APRIL 1978

- OSCAR 8 16
- 432-MHz GaAs fet preamp 22
- spectrum analyzer tracking generator 30
- matching network design 44
- testing power tubes 60
- and much, much more...
The new 2KD-5 linear amplifier...a one piece desk model with the power and reliability of a console

At Henry Radio, we know how to build only one kind of amplifier...the best. We want you to compare the 2KD-5 with any other desk model at any price. Remember, the 2KD-5 is only one model in the world's broadest line of amplifiers...both vacuum tube and solid state...for HF, VHF and UHF...fixed station and mobile...low power and high power.

Never before has any one company offered such a cornucopia of high power RF amplifiers. Remember also that Henry Radio offers a broad line of mobile...low power and high power.

We also carry the complete line of BIRD products.

---

**TEMPO COMPONENTS**

- **Components**
  - **console...**
  - **$995.00**

- **Cornucopia of high power**
  - **Solid state.**
  - **$995.00**

- **Reliability**
  - Operates on all amateur bands.
  - **80 thru 10** meters.
  - **Remember also that Henry Radio offers a broad line of mobile...low power and high power.**

- **2KD-5**
  - **Linear Amplifier**
  - **$795.00**

- **2KD-6**
  - **Linear Amplifier**
  - **$1395.00**

- **100AL10**
  - **VHF Linear Amplifier**
  - **$349.00**

---

**TEMPO 2002**

Sun says 2002. The same fine specs and features as the 6N2, but for 2 meter operation only: $745.00.

**TEMPO 2006**

Like the 2002, but for 6 meter operation: $795.00.
Which model should you choose now that you've chosen Rockwell-Collins?

If you work mainly voice, and just dabble in CW, RTTY, or SSTV, build your station around our KWM-2A Transceiver. The unit is compact and lightweight, designed for portable as well as fixed operations.

You're not limited to SSB voice communication, though. The KWM-2A's CW features include break-in and sidetone monitoring circuits. And with the optional 516F-2 Power Supply and external cooling air, you can operate RTTY communications as well.

But if your communications interest is varied and you want maximum voice, CW, RTTY or SSTV capability, we recommend the Rockwell-Collins 75S-3C Receiver and 32S-3A Transmitter.

Optional filters, rejection tuning and variable BFO on the receiver, plus features like carrier reinsertion on our transmitter, give you as much control of your equipment as possible.

And our S/Line is famous as the cleanest sound around.

This NEW MFJ Versa Tuner II . . .

has SWR and dual range wattmeter, antenna switch, efficient airwound inductor, built in balun. Up to 300 watts RF output. Matches everything from 160 thru 10 Meters: dipoles, inverted vees, random wires, verticals, mobile whips, beams, balance lines, coax lines.

Antenna matching capacitor. 208 pf. 1000 volt spacing.

Sets power range, 300 and 30 watts. Pull for SWR.

Meter reads SWR and RF watts in 2 ranges.

Efficient airwound inductor gives more watts out and less losses.

Transmitter matching capacitor. 208 pf. 1000 volt spacing.

NEW $79.95

Antenna switch lets you select 2 coax fed antennas, random wire or balance line, and tuner bypass.

One existing antenna. No need to put up separate antennas for each band.

Increase the usable bandwidth of your mobile whip by tuning out the SWR from inside your car. Works great with all solid state rigs (like the Atlas) and with all tube type rigs.

It travels well, too. Its ultra compact size 5x2x1 inches fits easily in a small corner of your suitcase.

This beautiful little tuner is housed in a deluxe eggshell white Ten-Tec enclosure with walnut grain sides.

50-239 coax connectors are provided for transmitter input and coax fed antennas. Quality five way binding posts are used for the balance line inputs (2), random wire input (1), and ground (1).

For Orders Call toll-free 800-647-8660

For technical information, order and repair status, and in Mississippi, please call 601-323-5869.

Order any product from MFJ and try it. If not delighted, return within 30 days for a prompt refund (less shipping).

Order today. Money back if not delighted. One year unconditional guarantee. Add $2.00 shipping/handling.

Order By Mail or Call TOLL FREE 800-647-8660 and Charge It On

MFJ ENTERPRISES P. O. BOX 494
MISSISSIPPI STATE, MISSISSIPPI 39762

More Details? CHECK — OFF Page 126
contents

10 advanced electronic keyer
Pavel Horvath, OK3IA

16 AMSAT-OSCAR-D
Perry I. Klein, W3PK

22 432-MHz GaAs fet preamplifier
Shigeru Sando, JH1BRY

28 simple paddle for electronic keyers
Vidi la Grange, ZS6AL

30 spectrum analyzer tracking generator
Wayne C. Ryder, W6URH

34 battery charger for portable operation
Francis E. Hinkle, Jr., K5PA

38 modifying linear amplifiers for full break-in operation
Richard B. Frey, K4XU

44 designing matching networks
Leonard H. Anderson

50 overtone crystal oscillators
Courtney Hall, W4SSN2

54 correcting repeater interference
Robert P. Haviland, W4MB

60 testing power tubes
Joseph J. Carr, K4IPV

66 microprocessors: microcomputer interfacing
Peter R. Racy, Jonathan A. Titus, David G. Larson, WB4HYJ

72 improve audio quality for vhf-fm
Budd M. Meyer, K2PMA

4 a second look
82 new products

126 advertisers index 126 reader service

101 flea market 60 repair bench

116 ham mart 6 stop press

66 microprocessors
If you look at technological advances with the eye of a historian, you'll see periodic peaks in new technology, followed by nulls where everything seems to come to a standstill. This phenomenon is most noticeable in the semiconductor industry during the past few years, but if you look back to the 19th century, you'll see the same thing happened then, with George Stephenson's steam-powered locomotives and Eli Whitney's cotton gin early in the century, and later with the development of mass production techniques, the electric telegraph, and Marconi's wireless. Every few years, it seems, a major breakthrough in technology occurs which produces an avalanche of new products on the market place. If you analyze it carefully, in most cases you'll find that the "major breakthrough" didn't happen all at once as it first appears, but was the culmination of years of research by many different workers in many diverse fields.

In many ways the cyclic rise and fall of technological achievement is an extension of the well-known domino theory — the apparent lulls in activity occur when the dominoes are being lined up; the breakthrough comes when the last domino is set in place and the whole line is knocked down, one domino after the other. It takes but one missing or misplaced domino to prevent the whole line from going down.

In the field of gallium-arsenide field-effect transistors (GaAs fets or "gas" fets, for short), the last of the dominoes has been set in place, and in the near future there will be devices on the market which will provide noise figures of less than 1 dB at 4000 MHz, and power outputs of 6 watts or more at 10 GHz. At a conference last summer at Cornell University, researchers from Bell Labs reported on a GaAs fet amplifier which yielded 10 dB gain at 4 GHz with a noise figure of 0.7 dB; at 6 GHz the noise figure increased to 1.25 dB and gain dropped to 9 dB. At the same conference, scientists from Rockwell International were talking about a device which gave a 2.2 dB noise figure at 10 GHz with 8.5 dB gain. These devices and similar ones from other manufacturers will be available on the commercial market this year, but be prepared to pay a pretty healthy price for the privilege of building a circuit around them. As manufacturing processes are improved and yields go up, however, I expect device cost will drop within the amateur price range. If you can't wait, in this issue JH1BRY describes a high-performance GaAs fet preamp for 432 MHz that has a noise figure below 1 dB.

At Texas Instruments the accent is on power GaAs fets with claimed power output of 4.2 watts at 10 GHz; and RCA has announced 140 mW output at 22 GHz. The most impressive of the power GaAs fets, however, is a device from Fujitsu which provides 10 watts output at 4000 MHz. In theory 14 or 15 watts should be possible at 4 GHz with GaAs fet devices, and 6-7 watts at 10 GHz, but there are still a number of problems to be solved, so this capability may be five years in the future.

Some of the same technology that has produced high-performance microwave GaAs fets is also being used in other areas. At the International Solid State Conference in February, an engineer from Hewlett-Packard described a monolithic 4-GHz integrated amplifier which provides 28 dB gain from dc to 2000 MHz (gain is 7 dB from dc to 4 GHz). The three-stage amplifier is built on a single GaAs chip and uses reverse biased Schottky diodes as capacitors and MESFETs as resistors. At the same conference, Bell Labs reported on a uhf operational amplifier which has a unity gain frequency in excess of 1000 MHz. Silicon NPN transistors are used in the design, which provides 20 dB gain at 300 MHz; the operational frequency range is 10-500 MHz.

While GaAs fets threaten to displace bipolars above 3000 MHz, silicon MOSFETs are quietly moving in on microwave bipolars from the lower end of the frequency spectrum. Attention has been focused recently on advances in VMOS devices for vhf and uhf applications. Since the first commercial VMOS device was announced by Siliconix two years ago (ham radio, September, 1976), a number of semiconductor manufacturers have gotten on the VMOS bandwagon including Intersil, Motorola, and Westinghouse. One firm has reportedly obtained 10 watts at 1000 MHz and more than 5 watts at 1500 MHz with a VMOS transistor. One of the big advantages of VMOS is its negative temperature coefficient which eliminates thermal runaway and secondary breakdown. This means that emitter resistors, temperature sensing diodes, and other protection circuitry required for bipolars can be eliminated, resulting in a substantial cost savings. VMOS also offers better linearity with third-order IMD typically 3 to 5 dB better than bipolar power amplifiers.

As I said earlier, technological breakthroughs seem to come in spurts. During the past year or so there have been some remarkable achievements in the world of digital electronics, but it has been pretty quiet on the analog front. With the latest rf devices just now emerging from the laboratory, how long will we have to wait before all the dominoes are gathered for the next breakthrough?
IC-22S, Small wonder

ICOM's matchless mobile **IC-22S** has, since its introduction, been the standard against which all other VHF mobile transceivers have been measured. It is a prime example of ICOM's quality engineering, peak performance and phenomenal flexibility blended into one splendidly simple and affordable radio. Small wonder that the **IC-22S** has been the most popular radio that ICOM has ever offered.

Built to be viable operating hardware for years to come, with a magnificent high sensitivity receiver and instant programming and reprogramming of any 22 of 256 possible frequencies, the **IC-22S** is priced for the mobile beginner and the multi-vehicle serious VHF enthusiast. Small wonder that many hams own and operate more than one **IC-22S**.

With Touch Tone adaptability, quick change mobile mount, external speaker provisions, optional AC base power supply and other great flexible growth characteristics, the **IC-22S** is the perfectly affordable radio for those to whom present performance and future possibilities are important. Small wonder.

---

**All ICOM radios significantly exceed FCC Specifications limiting spurious emissions.**

**Specifications:**
- Frequency Range: 144-148 MHz
- Voltage: 13.8 V DC negative ground
- Current Required:
  - TX: 2.4 amps at 10 W, 0.9 amp at 1 W; RX: 750 mA at max audio
  - Size: 5.83" x 12.75" x 2.18"
- Weight: 1.9 Kg
- Number of Channels: 22 selected from 256 possible
- Power Output: 10 W or 1 W, selected
- Modulation Width: 5 KHz
- Microphone Impedance: 500 ohms
- Spurious Level: -60 dB below carrier
- Modulation Acceptance: 15 dB
- Receiver Sensitivity: 4 mV for 20 dB quieting
- Spurious Response: 60 dB or more attenuation
- Bandpass: ± 7.5 KHz/± 6 dB, ± 15 KHz/± 60 dB
- Squelch Sensitivity: 8 mV below 1 W

**ICOM WEST, INC.**
Suite 3
13256 Northrup Way
Bellevue, Wash. 98005
(206) 747-9020

**ICOM EAST, INC.**
Suite 307
3331 Towerwood Drive
Dallas, Texas 75234
(214) 620-2780

**ICOM CANADA**
7087 Victoria Drive
Vancouver B.C. V5P 3Y9
Canada
(604) 321-1833
TEN-METER AMATEUR LINEARS WERE BANNED by the FCC Commissioners in an early February meeting, and it seemed evident that most had already decided on the ban before the meeting began. The ban covers the commercial manufacture, distribution and sale of any RF power amplifier covering the 24-35 MHz range. It appears that linears in the marketing "pipeline" — in manufacturers' stock or on dealers' shelves — will receive some sort of "blanket" waiver to be sold providing that they meet all the Type Acceptance criteria other than frequency coverage. Any that don't will have to be considered individually. Amplifier sales between individual Amateurs are still permitted, and individual Amateurs are still permitted to build their own 10-meter linears.

LIMITED TYPE ACCEPTANCE of Amateur amplifiers below 144 MHz was also adopted with technical standards similar to those already in Part 97; actual implementation of Type Acceptance won't take place until detailed specifications and procedures are ready in several months.

To Meet The New Type Acceptance requirements an amplifier will have to be capable of accepting 50 watts (mean power) of drive, have less than 15 dB power gain, require external transmit-receive switching (no RF sensing) — and, of course, not operate in the 24-35 MHz spectrum. How difficult a manufacturer is supposed to make it for an individual Amateur to modify his product to cover 10 meters is still unclear.

It's expected that the ban and Type Acceptance will go into effect at the same time, but just when won't be known until a Report and Order on the two dockets is released. Further clouding the issue is what action industry plans, with several manufacturers, ARRA, and the ARRL all likely candidates for filing petitions for reconsideration. In both industry, and among individual Amateurs, the feeling is that the Type Acceptance requirements in themselves would have been sufficient to drive the illegitimate amplifiers off the market, so the ban on top of Type Acceptance serves only to unnecessarily penalize Amateurs.

AMATEUR SECONDARY STATION licenses for individuals will be phased out as their present terms expire as a result of the first Report and Order on Docket 21135, effective March 24. Special events stations and callsigns were also eliminated as the Commissioners attempted to reduce the Amateur Radio workload at Gettysburg to within budgetary limitations. For Amateurs who presently hold more than one station license, the effect will be a decision on their part as to which callsign to keep when it is time to renew; the freeze on issuance of new secondary licenses, in effect for almost a year, is now permanent.

Extra Class Requests for specific 1x2 or 2x2 calligns will no longer be honored under the newly adopted rules, though they will still be able to request an unspecified 2-letter-suffixed callsign. Eventually, but well in the future, it's planned to offer 1x3 calligns to all the holders of Advanced or Extra Class licenses who wish them. Also, the present process by which a 1x3 callign holder receives a 1x2 "preferred" callign when changing call areas is to be eliminated. However, as the rules now permit an Amateur to retain his former callsign even after moving permanently to a new call area, it's likely many present 1x3 and 1x2 callign holders will elect that option. Along that line, future initial callign assignments are now going to be based on the applicant's mailing address rather than station location.

Club, RACES, and Military Amateur station licenses are to be further considered under a new Notice of Proposed Rule Making on Docket 21135. Distinctive prefixes for club stations (WK) and military stations (WM) are also proposed in that NPRM, while RACES stations would continue with WC calligns as at present. It's also proposed that the criteria for a club station license be tightened considerably, requiring that the organization demonstrate a "compelling need" (distinctive use, past and present) for a club license before one would be issued or renewed. RACES licenses would also be reduced to only one per Civil Defense organization, and licenses for all three classes of organizations would be issued to the organization, not an individual trustee. Due date for Comments on this NPRM is June 2, with Reply Comments June 30.

REPEATER LICENSES AREN'T REQUIRED to put a repeater on the air under terms of a recent waiver. No prior FCC approval or additional license is now required to operate a repeater, auxiliary link, control, or remotely controlled Amateur station — all may be operated with the individual's primary station license, callign, and appropriate ID. The waiver is effective until the Commission releases an Order on Docket 21033.

KH1 THROUGH KH6 are the new prefixes for U.S. Pacific islands, while KPI-KP0 will identify Caribbean areas; the change was effective March 24. As some spots such as KX6 and KC6 are not FCC administered and would apparently continue with present prefixes, there seems to be enough in each block to handle the needs.

THE 2-METER DX RECORD has been stretched again, this time to 6300 km (3940 miles), as KP4EOR worked LU8DIN. YV5ZZ has heard LU3AT on 432.1 MHz, and they plus KP4EOR are attempting schedules on that band as well as on 2 meters.
This one's for you.

Because you asked for it...we built it. The all-new JR. MONITOR™ Antenna Tuner.

Call it what you will—antenna tuner, matchbox, or matching network, the JR. MONITOR™ has it all wrapped up in one neat 5¾"Wx2¾"Hx6¾"D all metal cabinet.

Here are the features you said you wanted:


With so many special features — think of the unlimited possibilities you'll have for experimenting with dozens of antennas! For instance, the DenTrot All Band Doublet fed with balanced feed line hooked to the JR. MONITOR™ covers 1.8-30 MHz in one antenna...or try this mobile suggestion: 108" mobile whip fed with coax to the JR. MONITOR™ located under the dash will give you 10-40 meter mobile coverage and no coils to change!

It's easy to understand the excitement the JR. MONITOR™ has created. Wherever you are—home, boat, car, plane, or campsite you'll always be in contact. It's a fun little tuner that easily fits in a briefcase or coat pocket — but why would anyone want to smuggle it into their radio room?

JR. MONITOR™ $79.50
ALL BAND DOUBLET $24.50

DenTrot Radio Co., Inc.
2100 Enterprise Pkwy,
Twinsburg, Ohio 44087
(216) 425-3173
Kenwood's exciting 2-meter transceiver...still the most powerful. 800 channels, repeater offset over all 4 MHz (144-148 MHz), dual frequency readout, easy to read 6 digit display, Kenwood's unique continuous tone coded squelch system and outstanding receiver performance. All in a rugged, compact package.

The TR-7400A lets you go anywhere on the 2-meter band...covers the entire band without compromise. It exceeds all FCC emission requirements for amateur transceivers. Its RF output is factory spec'd at 25 watts...but is typically over 30! It offers a dual frequency readout with large easy to read 6 digit LED display plus a functional dial readout system, fully synthesized 800 channel operation and repeater offset over all 4 MHz (144-148 MHz). The unique Continuous Tone Coded Squelch system is a Kenwood exclusive.

Outstanding sensitivity, large-sized helical resonators with High Q to minimize undesirable out-of-band interference, and give a 2-pole 10.7 MHz monolithic crystal filter the most powerful. 800 repeater channels 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. (Active filters and Tone Burst Modules optional)
The TR-7500 is a 100 channel PLL synthesized 146-148 MHz mobile transceiver offering the dependability you've come to expect from Kenwood products.

ALL THE FREQUENCIES YOU NEED FOR MOST REPEATER OPERATIONS AND RECOMMENDED SIMPLEX CHANNELS ARE PRE-PROGRAMMED. 88 channels are pre-programmed 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.

THE 7500 FEATURES AN EASY TO READ LED DIGITAL FREQUENCY DISPLAY... unlike the difficult to read mechanical displays on many mobile units.

ALSO, A SINGLE KNOB CHANNEL SELECTOR makes the TR-7500 one of the most convenient units to operate while driving.

Its output is a full 10 watts and it offers -600 KHz offset, along with other worthwhile features. The man to see... your local Authorized Kenwood Dealer. He can give you all the information you need and the best deal.

TR-7500

THE TR-7500 IS AN ADVANCED 2 METER FM TRANSCEIVER OFFERING EXCITING FEATURES AND EXTREME RELIABILITY AT A REASONABLE PRICE

TR-8300

The luxury of 450 MHz at an economical price. The TR-8300 is capable of Fs emission on 23 crystal controlled channels (3 supplied). The transmitter output is 10 watts. It 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.

TRIO-KENWOOD COMMUNICATIONS INC.
1111 WEST WALNUT/COMPTON, CA 90220
advanced electronic keyer

By defining keying intervals the author has developed a practical keyer that permits maximum time for character keying — enabling you to send letter-perfect code.

About thirty years ago, the bug was the most popular keying device, being widely used by hams all over the world. Only a small minority were using a new device, the electronic keyer, which had just begun to appear on CW bands, to produce fast and perfect machine keying. In the late 1940s, W6OWP described in QST a new and simple principle for the electronic keyer. In Europe, this keyer was modified and popularized on the amateur bands by OZ7BO.

The W6OWP electronic keyer was simple, yet reliable. It did not use any clock-pulse generator, with the timing of dots, dashes and spaces performed by RC circuits, two triode vacuum tubes, and two relays. The dot, dash, and space time ratio was practically constant over the whole speed range. The most important features, though, were the self completing dots and dashes (including the following space), instant response when the paddle was closed, and sufficient time to release the paddle when the character generation was to be stopped.

electronic keyer requirements

Are there new requirements for the electronic keyer today? The optimum timing of characters, (dots, dashes, and spaces) over the entire speed

By Pavel Horvath, OK31A, Institute of Physics, Slovak Academy of Sciences, 899 30 Bratislava, Czechoslovakia
range, and simple but reliable control of the keyer with the paddles are, of course, still expected. This can be easily understood by examining the timing of characters as shown in fig. 1. The time durations of the dash, dot, space within a character, space between characters, and space between words are defined as 3, 1, 1, 3, and 7 elementary time intervals. This timing of characters seems to be optimal for fast speeds. A different timing could be required at very low speeds; this problem, however, is not discussed here. Even though the keyer must accept imperfect keying, the output characters should be generated without errors.

Control of the keyer with the paddles is very important. Two types of paddles are generally used; the single paddle for standard keying and the dual paddle for squeeze or iambic keying. The single paddle, when released, slips into the neutral position and can be closed for a dot or for a dash. The dual paddle can be closed simultaneously for a dot and for a dash. Keying with a dual paddle is somewhat different than that with a single one.

Using the single paddle, there are two distinct groups of characters. First, those characters having an alternate sequence of dots and dashes (C for example) are generated by alternatively closing the paddle for a dash and then a dot. The first dash starts at the instant $t_d = t_b$, when the paddle is closed. No delay time should occur. By using dot and dash memories, the paddle can be moved to the dot side after the first dash begins. Fig. 2 shows the permitted time intervals for closing the paddle to generate the character C without errors.

The second group of characters are those which have a series of dots or dashes. Fig. 3 shows the keying required for the character $\text{= (BT)}$. The paddle is first closed to generate a dash at the instant $t_d = t_b$, but yet, must be released and moved to the dot side before $t_d$. During the interval $t_c$ to $t_{10}$, the paddle must be repositioned to form the last dash. For example, the paddle could be closed during $t_c$ to $t_{10}$ and released during $t_d$ to $t_{14}$.

A somewhat different situation arises if you use dual paddles for iambic keying. The output with both paddles closed is called an iambic sequence. Fig. 4 shows the keying for CQ. You start by closing the dash paddle, followed by closing the dot paddle. The
fig. 3. Permitted time intervals for closing and releasing paddles to generate the character = (BT).

dot paddle can be closed any time during the $t_8$ to $t_4$ interval. Both paddles are held until you recognize the last dot in the character C. Then you release both paddles. The sequence for releasing the paddles is not important, but both must be released during $t_{10}$ to $t_{12}$. If the keyer also completes the spaces between characters, you can re-close the dash paddle anytime during the $t_{12}$ to $t_{14}$ interval. After the second dash in the Q has started ($t_{18}$), you must close the paddle for a dot during $t_{18}$ to $t_{22}$, keeping both paddles closed to produce the character in the iambic mode. If both paddles are released anytime during $t_{24}$ to $t_{28}$, the Q will be completed. When both paddles are released, the iambic sequence must stop after one bit (dash or dot) is completed. No second bit should be generated.

The permitted time intervals previously discussed are the maximum intervals in which the paddles can be closed or released, allowing the characters to be generated without errors. Any shorter time intervals make the keying worse. A summation of the previous points produces a list of features which an electronic keyer should incorporate:

1. Keying by both single and dual paddles.
2. Maximum possible permitted time intervals to make the keying easy.
3. At the beginning of the message, the character should start the instant the paddle is closed.
4. Optimum timing of dots, dashes, and spaces, throughout the entire speed range.
5. Stable clock generator, without clock pulse variations after triggering.

I began my design with the circuit described by WB2DFA. In my version, I use very similar timing circuits, modified for a triggered clock and complete timing of spaces. My efforts were concentrated on improving the control of the keyer with paddles, making keying easy and convenient.

A block diagram of this keyer, with the significant signal names, is shown in fig. 5.
Clock generator. As shown in fig. 6, the schematic diagram, the clock pulses are generated by transistors T₄, T₅, and the associated logic. In the initial state, the clock generator is off since GEN TRIG is low (0). The signal GEN TRIG is the logical sum of DASH TRIG, DOT TRIG, SQZ TRIG, MESSAGE START, and A•B•C•D. Because of the low from GEN TRIG, T₄ is turned on by the current flowing through D₃ and subsequently T₅ is also turned on. At the instant the paddle is closed, GEN TRIG goes high, enabling the clock generator. Simultaneously, a short, negative pulse is formed by the gates connected to D₄. This negative pulse turns off T₄ and starts the generation of clock pulses. This circuit philosophy allows the "generator to start in synchronization with the paddle.

The clock pulses (GEN) are perfectly formed, the first pulse being the same as the following ones. The clock frequency is continuously variable and corresponds to speeds of 10 to 50 words per minute.

When a dash is to be sent, for example, the paddle is pressed, causing the clock generator to be activated, and the DASH signal to be generated. This signal, DASH, is the actual eventual output from the keyer. And, in addition to being the output, it is used to reset the binary counter for the duration of the signal. When DASH resets the counter, through the RO(1) and RO(2) inputs, the B•C•D and A•B•C•D are high, thus feeding the clock pulses to the binary counter. But, the pulses will not be counted until the completion of the dash since the resets override the normal clock input.

When the dash is completed, the CLOCK and DLD CLOCK pulses will then be counted. The gates connected to the B and D outputs of the binary counter will give an ENABLE TIMING pulse at the completion of the first or third timing interval; if there is a dot or dash waiting in the buffers, it will be generated after the first interval and the process will start again. If a dot or dash is not waiting, another ENABLE TIMING pulse will occur after the third timing interval (character space). If a character is still not in the input buffers, the word space will be generated (seven time intervals) by the gates connected to the B, C, and D outputs of the counter. At the completion of the word space, the A•B•C•D line will go low, stopping the pulse generator. If a character had been keyed in as the beginning of a new word, however, the pulse generator will not stop. Thus, if you are keying properly, the clock generator runs without interruption through the whole message.

The toggle and delay circuits divide the GEN signal by two, producing CLOCK and DLD CLOCK signals, with a delay of about 200 nS.

Space generation timing circuits. The circuitry in this portion of the keyer is used to provide a constant-width space following each element of a character, whether a dot or a dash. This self-completing space corresponds to the length of one dot. In addition, the timing of the space between characters and words can also be made self-completing, corresponding to 3 and 7 elementary-time intervals.

In the initial state (completion of a space), the four outputs of the binary counter are all high, causing the ENABLE TIMING line to also be high. When this line is high, the circuits for generating a dot or dash are not inhibited, and can be activated by pressing either paddle. Now, if a dash is to be sent, for example, the paddle is pressed, causing the clock generator to be activated, and the DASH signal to be generated.

Buffers and registers. The input buffers (or dot and dash memories) are used to store the code elements as they are put into the keyer. The dash and dot memories are actually 2-bit shift registers set up...
as FIFO registers, composed of D-type flip-flops. During keying, the dots and dashes are not only stored, but are also simultaneously shifted into the timing circuits. Therefore, it is possible to buffer characters in which the sum of the dots and dashes is greater than four.

**Dash and dot distributors.** The input and output dash/dot distributors remember which kind of a bit, dash or dot, was stored first. The input distributor stores the dots and dashes in a sequence depending on the first bit keyed in; the output distributor correctly loads the content of the buffers into the timing circuits.

The character C, if stored in the buffers, is processed to the keyer output in the following manner. The output dash/dot distributor, being enabled for a dash, allows the DASH TRIG signal to pass through the gates into the dash timing circuit, triggering the first dash. When the dash and the following single width space are completed, the signal SHIFT DASH REG shifts the dash register and clocks the output distributor to the dot memory, thus enabling the DOT TRIG signal through the gates into the dot timing circuit, triggering the dot. When the dot and the single width space are completed, the signal SHIFT DOT REG shifts the dot register, turning the output distributor back to the dash buffers. The same procedure is followed until the character C is shifted out of the buffers.

**Dash and dot timing.** The timing of a dash will start if the DASH TRIG or SQZ TRIG signal is low, the output dash/dot distributor enabled for a dash, and the signal ENABLE DASH TIMING high. The pulses, DLD CLOCK, transfer the high level on the D input to the output of the flip-flop, causing DASH TIMING to go high. With this signal high, a four-state binary counter receives the DLD CLOCK pulses. The counter states are then decoded into the signal DASH, which is three elementary-time intervals long. While the DASH is executed, the DOT circuit is disabled.

**Dash shift and dot shift.** The signals SHIFT DASH REG and SHIFT DOT REG, shown in fig. 7, are short pulses positioned at the end of the single width space following the dash or the dot. By having these pulses at the end of the space, you have the maximum amount of time in which to key in another dot or dash.

The block diagram in fig. 5 illustrates how these signals are formed. The signal CLOCK is delayed 200

![fig. 6. Schematic diagram of the advanced electronic keyer.](image)
nS, producing DLD CLOCK. Also, CLOCK is used to drive the A section of the binary counter. After the DASH and DOT signals are formed, they're shifted into another D-type flip-flop, which is clocked by DLD CLOCK. The dash or dot therefore initiates the shift register signal, while the DLD CLOCK stops it, 200 nS later.

**Squeeze.** During the initial phase of keying, the buffers, dash and dot registers, and input and output dash-dot distributors are involved. When both paddles are squeezed, SQZ TRIG goes low, clearing both buffer registers, enabling the clock generator, and executing the iambic sequence. When both paddles are released, RESET SQZ resets the squeeze circuit forcing SQZ TRIG to go high at the end of the first completed single-width space.

**Monitor.** The keyer contains an internal side-tone oscillator, which consists of a multivibrator, an integrating amplifier, and internal speaker. The multivibrator generates a 1-kHz rectangular waveform, which is integrated in the amplifier. The triangularly shaped sidetone drives an internal 8-ohm permanent magnet speaker.

**Message memory.** Provisions have been made to connect the keyer to an external random-access memory. Four signals are available on a rear panel connector for operation of the memory. During the “message write operation” the MEMORY CLOCK and DASH or DOT are used for synchronous storing of the message. The MEMORY CLOCK automatically starts when the paddle is activated and continues to run during the manual keying. When the manual keying stops, the MEMORY CLOCK runs for seven clock pulses after message generation ceases. MEMORY CLOCK can be enabled to run through the remaining addresses by taking MESSAGE START low. During the “message read operation” MESSAGE represents the memory content previously stored and is transmitted through the OR gate to the keyer output.

**construction**

The electronic keyer is built in a 7 x 10 x 21 cm (2 3/4 x 4 x 8 1/4 inch) steel cabinet. The overall view is shown in the photographs. The ICs are mounted on a universal printed-circuit board with wire wrap used for the circuit connections. The parts list is shown in table 1.

**concluding thoughts**

This advanced electronic keyer could seem to some readers to be rather complicated. However, even an inexperienced homebrewer can expect perfect performance by exercising reasonable care during construction. Additionally, there are no special circuit adjustments necessary.

<table>
<thead>
<tr>
<th>table 1. Semiconductors used in the electronic keyer</th>
</tr>
</thead>
<tbody>
<tr>
<td>integrated circuits</td>
</tr>
<tr>
<td>7400</td>
</tr>
<tr>
<td>7404</td>
</tr>
<tr>
<td>7410</td>
</tr>
<tr>
<td>7420</td>
</tr>
<tr>
<td>7430</td>
</tr>
<tr>
<td>7474</td>
</tr>
</tbody>
</table>

Only inexpensive TTL ICs were used in this project. The more experienced builder could change some circuit components or integrated circuits to ones more available in the United States. Or he could use NOR gates, monostable multivibrators, or MSI shift registers to minimize the number of parts and energy consumption. This should not be in contradiction with the aim of this article, however, which is to provide optimum keyer control and timing.

**references**


ham radio
The AMSAT-OSCAR D spacecraft is scheduled for launch sometime this month — here are the complete operating parameters for this new amateur satellite.

AMSAT-OSCAR D, the next spacecraft in the OSCAR series, is a Phase II spacecraft which was built over the past two years by radio amateurs in the United States, Canada, Japan, and West Germany and is the first spacecraft in which AMSAT, Project OSCAR, and the ARRL have joined together to build flight hardware. The spacecraft makes extensive use of parts left over from the OSCAR 7 and Phase III programs, and was built primarily because the Phase III spacecraft will not be available until 1979. By stretching its resources almost to the limit, AMSAT has been able to work on both the Phase III spacecraft (with lots of publicity) and OSCAR D (with little publicity).

