
□ SN7442	.49
□ SN7443	.61
□ SN7444	.61
□ SN7445	.69
□ SN7447	.69
□ SN7450	.14
□ SN7451	.14
□ SN7453	.14
□ SN7454	.14
□ SN7455	.14

Type	Sale
□ SN7460	.20
□ SN7462	.14
□ SN7464	.14
□ SN7465	.14
□ SN7470	.28
□ SN7471	.69
□ SN7472	.26
□ SN7473	.31
□ SN7474	.31
□ SN7475	.48
□ SN7476	.33
□ SN7478	.79
□ SN7480	.33
□ SN7482	.69
□ SN7483	.69
□ SN7485	.88
□ SN7486	.29
□ SN7488	2.95
□ SN7490	.69
□ SN7491	.63
□ SN7492	.45
□ SN7493	.45
□ SN7494	.69
□ SN7495	.69
□ SN7496	.69
□ SN7498	.69
□ SN74107	.29
□ SN74112	.19
□ SN74113	.19
□ SN74114	.19
□ SN74121	.31
□ SN74123	.49
□ SN74125	.39
□ SN74126	.39
□ SN74132	.83
□ SN74140	1.00

& Type No	
□ SN74141	.92
□ SN74145	.89
□ SN74148	1.25
□ SN74153	.63
□ SN74154	.99
□ SN74155	.78
□ SN74156	.66
□ SN74157	.64
□ SN74160	.89
□ SN74161	.87
□ SN74163	.87
□ SN74164	.95
□ SN74165	.95
□ SN74166	1.15
□ SN74173	1.19
□ SN74174	.93
□ SN74175	.88
□ SN74177	.77
□ SN74179	1.49
□ SN74180	.69
□ SN74181	1.95
□ SN74182	.69
□ SN74190	1.15
□ SN74191	.99
□ SN74192	.83
□ SN74193	.83
□ SN74194	.83
□ SN74195	.75
□ SN74197	.75
□ SN74199	1.69
□ SN74200	5.50
□ SN74251	1.39
□ SN74284	4.25
□ SN74285	4.25

BARREL KITS

TEST 'EM YOURSELF 'N SAVE!

EXCLUSIVE GUARANTEED 50% YIELD ON UNTESTED......

Buy 10 BARREL KITS AND CHOOSE THE 11TH KIT Free

BARREL KIT #264 PRE-CUT'N'TINNED HOOKUP WIRE 200 lengths* $1.98. Breadboarders note. #22 wire, precut into 4" to 8" lengths. Asst. color plastic jackets. Wt. 12 ozs. *200 ft. approx. No. 12H3959

BRIDGES! BRIDGES! KIT #270 20 for $1.98. We bot 2 tons of 2, 4, 10 and 25 amp full wave bridges. How good, we don't know. Untested and hobby. Wt. 9 ozs. No. 12H4022

BARREL KIT #203 CALCULATOR KEYBOARDS 10 for $1.98. It's true! 20-key, 4 function keyboards at ridiculous give-away. Wt. 12 ozs. Cat. No. 12H3524

BARREL KIT #253 LINE CORDS 8 for $1.98. 100's of AC power uses! Heavy-duty, 6-ft. long, 18 gage. White vinyl insulation & molded plug. Wt. 8 ozs. Cat. No. 12H3843

BARREL KIT #35 NEON LAMPS 30 for $1.98. Famous NE-2's. All prime, but factory made millions and barrel'ed 'em. Your advantage. 12H2613

BARREL KIT #244 HOBBY 1702A ROMS 3 for $1.98. Hobby fallouts of the famous eraseable programmable ROM. 2048 bit. Cat. No. 12H3729

BARREL KIT #239 SHIELDED CABLE 40-ft. $1.98. For mikes, stereos; 1-cond. plus shield, 22 ga, vinyl jacket. Wt. 1 lb. Cat. No. 12H3577

BARREL KIT #73 TRANSISTOR ELECTROS 50 for $1.98. It "bugs" us why the factories dump 'em in barrels. We don't wish to separate wide asst voltages & values to 300 mf. 12H2747

BARREL KIT #225 SOUND TRIGGERS 3 for $1.98. "Hand clap" sensitizes crystal mike amplifier, triggers SCR. Use for alarms, etc! Wt. 6 ozs. No. 12H3625

BARREL KIT #221 IC SOCKETS 8 for $1.98 hobby. Mfr unloads! Four 14-pin, four 18-pin. Solder tail, lo-profile. No. 12H3621

BARREL KIT #205 MINI BLOCK CAPACITORS 50 for $1.98. Unbelievable! Worth $50. High precision submini caps for all applications. Wt. 3 ozs. No. 12H3528

BARREL KIT #201 6V INDICATORS w/leads 15 for $1.98. Test lamp manufacturer dumps inventory! Worth 69¢ ea. Like grain-o-wheat. Cat. No. 12H3526 hobby

BARREL KIT #210 GLOWIN' PANELS 3 for $1.98. 4" x 1" panels that glow blue-green with 110VAC. Use for nite lites, indicators, etc. Cat. No. 12H3550

BARREL KIT #76 1-WATT ZENERS 100 for $1.98 Untested. Factory same as 400-mw's. Never-to-see-again offer. 6, 8, 10, 12, 15V, under glass. Double plug. 12H2741

BARREL KIT #188 400 PARTS $1.98. Includes resistors, caps, diodes, IC's, for PC work, some on PC boards. Dumped into barrels by factories, 100% material. Wt. 12 ozs. Cat. No. 12H3401

BARREL KIT #184 ¼-WATT METAL FILM 150 for $1.98. 100% metal film resistors. Long leads. 12H3413

BARREL KIT #182 JUMBO RED LEDS 15 for $1.98. 100% material, user cancellation from factory dumps, 3V 10 mils. For 100's of projects, red lens. Cat. No. 12H3369

BARREL KIT #163 MINI TRIM POTS 30 for $1.98 1 oz. Asst. values 100 to 1 meg What a buy. Single turn. ¼ W. Wt. 6 oz. 12H3345

BARREL KIT #160 HOBBY VOLTAGE REGULATORS 10 for $1.98. LM-309K TO-3 barreled, bot by the pound, but who wants to check 'em? Your gain. Wt. 20 ozs. 12H3330

BARREL KIT #138 PANEL SWITCHES 30 for $1.98 9 ozs. Did you hear of OAK? Another eqpt maker barrelled all types of rotaries, electric, slides, etc. 12H3268

BARREL KIT #128 MINI-DIP IC'S 100 for $1.98. 741's, LM380, 703, 567, 555, who knows? Factory mixed, you test. Untested and hobby. Wt. 1 lb. Cat. No. 12H3245

BARREL KIT #127 AXIAL ELECTROS 40 for $1.98. Asst. capacities and voltages. Cat. No. 12H3227

BARREL KIT #126 UPRIGHT ELECTROS 40 for $1.98. 1mf to 300mf in mixture of voltages. 100% marked 'n good. 12H3226

BARREL KIT #115 MOLEX SOCKETS 100% good 150 for $1.98 Cat. No. 12H3144. Calculator maker dump! We gut a zillion of 'em.

BARREL KIT #109 TERMINAL STRIPS 100 for $1.98. Wide asst. of terminal strip connectors, from 1 contact up. Strip manufacturers barrel dump is your gain. Wt. 1 lb. Cat. No 12H3136

BARREL KIT #104 SLIDE VOLUME CONTROLS 10 for $1.98. Cat. No. 12H3057

BARREL KIT #101 RESISTOR SPECIAL 200 for $1.98. Includes: ⅛, ¼, ½, 1, 2-watters, carbon. 8 oz. 100% good. 12H3054

BARREL KIT #99 PHOTO ELECTRIC CELLS 10 for $1.98. Asst. GE types, CDS types. Mixed by factory. Big job for us to separate. 100% good. Cat. No. 12H3052

BARREL KIT #93 HALF WATTERS 200 for $1.98. Resistor factory tried to fool us by mixing 100% color-coded resistors in barrel. But value is there. 4 oz. 12H3046 Untested

BARREL KIT #87 NAT. IC BONANZA! 100 for $1.98. Hobby and untested, factory mixed in barrels. Linears, 7400's, ROMS, DTL'S, registers, clock and calculator chips and more. Wt. 12 ozs. Cat. No. 12H2860

BARREL KIT #86 HOBBY LEDS 40 for $1.98. WOW! Top U.S.A. maker dumps discretes in barrels. Hobby and untested. Useable yield 50% or better! Wt. 4 ozs. Cat. No 12H2859

BARREL KIT #83 LM-340T VOLTAGE REGULATORS 15 for $1.98. Factory rejects, hobby, cosmetic rejects May include 5, 6, 12, 15, 18 or 24 volts, TO-220 power tab. Wt. 4 ozs. Cat. 12H2635

BARREL KIT #71 CAPACITOR SPECIAL 100 pcs. $1.98. micas, moldeds, plastics, ceramics, discs, etc. Nifty 100% good Cat. No. 12H2738

BARREL KIT #68 2 WATTERS 100 for $1.98 100% good. Suppliers throw 'em in the barrel. It's a li'l gold mine. All marked Cat. No. 12H2735

BARREL KIT #61 POLYSTYRENE CAPS 100 for $1.98. Finest caps made. As a gamble we bought 10 barrels from factory, mixed values; all good. Cat. No. 12H2729

BARREL KIT #58 SLIDE SWITCHES 30 for $1.98. All shapes, sizes, spst, dpdt, momentaries, etc. Tremendous shop pak for 100's of switching projects. Cat. No. 12H2726 100% good

BARREL KIT #39 HOBBY NPN POWER TRANSISTORS 15 for $1.98. Factory fallouts and "off spec" TO-3 powers. 100% hobby, no opens, no shorts. Wt. 1 lb. Cat. No. 12H2617

BARREL KIT #31 METALLIC RESISTORS 100 for $1.98. Made mostly by Corning, the finest resistor made. Mostly ½ watters, 1% to 5% tol. & a barrel of values. Cat. No. 12H2609

BARREL KIT #30 PREFORMED RESISTORS 200 for $1.98. We got barrels of ¼ and ½" watters for pc use. 100: ¼, 100 ½" watters. No. 12H2608 100% good

BARREL KIT #27 PREFORMED DISCS 150 for $1.98. Hi-Fi mfr's shelf inventory but he dumped 'em in barrels. Preformed, for PC use, Mixed values too! 12H2605

BARREL KIT #26 PLASTIC TRANSISTORS 100 for $1.98. Untested and hobby transistors, TO-92 (TO-18), asst. 2N numbers, asst. manufacturers. Wt. 8 ozs. 12H2604

BARREL KIT #20 LONG LEAD DISCS 100 for $1.98. "auction sale" Prime, marked only. Long leads Cat. 12H2598 100% good

BARREL KIT #19 DIPPED MYLARS 60 for $1.98. Finest capacitors made, shiny finish. Imagine factory dumping 'em in barrels. Cat. No. 12H2597 100% good

BARREL KIT #14 PRECISION RESISTORS 200 for $1.98. Marked and unmarked ¼, ½, 2 watts. No 12H2428

BARREL KIT #7 VOLUME CONTROL 30 for $1.98 100% good. Singles, duals, variety of values, styles, big ones — small ones. Cat. 12H2421

BARREL KIT #3 1N4148/914 SWITCHING DIODES 100 for $1.98. Imagine famous switching diodes at these prices! Cat. No 12H2418 Untested.

BARREL KIT #1 SN7400 DIP IC'S 75 for $1.98. Marked 14 and 16 pin dips, may include gates, flip-flops, registers, counters, who knows? Untested, hobby. Wt. 14 ozs. 12H2415

Terms: Add postage Rated: net 30
Phone: Wakefield, Mass. (617) 245-3829
Retail: 16-18 Del Carmine St., Wakefield.

POLY PAKS

P.O. BOX 942H LYNNFIELD, MA. 01940

SALE □ Send for FREE SPRING CATALOG

C.O.D.'s MAY BE PHONED

MINIMUM ORDER — $6.00

More Details? CHECK—OFF Page 150

flea market

RATES Non-commercial 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). 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.

MOBILE IGNITION SHIELDING provides more range with no noise. Available most engines. Many other suppression accessories. Literature, Estes Engineering, 930 Marine Dr., Port Angeles, WA 93862.

YAESU EQUIPMENT OWNERS — Present or Prospective — Join the six-year-old, 2500 member, 42-country, International Fox-Tango Club. Members receive valuable monthly Newsletter, money-saving purchasing service, technical committee consultation, free ads, FT net, more. Back issues of Newsletter available from 1972. To join, send $5 for calendar year (includes all 1977 issues of Newsletter) or $1 creditable towards dues, for complete information and sample Newsletter. Milton Lowens, WA2AOQ/N4ML, 248 Lake Dora Drive, W. Palm Beach, Fl. 33411.

QRP TRANSMATCH with Preamp for HW7 Ten-Tec. Send stamp for details to Peter Meacham Associates, 19 Lorreta Road, Waltham, Mass. 02154.

WANTED — Manual for Panoramic Electronics Model SPA-4a Spectrum Analyzer — Judson Snyder, K2CBA, Petersburg, N.Y. 12138.

CANADIANS 1,000,000 surplus parts. Bargains galore. Free catalog. Etco-HR. Box 741, Montreal, H3c 2v2.

Foreign Subscription Agents for Ham Radio Magazine

Ham Radio Austria
Karin Ueber
Postfach 2454
D-7850 Loerrach
West Germany

Ham Radio Belgium
Stereohouse
Brusselsesteenweg 416
B-9218 Gent
Belgium

Ham Radio Canada
Box 114, Goderich
Ontario, Canada N7A 3Y5

Ham Radio Europe
Box 444
S-194 04 Upplands Vasby
Sweden

Ham Radio France
Christiane Michel
F-89117 Parly
France

Ham Radio Germany
Karin Ueber
Postfach 2454
D-7850 Loerrach
West Germany

Ham Radio Holland
MRL Ectronics
Postbus 88
NL-2204 Delft
Holland

Ham Radio Italy
STE, Via Maniago 15
I-201 34 Milano
Italy

Ham Radio Switzerland
Karin Ueber
Postfach 2454
D-7850 Loerrach
West Germany

Ham Radio UK
P.O. Box 63, Harrow
Middlesex HA3 6HS,
England

Holland Radio
143 Greenway
Greenside, Johannesburg
Republic of South Africa

PORTA PAK the accessory that makes your mobile really portable. $67.50 and $88.00. Dealer inquires invited. P.O. Box 67, Somers, Wisc. 53171.

TRAVEL PAK QSL KIT — Send call and 25¢; receive your call sample kit in return. Samco, Box 203, Wynantskill, N.Y. 12198.

MERRY XMAS and HAPPY NEW YEAR from WØCVU. Now Using: KENWOOD TS-820S, DRAKE L-4B and TELREX Xmas Tree.

MULTIBAND INVERTED VEE 80-10m. Shorter than 75m "V" G5RV plans $1. WB3EZH, 229 Noble, Souderton, PA. 18964.

QSL — BROWNIE W3CJI — 3035B Lehigh, Allentown, Pa. 18103. Samples with cut catalog 50¢.

VHF ENGINEERING COMPANY REPEATER 35 watt Power Amplifier. North Shore Technology Duplexer Power Supply All in one package — Operating Xtals for 31-91. Ozone Amateur Radio Club, P.O. Box 553, Slidell, LA 70459.

NATIONAL NC-183 General Coverage receiver complete with manual. Poor condition as is $40. Steven Terhaar, WAØPXQ, 650 Beech, Moorhead, MN. 56560.

FOR SALE, Brand new boxed advance coax relays. 6, 12, 24, 100VDC. 117VAC. $15.00 with aux. contacts. $12.00 each without. Antique R.R. Sounders (new) $50.00 each — have three. Add $1.00 shipping. James Gysan W1VYB, 53 Lothrop Street, Beverly, Mass. 01915.

SELL: ROBOT 70A monitor, 61 viewfinder, 80A camera with 25mm 1.4 lens, 8- and 15-foot camera cables. Original cartons and instruction books. Recently factory calibrated. $500. Gordon Buckner, WØVZK, Box 721, Marshall, MO. 65340.

MOTOROLA HT220, HT200, and Pageboy service and modifications performed at reasonable rates. WA4FRV (804) 320-4439, evenings.

AUTHORIZED DEALER for Dentron, KLM, Larsen, Bearcat, etc., Big Catalog 201-962-4695 Narwid Electronics, 61 Bellot Road, Ringwood, N.J. 07456.

RECONDITIONED TEST EQUIPMENT for sale. Catalog $.50. Walter, 2697 Nickel, San Pablo, Ca. 94806.

PERSONALIZED CODE TAPES Specify: Speed (5-99 WPM), Content (Letters, or Punctuation and Numbers, or Both). 60 minutes for $4.00. TRICOMM, P.O. Box 5036, Aloha, OR 97005.

VERY in-ter-est-ing! Next 4 issues $1. "The Ham Trader", 2435 Fruitville, Sarasota, FL 33577.

D & V RADIO PARTS — variable & trimmer capacitors, chokes, Miniductors, stocked for immediate shipment. First class stamp for flyer — 12805 W. Sarle Rd., R#2, Freeland, Michigan 48623.

REGENCY: HR2A with SYN II, Synthesizer, P-107 Power Supply, all $180.00: in mint condition. C. P. Gibson, 101 N. Henniger, Leitchfield, Kentucky 42754.

CASH for your clean ham gear. Beacon Communications — used equipment specialists, 879 Beacon St., Boston, Mass. 02215. 617-267-1975.

BECKMAN/BERKELEY Counter manuals. Most models, $5.00 each postpaid. 51J4; $425.00, 618T3; $1,990.00. W9AMZ, 2009 Hopi, Mont Prospect, IL. 60056.