The new spacecraft carries transponders for two modes of operation. There is a conventional 145.9 MHz to 29.4 MHz Mode A transponder, and a new 145.9 MHz input, 435.1 MHz output, Mode J transponder — a similar frequency combination was used on the short-lived OSCAR IV spacecraft in 1966. In addition, six channels of telemetry are provided to monitor the onboard status of the satellite.

mission objectives

The principal objective of AMSAT-OSCAR D is its use as an educational tool in schools. Other objec-

By Perry Klein, W3PK, and Joe Kasser, G3ZCZ, AMSAT, Post Office Box 27, Washington, D.C. 20044.
Objectives include the continuation of communications demonstrations by means of stations in the amateur-satellite service, of the feasibility of using satellites with small amateur terminals for emergency communications, communications between medical centers and isolated areas, aeronautical, maritime, and land-mobile communications, direct satellite-to-home voice “broadcasting” to simple amateur receivers, and other similar applications. Further objectives are to demonstrate special operating techniques that enhance the usefulness of low orbits for these satellite applications, and to test the suitability of a new communications transponder frequency combination (Mode J) for small terminal users.

AMSAT-OSCAR D will permit the continuation of the education program, which began with OSCARs 5, 6, and 7, over the next several years, the anticipated lifetime of the satellite. OSCAR satellites have begun to play an important role in a new approach to science education. Used as remote laboratory tools, these satellites represent a pioneering utilization of an active space system in the classroom. Using inexpensive ground terminals for OSCAR satellites in schools, students can gain firsthand experience in space science. This type of direct, active involvement has relevance to the study of communications, astronomy, engineering, physics, mathematics, and meteorology. The low-cost OSCAR ground terminal puts an active satellite system at the disposal of the instructor and student.

**spacecraft description**

OSCAR D is a communications satellite in the Phase II (low-orbit) series which is designed to operate with small stations in the amateur-satellite service on a non-commercial basis. The spacecraft contains two communications transponders and command and telemetry systems; it is solar powered, weighs 27 kg (60 pounds), and is a 38 cm (15-inch) rectangular solid 33 cm (13 inches) high. Its anticipated useful operating lifetime is three years.

Two types of communications transponders are aboard the spacecraft. Normally, only one transponder will be operated at a time because of spacecraft battery constraints.

**Two-to-ten meter transponder.** The Mode A transponder is a two-to-ten meter unit similar to the one used on OSCAR 7 (input frequency passband 145.85-145.95 MHz, and output frequency passband between 29.40 and 29.50 MHz). A 250 mW telemetry beacon provides telemetry data in Morse code at a frequency of 29.402 MHz. Approximately -95 dBm is required at the transponder input terminals for an output of one watt. This corresponds to an effective radiated power from the ground of 80 watts for a distance to the satellite of 1930 km (1200 miles) and a polarization mismatch of 3 dB. The transponder translation frequency (input frequency minus output frequency) is 116.458 MHz. Thus, the relationship between the uplink ($f_u$) and downlink ($f_d$) is

$$f_d = f_u - 116.458 \pm \text{Doppler}$$

where both $f_d$ and $f_u$ are in MHz.

An uplink signal at 145.900 MHz, for example, will produce a down-link signal from the transponder on 29.442 MHz ± Doppler. As in the two-to-ten meter transponders in OSCAR 6 and 7, the passband is not inverted, and upper-sideband uplink signals become upper-sideband downlink signals. Output power is 1 to 2 watts.

Note that the downlink frequency will be slightly different (8 kHz) from that of the equivalent OSCAR 7 Mode A transponder which has an equivalent frequency relationship of

$$f_d = f_u - 116.450 \pm \text{Doppler}$$

AMSAT OSCAR D spacecraft to be launched in March, 1978, by NASA. When it is in orbit it will be designated AMSAT OSCAR 8.
Two meter-to-70cm transponder. The Mode J transponder, constructed by members of the Japan AMSAT Association in Tokyo, uses a two-meter input, 70 centimeter output combination which has not yet been flown in the AMSAT Phase II series. This transponder operates with an input frequency passband of 145.90-146.00 MHz, and an output frequency passband of 435.10-435.20 MHz. Power output is about 1-2 watts PEP, and the output passband is inverted, i.e., upper-sideband uplink signals become lower-sideband downlink signals. The transponder translation frequency (input frequency plus output frequency) is 581.1 MHz ± Doppler. Uplink sensitivity for one-watt output is −105 dBm, corresponding to an effective radiated power from the ground of 8 watts for a distance to the satellite of 1930 km (1200 miles).* Note the greatly improved sensitivity of this mode, and keep your power down. A 100-milliwatt beacon carries telemetry at a frequency of 435.095 MHz. The relationship between the uplink \( f_u \) and downlink \( f_d \) is

\[
f_d = 581.1 - f_u ± \text{Doppler}
\]

where both \( f_d \) and \( f_u \) are in MHz.

**antenna system**

Both the Mode A and Mode J transponders use the same receiving antenna, a cantedturnstile comprised of four 48 cm (19-inch) lengths of 12.5 mm (1/2-inch) carpenter’s rule fed by a hybrid and matching network so as to develop circular polarization.

---

* Sensitivity may decrease by a factor of ten (10 dB) under different conditions of battery voltage and satellite operating temperature, so that as much as 80 watts may be required at certain times.

One port of the hybrid feeds the Mode A receiver; left-hand circular polarization is required by users in the Northern Hemisphere and right-hand circular polarization is required in the Southern Hemisphere. A second port of the hybrid is connected to the Mode J receiver; right-hand circular polarization is required in the Northern Hemisphere, and left-hand circular polarization in the Southern Hemisphere. The antenna gain should approach 5 dB in the \(-Z\) direction (i.e., toward the bottom of the satellite).

The Mode A ten-meter downlink antenna is a linearly-polarized dipole which is oriented perpendicular to the stabilization magnets in the spacecraft as in OSCAR 6 (but unlike OSCAR 7, which has the ten-meter antenna parallel to the axis of the magnets).

The 435-MHz Mode J downlink antenna is a simple monopole, linearly polarized, and located on the top of the spacecraft. Note that its location may result in some radiation shielding at high Southern Hemisphere latitudes.

**telecommand system**

A five-function telecommand system of a new design is carried on OSCAR D. The system is based on the best features of the OSCAR 6 and 7 telecommand systems, and is designed to be virtually immune to noise and interference. The command functions are:

- **Mode A Select** (Two-to-ten meter transponder ON)
- **Mode J Select** (2 meter to 70 cm transponder ON)
- **Mode D Select** (recharge mode; both transponders OFF)
- **Ten-meter Antenna Deployment**
- **Ten-meter Antenna Reset**

**telemetry system**

OSCAR D contains a six-channel Morse code telemetry system similar to the units flown in OSCARs 6 and 7. Telemetry is sent at 20 words per minute as three-digit numbers; \( A1 \) emission is used in keying the Mode A or Mode J telemetry beacons, depending upon which transponder is in use. The six telemetry parameters are:

- **Channel 1.** Total Solar Array Current —
  \[ I_T = 7.15 \ (101-N) \text{ ma.} \]

- **Channel 2.** Battery Charge-Discharge Current —
  \[ I_{Bat} = 57 \ (N-50) \text{ ma.} \]

- **Channel 3.** Battery Voltage —
  \[ V_B = 0.1 \text{ N} + 8.25 \text{ Volts} \]
Channel 4. Baseplate Temperature —
\[ T_{bp} = 95.8 - 1.48 \text{ N}(^\circ\text{C}) \]

Channel 5. Battery Temperature —
\[ T_{Bat} = 95.8 - 1.48 \text{ N}(^\circ\text{C}) \]

Channel 6. RF Power Output, Mode J —
\[ P_{J} = 23 \text{ N milliwatts} \]

Note that, unlike OSCAR 6 and 7 telemetry, OSCAR D has only one parameter per line (OSCARs 6 and 7 had 4). As a result, a complete telemetry frame is sent in approximately 20 seconds.

power supply

The spacecraft contains solar panels on its four sides (along the +X, -X, +Y, and -Y axes), and on the top (the +Z axis). No panels are contained on the bottom (-Z axis) since this is where the spacecraft is attached to the launch vehicle. The solar cells, combined with a 12-cell, six-ampere-hour rechargeable nickel-cadmium battery should be adequate to power the spacecraft with a positive power budget in Mode A for several years, even considering solar cell degradation in the radiation environment. The power drain in Mode J, however, is somewhat larger, so the Mode J transponder probably cannot be operated continuously.

A battery charge regulator is also contained which converts from the 28-30 volt solar array voltage to the 14-16 volts required by the battery. It also tapers the charge rate so the battery trickle-charges as the battery approaches full charge (as indicated by the battery voltage).

stabilization system

Four permanent magnets located inside the spacecraft and aligned along the Z axis provide stabilization, as in OSCARs 6 and 7. The polarity of the magnets is such that the top (+Z axis) of the spacecraft always points toward the magnetic north pole of the earth. Hysteresis permalloy damping rods mounted behind the +X, -X, +Y, and -Y solar panels are designed to reduce the spin of the spacecraft about the Z axis; they function in a manner similar to a shorted transformer turn as it cuts the lines of flux of the earth’s magnetic field. The permalloy rods are left over from OSCAR 7, which successfully used the same type of stabilization system.

launch interface and orbit

The OSCAR D spacecraft is being launched from the NASA Western Test Range as a secondary payload with the NASA Landsat-C earth resources technology satellite and the NASA PIX (Plasma Interaction Experiment). The spacecraft will be ejected from the second stage of the two-stage Thor-Delta 2910 launch vehicle 5120.6 seconds after lift-off, at an approximate position of 78 degrees N. latitude and 15 degrees W. longitude. Programmed orbital parameters are:

- Apogee: 928 km (577 statute miles)
- Perigee: 884 km (549 statute miles)
- Period: 103 minutes
- Inclination: 99.0 degrees
- Time of Descending Node: 9:30 AM

The orbit is planned to be sun-synchronous with passes repeating at the same time each day on a one-day cycle (as opposed to the two-day cycle of OSCARs 6 and 7).

spacecraft initialization

AMSAT-OSCAR D will automatically be powered up upon ejection from the Thor-Delta launch vehicle over northern Greenland at which time it will assume the next available number in the OSCAR series. It is designed to initialize itself in Mode J (two-meter-to-70-cm transponder ON). The two-to-ten meter (Mode A) transponder will be initialized OFF and should be kept off until the spacecraft is nearly completely stabilized, which may require as much as a
The "Ten-meter Antenna Reset" command should generally track within a few degrees (except perhaps in the first day or so after launch when the spacecraft has not yet stabilized at thermal equilibrium). Experience from OSCARS 6 and 7 indicate that the battery can overcharge and overheat during periods of the year when the spacecraft

---

**telecommand verification**

OSCAR D's telecommand and telemetry systems have been designed to provide two means to verify whether the spacecraft is accepting commands. First, when the telecommand system has been enabled and is ready to accept a command, the Morse code telemetry will be interrupted and an unmodulated carrier will be heard on the beacon frequency. The beacon will revert back to Morse code telemetry when the telecommand system is no longer enabled.

The second method of telecommand verification is to use the "Ten-meter Antenna Deployment" command. This will cause a series of keying pulses to be heard on the telemetry beacon in place of the Morse code telemetry if the command has been accepted. The "Ten-meter Antenna Reset" command should be sent soon afterward to restore the beacon to the Morse code telemetry mode.

---

**telemetry interpretation**

The most important telemetry channel that will affect operations decisions is channel 3 (battery voltage). In Mode A the spacecraft should maintain a positive power budget so there should not be a net discharge of the battery over an orbit average. Mode J operation, however, requires somewhat more power, which may result in a net discharge of the battery, especially under conditions of high transponder loading; therefore it will be necessary for telemetry and telecommand stations to keep a close watch on the battery voltage so that action can be taken as necessary to command the spacecraft into Mode D (the recharge mode) before the battery discharges too far. Three cutoff levels are specified below:

- **Red Level A** (1.2 volts/cell) Channel 3 = 61 counts
- **Red Level B** (1.1 volts/cell) Channel 3 = 50 counts
- **Red Level C** (1.0 volts/cell) Channel 3 = 38 counts

Red Level A should be used during the first year or so of the spacecraft's life as the cutoff point below which telecommand stations should command the satellite into Mode D for recharging. Later in the spacecraft's life, as the battery discharge characteristic curve changes, Red Level B should be used; Red Level C should be used if there is evidence of battery deterioration or if it is desired to recondition the battery.

**Channel 1** (solar array current) provides an indication of whether the spacecraft is in the sun or eclipse (it should read in the nineties in counts when in eclipse). Fluctuation in channel 1 telemetry is the best indicator of the rate of spin of the spacecraft, along with observations of fading, particularly of the 435-MHz Mode J downlink signal from the quarter-wave 435-MHz monopole antenna.

**Channel 2** (battery charge-discharge current) gives information on whether the battery is charging or discharging. A reading larger than 50 counts indicates that the battery is charging, while a reading of less than 50 counts means the battery is discharging. There is a two-second integration time associated with the current telemetered on this channel. The total power drain of the spacecraft can be determined by observing channel 2 while the spacecraft is in darkness (as indicated by channel 1, which should read in the 90s in darkness).

**Channels 4 and 5** (baseplate temperature and battery temperature) should generally track within a few degrees (except perhaps in the first day or so after launch when the spacecraft has not yet stabilized at thermal equilibrium). Experience from OSCARS 6 and 7 indicate that the battery can overcharge and overheat during periods of the year when the spacecraft
sees the most sunlight. If this is the case, channel 5 may exceed channel 4 in temperature by 10 degrees celsius or more, and action should be taken to reduce this overheating. This can be accomplished by keeping the spacecraft in Mode J to consume any extra charge current from the battery.

Channel 6 is a measure of the Mode J transponder 435-MHz rf power output. Associated with the telemetered readings is an integration time of 2.5 seconds, so that it is average power rather than peak power that is telemetered. There is no telemetry of the Mode A transponder. The Mode A transponder power consumption (largely determined by power amplifier current) can be measured by observing channel 2 telemetry as noted above.

operating schedule

Since the prime mission of the AMSAT-OSCAR D spacecraft is to use the Mode A transponder for the ARRL OSCAR educational program in schools, the spacecraft may be left in Mode A during weekdays (Monday through Fridays, United States time), and put in Mode J on weekends. Note that all communications should conform to the G32CZ band plan shown in figs. 1 and 2. Additionally, if not an excessive burden on the telecommand stations, evening orbits in the Western Hemisphere (morning orbits in the Eastern Hemisphere) can be switched to Mode J, battery permitting. In any case, all operation in Mode J will require careful monitoring of the battery charge level (as indicated from channel 3 telemetry). The power budget may not support the Mode J transponder for continuous fulltime operation in this mode for an entire weekend. In any event, details of the operational modes of the spacecraft will be announced by AMSAT in the Newsletter, with late updates on the AMSAT Nets.

OSCAR D will operate in a 900 km (560 statute mile) orbit, i.e., at just over half the altitude of the orbit of OSCAR 7. Thus, communication ranges will be different. The usable time on an overhead pass will be about 18 minutes instead of the 22 minutes provided by OSCAR 7, and the horizon range will be 3220 km (2000 miles) instead of the 3940 km (2450 miles) of OSCAR 7. This means that transatlantic communications will still be possible, but not as often as with OSCAR 7.

Keeping track of this satellite is going to be much simpler than for OSCAR 7. It will come into range at approximately the same time each day; the overhead descending node pass is planned for 9:30 AM local time.

credits

It is impossible to single out all those who contributed to the construction of the spacecraft, but a few calls can be listed.

JAMSAT — Mode J Transponder: JA1ANG, JA1CBL, JG1CDM, JA1VDV, JA1JHF, JR1SWB

AMSAT — Mode A Transponder: WA4DGU, W3PK

Morse Code Telemetry System: W5CAY, WA4DGU

Telecommand System: W3GEY, WA3LND, WA3ZCE, W3HUC, W3ITO, K1RT/WA1JZC

Antenna and Antenna Deployment Module: W3GEY, W3HUC, W3ITO, K1RT, WA3LND

Power System: DJ4ZC, JA1TUR, JF1DMQ, K1RT, W3HQ

Structure and Module Containers: K6GSJ and Project OSCAR, K1JX/KA1JLD, K1RT, WA4DGU, VE3DPB, W3HS0, WB0GIM, Henry Smith, David Vanderbeke, W3ZKI

Cables and Wiring: Marie Marr, W3TMZ

Engineering Drafting: WB4GlB

To others who contributed or assisted, our thanks and the thanks of thousands of radio amateurs, school children, and educators. Let's use the satellite wisely so that it will further help the educational program until the Phase III satellites are flying high.

ham radio

"Alfred was never any good in a crisis!"
very low-noise
GaAs FET Preamp
for 432 MHz

Construction details for a uhf GaAs fet preamp that will provide a 0.7 dB noise figure with 18 dB gain at 432 MHz.

Every amateur who is active on the uhf bands is looking for ways to improve his system performance. One of these ways is to use a receiver preamplifier with lower noise figure and higher gain; some excellent preamplifier circuits have been published in ham radio. The low-noise uhf preamplifier described by W1JR in the March, 1975, issue is perhaps the best known of these circuits, and is widely used by EME operators and others who are interested in long distance, weak-signal uhf communications.

This article describes a low-noise, state-of-the-art preamplifier for 432 MHz which uses an NEC NE24406 (2SK85) GaAs fet. This preamp is capable of a 50°K (0.7 dB) noise figure at 423 MHz, so it can improve the performance of your uhf receiving system by about 100°K, as compared with a conventional bipolar transistor.

By Shigeru Sando, JH1BRY, 8-17-204 Sakonyama Asahi-ku, Yokohama 241, Japan. Mr. Sando is a microwave semiconductor development engineer at the Semiconductor Division of the Nippon Electric Company.
field-effect transistors

The history of the fet is older than most people realize. In fact, it’s one of the oldest three-terminal solid-state devices. Dr. Shockley first proposed the fet in 1952, but because of a variety of technological and fabrication difficulties, fets did not become practical until the early 1960s.

Basically, there are three different types of fets. The junction fet or jfet is the simplest of the three types and became commercially available about the same time as the first bipolar microwave transistors.

![Image](image)

fig. 1. Smith chart plot of the NE24406 impedance characteristics at 432 MHz. \( Z_{OPT} \) is the optimum source impedance for noise figure at 423 MHz.

Advances in fabrication techniques and requirements for lower power fostered the development of the metal-oxide-semiconductor fet or mosfet. Both the jfet and mosfet are widely used in applications which require high input impedances, such as in the input stages of test instruments. The same fabrication processes developed for mosfets are also useful in the manufacture of integrated circuits.

In the microwave region the bipolar transistor has reigned supreme for a number of years — it wasn’t threatened by either the jfet or the mosfet. However, a third type of fet has changed that. This new fet, which uses a Schottky barrier at the gate electrode, is called the metal-semiconductor fet or mesfet. Mesfets use Gallium Arsenide (GaAs) as the semiconductor material and are usually referred to as GaAs fets (pronounced gas fets).

Gallium arsenide has high electron mobility (5 to 7 times as high as silicon), and offers significant advantages over silicon at microwave frequencies. The intrinsic characteristics of GaAs result in shorter transit times and lower resistance, thereby providing higher gain, lower noise figures, and extremely high cut-off frequencies — all important characteristics for microwave transistors.

Gallium arsenide has been under development for several years, and practical microwave GaAs fets are now available off the shelf. Recently I had an opportunity to experiment with the NEC NE24406 (2SK85) GaAs fet. Although there have been many published reports which describe the performance of the NE24406 in amplifiers up to X band (about 12 GHz), there have been no published data on their use below 500 MHz. This article describes the first experimental results of the NE24406 GaAs fet on the amateur 70 cm band.

noise figure

Obviously a transistor with a low noise figure is required in a low noise preamplifier, but that’s not the

![Image](image)

fig. 2. Recommended GaAs fet bias circuit uses a series resistor in the gate circuit to protect the device from transients.

---

Layout of the low-noise 432-MHz preamplifier. The input is to the left, output to the right. The GaAs fet is installed in the center shield partition. Capacitors C1 and C3 are supported by their own leads; C2 (left compartment) and C4 (right compartment) are mounted in the side walls of the chassis.
only requirement. Also to be considered are the effects of the next stage's noise figure and the requirements for a low-loss matching circuit, low feedback, and good stability.

The overall noise figure of a receiving system is given by the following formula

\[
NF_T = NF_1 + \frac{NF_2 - 1}{G_I}
\]  

(1)

Where

- \(NF_T\) = Total overall noise factor
- \(NF_1\) = Noise factor of the first stage
- \(NF_2\) = Noise factor of the second stage
- \(G_I\) = Available power gain of the first stage

Note that the noise factors and power gains must be in ratios, not in dB. For example, consider that you have a preamplifier with a 1.0 dB noise figure (\(NF_1 = 1.259\)) and 10 dB power gain (\(G_I = 10\)); the noise figure of the second stage is 5 dB (\(NF_2 = 3.162\)). The calculated overall noise factor \(NF_T\) is 1.475 (or a noise figure of 1.688 dB).

Note that the system noise figure has increased about 17 per cent as compared to the preamplifier's noise figure. For best results, it's recommended that you use a lower noise second stage with a higher gain preamp.

One question that often arises is, "Can the noise figure of the preamplifier be as low as the noise figure of the transistor itself?" No, it cannot, even on the assumption that there are no matching or circuit losses. One way to describe the optimum noise figure of a transistor is noise measure which is expressed as

\[
M + 1 = \frac{NF - 1}{1 - \frac{1}{G}}
\]

(2)

where

- \(NF\) = Noise figure of the transistor
- \(G\) = Associated gain of the transistor

The value of \(M + 1\) shows the ideal total system noise figure, and indicates the same result where an infinite number of transistors with the same characteristics are used in cascade.

Assume you have a transistor which has a specified noise figure of 1.2 dB (\(NF = 1.318\)) and 14 dB gain (\(G = 25.12\)). From eq. 2

\[
M + 1 = \frac{1.318}{1 - \frac{1}{25.12}} = 1.351 \text{ or } 1.243 \text{ dB}
\]
The importance of affording adequate protection against transients and change in $f_{DSS}$ cannot be over emphasized. As every designer who uses GaAs fets will eventually discover, transistors are the leading "fet killer." The most likely burn-out mode is a short from gate to drain or from gate to source which is caused by high field or high current transients. The highest field in common-source operation is between the drain and gate, and should never exceed 10 volts.

The best way of applying bias is to use a battery through a series resistor to the gate, as shown in fig. 2. Although two power supplies are normally required, a source resistor may be used to develop the necessary reverse bias, but it may reduce both gain and noise figure. Several bias circuits are shown in fig. 3. It should be mentioned that all bias circuits must be bypassed to rf; a series gate resistor from 1000 ohms to 10k will protect the gate from high-frequency transients.

For best performance a low-loss input matching circuit is very important; low-loss components should be used in the simplest possible low Q circuit. As can be seen in the Smith chart plot of the NE24406's S-parameters, $|S_{11}|$ and $|S_{12}|$ are very large; the optimum source impedance for noise figure, $\Gamma_{FOPT}$, is also very high. Fortunately, the optimum source impedances for gain and noise figure are not greatly different. Therefore, the input matching circuit can consist of a series capacitance or inductance. Since the series reactance must be carefully selected, the capacitor has the advantage of being easily tuned.

Theoretically the preamplifier will work fine with only a series capacitance in the input circuit, but the NE24406 can provide 12 dB gain in the 4-GHz band, so there's a possibility of oscillation outside the 430-MHz band. The parallel resonant circuit, $L1-C2$, in fig. 4 suppresses these oscillations. $L1$ is also used to supply bias to the gate of the GaAs fet. The resonant impedance of $L1-C2$ is very high, and input matching is actually provided only by $C1$.

As was shown in eq. 2, the noise figure of a transistor amplifier depends greatly on the available gain of the device being used. Since a gain increment of 4.0 to 4.5 dB ($|S_{22}| \approx 0.8$) can be anticipated at 432 MHz for the NE24406 when the output is matched,

The GaAs fet has several disadvantages which make it somewhat more difficult to use than the bipolar transistor. For one thing, as shown in the Smith chart plot of fig. 1, the impedances are very high. This also indicates that the GaAs fet is a high Q device and not easy to match to low impedances such as 50 ohms. Also to be considered is the bias circuit. Once an operating point has been established for the GaAs fet, a bias circuit must be chosen which will provide stable operation over the required temperature and frequency range.

This shows the minimum value of amplifier noise available from a transistor with a 1.2 dB noise figure and 14 dB gain (assuming no matching or connector losses).

**circuit description**

The GaAs fet has several disadvantages which make it somewhat more difficult to use than the bipolar transistor. For one thing, as shown in the Smith chart plot of fig. 1, the impedances are very high. This also indicates that the GaAs fet is a high Q device and not easy to match to low impedances such as 50 ohms. Also to be considered is the bias circuit. Once an operating point has been established for the GaAs fet, a bias circuit must be chosen which will provide stable operation over the required temperature and frequency range.

**fig. 5. Layout of the low-noise GaAs fet preamp for 432 MHz.**

The enclosure is made from brass sheet, 0.028" - 0.048" (0.7 - 1.2mm) thick.

**fig. 6. Recommended drain voltage supply circuit for the NE24406 GaAs fet preamplifier.**
Although no particular care is required when mounting the GaAs fet, the source leads should be separated and soldered directly to the holes in the shield plate. Also, when soldering the drain and gate leads to the input and output coils, take care not to pull on them too strongly.

Any type of coaxial connector may be used at the input and output, but for best noise performance it's important that the connector have good uhf characteristics. The losses of BNC connectors will degrade the noise figure. I used type SMA connectors. Type N or TNC connectors could also be used, but SMA types are much smaller and therefore more suitable.

Improper output matching will degrade noise figure. Since the output impedance of the GaAs fet is extremely high, I installed a simple parallel resonant circuit at the output (L2, C2, C3), and matched to the 50-ohm output with the capacitive portion of the network. Both the input and output circuits have relatively high Q, so stable operation is obtained over a narrow bandwidth.

**construction**

Basic construction of the low-noise 432-MHz preamplifier is shown in fig. 5. The enclosure is made from no. 18 to no. 22 (0.028-0.048 inch or 0.7-1.2mm thick) brass sheet. Do not omit the center shield — it's absolutely necessary to obtain stable operation.

![fig. 7. Preamp noise figure and power gain as a function of drain current. Note that lowest noise figure occurs at I_D = 10 mA.](image)

![fig. 8. Passband response of the low-noise 432-MHz preamp; gain is 3 dB down at approximately 414 and 456 MHz.](image)

Although no particular care is required when mounting the GaAs fet, the source leads should be separated and soldered directly to the holes in the shield plate. Also, when soldering the drain and gate leads to the input and output coils, take care not to pull on them too strongly.

Any type of coaxial connector may be used at the input and output, but for best noise performance it's important that the connector have good uhf characteristics. The losses of BNC connectors will degrade the noise figure. I used type SMA connectors. Type N or TNC connectors could also be used, but SMA types are much smaller and therefore more suitable for a miniature low-noise preamplifier such as this one.

**operation and test**

After construction is completed, inspect each part to make sure you haven't made any wiring errors. The components in the bias circuit should be checked and double checked. When you are satisfied that the circuit is correctly built, the bias and drain supply voltages should be applied to the GaAs fet in the following manner:

1. Voltage is initially applied to the gate circuit with a 3-volt battery (see fig. 4). This reverse biases the gate and prevents current flow in the drain circuit, which may reach the magnitude of $I_{DSS}$. There is no problem in allowing current flow up to $I_{DSS}$, but the intention here is to suppress any transient phenomenon due to this current (there are examples where $I_{DSS}$ reaches 100 mA).

2. Next apply the drain voltage, but make sure that the voltage between drain and source, $V_{DS}$,
does not exceed 3 volts. When the drain voltage approaches 2.7 volts, the drain current should be set to 10 mA by adjusting the 10k pot in the bias circuit.

With the completion of these two steps, amplifier bias is established. A recommended drain bias circuit is shown in fig. 6.

Note that when a reverse bias is applied to the gate and drain, and current flows with only a slight application of drain voltage, either the gate circuit is open or a breakdown has occurred in the GaAs fet.

After completing the bias adjustments, adjust the input tuned circuit to resonance with a grid dipper. Apply a weak signal in the 430-MHz band and tune C1, C3, and C4 for maximum gain. When the preamp is adjusted for maximum gain, the noise figure will deteriorate slightly, but not seriously.

**performance**

The performance of the GaAs fet preamplifier is shown in the graphs of figs. 7, 8, and 9. The plot of noise figure vs drain current (fig. 7) shows that lowest noise figure occurs at $I_D = 10 \text{ mA}$. The band-pass characteristic of the preamp is shown in fig. 8; when the preamplifier is peaked up to 432 MHz, gain is 3 dB down at approximately 414 and 456 MHz. In most applications no external bandpass filter should be required. Fig. 9 shows the vswr at the input and output of the preamplifier. The third-order IMD products are shown in fig. 10; 1 dB compression occurs at about 0 dBm — the third-order intercept point is at a very respectable $+20 \text{ dBm}$ ($100 \text{ mW}$).

When this preamplifier is adjusted for maximum gain, the measured noise figure is about 0.75 dB. If an automatic noise figure meter is available, the input and output circuits can be adjusted for best noise figure — my measurements indicate that a noise figure improvement of about 0.1 dB is possible.

When making noise-figure measurements, I use an AIL noise-figure meter with a solid-state noise source (fig. 11). Gaseous-discharge noise sources are also available for this frequency range, but they should never be used with fragile GaAs fet circuits which are susceptible to damage from surge transients.

**summary**

This GaAs fet preamplifier should bring you right up to the state-of-the-art in noise figure at 432 MHz. The NE24406 GaAs fets are available in the United States from California Eastern Laboratories* or one of their sales representatives.

I would like to express my deep appreciation to Aki Munezuka, JA1VDV, for providing me with detail information on 432-MHz EME and kindling the fire of uhf ssb, and to Carl Peterson, KE6JN, who gave me an opportunity to publish this article. I also wish to thank the Nippon Electric Company for the use of test equipment and devices necessary to design this preamplifier. Special thanks go to Haruo Yoneda, JA1ANG, for all his helpful suggestions.

*California Eastern Laboratories, Inc., One Edwards Court, Post Office Box 915, Burlingame, California 94010; telephone (415) 342-7744. The NE24406 is priced at $190.00 in small quantities. After this article was written, NEC announced the basic GaAs fet in a smaller package at a lower price; this device is designated the NE24483 and is priced at $120.00.

**references**

The need may arise for the serious CW operator to take a battery operated electronic keyer on a mobile trip or to environments where a heavy fixed station dual-lever paddle simply has to stay home. I have improvised several keying devices in the past which provide comfortable keying of the mobile or portable rig under the varied conditions typical of such excursions. These devices were, however, all of the single lever variety that either had to be wedged, clamped, or clipped on to something, and moreover, had an extra lead going to the keyer — a nuisance at the best of times.

The keying paddle described here is essentially a dual-lever device which has proved to be so versatile that most of the problems typical of portable or mobile operation could be surmounted. As a matter of fact since inventing this Ambidextrous Paddle for Electronic Keyers, which I call APEK, the heavy dual-lever paddle at the fixed station has hardly been used at all.

The APEK is basically a three-contact jack plug with a few bits and pieces added, the total cost of which is hardly worth mentioning. Should a particular keyer, however, not be fitted with a jack type paddle socket, such a socket will have to be mounted on the front panel in a convenient position and connected in parallel with the existing socket. Since the

By Vidi la Grange, ZS6AL, 3 Elgar Street, Vanderbijlpark, 1900 Republic of South Africa
APEK plugs directly into the keyer, it can be rotated to have the dot lever at the right or left — a real ambidexter! As a matter of fact, it can be rotated into any convenient angle depending on the orientation of the keyer, which, during mobile or portable work can be just about anything imaginable.

The keyer shown in the photograph was built into a box which fits snugly into the car’s door box. The APEK sticks out vertically so you can reach it without effort. Another attractive feature is the fact that the APEK is compatible with dual-lever keying devices. Squeeze keying features, if provided, don’t have to be sacrificed when using the APEK, a feature impossible to achieve with single-lever keying devices.

construction

Obtain a standard three-connector jack plug and remove the shell. Cut off the ground connection close to the jack body. Drill and countersink two opposing holes in the plug shell about 8 mm (5/6 inch) from the unthreaded end. The holes should be suited to take two 2.3 mm by 4 mm (3/56 x 5/32 inch) countersink machine screws.

Take two small solder lugs and connect about 60 mm (2-1/4 inch) of thin flexible hook-up wire to each. Fit one of these lugs to each screw on the inside of the shell and secure with a nut. Find a suitable flat washer which will fit over the threaded part of the jack body and having an outside diameter slightly larger than that of the shell.

Prepare two strips of spring brass approximately 0.5 mm (1/64 inch) thick, 5 mm (3/16 inch) wide and 40 mm (1-1/2 inches) long. De-burr the edges and bend them into the shape shown in fig. 1. Solder these strips to the rim of the flat washer in opposing positions. This step can be simplified by temporarily assembling the plug. Mark off, on the underside of each strip, the positions of the screw heads fitted to the shell.

Disassemble the plug, clean and tin the positions marked off on the strips. Form a small blob of solder at these points and file them lightly to give a flat contact surface. Solder the two pieces of hookup wire, already connected to the screws on the shell, to the inner and outer lugs of the jack. Leave these wires long enough to survive the twist they will get when putting the jack together.

Shape two pieces of old PC board according to taste or as shown in fig. 1 to form the paddle handles. Fix them to the brass strips with a small amount of epoxy. Finally, one or two wraps of electrical tape cut to the correct width should be wound onto the jack shell. This will provide the necessary damping of the otherwise too springy brass strips.

final adjustment

Contact spacing and spring tension can be adjusted by means of long nosed pliers. If you find that the spring tension is too high, a small hole drilled through the spring at the position indicated should do the trick. Then determine by experiment which side of the APEK activates dots or dashes and mark it for your convenience.

I call it a "Plumber’s Trap" vertical.
**spectrum analyzer tracking generator**

What is a tracking generator? When used with a spectrum analyzer it generates a CW signal corresponding to the frequency at which the spectrum analyzer is tuned. It's useful for looking at filter response. Filter blowby and undesired responses can be readily observed.

The generator described here was built for use with the spectrum analyzer described in reference 1. A tracking generator identical to this one is now being used with a Hewlett-Packard 8554/141. The tracking generator can be used with almost any spectrum analyzer that provides first-local oscillator output and has a first i-f of 200 ± 20 MHz.

Because of the tracking generator's oscillator instability, narrow-bandwidth measurements can't be made, such as the bandpass response of crystal filters. Nevertheless, it's useful for measuring responses at other frequencies (parasitic resonances) often found in crystal filters.

**circuit description**

The schematic is shown in fig. 2. Q1 and Q2 provide some gain and isolation between the 200-MHz oscillator, Q3, and the first i-f amplifier of the spectrum analyzer. R1 provides fine tuning and should be located for easy access by the operator. MX1 mixes the 200-MHz output with the signal from the first local oscillator to provide the 100-KHz to 100-MHz tracking signal. An optional 130-MHz lowpass filter is shown. The lowpass filter attenuates the 400-500 MHz component generated by the mixer in the tracking generator.

The tracking generator is built in a box made from 1/16-inch thick (1.5mm) copper-clad board. The same board is used as separators between stages. Paper-thin copper, available from hobby shops, is wrapped over the surface where the cover for the 200-MHz oscillator attaches. The other stages do not have shield covers. A blank compartment is available for the optional 130-MHz lowpass filter. Fig. 1 shows the layout.

The oscillator is built on a separate piece of copper-clad board, 7/8 x 1-1/2 inch (22x38mm) and

---

By Wayne Ryder, W6URH, 115 Hedge Road, Menlo Park, California 94025
is held in place with double sticky-back tape. Two ferrite beads are strung on the ground wire that connects the oscillator ground to the compartment ground to minimize ground-loop currents, which can cause radiation from the oscillator. The mixer can be a standard mixer or the home-made mixer described in reference 1.

Dimensions shown inside are inside dimensions. The assembly is 1 inch (25.5mm) high. The 1/4 inch (6.5mm) overhang at each end is for mounting.

operation

The spectrum analyzer vfo output is connected to the tracking generator input of the spectrum analyzer.

1. Set spectrum-analyzer bandwidth to 250 or 300 kHz and scan width to 100 MHz.
2. Set R1 to the center of its range.
3. Adjust C1 so that the baseline on the spectrum analyzer shifts up.
4. Move L2 away from L1 until the baseline starts to move down.
5. Install the shield on the 200-MHz oscillator and adjust R1 so that the baseline is as high as possible, consistent with a flat response. As the tracking generator is being used, the 200-MHz oscillator will drift, and some readjustment of R1 will be required.

design considerations

One of the more challenging problems here is preventing the 200-MHz oscillator from radiating into the first i-f. If this happens, the baseline on the spectrum analyzer will shift up without a signal input. The signal from the oscillator will leak through MX1 backward through buffers in the tracking genera-

---

fig. 2. Schematic of the spectrum-analyzer tracking generator using Motorola devices.
fig. 3. Suggestion for a tracking generator for measuring narrowband signals. Oscillators within the spectrum analyzer are used. A highly stable signal is provided.

tor, backward through any buffer in the vco and will follow the path of the vco to the first mixer in the spectrum analyzer and leak through the first mixer into the first i-f. This is not surprising, since the output from the oscillator is about 0.5 volt and the spectrum analyzer sensitivity is only a few microvolts. Also, the 200-MHz oscillator can radiate directly into the spectrum analyzer if both are not carefully shielded.

The tracking generator described here was mounted on the outside back of the spectrum analyzer to minimize coupling. If your spectrum analyzer has a phase-locked vco, or if the vco is stabilized in some other way, you might consider a different form of tracking generator for measuring narrow bandwidth. This method uses the local oscillators within the spectrum analyzer and provides a more stable tracking-generator signal. The block diagram (fig. 3) assumes that the last i-f is 10.7 MHz.

reference

**zip-cord feedlines**

Many years ago I watched as someone set up a rig in the desert. The power plant was set out, the rig was set up, and the antenna was strung out between two convenient cactus plants (cactus attain a respectable height here). The thing that caught my eye was the feedline. It consisted of a long length of garden variety zip cord. My funny look at it gained a quick assurance that lamp cord was a perfectly good feedline.

Everything seemed to work just fine and the operators had no trouble working out on the band of the day, which was 75-meter phone. In those days it was common to run 100 to 200 watts input with high level a-m.

After a recent move I decided to put up a 75-meter antenna at home and use the most economical feedline. In the process of getting on the air, intermediate forms of antennas were used. That means some wire of about the resonant length was thrown up on the roof, and the near end was run into the rig. It was somewhat of a disappointment to discover that the intermediate antenna worked better than the well elevated final installation. A little checking showed that when the feedline itself was loaded up, it worked better than the antenna it was supposed to be feeding. In short, it appeared that something was not quite right.

A little further investigation revealed some rather interesting facts. RG-8/U, RG-58/U, and lamp cord were tested at 4 and 21 MHz. The rig was tuned up into a terminating type of wattmeter and the feedline under test was inserted between the rig and the meter. Power out with 60 cm (24 inches) of feedline vs power out with 9 to 18 meters (30 to 60 feet) of feedline was measured and the results were tabulated.

RG-58/U coax showed a 58 per cent loss at 21 MHz; it showed almost no attenuation at 4 MHz. RG-8/U gave about 12 per cent loss at 21 MHz.

Zip cord looked like it was best suited for use on the other end of a lamp or soldering iron. If you really want to know, it showed about a 60 per cent loss at 4 MHz. There was no need to measure it at 21 MHz!

About 20 meters (65 feet) of coax was used in the tests, and only 9 meters (30 feet) of zip cord (the rest of the zip cord was still attached to the antenna). Obviously, more lamp cord would have shown more loss. These tests were not conducted under laboratory conditions, but the variables were held to a reasonable level so that it was possible to reach a reasonable conclusion.

In any case, the zip cord came down and the RG-58/U went up. A crosstown telephone call got K70XS on the air, again. Bill indicated that my 3-5 watt rig was back up to its normal signal strength at his location. He was almost as glad as I was that my antenna problems were finally resolved.

Evert Fruitman, W7RXV
We'll give it to you straight! The HW-2036 was a great 2-meter transceiver — but our new HW-2036A is just that much better.

It boasts the same impressive specifications, but now gives you a full 4 MHz of coverage over any portion of its 143.5 to 148.5 MHz operating range. But most startling of all is the price tag. At $269.95* in easy-to-build kit form, the HW-2036A is the lowest priced, synthesized 2-meter transceiver you'll find anywhere!

At Heath we're holding down the soaring cost of Amateur Radio. Look over our entire line of quality kit products. Then join the thousands of Radio Amateurs who've taken the sensible alternative — and built Heath!

**Heath Amateur Radio Gear...**

...the quality that measures up!

Send for your FREE Heathkit Catalog today!

Or you may obtain a catalog by bringing this coupon to one of the 50 Heathkit Electronic Centers coast-to-coast (units of Schlumberger Products Corp.) Where Heathkit products are displayed, sold, and serviced. Retail prices on some products may be slightly higher. See the white pages of your telephone directory.

Heath Company, Dept. 122-400, Benton Harbor, MI 49022

---

*Price is mail order. F.O.B. Benton Harbor, MI. Prices and specifications subject to change without notice.

**AM-366**
The use of portable battery-operated equipment requires fully charged batteries to obtain maximum usefulness of the equipment. For handheld transceivers, keeping the batteries fully charged would normally require frequent overnight charging. If the handheld is operated in a mobile environment it must be removed often from the car to the battery charger. However, it’s possible to charge the equipment’s batteries while in use, thus always assuring a full charge and maximum lifetime from the batteries between charges.
defined and limited, this simple circuit will not charge a nicad battery with a constant current all the time.

If a large value of V1 is available, the circuit in fig. 1B works well. Since V1 is much larger than V2, the battery potential, the change in V2 versus charge time has little effect on the charging current. A lamp is used to decrease the voltage to the nicad at a specified current. This circuit is representative of many chargers on the market today. Its disadvantage is that the charging current is not exact and V1 must be much greater than V2, which is not the case in an automobile system.

Fig. 2 shows an excellent method of obtaining a constant-current from a common three-terminal voltage regulator. The three-terminal voltage regulator would normally have its common terminal grounded and would deliver a constant voltage between the output and common terminal. However, if the common line is not grounded, but left floating, and a fixed resistance is connected from the output to the common terminal, the regulator will try to furnish a fixed voltage across the resistance. The current through the resistor is given by Ohm's law:

\[ I_{OUT} = \frac{V}{R} \]

where \( I_{OUT} \) is current through resistor R; \( V \) is the voltage regulated by the device.

Once the circuit is completed between the three-terminal regulator's common and power return (ground connection), current will flow through this connection, even if a resistance or voltage exists in the path to ground. The only requirement is that the input voltage must be equal to or greater than the full charge battery potential plus 5 volts (for a 5-volt regulator) plus 2 volts (overhead voltage). Thus, for a 13-volt full-charge nicad potential and a 5-volt-type voltage regulator, the input voltage to the current regulator circuit must be greater than 20 volts.

In the circuit shown, a transformer and rectifier were used to provide 30 volts dc. A 50 mA, 6-volt lamp was used in series with the regulator to indicate when the 50 mA charge current was flowing; it also dropped the power-supply voltage to 24 volts dc.

The use of three-terminal regulators is an excellent technique for defining a constant current level. The current level is easily adjusted by changing resistor \( R1 \) in the output circuit. The current is essentially constant regardless of the discharge state of the nicad battery.

**Voltage-doubler circuit**

To use a constant-current source as described it's necessary to provide an input source voltage of at least 20 volts. In an automobile situation, a 20-volt source is not available, so the circuit of fig. 3 was designed. This circuit uses a NE-555 universal timer IC and two power transistors in a voltage doubling circuit. The output voltage is roughly twice the input voltage, minus any diode voltage drops. Thus, a 10-volt source will be converted to 19 volts and a 13-volt source to 25 volts. This doubled voltage is then used to drive a source current into a three-terminal current regulator.

The operation of the voltage doubler is as follows, referring to fig. 3.

The NE-555 is used in the common astable multivibrator configuration. The oscillation frequency is determined by \( R1 \), \( R2 \), and \( C1 \) and is equal to

\[ F = \frac{1.44}{(R1 + 2R2)C1} \]

To have a near 50 per cent duty cycle the ratio of \( R1 \) to \( R2 \) should be around 1 to 4 as shown.

The 555 astable oscillator drives a pair of complementary transistors. High-current power transistors were used to switch the large charge and discharge currents. Transistor Q1 charges capacitor C2 to the input voltage during the first part of the astable cycle. During the second half of the cycle, transistor Q2 puts the fully charged capacitor C2 in series with the supply voltage. Typical values for C2 are

\[ C2 = \frac{I_{OUT}}{F} \]

where \( F \) was defined earlier and \( I_{OUT} \) is the constant
output current required. A diode and capacitor (C3) filter the pulsating dc to a value nearly equal to two times the supply voltage. The value of C3 should equal C2.

Transistors Q1 and Q2 are plastic-cased power transistors. Power transistors are used because of the high peak currents during the charge and discharge cycle of C2. Although MJE 2955 and MJE 3055 types are shown, most common power transistors will work. The transistors are not heat sinked because both are operated in the saturated mode, thus power dissipation is held to a minimum. The diodes are 1-amp silicon types and may also be substituted with similar devices.

The current regulator operates as the one previously described. It may be attached to a heat sink, but is not mandatory. If the regulator's input terminal voltage is 25 volts, and the output terminal is at 17 volts, only 400 mW of heat must be dissipated in the worst case. The oscillation frequency of the voltage-doubling circuit can be increased, but transistor switching becomes less efficient with the increased switching speed. A too-low frequency requires larger values of capacitance for C2 and C3. A good compromise is to make the frequency between 1 and 10 kHz.

In the circuit shown the switching frequency was set to 1.4 kHz. Since ten 500 mA-hr nicads were being charged, the charging current (I\text{OUT}) was set to 50 mA. For an input voltage range of 10-15 volts, the charging current was a constant 50 mA.

**practical approach**

To make these charging schemes work in a mobile charging system, charging current may be delivered to the portable unit through the antenna coaxial cable. This approach makes it easy to connect the handheld or other equipment to the charging source as well as to the antenna.

It's quite common to use small power amplifiers in a mobile system. This creates a convenient location for the current source circuits. Fig. 4 shows a typical mobile setup. The current source is located inside the amplifier housing. A small rf choke isolates the incoming and outgoing rf energy from the current-source circuits. A small capacitor in series with the

![fig. 4. Use of the constant-current charging source requires only the connection of the antenna lead to the radio in a mobile or base station. The current source may be located inside your power amplifier or within an ac-operated charger. For 2 meters, the rf choke, RFC, is ten turns no. 26 AWG (0.3mm) copper wire on a 1-megohm 1/2-watt composition resistor.](image)

advantages

By charging the nicads through the coax line, the batteries can be maintained at full charge at all times. By using the a-c operated charger and the automobile charger system, the nicads can be charged at any location. The current source could be switched to a lower trickle charge if desired. A 3-position switch could be used for this purpose and for turning off the regulator.

**ham radio**
ALDA 103, the trim little powerhouse with incredible performance for the price! ALDA 103 provides a full 250 watts PEP input for SSB operation, and 250 watts DC input for CW. And when it comes to performance, ALDA 103 is the hottest little transceiver going — all solid state, totally broadbanded and super-stable VFO.

Ideal first transceiver for brand new novices! You'll want a full-capability CW/USB/LSB unit with all the power and performance you can use. ALDA 103 gives you 250 watts DC input for CW, the maximum allowable power for your novice license. When you upgrade to technician, you've got 2 bands for CW operation. And with your general license, just plug in your mic and use the ALDA 103's full 250 watts PEP on SSB! Perfect second or mobile unit for seasoned hams! If you're looking for a super-sharp, compact unit to use in your car or boat, ALDA 103 will live up to your expectations. Absolute worst case sensitivity 0.5 µV for 10 dB S+N/N — a must for mobile operation. Receiver audio output of 3 watts minimum — another must. Also, very low receiver power drain of only 5.5 watts — that's 0.4 amps at nominal 13.8 VDC including power for dial and meter lamps!

GENERAL SPECIFICATIONS
Semiconductors: 39 diodes, 23 transistors, 11 integrated circuits
Power Requirements: Nominal 13.8 VDC input at 15 amps, negative ground only
Power Consumption: Receive — 5.5 watts (includes dial and meter lamps); Transmit — 260 watts
Dimensions: 3-1/4" high x 9" wide x 12-1/2" deep (82.55 mm x 228.6 mm x 317.5 mm)
Weight: 8-1/4 lbs. (3.66 kg)

PERFORMANCE SPECIFICATIONS
Frequency Range: 80 meter band — 3.5 to 4.0 MHz
40 meter band — 7.0 to 7.3 MHz
20 meter band — 14.0 to 14.5 MHz
Modes: CW; USB; LSB
RF Input Power: SSB — 250 watts PEP nominal CW — 250 watts DC maximum (adjustable)
Transmitter:
Antenna Impedance: 50 ohm, unbalanced
Carrier Suppression: Better than — 45 dB
Side-Band Suppression: Better than — 55 dB at 1000 Hz
Distortion Products: Better than — 26 dB
AF Response: Nominal 500 to 2500 Hz
Sporous Harmonics: Better than — 45 dB below
Radiation: 30 MHz, better than — 60 dB above
Frequency Stability: Less than 100 Hz drift per hour (from a cold start at room temperature)
Microphone: High impedance 3000 ohm
Receiver:
Sensitivity: Better than 0.5 watts audio output for 0.5 µV input
Signal-to-Noise: Better than 10 dB S+N/N for
Ratio: 0.5 µV input
Image Ratio: Better than — 60 dB
(typical with respect to 0.5 µV input; 80 meters —
— 130 dB; 40 meters — 100 dB; 20 meters — 75 dB).
IF Rejection: Better than — 70 dB
(typical with respect to 0.5 µV input; 80 meters —
110 dB; 40 meters — 80 dB; 20 meters — 75 dB).
Intermodulation Intercept Point: Better than 10 dBm
Selectivity: 2.5 kHz — 6 dB, 5.0 kHz — 60 dB
Audio Output Power: More than 3 watts
Audio Distortion: Less than 5% at 3 watts

$495
including microphone and mobile mount, too.

OPTIONS & ACCESSORIES
Noise Blanker —
Model No. PC 701 ......... $29.95
100 kHz and 25 kHz Dual Crystal Calibrator —
Model No. PC 801 .......... $14.95
Portable Power Supply — Model No. ALDA PS 115: average duty
15 amp unregulated; input —
115/230 VAC, 50/60 Hz; output —
13.8 V nominal at 15 amps .... $79.95
Heavy Duty Power Supply — Model No. ALDA PS 130: output —
regulated 30 amp at 13.8 VDC; input —
115/230 VAC, 50/60 Hz ...... $149.95

ALDA 103 is completely manufactured in the USA.

Aldea communications, inc.  215 Via El Centro  Oceanside, CA 92054  (714) 433-6123
how to modify linear amplifiers for full break-in operation

With the introduction of the Ten-Tec Triton IV, which provides full break-in operation on CW, I needed a companion linear amplifier which also had this very desirable operating feature. At the present time, however, there is only one commercially produced amplifier on the market which meets this requirement — and it’s priced at almost $3000. The purpose of this article is to outline the theory and give some typical circuits which can be used to modify any power amplifier to provide full break-in capability. The circuitry is for use with grounded-grid triode linear amplifiers; class B or AB is assumed.

While class C might seem to be a better choice for a CW power amplifier, there are several reasons to maintain linear operation. First, and most important, since class C operation is not linear, the CW waveform supplied by the exciter will be distorted and the resulting output wave may produce serious key clicks and other unwanted spurious signals.

For the modification described here the grid of the amplifier tube must be at chassis ground, with a positive voltage applied as cutoff bias to the cathode. The classical biasing scheme, with the cathode at ground, fig. 1A, is rearranged to place the grid at both rf and dc ground, fig. 1B. The operating or cutoff bias is in the form of a positive voltage which is applied to the cathode; the high-voltage B+ plate supply is above ground by this potential.

When the amplifier is used for break-in operation, it is essential that the tube be biased to cutoff — with no plate current flowing — so the tube doesn’t generate noise which would mask weak received signals.

cutoff bias

Of the several types of tubes commonly used for linear amplifier service, there are two basic types: those with hot cathodes and those with indirectly heated cathodes (see fig. 2). For the purposes of this discussion the main difference is that the bias on a hot cathode is applied through the center tap of the filament transformer (fig. 2A); bias for indirectly heated tubes is fed directly to the cathode through an rf choke (fig. 2B).

Figs. 3 and 4 show two common ways to bias rf power amplifiers to cutoff. The circuit in fig. 3 (from the ARRL Handbook), uses a 10k resistor in series with the cathode circuit to develop self bias. It is the least acceptable method, however, because it requires a certain amount of plate current flow to provide the bias. Therefore, the tube is not completely cut off.

Another cutoff bias circuit is shown in fig. 4. It uses a +150 volt bias supply which cuts off all plate current and powers the T/R relay, K1. Actually, for B+ supplies up to about 3500 volts, 75 volts of bias is enough to cut off a pair of 3-B00Zs — 75-volt relays, however, are hard to find.

Fig. 5 shows a circuit which uses an rf-sensing transistor switch to remove the cutoff bias from the amplifier. Under standby conditions Q2 is an open circuit and 50 volts cutoff bias is applied to the cathode. When the drive signal is applied, Q2 turns on.

By Dick Frey, K4XU, Chief Engineer, Ten-Tec, Inc., Sevierville, Tennessee 37862
and the operating bias becomes the sum of the zener voltage, $V_z$, Q2's collector-emitter saturation voltage, $V_{CE(SAT)}$, and the voltage drop across the grid meter shunt, $R_g$. $V_{CE(SAT)}$ for the specified 2N5321 resistor is 0.8 volt at 500 mA.

When selecting Q2, two criteria must be met: a low $V_{CE(SAT)}$ because this adds to the operating bias, and a maximum collector-voltage rating that is greater than the applied voltage bias voltage. The Darlington configuration is used because transistors which meet the two voltage requirements seldom have the necessary current gain for this circuit. The power requirement for Q2 is quite low because the voltage impressed across it is low when it carries the grid current. A power dissipation rating of 10 watts is more than adequate. The resistance of the grid meter shunt resistor, $R_g$, should be as low as possible; usually 0.5 ohm is sufficient with a grid current meter which has a 1 mA movement.

The basic bias circuit of fig. 5, modified to accommodate the directly heated cathodes of two 3-500Zs, has been used successfully in a Heath SB-220. Note that the zener diode no longer has to pass the full plate current so it is permissible to use a less expensive 20-watt zener diode. An added feature of this circuit is that if any of the devices which supply operating bias fail open, cutoff bias will be applied to the tube — this prevents any damage that might otherwise occur.

The 1N4004 diode shown in the negative high-voltage line is a clamp which prevents the B+ from going negative with respect to the chassis in case of bias supply failure.

When the linear amplifier is in the standby condition virtually no current is drawn from the bias supply. When Q2 turns on, resistor R1 limits the current flow. This current will show as grid current, so it's a good idea to keep R1 as large as possible. When testing this circuit I found it was useful to provide a means for turning on Q2 without applying rf drive power; S1 is a test button which does this.

In normal operation, the linear appears to be running class C because plate current is drawn only when an rf drive signal is present. The amplifier is not operating class C, of course, but since quiescent plate current is no longer being drawn under no-signal conditions, the average power dissipated by the tube due to quiescent bias (200 to 600 watts in a typical class AB amplifier) is greatly reduced; this increases tube life, improves reliability, and results in a cooler ham shack.

**receiver switching**

When the power amplifier can be operated without using relays to switch the bias, one step remains: receiver antenna switching. Electronic T/R switches have been available for years, but have never been widely accepted because, when the transmitter is tuned to resonance, the tank circuit acts as a “suck out” filter which reduces received signal strength. The electronic T/R switch was not the culprit — its placement in the system caused the problem. The solution is to place the electronic T/R switch at a high impedance point in the system. If you want to eliminate noisy relays which are slow and prone to failure and go to full break-in operation, the antenna

![](image.png)

fig. 3. Typical linear amplifier bias and control using self bias developed across the 10k resistor in the B-line. Relay K1 is shown in the operating position with the amplifier on.

![fig. 2. Grounded-grid biasing arrangements for hot cathode tubes, A, and indirectly-heated cathodes, B. Typical hot-cathode tubes are the 3-500Z, 3-1000Z, and 3CX1000; the 8877 and 8874 series of power amplifier tubes have indirectly-heated cathodes.](image.png)
must be connected to the transmitter at all times. Thus, to find a high impedance point to connect an electronic T/R switch, the plate tank of the amplifier is a good choice.

Coupling to the plate tank is not without its problems, however. First of all, it's dangerous because of the high voltage that is present. Secondly, since there is a large amount of rf voltage present, the coupling capacitor C1 (fig. 6), must be small both to reduce its effect on the amplifier tuning and to assure that the T/R switch is not overdriven. This presents a problem because the optimum value of C1 for receiving purposes, about 5 pF, is too much capacitance when used at the kilowatt level on transmit. Therefore, a compromise is made on the side of safety and reliability.

The capacitor specified is made from RG-8/U coaxial cable with the center conductor overlapping the braid for approximately 12 mm (1/2 inch). Two 25 mm (1 inch) square tabs, spaced 1 cm (3/8 inch), will also work if the mechanical layout of the amplifier will permit placement of this arrangement. Be sure that this capacitor is placed directly across the plate tuning capacitor after the plate blocking capacitor. This compromise results in a slight loss of gain on receive, but most transceivers have more than enough front-end gain to make up for the loss.

**Construction**

Since most modern kilowatt linears use some sort of input tuning, the placement of S1 in fig. 6 is not too difficult. The switch wafer can usually be added to an existing switch shaft, or the shaft can be extended to provide room for the wafer. When pur-

---

**fig. 4.** Linear bias and control using an external bias supply; this method provides better operation than the arrangement of fig. 3. Relay K1 is shown in the operating position with the amplifier biased to cutoff.

**fig. 5.** Cutoff bias circuit for a linear amplifier which uses an rf sensing transistor switch. The zener voltage, $V_z$, provides the proper operating bias and was part of the original amplifier circuit. Cutoff bias circuit operation is described in the text.
chasing the wafer switch for \( S_1 \), be sure to note whether the amplifier uses 30, 45, or 60 degree indexing between switch positions.

The location of \( Q_1 \) and its associated circuitry is not too critical except that it must be reasonably close to both \( C_1 \) and \( S_1 \) to minimize losses. It should be shielded if it is located inside the plate tank enclosure and all dc leads must be shielded. Since the dc current drawn is very small, the +18 volts can be obtained with a voltage doubler from the amplifier filament supply, or from a zener regulated drop from the positive bias supply. The switched coils form broadly resonant tuned circuits with the existing circuit capacitance, so some adjustment of the given values may be necessary.

**Triton IV modifications**

There are also modifications to the Triton IV which will improve performance when using a linear amplifier. First is a simple change to eliminate the delay of the control relay while using ssb. As built at the factory, the time constant capacitor, \( C_3 \) in fig. 7 and page 3.34 of the manual, is tied directly to ground on the circuit board. By lifting the ground end of \( C_3 \) and taking it to the unused center pin on the board, a wire can be run to the mode switch, \( S_{1E} \) (CW1 and CW2 positions), which will activate the delay only when using CW. \( S_{1E} \) is part of the rear wafer, closest to the chassis.

The second modification involves removal of the control relay, \( K_1 \). This should be done only if the amplifier uses a positive voltage to key its control and changeover relay. The reason for doing this is to eliminate the turn-on delay which is caused by using one relay to activate another. Relay \( K_1 \) has no function in the operation of the Triton by itself. When the key is closed, it takes about 25 milliseconds for this relay to close, and perhaps another 23 ms for the amplifier relay to pick up, before the output of the Triton is amplified. This causes key clicks on the first dot. The transistor used for \( Q_4 \) depends on the voltage used on the amplifier control relay and the relay current. With \( K_1 \) removed, there is plenty of room for the added components on the board.

Some Triton users have complained of an ac hum in the receiver when using a linear amplifier — especially in the narrow CW-1 position. This is caused by ac ripple (or raw ac) on the relay control line. When attached to the Triton T/R relay’s normally-open jack, unshielded wires going to \( K_1 \) pass underneath the CW filter which picks up the hum. The solution is simple: reroute the wiring between \( K_1 \) and T/R normally-open jacks on top of the chassis. This change has been incorporated in late production Tritons.

**Conclusion**

What has been presented here are notes and basic technical information needed to modify an existing rf power amplifier for full break-in operation with a Triton IV; the circuits can also be adapted to other transceivers. Ten-Tec in no way assumes responsibility for the use or misuse of this information, nor for any damage to other manufacturer's equipment resulting from implementation of these circuits.

---

**Fig. 6.** Electronic T/R switch for the receive antenna. The station antenna is connected to the linear at all times. Capacitor \( C_1 \) is less than 1 pF and consists of 12 mm (1/2 inch) of RG-8/U coaxial cable (see text).

**Fig. 7.** Modification of the Triton IV to remove the control relay and to eliminate unwanted delay times during CW break-in operation.
Model 1346  Drake UV-3 (144-220-440)  ...... $795.00
Model 1344  Drake UV-3 (144-440)  ........ $695.00
Model 1343  Drake UV-3 (144-220)  ........ $695.00
Model 1345  Drake UV-3 (220-440)  ........ $695.00
Model 1340  Drake UV-3 (144)  ............. $595.00
Model 1359  Drake UV-3E (144-430)*

(Optional Drake 1525EM Encoding Mike)

Model 1504  Drake PS-3 AC Power Supply  .... $89.95
Model 1525  Drake 1525EM Encoding Mike  .... $49.95
Model 1330  UMK-3 Remote Trunk-Mount Kit  ... $69.95

NOTE: Certain of the above models will be available before others. Check with your dealer for specific availability.

Add-on modules expand band coverage of models which may have been purchased in a single band or two band configuration. Prices include factory installation which is necessary to meet FCC receiver certification requirements.

* This model tuned for European fm bands. See your dealer for price details.

Designed and manufactured in the U.S.A.
synthesized fm system

For the serious amateur who...
- considers fm a vital part of a total communication system
- needs multi-band coverage in a single transceiver
- needs to continuously scan-monitor a priority amateur repeater dedicated to public service, weather, or DX alerts
- needs extra programmed channels for quick selection, in addition to the synthesizer...

The Drake UV-3 provides it all!

- Continuous priority channel scan
- Remote trunk operation (optional)
- Four extra diode-programmed channels on each band
- All three bands in a single bandswitched unit, or start with basic models and add extra band-modules later
- Non-standard offsets available for each band

The Extra Diode-Programmed Channels
You can diode-program up to four fixed channels, with their offsets, for each band. This feature allows super-quick selection of favorite channels. The five-kHz synthesizer operates independently of these programmed channels. And best of all, soldering is not necessary for programming. The program board has special sockets mounted on it for direct insertion of diodes. We even provide the diodes.

Remote Trunk Mount Kit
The control panel of every UV-3 removes for installation in the UMK-3 Remote Kit. This provides for safety, as well as easy installation in small cars where under-dash space is limited.

Write for a fully illustrated brochure on the Drake UV-3 System.

R. L. DRAKE COMPANY
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
how to design matching networks

Six basic impedance matching networks and how to design them for your own applications

Common L, T, and pi networks work well for impedance matching but they lack the selectivity required for amplifiers or frequency-multiplier chains. Adding a component to the network and rearranging allows it to be selective on both sides of band center. Presented here are six simple matching circuits and their design equations that allow adjustment of design Q for selectivity and different source or load impedances.

Fig. 1 shows the basic network with its source and load interfaces. The assumption is that $R_s$ is less than $R_o$. Simply reverse the input, output, and the network if $R_o$ is less than $R_s$. Both source and load are assumed to have shunt capacitances; this is usually true and will include stray capacitance as well.