HAM RADIO HORIZONS, a super new magazine for the Beginner, the Novice and anyone interested in Amateur Radio . . . What it's all about, How to get started, The fun of ham radio. It's all here and just $10.00 per year. HURRY! HURRY! Ham Radio HORIZONS, Greenville, NH 03048.

FOR SALE: Send long, stamped SASE for list of Radio and Optical parts. Fred Redburn, 3300 Hobbs #127, Amarillo, Texas 79106. 806-352-2443.

TELETYPE FOR SALE: Model 28ASR's, KSR's, typing reperfs, and TD's. New and used parts available including cabinets, tables, mod kits, gears and gearshifts. Paper, ribbons, and supplies. Some 8-level Model 33 and 35 equipment available. Send SASE for complete list and prices. K9WJB, Lawrence R. Pfleger, 2141 N. 52nd St., Milwaukee, WI 53208.

BUY-SELL-TRADE. Write for free mailer. Give name, address and call letters. Complete stock of major brands new and reconditioned equipment. Call for best deals. We buy Collins, Drake, Swan etc. SSB & FM. Associated Radio, 8012 Conser Overland Park, Kansas 66204.

LET'S TRADE. I have new HORNET ANTENNAS. 6-10-15 & 20 meter beams; 10 to 80 element 2-meter antenna systems; stacking kits, antenna hardware, etc. I need good clean transmitters, receivers, transceivers, test equipment. Jack W5AJZ, Box 880, Duncan, OK 73533.

flea market

SELLING: 120 Hz sharpest CW filter for TS-820. New. $95. Yamada, Box 272, FPO, Seattle 98761.

FREE Catalog Solar Cells, Nicads, Kits, Calculators, Digital Watch Modules, Ultrasonics, Strobes, LEDS, Transistors, IC's, Unique Components. Chaney's, Box 27038, Denver, Colo. 80227.

TELETYPE EQUIPMENT for beginners and experienced operators. RTTY machines, parts, supplies. Beginner's special: Model 15 Printer and demodulator $139.00. Dozen black ribbons $6.50; case 40 rolls 11/16 perf. tape $17.50 FOB. Atlantic Surplus Sales, 3730 Nautilus Ave., Brooklyn, N. Y. 11224. Tel: (212) 372-0349.

KEYER Micro-TO MKII PC boards, parts. K3CU(W), 5414 Old Branch, Washington, DC 20031.

MOBILE BONDING STRAPS under 50¢ each. Literature. Estes Engineering, 930 Marine Drive, Port Angeles, Wash. 98362.

COLLINS CW Filter, 300Hz bandwidth X455KF300. For use in 75S3, 75S3B and 75A4 receivers. See Sept. 1975 H.R. for article. $60.00 postpaid. W1EBC, Gary Firtick, 40 Pilgrim Trail, Woodbury, CT. 06798.

FERRITE BEADS: w/specification and application sheet - 10/$1.00. Assorted PC pots - 5/$1.00. Miniature mica trimmers, 3-40 pf. - 5/$1.00. Postpaid. Includes latest catalog. Stamp for catalog alone. CPO Surplus, Box 189, Braintree, MA 02184.

THE "CADILLAC" of QSL's! New! Samples: $1.00 (Refundable) — MAC'S SHACK; Box #1171-D; Garland, Texas 75040.

CASH for any Collins unit, 618T, 490T, modules, parts, accessories. Air Ground Electronics, P.O. Box 416, Kearny, NJ 07032.

TELETYPEWRITER PARTS, gears, manuals, supplies, tools, toroids. SASE list. Typetronics, Box 8873, Ft. Lauderdale, FL. 33310. N4TT Buy parts, late machines.

EXCLUSIVELY HAM TELETYPE 23rd year, RTTY Journal, articles, news, DX, VHF, classified ads. Sample 35¢. $3.50 per year. 1155 Arden Drive, Encinitas, Calif. 92024.

FIGHT TVI with the RSO Low Pass Filter. For brochure write: Taylor Communications Manufacturing Company, Box 126, Agincourt, Ontario, Canada MIS 3B4.

RUBBER STAMP, name/call/QTH $2.50 ppd. (CA residents add tax). LWM Press, Box 22161, San Diego, CA 92122.

COMPUTER HOBBYISTS — Classified advertising newsletter. Ads, New Products, etc. Every 3 wks. — Since Jan 76. $3.75/year. Free Sample. ON_LINE, 24695 Santa Cruz Hwy., Los Gatos, CA 95030.

FOR SALE: Cleaning our garage and store room. Many choice items. SASE for large list. W9ZPP 2824 Forest Ave., Evansville, Ind. 47712.

FOR SALE: GE TPL rear mount 80 watt RE73 130-150 MHz. 2-freq. transceivers. No accessories. $40 each. W9ZPP 2824 Forest Ave., Evansville, Ind. 47712.

TRANSFORMER Brand new with application note. 115V Primary, Dual Secondaries each 18VCT at 4 amperes. $24.00 NY Residents add 8% Tax. Inquiries Invited. Classical Electrodynamic Labs, PO Box 190, Jackson Heights, NY 11372.

WANTED: HRO dial w/drive, 455 kHz SSB, CW filters. Thurtell, Rte. #1, Paw Paw, MI 49079.

TOROID CORES! 20 for $6.00. Various sizes. SASE Catalog. OK Electronics, Box 291, Onalaska, WI. 54650.

WANTED: 40 Channel SSB/AM CB Transceiver with Antenna, ATLAS 180/210/215X. TRADE or SELL: New Television Camera with Zoom lens, SLR viewfinder, 2:1 interlace; OR HW-2021 Handytalky 2M transceiver. W6DOM, 6017 Majorca Ct., San Jose, Calif. 95120 (408) 997-0132.

OLD TELEPHONE WANTED, Handheld upright with or without dial. Also Old spring suspended mike & Old Key. Del Popwell, K4NBN, Box 23413, Jacksonville, Fla. 32217.

QSL FORWARDING SERVICE — 30 cards per dollar. Write: QSL Express, 30 Lockwood Lane, West Chester, PA. 19380.

ELECTRONIC PARTS — Service supplies. Talk to me! Free list — Tommy, WD4EKJ, Comm-Tech, 104 North Third Street, Richmond, Kentucky.

More Details? CHECK—OFF Page 150

flea market

ELECTRONIC Voltage Regulators for Automobile Alternators. Available for most cars. Free literature. Send $14.95 (ppd) to SOLID STATE DEVELOPMENT CO. P.O. Box 108, Clarkson, Mississauga, Ontario, Canada L5J3X9

ELIMINATE QRM and QRN problems with our superior CW and SSB Filters. Also CW keyers, speech compressors, power supplies, teletype converters, and multiband antennas assembled or in kits. Dealer discounts. Dynamic Electronics, Box 896, Hartselle, AL 35640. (205) 773-2758.

EZ does it best. Deals, that is, on Yaesu, ICOM, Drake, Swan, Cushcraft, Larsen, KLM, Dentron, VHF Engineering and Wilson. For new or used gear call, see or write WØEZ, Bob Smith Electronics, 12 So. 21st St., Fort Dodge, Iowa 50501. (515) 576-3886.

WANTED General Electric Mastr Pro Mobile Radio, High band for 2 meters. Must be late model, clean and in good operating condition. SID PURVIS, 1306 Sioux Dr., Jacksonville, N.C. 28540. (919) 455-2080.

LOOKING for a used fax-equipment suitable for amateurs. H.-Ch. Als, Stegerwaldweg 7, 6800 Mannheim 31, W-Germany.

STOP LOOKING For a good deal on amateur radio equipment — you've found it here — at your amateur radio headquarters in the heart of the Midwest. We are factory-authorized dealers for Kenwood, Drake, Collins, ICOM, Ten-Tec, Atlas, Hallicrafters, KLM, Wilson, Regency, Tempo, Swan, Midland, Alpha, Standard, Dentron, Hy-Gain, Mosley, Cushcraft, and CDE, plus accessories. Thousands of thrifty hams from coast to coast already know us and we invite you to join them by writing or calling us today for our low quote and trying our personal and friendly Hoosier service. HOOSIER ELECTRONICS, P. O. Box 2001, Terre Haute, Indiana 47802. (812) 238-1456.

TECH MANUALS for Govt. surplus gear — $6.50 each: SP-600JX, URM-25D, OS-8A/U, TS-173/UR. Thousands more available. Send 50¢ (coin) for 22-page list. W3IHD, 7218 Roanne Drive, Washington, DC 20021.

WANTED: Military freq. counter USM-207. Will consider non-working unit in reparable condition. R. Allen, WA3GQL, 606 Patterson Ave., Willow Grove, PA. 19090.

WANTED: Riders TV, Sams Photofacts #650-#1000, RADEXs, 1940's and 1950's SWL club bulletins, ARRL Handbooks, 1930's Callbooks, and anything else for radio library. Swap or buy. State price and condition. Don Erickson, 6059-N Essex Street, Riverside, California 92504. (714) 687-5910.