The value of $Q$ is the design $Q$ of the network and determines selectivity. It is not component $Q$ which should be at least five times design $Q$. Selectivity around band center is treated the same as a tuned circuit with a certain $Q$. Each of the six networks has different attenuation far from center; examples of this are shown later.

The constants listed in fig. 1 reduce the size (and complexity) of the network equations, and will be used with all six networks. It must be emphasized that all capacitive reactances must calculate negative, inductive reactances positive. Any exception to this rule with a network indicates that particular network cannot be used.

\[ X_s = \frac{-1}{2\pi fC} \]
\[ X_o = \frac{-1}{2\pi fC_o} \]
\[ F = \text{CENTER FREQUENCY} \]
\[ N = \frac{R_s X_s}{R_s X_s + X_o X_o} \]
\[ R_o = X_o N \]
\[ Q = R_s + X_s N \]
\[ Q_o = R_o + X_o Q \]

fig. 1. The basic matching network. Constants shown here will be used in calculating the values for the six different networks discussed in this article.

**Different sources and loads**

Fig. 1 shows a parallel capacitive reactance across the input and output terminals. Sometimes the end impedances are given (or measured) in series form. This may be converted to parallel form either by impedance-to-admittance plus inversion of resulting conductance and susceptance. Any of the calculators with rectangular/polar conversion can handle this easily. The following conversion formula can be

By Leonard H. Anderson, 10048 Lanark Street, Sun Valley, California 91352
used if those functions are not available on your calculator:

\[
R_p = R_s + (X_s^2/R_p) \\
X_p = X_s + (R_s^2/X_p)
\]

where

- \( R_s \) = Series resistance
- \( X_s \) = Series reactance
- \( R_p \) = Parallel resistance
- \( X_p \) = Parallel reactance

Note that the sign of the reactance is preserved in conversion.

An inductive reactance is a special problem. Compensation of this is done by capacitive shunting so that the total reactance at the band center becomes capacitive. Some of the networks will have shunt inductors at the ends. This condition allows the physical inductor to be the parallel difference with stray capacitance (always present) forming \( C_i \) or \( C_o \). If the end reactance changes rapidly around the band center, it is better to add a physical capacitor and use calculated inductance directly. In any case, end reactances must be capacitive.

**handling data from the spec sheet**

Transistor data is invariably given in admittance or S-parameters. Admittance is already in parallel form so the conductance and susceptance values are taken directly and inverted to yield end resistance and \( X_i \) or \( X_o \) (watch the sign of susceptance, it is positive when capacitive).

S-parameters are a bit different and are found on Smith chart representations. These are normalized to 50 ohms or 0.02 mho and can be taken directly, then un-normalized. \( S_{11} \) is the input impedance while \( S_{22} \) is the output impedance; both are complex numbers. Knowledge of Smith chart interpretation is required

Data in admittance or S-parameter form is invariably frequency sensitive. They also represent the average data of a production run so individual devices can vary. Under such conditions it is well to keep the design \( Q \) relatively low. There may be an advantage to swamping the end with a parallel resistance (small carbon composition resistor) to reduce sensitivity of values. This has two cautions: power loss and about 2 pF extra capacitance with each resistor.

**examples**

Numerical examples all assume matching a 50-ohm line to the input of a Motorola MC1590 amplifier IC (single-ended) at 7.15 MHz with a design \( Q \) of 20. Stray capacitance of 3 pF is assumed at each end; the MC1590 is insensitive with a parallel, single-ended impedance of 5k and 5 pF. The line is assumed perfect. **Fig. 1** constants are then:

- \( R_i = 50 \)  \( R_o = 5000 \)
- \( C_i = 3 \text{ pF} \)  \( C_o = 8 \text{ pF} \)
- \( X_i = -7419.81 \)  \( X_o = -2782.43 \)
- \( N = -6.73841 \times 10^{-3} \)  \( R_x = 49.9977 \)
- \( Q_i = -148346 \)  \( Q_o = -50648.6 \)

\( t_i = R_s - R_o \) (see text if negative)  \( r_o = \sqrt{r_s t_i} \)

\[
x_i = r_s - Q \cdot N \\
x_o = \left( \frac{r_s}{r_o} \right) - Q \cdot N
\]

**fig. 2. Networks 1 and 2.**

**fig. 3. Networks 3 and 4.**
An HP-25 calculator was used for these and following calculations.

**networks 1 and 2**

These are shown in fig. 2. Variable \( T_1 \) is a test value and is also used for Networks 3 and 4. If \( T_1 \) results in a negative, none of the first four networks can be used with the given constants. Design \( Q \) and/or end resistances can be changed to make it positive. The negative situation only comes about with low \( R_c/R_t \) ratios.

For the first four, \( T_1 = 4950 \) so \( R_4 = 497.483 \). Values of Network 1 are then:

\[
X_c = -502.135, \quad C_c = 44.33 \ \text{pF}
\]
\[
X_d = -613.263, \quad C_d = 36.30 \ \text{pF}
\]
\[
X_e = 999.555, \quad L_e = 22.26 \ \mu\text{H}
\]

Note that all reactance signs are correct. Values for Network 2 are:

\[
X_c = -497.146, \quad C_c = 44.77 \ \text{pF}
\]
\[
X_d = -605.847, \quad C_d = 36.74 \ \text{pF}
\]
\[
X_e = 250.000, \quad L_e = 5.565 \ \mu\text{H}
\]

Reactance signs are correct here, too.

**networks 3 and 4**

Test variable \( T_1 \) and \( R_4 \) apply here. Both inductors of both networks have two possible solutions. The reactance sign rule still applies so both \( X_e \) and \( X_f \) must be positive or both \( X_e \) or \( X_f \) must be positive. Do not mix \( X_e \) and \( X_f \) or vice-versa; use either all non-prime or all prime values. Network 3 will have:

\[
X_c = -1089.46, \quad C_c = 20.43 \ \text{pF}
\]
\[
X_d = 425.637, \quad L_e = 9.474 \ \mu\text{H}
\]
\[
X_f = 592.318, \quad L_f = 13.18 \ \mu\text{H}
\]

Non-prime values obey the rules as do Network 4 values:

\[
X_c = -274.782, \quad C_c = 81.01 \ \text{pF}
\]
\[
X_d = 497.819, \quad L_e = 11.08 \ \mu\text{H}
\]
\[
X_f = 497.853, \quad L_f = 11.08 \ \mu\text{H}
\]

The inductors in Network 4 came out very close to the same value. This happened with this particular example, but is not true of other conditions.

**network 5**

This one is shown in fig. 4. It must be noted that the two inductors have zero coupling and must be physically separate. The schematic may appear to be a conventional tapped-inductor circuit but such

would need a different set of equations plus measurement of mutual coupling. Networks 3 and 4 must also have separate inductors.

Test variable \( T_2 \) cannot be negative. If \( T_2 \) is negative design \( Q \) or end resistances, and possibly input capacitance, may have to be changed. Example conditions fit alright so we get:

\[
R_s = 22.0617 \ \times 10^9
\]
\[
T_2 = 827.815 \ \times 10^9
\]
\[
X_c = -274.782, \quad C_c = 81.01 \ \text{pF}
\]
\[
X_d = 227.822, \quad L_e = 5.071 \ \mu\text{H}
\]
\[
X_f = 28.7208, \quad L_f = 0.639 \ \mu\text{H}
\]

Non-prime inductor values were correct in this example. Note that \( C_c \) is the same as for Network 4.

**network 6**

Fig. 5 shows this to be the tuned circuit often found in receiver front ends. The test variable is \( T_3 \) and there is only one set of solutions. Our example condition results in:

\[
R_s = 2.57302 \ \times 10^9
\]
\[
T_3 = 89.9416 \ \times 10^9
\]
\[
X_c = -250.921, \quad C_c = 88.71 \ \text{pF}
\]
\[
X_d = -32.9475, \quad C_d = 675.60 \ \text{pF}
\]
\[
X_e = 250.000, \quad L_e = 5.565 \ \mu\text{H}
\]

The inductor is the same value as in Network 2.

**wideband response**

Fig. 6 shows the frequency response over a two-decade range for the examples given. Voltage response has been calculated with constant end resistances. As such, it will be the same in either direction. Frequency is normalized to 7.15 MHz.

The joker in the deck is Network 3. The extra peak on the high side of resonance will vary in frequency and relative amplitude depending on the design \( Q \) and end impedances. A saving grace is that Network 3 has the best low-frequency attenuation. All networks will vary in other applications, primarily with different design \( Q \); the general shape of the response curve, however, will still be the same.

Choice of a network depends on the application. A frequency-multiplier chain should consider Networks 2, 5, or 6 because of their better low-frequency attenuation. The last stage could use Networks 1, 4, or 5 in the output to reduce unwanted harmonics. An amplifier chain such as an i-f strip could alternate Networks 5 and 6 between stages for best skirt attenuation.*

* There are better ways; this would only be for miniature construction or multiple stages with degeneration of gain.
impedances presented to the source

The impedance presented to the source can be easily calculated. Networks 1 through 4 have variations far from band center that might cause stability problems. Network 1 is inductive from the band center to about 20.75 MHz from the example. Parallel resistance climbs abruptly to about a megohm while parallel reactance changes swiftly to capacitive reactance. Network 2 has a similar, less abrupt change at about 9.76 MHz. Network 3 is also similar with the changeover coinciding with the voltage response peak at about 24.3 MHz.

Network 4 becomes inductive below 4.9 MHz and capacitive above 28 MHz, resistance peaking to 4 megohms at that frequency. Networks 5 and 6 were much less susceptible to changes, and showed only slight variations at passband edges. All components were assumed lossless so a practical circuit would exhibit much less variation due to finite component Q.

The swamping-resistor method with transistor collectors works well from 6 meters and down with $f_t$ of 150 MHz or greater. This increases a normally low-collector conductance but does have some power loss. A swamping resistor can also be used at the load since load changes reflect to the source. A rule of thumb is to add 2 pF for every resistor, using only carbon composition types.

Mismatch loss will add out-of-band attenuation when used with receiver front ends. An exception is where the input impedance of the network matches the antenna impedance out of band. This is rare, but it happens. A similar condition occurs with different equipment connected with coax cable: the line length may cause a match out of band.

Table 1 is a tabulation of design Q for Networks 1 through 5 based on one specified reactance. Our example for Network 2 gives a $C_d$ value of 36.74 pF. A 39 pF mica is a standard value with a reactance of -570.755 ohms at 7.15 MHz. This $X_d$ value is used and gives a design Q of 20.5074. The $X_c$ of Network 2 is unaffected by Q but $X_c$ changes to 243.814 ohms or 5.427 pF.

Network 6 is a bit difficult to solve for Q but it can be done by programming an HP-25 or similar calculator to solve either $X_c$ or $X_d$ with manual Q input. An approximation that works in some cases is:

$$\Delta X \approx (R_d + R_j) / X_c$$

The Network 6 example had $C_c$ at 88.71 pF. A fixed 82 pF capacitor will have -271.456 ohms so the approximate Q is 18.6034. Recalculating with Q gives:

$$X_c = -272.564 \quad C_c = 81.67 \text{ pF} \quad (close)$$

$$X_d = -37.0998 \quad C_d = 599.99 \text{ pF}$$

$$X_c = 568.768 \quad L_c = 5.983 \mu \text{H}$$

$C_c$ is within 0.4 per cent of desired value so it should work well.
Usual tolerances of fixed components are only 5 per cent. This will have little effect on matching when the other two components are trimmable. Lower design Q will show less sensitivity to tolerances.

applications and variations

Some situations cannot be met with given end resistances. This can sometimes be cured by using a broadband toroidal transformer. Impedance changes of up to 16:1 are possible. Remember that parallel reactance is also changed by the same ratio in this application.

Good bypassing in active-device applications cannot be over-emphasized. A poor bypass and decoupling not only cause trouble between stages but also become networks. Resonance of bypass capacitors with lead length is common at higher frequencies; one cure is to double up several lower-capacitance bypasses. Short lead lengths and a large ground plane should always be used.

An interesting application is the replacement of the preselector tuning used in 1960-era receivers such as the Heath SB-300 series. These all have one band per bandswitch position so the front end can be stagger-tuned over the desired portion of the band. Fixed capacitors replace the variable and Networks 5 or 6 can be used at the antenna input. The Heath design has enough room to add a couple of bandswitch wafers to allow selection of other matching networks for other antennas such as a longwire. The variable capacitor can be retained, insulated, and used as part of a Wien-bridge audio notch filter.

Antenna networks used in receivers should have a dc path to ground such as in Network 5. This avoids static build-up during electrical storms and potential arcing.

other networks

End impedance frequency sensitivity may require simpler networks. An excellent treatment of L-networks is found in the first reference along with proper use of the Smith chart. Tabulated values are available and theoretical aspects can be found in texts.

Application of transistor amplifiers and matching is well covered in reference 7. Access to a computer that speaks FORTRAN can use the program of reference 8 to calculate other networks and also determine amplifier stability.

references


ham radio

"I DID clean up my desk . . . two years ago, just before I picked up that call from Russia."
This new instrument has taken a giant step in front of the multitude of counters now available. The Opto-8000.1 boasts a combination of features and specifications not found in units costing several times its price. Accuracy of ±0.1 PPM or better — Guaranteed — with a factory-adjusted, sealed TCXO (Temperature Compensated Xtal Oscillator). Even kits require no adjustment for guaranteed accuracy! Built-in, selectable-step attenuator, rugged and attractive, black anodized aluminum case (.090” thick aluminum) with tilt bail. 50 Ohm and 1 Megohm inputs, both with amplifier circuits for super sensitivity and both diode/overload protected. Front panel includes “Lead Zero Blanking Control” and a gate period indicator LED. AC and DC power cords with plugs included.

SPECIFICATIONS:
- Time Base—TCXO ±0.1 PPM GUARANTEED!
- Frequency Range—10 Hz to 600 MHz
- Resolution—1 Hz to 60 MHz; 10 Hz to 600 MHz
- Decimal Point—Automatic
- All IC's socketed (kits and factory-wired)
- Display—8 digit LED
- Gate Times—1 second and 1/10 second
- Selectable Input Attenuation—X1, X10, X100
- Input Connectors Type—BNC
- Approximate Size—3” x 7½” w x 6½” d
- Approximate Weight—2½ pounds
- Cabinet—black anodized aluminum (.090” thickness)
- Input Power—9-15 VDC, 115 VAC 50/60 Hz or internal batteries

OPTO-8000.1 Factory Wired $299.95
OPTO-8000.1K Kit $249.95

ACCESSORIES:
- Battery-Pack Option—Internal Ni-Cad Batteries and charging unit $19.95
- Probes:
  - P-100—DC Probe, may also be used with scope $13.95
  - P-101—LO-Pass Probe, very useful at audio frequencies $16.95
  - P-102—High Impedence Probe, ideal general purpose usage $16.95
- VHF RF Pick-Up Antenna—Rubber Duck w/BNC #Duck-4H $12.50
- Right Angle BNC adapter #RA-BNC $2.95

FC-50 — Opto-8000 Conversion Kits:
Owners of FC-50 counters with #PSL-650 Prescaler can use this kit to convert their units to the Opto-8000 style case, including most of the features.
- FC-50 — Opto-8000 Kit $59.95
- *FC-50 — Opto-8000F Factory Update $99.95
- FC-50 — Opto-8000.1 (w/TCXO) Kit $109.95
- *FC-50 — Opto-8000.1F Factory Update $149.95
*Units returned for factory update must be completely assembled and operational

TERMS: Orders to U.S. and Canada, add 5% to maximum of $10.00 per order for shipping, handling and insurance. To all other countries, add 10% of total order. Florida residents add 4% state tax. C.O.D. fee: $1.00. Personal checks must clear before merchandise is shipped.
overtone crystal oscillators
without inductors

A discussion of overtone crystal oscillator circuits which don’t require inductors

Until recently, all of the circuits for overtone crystal oscillators I’ve seen have included tuned LC circuits. It seemed necessary to have an LC resonator, tuned to the desired overtone frequency, to be sure the oscillator would operate at the proper overtone frequency and prevent operation at the crystal’s fundamental frequency or some undesired overtone. It would be nice if the LC tuned circuit could be eliminated, of course, because it would simplify bandswitching of the crystal oscillator.

International Crystal has introduced a crystal oscillator circuit called the OF-1. Although the OF-1 circuit has no inductor, and thus no LC tuned circuit, it can be used with crystals operating in the third-overtone mode. I found this quite interesting and did some relevant experimenting to satisfy my curiosity. My efforts are documented here for others who may share this interest.

the circuit

International Crystal supplies two different kits of the OF-1 type. The OF-1 LO uses crystals operating in the fundamental mode from 2 to 22 MHz; fig. 1 is a schematic of the circuit. The OF-1 HI uses crystals operating in the third-overtone mode from 18 to 60 MHz; fig. 2 is a schematic of the OF-1 HI. Notice that in the latter circuit capacitor C3 has been omitted; in the overtone mode, the crystal operates near series resonance.

I breadboarded and tested both of these circuits using a 2N4996 transistor. The crystal I used in all of my tests was a 28.3 MHz third-overtone type originally purchased for use in International Crystal’s older OX oscillator circuit (which has an inductor). Using this crystal, the circuit of fig. 1 had an output frequency at the crystal’s fundamental, or about 9.43 MHz. The circuit in fig. 2 produced the third-overtone frequency of 28.3 MHz when the smaller values shown for C1 and C2 were used; using the larger values for C1 and C2 given in fig. 2 produced oscillation at the fundamental frequency of 9.43 MHz.

By Courtney Hall, WA5SNZ, 7716 La Verdura Drive, Dallas, Texas 75248
fig. 3. Third-overtone crystal oscillator which uses a 74S00 Schottky TTL gate; no inductors are required.

**TTL version**

To obtain increased output amplitude I developed the circuit shown in fig. 3. The 74S00 quad NAND gate acts as both oscillator and output buffer. One of the gates in the IC is unused. A 74S00 is required because of the relatively high frequency; I don’t believe the 7400, 74LS00, or 74H00 will work as well, if at all, at 28.3 MHz.

All wiring should be as short as possible, and the circuit should be shielded. The peak-to-peak output amplitude swings from about 0.4 to 3.5 volts, which are acceptable TTL levels. If the capacitor which couples the first two gates together (30 pF in fig. 3) is too large (1000 pF), the circuit’s output frequency will drop down to the crystal’s fundamental. Some experimentation with the value of this capacitor may be required for different crystals.

**conclusion**

The simplicity of these overtone crystal oscillators could make them desirable in many applications. I have not had the opportunity to investigate them to the degree I would like; therefore, I would welcome comments from interested readers on this type of overtone oscillator circuit.

**simple method for making printed-circuit boards**

I have developed a method of making printed-circuit boards that, while not professional in appearance, work well and beat the mess that results from using wire-wrap sockets and soldering them in place.

I use paint (enamel) in a K&E Leroy pen, inserted in a hole of a test probe. When using paint, do not use the insert for the pen, which is used to prevent the ink from running through. The paint is not thinned but just as it comes from the can: the result is a slow writing paint pen. I have found that a no. 2 or no. 3 Leroy pen is just about right. Cleaning is easy with pipe cleaners and paint thinner. I have found that a no. 2 or no. 3 Leroy pen is just about right. Cleaning is easy with pipe cleaners and paint thinner. I use an inking pen with paint for the long straight lines, and a small brush for the large areas.

To make a PC board, place the copper board under the layout, secure it so it won’t slip, then use a sharp instrument such as a scribe and punch a prick hole through each place where there is a dot, or where there will be a hole. This gives the spacing you’ll need to draw (free hand) the circuit on the board. After you have completed the hole punching (not through the board), remove the layout. Note that this does not destroy your layout. Now you can fill your pen and draw the circuit on the copper board.

I recommend you practice with simple circuits before you jump into a complex layout. After the paint has dried naturally or in an oven heated to 150 to 160 degrees, check to see that your layout is as you want it. If two lines are touching, the scribe will allow you to make a fine line between them.

I have tried two types of etching solutions: ferric chloride and an etch solution from Vector Electronics. The paint stood up well in both. First I tried two types of paint, Sears acrylic enamel, and Ace Hardware quick-drying black enamel. There was no apparent difference.

Drilling the board can be done before painting the circuit or after etching. The little prick marks show you exactly where the hole belongs. Removing the paint after etching is done with trichloroethane or other solvent that will not contaminate the board.

Robert H. Kernen, W4MTD
Super Terminals with Hidden Features

For super operator convenience,
Our keyboard works in MORSE, BAUDOT, and ASCII codes and controls the terminal, too.
You can edit a message, program the HERE IS message, send the "QUICK BROWN FOX..." test message, change speeds, and change the terminal modes, all from the keyboard itself. In fact, the KOS (Keyboard Operated Switch) feature even turns the transmitter on and off from the keyboard. The DS-3000 KSR also features full-length 72 character lines (16 lines per screen), 5 speeds of BAUDOT and ASCII RTTY and Morse code from 1 to 175 wpm (Version 3), and word wrap-around to prevent splitting of words at the end of a line. When combined with the HAL ST-6000 Demodulator, you have the ULTIMATE in RTTY equipment.

DS-3000 KSR Version 3 (MORSE, BAUDOT, ASCII) ........................................... $1575.00
DS-3000 KSR Version 2 (BAUDOT & ASCII only) ............................................ $1195.00

Write for our latest catalog & RTTY guide.

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

For our Overseas customers:
see HAL equipment at:
Richter & Co.; Hannover
I.E.C. Interelco; Bissone
Vicom Imports; Auburn, Vic., Australia
Full Features and Superior Performance
ST-6000 RTTY DEMODULATOR

Select Rx & Tx Shifts
Accurately Tuned Rx Filters
Crystal Controlled Tx Tones
True Transceive Operation

Invert Both Rx Demod, and Tx Tones

Data Status Indicators
Loop 1
Post-Autostart
Pre-Autostart

Hard-Limiting [FM] or Non-Limiting [AM] Reception
Correct for Bias Distortion

Correct For Multi-Path Distortion
Local Loop Operation

Correct for

Automatic Tx/Rx Station Control with Keyboard Operated Switch [KOS]

Tuning Oscilloscope [Front Panel Controls] Meter Indicator Option Also Available

Why not have the best?
The HAL ST-6000 Demodulator offers outstanding performance, versatility, and ease of operation. The Receive Demodulator features multiple-pole active filters available for "high" or "low" tones. These filters are frequency-matched to the transmit tone crystals for true transceive operation. Input bandpass filters, discriminator filters, and post-detection filters are carefully designed and tested for optimum weak-signal recovery. The ST-6000 has an internal loop power supply, 2 loop keyers, RS-232, MIL-188C, and CMOS data I/O, and rear panel connections to data and control circuits for connection to UART and computer devices. Use it with the HAL DS-3000 KSR for the best in RTTY performance.

$595.00

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

For our Overseas customers:
see HAL equipment at:
Richter & Co.; Hannover
I.E.C. Interelco; Bissone
Vicom Imports; Auburn, Vic., Australia
repeater interference:
some corrective actions

Suggestions for repeater associations to minimize the ever-increasing interference problem

Our local repeater, WR4ADC, operating on the 146.34/146.94 pair, has been experiencing interference on both the input and output frequencies. This article covers the technical corrective actions which have been considered for this interference. Some of these are now being used or are being installed for future use.

input channel anti-interference measures — lockout

Since repeaters operate on a fixed-frequency plan, one method of avoiding unnecessary call-up is to use a repeater lockout signal on transmissions not intended for repeaters. Technically, as in fig. 1, this would be simple. An NE-555 subaudible oscillator producing a small deviation would be required at the non-using transmitters. The repeater input receiver would need a tone detector and a relay contact in series with the carrier-operated relay (COR) to block operation when the tone is received.

While technically simple, this method of input interference prevention requires cooperation by the interfering stations. Lacking this, it is completely ineffective. It does seem to be a useful approach and could be adopted as a national standard. If done, the standard should include designation of the lockout tone frequency and of the deviation it produces.

While the lockout tone is not currently a useful technique, there are several technical anti-interference approaches available based on the characteristics of interfering signals. One of the most common of these is the frequency window, fig. 2, which locks out transmission if the incoming signal is appreciably off frequency. While this is usually done to avoid excessive distortion, it is a powerful anti-interference method. In its simplest form, it may be a Schmidt trigger on the dc voltage at the discriminator, set to the value corresponding to the selected value of allowable frequency error, with the trigger interrupting the COR. Some filtering, on the order of a tenth-second time constant, is needed.

signal characteristic measures

Other anti-interference measures based on the characteristics of interfering signals include:

1. a-m rejection
2. Wideband fm rejection
3. Non-voice modulation rejection

The purpose of a-m rejection, fig. 3, is to prevent operation of the repeater COR by an a-m carrier. In simple form this requires a pickoff from the receiver ahead of the limiters, feeding to an agc-controlled stage and an a-m detector. The lockout circuit would require presence of carrier in the fm section and in the a-m section, plus presence of a-m exceeding some percentage, say around 25 per cent. Some protection against noise pulses or unmodulated pauses would probably be required, at least several seconds time constant of filtering.

Rejection of wideband fm, fig. 4, would require a wideband receiver, and a form of detection of the out-of-band energy component. A simple form would be to compare audio levels of the narrow and wideband discriminator outputs: if they approach equality, the incoming signal would be wideband. Another wideband modulation detector would beat the limiter output against a local oscillator, followed by a highpass filter. The filter cutoff frequency would be set to the desired peak deviation.

A lockout system based on the absence of voice modulation, fig. 5, would be a powerful anti-interference technique. In principle, this is relatively simple — just measure the ratio of peak-to-average power in the audio. The ratio varies from 3 dB for pure sine waves, to 13 dB for noise, and to about 16 dB for voice. Noise-operated squelch makes the distinction between the last two easy.

However, in current fm practice, the approach is not this simple, since most fm transmitters use a

By R. P. Haviland, W4MB, 2100 South Nova Road, Box 45, Daytona Beach, Florida 32019
limiter to keep the deviation high, and this reduces the peak-to-average ratio. Because of this, a peak-to-average detector would have to be set to a lower ratio. About 6 dB, or 2:1 in voltage, with a time constant of about one-tenth second should be good and would provide appreciable protection against non-voice signals.

**wanted signal anti-interference measures**

All of the above anti-interference measures are based on some characteristic of the unwanted signal. The other family of input frequency measures is based on characteristics of wanted signal. The two standard forms of this, fig. 6, are the subaudible tone, or *private line*, required continuously for access; and whistle-on, a single tone or a Touch-Tone signal giving access. Access may be for a definite time period or until the COR is dropped for a time period. Various other forms have been used, including carrier-formed Morse and two-band interrogation.

**fig. 1. Elements of the repeater lockout system.**

Most of these methods have the disadvantage of requiring additions to the using transmitter. This is not a severe problem for closed repeaters, where the number of users is small, but represents a serious drawback for open repeaters, especially those on the common frequencies or close to holiday areas or heavily traveled routes.

One method of partially overcoming this objection is to operate the repeater with carrier access only during no interference periods, and to switch to one of the other access methods when interference is experienced. This switch could be coupled with voice announcement on the identifier, giving instructions as to access method. A Touch-Tone access is probably best since such pads are common and since the signal should never be used in normal communication, except for signaling.

It would seem that this method would give good protection against incidental interference. Willful interference is another matter, since operation in accordance with the announcement instructions would turn the repeater on. However, malicious intent would seem to be proven if interference continues.

**output channel anti-interference measures — channel guards**

Repeaters also cause interference, and some technique of guarding against the interference they cause may be desirable. Probably the best method of doing this is to guard the output channel, *fig. 7*, holding repeater operation in abeyance if the channel signal exceeds some predetermined value. To account for emergency operation, this guard could be combined with a timer identification announcement, giving instructions on the procedure to override the lockout.

The setting of the guard receiver would need to be based on a value of "signal to be protected," and a margin, or "protection ratio." These are common concepts in other radio services, but they have not been used in amateur operations. As a result, there are no accepted values for these quantities.

The closest other service is the Mobile Service, which includes land mobile. Since this was the source of many 2-meter repeater concepts and equipment, it should provide good guidance.

**fig. 3. Principle of a-m lockout, which prevents operation of the repeater COR by an a-m carrier.**
It is easy to see the effect of this protection level if the values are translated to power and distance relationships. For average terrain, the effective radiated transmitter power to just reach the 10 \( \mu V/m \) signal, as a function of distance from the repeater, is approximately:

<table>
<thead>
<tr>
<th>distance</th>
<th>transmitter antenna height</th>
</tr>
</thead>
<tbody>
<tr>
<td>km (miles)</td>
<td>100 ft (30m)</td>
</tr>
<tr>
<td>----------</td>
<td>---------------</td>
</tr>
<tr>
<td>10</td>
<td>0.02</td>
</tr>
<tr>
<td>15</td>
<td>0.5</td>
</tr>
<tr>
<td>20</td>
<td>1.0</td>
</tr>
<tr>
<td>30</td>
<td>8.0</td>
</tr>
<tr>
<td>50</td>
<td>31.0</td>
</tr>
<tr>
<td>100</td>
<td>62.1</td>
</tr>
</tbody>
</table>

The ERP is the product of the transmitter output and the antenna gain multiplied by 2.5 (to include the effect of ground reflection).

Stated another way, the 10-microvolt signal would be produced by a typical mobile at about 8 miles (13km) distance, by a typical base station at about 18 miles (29km), or by a DX station about 90 miles (144km) away and beaming toward the repeater. The signal would be the same as that of another typical repeater if it were some 50 miles (80km) away.

These values indicate that output channel guarding to the 10 \( \mu V/m \) level would not eliminate all interference. However, it would prevent interference to simplex operation within reasonable distances, to the point that any resulting interference would hardly be considered harmful. Accordingly it would appear that repeater associations wishing to minimize interference problems should consider this approach.

Construction of an automatic protection system should not be difficult. The output-channel monitor-receiver antenna could be mounted on the repeater tower at a height of 30 feet (9m). (This level is used because the height gain is zero.) Assuming use of a

---

**fig. 4.** Principle of wideband fm lockout, which would require a wideband receiver and a form of detecting the out-of-band energy component.

**fig. 5.** The non-voice lockout principle. Comparator measures peak-to-average power ratio in the audio, which varies from 3 dB for pure sine waves to about 16 dB for voice.
A limited number of tests with this method indicate that the effect on normal repeater operation would be negligible — a small increase in distortion and a small decrease in range. With no other action, the effect on the other station on the channel would also be small. However, if the other station would also QSY by the same amount, but in the opposite direction, he would escape the interference completely. At the same time his operation would be affected only by a small amount. For the repeater users and the other stations involved, nearly full operation could be restored by retuning.

The signal for this scheme can be generated by the circuitry used for transmit lockout. (If desired, the channel-occupied receiver could be widened out a bit to give better detection of these slightly offset signals.)

\[ \text{fig. 8. Principle of channel-occupied QSY method, which would make it worthwhile for the station on the repeater output to change frequency slightly.} \]

It may be noted that this offset method is used in vhf television to reduce co-channel interference and to allow closer station spacings. It is a powerful anti-interference technique.

A number of other anti-interference measures have been considered with respect to WR4ADC interference problems. The other technical ones considered did not seem attractive and so are not reported. There were several operational ones of value, and these have been discussed along with the technical solutions above.

With increasing numbers of amateurs on the air, and especially with the continued expansion of repeater operation, interference is going to increase. It seems to be time for the repeater associations to consider the steps that should be taken to minimize those interference problems. This should include recommendation of standard techniques and of protection ratios.
The age of tone control has come to Amateur Radio. What better way to utilize our ever diminishing resource of frequency spectrum? Sub-audible tone control allows several repeaters to share the same channel with minimal geographic separation. It allows protection from intermod and interference for repeaters, remote base stations, and autopatches. It even allows silent monitoring of our crowded simplex channels. We make the most reliable and complete line of tone products available. All are totally immune to RF, use plug-in, field replaceable, frequency determining elements for low cost and the most accurate and stable frequency control possible. Our impeccable 1 day delivery is unmatched in the industry and you are protected by a full 1 year warranty when our products are returned to the factory for repair. Isn't it time for you to get into the New Age of tone control?
OF A NEW AGE.

**TS-1** Sub-Audible Encoder-Decoder • Microminiature in size: 1.25" x 2.0" x .65" • Encodes and decodes simultaneously • $59.95 complete with K-1 element.