PC BOARDS HAM RADIO ARTICLES Tone encoder 8/77 $3.50, Freq. Standard 8/77 $3.50, Capacitor checker 4/75 $3.50, Prescaler 12/75 $3.00. Glass, plated, drilled, instructions. RTC Electronics, Box 2514, Lincoln, Nebr. 68502.

OLD QSTs WANTED, also HT-100, W1BL Al Blank, 727 Pine St., Bristol, CT. 06010.

GALAXY V, with AC power supply, calibrator, VOX, $200.00. James Honey, WA9ZCK, (618) 687-1937.

HEATH HW-16, with MFJ audio filter and Accu-Keyer, $125.00. James Honey, WA9ZCK, (618) 687-1937.

Coming Events

SOUTH BEND, INDIANA Hamfest Swap & Shop January 8, 1978, first Sunday after New Years Day at NEW CENTURY CENTER downtown by river on U.S. 31 ONEWAY North across from St. Joseph Bank Building. Half acre in one large room at same ground level as entrances and loading dock. Tables $2 each. Food catering service, automobile museum and Art Center in the same building. Four lane highways to door from all directions. Talk-in freq: 146.52-52, 04-64 East, 13-73, 25-85 SE, 34-94; 147.99-39, 93-33, 84-24, 69-09. Wayne Werts K9IXU, 1889 Riverside Drive 46616.

THE ANNUAL FORT WAYNE WINTER HAMFEST is at Shiloh Hall, North of Fort Wayne, on January 22 from 8 AM until 4 PM local time. Early parking is available and 28/88 and 52/52 will be monitored. This yearly event is sponsored by the Allen County Amateur Radio Technical Society (AC/ARTS). Admission is $2.00 at the door. Table space is available at $1.50 per half table (about 4 feet). For information or table reservations (held until 9:30 AM) write: Hamfest Chairman; AC/ARTS, P.O. Box 342, Fort Wayne, IN. 46801.

More Details? CHECK—OFF Page 150

flea market

LAPORTE ARC'S WINTER HAMFEST, Sunday, February 26, 1978 at the LaPorte Civic Auditorium, 50 miles southeast of Chicago. Plenty of room, free tables, good food. Donation $2 at gate. Talk in on 01/61 and 52 simplex. LPARC, Box 30, LaPorte, IN 46350.

RICHMOND, VIRGINIA WINTERFEST — 78 January 15, 1978, Bon Air Community Center, sponsored by The Richmond Amateur Telecommunications Society. Talk in 28-88 and 52 simplex. ARRL coordinated. Technical symposium, drawing, home brewers contest — 2 divisions, over 18 and under — with framed certificate to winners with Most Original Idea, Best Mechanical and Best Electrical Construction. FCC exams will be administered, starting at 10:00 AM, to take exam, mail Form 610 at least five days prior to Fest to address below. Send self-addressed, stamped envelope if you need Form 610. Commercial Exhibits, Indoor Flea Market, $2.00 (table included), Outdoor Frost Bite Tail Gate Flea Market, $1.00. Admission $2.00, children under 12 free. R.A.T.S. members excluded from contest and drawing. Bring the family and spend the weekend in beautiful, historic Richmond. Richmond Amateur Telecommunications Society, Post Office Box 1070, Richmond, Virginia 23208.

Stolen Equipment

DRAKE ML-2, SN 11546, with 34/94, 94/94, 16/76, 07/67, 22/82, and 25/85 crystals installed. Stolen from Tom Fraser, WAØQQT, Colorado Springs, Colorado. Call (303) 635-8911, Ext. 3874. Anyone desiring to list stolen Amateur radio equipment please send information to Colorado Council of Amateur Radio Clubs C/O Charles E. Myers WØRNT 1120 Yosemite Drive, Colorado Springs, Co. 80910. Please include as much identification information as possible. Free distribution will be made to all Amateur radio magazines and Colo. Amateur radio clubs. Funds for postage and printing will be greatly appreciated.

ATLAS 350 XL with DD6-XL Digital dial Ser. #877025. **AC POWER SUPPLY** for the Atlas, Ser. #877104PS. Jay Leonard, Rt. 1, Box 32A, Pottsville, Ark. 72858.

More Details? CHECK—OFF Page 150

- Advance Registration $14.00 per person; with Hotel Sahara Late Show and two drinks $28.00 per person or with Hotel Sahara Congo Dinner Show (entree Cornish Hen), no drinks $35.00 per person. Tax and Gratuity included.
- Entertainment in Hotel Sahara's Congo Room has not been selected at press time.
- Advance Registration must be received by SAROC on or before December 22, 1977.

The NATION'S ANNUAL LAS VEGAS PRESTIGE CONVENTION

SAROC™

HOTEL SAHARA'S CONVENTION SPACE CENTER

January 5-8, 1978

- SAROC Registration includes: registration tickets, admission to technical sessions, Friday cocktail party hosted by TRI-EX Tower Corp.; Saturday cocktail party hosted by Ham Radio Magazine; Hotel Sahara Buffet Brunch on Sunday, Tax and Gratuity.
- Hotel Sahara room rate for SAROC registered delegates $22.00 per night plus room tax, single or double occupancy.
- Hotel Sahara room reservation request card will be sent only to SAROC registered delegates and exhibitors only until December 22, 1977.

Send your check or money order to SAROC, *P. O. Box 945, Boulder City, NV 89005*

More Details? CHECK—OFF Page 150

TOROID CORES

- √ All the popular sizes and mixes.
- √ Fast Service. Same day shipment via first class mail or air.
- √ No minimum order.

IRON POWDER TOROIDS:

CORE SIZE	MIX 2 5-30 MHz u = 10	MIX 6 10-90 MHz u=8.5	MIX 12 60-200 MHz u = 4	SIZE OD (in.)	PRICE USA $
T-200	120			2.00	3.25
T-106	135			1.06	1.50
T-80	55	45		.80	.80
T-68	57	47	21	.68	.65
T-50	51	40	18	.50	.55
T-25	34	27	12	.25	.40

RF FERRITE TOROIDS:

CORE SIZE	MIX Q1 u=125 .1-70 MHz	MIX Q2 u = 40 10-150 MHz	SIZE OD (in.)	PRICE USA $
F-240	1300	400	2.40	6.00
F-125	900	300	1.25	3.00
F-87	600	190	.87	2.05
F-50	500	190	.50	1.25
F-37	400	140	.37	1.25
F-23	190	60	.23	1.10

Chart shows uH per 100 turns.

FERRITE BEADS:

$2.00 DOZEN

WIDE BAND CHOKES

95¢ EACH

TO ORDER: Specify both core size and mix for toroids. Packing and shipping 50 cents per order USA and Canada. Californians add 6% sales tax.

Fast service. Free brochure and winding chart on request.

PALOMAR ENGINEERS

BOX 455, ESCONDIDO, CA 92025
Phone: (714) 747-3343

This is easy- anyone can solder- WITH KESTER SOLDER

Handymen! Hobbyists! DO-IT-YOURSELFERS!

Let Kester Solder aid you in your home repairs or hobbies. For that household item that needs repairing — a radio, TV, model train, jewelry, appliances, minor electrical repairs, plumbing, etc. — Save money — repair it yourself. Soldering with Kester is a simple, inexpensive way to permanently join two metals.

When you Solder go "First Class" — use Kester Solder.

For valuable soldering information send self-addressed stamped envelope to Kester for a FREE Copy of "Soldering Simplified".

KESTER SOLDER
Litton 4201 WRIGHTWOOD AVENUE/CHICAGO, ILLINOIS 60639

RADIO WORLD

CENTRAL NEW YORK'S FASTEST GROWING HAM DEALER

FT-101E TRITON IV

Featuring - Yaesu, Atlas, Dentron, Ten-Tec, Swan, Regency, Standard, Tempo, KLM, Hy-Gain, Mosley, Larsen, Midland, Wilson.

We service everything we sell! Write or call for quote. YOU WON'T BE DISAPPOINTED.

We are just a few minutes off the NYS Thruway (I-90) - Exit 32.

RADIO WORLD
ONEIDA COUNTY AIRPORT
TERMINAL BUILDING
ORISKANY, NY 13424
315-337-2622

Warren K2IXN — Joe WB2GJR

ENERGY CRISIS SOLVED!

Personal energy crisis? Get precious RF on DX target with World Record Breaking antenna that won W6TYP the QRP ARC 1,000,000 miles/watt award.

THE JOYSTICK VFA

(Variable freq. ant) gives low angle, omnidirectional, harmonic free radiation on all bands 160 thru 10 (MARS and receive on all BC & SW).

1000's of glowing reports in our files of the VFA in use, often in poor QTH and/or under QRP., contests, etc.