**TS-1JR** Sub-Audible Encoder-Decoder • Microminiature version of the TS-1 measuring just 1.0" x 1.25" x .65", for handheld units • $79.95 complete with K-1 element.

**ME-3** Sub-Audible Encoder • Microminiature in size, measures .45 x 1.1 x .6 • Instant start-up • $29.95 complete with K-1 element.

**TE-8** Eight-Tone Sub-Audible Encoder • Measures 2.6" x 2.0" x .7 • Frequency selection made by either a pull to ground or to supply • $69.95 with 8 K-1 elements.

**PE-2** Two-Tone Sequential Encoder for paging • Two call unit • Measures 1.25" x 2.0" x .65" • $49.95 with 2 K-2 elements.

**SD-1** Two-Tone Sequential Decoder • Frequency range is 268.5 - 2109.4 Hz • Measures 1.2" x 1.67" x .65" • Momentary output for horn relay, latched output for call light and receiver muting built-in • $59.95 with 2 K-2 elements.

**TE-12** Twelve-Tone Sub-Audible or Burst-Tone Encoder • Frequency range is 67.0 - 263.0 Hz sub-audible or 1650 - 4200 Hz burst-tone • Measures 4.25" x 2.5" x .5 • $79.95 with 12 K-1 elements.

**ST-1** Burst-Tone Encoder • Measures .95" x .5" x .5 plus K-1 measurements • Frequency range is 1650 - 4200 Hz • $29.95 with K-1 element.

COMMUNICATIONS SPECIALISTS
426 W. Taft Ave., Orange, CA 92667
(714) 998-3021
Several months ago a reader of this column wrote me asking the question, "How do you test rf power tubes?" Not long afterward a close friend of mine, about to build a linear amplifier for 80 through 10 meters, bought a box full of used 4X150 power tetrodos at a hamfest. After building the amplifier he found that none of the tubes were good and that he would have been better off using another type of tube from his collection that was known to be good. He naturally wanted to know if there was a better way available to amateurs than testing by trying.

In my work, medical electronic servicing, we repair electrosurgical generators, which are rf power oscillators that produce up to several hundred watts in the 500-2500-kHz range. Some old but still perfectly good electrosurgical generators use the type UXCV-11 power triodes in a push-pull pair. These tubes cost about $120 each ($240 per pair!) unless you are clever enough to know about United Electronics in Newark, New Jersey. The cost makes stocking a number large enough to permit routine testing by substitution too costly — especially in a shop with a limited budget. Again, there "has to be a better way!"

Three times within the past six months people and situations have forced the issue of testing transmitting tubes, so perhaps it is time that we covered that point in this column. But before we answer the question posed originally, let's recap a little about elementary vacuum tubes.

A vacuum tube consists of an electron emitter called a cathode, several grids, and an electron collector called either a plate or an anode. The cathode can be either an incandescent filament, or an indirectly heated metal cylinder that has a heated filament at its center. The plate surrounds the cathode but is insulated from it. The various grids are placed in the space between the cathode and the plate.

The plate will have an electrical potential that is positive with respect to the cathode. Grid no. 1, the control grid, is given a negative potential with respect to the cathode so it can control the flow of electrons between cathode and plate. The second grid is called the screen grid or accelerator grid and is given a positive potential with respect to the cathode. The third grid, that nearest the plate (G3), is called the suppressor grid and may be either biased negative with respect to the cathode or (more commonly) tied directly to the cathode either internally or externally, as shown in fig. 1.

Variations in the grid voltage will produce variations in the plate current, which by Ohm's law, become variations in the voltage drop across the load resistor, $R_L$.

Several vacuum tube parameters are of interest when trying to ascertain overall quality. These are: amplification factor ($\mu$ or $\mu$), plate resistance ($R_p$ from the spec sheet or data book), and the transconductance ($g_m$).

The amplification factor is defined as the change in output voltage caused by a given change in grid no. 1 (input) voltage. In fact, the amplification factor of any amplifying device can be given by:

$$amplification = \frac{E_{out}}{E_{in}}$$

But for vacuum tubes specifically we can use the notation:

$$\mu = \frac{\Delta E_b}{\Delta E_c}$$

where:

$\Delta E_b$ is the change in plate voltage
$\Delta E_c$ is the change in plate current

The transconductance rating relates a change in plate current ($I_p$) for a small change in grid voltage,
with the plate voltage held constant. In other words:

$$g_m = \frac{\Delta I_p}{\Delta E_c} \quad E_b = \text{constant}$$  \hspace{1cm} (3)

where:

- $\Delta I_p$ is the change in plate current expressed in amperes
- $\Delta E_c$ is the small change in grid bias voltage expressed in volts
- $g_m$ is the transconductance expressed in mhos

This relationship will lead us to a method for testing tubes easily and quickly.

**tube tester configurations**

Fig. 2 shows the basic circuit for a short-circuit tester. This will give only limited information but is useful when screening a large number of hamfest specials. Why perform a more time-consuming test on a tube that has a high resistance short between the filament and cathode, for example?

The tester circuit is nothing more than a series of several continuity testers arranged to ascertain the existence of any resistance paths between adjacent elements. Each continuity tester consists of a low-current filament transformer (i.e., rated at less than 1 ampere) and a compatible lamp. I was tempted to specify the use of light emitting diodes instead of lamps but was quickly persuaded to use lamps because the LEDs made the device too sensitive. This problem causes apparent shorts, when all we are reading is electrons flowing from the heated filament to the electrode on half cycles when the ac is positive-going.

It is best to test for shorts after allowing the tube to warm up for a few minutes. Some shorts do not become apparent until after the tube has reached operating temperature. This is also the reason why the use of an ohmmeter is not recommended in this case.

The simplest tester circuit that gives us a qualitative insight into the worth of any given tube is the emission tester of fig. 3. This circuit tests the tube for the emission of electrons from the cathode. Notice that the tube is connected in a diode configuration in which all elements except the cathode and filaments are connected to the plate.

The tube in a circuit such as fig. 3 acts very much like the classic diode. The emission current is defined as the saturation current of the tube. If the plate voltage is increased from near zero, we find that the plate current will also increase in a nearly linear manner (except at very low plate potentials). But once a certain critical plate voltage is reached, we find that the plate will attract all the electrons that the cathode produces. Any further increase in plate voltage will produce very little, if any, increase in plate current. The current level at which this occurs is the saturation or emission current.*

The emission-type tube tester checks for this current, and if the current is low, it will indicate "reject." Some tubes cannot be tested at the actual saturation current either because it is inconvenient to do so, or because the current is too high and may damage the tube. These tubes are tested at a specific plate potential, at which a given current is expected. If the tube will not produce at least a certain predetermined percentage of that current (usually 80 to 90 per cent), then it is rejected. The emission tester can spot a grossly bad tube, but there are certain problems with

---

*An interesting variation of the emission tester, which does not require high voltage but uses a low-voltage bias source, is described in reference 1.
this type. Note that most drug-store tube testers are emission types.

Defects that will prevent the tube from operating normally will not always show up on a simple emission tester, so some better means is necessary. The type of tester preferred by most professional servic-ers is the mutual conductance or transconductance tester. Examples of this type of circuit are given in fig. 4. The circuit shown in fig. 4A is a static transconductance tester using the grid-shift method, also called grid-level shift.

Switch S1 is in position 1 at the beginning of the test, making grid voltage \( E_c \) equal to \( E_2 \) alone. Both \( E_1 \) and \( E_2 \) are adjusted to produce a convenient (safe!) plate current. It is usually wiser to begin with the plate voltage \( (E_1) \) at some level well within the range that can be tolerated by the particular tube being tested, and have the grid voltage at some value in excess of cutoff for that tube. This may be unnecessary much of the time but could save you some grief often enough to make it a good standard practice. You may then adjust the grid voltage downward until the plate current is at a convenient level. When this adjustment is completed, make a note of the values of \( E_b, I_p, \) and \( E_c \).

To perform the test, place switch S1 in position 2. This operation makes grid voltage \( E_c \) equal to \( (E_2 + E_3) \). The plate voltage is then measured and the supply readjusted if a change has been noted. The plate voltage at this point must be equal to the plate voltage that existed initially.

Now read the plate current, and find the difference between this reading and the initial reading. Plug the difference current into the formula:

\[
gm = \frac{\Delta I_p}{I_1.5} \tag{4}
\]

where:
\( \Delta I_p \) is in amperes
\( gm \) is in mhos

This answer is given in mhos, but most vacuum tube spec sheets list the transconductance in micro-mhos. 1 mho = 1-million \( \mu \)mhos, so multiply the answer by \( 10^6 \).

A dynamic transconductance tube tester is shown in fig. 4B. This circuit is the basis for most commercial tube testers. A low voltage alternating current transformer is connected in series with the grid bias power supply, so that the transformer secondary voltage forms the "delta-\( E_c \)." Actual transconductance is measured on the plate ac milliammeter, which is calibrated in units of conductance.

Fig. 5 and the photo show a test jig I built to test power tubes at work. It will serve equally well for amateurs. The circuit is the simple grid-shift method for finding the transconductance of the tube being tested. Note that it is not a real tube tester construction project because it lacks power supplies. Almost all amateurs can jury-rig adequate power supplies to make this test or can borrow bench supplies. Note also that it is not strictly necessary to use the full operating voltage of the tube to obtain meaningful results.

Please, be very careful when using this jig; high voltages will be exposed! If there is any doubt, place the tube socket subassembly inside an insulated or grounded metal enclosure. I may seem to harp on
safety an awful lot, but it is so very important. Recall the note on one of my past articles which pointed out that an editor almost canned himself while working on a 4000-volt final amplifier power supply.

The test jig is built in two main parts, a main assembly and a tube-socket subassembly. A multiconductor cable connects the two parts of the jig. This design was selected so that the same mainframe can be used to accommodate a larger number of different tube types.

Jacks J1-J8 are heavy duty banana-jack binding posts, while J9/P1 are a mating pair of multipin connectors such as the circular MS or AN series. I used a high-voltage power supply that delivered 500 Vdc, but if greater potentials are needed (I doubt that they will) it would be wise to change J1-J4 to high-voltage chassis connectors.

Meter M1 is an appropriate high-voltage meter, although in my case a voltmeter was made from a suitable multiplier resistor (a pot and a fixed resistor) and an available 0-50-μA meter movement. Meter M2 is a dc voltmeter with a range suitable for the range of grid voltages expected.

Resistors R1-R3 were selected so that varying R2 produced approximately 1 volt of grid voltage change. R1 is used to allow precision trimming of that change. In my case, $E'_c$ was 25 Vdc, but if your voltage is different, use the normal voltage divider equation to find appropriate resistor values.

Resistor R4 is made approximately equal to the plate resistance of the tube being tested, which in this case was about 3000 ohms.

I used an external plate current milliammeter because there was a digital multimeter available that would measure current very accurately.

Table 1 lists the values of transconductance actually measured for both known good and known bad tubes. The UXCV-11 has a $\mu$ of 14 and a plate resistance of 3220 ohms. The spec sheet does not give the transconductance, but we may compute it from:

$$gm = \frac{\mu}{R_p}$$

$$gm = \frac{14}{3220}$$

$$gm \approx 0.00435 \text{ mhos}$$

$$gm \approx 4350 \mu\text{mhos}$$

(Note that all the bad tubes had grossly lowered gm readings.)

This tester is not “scientifically” designed but is intended to allow amateurs to test power tubes on an occasional basis. Its saving grace is that it can be built inexpensively! Note that I defined “bad tube” by saving from my own work those tubes that had been found to produce customer complaints similar to, “It seems to work, but has low output.” These observations were confirmed by an rf ammeter in series with my 500-ohm (not 50-ohm; these were medical rf generators) dummy load. The real value of this tester is that it will allow you to test hamfest specials or perform preventive maintenance on your equipment. Of course, if you have an rf power meter or rf ammeter in your feedline, then a low-power output coupled with seemingly normal drive will point the finger to the final amplifier tubes. But the thought of that poor guy building an entire linear amplifier around a whole box full of bad tubes seems to justify doing a little testing — at five minutes per tube, how could he have gone wrong?

### references
The TS-820S... still the Pacesetter. It has proven itself to be the performer we promised, proven itself through thousands of hours of operating time, world wide and under the most difficult conditions. Unique features, superb specifications and top quality construction... all hallmarks of Kenwood amateur products are eminently displayed in the TS-820S. But then, you've probably heard all that on the air by now.

The TS-820S puts out probably the cleanest signal on the bands. The third order products are at least -35 dB due to Kenwood's unique RF Negative Feedback (RFNFB) circuit. State-of-the-Art PLL and single conversion design are combined for superb spurious characteristics far exceeding today's FCC requirements... the non-harmonic spurious emissions are better than -60 dB and the harmonic spurious are better than -40 dB. The receiver boasts outstanding sensitivity... better than .25 uV for 10 dB S/N. And when it comes to dynamic range, it's tough to beat the TS-820S. These are impressive numbers. That's why so many prominent DXers are using the Kenwood Pacesetter... the TS-820S.

The man to see... your local Authorized Kenwood Dealer. He can give you all the information you need and the best deal.
The TS-520S provides full coverage on all amateur bands from 1.8 to 29.7 MHz. It provides 160 meter capability, WWV on 15.0 MHz and an auxiliary band position for maximum flexibility. With the addition of the DG-5, you have an easy to read, accurate readout of your operating frequency while transmitting and receiving. The TS-520S is solid state except for the driver and the two final tubes. It also incorporates a 3SK35 dual gate MOSFET for outstanding cross modulation and spurious response characteristics.

The TS-520S is completely self-contained with a rugged AC power supply built in. The addition of the DS-1A DC-DC converter (option) allows for mobile operation. Additional features of the TS-520S include: A new improved speech processor • An extremely effective noise blanker • A built in 20 dB attenuator • Convenient jacks for PHONE PATCH IN and PHONE PATCH OUT • Amplified type AGC circuit 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 • Provision for 4 fixed frequency channels • Heater switch.

The man to see... your local Authorized Kenwood Dealer. He can give you all the information you need and the best deal.

The TS-520S... still the most popular transceiver in the world, is a solid foundation for an expanding series designed to please any ham... from Novice to Extra.

TS-520S

A great station... at an affordable price! The TS-520S with its companion accessories... including two new units. The AT-200 antenna tuner provides a versatile tool in any station. The other is the TV-520S, Kenwood's 2 meter transverter for SSB and CW operation from 146 to 148 MHz.

TRIO-KENWOOD COMMUNICATIONS INC.
1111 WEST WALNUT/COMPTON, CA 90220
microcomputer interfacing: interfacing a 10-bit DAC

A Digital-to-Analog Converter or DAC is an electronic device that converts digital signals into analog signals. A typical converter consists of an arrangement of "weighted" resistors, each controlled by a single bit of input data, that develops varying output analog voltages or currents in accordance with the digital input code. You could use a DAC to provide a small analog error signal from a microcomputer used in a feedback circuit, to convert a sequence of bytes in memory into analog-vs-time data and thus simulate the output from an analog instrument such as a rotator control box for tracking OSCAR; to provide analog data for the two channels of an x-y recorder, or in general, to operate any device that requires an analog voltage or current and is interfaced to a digital device, such as a microcomputer.

For a general discussion of the principles of analog/digital conversion, you should read the excellent Analog Devices conversion handbook or the series of small pamphlets distributed by National Semiconductor Corporation. Important terms and concepts associated with DACs include resolution, accuracy, scale error, gain error, offset error, linearity, differential linearity, settling time, slew rate, overshoot and glitches, temperature coefficient, supply rejection, conversion rate, and output drive capability. A few of the terms have been summarized in table 1.

To help understand how you'd interface a DAC to an 8-bit microcomputer, fig. 1 shows the connections between an Analog Device AD7522 and an 8080A-based microcomputer. An important feature of this specific DAC is the fact that it is double buffered; this means that there exist within the device

---


By Peter R. Rony, Jonathan A. Titus, Christopher Titus, and David G. Larsen, WB4HYJ

Mr. Larsen, Department of Chemistry, and Dr. Rony, Department of Chemical Engineering are with the Virginia Polytechnic Institute and State University, Blacksburg, Virginia. Mr. Jonathan Titus, and Dr. Christopher Titus are with Tychon, Inc., Blacksburg, Virginia.
two independent 10-bit registers, the DAC register and the two-bit and eight-bit shift registers (fig. 2).

A DAC is an output device for a microcomputer, and thus data is strobed from the microcomputer data bus into the internal registers or latches, of the DAC. In fig. 1, are shown the connections to the 8-bit bidirectional data bus, D0 through D7, the 8080A control signals OUT or MEMW, which are used with accumulator I/O or memory I/O data transfers, and the channel select outputs 003 through 005 that are generated by a decoder tied to the microcomputer address bus.

Since the AD7522 is a 10-bit DAC, it is not possible to simultaneously load all ten bits from an 8-bit microcomputer. The sequence that actually occurs can be summarized as:

1. The DAC input bits DB0 through DB7 are first strobed into the 8-bit shift register/latch using a positive device select pulse applied at pin 24, (LBS or Low Byte Strobe).

2. The most significant two bits, DB8 and DB9, are then strobed into the 2-bit shift register via the use of a device select pulse applied at pin 25 (HBS or High Byte Strobe).

3. Finally, a device select pulse applied at pin 22 (LDAC or Load DAC) transfers the ten bits of input data, DB0 through DB9, into the second buffer within the DAC chip, the DAC register.

The output current appears at IOUT1 and IOUT2 and is converted into a voltage with the aid of a 741 operational amplifier. The two most significant bits are loaded from the eight-bit microcomputer bus using any two bits. Generally bits D0 and D1 are chosen since it makes data formatting easier. Thus, the ten bits are transferred as eight bits D0 to D7 and as two additional bits, D0 and D1.

A simple program that exercises the DAC over its full operating range is provided in table 2. The program generates a slow linear ramp at the analog out-

![fig. 1. Schematic diagram of an interface circuit between an 8080A-based microcomputer and an Analog Devices AD7522 digital-to-analog converter.](image)

![fig. 2. Functional diagram of the AD7522 IC. This figure is courtesy of Analog Devices.](image)
table 1. Important concepts and terms associated with digital-to-analog converters.

Resolution The smallest standard incremental change in output voltage of a DAC. A converter with $n$ input bits can resolve one part in $2^n$.

Accuracy Describes the worst case deviation of the DAC output voltage from a straight line drawn between zero and full scale; it includes all errors.

Settling time The elapsed time after a code transition for a DAC output to reach a final value within specified limits.

Conversion rate The speed at which a DAC can make repetitive data conversions.

Nonlinearity Error contributed by a deviation of the DAC transfer function from a best straight line function. Normally expressed as a percentage of full scale range.

Monolithic chip An integrated circuit chip in which both active and passive elements are simultaneously formed in a single small silicon wafer via the use of diffusion and epitaxial processes. Metallic stripes are evaporated onto the oxidized surface of the silicon to interconnect the elements.

Multiplying DAC A digital-to-analog converter in which the output analog signal is the product of the number represented by the digital input code and the input analog reference voltage, which may vary from scale to zero, and in some cases, even to negative values.

<table>
<thead>
<tr>
<th>LO address byte</th>
<th>instruction byte</th>
<th>mnemonic</th>
<th>comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>START: 000</td>
<td>042</td>
<td>SHLD</td>
<td>Strobe ten bits of digital data into the AD7522 DAC shift registers. The ten input data bits are contained in register pair H. The address select code for the LBS input is HI = 200 and LO = 004; the address select code for the HBS input is HI = 100 and LO = 006.</td>
</tr>
<tr>
<td>001</td>
<td>004</td>
<td>004</td>
<td></td>
</tr>
<tr>
<td>002</td>
<td>200</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td>003</td>
<td>062</td>
<td>STA</td>
<td>Strobe ten bits of digital data from the input buffer into the DAC register within the AD7522 DAC. The address select code for the LDAC input is HI = 200 and LO = 003.</td>
</tr>
<tr>
<td>004</td>
<td>003</td>
<td>003</td>
<td></td>
</tr>
<tr>
<td>005</td>
<td>200</td>
<td>200</td>
<td></td>
</tr>
<tr>
<td>006</td>
<td>043</td>
<td>INX H</td>
<td>Increment register pair H</td>
</tr>
<tr>
<td>007</td>
<td>315</td>
<td>CALL*</td>
<td>Call 10 ms time delay routine, DELAY</td>
</tr>
<tr>
<td>010</td>
<td>277</td>
<td>277</td>
<td>LO address byte of DELAY</td>
</tr>
<tr>
<td>011</td>
<td>000</td>
<td>000</td>
<td>HI address byte of DELAY</td>
</tr>
<tr>
<td>012</td>
<td>303</td>
<td>JMP</td>
<td>Unconditional jump to START, where the input of new data into the DAC occurs</td>
</tr>
<tr>
<td>013</td>
<td>000</td>
<td>000</td>
<td>LO address byte of START</td>
</tr>
<tr>
<td>014</td>
<td>003</td>
<td>003</td>
<td>HI address byte of START</td>
</tr>
</tbody>
</table>

*On the 8080-based microcomputer that we use in our courses, a 10 millisecond time delay subroutine is located in EPROM starting at HI = 000 and LO = 277. Such a routine can be located anywhere in memory.

Put of the AD7522. This can be observed on a Vom, digital multimeter, or oscilloscope. The ramp is subdivided into 1024 small steps, each step being approximately 5 mV in magnitude. The total time required to change from 0.0 volts to +5.12 volts is 10.24 seconds. The SHLD <B2> <B3> instruction outputs two data bytes in succession, from register pair H, into the input buffer registers of the DAC. The contents of register L are transferred into the 8-bit shift register, while the least significant two bits in register H go into the 2-bit shift register. Note that the address is automatically incremented, and a second MEMW control pulse generated by the 8080A when the SHLD instruction is executed. The STA <B2> <B3> instruction provides only a strobe pulse at the LDAC input to the DAC; no data transfer occurs between the accumulator and the DAC.

Other small monolithic and hybrid DAC systems are available from different manufacturers. The Analog Devices converter was chosen because of the on-the-chip latches and double buffering registers. The use of a reference potential is common to many DAC modules. Perhaps in the future it, too, will be included in the module.

references
The Perfect Mobile Rig

With its exclusive PLUG-IN-AND-GO MOBILE MOUNT, its light weight (7 pounds), and compact size (3½" high X 9½" wide X 9½" deep) the Atlas 210x/215x is the perfect mobile rig.

To go mobile just slip the 210x into its mobile mount and all connections are made automatically.

In just 10 seconds you're on the air mobile!

ATLAS 210x or 215x $679
with noise blanker $719

ATLAS RADIO INC.
417 Via Del Monte, Oceanside, CA 92054
Phone (714) 433-1983
Special Customer Service Direct Line
(714) 433-9591
MADE IN AMERICA
Cushcraft engineers have incorporated more than 30 years of design experience into the best 3 band HF beam available today. ATB-34 has superb performance with three active elements on each band, the convenience of easy assembly and modest dimensions. Value through heavy duty all aluminum construction and a price complete with 1:1 balun.

Enjoy a new world of DX communications with ATB-34!

**SPECIFICATIONS**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FORWARD GAIN</strong></td>
<td>7.5 dBi</td>
</tr>
<tr>
<td><strong>F/B RATIO</strong></td>
<td>30 dB</td>
</tr>
<tr>
<td><strong>VSER</strong></td>
<td>1.5-1</td>
</tr>
<tr>
<td><strong>POWER HANDLING</strong></td>
<td>2000 WATTS PEP</td>
</tr>
<tr>
<td><strong>BOOM LENGTH/DIA.</strong></td>
<td>18' x 2 1/8'</td>
</tr>
<tr>
<td><strong>LONGEST ELEMENT</strong></td>
<td>32'8''</td>
</tr>
<tr>
<td><strong>TURNING RADIUS</strong></td>
<td>18'9''</td>
</tr>
<tr>
<td><strong>WIND SFC</strong></td>
<td>5.4 Sq.Ft.</td>
</tr>
<tr>
<td><strong>WEIGHT</strong></td>
<td>42 Lbs.</td>
</tr>
<tr>
<td><strong>WIND SURVIVAL</strong></td>
<td>90 MPH.</td>
</tr>
</tbody>
</table>

COMPLETE NO EXTRAS TO BUY

**UPS SHIPPABLE**

IN STOCK WITH DISTRIBUTORS WORLDWIDE

Cushcraft CORPORATION

BOX 4680, MANCHESTER, N.H. 03108
**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!

**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!**
let's reduce audio pollution in the vhf bands

How's your audio quality over the repeater? Here are some ideas for improvements

Much has been written about the control and power output of vhf fm equipment. But little has been written, that I can discover, about the input part — audio signal generation — particularly the how and why of obtaining audio quality throughout the entire chain of repeater operation.

As a one-time audiophile I have paid close attention, the past several months, to the audio quality of signals being retransmitted by amateur repeaters. It’s been a pretty sad experience, but there’s a glimmer of hope. I’ve also been hearing others commenting on the situation, and steps are being taken to remedy it.

Other than from equipment electrical malfunctions, bad audio is caused mostly by close talking into the dynamic microphone that usually comes with the radio. A couple of years ago I wrote an article on the subject of proximity effect for my club paper. The article was subsequently published in ham radio. It pointed out that all conventional moving-coil microphones (including speakers used as microphones) accentuated the bass tones by a factor of 3 to 4 dB at 200 Hz (fig. 1). Such response can easily cause the first audio amplifier stage to overload and feed this signal into the transmitter.

I’ve heard many reasons why amateurs don’t remain at least 5 cm (2 inches) from their microphones, none of which are valid. Many old wives’ tales have sprung up regarding the use of microphones. The most ridiculous is that foreign equipment manufacturers have “set the audio stages of their radios for their countrymen.” Sheer nonsense! It’s usually not necessary to touch any internal controls in any radio, regardless of its origin, foreign or domestic. This statement is qualified by reminding you that, in most transceivers, audio is set using one audio frequency at a time from an audio oscillator, and that the radio and microphone are packaged in a carton as the equipment goes out the door.

talking across the microphone

The next fallacious theory to be laid to rest is the “talk-across-the-microphone” nonsense. All micro-

By Budd Meyer, K2PMA, 6505 Yellowstone Blvd., Forest Hills, New York 11375
phones are designed for speaking directly into the active element (fig. 2). The sound waves should impinge onto the element perpendicularly; the microphone element should be in the same plane as your mouth. The microphone element is designed to react to, or transduce, all frequencies pretty much equally.

Unfortunately, microphone designers have a problem in that the higher audio frequencies are more directive. The further from a straight line access to the microphone element, the greater will be the loss of the higher audio frequencies reaching the microphone element. Fig. 3 gives an idea of what happens when an audio signal (your voice) impinges indirectly onto the microphone element. Audio frequencies above about 800 Hz travel almost directly toward the element, whereas lower audio frequencies have much less directivity and much more power per unit bandwidth.

So if you talk across the microphone, the bass voice frequencies can overload the audio chain in the radio; and the high frequencies, which are essential to intelligibility, are attenuated. I'd like to emphasize that the information above applies to all microphones whether crystal, dynamic, ceramic, or whatever. If you talk across the microphone, you're going to sacrifice the higher audio frequencies.

over-deviation

Another situation that should be remedied is the idea that increasing the fm deviation will increase power output. More nonsense! The rf output of an fm transmitter is constant, and no amount of "dinking" with the deviation control will increase power output. If you adjust the deviation control so that the radio is over-deviating, all you will do is increase distortion, since the transmitted signal bandwidth will be increased.

Most amateur repeaters have some form of deviation limiting control to prevent their signals from spreading out. If your radio's deviation setting is above this predetermined limit, you'll probably experience the phenomenon of "popping out the repeater." You won't gain anything but shrugs from other repeater users who know better. You may even get an admonishment to clean up your signal.

some answers to the problem

How do you obtain good audio quality through the repeater? Much of the answer lies in the desire to do so. A standard answer you'll get, as I have, when you mention to someone who is over-deviating that perhaps he might try backing away from the microphone, is "You're the first to complain." Don't let this answer put you off. Most amateurs will back away from the microphone if asked to do so. Of course, if you tell him he sounds better at that distance from the microphone, and he realizes he's a half-meter (2 feet) away, he just might consider adjusting his microphone gain control!

simple tests

Some time ago I came across a good buy in volume unit (VU) meters for my stereo system. I purchased an additional meter and connected it to the output of my vhf transceiver, which uses an 8-ohm speaker. I now had a reference of sorts — the fact that it was qualitative rather than quantitative served my purpose. At a comfortable listening level, the VU meter indicated average and peak audio output. To get quantitative values, I connected a calibrated audio-power meter to the output, which proved the validity of my VU-meter measurements.
Being aware that most amateurs don't have VU or audio-power meters, I connected a Simpson 260 Vom to the speaker output. Lo and behold — the VU-meter and Simpson 260 Vom readings matched! Such instrumentation can be used to advise the fellows low on the other end that he's over-deviating, and you can prove it by comparison.

As a rough approximation, I suggest to the other fellow that he adjust his level to cause my VU meter, which has 300 ohms rather than the standard 600-ohm impedance, to average -7 VU and peak at -4 VU. (A correction factor of 15.75 dB must be added to the reading.) This comes out to about 7.5 mW average and 15 mW peak. These numbers are only guides; you can set your own standards based on your own equipment.

**measurement problems**

Audio measurements are subjective, which means that all such measurements obtained by instrumentation are subject to individual taste and hearing characteristics. I've listened to rigs set up by deviation meters and oscilloscopes and note that this method just doesn't accomplish the job. There are resolution problems with oscilloscopes and frequency problems with deviation meters. Personal habits and voice characteristics color the tests. Obviously an oscilloscope presentation will show clipping; however, by the time the clipping is discernible the distortion will probably be very high.

How can we obtain good audio? Probably 90 percent of the distortion heard on repeaters can be eliminated if we all talked at least 5 cm (2 inches) away from the microphone. Also, accepting the fact that talking loudly does not equate to more output power will eliminate the other major culprit causing distortion, as noted previously.

I've no recommendation for setting up metered standards since an infinite number of variables must be considered. And no matter what one could come up with, we still must contend with the subjective aspect of audio measurements. I've heard many amateurs with unbearable distortion access a repeater and ask for an audio check, only to be told that they sound good. The smartest thing to do would be to listen to your favorite repeater for awhile and learn which people give accurate reports. If one fellow consistently improves the audio of others with honest reports, then he's your man.

**level setting**

Here are some ideas for setting the level of your radio. As an example of the typical imported fm transceiver, I've provided a couple of sketches showing where to find the deviation and microphone gain control (fig. 4).

First, you must have someone listen to your signal over a period of time, preferably on a simplex frequency, so that the repeater doesn't affect your audio. Start by practicing the technique of talking at least 5 cm (2 inches) from the microphone. Once you get the hang of it, this procedure will become second nature.

**measurement problems**

Audio measurements are subjective, which means that all such measurements obtained by instrumentation are subject to individual taste and hearing characteristics. I've listened to rigs set up by deviation meters and oscilloscopes and note that this method just doesn't accomplish the job. There are resolution problems with oscilloscopes and frequency problems with deviation meters. Personal habits and voice characteristics color the tests. Obviously an oscilloscope presentation will show clipping; however, by the time the clipping is discernible the distortion will probably be very high.

How can we obtain good audio? Probably 90 percent of the distortion heard on repeaters can be eliminated if we all talked at least 5 cm (2 inches) away from the microphone. Also, accepting the fact that talking loudly does not equate to more output power will eliminate the other major culprit causing distortion, as noted previously.

I've no recommendation for setting up metered standards since an infinite number of variables must be considered. And no matter what one could come up with, we still must contend with the subjective aspect of audio measurements. I've heard many amateurs with unbearable distortion access a repeater and ask for an audio check, only to be told that they sound good. The smartest thing to do would be to listen to your favorite repeater for awhile and learn which people give accurate reports. If one fellow consistently improves the audio of others with honest reports, then he's your man.

**level setting**

Here are some ideas for setting the level of your radio. As an example of the typical imported fm transceiver, I've provided a couple of sketches showing where to find the deviation and microphone gain control (fig. 4).

First, you must have someone listen to your signal over a period of time, preferably on a simplex frequency, so that the repeater doesn't affect your audio. Start by practicing the technique of talking at least 5 cm (2 inches) from the microphone. Once you get the hang of it, this procedure will become second nature.