SYSTEM 'A' $75.00
250W P.E.P. &/or Receiving Only

SYSTEM 'J' $99.00
500W P.E.P. &/or Improved Q Factor Receive

Air Mail cost included. (Each system 3 sections easily assembled to make unit 7' 6" long. Matching ATU). Not only will you save space but you will save $$$ at present low exch. rate and by buying direct UK manuf. Rush your order – Mastercharge or check, or ask for brochure.

PARTRIDGE (HR) ELECTRONICS LTD.
Broadstairs, Kent, England
Tel. Thanet 62535

G3CED G3VFA

TRANSFORMERS

American made, 115V Primaries:

6.3V, 1 Amp Shielded	$1.80 ea.
12V, 250 mils, for P. C. Board.	$1.66 ea.
12 volt ½ amp.	$2.05
12V 1.2 Amp	$2.84
12V, 3 Amp	$4.48
36V CT, 1A; 14V CT, 400 Ma	$4.20 ea.
44V CT — 1A; 6.3V, ¼ amp tap	$3.47 ea.
48V CT — 1A; 6.3V, ¼ amp tap	$3.46 ea.

NEW ITEM — PHILCO TRANSFORMER — 115V Pri., Secs 6.3V 3A, 115V 1A, 24V 2A w/6.3V TAP 2A Shlded. Wt. 7 lbs. 4" x 3½" x 3¼". $7.55 ppd. Qty Prices Available

8 PIN "TO5" IC Socket, gold plt. 6/$1.08

3000 MFD @ 30 Volts Capacitors. 1" Dia. x 3" — 90¢ ea. or 3/$2.25

UNPOTTED TOROIDS — Center tapped. 88 MHY - 5 oz. 5/$2.95; 9 oz. - 5/$3.49
44 MHY - 5/$3.95

SEMTECH BRIDGES

Heat sink w/center hole mtg. 10 Amp — Tested —

200V P.I.V.	$1.75 ea. ppd.
400V P.I.V.	$1.95 ea. ppd.
600V P.I.V.	$2.15 ea. ppd.

25 AMP — TESTED

200V P.I.V.	$2.25 ea. ppd.
400V P.I.V.	$2.50 ea. ppd.
600V P.I.V.	$2.85 ea. ppd.

CARBON TRIMMERS

Miniature ¼ watt units. PC type. Values: 200, 700, 1000, 1.5K, 250K, 700K
30¢ ea. or 5/$1.35 ppd.

NEW SIZES — VERTICAL MOUNT PC BOARD POTENTIOMETERS

American made (CRL) Cermet sizes: 25K, 100K ohms. 5/$1.30 ppd. CTS Blue wheel. Values: 750, 1K, 1.5K, 50K, 300K ohms. 5/$1.25 ppd.

m. weinschenker
electronic specialties-BOX 353, IRWIN, PA 15642

More Details? CHECK—OFF Page 150

HAM MART

Ham Radio's guide to help you find your local

Alabama

LONG'S ELECTRONICS
2808 7TH AVENUE SOUTH
BIRMINGHAM, AL 35202
800-633-3410
Call us Toll Free to place your order

Arizona

HAM SHACK
4506 A NORTH 16TH STREET
PHOENIX, AZ 85016
602-279-HAMS
Serving all amateurs from beginner to expert.

MASTERS COMMUNICATIONS
7025 N. 57th DRIVE
GLENDALE, AZ 85301
602-939-8356
Rohn tower distributor, Atlas, Icom, Tempo, HyGain & service.

POWER COMMUNICATIONS
6012 NORTH 27th AVE.
PHOENIX, AZ 85017
602-242-8990
Arizona's #1 Ham Store.

California

C & A ELECTRONICS
2529 EAST CARSON ST.
P. O. BOX 5232
CARSON, CA 90745
213-834-5868
Not the biggest, but the best — since 1962.

CARSON ELECTRONICS
12010 EAST CARSON ST.
HAWAIIAN GARDENS, CA 90716
213-421-3786
Dealing exclusively in ICOM communications equipment.

COMMUNICATIONS CENTER
705 AMADOR STREET
VALLEJO, CA 94590
707-642-7223
Who else has a Spectrum Analyzer?

HAM RADIO OUTLET
999 HOWARD AVENUE
BURLINGAME, CA 94010
415-342-5757
Visit our stores in Van Nuys and Anaheim.

QUEMENT ELECTRONICS
1000 SO. BASCOM AVENUE
SAN JOSE, CA 95128
408-998-5900
Serving the world's Radio Amateurs since 1933.

TOWER ELECTRONICS CORP.
24001 ALICIA PARKWAY
MISSION VIEJO, CA 92675
714-768-8900
Authorized Yaesu Sales & Service. Mail orders welcome.

Colorado

C W ELECTRONIC SALES CO.
1401 BLAKE ST.
DENVER, CO 80202
303-573-1386
Rocky Mountain area's complete ham radio distributor.

MILE-HI COMMUNICATIONS, INC.
1970 SOUTH NAVAJO
DENVER, CO 80223
303-936-7108
Rocky Mountain's newest ham store. Lee Tingle KØLT.

Connecticut

ARCOMM ELECTRONICS
2865 MAIN STREET
BRIDGEPORT, CT 06606
Come on in, Tues. thru Sat. 10:00 - 6:00

AUDIOTRONICS INC.
18 ISAAC STREET
NORWALK, CT 06850
203-838-4877
The Northeast's fastest growing Ham Dept. dedicated to service.

Florida

AGL ELECTRONICS, INC.
1800-B DREW ST.
CLEARWATER, FL 33515
813-461-HAMS
West Coast's only full service Amateur Radio Store.

CENTRAL EQUIPMENT CO.
18451 W. DIXIE HIGHWAY
NORTH MIAMI BEACH, FL. 33160
305-932-1818
Specializing in Amateur, CB & Marine Equipment.

RAY'S AMATEUR RADIO
1590 US HIGHWAY 19 SO.
CLEARWATER, FL 33516
813-535-1416
West coast's only dealer: Drake, Icom, Cushcraft, Hustler.

Illinois

ERICKSON COMMUNICATIONS, INC.
5935 NORTH MILWAUKEE AVE.
CHICAGO, IL 60646
312-631-5181
Hours: 9:30-9 Mon. & Thurs. 9:30-5 Tues., Wed., Fri. 9-3 Sat.

KLAUS RADIO, INC.
8400 NORTH PIONEER PARKWAY
PEORIA, IL 61614
309-691-4840
Let us quote your Amateur needs.

SPECTRONICS, INC.
1009 GARFIELD STREET
OAK PARK, IL 60304
312-848-6777
Chicagoland's Amateur Radio leader.

Indiana

HOOSIER ELECTRONICS
P. O. BOX 2001
TERRE HAUTE, IN 47802
812-238-1456
Ham Headquarters of the Midwest. Store in Meadow Shopping Center.

KRYDER ELECTRONICS
GEORGETOWN NORTH SHOPPING CENTER
2810 MAPLECREST RD.
FORT WAYNE, IN 46815
219-484-4846
We service what we sell. 10-9 T, TH, F; 10-5 W, SAT.

Iowa

BOB SMITH ELECTRONICS
12 SOUTH 21ST STREET
FT. DODGE, IA 50501
515-576-3886
For an EZ deal.

Kansas

ASSOCIATED RADIO
8012 CONSER P.O.B. 4327
OVERLAND PARK, KS 66204
913-381-5901
Amateur Radio's Top Dealer. Buy — Sell — Trade.

Dealers - you should be here too! Contact Ham Radio today for complete details.

Amateur Radio Dealer

Kentucky

COHOON AMATEUR SUPPLY
HIGHWAY 475
TRENTON, KY 42286
502-886-4535
Yaesu, Ten-Tec, Tempo, Dentron.
Our service is the BEST.

Maryland

COMM CENTER, INC.
9624 FT. MEADE ROAD
LAUREL PLAZA RT. 198
LAUREL, MD 20810
301-792-0600
New & Used Amateur Equipment.
Wilson, Ten-Tec, R. L. Drake, Tempo

PROFESSIONAL ELECTRONICS CO., INC.
1710 JOAN AVENUE
BALTIMORE, MD 21234
301-661-2123
A professional place for amateurs.
Service-sales-design.

Massachusetts

TUFTS RADIO ELECTRONICS
209 MYSTIC AVENUE
MEDFORD, MA 02155
617-395-8280
New England's friendliest ham store.

Michigan

RADIO SUPPLY & ENGINEERING
1207 WEST 14 MILE ROAD
CLAWSON, MI 48017
313-435-5660
10001 Chalmers, Detroit, MI 48213, 313-371-9050.

Minnesota

DACOM
3926 BEAU D'RUE DRIVE
EAGAN, MN 55122
612-454-7420
Full Sales & Service
HF thru UHF

ELECTRONIC CENTER, INC.
127 THIRD AVENUE NORTH
MINNEAPOLIS, MN 55401
612-371-5240
ECI is still your best buy.

Missouri

HAM RADIO CENTER, INC.
8340-42 OLIVE BLVD.
ST. LOUIS, MO 63132
800-325-3636
See Our Ads In This Issue.