**measurement problems**

Audio measurements are subjective, which means that all such measurements obtained by instrumentation are subject to individual taste and hearing characteristics. I've listened to rigs set up by deviation meters and oscilloscopes and note that this method just doesn't accomplish the job. There are resolution problems with oscilloscopes and frequency problems with deviation meters. Personal habits and voice characteristics color the tests. Obviously an oscilloscope presentation will show clipping; however, by the time the clipping is discernible the distortion will probably be very high.

How can we obtain good audio? Probably 90 percent of the distortion heard on repeaters can be eliminated if we all talked at least 5 cm (2 inches) away from the microphone. Also, accepting the fact that talking loudly does not equate to more output power will eliminate the other major culprit causing distortion, as noted previously.

I've no recommendation for setting up metered standards since an infinite number of variables must be considered. And no matter what one could come up with, we still must contend with the subjective aspect of audio measurements. I've heard many amateurs with unbearable distortion access a repeater and ask for an audio check, only to be told that they sound good. The smartest thing to do would be to listen to your favorite repeater for awhile and learn which people give accurate reports. If one fellow consistently improves the audio of others with honest reports, then he's your man.

**measurement problems**

Audio measurements are subjective, which means that all such measurements obtained by instrumentation are subject to individual taste and hearing characteristics. I've listened to rigs set up by deviation meters and oscilloscopes and note that this method just doesn't accomplish the job. There are resolution problems with oscilloscopes and frequency problems with deviation meters. Personal habits and voice characteristics color the tests. Obviously an oscilloscope presentation will show clipping; however, by the time the clipping is discernible the distortion will probably be very high.

How can we obtain good audio? Probably 90 percent of the distortion heard on repeaters can be eliminated if we all talked at least 5 cm (2 inches) away from the microphone. Also, accepting the fact that talking loudly does not equate to more output power will eliminate the other major culprit causing distortion, as noted previously.

I've no recommendation for setting up metered standards since an infinite number of variables must be considered. And no matter what one could come up with, we still must contend with the subjective aspect of audio measurements. I've heard many amateurs with unbearable distortion access a repeater and ask for an audio check, only to be told that they sound good. The smartest thing to do would be to listen to your favorite repeater for awhile and learn which people give accurate reports. If one fellow consistently improves the audio of others with honest reports, then he's your man.
nature. Chances are you won’t have to touch the radio’s innards.

If you have to reduce the audio, locate the microphone gain control (not the deviation control), and turn it in small increments until your listener agrees the microphone

As a final attempt to clean up your signal, you can always buy a new microphone. Perhaps yours is out of spec, or you dropped it once too often. The thing to look for here is not so much impedance match

that your audio is sufficient and clean — no rough edges. I don’t believe that these tests can be done in committee fashion — stay with one man!

Only rarely is it necessary to touch the deviation control. What procedure do you use if there’s only one control in your radio? Not much, really. The situation then becomes a tradeoff between microphone talking distance and level. Make every attempt to keep your audio clean. If your radio has only one control, not eating the microphone is bound to improve your signal quality. Some hand-held radios use the speaker as a microphone; not much can be done here.

If your radio has a deviation control but no microphone gain control, it’s easy to adjust the deviation control so that your signal isn’t two barn doors wide. As I’ve mentioned previously some repeaters are deviation limited, and if your fm signal swing is beyond the preset standard set by the repeater, the machine will pop out when you try to talk.

Locate the deviation control, which is generally near the end of the speech amplifier and audio chain. Ask your friend to listen to your signal while you adjust the deviation control for minimum swing with clean audio. Keep in mind that excessive deviation does not increase talk power or rf output. You can adjust the deviation control so that your signal will deliver all the talk power you can use without objectionable distortion.

(since most dynamic microphones will work with most transistorized amplifiers) but the microphone output level — somewhere in the vicinity of 10-50 mV across 2000 ohms. How do you ascertain this without meters? Buy it with return privileges.

closing remarks

Let us not forget that your transmitter is only one-third of the communications chain. Repeater operators should also get into the loop. Someone in the group should listen to the average quality of the repeater audio. Sad to say, many repeaters have all kinds of added exotic features, but repeated audio is poor because no one has taken the time to check it.

We have autopatch, beeps, timers, tone-encoded outputs, frequency checks, automatic signal reports, welcoming speeches, and the like, but bad audio in many cases. I earnestly believe that control stations should absolutely and positively comment on bad audio coming into the repeater.

I hope this article will help improve a long-neglected aspect of amateur radio. I’ve found most hams to be cooperative in helping to rid the airwaves of audio pollution.

reference

DSI INSTRUMENTS INC.

Be the one who's on FREQUENCY!!

With your DSI Counter...save the shop cost of tweaking xtals... know your frequency...from 160 meters through 450 MHz. Now DSI offers the most counter for your dollar. Latest state-of-the-art technology...DSI advanced LSI design far exceeds outdated TTL. Go with the leader...buy a DSI FREQUENCY counter and SAVE TIME & MONEY!!

NOT A KIT

MODEL 3500 $139.95

500 MHZ Frequency Counter
- Includes 500 MHz Prescaler — Not an addon
- 7 Large bright — ½ inch LED Readouts
- Temperature compensated crystal timebase
- Accuracy 1 PPM Typ
- Sensitivity 50 MvRms 150 & 250 MHz 150 MvRms 450 MHz
- Gate time light
- No direct RF connection Required
- AC or DC operation
- 50 Hz to 500 MHz typ
- Comprehensive owners manual with complete accurate schematics
- Factory assembled & tested

MODEL 3600A $189.95

Includes oven timebase

600 MHZ Frequency Counter
- Includes oven compensated crystal timebase
- Includes built-in 600MHz Prescaler-Not and addon
- 8 Large bright — ½ inch LED Readouts
- Two timebases 0.1 sec & 1 sec
- Resolution 1 Hz Direct 10 Hz Prescaled
- Sensitivity 20 MvRms @ 150 & 220 MHz 100 MvRms 450 MHz
- Accuracy .5 PPM over temperature
- Oven light & Gate time light
- Automatic Decimal point placement
- NO DIRECT RF CONNECTION Required.
- Comprehensive owners manual with complete accurate schematics
- AC or DC operation
- 50 Hz to 600 MHz Typ.
- Factory assembled & tested

Use it in the car or on the bench...take it to the repeater site...high-impact case...light weight—but rugged. Designed with the latest readily available LSI, CMOS, Schottky, Meci-integrated circuits.

NEW PRODUCTS
- 250 MHz 7 Digit Battery operated hand held counter $109.95
- 3½ Digit Bench Digital Multi-meter AC or Battery operated $99.95

Visit us at the DAYTON HAMVENTION — APRIL 28, 29, 30

Strongest Warranty in the Counter Field. ONE Year Parts and Labor we pay the return shipping plus...satisfaction guaranteed...Dennis Romack...WA6OYI.

VP-MARKETING, DSI

TO ORDER CALL COLLECT (714) 565-8402

Name ___________________ Call ___________________
Address ___________________ State ______ Zip ______
Phone ___________________

Order: [ ] Check enclosed [ ] Please send more information on your full line of Instruments and Accessories.
[ ] BankAmericard [ ] MasterCharge [ ] VISA [ ] R.E.

Credit card # _______ Card expiration date _______ Signature _______

DSI INSTRUMENTS INC.
Div. Diversified Security Ind. Inc.

We pay shipping charges anywhere in the U.S.A. UPS Brown or P.P. — CA Residents please add 8% state sales tax.

- American Express — Bank of America
- MasterCharge — VISA

7914 Ronson Road No. G, San Diego, CA 92111

76 April 1978 More Details? CHECK — OFF Page 126
ALL NEW! Unparalleled DSI quality hand-held counter at a price that is affordable for any budget. Remember the 3240 is factory assembled and ready to use. GO with the leader and order your counter today.

MODEL 3240HH
$109.95
Made in USA
Not A Kit

- Fully Portable.
- Battery Operated.
- Factory Assembled.
- 7 Large .4” LED Readouts.
- 1 Year Warranty.
- 10MHZ to 250MHZ.
- Built in Ant.
- 20 HR Batt. Life.
- Uses H AA Batteries.
Finally, a digital multimeter that's yours, just like your pocket calculator, and more useful. Only $169.*

You pack only 13 ozs. in your pocket or service kit, but size is deceptive. The 8020A has more useful features than any other multimeter available—at any price! Features like 26 ranges and seven functions, including conductance, 2000-count resolution, Hi/Lo power ohms.

And it's rugged. The high-impact case protects a minimum number of component parts (47 in all), and they're all readily available from any of the worldwide Fluke service centers. Your 8020A is factory calibrated by NBS traceable equipment. And we guarantee it'll live up to published specs for a full year.

The 8020A is a true field instrument, designed with a highly readable LCD display, and inexpensive 9V transistor battery power for continuous use up to 200 hours. Reliability, quality and value: that's Fluke tradition.

To get your hands on one, call (800) 426-0361, toll free. Give us your charge-card number and we'll ship an 8020A the same day. Or, we'll tell you the location of the closest Fluke office or distributor (where you can save by buying a ten-pack of 8020As for only $1521*).

*U.S. price only.

The DMM for Home Electronics Experts.

FLUKE

The BIG DEAL — send me all available back issues right away. Enclosed is $65.00.

I want _______ back issue(s), $2.00 each or 3 for $4.95. (Specify month and year) 19 19 19 19 19 19 19

Send a free Back Issue brochure.

Charge my □ Master Charge □ BankAmericard/VISA

Acct # __________ Bank # __________

Ex. Date __________ (MC only)

Name ____________ Call __________

Address ________________________________________

City __________________ State ______ Zip ______

Mail to: HAM RADIO Magazine
Greenville, NH 03048

More Details? CHECK — OFF Page 126
Hobbyist or professional, there are probably a lot of circuits you build just for the fun of it. And a lot you'd like to build, but never get around to.

One reason is the cost of parts. Parts you buy for one project, but can't re-use... because you haven't time to take them carefully apart. Or because of heat and mechanical damage that occur when you do.

Now, there's an easier way that can save you big money on parts and hours on every project, as well: Proto-Board® Solderless Breadboards.

Now, assembling, testing and modifying circuits is as easy as pushing in... or pulling out... a lead. IC's, LED's, transistors, resistors, capacitors... virtually every kind of component... connect and interconnect instantly via long-life, nickel-silver contacts. No special patch cords or jumpers needed... just lengths of ordinary #22-30 AWG solid hookup wire.

Circuits go together as quickly as you can think them up. And parts are re-usable, so as your "junk box" builds, you build more and more projects for less and less money.

Before you invest in your next project, invest in a CSC breadboard. Order today. Call 203-624-3103 (East Coast) or 415-421-8872 (West Coast): 9 a.m.-5 p.m. local time. Major credit cards accepted. Or see your CSC dealer. Prices slightly higher outside USA.

<table>
<thead>
<tr>
<th>MODEL</th>
<th>NO. OF TIE-POINTS</th>
<th>1A PIN DIP CAPACITY</th>
<th>SUGG. LIST</th>
<th>OTHER FEATURES</th>
</tr>
</thead>
<tbody>
<tr>
<td>PB-6</td>
<td>6</td>
<td>6</td>
<td>$15.95</td>
<td>Kit - 10 minute assembly</td>
</tr>
<tr>
<td>PB-100</td>
<td>760</td>
<td>10</td>
<td>19.95</td>
<td>Kit - with larger capacity</td>
</tr>
<tr>
<td>PB-101</td>
<td>940</td>
<td>10</td>
<td>29.95</td>
<td>8 distribution buses, higher capacity</td>
</tr>
<tr>
<td>PB-102</td>
<td>1240</td>
<td>12</td>
<td>39.95</td>
<td>Large capacity, moderate price</td>
</tr>
<tr>
<td>PB-103</td>
<td>2250</td>
<td>24</td>
<td>59.95</td>
<td>Even larger capacity only 2.74 per tie point</td>
</tr>
<tr>
<td>PB-104</td>
<td>3060</td>
<td>32</td>
<td>79.95</td>
<td>Largest capacity, lowest price per tie point</td>
</tr>
<tr>
<td>PB-203</td>
<td>2250</td>
<td>24</td>
<td>80.00</td>
<td>Built-in 1%-regulated 5V, 1A low-ripple power supply</td>
</tr>
<tr>
<td>PB-203A</td>
<td>2250</td>
<td>24</td>
<td>129.95</td>
<td>As above plus separate ½-amp +10V and -10V internally adjustable regulated outputs</td>
</tr>
</tbody>
</table>

*Manufacturer's suggested list
Prices and specifications subject to change without notice.
NEW! ALDA 103 HF TRANSCEIVER

Please write for Special Package Prices
  • Superb Commercial Grade Quality and Construction
  Second to none!
  • Superior Audio Quality!
  • Totally Solid State
  • 250 Watts
  • Modular Plug-in Circuit Board Assembly
  • Dual Speed VFO Dial-Vernier
  • Semi-Break In CW with Sidetone

SUPERB NEW WAZNER Z-4 TRANSMATCH

  • Solid Inductor
  • Switchable Double-L or Pi
  • In-Out Switch
  • Commercial Grade Construction
  • 160-Meter
  • 30W

Introductory Price

CAMPARVE!

600 MHZ FREQUENCY COUNTER
WITH CRYSTAL OVEN TIMEBASE

  • Sensitive—No Direct RF Connection Required
  • Accurate—5PPM • Selectable Resolution

NEW TRISTAO'S

$189

factory assembled
not a kit

FLUKE

Model 8020A
Professional DMM

$169

Please write for details

SUPERB NEW ICOM
IC-701 HF TRANSCEIVER

$29

Introductory Price

SIGMA XR3000D LINEAR AMPLIFIER

INTRODUCTORY PRICE $789

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

SPECIFICATIONS:
  • Full band coverage 160-10 meters including MARS.
  • 2000 watts P.E.P. SSB input. 1000 watts input continuous duty.
  • CW, RTTY & SSTV.
  • Two Elmac 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 plug unit out and send to us.
  • Heavy duty commercial grade quality and construction second to no other unit at any price!
  • Weight: 90 lbs. Size: 9½” (b) x 16” (w) x 15¾” (d)

SIGMA RF-2000 SWR & POWER METER

$29

Introductory Price

SHIPPING ANYWHERE U.S. - $1

FM2015R Accessories

FMSS
FMPS-9R Regulated AC/PS
FMXMC 11 Microphone with Built-in Touch Tone Pad
FMSTD-1 1/2 Wave Portable Antenna for Hotel, Motor or Apartment $7.95
Extra DC Cord & Plug ........................................... $4.00
Service Manual .................................................. $6.00
Mounting Bracket (Extra) ..................................... $6.00

FM2015R Accessories KDK SPECIAL SALE FM14 Accessories

FMF-1 Other Option Kit - 2 Extra Positions, Cystals Required $5
FMF-2 1 MHz Offset Option Kit No Cystals to Buy $5
MARS-CAP Option Kit - Any Frequency Any Split $5

New Standard 2 Meter FM Transceivers
Model SRC 146A

Special Package SRC 146A
8多い 39.94 and 94.94 NC
USA 2 Deluxe Blue Cover $47
P3044 Leather Case $12
AT 19 Ribbed Ant. and Whip $10
N-1 cars $30

NEW!!! Touch Tone pad completely wired and ready to plug in $59.95

FLUKE

Model 8020A
Professional DMM

$169

Please write for details

NEW CDE HAM III ROTATORS— Reg. $158.95 —$125

AMATEUR- WHOLESALE ELECTRONICS

8817 S. 129th Terrace, Miami, Florida 33175
COUROUS PERSONAL SERVICE —SAME DAY SHIPMENT — Prices subject to change without notice.
Telephone: (305) 233-3631 • Telex 51-5628 • Store Hours: 10-5 Mon.-Fri.

More Details? CHECK—OFF Page 126
NEW!
THE FUTURE NOW!
FM2015R

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

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

- 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 - Unequalled 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

$419.00

Regulated AC/PS
Model FMPS-4R...$39.95

- FREQUENCY RANGE: Receive and Transmit; 144.00 to 148.995 MHz, 5KHz steps (1000 channels ) INCLUDING NEW BAND 144.5-
145.5MHz + MARS-CAP and MULTIPLE OFFSET *

- LED DIGITAL READOUT.

- 4 CHANNEL RAM SCANNER WITH IC MEMORY: Program any 4 frequencies and reprogram at any time using the front panel controls — 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 - 500 KHz PLUS or MINUS 5 KHz steps, plus simplex, any frequency.

- INTERNAL MULTIPURPOSE TONE OSCILLATOR BUILT IN: 1750 Hz 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. AIC (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.


- MODULAR COMMERCIAL GRADE CONSTRUCTION: 6 Unified 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 2⅝ x 7 x ¾. All cords, plugs, fuses, microphone hanger, etc. included. Weight 5 lbs.
NEW products

For literature on any of the new products, use our Check-Off service on page 126.

DenTron Jr. monitor antenna tuner

DenTron's newest tuner, called the Jr. Monitor, has power-handling capability of 300 watts, and can handle balanced, coaxial and random-wire-fed antennas. It also includes a relative-power-output meter and a mobile-mounting bracket. The Jr. Monitor measures a mere 5 1/2-inches wide, by 2 3/4-inches high, by 6-inches deep (14x7x15cm). This size makes it ideal for portable, mobile, or fixed operation. Designed to handle virtually any transceiver or receiver-transmitter combination, the Jr. Monitor is priced at $79.50 and is available at DenTron dealers throughout the United States and the world. For more information, write DenTron Radio Company, 2100 Enterprise Parkway, Twinsburg, Ohio 44087.

OSCAR amateur radio satellites

For most amateurs, obtaining information about any of the Oscar satellites has been somewhat of a piecemeal process. Almost every area of interest was covered in a separate publication or source, and some information just did not seem to be available at all.

Author and engineer Stratis Carmanolis has written a very useful book, OSCAR Amateur Radio Satellites, that ties it all together in one place. The original was published in German, and now an English-language version is being distributed by the Radio Society of Great Britain, and by Ham Radio's Communications Bookstore.

Almost any question that you may have about amateur radio satellites can be answered by consulting OSCAR Amateur Radio Satellites. It shows a high degree of competence in presenting the technical and theoretical facts of satellite operation, but at the same time these facts are covered in language that the non-engineer can understand and work with. The author uses just enough mathematics to prove whatever theory or point is being discussed, but not so much as to scare away any neophyte to amateur radio or satellite communications.

The book starts out with a discussion of the solar system from the first misconceptions that placed the earth at the center of the universe, and brings you right through the changes in scientific thinking into the current period of knowledge, which was started by Johannes Kepler. The first three laws formulated by Kepler are essential in understanding the mechanics of orbiting bodies, no matter what size they are. The book uses this Keplerian foundation to build a subsequent discussion of satellite orbital mechanics starting with a simple explanation of the trajectory of a projectile and then developing this into a trajectory that has no terminus, thus being an orbit.

Once the essential mechanics of orbits and satellite theory are taken care of, the author gets into a good explanation of satellite types, systems, control, power requirements, and structures. This is followed by a chapter on the fundamentals of telecommunications by means of satellites, which includes such areas as free-space loss (of signal strength) and receiver sensitivity — both important considerations if you plan to use a satellite system.

All of this groundwork material takes up a good portion of the book, but it is interesting and essential reading if you are to really understand what makes any satellite behave the way it does. Chapter seven is the first one that is devoted entirely to amateur radio satellites, and it starts with the background of amateur work in planning, building, and launching the first OSCAR. It continues with a history of each amateur satellite right through to the current OSCARs 6 and 7.

This chapter is followed by one that, logically, devotes many pages to detailed descriptions of all the systems that go to make up an OSCAR satellite package — transponders, telemetry, antennas, receivers, modes, decoding, and much more. It explains how you can calculate orbital information, how you can interpret the telemetry data that indicates the condition of the spacecraft systems, and what you need at your home (ground) station to work with satellites.

The last chapter is devoted to the subject of learning with satellites. It is a section designed to acquaint educators with the possibilities of classroom use of amateur satellite signals and experiments. The author points out some of the uses that have been made of this material, and provides names and addresses where those interested can obtain more information. Some samples of techniques useful in classrooms are given, such as measurement and explanation of Doppler effects, orbital data, and transmission of amateur television and weather satellite pictures through the OSCAR spacecraft. Future satellites are discussed, but because of the many variables in timing of launch vehicles, satellite construction, and the like, this coverage can be only tentative at best.
All-in-all, the book is recommended as an excellent reference for the amateur (or anyone else) who is curious about any phase of satellites, or who is seriously contemplating the use of OSCAR for communication or educational purposes. *OSCAR Amateur Radio Satellites*, by Stratis Caramanolis, is 194 pages, paperback, and is $8.50 postpaid from Ham Radio's Communications Bookstore, Greenville, New Hampshire 03048; order RS-0.

**active filter design**

*The Design of Active Filters and Experiments* by Howard M. Berlin, published by E&L Instruments, is an introduction to theory, implementation, and design of active filters. The text includes descriptions and schematic diagrams of designs for the various lowpass, highpass, bandpass, and notch filters based on the 741 operational amplifier IC. Recommended for the experimenter and hobbyist who want to learn the basics of active filters, the book is complete enough to serve as a college-level laboratory manual. It is also an excellent reference for the practicing circuit designer.

---

**Antenna Baluns**

- **1 Kw CW, 3 Kw PEP input.** For dipoles, inverted Vees, beams, quads. Dependable. Takes temporary overloads in stride. Specify 1:1 or 4:1 ratio. **Model 1K $16.95**
- **2 Kw CW, 6 Kw PEP input.** Far more rugged than any other balun made for amateur use. Specify 1:1 or 4:1 ratio. **Model 2K $32.50**
- **2 Kw CW, 6 Kw PEP input.** Our heavy duty balun with mounting bracket for 2" mast or boom. Specify 1:1 or 4:1 ratio. **Beam Balun $37.50**

Only Palomar Baluns Have All These Features
- RF toroidal core for highest efficiency.
- Teflon insulated wire.
- Stainless steel hardware. Won’t rust.
- Epoxy filled case. Waterproof.
- Wideband 1.7 to 30 MHz.
- White case to reflect the sun.
- Lightning protection built in.

Free brochure sent on request

How many lightweight baluns have you burned out already? Install the balun that will stay up there working year after year.

Order direct. Add $2 shipping/handling. California residents add sales tax.

**Palomar Engineers**

Box 455, Escondido, CA. 92025 • Phone: (714) 747-3343
UV-3 PRICE REDUCTION

In this day of rising prices on almost everything, it is not only refreshing but even remarkable to be able to announce a significant price reduction on the Drake UV-3 System.

How can this be? Well, considering that no one has ever produced a 144-220-440 MHz multi-band fm system before, at the time it was priced we could only use our best estimate on materials, labor, etc. Now that we are shipping the first UV-3 units, we refigured our costs on the entire system and are pleased to announce that we can pass along these substantial savings to you:

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
<th>Original Price</th>
<th>Reduced Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>1346</td>
<td>Drake UV-3 (144-220-440)</td>
<td>$995.00</td>
<td>$795.00</td>
</tr>
<tr>
<td>1344</td>
<td>Drake UV-3 (144-440)</td>
<td>$795.00</td>
<td>$695.00</td>
</tr>
<tr>
<td>1343</td>
<td>Drake UV-3 (144-220)</td>
<td>$795.00</td>
<td>$695.00</td>
</tr>
<tr>
<td>1345</td>
<td>Drake UV-3 (220-440)</td>
<td>$795.00</td>
<td>$695.00</td>
</tr>
<tr>
<td>1340</td>
<td>Drake UV-3 (144)</td>
<td>$695.00</td>
<td>$695.00</td>
</tr>
<tr>
<td>1359</td>
<td>Drake UV-3E (144-430)</td>
<td>$595.00</td>
<td>$595.00</td>
</tr>
</tbody>
</table>

(Prices above include factory installed modules for bands as listed, standard dynamic mike, and mobile mounting bracket.)

Model 1346 Drake UV-3 (144-220-440) ................................ $995.00 $795.00
Model 1344 Drake UV-3 (144-440) ..................................... $795.00 $695.00
Model 1343 Drake UV-3 (144-220) ..................................... $795.00 $695.00
Model 1345 Drake UV-3 (220-440) ..................................... $795.00 $695.00
Model 1340 Drake UV-3 (144) .......................................... $695.00 $695.00
Model 1359 Drake UV-3E (144-430) European Model ............. see dealer

*Add-on modules expand band coverage of models which may have been purchased in a single band or two band configuration. Prices include factory installation which is necessary to meet FCC Type Certification requirements.

To receive a FREE Drake Full Line Catalog, please send name and date of this publication to:

R. L. DRAKE COMPANY
540 Richard Street, Miamisburg, Ohio 45442 • Phone (513) 866-2421 • Telex 288-017
Western Sales and Service Center, 2020 Western Street, Las Vegas, Nevada 89102 • 702/382-9470

flex-i-pak
instrument case

A flexible instrument housing system has just been designed by the Buckeye Stamping Company of Columbus, Ohio. This case, tradenamed Flex-i-pak, is supplied in a basic unit/frame configuration with a variety of chassis and brackets to choose from. This allows custom designing of prototype units at a minimum cost, without tooling. It’s also a sturdy, economical case for production run equipment.

Since Flex-i-pak extrusions, brackets, and panels contain a pattern of holes on 1/2 inch (12.5cm) centers, an almost infinite number of configurations is possible. Card guides may be installed spaced for popular connector lengths.

The basic case features vinyl covered top and bottom, with side rails and perimeter frame of extruded aluminum. The standard case width is 17 inches (43cm) with 13-inch (33cm), 16-inch (41cm), or 20-inch (51cm) depths. Heights are 3-1/2, 5-1/4, 7, 8-3/4, 10-1/2, and 12-1/4 inches (8.9, 13.3, 17.8, 22.2, 26.7, and 31.1cm).

For complete specifications, contact The Buckeye Stamping Company, 555 Marion Road, Columbus, Ohio 43207.
WHERE RELIABILITY & ACCURACY COUNT

INTERNATIONAL CRYSTALS
70 KHz to 160 MHz

HOLDER TYPES

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

INTERNATIONAL CRYSTAL MFG. CO., INC.
10 North Lee, Oklahoma City, Oklahoma 73102
405/236-3741
'Hiram Percy Maxim' will be a featured book among the several hundred book titles awaiting you at Ham Radio's exciting exhibit at the Dayton Hamvention.

Inventor, author, technological pioneer — the life story of the 'Father of Amateur Radio' details this outstanding American's unique contributions. You can use this special show savings coupon or purchase the book directly from HRPG for just $4.50.

Visit Ham Radio — and 'Hiram Percy Maxim' at the Dayton Hamvention. See you there!

HAM RADIO PUBLISHING GROUP
GREENVILLE, NH 03048

---

**NEW FROM GLB**

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

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

Now available in KIT FORM — GLB Model 200 MINI-SIZER.

Fits any HT. Only 3.5 mA current drain. Kit price $159.95 Wired and tested. $239.95

Send for FREE 16 page catalog.

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

---

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

---

Visit the Ham Radio Publishing Group's exhibition at the Dayton Hamvention and present this coupon for a 10% discount on the cover price of Hiram Percy Maxim.

This coupon is good only at the Dayton Hamvention on April 28th, 29th, and 30th, 1978.

---
TEN-TEC 540/544 — the transceivers that almost seem like an extension of yourself. Following your every command, easily, simply — because we did our homework. They are designed with the same out-front thinking that characterizes all Ten-Tec equipment — super-sophisticated to make things simple for you.

TAKE BAND CHANGING. IT'S SIMPLE! No more peak and dip, peak and dip. Just snap a switch and there you are. Anywhere you want to be, in any part of a band segment — and always at full efficiency without danger of out-of-resonance damage to the final amplifier. Thanks to the Ten-Tec broadband design, and thanks to the leadership of Ten-Tec engineers in solid-state high power HF design.

FREQUENCY READOUT. IT'S SIMPLE! The 544 has big easy-to-read numerals with significant figures in red for instant recognition. No more studying a dial or misreading, and no more lags in readout — you instantly know where you are on the band. Even the 540 has an optional add-on digital readout, in case you change your mind later. More operating simplicity from Ten-Tec.

THE SMART "S"-METER. IT MAKES THINGS SIMPLE FOR YOU. It's electronically switched to read SWR when you are transmitting so that without throwing switches you know at a glance that the correct antenna is in use. Simple for you, extra effort for us.

IGNAL HANDLING OF ALL SIZES. IT'S SIMPLE! From the “down under” DX to the KW next door, the 540/544 series' dynamic range goes a long way in minimizing front-end overload. And that's important in today's growing amateur radio population. So is the 8-pole i-f filter. It gives you State-of-the-Art signal separation in those crowded bands — to make your operating simpler, more enjoyable.

SUPERIOR SPEECH QUALITY. IT'S SIMPLE! Ten-Tec rigs are known for their crisp articulation — the kind that brings compliments and satisfaction. Articulated, shaped speech for maximum penetration, yet smooth and clean, with less than 2% distortion to reduce fatigue and enhance the quality of both transmitted and received signals. The signal that's easy to listen to is the one everyone wants to work. And it's yours in the sophisticated simplicity of the 540/544.

CW CONVERSATION. IT'S SIMPLE! The CW buffs used to speak in monologs. Now they carry on conversations, thanks to Ten-Tec's full break-in. It provides a constant window on the band to check for QRM, to save useless calling, to allow conversations that are natural, easier, and a lot more fun. And no more clattering relays! Simply sophisticated.

FAST, EASY, LOW-COST SERVICING. IT'S SIMPLE! The thoughtful modular design of the 540/544 makes any trouble-shooting simple and fast, resolving itself down to one of 22 circuit boards, any of which are readily replaced or serviced in the field! Or give the Ten-Tec service people a shout — they will have an exchange on its way to you the same day.

But, best of all, little if any service will be needed because while your 540/544 is sophisticated, complex equipment, it also is designed to conservative ratings with high standards of American craftsmanship. Simply durable.

FEATURES — • Instant Band Change (no xmtt. tune-up) • Covers 3.5 to 30 MHz (plus One-Sixty with option) • 200 Watts Input — all bands • Receiver Sensitivity 0.3 uV • VFO changes less than 15 Hz per ° after 30 min. warm-up • 8-pole Crystal IF Filter • Direct Readouts — choose LED digital model or 1 kHz dial model • 1 kHz CW filter • Offset Tuning • WWV at 10 & 15 MHz • Separate Receive Capability • Automatic Sidetone Selection, Reversible • Sidetone Level and Pitch control • Pre-Setable ALC • 100% Duty Cycle • S Meter and SWR Bridge • LED indicators for ALC and OFFSET • Modular Plug-In Circuit Boards • Broad Accessory Line

544 Digital — $869 540 Non-digital — $699

To make your operating simple, simply see your Ten-Tec dealer, or write for full details.
TEN-TEC HEADQUARTERS

ENCORE! ENCORE!
TEN-TEC'S 540 GOES 544!
REQUEST FURTHER DETAILS

ELECTRONIC DISTRIBUTORS, INC.
Communications Specialists for over 39 Years

1960 PECK STREET
MUSKEGON, MICHIGAN 49441

You can't buy a better 2-Meter Antenna

Make the best of fine equipment
Take full advantage of the potential of fine radios with Antler. The famous Antler %-wave "Posi-Grip" magnetic mount ... or the easy-to-install roof or trunk mount that snaps into a ⅜" hole.
There's also a new snap-in "shorty" %-wave. Ideal for repeater use and in-town driving with overhead obstruction problems. You can rely on precision engineering and craftsmanship with "made in U.S.A." quality. Antler ... you can't buy a better antenna.

antler antennas

More Details? CHECK — OFF Page 126
SUBSCRIBE NOW

TO AMATEUR RADIO'S
JAM-PACKED TECHNICAL
MAGAZINE

Yes, HAM RADIO, I'll take you up on your offer, let me save up to 45% off the newsstand cost. Send me my FREE biography of Hiram Percy Maxim and start my subscription with the next available issue. I understand I may cancel my subscription at any time and receive a refund for all undelivered copies and the book is mine to keep in any case.

SAVE UP TO $24
OFF THE NEWSSTAND PRICE.

"Hiram Percy Maxim" is the life-saga of the fascinating American who contributed more to Amateur Radio than any other individual. This unique story documents Maxim's accomplishments as an inventor, author and pioneer in many fields during an era of unprecedented technological progress. Includes fascinating excerpts from Maxim's "The Old Man" editorials that appeared in early issues of QST. This $4.50 value, yours FREE by subscribing now.
And behold there was a great earthquake for the Angel of the Lord descended from Heaven, and came and rolled back the stone from the door. And the Angel said to the women, "Fear not, for I know that ye seek Jesus who was crucified. He is not here; for he is risen as he said. Come see the place where the Lord lay."