MIDCOM ELECTRONICS, INC.
2506 SO. BRENTWOOD BLVD.
ST. LOUIS, MO 63144
314-961-9990
At Midcom you can try before you buy!

Nebraska

COMMUNICATIONS CENTER, INC.
2226 NORTH 48 ST.
LINCOLN, NE 68504
800-228-4097
Yaesu, Drake, Tempo, Swan, HyGain - call Toll Free

New Hampshire

EVANS RADIO, INC.
BOX 893, RT. 3A BOW JUNCTION
CONCORD, NH 03301
603-224-9961
Icom, Dentron & Yaesu dealer.
We service what we sell.

New Jersey

ATKINSON & SMITH, INC.
17 LEWIS ST.
EATONTOWN, NJ 07724
201-542-2447
Ham supplies since "55".

New Mexico

ELECTRONIC MODULE
601 N. TURNER
HOBBS, NM 88240
505-397-3012
Yaesu, Kenwood, Swan, Dentron, Tempo, Atlas, Wilson, Cushcraft

New York

ADIRONDACK RADIO SUPPLY, INC.
185 W. MAIN STREET
AMSTERDAM, NY 12010
518-842-8350
Yaesu dealer for the Northeast.

CFP COMMUNICATIONS
211 NORTH MAIN STREET
HORSEHEADS, NY 12010
607-739-0187
Jim Beckett, WA2KTJ, Manager
Bryant Hozempa, WB2LVW, Sales

GRAND CENTRAL RADIO
124 EAST 44 STREET
NEW YORK, NY 10017
212-682-3869
Drake, Atlas, Ten-Tec, Midland, Hy-Gain, Mosley in stock

HARRISON "HAM HEADQUARTERS, USA"
ROUTE 110 & SMITH STREET
FARMINGDALE, L. I., N. Y. 11735
516-293-7990
Since 1925 . . . Service, Satisfaction, Savings. Try Us!

RADIO WORLD
ONEIDA COUNTY AIRPORT
TERMINAL BLDG.
ORISKANY, NY 13424
315-337-2622
New & used ham equipment.
See Warren K2IXN or Joe WB2GJR

Ohio

UNIVERSAL SERVICE
114 N. THIRD STREET
COLUMBUS, OH 43215
614-221-2335
Give U.S. a try when ready to buy.

Oklahoma

RADIO STORE, INC.
2102 SOUTHWEST 59th ST.
(AT 59th & S. PENNSYLVANIA)
OKLAHOMA CITY, OK 73119
405-682-2929
New and used equipment — parts and supply.

Oregon

PORTLAND RADIO SUPPLY CO.
1234 S.W. STARK STREET
PORTLAND, OREGON 97205
503-228-8647
Second location, 1133 S. Riverside Avenue, Medford, OR 97501.

Pennsylvania

ELECTRONIC EXCHANGE
136 N. MAIN STREET
SOUDERTON, PA 18964
215-723-1200
New & Used Amateur Radio sales and service.

"HAM" BUERGER, INC.
68 N. YORK ROAD
WILLOW GROVE, PA 19090
215-659-5900
Communications specialists.
Sales and service.

HAMTRONICS, DIV. OF TREVOSE ELECT.
4033 BROWNSVILLE ROAD
TREVOSE, PA 19047
215-357-1400
Same location for 25 years.

HAM MART

More Details? CHECK—OFF Page 150

ham radio cumulative index

1968-1977

antennas and transmission lines

general

high-frequency antennas

Simple antennas for 40 and 80
W5RUB p. 16, Dec 72
Simple 1-, 2- and 3-band antennas
W9EGQ p. 54, Jul 68
Sloping dipoles
W5RUB p. 19, Dec 72
Performance (letter) p. 76, May 73
Small-loop antennas
W4YOT p. 36, May 72
Stub bandswitched antennas
W2EEY p. 50, Jul 69
Suitcase antenna, high-frequency
VK5BI p. 61, May 73
Tailoring your antenna, how to
KH6HDM p. 34, May 73
Telephone-wire antenna (HN)
K9TBD p. 70, May 76
Three-band ground plane
W6HPH p. 32, Oct 68
Triangle antennas
W3FQJ p. 56, Aug 71
Triangle antennas
W6KIW p. 58, May 72
Triangle antennas (letter)
K4ZZV p. 72, Nov 71
Triangle beams
W3FQJ p. 70, Dec 71
Tuning aid for the sightless (HN)
W6VX p. 83, Sep 76
Unidirectional antenna for the low-frequency bands
GW3NJY p. 61, Jan 70
Vertical antenna radiation patterns
W7LR p. 50, Apr 74
Vertical antenna, low-band
W4IYB p. 70, Jul 72
Vertical antenna, three-band
W9BQE p. 44, May 74
Vertical antennas, improving performance of
K6FD p. 54, Dec 74
Vertical antennas, performance characteristics
W7LR p. 34, Mar 74
Vertical beam antenna, 80 meter
VE1TG p. 26, May 70
Vertical dipole, gamma-loop-fed
W6SAI p. 19, May 72
Vertical for 80 meters, top-loaded
W2MB p. 20, Sep 71
Vertical radiators
W4OQ p. 16, Apr 73
Vertical, top-loaded 80 meter
VE1TG p. 48, Jun 69
Vertical-tower antenna system
W4OQ p. 56, May 73
Whips and loops as apartment antennas
W2EEY p. 80, Mar 68
Windom antenna, four-band
W4VUO p. 62, Jan 74
Correction (letter) p. 74, Sep 74
Zepp antenna, extended
W6QVI p. 48, Dec 73
ZL special antenna, understanding the
WA6TKT p. 38, May 76
3.5-MHz phased horizontal array
K4JC p. 56, May 77
7-MHz short vertical antenna
W8TYX p. 60, Jun 77
160-meter loop, receiving
K6HTM p. 46, May 74
160-meter vertical, shortened (HN)
W6VX p. 72, May 76
160 meters with 40-meter vertical
W2IMB p. 34, Oct 72

vhf antennas

Antennas for satellite communications, simple
K4GSX p. 24, May 74
Circularly-polarized ground-plane antenna for satellite communications
K4GSX p. 28, Dec 74
Collinear antenna for two meters, nine-element
W6RJO p. 12, May 72
Collinear antenna (letter)
W6SAI p. 70, Oct 71
Collinear array for two meters, 4-element
WB6KGF p. 6, May 71
Collinear antenna, four element 440-MHz
WA6HTP p. 38, May 73
Collinear, six meter
K4ERO p. 59, Nov 69
Converting low-band mobile antenna to 144-MHz (HN)
K7ARR p. 90, May 77
Corner reflector antenna, 432 MHz
WA2FSQ p. 24, Nov 71
Cubical quad, economy six-meter
W6DOR p. 50, Apr 69
Feed horn, cylindrical, for parabolic reflectors
WA9HUV p. 16, May 76
Ground plane, 2-meter, 0.7 wavelength
W3WZA p. 40, Mar 69
Ground plane, portable vhf (HN)
K9DHD p. 71, May 73
J-pole antenna for 6-meters
K4SDY p. 48, Aug 68
Log-periodic, yagi beam
K6RIL, W6SAI p. 8, Jul 69
Correction p. 68, Feb 70
Magnet-mount antenna, portable (HN)
WB2YYU p. 67, May 76
Matching techniques for vhf/uhf antennas
W1JAA p. 50, Jul 76
Microwave antenna, Low-cost
K6HIJ p. 52, Nov 69
Mobile antenna, magnet-mount
W1HCI p. 54, Sep 75
Mobile antenna, six-meter (HN)
W4PSJ p. 77, Oct 70
Mobile antennas, vhf, comparison of
W4MNW p. 52, May 77
Moonbounce antenna, practical 144-MHz
K6HCP p. 52, May 70
Oscar antenna, mobile (HN)
W6OAL p. 67, May 76
Parabolic reflector antennas
VK3ATN p. 12, May 74
Parabolic reflector element spacing
WA9HUV p. 28, May 75
Parabolic reflector gain
W2TQK p. 50, Jul 75
Parabolic reflectors, finding the focal length (HN)
WA4WDL p. 57, Mar 74
Parabolic reflector, 16-foot homebrew
WB6IOM p. 8, Aug 69
Quad-yagi arrays, 432- and 1296-MHz
W3AED p. 20, May 73
Short circuit p. 58, Dec 73
Simple antennas, 144-MHz
WA3NFW p. 30, May 73
Switch, antenna for 2 meters, solid-state
K2ZSQ p. 48, May 69
Two-meter antenna, simple (HN)
W6BLZ p. 78, Aug 68
Two-meter fm antenna (HN)
WB6KYE p. 64, May 71
Two-meter mobile antennas
W6BLZ p. 76, May 68
Vertical antennas, truth about ⅝-wavelength
KØDOK p. 48, May 74
Added note (letter) p. 54, Jan 75
Vhf antenna switching without relays (HN)
K2ZSQ p. 76, Sep 68
Whip, 5/8-wave, 144 MHz (HN)
VE3DDD p. 70, Apr 73
Yagi antennas, how to design
W1JR p. 22, Aug 77
Yagi, 1296-MHz
W2CQH p. 24, May 72
7-MHz attic antenna (HN)
W2ISL p. 68, May 76
10-GHz dielectric antenna (HN)
WA4WDL p. 80, May 75
144-MHz vertical, ⅝-wavelength
K6KLO p. 40, Jul 74
144-MHz antenna, ⅝-wavelength built from CB mobile whip (HN)
WB4WSU p. 67, Jun 74
144-MHz colinear uses PVC pipe mast (HN)
K8LLZ p. 66, May 76
144-MHz mobile antenna (HN)
W2EUQ p. 80, Mar 77
144-MHz vertical mobile antennas, ¼ and ⅝ wavelength, test data on
W2LTJ, W2CQH p. 46, May 76
144-MHz, ⅝-wavelength vertical
W1RHN p. 50, Mar 76
144-MHz, ⅝-wavelength, vertical antenna for mobile
K4LPQ p. 42, May 76
432-MHz high-gain Yagi
K6HCP p. 46, Jan 76
Comments, WØPW p. 63, May 76
432-MHz OSCAR antenna (HN)
W1JAA p. 58, Jul 75
1296-MHz Yagi array
W3AED p. 40, May 75

matching and tuning

Antenna coupler for three-band beams
ZS6BT p. 42, May 72
Antenna coupler, six-meter
K1RAK p. 44, Jul 71
Antenna impedance transformer for receivers (HN)
W6NIF p. 70, Jan 70
Antenna instrumentation, simple, (repair bench)
K4IPV p. 71, Jul 77
Antenna matcher, one-man
W4SD p. 24, Jun 71
Antenna tuner adjustment (HN)
WA4MTH p. 53, Dec 75
Antenna tuner, automatic
WAØAQC p. 36, Nov 72
Antenna tuner, medium-power toroidal
WB2ZSH p. 58, Jan 74
Antenna tuner for optimum power transfer
W2WLR p. 28, May 70
Antenna tuners
W3FQJ p. 58, Dec 72
Antenna tuning units
W3FQJ p. 58, Jan 73
Balun, adjustable for yagi antennas
W6SAI p. 14, May 71
Balun, Simplified (HN)
WAØKKC p. 73, Oct 69
Baluns, wideband bridge
W6SAI, WA6BAN p. 28, Dec 68
Broadband Antenna Baluns
W6SAI p. 6, Jun 68
Couplers, random-length antenna
W2EEY p. 32, Jan 70
Dummy loads
W4MB p. 40, Mar 76
Feeding and matching techniques for vhf/uhf antennas
W1JAA p. 54, May 76
Gamma-match capacitor, remotely controlled
K2BT p. 74, May 75
Gamma-matching networks, how to design
W7ITB p. 46, May 73
Impedance bridge, low-cost RX
W8YFB p. 6, May 73
Impedance-matching baluns, open-wire
W6MUR p. 46, Nov 73
Impedance-matching systems, designing
W7CSD p. 58, Jul 73
Loads, affect of mismatched transmitter
W5JJ p. 60, Sep 69
Matching, antenna, two-band with stubs
W6MUR p. 18, Oct 73
Matching system, two-capacitor
W6MUR p. 58, Sep 73
Measuring complex impedance with swr bridge
WB4KSS p. 46, May 75
Mobile transmitter, loading
W4YB p. 46, May 72
Noise bridge, antenna
WB2EGZ p. 18, Dec 70
Noise bridge, antenna (HN)
K8EEG p. 71, May 74
Noise bridge for impedance measurements
YA1GJM p. 62, Jan 73
Added notes p. 66, May 74; p. 60, Mar 75
Phase meter, rf
VE2AYU, Korth p. 28, Apr 73
Quadrifilar toroid (HN)
W9LL p. 52, Dec 75
Stub-switched, stub-matched antennas
W2EEY p. 34, Jan 69
Swr alarm circuits
W2EEY p. 73, Apr 70
Swr bridge
WB2ZSH p. 55, Oct 71
Swr bridge and power meter, integrated
W6DOB p. 40, May 70
Swr bridge readings (HN)
W6FPO p. 63, Aug 73
Swr indicator, aural, for the visually handicapped
K6HTM p. 52, May 76
Swr meter
W6VSV p. 6, Oct 70
Swr meter, improving (HN)
W5NPD p. 68, May 76
Transmatch, five-to-one
W7IV p. 54, May 74
Transmission lines, grid dipping (HN)
W2OLU p. 72, Feb 71
Transmission lines, uhf
WA2VTR p. 36, May 71
Uhf coax connectors (HN)
WØLCP p. 70, Sep 72

towers and rotators

Antenna and rotator preventive maintenance
WA1ABP p. 66, Jan 69
Antenna and tower restrictions
W7IV p. 24, Jan 76
Antenna mast, build your own tilt-over
W6KRT p. 42, Feb 70
Correction p. 76, Sep 70
Az-el antenna mount for satellite communications
W2LX p. 34, Mar 75
Cornell-Dubilier rotators (HN)
K6KA p. 82, May 75
Ham-M modifications (HN)
W2TQK p. 72, May 76
Ham-M rotator automatic position control
WB6GNM p. 42, May 77
Keeping your beam, tips for
W6BLZ p. 50, Aug 68
Pipe antenna masts, design data for
W3MR p. 52, Sep 74
Added design notes (letter) p. 75, May 75
Rotator, AR-22, fixing a sticky
WA1ABP p. 34, Jun 71
Rotator for medium-sized beams
K2BT p. 48, May 76
Rotator, T-45, Improvement (HN)
WAØVAM p. 64, Sep 71
Stress analysis of antenna systems
W2FZJ p. 23, Oct 71
Telescoping tv masts (HN)
WAØKKC p. 57, Feb 73
Tiltover tower base, low-cost
WA1ABP p. 86, Apr 68
Tilt-over tower uses extension ladder
W5TRS p. 71, May 75

transmission lines

audio

commercial equipment

construction techniques

features and fiction

fm and repeaters

integrated circuits

keying and control

measurements and test equipment

microprocessors, calculators computers and

miscellaneous technical

novice reading

operating

oscillators

power supplies

propagation

receivers and converters

general

high-frequency receivers

vhf receivers and converters

receivers and converters, test and troubleshooting

RTTY

satellites

semiconductors

single sideband

television

transmitters and power amplifiers

general

high-frequency transmitters

vhf and uhf transmitters

transmitters and power amplifiers, test and troubleshooting

troubleshooting

vhf and microwave

general

vhf and microwave antennas

vhf and microwave receivers and converters

vhf and microwave transmitters

STATEMENT OF OWNERSHIP, MANAGEMENT AND CIRCULATION

HAM RADIO MAGAZINE

MONTHLY

12 $12.00

MAIN ST., GREENVILLE, N.H. 03048

MAIN ST., GREENVILLE, N.H. 03048

T. H. TENNEY JR., MAIN ST., GREENVILLE, N.H. 03048

COMMUNICATIONS TECHNOLOGY INC. — MAIN ST. GREENVILLE NH 03048

T. H. TENNEY JR. — MAIN ST. GREENVILLE NH 03048

T. H. TENNEY JR. — MAIN ST. GREENVILLE NH 03048

A	59,920	60,500
B 1	10,909	12,236
B 2	45,287	42,997
C	56,196	56,233
D	2,331	2,324
E	58,527	58,557
F 1	1,344	1,900
F 2	57	43
G	59,928	60,500

I certify that the statements made by me above are correct and complete

T. H. TENNEY JR., PUBLISHER

PS Form 3526

Advertisers check-off

...for literature, in a hurry — we'll rush your name to the companies whose names you **"check-off"**

Place your check mark in the space between name and number. **Ex: Ham Radio ✓ 234**

INDEX

*Please contact this advertiser directly.

Limit 15 inquiries per request.

December 1977

Please use before January 31, 1978

Tear off and mail to

HAM RADIO MAGAZINE — "check off"
Greenville, N. H. 03048

NAME ....

CALL ....

STREET ....

CITY ....

STATE.................. ZIP..................

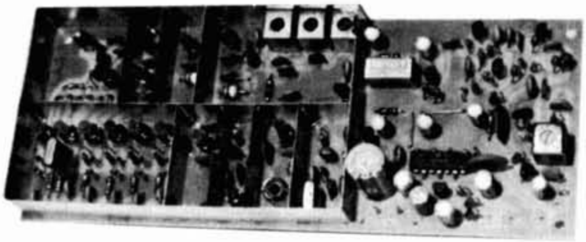
Advertisers index

ANNOUNCING--A New Generation of VHF/UHF
FM RECEIVER KITS

More Sensitive, More Selective, Easier to Build, Smaller Than Ever Before!