Then the eleven disciples went to Galilee... and when they saw him they worshipped him: but some doubted. And Jesus came and spoke to them saying, "All power is given to me in Heaven and in earth. Go ye therefore and teach all nations baptizing them in the name of the Father, Son and Holy Spirit, and lo, I am with you always, even to the end of the world."

Matthew 28, 2-20

We would like to share the message and joy of Christ risen this Easter.

DenTron Radio Co., Inc.
2100 Enterprise Parkway
Twinsburg, Ohio 44087
(216) 425-3173

Pipo Communications

PEOPLE WHO KNOW QUALITY
AND NEED RELIABILITY
(Military, Industry, RCC's) Demand
Pipo Communications For Trouble Free
Touch Tone Encoders

See You At DAYTON

WANT TO KNOW WHY?
Send for Descriptive Brochure and Complete Dealers List
P.O. Box 3435, Dept. B, Hollywood, CA 90028

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


$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.

$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.

WRITE FOR FREE BROCHURE!

90 APRIL 1978

More Details? CHECK — OFF Page 126
**FAMOUS HAMTRONICS PREAMPS**

**let you hear the weak ones!**

Great for OSCAR, SSB, FM, ATV. Over 10,000 in use throughout the world on all types of receivers.

- **P9 Kit** $12.95
- **P14 Wired** $24.95

Deluxe vhf model for applications where space permits.

- **VX2-4** 28-30 MHz, output with 5 MW of drive
- **VX2-5** 28-29 MHz, output with 5 MW of drive
- **VX2-6** 26-28 MHz, output with 5 MW of drive

**MODEL RANGE**

- **P9-LO** 26-88 MHz
- **P9-HI** 88-172 MHz
- **P9-220** 172-230 MHz
- **P14 Wired** Give exact band

**Features**

- Linear Converter for SSB, CW, FM, etc.
- A fraction of the price of other units
- 2W p.e.p. output with 5 MW of drive
- Use low power tap on an exciter or attenuator pad
- Easy to align with built-in test points

**New VHF&UHF Converter Kits**

**let you receive OSCAR signals and other exciting SSB, CW, & FM activity on your present HF receiver.**

- **Only $34.95**

**Model Range**

- **C50** 50-52 MHz, 28-30 MHz
- **C144** 144-146 MHz, 28-30 MHz
- **C145** 145-147 MHz, 28-30 MHz
- **C146** 146-148 MHz, 28-30 MHz
- **C110** Aircraft, 28-30 MHz
- **C220** Band, 28-30 MHz

**Features**

- NEW GENERATION RECEIVERS
- MORE SENSITIVE & MORE SELECTIVE (70 or 100 dB)
- COMMERCIAL GRADE DESIGN
- EASY TO ALIGN WITH BUILT-IN TEST CKTS
- LOWER OVERALL COST THAN EVER BEFORE

**VHF/UHF FM RCVR KITS**

- 6-channel VHF Receiver Kit for 2M, 6M, 10M, 20 MHz, or color bands
- Optional 8-channel filter for 100 dB adj. channel

**RF Power Amplifiers**

- **I-F Range**

**Frequency Schemes Available**

- **VX2-4** 28-30 = 144 MHz
- **VX2-5** 28-29 = 145 MHz
- **VX2-6** 26-28 = 146 MHz

**2M LINEAR POWER AMPLIFIERS**

- **LPA-2** 15 W p.e.p., $69.95
- **LPA-20** 70 W p.e.p., $139.95

**40 PAGE CATALOG IS YOURS FOR THE ASKING!**

**IT'S EASY TO ORDER!**

- **Call or Write Now For Free Catalog or To Place Order:**
  - 716-564-2581
  - 514-462-2640

**IN CANADA, send to Comtec: 5605 Westlake Ave, Montreal, Que H4W 2N3 or phone 514-462-2640. Add 28% to cover duty, tax, and exchange rate.

**hamtronics, inc.**

182-C Belmont Rd; Rochester, NY 14612
HAVE YOU WORKED THE NEW OSCAR 8 SATELLITE?
IT'S UP THERE NOW, AND READY FOR USE.
AND LUNAR PUTS YOU THERE!

NEW FROM LUNAR OSCARBOX

"J"

Dual frequency receiving Model J. down converter for reception of the new OSCAR 8 satellite.
Use your Mode A receiver for Mode J. 435-1.2 converts to 29.4-5
432 converts to 28.0 by use of front panel selector switch for normal 432 reception capability.

SPECIFICATIONS:
NF 3 dB Nominal. Conversion Gain 27 dB. Nominal. Power required: 11 to 14 Volts DC, 50 mil amps nominal. Available with three connector configurations:

In Line Switching PREAMPLIFIERS

Newest addition to the preamplifier line from Lunar
In Line RF Actuated PREAMPLIFIER

For use external to your transceive.

SO 239 input, RCA output. $99.95
Type N input, BNC output. BNC input, BNC output. $99.95

Additional models available soon.
Also new from Lunar PREAMPLIFIER PAE424-2
Under 1.0 dB NF, 16 dB Gain.

MODEL 1275 KIT
REGULAR $59.50 VALUE, NOW ONLY $35.95

FACTORY PROGRAMMED

Make/Model Fast/Slow/No AGC Control
Yaesu FT-101 Series Yes No
Yaesu FR-101, FT-301, FT-901 Yes No
Kenwood TS-520, TS-820, R-599 Yes No
Heath SB-104 Yes No
Drake R-4C, TR-4C Yes No
Tempe 2020, etc., etc., etc., etc.

Your FT-101 should have this control, like the others, to improve CW/SSB reception under difficult conditions. Our new kit makes it easy and inexpensive. No holes to drill, only two soldered connections to rig, complete easy-to-follow instructions. Includes all parts — even solder!

THEY MIGHT WORK LIKE THIS:

$500 AIRMILE POSTPAID US & CANADA. OVERSEAS ADD $1.

Another winning idea from the International Fox Tango Club. Money back guarantee.

FT ACCESSORIES
DIVISION OF FOX TANGO CORPORATION
BOX 274, BRONX, N. Y. 10463

FT-101 OWNERS

Does your rig have a fast/low/no AGC control? Compare it with these other fine sets:

Make/Model Fast/Slow/No AGC Control

MODEL 11764 — semi-auto, MCW Idler Kit
MODEL 12751 — connects in line between mic, and transmitter requiring no modification to transceiver — automatic 1 to 10 min. timer 5 to 40 wpm adjustable code speed — built-in squelch tail — auto or manual models — ideal for repeaters 5" x 7" PCB and 20-page manual.

FULLY AUTOMATIC C.W. IDENTIFIER

MODEL 12751 KIT

PROGRAMMABLE CODE SPEED

MODEL 11765 — beacon CW Idler

PROGRAMMABLE CODE SPEED — GREAT FOR 1750-METER BAND — 1.3" x 2.5" PCB — $19.95/kit

MODEL 11766 — programmable code speed — great for 1750-meter band — 1.3" x 2.5" PCB — $24.95/kit

FACTORY PROGRAMMED MEMORY IDER KITS

MODEL 11764 — adjustable audio level, programmable code speed, tone and repeat interval 1.7" x 3" PCB — $9.95/kit

MODEL 97710 — manual CW Idler programmable code speed & IDs upon request — ideal for contesting or repeated messages 1.5" x 2.2" PCB — $24.95/kit

includes $3 ship/hand, 6% tax. COD accepted.

2 weeks on personal checks. Write for additional information.

Phone (408) 294-8383

SECFURIOH Oo
P. O. Box 24899
San Jose, Ca 95154

$5 foreign, CA res. add Snd check or MO, allow 2 weeks.

FT-101 OWNERS

Does your rig have a fast/low/no AGC control? Compare it with these other fine sets:
THE FIRST NAME IN AMATEUR "HAND-HELD" RADIOS

FAMOUS Mark II & Mark IV 2-METER HAND-HELDs

Mark II
2½-Watt $219.95
Mark IV
4-Watt $249.95

Wilson's Mark II and Mark IV—the smallest size hand-held two-meter transceivers ever marketed. These high-performing, high-quality, American-made radios are designed for the Amateur who demands the ultimate in dependability, durability, ease of servicing—and value. Both models feature excellent adjacent channel selectivity and intermod/image rejection (60 dB). Individual trimmers on all TX/RX crystals. Microswitch control of Transmit/Receive. Can be modified for MARS or CAP operation. Easily accessible circuitry for simplified servicing. Powered by inexpensive rechargeable Ni-Cad battery pack. Includes rubber flex antenna and one pair of crystals (146.52/.52 MHz). BNC type antenna connector. Attractive and rugged blue-gray Lexan® outer case. Double conversion receiver with sensitivity of 0.3 uV or less for 20 dB quieting. Freq. Range: 144-146 MHz. Size: 6½" x 1.77" x 2.44". Weight: 1 lb.

Wilson Mark II, 2.5-watt RF output. $219.95
Wilson Mark IV, 4-watt RF output. $249.95

ACCESSORIES
Model BC-2 Desk Battery Charger, ½ lb. $39.95
Model BP-4 Rechargeable Battery Pack, ½ lb. $20.95
Model LC-3 Leather Carrying Case, 1 lb. $18.95
Model SM-3 Speaker Mike, Wt. 1 lb. $30.95
Model TTP Auto Patch Pad. Factory installed at time of purchase only. Add to price of radio. $61.95

MOBILE/PORTABLE 2-METER 800-CHANNEL SYNTHESIZED RADIO

Model WE-800 $459.00

All-purpose 2-meter rig operates on 800 channels from 144,000 to 147,995 MHz in 5 kHz steps—or down 600 kHz for local repeater. Provision for pre-programming five frequencies or changing to two optional offsets. Detachable rubber flex antenna, S-meter/output indicator. With plug-in speaker-mike, mobile bracket/handle. Powered by 13.6 VDC negative ground; takes optional rechargeable battery pack. 6½" x 6½" x 1½". Wt. 3 lbs.

Model WE-800. $459.00

PRICES AND SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE
NEW! 600 MHz Mini Counter

See You at the Dayton Show

NOW:...
• Complete PORTABLE with Ni-Cd Batteries
• Crystal Oven Available

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
- B Digit 4" LED Display
- 115V or 12V Operation
- Input Cable Included
- 12V Input Jack
- Gate Light

720BK 600 MHz Kit .... $149.95
720B Assembled .... $199.95

OPTIONS:...
01) Portable w/Ni-Cd Battery (Built-in Charger) .... $39.95
02) Crystal Oven (1 ppm 0 to 60°C) .... $37.95
03) Handle .... $5.00

DAVIS ELECTRONICS 636 Sheridan Dr., Tonawanda, NY 14150 716/874-5848

QUALITY KENWOOD TRANSCEIVERS

...from KLAUS RADIO

The TS-820S is the rig that is the talk of the Ham Bands. Too many built-in features to list here. What a rig and only $1098.00 ppd. in U.S.A. Many accessories are also available to increase your operating pleasure and station versatility.

TS-820S

160-10M TRANSCEIVER

Super 2-meter operating capability is yours with this ultimate design. Operates all modes: SSB (upper & lower), FM, AM and CW. 4 MHz coverage (144 to 148 MHz). The combination of this unit’s many exciting features with the quality & reliability that is inherent in Kenwood equipment is yours for only $1299.00 ppd. in U.S.A.

TS-700S

2M TRANSCEIVER

Guess which transceiver has made the Kenwood name near and dear to Amateur operators, probably more than any other piece of equipment? That’s right, the TS-520S. Reliability is the name of this rig in capital letters. 80 thru 10 meters with many, many built-in features for only $739.00 ppd. in U.S.A.

TR-7400A

2M MOBILE TRANSCEIVER

Send SASE NOW for detailed info on these systems as well as on many other fine lines. Or, better still, visit our store Monday thru Friday from 8:00 a.m. thru 5:00 p.m.

The Amateurs at Klaus Radio are here to assist you in the selection of the optimum unit to fulfill your needs.

KLAUS RADIO Inc.
8400 N. Pioneer Parkway, Peoria, IL 61614
Jim Plack W9NWE — Phone 309-691-4840

COLLINS & MORE

Ham Gear

Collins 18081, Antenna tuner $325
Collins 301L, Linear amp. $995
Collins 31284, Stat. Contl, rd, exc. $750
Collins 31285, Vfo Console, vy gd $550
Collins 31284, Vfo Console, new, orig. box $750
Collins 3283, Transmitter, rnd, exc. $1895
Collins MP-1, DC supply, new $175
Collins R-388/S113, rcv, vy gd $275
Collins 7553, Ham receiver, vy gd $245
Collins 7553A, Ham receiver, vy gd $245
Collins 5151, 2.5MHz rcvr Special $395
Collins CP-1 Crystal Pack $395
Johnson KW Matchbox, w/SWWR meter $225
National NCL 2000, Linear amp., vy gd $50
Racal 6217E, 5-30MHz receiver Special $390

Test Gear

HP-302A Wave Analyzer $495
HP RM 5080D, 10-4200MHz sig. gen. $595
Tektronix 585A, scope, 80-MHz bandwidth $395
Tektronix 585A, scope, 80-MHz bandwidth $395
Tektronix 585A, scope, 80-MHz bandwidth $395
Tektronix 585A, scope, 80-MHz bandwidth $395

DAMES COMMUNICATION SYSTEMS

201-998-4256
10 SCHUYLER AVENUE
NORTH ARLINGTON, N.J. 07032

All equipment sold checked and realigned

PCP "TYPE-A"

SEE POPULAR ELECTRONICS

FEB.'78 ISSUE!

GROTH-Type

COUNTS & DISPLAYS YOUR TURNS

• 99.99 Turns
• One Hole
• Panel Mount
• Handy Logging Area
• Spinner Handle Available

Case: 2x4"; shaft 1/4x3/4"
Model TC2: Skirt 2-1/8";
Knob 1-5/8"
Model TC3: Skirt 3"
Knob 2-3/8"

PRICES

Post Priced

TC 2 - $8.00
TC 3 - $8.75
Spinner (5) - $1.50
Add $0.75 per Art or UFS

R. H. BAUMAN SALES

P.O. Box 122, Itasca, Ill. 60143
Pound for pound, there is no match for the

Vhf engineering

PS-25M Power Supply

25 Amp regulated power supply with fold back current limiting, over voltage and transient protection. Also, output voltage and current meters.

You might find a cheaper power supply, but you can't find one as well built with top quality components. Other power supplies with lighter weight transformers and components are no match for the VHF Engineering PS-25M. It is rated at 14 amps continuous duty (not 10 amps). This power means extra dependability and versatility when you need it.

Compare VHF Engineering's quality and specifications.

FEATURES
- Over-voltage protection crowbar.
- Electrostatic shield for added transient surge protection.
- A foldback output limiter operates for loads outside of the operating range.
- Isolation from ground. The circuit is isolated from the case and ground.
- 115/220 volt input - 50/60 cycle.
- Units are factory wired for 110 volt AC, 50/60 cycle power. A simple jumper will reconfigure the input for 220 volt AC, 50/60 cycles.
- Temperature range-operating 0 to +55 C.
- Black anodized aluminum finish.

SPECIFICATIONS
Voltage Output: adjustable between 10-15V
Load Regulation: 2% from no load to 20 amps
Current Output: 25 amps intermittent (50% duty cycle)
14 amps continuous
Ripple: 50 mV at 20 amps
Weight: 25 pounds
Size: 12¼" x 6¾" x 7½"

PS-25M - 21 lb. 6 oz.
Wired & tested ($8.42 per lb.) . . . $179.95
Kit ($7.25 per lb.) . . . . . . . . . . $154.95

The competition
Weighs about 10 lbs. less than the PS-25M ($12.63 per lb.) . . . . . . $139.00

DIVISION DIVISION OF BROWNIAN ELECTRONICS CORP.
320 WATER STREET / BINGHAMTON, NEW YORK 13901 / PHONE 607-723-9574
F.O.B. Binghamton / Prices and specifications subject to change without notice. / Export prices slightly higher.
Look what's new from Whitehouse:

**DX-ARRAYS 20 ELEMENTS**

<table>
<thead>
<tr>
<th>DX-ARRAYS 20 ELEMENTS</th>
<th>OUR PRICE</th>
</tr>
</thead>
<tbody>
<tr>
<td>DX 120 144 MHz</td>
<td>$42.95</td>
</tr>
<tr>
<td>OUR PRICE &amp; MAIL ORDER</td>
<td>$39.95</td>
</tr>
</tbody>
</table>

**OSCAR ANTENNAS**

- A144-10T 145 MHz 10 El. Twist $34.95
- A432-20T 430-450 MHz 20 El. Twist $49.95
- A14T MB Twist Boom & Bracket $15.95

Total List Price $108.85
OUR PRICE $94.95

**RINGO RANGER for FM**

- ARX 2 135-170 MHz YOUR CHOICE $30.00
- ARX 220 220-225 MHz
- ARX 450 435-450 MHz Delivered in USA Reg. List $32.95

Make 2 Meters all the fun you had hoped for... put more signal into the other guy's receiver with a new Cushcraft 2 meter antenna.

- A147-4 146-148 MHz 4 El. Yagi $19.95
- A147-11 146-148 MHz 11 El. Yagi $29.95
- A147-22 146-148 MHz 22 El. Yagi $84.95
- AFM 4D 144-148 MHz Four Pole (95B over ½ wave dipole) $69.95
- A14410T 145 MHz 10 El. Twist $34.95
- A144-20T 145 MHz 20 El. Twist $54.95
- A147-20T 146 & 147 MHz 20 El. Twist $84.95

Prices subject to change without notice.

**CUSHCRAFT HF ANTENNAS**

- ATB-34 Tri-band 4 El. $224.95
- A14-M 14 MHz 3 El. Monoband $125.95
- A21-4 21 MHz 4 El. Monoband $107.95
- A28-4 28 MHz 4 El. Monoband $71.95

Move those 220 and 430 MHz signals in and out with the quality you deserve. A Cushcraft antenna from G.R. Whitehouse & Co.

**Ringing the Changes**

- A Cushcraft antenna from G.R. Whitehouse & Co.
- A220-7 220-225 MHz 7 El. $21.95
- A220-11 220-225 MHz 11 El. $27.95
- A220-20 220-225 MHz 20 El. $84.95
- AFM 24D 220-225 MHz Four Pole $57.95
- AFM 4D 440-450 MHz Four Pole $54.95
- A3220T 430-450 MHz 20 El. $0.95

Excellent stability

Send for more information.

**AVIONICS FOR HAM PILOTS**

Free catalog describes high technology, low cost avionics and test equipment offered in kit form. Product line includes audio panel, aircraft band two-channel transceiver, digital chronometer, navigation and communications test equipment, bench power supply, and more. Shoot us the coupon for details.

Name ____________________________
Address __________________________________
City ____________________________________
State ___________________ Zip ______

Price $19.95
Freq. set at factory $5.00 extra
Call for availability

More Details? CHECK — OFF Page 126

96 APRIL 1978
YOUR BEST BUY IN KITS

6 GOOD REASONS FOR BUYING A HAL-TRONIX FREQUENCY COUNTER

(1) 100% COMPLETE KIT. (2) EASY ASSEMBLY. (3) COMPLETELY ENCLOURED IN METAL CABINET. (4) IC SOCKETS USED THROUGHOUT. (5) FAST REPLACEMENT. (6) COSTS LESS THAN ON YOUR POCKET BOOK. AND (6) NO EXPENSIVE CHIPS TO REPLACE. (EXAMPLE — IF YOU LOSE A DECIDER, LATCH OR DRIVER IN HAL-TRONIX COUNTER, THE AVERAGE COST OF REPLACEMENT OF THE LOW-COST TTL IS LESS THAN $1.00) EXCLUDING THE PRE-SCALE CHIPS IN SOME OF THE NEWER COUNTERS NOW BEING MARKETED BY MY COMPETITION, THEY ARE USING THE EXOTIC SINGLE CHIP AND WOULD COST YOU CLOSE TO $30.00 TO REPLACE). THIS IS SOMETHING YOU SHOULD CONSIDER.

ANALOG-DIGILAB KIT $139.50

DESIGNED BY HAL-TRONIX AND MIKE GOLDEN OF R.E.T.S. ELECTRONICS SCHOOL OF DETROIT, FOR HOME, RADIO AND EXPERIMENTAL WORK.

FOR THE RADIO AMPER, STUDENT, EXPERIMENTER OR DESIGNER:

SPECIFICATIONS: OUTPUT VOLTAGES: +5V, -12V, +12V. USEABLE CURRENT: 750mA. REGULATION AT 500mA 92%. SHORT-CIRCUIT LIMITED AT 1 A. LOW VOLTAGE OVERPROTECTED. Power requirements: 117VAC, 60HZ, 4WATS. Frequency Generator: Function generator frequency range: 1Hz to 100Hz in 5 bands. Adjustable sweep from 0 to 10 MHz. Output level adjustment from 0 to ±500mV. Wavelength: Single, square, triangular and TTL Clock. TTL Clock 0 to ±4V, 200uSec rise time and full time. Frequency determined by Function Generator. Output impedance 1.2K ohm.

Most of all, it's easy to construct and service. PC boards are predrilled, plated through and soldered. Over 1000 units sold.

NEW FIRST TIME OFFER

SIX-DIGIT ALARM CLOCK KIT for home, camper, RV, or field-day use. Operates on 12-volt AC or DC, and has its own 60-Hz time-base on the board. Complete with all electronic components and two-piece, pre-drilled PC boards. Board size 4" x 3". Complete with speaker and switches. If operated on DC, there is more to buy. PRICED AT $16.95

110-volt AC $2.50

12-volt AC $1.95

Fits clock case advertised below.

ATTENTION RADIO CLUBS:

For club or group projects, request FREE information about our DISCOUNTS on any of the HAL-TRONIX kits. Discounts range from 10-25%, depending upon the quantity needed.

We are experienced in supplying kits in volume quantities to schools, laboratories, clubs, and commercial interest groups. Nobody beats HAL-TRONIX quality and price. Just try us and see for yourself.

PRICED AT $12.95

CLOCK CASE

Available and will fit any one of the above clocks. Regular Price $6.50. But Only $4.50 when bought with clock.

60-HZ TIME BASE

CRYSTAL TIME BASE KIT. WILL ENABLE MOST ALL DIGITAL CLOCKS TO OPERATE FROM 12 VDC LOW PROFILE UNIT, EASY 3-WIRE CONNECTOR. ACC 2PPM, ADJUSTABLE. COST ONLY $5.95 EACH OR 2 FOR $10.00 OR ONLY $4.50 WITH CLOCK PURCHASE.

NEW FROM HAL-TRONIX

FIRST TIME OFFER

DELUXE 12-BUTTON TOUCH-TONE ENCODER KIT utilizing the new ICM 7264 chip. Provides both VISUAL AND AUDIO indications! Comes with its own two-tone anodized aluminum cabinet. Measures only 3" x 3/4". Complete with Touch-Tone pad, board, crystal, chip and all necessary components to finish the kit.

PRICED AT $29.95

For those who wish to mount the encoder in a hand-held unit, the PC board measures only 11/16" x 11/16". This partial kit with PC board, crystal, chip and components.

PRICED AT $14.95

DISTRIBUTOR FOR A P PRODUCTS, INCORPORATED

SUPER STRIP

S-8-2 2923252

PRICE $17.00

FREQUENCY COUNTERS

BY POPULAR DEMAND — we are continuing to offer with any purchase of $99 or more from ad or Free Flyer, a Fairchild clock module FCS-8100A (suggested retail price $20).

COMPLETE KITS: CONSISTING OF EVERY ESSENTIAL PART NEEDED TO MAKE YOUR COUNTER COMPLETE. HAL-600A 7-DIGIT COUNTER WITH FREQUENCY RANGE OF ZERO TO 600 MHz. FEATURES TWO INPUTS: ONE FOR LOW FREQUENCY AND ONE FOR HIGH FREQUENCY; AUTOMATIC ZERO SUPPRESSION, TIME BASE IS 1.0 SEC OR 1 SEC GATE WITH OPTIONAL 10 SEC GATE AVAILABLE, ACCURACY ± 0.001%, UTILIZES 10 MHZ CRYSTAL 5 PPM.

COMPLETE KIT $149.00

HAL-300A 7-DIGIT COUNTER WITH FREQUENCY RANGE OF ZERO TO 300 MHz. FEATURES TWO INPUTS: ONE FOR LOW FREQUENCY AND ONE FOR HIGH FREQUENCY; AUTOMATIC ZERO SUPPRESSION, TIME BASE IS 1.0 SEC OR 1 SEC GATE WITH OPTIONAL 10 SEC GATE AVAILABLE, ACCURACY ± 0.001%, UTILIZES 10 MHZ CRYSTAL 5 PPM.

COMPLETE KIT $124.00

HAL-50A 8-DIGIT COUNTER WITH FREQUENCY RANGE OF ZERO TO 50 MHz OR BETTER. AUTOMATIC DECIMAL POINT, ZERO SUPPRESSION UPON Demand. FEATURES TWO INPUTS: ONE FOR LOW FREQUENCY INPUT, AND ONE ON PANEL FOR USE WITH ANY INTERNALLY MOUNTED HAL-TRONIX PRE-SCALER FOR WHICH PROVISIONS HAVE ALREADY BEEN MADE. 1.0 SEC AND 1 SEC TIME GATES. ACCURACY ± 0.001%, UTILIZES 10 MHZ CRYSTAL 5 PPM.

COMPLETE KIT $124.00

HAL-TRONIX BASIC COUNTER KITS

STILL AVAILABLE

THE FOLLOWING MATERIAL DOES NOT COME WITH THE BASIC KIT: THE CABINET, TRANSFORMER, SWITCHES, COAX FITTINGS, FILTER LENS, FUSE HOLDER, T-03 SOCKET, POWER CORD AND MOUNTING HARDWARE.

HAL-600X (Same Specifications as HAL-600A) $124.00

HAL-300X (Same Specifications as HAL-300A) $99.00

HAL-50X (Same Specifications as HAL-50A) $99.00

PRE-SCALER KITS

HAL-0-300PRE (Pre-drilled G10 board and all components) $19.95

HAL-0-300PA (Same as above but with preamp) $29.95

HAL-0-600PRE (Pre-drilled G10 board and all components) $39.95

PRE-BUILT COUNTERS AVAILABLE

HAL-600A $229.00 (HAL-300A $199.00) (HAL-50A $199.00). ALLOW 4- TO 6-WEEK DELIVERY ON PRE-BUILT UNITS.

See you in Dayton

HAL-TRONIX

P.O. BOX 1101
SOUTHGATE, MICH. 48195
PHONE (313) 285-1782

SHIPPING

ORDERS OVER $15.00 WILL BE SHIPPED POSTPAID EXCEPT ON ITEMS WHERE ADDITIONAL CHARGES ARE REQUESTED. ON ORDERS LESS THAN $15.00 INFORMATION: PLEASE INCLUDE ADDITIONAL $1.00 FOR HANDLING AND MAILING CHARGES.

SEND SASE FOR FREE FLYER
The Bearcat 210 is a sophisticated scanning instrument with the ease of operation and frequency versatility you've dreamed of. Imagine, selecting from any of the public service bands and from all local frequencies by simply pushing a few buttons. No longer are you limited by crystals to a given band and set of frequencies. It's all made possible by Bearcat's space-age solid state circuitry. You can forget crystals forever.

Automatic search lets you scan any given range of frequencies of your choice within a band. Push button lockout lets you to selectively skip frequencies out of current interest. The decimal display with its exclusive "rolling zero" tells you which channels you're monitoring. When the Bearcat 210 locks in on an active frequency the decimal display shows the channel and frequency being monitored.

REG. $349.95
NOW $269
Offer good to licensed hams only. Include call with order. Freight prepaid in continental U.S. No COD's

1401 Blake Street
Denver, Co. 80202

RTTY for ALL Systems

ELECTROCOM® "SERIES 400" FREQUENCY SHIFT CONVERTERS

Professionally engineered for outstanding performance, stability, and reliability the Electrocom® Models 400 and 402 add new dimensions of compatibility between radio and teletypewriter systems. Manufactured to highest quality standards—an Electrocom tradition for nearly two decades—these units are ideal for military, government, commercial, civil defense and amateur applications. The Model 400 front panel digital knob accurately selects shifts up to 1000 Hz., while two such knobs on the Model 402 independently set the mark and space frequencies. Both models may also be preset with any tone pair between 1000 and 3200 Hz.

Optimum performance with FSK or AFSK systems is assured by matched filters, precision linear detectors, baud rate selector, bias compensation, and semi-diversity circuitry. Operation is enhanced by a CRT monitor, autoadjust with solid-state motor switching, antispacing, markhold, EIA-MIL output voltages, and a constant current loop supply. In addition, various options are available including rack mounting and polar current output.

Write or call us for complete product details and specifications. Learn why Electrocom® "400" Converters are designed not only for today's communication environment, but ultimately to fulfill RTTY requirements for years to come.

TRANSFORMERS

American made, 115V Primaries:
12 volt 1/2 amp. $2.05 ea.
12V 1.2 amp. $2.84 ea.
12V 3 amp. $4.40 ea.
12V, 250 ma for P.C. board $1.66 ea.
36VCT, 1A; 44VCT, 400mA $4.20 ea.
44VCT, 1A; 6.3V 1/2 amp tap $3.47 ea.
48VCT, 1A; 6.3V, 1/4 amp tap $3.46 ea.
6.3V, 1 amp shielded $1.80 ea.
UNPOTTED TOROID—Center tapped, 88 MHZ—5 oz. 3.95; 9 oz. $5.49 ea.
44 MHZ—5 oz. $3.95 ea.
NEW—LINE CORDS—US—7 AMP 6"—BK—50 ea. 4/$1.90 pnd.
6"—Gray—60 ea. 4/$1.90 pnd.
EDGEVIEW METERS 250 × 6" METERS
NEW—$2.65 ea. 3/$7.25 pnd.
8 PIN "TOS" IC Sockets, gold pln. $0.68 ea.

m. weinschenker
electronic specialties-801 353, IRWIN, PA 15642

BIRD WATCHERS

Don't be absorbed, buy a BIRD! . . . from your Bird distributor

MODEL 43
$120

ALL ITEMS AND ELEMENTS ORDNARILY IN STOCK
Prepaid Shipping in Continental USA Only

MADISON ELECTRONICS SUPPLY, INC.
1508 McKinney Street, Houston, Texas 77002
713/586-0268

Madison Electronics Supply, Inc.
**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 3/4". Built-in neon tune-up indicator. SO-239 connector. Attractive bronze finished enclosure.

only **$29.95**

THE ORIGINAL Random Wire Antenna Tuner... in use by amateurs for 6 years.

---

**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: 5/8" x 2-1/8" x 2-1/2". 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 $39.95**

---

**sst t-3 IMPEDANCE TRANSFORMER**

<table>
<thead>
<tr>
<th>only</th>
<th><strong>$19.95</strong></th>
</tr>
</thead>
</table>

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.

---

**SST A-1 VHF AMPLIFIER KIT**

1 watt input gives you 15 watts output across the entire 2 meter band without re-tuning. This easy to build kit (approx. 1/2 hr assembly) includes everything you need for a complete amplifier. Top quality components. Compatible with all 1-3 watt 2 meter transceivers. Kit includes:

- Etched & drilled G-10 epoxy solder plated board.
- Heat sink & mounting hardware. All components — including pre-wound coils.
- Top quality TRW RF power transistor.
- Complete assembly instructions with details on a carrier operated T/R switch.

only **$29.95**

$49.95 wired & tested

---

**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.

---

**ELECTRONICS**

P.O. BOX 1 LAWNDALE, CALIF. 90260 (213) 376-5887
PS-14 12V, 15A Power Supply Kit

If its POWER you need, than look no further. The PS-14 gives you a highly regulated power supply with features only the commercial units offer at a fraction of the cost.

**SPECs:**
- Output: 11.5-14.5 adjustable
- Current: 15A continuous, 20A int.
- Current Limit: Adjustable Foldback type
- Ripple: Less than 1% at 15A
- Regulation: Better than 200 millivols from no load to full load
- Thermal: Adjustable thermal shut down protects series pass.