CHECK THESE FEATURES-

- Lower system cost than ever before
- Better selectivity, 70-80 dB adjacent channel, over 100 dB with crystal filter option
- Six channels at no extra cost
- 60 dB image rejection
- Latest design — new easy-to-wind high Q coils, compartmentized shielding
- Easy to build, test circuits on board allow tune up with only sig gen & vtvm



VHF MODEL R70 $69.95
- Available for 2M, 6M, 10M, 220 MHz, or com'l bands
- Sensitivity 0.4uV for 20 dB

Optional Crystal Filter Kit $10
Channel Crystals $5.95 ea

UHF MODEL R90 $89.95
- For any 2 MHz segment of the 380-520 MHz range
- Sensitivity 0.8uV

Optional crystal filter kit $10
Channel crystals $5.95 ea

These low noise PREAMPS let you hear the weak ones!

Great for OSCAR, SSB, FM, ATV. Over 8000 in use throughout the world.

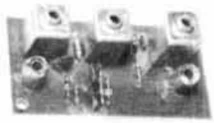
P8 KIT $10.95
P16 Wired $21.95
Miniature model for tight spaces - only 1/2 x 2-3/8 inches

- 20dB gain
- Covers any 4 MHz band in range

MODEL	RANGE
P8-LO	20-83 MHz
P8-HI	83-190 MHz
P8-220	220-230 MHz
P16 Wired	Give exact band

P9 KIT $12.95
P14 Wired $24.95

Deluxe model for applications where space permits.



- 1-1/2 x 3 inches
- Covers any 4 MHz band in range
- Ideal for OSCAR
- Diode protection
- Connectors
- 20 dB gain

MODEL	RANGE
P9-LO	26-88 MHz
P9-HI	88-172 MHz
P9-220	172-230 MHz
P14 Wired	Give specific band

P15 KIT $18.95
P35 Wired $34.95
- Covers any 6 MHz band in band in range of 380-520 MHz
- 20 dB gain

These new CONVERTER KITS
let you receive OSCAR signals and other exciting VHF & UHF activity on your present HF receiver.

either one
ONLY $34.95
including crystal

MODEL	RF RANGE (MHZ)	IF RANGE
C50	50-52	28-30
C144	144-146	28-30
C145	145-147	28-30
C146	146-148	28-30
C220	p/o 220-230	28-30
Special	Other rf & i-f ranges are available on special request	

MODEL	RF RANGE (MHZ)	IF RANGE
C432-2	432-434	28-30
C432-5	435-437	28-30
C432-9	439.25 (ATV)	61.25
Special	Other rf & i-f ranges are available on special request	

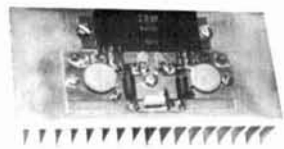
An extruded aluminum case is available for vhf and uhf converters at $12.95, including connectors and hardware.

FM/CW TRANSMITTER KITS

200 MW EXCITER MODULE KITS

T40 Eleven Channel Exciter Kit for 2M or 6M band. $39.95

T20 Tripler/Driver Module Kit, 150 mW 2M input, 200 mW 450 MHz output $19.95



RF POWER AMPLIFIER MODULES

- NO TUNING
- VSWR PROTECTED
- COMPLETELY STABLE
- 150MW DRIVE

T80-150, 140-175 MHz, 20-25W output, wired and tested, simply connect your cables. . $79.95
T80-450, 430-470 MHz, 13-15W. $79.95

TEST PROBE KITS

only $9.95 ea

Contain scope type probe, ground clip, cable, & all components except plug for test equipment.

TE-3	RF Detector Probe for vtvm; good from 100 kHz to over 500 MHz
TE-4	Direct Probe for ac/ohms, etc.
TE-5	DC Probe w/res for 11 meg input vtvm
TE-6	Blocking Capacitor Probe for counter, signal generator, etc.
TE-7	Wideband Detector Probe for scopes
TE-8	High Z/Low Capacitance scope probe

*FREE 1978 CATALOG

is yours for the asking. NEW 40 page catalog gives details on these and other kits, including scanner adapters, receiver multicouplers, NPC power supplies, M-tech PA's, CES tone pads & mics, Hy-Gain HT's & hf rigs, & antennas. GET YOURS TODAY!

FREE SHIPPING ON LARGE STOCK OF ANTENNAS!!! We now offer free delivery of Cushcraft, Larsen, & Hy-Gain antennas in the 48 states. Popular models such as Ringo Rangers, VHF & triband beams, magnet mount whips, hf verticals, rubber duckies, lightning arrestors, Reyco traps, W2AU & Hy-Gain baluns. Call or write NOW! We'll be glad to send free catalogs.

It's Easy To Order!
- CALL OR WRITE NOW FOR FREE CATALOG OR TO PLACE ORDER!
- PHONE 716-663-9254. (Answering service for evenings and weekends for your convenience. Personal service 9-5 eastern.)
- Use credit card, COD, check, m.o.
- Add $2.00 shipping & handling.

hamtronics, inc.

182-A Belmont Rd; Rochester, NY 14612
Dealer Inquiries Invited

IN CANADA:
Send order to COMTEC; 5605 Westluke Ave.; Montreal, Que H4W 2N3 or call 514-482-2640. Add 28% to prices shown above to cover customs duty, exchange rate, and federal tax.

Buy the 599D's & get a Free gift

Call: 1-800-633-3410 for your FREE gift and 599D station from Long's

1023.00
FOR THE 599D STATION & YOUR CHOICE OF ONE FREE GIFT SHOWN BELOW

KENWOOD S-599D speaker

The S-599D speaker is designed specifically for the 599D series station. • Frequency range: 100 to 5000 Hz • Speaker diameter: 4¾" • Dimensions: 5⅞" W x 5½" H x 7¼" D • Weight: 3.3 lbs.

KENWOOD R-599D receiver

R-599D: • Entirely solid-state • Covers 10-80 meters • Highly stable VFO • Oscillator for 5 fixed channels • Built-in crystal filters • Noise blanker • Squelch circuit • Modes: USB, LSB, CW, AM, FM • Power consumption: 15 watts.

KENWOOD T-599D transmitter

T-599D: • Solid-state, except driver and final stage • 10-80 meters • Modes: USB, LSB, CW, AM • Effective 8-pole crystal filter • Antenna impedance: 50 to 75 ohms • Carrier suppression: 40 dB • Power consumption: 350 watts.

CUSHCRAFT ATB-34
10, 15, 20 meter antenna.
List Price: 239.00

FREE GIFT NUMBER 1.

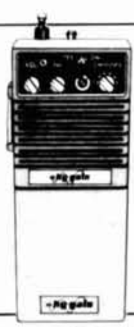
BIRD Model 43
THRULINE wattmeter
List Price: 120.00

FREE GIFT NUMBER 2.

KENWOOD TR-7200A
2m FM transceiver List Price: 189.00

FREE GIFT NUMBER 3.

HYGAIN 3806
handy-talky.
List Price: 189.95



FREE GIFT NUMBER 4.

DENTRON 160-10AT
super tuner
List Price: 129.50

FREE GIFT NUMBER 5.

REGENCY HRT-2
handy-talky.
List Price: 179.00

FREE GIFT NUMBER 6.

Remember, you can call TOLL-FREE: **1-800-633-3410** in U.S.A. or call **1-800-292-8668** in Alabama for our low price quote. Store hours: 9:00 AM til 5:30 PM, Monday thru Friday.

Your BANKAMERICARD welcome here

Long's Electronics

master charge THE INTERBANK CARD

MAIL ORDERS: P.O. BOX 11347 BIRMINGHAM, AL 35202 • STREET ADDRESS: 2808 7TH AVENUE SOUTH BIRMINGHAM, ALABAMA 35233

More Details? CHECK—OFF Page 150

YAESU PROUDLY ANNOUNCES THE SENSATIONAL NEW SMART FT-901D–YEARS AHEAD WITH YAESU!

■ Two rugged 6146B's in the final, with negative feedback ■ A variable IF bandwidth that allows 100 Hz to 2.4 KHz selectivity at the turn of a knob ■ IF rejection tuning to notch out interfering signals ■ Optional synthesized VFO, or enlarged frequency memory bank ■ Selectable AGC ■ Built in speech processor ■ Built in Curtis Keyer ■ Full range 160-10M coverage ■ Provision for new WARC frequencies ■ Meets Part 97.73 of FCC requirements. . . . at your dealers soon!

Design And Specifications Subject To Change Without Notice Or Obligation

member arma amateur radio manufacturer's association

YAESU

The smart radio

YAESU ELECTRONICS CORP., 15954 Downey Ave., Paramount, CA 90723 (213) 633-4007
YAESU ELECTRONICS CORP., Eastern Service Ctr., 613 Redna Ter., Cincinnati, OH 45215

1A78

HEATH COMPANY

BENTON HARBOR MI 49022

PUT STAMP HERE

The Post Office will not deliver mail without postage

Get your very own copy of the latest

HEATHKIT

MAIL-ORDER KIT CATALOG

FREE!