**YOU GET:**
- Heavy duty 12 lb. transformer
- 2 large finned heat sinks
- Regulator PC board with all parts.
- Huge 34,000 mt/lb computer grade filter cap.
- 40 amps of series pass transformers.
- Wire, transistor mounting kits, line cord.

**$39.95**

**METERS:** Quality 3½" meters for PS-14. 0-15VDC. 0-25 ADC matched set. Individually packaged. 

**NOT SURPLUS!**

**OVERVOLTAGE PROTECTION KIT:** $6.95

Protection for sensitive instrumentation 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 not direct connected. Directly connectable to PS-12 and PS-14. All electronics supplied. Drilled & plated PC board. 

**THE LAST CHANCE!**

That's right! The last chance to buy our Super Popular MK-05 Mini Mobile Six Digit Clock Kit at this super low price. The response has been great but supplies are starting to run low. So order now!

**Features:**
- Quartz crystal timebase
- Toroid & zener noise & over-voltage protection.
- Magnified 1.5", 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 & plated PC Board.
- Clock board: 2.6" x 2.7".
- Readout board: 3/8" x 3/4"

**$12.95**

**2N6028**
Programmable unijunction for oscillators, timers, delay etc. 50c

**2N6111**
PNP Transistors 40Wat 3A TO-220 Case 2/$1.00

**MC1468R**
500ma positive regulator 3 to 30 volts. With complete specs and applications. $1.25 - house no.

**MC1351P FM IF AMP.** 14 pin IC. Complete FM sound subsystem, similar to LM2111. House no. 5/$1.00

**ML900, ML1000**
Complimentary Darlington. PNP, NPN power transistor. 8 amps. max. for $3.

**MC3569 NPN**
6p04 to 5 case. VCEO=60. HFE=200. 800MW power 6/$1.00

**WESKTON MICRO PC module trim.** Single turn 1K. 3/$1.00

**ROCKER SWITCHES**
DPDT Rocker Switches 5/$1.00

**500mfd**
505V Axial Cap 5/$1.00

**220mfd**
@ 25V Axial Cap 7/$1.00

**1100mfd**
@ 35V Axial Capacitor 4/$1.00

**Sprague**

Heathkirk Tubing
A very good ast. of 3/32", 1/8", 3/16", 1/4" & 7/16" lengths. 12 pcs. 75c

Above item FREE! with $15.00 purchase or more!

**21.50**

**BULLET LUCKY NUMBER FOR MAR. 15**: 159943 (Number worth $100; numbers in catalog are 21)

**BEAUTIFUL HARDWOOD CASE**
FOR MK-01: Case is cut, grooved & finished for clock. Includes ruby front fillet. Quick, easy assembly requires only 4 screws (incl.) $19.95

You've read the reviews on our MK-03 clock/Timer Kit. Wait till you see the new MK-03A 6 Digit Clock/Timer Kit:

- Separate 24 hour clock and 24 hour elapsed timer functions.
- Presetable alarms on both clock and timer
- Smaller more compact kit is 2½" wide x 3 8/9" long x 1½"
- Super revised manual makes assembly easy
- Many options available by adding switches.
- Sold less case & switches.

**$28.95**

**SPECIAL! Limited Qty!** L6567 Tone Decoders while they last! $0.99

**SPECIAL!**

26 Conductors Ribble Cable No. 28 wire with a woven binder. Super Flexible! 10' roll $2.95

**60' roll** - $9.95

**SMALL ENOUGH TO MOUNT IN THE INSTRUMENT PANEL.**

**$12.95**

**FANTASTIC NEW SOUND SYNTHESIZER IC** $3.95 each

Make any sound under the sun with this 28 pin marvel! Single IC contains: Noise generator, super low frequency OSC, VCO, one shot, mixer envelope control and amp. Works from a simple 5 to 9 VDC source. With 8 page manual.

**MK-06 Clock/Calendar Auto Home Clock Kit**

We designed this to be a SUPER CLOCK with all the features you want. Quality mobile sized PC board make assembly easy. Mobile (12VDC) or home (12VAC)

- Large 5½" LED readout
- Alarm circuit
- 30 day calendar
- Stop watch
- Calendar automatically updates itself
- Display can be dimmed or turned off
- Flashing Colon counts the seconds

**$39.95**

**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 Swingy 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 o’clock). Housed in the optional Solid Hardwood Case, the unit makes a beautiful addition to any room as well as a great gift.

- 5½" 4 digit LED readout
- Adjustable time & duration on chime
- Simulated swingy pendulum uses LEDS
- All CMOS construction
- All electronics, switches and transformer included
- Quality plated PC boards (2) 8.5" x 4.5"

**$89.95** (Will fit standard 3 1/8" instrument case)
SMOKE DETECTOR
Protect your family — home — and business. These U.L. Approved. All METAL units were removed from large apartment complex being torn down. 115 Volt AC input. Sensitivity to smoke is 2% per ft. max. Paint may be scratched but all units tested before shipment. Buy now — Don’t delay longer. $8.95 ea. ppd.

Transformer: 115V AC Primary, Secondary 17-0-17V @ 7 Amps. We tested and find good for 10 Amps intermittent duty. Ideal for 2M rigs! $8.00 ea. ppd.

40c ea. ppd.

Computer Grade Capacitor. 5100 mfd @ 50 volts. Size: 2" dia. x 2-1/4" high. $1.90 ea. ppd.

Mini-Toggle DPDT Cutler-Hammer wire-wrap terminals but can also be soldered. Gold plated. A very high quality unit. Hardware supplied. $1.50 ea. ppd.

SMOKE DETECTOR
Protect your family — home — and business. These U.L. Approved. All METAL units were removed from large apartment complex being torn down. 115 Volt AC input. Sensitivity to smoke is 2% per ft. max. Paint may be scratched but all units tested before shipment. Buy now — Don’t delay longer. $8.95 ea. ppd.

Transformer: 115V AC Primary, Secondary 17-0-17V @ 7 Amps. We tested and find good for 10 Amps intermittent duty. Ideal for 2M rigs! $8.00 ea. ppd.

40c ea. ppd.

Computer Grade Capacitor. 5100 mfd @ 50 volts. Size: 2" dia. x 2-1/4" high. $1.90 ea. ppd.

Mini-Toggle DPDT Cutler-Hammer wire-wrap terminals but can also be soldered. Gold plated. A very high quality unit. Hardware supplied. $1.50 ea. ppd.

SMOKE DETECTOR
Protect your family — home — and business. These U.L. Approved. All METAL units were removed from large apartment complex being torn down. 115 Volt AC input. Sensitivity to smoke is 2% per ft. max. Paint may be scratched but all units tested before shipment. Buy now — Don’t delay longer. $8.95 ea. ppd.

Transformer: 115V AC Primary, Secondary 17-0-17V @ 7 Amps. We tested and find good for 10 Amps intermittent duty. Ideal for 2M rigs! $8.00 ea. ppd.

40c ea. ppd.

Computer Grade Capacitor. 5100 mfd @ 50 volts. Size: 2" dia. x 2-1/4" high. $1.90 ea. ppd.

Mini-Toggle DPDT Cutler-Hammer wire-wrap terminals but can also be soldered. Gold plated. A very high quality unit. Hardware supplied. $1.50 ea. ppd.

SMOKE DETECTOR
Protect your family — home — and business. These U.L. Approved. All METAL units were removed from large apartment complex being torn down. 115 Volt AC input. Sensitivity to smoke is 2% per ft. max. Paint may be scratched but all units tested before shipment. Buy now — Don’t delay longer. $8.95 ea. ppd.

Transformer: 115V AC Primary, Secondary 17-0-17V @ 7 Amps. We tested and find good for 10 Amps intermittent duty. Ideal for 2M rigs! $8.00 ea. ppd.

40c ea. ppd.

Computer Grade Capacitor. 5100 mfd @ 50 volts. Size: 2" dia. x 2-1/4" high. $1.90 ea. ppd.

Mini-Toggle DPDT Cutler-Hammer wire-wrap terminals but can also be soldered. Gold plated. A very high quality unit. Hardware supplied. $1.50 ea. ppd.

SMOKE DETECTOR
Protect your family — home — and business. These U.L. Approved. All METAL units were removed from large apartment complex being torn down. 115 Volt AC input. Sensitivity to smoke is 2% per ft. max. Paint may be scratched but all units tested before shipment. Buy now — Don’t delay longer. $8.95 ea. ppd.

Transformer: 115V AC Primary, Secondary 17-0-17V @ 7 Amps. We tested and find good for 10 Amps intermittent duty. Ideal for 2M rigs! $8.00 ea. ppd.

40c ea. ppd.

Computer Grade Capacitor. 5100 mfd @ 50 volts. Size: 2" dia. x 2-1/4" high. $1.90 ea. ppd.

Mini-Toggle DPDT Cutler-Hammer wire-wrap terminals but can also be soldered. Gold plated. A very high quality unit. Hardware supplied. $1.50 ea. ppd.

SMOKE DETECTOR
Protect your family — home — and business. These U.L. Approved. All METAL units were removed from large apartment complex being torn down. 115 Volt AC input. Sensitivity to smoke is 2% per ft. max. Paint may be scratched but all units tested before shipment. Buy now — Don’t delay longer. $8.95 ea. ppd.

Transformer: 115V AC Primary, Secondary 17-0-17V @ 7 Amps. We tested and find good for 10 Amps intermittent duty. Ideal for 2M rigs! $8.00 ea. ppd.

40c ea. ppd.

Computer Grade Capacitor. 5100 mfd @ 50 volts. Size: 2" dia. x 2-1/4" high. $1.90 ea. ppd.

Mini-Toggle DPDT Cutler-Hammer wire-wrap terminals but can also be soldered. Gold plated. A very high quality unit. Hardware supplied. $1.50 ea. ppd.

SMOKE DETECTOR
Protect your family — home — and business. These U.L. Approved. All METAL units were removed from large apartment complex being torn down. 115 Volt AC input. Sensitivity to smoke is 2% per ft. max. Paint may be scratched but all units tested before shipment. Buy now — Don’t delay longer. $8.95 ea. ppd.

Transformer: 115V AC Primary, Secondary 17-0-17V @ 7 Amps. We tested and find good for 10 Amps intermittent duty. Ideal for 2M rigs! $8.00 ea. ppd.

40c ea. ppd.

Computer Grade Capacitor. 5100 mfd @ 50 volts. Size: 2" dia. x 2-1/4" high. $1.90 ea. ppd.

Mini-Toggle DPDT Cutler-Hammer wire-wrap terminals but can also be soldered. Gold plated. A very high quality unit. Hardware supplied. $1.50 ea. ppd.
TELETYPEWRITER PARTS, for all machines manufactured by: Klienschmidt Corp., Teletype Corp., and Mke. Any quantity, top prices paid send list for quote. Phil Rickson, W4ILN, Rt. 6, Box 1103GZ, Brookville, F1. 33512.


QSL CARDS 5000/10. 400 illustrations, sample Bowman Printing, Dept. HR, 743 Harvard, St. Louis, MO 63130.

HOMEMAKERS: Stamp brings component list. CPO Surplus, Box 169, Braintree, Mass. 02184.

CHANNEL ELEMENTS NEEDED KKN1026A, Motorola for Micor. Need several. WACOSA, 4 Ajax, Berkeley, CA 94706 (415) 843-5253.

WANTED: Hallicrafters HA-20 VFO. Write or call W1OUT, 22 Woodridge Road, Wayland, MA 01771 617-358-4953.

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 $12.00 per year. HURRY! HURRY! Ham Radio HORIZONS, Greenwich, NH 03048.


PROP PITCH gasket sets for smaller prop pitch series. Same condition, $33. w6ko, 1140A. Send $2.00 for list, postpaid.

HURRY! Ham Radio HORIZONS, the Goldmine of ham radio. It's all here and just $12.00 per year. HURRY! HURRY! Ham Radio HORIZONS, Greenwich, NH 03048.

CLEANING OUT SHACK: Scopes, Xmters, Recvrs, Stocks, Meters, Racks, Tools, other VHF etc. 15 yr. collection, price right. SASE for list.

TELETYPEWRITER PARTS WANTED: for all models. Write: Taylor Communications Manufacturing Company.

FORWARDING TVI with the RSO Low Pass Filter. For brochure and Mite. Any quantity, top prices paid send list for quote. Phil Rickson, W4ILN, Rt. 6, Box 1103GZ, Brookville, F1. 33512.


WANTED: Hallicrafters HA-20 VFO. Write or call W1OUT, 22 Woodridge Road, Wayland, MA 01771 617-358-4953.

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 $12.00 per year. HURRY! HURRY! Ham Radio HORIZONS, Greenwich, NH 03048.


PROP PITCH gasket sets for smaller prop pitch series. Same condition, $33. w6ko, 1140A. Send $2.00 for list, postpaid.

HURRY! Ham Radio HORIZONS, the Goldmine of ham radio. It's all here and just $12.00 per year. HURRY! HURRY! Ham Radio HORIZONS, Greenwich, NH 03048.

CLEANING OUT SHACK: Scopes, Xmters, Recvrs, Stocks, Meters, Racks, Tools, other VHF etc. 15 yr. collection, price right. SASE for list.

TELETYPEWRITER PARTS WANTED: for all models. Write: Taylor Communications Manufacturing Company.

FORWARDING TVI with the RSO Low Pass Filter. For brochure and Mite. Any quantity, top prices paid send list for quote. Phil Rickson, W4ILN, Rt. 6, Box 1103GZ, Brookville, F1. 33512.
flea market

RARS SIXTH ANNUAL HAMFEST, April 23, Crabtree Valley Mall, US 70 West, Raleigh, NC. Big, big flea market — all under cover. Fantastic prizes. Ladies activities, meetings. Walk to nearby malls, restaurants, shopping. More info? Write RARS, Box 17124, Raleigh, NC 27609.

ZERO DISTRICT QSO PARTY, organized by the Mississippi Valley Radio Club, 20022, Saturday, April 22nd to 0002Z, Monday, April 24th. Stations outside of zero district work zero stations only; while zero stations may work any station. Same stations on each band, each mode, except for special mobile stations which may be worked each time they change counties. All stations exchange QSO number and ARRL section; all zero stations must send county. Suggested frequencies are: Phone: 3900, 7270, 14300, 21370, 28570; CW: 3560, 7060, 14060, 21060, 28060; Phone: 3905, 7275, 14375, 21375, 28575. Awards to high scorer in each ARRL section and DX country. Also top Novice/Technicians and special mobile station winner. All ARRL section leaders (S.A.E.) WBNQJU, 3158 W. Columbia, Davenport, Iowa 52804. 

HOLIDAY — IN — DIXIE FESTIVAL sponsored by ARCCOS (Amateur Radio Club of Shreveport, LA) from 1800Z, April 21st, through 2400Z, April 30th, 1978. Contact a station within 75 miles of Shreveport, exchange RST; power, ARRL section or country. ARCCOS members will be on air as a group from 1800Z, April 21st, to 2400Z, April 22nd, but QSOs can be made anytime during the ten-day festival. Suggested CW: 3565, 3716, 7055, 14055, 21130, and 28117; Phone: 3935, 3975, 7225, 14320, 21380, and 28057; VHF: 5100 +/- SSB, and 52.525 +/— simplex FM; 145.100 +/— SSB, and 145.015 +/— simplex FM. Local contacts for dem on 6776 and 1676. Local ops work each for. For extra points ask members for their Holiday-In-Dixie number. Info in log book. Contact Holiday-In-Dixie QSO Party, P.O. Box 1485, Shreveport, LA 71164.


ALABAMA FORESTRY FESTIVAL — April 22, 1978. The Twin Base Amateur Radio Club station WA4PFR will be operating on site in conjunction with the Alabama Forestry Festival at the State Fair Grounds, Montgomery, Alabama. Any ARS completing a two-way contact will receive a special certificate in exchange for a QSL card and SASE. Operations will be conducted from 1600 hours to 2000 hours UTC on frequencies 14.200 MHz and 28.900 MHz normal SSB; slow CW, (8 to 10 WPM) on 7.125 MHz during even hours UTC and 21.150 MHz during odd hours UTC. QRM frequency adjustments will be up band.

MIDWEST SPRING CONVENTION — Saturday, April 1, 1978. Holiday Inn-Holteone, Kearney, Nebraska sponsored by the Midway Amateur Radio Club. Flea market, auction, technical symposiums, ARRL Forum, State MARs Meeting, State QST meeting, special "Ladies Day," and evening banquet. Over $2,500.00 worth of door prizes up for grabs with a Wilson Mark II with touchscreen presented to a ham and, for the lucky "Lady" — a microwave oven. Over 200 other prizes to be given away. For registration and further details contact Chuck, W3CRA, Midwest Spring Convention, 3003 Third Avenue, Kearney, Nebraska 68847.


ATLANTIC CITY AREA HAMFEST Sunday, April 16th. Rain or Shine. 200 Indoor, 400 Outdoor table spaces; Stockton State College Campus, Pomona NJ. Lots of dealers, $1 advance, $1.50 gate. Door prizes, More info SPAEC, P.O. Box 142, Absecon, NJ 08205.

27TH DAYTON HAMVENTION at Hara Arena, April 28, 29, 30, 1978. More room this year! Technical forums, exhibits and huge flea market. Program brochure mailed March 8th to those registered within this past three years. For accommodations or advance flyer, write Hamvention, P.O. Box 44, Dayton, OH 45401 or call 513-854-4126.

THE 4TH ANNUAL NORTHWESTERN PENNSYLVANIA HAMFEST, May 6th, Crawford County Fairgrounds, Meadville, PA. Gates open at 8:00 $2 prize ticket required for admission — $1 to children. Children FREE. Hourly door prizes, refreshments, commercial displays welcome. Indoors if rain. Talk in 04/64 and 52. Details CARS, P.O. Box 653, Meadville, PA 16335.
You've requested it, and now it's here! The CT-50 frequency counter kit has more features than counters selling for twice the price. Measuring frequency is now as easy as pushing a button, the CT-50 will automatically place the decimal point in all modes, giving you quick, reliable readings. Want to use the CT-50 mobile? No problem, it runs equally as well on 12 V dc as it does on 110 V ac.

Want super accuracy? The CT-50 uses the popular TV color burst freq. of 3.579545 MHz for time base. Tap off a color TV with our adapter and get ultra accuracy — .001 ppm! The CT-50 offers professional quality at the unheard of price of $79.95. Order yours today!

CT-50, 60 MHz counter kit $79.95
CT-50 WT, 60 MHz counter, wired and tested 159.95
CT-600, 600 MHz prescaler option for CT-50, add 29.95

CT-50, 60 MHz counter kit $79.95
CT-50 WT, 60 MHz counter, wired and tested 159.95
CT-600, 600 MHz prescaler option for CT-50, add 29.95

**NEW**

**Frequency Counter**

**$79.95**

**Utilizes New MOS-LSI Circuitry**

**Specifications**

- **Sensitivity:** less than 25 mv.
- **Frequency range:** 5 Hz to 60 MHz, typically 65 MHz
- **Gatetime:** 1 second, 1/10 second, with automatic decimal point positioning on both direct and prescale
- **Display:** 8 digit red LED. 4.4" height
- **Accuracy:** 0.01 ppm with TV time base!
- **Input:** BNC, 1 megohm direct, 50 Ohm with prescale option
- **Power:** 110 V ac 5 Watts or 12 V dc @ 1 Amp
- **Size:** Approx. 6" x 4" x 2", high quality aluminum case
- **Color burst adapter for .001 ppm accuracy available in 6 weeks.**

**CLOCK KIT**

6 digit 12/24 hour

Want a clock that looks good enough for your living room? Forget the competitor's kludges and try one of ours! Features: Jumbo 4.4" digits, Polaris lens filter, extruded aluminum case available in 5 colors, quality PC boards and super instructions. All parts are included, no extras to buy. Fully guaranteed. One to two hour assembly time. Colors: silver, gold, black, bronze, blue (specify).

Clock kit, DC-5...$22.95
Alarm clock, DC-6, 12 hour only...24.95
Mobile clock, DC-7...25.95
Clock kit with 10 min 10 timer, DC-10...25.95
Assembled and tested clocks available, add $10.00

**VIDEO TERMINAL KIT**

**$149.95**

A compact computer peripheral, a VDC card that requires only an ASCII keyboard and a TV set to become a complete interactive terminal. DC can be connected to any large scale minicomputer or microprocessor controlled interface. The multipurpose features are simple to use, provide total control over the TV set, and allow the TV set to serve as a complete communication terminal. The DC card is a high impedance input and can be used with any type of TV set. The DC card operates in parallel with any TV set, using only the TV set's ordinary video output. Choose between black and white or color versions of the DC-1 kit.

Complete Kit, DC-1...$189.95
Half Assembled and Tested Kit, DC-1...$129.95
Car Kit, DC-1 Car Clock...$129.95

**CALCULATOR KIT**

**$27.95**

The famous RC class C amplifier, now available in an easy-to-use package! Four Watts in for 30 Watts out, 2 for 60, 1 for 120. Staggered in design, 5 digital LED display, complete with all parts, instructions and details on T-R relay. Case not included.

Complete Kit, PA-1...$22.95

**TRANSMITTER**

- **MRF 238 300 MHz**
  - $49.95
- **PNP 63040 type**
  - $10.50
- **PNP 3906 type**
  - $10.50
- **PNP Transistor**
  - $10.50
- **PNP Transistor**
  - $10.50
- **PNP Transistor**
  - $10.50

**DIODES**

- **1KV.25A**
  - $9.50
- **100V.1A**
  - $19.50
- **100V.1A type**
  - $50.00

**LED Displays**

- **FND 559**
  - $7.50
- **FND 510**
  - $12.50
- **DL 707**
  - $12.50
- **HP 7330**
  - $1.25
- **HP 7330**
  - $1.25

**FERRITE BEADS**

- 6 hole Balun Beads
  - $5.00
- 2 hole Balun Beads
  - $5.00

**Microchip Kit**

- **Minimum Order $5.00**

**Siren Kit**

This kit produces upward and downward wave charactersitc of police sirens. 5 watts audio output, runs on 3-9 volts.

Complete Kit, SM-3...$29.95

**Decade Counter Parts**

Includes: 4700A, 4725, 4747, LED readout, 200 resistor, limit resistors, and instructions on an easy to build low cost frequency counter.

Kit of parts, DCU-1...$33.50

**Mini-Kits**

TONE DECODER KIT

A complete tone decoder is based on a single PC Board. Features: 400-5000 Hz adjustable frequency range, volume regulation, MELC. The MELC sub module, mieroform tone decoder, FSK decoder, and more with complete instructions for 12 button touchtone decoding. Runs on 5 to 12 volts.

Complete Kit, TD-1...$4.95

**Super Sleuth Amplifier**

A super sensitive amplifier which will pick up a pin drop at 15 feet! Great for monitoring baby's room or as a general purpose test amplifier. Full 2 watts of output, runs on 6 to 12 volts, uses any type of mike. Requires 8-45 ohm speaker.

Complete Kit, BN-9...$4.95

**FM Wireless Mike Kit**

Transmit up to 300' to any FM broadcast radio, uses any type of mike. Runs on 3 to 9 V. Type FM-2 has added super sensitive mike preamp.

FM-1...$2.95
FM-2...$4.95

**Color Organ/Music Lights**

See music come alive all different lights flicker with music or voice. One light for low, one for the mid-range and one for the high. Each channel individually adjustable, and drives up to 300 units -- perfect for party, band music, disco clubs and more.

Complete Kit, ML-1...$17.95

**LED Blinky Kit**

A great attention getter which alternately flashes 2 Jumbo LEDs. Use for name badges, buttons, or warning type panel lights. Runs on 3 to 9 volts.

Complete Kit...$2.95

**Power Supply Kit**

Complete kit regulated power supply provides variable 115 volts at 200 mA and 15 volts in 1 Amp. 60 volt load regulation better than 1% and small size. Kit less transformers. Requires 0-5 to 15 volts and 10 to 20 VCT.

Complete Kit, PS-777...$9.95

**Siren Kit**

Includes: 4700A, 4725, 4747, LED readout, 200 resistor, limit resistors, and instructions on an easy to build low cost frequency counter.

Kit of parts, DCU-1...$33.50

**More Details? Check-Off Page 126**
**SLEP SPECIALS**

**ALPHA LINEAR**
- PA-76R 2 Tubes $1,395.00
- PA-76R 3 Tubes $1,495.00
- PA-76C 3 Tubes 2.4 KW Harris XFR $1,695.00
- PA-76T 5 Tubes 2.4 KW 4.5/3.2 $1,795.00
- PA-76HS 2 Tubes $1,395.00
- PA-76HS 4 Tubes $1,795.00
- PA-775S Two 887 Tubes $3,095.00
- PA-374, No tune-up for amateur band operation $3.95

Alpha/Yomax SBP-3C Sprech Processor $197.50

**ATLAS**
- 350XL 10-16 350W Solid State Transceiver $1,995.00
- 350 PST 110/220V Console PS/P $2,295.00
- 300 Plug-In Auxiliary VF0 $355.00
- 311 Plug-In Auxiliary VF0 $355.00
- 505XL Plug-In Mobile Mounting Kit $565.00
- 20X10 800W Solid State Transceiver $6,795.00
- 20X80 With Noise Blanker $1,785.00
- 220CS 110/220 AC Console PS/P $1,495.00
- 220 CX/VS/5 With VOA/Semi-Break-In $1,795.00
- 200/110/220 Portable AC/PS $1,000.00
- 20X Auxiliary VF0 with extended front, coverage for all Atlas transceivers $2,995.00
- MT-1 Mobile Antenna Matching Transformer $275.00
- 10X Crystal Oscillator $59.00
- PC-120 Noise Blanker Kit $52.00
- DRX Plug-In Mobile Mounting Kit $48.00
- DL-200 Dummy Load 200W $99.00
- MSK Mobile Bracket $6.00

**ICOM**
- IC-225 FM 10W Transceiver $2,595.00
- IC-245 FM 10W Synthesized $2,995.00
- IC-245SS Transceiver $2,995.00
- IC-245 Multi-Band 150W Transceiver $4,995.00
- IC-202 2M Portable SSB $2,295.00
- IC-303 440 MHz Transceiver $2,495.00
- IC-202/IC-202 2M Portable FM $2,295.00
- IC-30A 450 MHz FM 10W $1,995.00
- IC-1PA Power Supply with speaker $99.00
- IC-1HF Transceiver all solid state 1.8 MHz The Ultimate $1,495.00

**TEN TEC**
- 509 Argonaut 5W SSB/CW $369.00
- 210 P S 3 Am $395.00
- 405 Linear Amplifier 16W $1,095.00
- 251 P/S 9 Amp 509/405 $395.00
- 206 Crystal Calibrator 259 $295.00
- 200 CW Filter $59.00
- 540 Transceiver 200W SSB/CW $6,995.00
- 324 Transceiver Digital 200W SSB/CW $6,995.00
- 252 Power Supply 544/544 $119.00
- 324 Power Supply with VOX 544/544 $145.00
- 260 300W SSB/CW $1,195.00
- 241 Crystal oscillator 544/544 $35.00
- 200 Remote VOX 544/544 $179.00
- 324 Digital Realtime 544 $1,797.00
- 245 CW Filter 544/544 $25.00
- 294 Noise Blanker 544/544 $295.00
- 215 Microwave with plus $295.00
- 207 Ammeter 251, 252, 252 $4.00
- 274 Century 21 CW Transceiver $2,995.00
- 274 Century 21 Digital $2,995.00
- 274 Crystal Calibrated 570/574 $295.00
- 274 Single Paddle Keyer 570/574 $295.00
- 2R-20A 2-Meter Transceiver $1,995.00
- 2R-50 Ultra-Linear Keyer Paddle + $110.00

**KLO**
- Echo 70CM UHF Transceiver $495.00
- Multi-2700 All Mode 2M Transceiver $575.00
- KLO 603 6 Meter SSB, CW, NBFM, AM Transceiver $695.95

**TEMPO**
- Tempo 100 SSB Transceiver $399.00
- Tempo AC/One AC PS $399.00
- Tempo VFO/One External VFO $199.00
- Tempo 2020 Deluxe SSB Transceiver 115V $1,795.00
- Tempo 8120 Ext. Speaker $295.00
- Tempo 8100/1 Ext. Speaker $395.00
- DM-20 Dual Impedance Desk Mike $39.00
- RFB-1A Dual Meter SWR/Wattmeter $42.95
- DD-17 Digital Digital Tempo One $197.00
- Tempo VF/HU Plus Two 2 meter Transceiver 25W $299.00
- Tempo SSB/One Adaptor SSB 2M $199.00
- Tempo 35FF Hand-Used $219.00
- Tempo 35MM-5 Hand Used 25W $299.00

**SPEL ELEKTRONIKO**
- P. O. Box 100, Highway 441, DeP, NR-4, Otte, North Carolina 28763

**flea market**

**TEST EQUIPMENT**

All equipment listed is operational and unconditionally guaranteed. Money back if not satisfied — equipment being returned must be shipped prepaid. Include check or money order with order. Prices listed are F.O.B. Monroe.

BOONTON 19A Q mt $30 300MHz $425
BOONTON 25A 25A RX mtr bridge meas. 65$ cap, 500Hz to 500KHz $255
FLUME 80B Grf ac dc vtm $95
GR-1001A L5/sq gen 5KHz $385
HP120B 450Hz gen pur scope $115
HP160B (US1050) 15MHz scope with hand tracr $375
HP16B (Mini) Delay sweep for above $130
HP170A (US140) 30MHz scope with a horiz, dual trace vert plug $475
HP175A 30MHz scope with hand tracr, dual trace vert plug $565
HP202LB LS 5.9Hz 50KHz 109 v $75
HP205G Lab audio gen 02-20KHz $195
HP212A Pulse gen 06-5kHzPR $65
HP524D FM 50Hz 30Hz 104Hz 10MHz extends w-plug $195
HP540B Trans osc to 12.4GHz for use w-HP524 ty counters $145
HP616 Sig gen 1.8 MHz FM CW $365
HP686 Sweep gen 2-12.4GHz sweep range 4MHz 4.4GHz $245
HP803A VHF Ant bridge 50 500MHz $135
HP801A Prec digit thermometer $285
for complete list of all test equipment send stamped, self-addressed envelope

**GRAY Electronics**
- P. O. Box 941, Monroe, Mich. 48161
- Specializing in used test equipment

**FACSIMILE**

COPY SATELLITE, PHOTOS, WEATHER MAPS, PRESS

The Fax Are Clear — on our full size (16-1/2’’ wide) recorders. These commercial-military units now available at surplus prices. Learn how to copy with our FREE Fax Guide.
- (Tel. 212) 372-0349

**ATLANTIC SURPLUS SALES**
- 3730 NAUTLIE
- BROOKLYN, N.Y. 11214

**See our HAM MART listings to find the Amateur Radio dealers nearest you.**

**GOING 2 OR 220?**

**GET ON WITH THE BEST:**

**Midland 13-510**
- **Synthesized**
- **144-148 MHz**
- **220-225 MHz**
- **1 or 2 watts**
- **209.95**
- **Our Price $438**
- **Master Charge and VISA welcome.**

**Midland 13-513**
- **Synthesized**
- **144-148 MHz**
- **220-225 MHz**
- **1 or 2 watts**
- **399.95**
- **Our Price $638**
- **Master Charge and VISA welcome.**

**burbank electronics, inc.**
- 2308 MAGNOLIA BOULEVARD
- BURBANK, CALIFORNIA 91506
- (213) 843-1647

**More Details? CHECK — OFF Page 126**
<table>
<thead>
<tr>
<th>DIODES/ZENERS</th>
<th>SOCKETS/BRIDGES</th>
<th>TRANSISTORS, LEDS, etc.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1N914 100v 10mA .05</td>
<td>8-pin pcb .25 ww .45</td>
<td>2N2223A NPN (2N2223 Plastic) .15</td>
</tr>
<tr>
<td>1N4005 600V 1A .08</td>
<td>14-pin pcb .25 ww .40</td>
<td>2N2907A PNP .15</td>
</tr>
<tr>
<td>1N407 300V 1A .15</td>
<td>16-pin pcb .25 ww .40</td>
<td>2N3906 PNP (Plastic) .10</td>
</tr>
<tr>
<td>1N4148 75v 10mA .05</td>
<td>18-pin pcb .25 ww .75</td>
<td>2N3904 PNP (Plastic) .10</td>
</tr>
<tr>
<td>1N753A 6.2v .25</td>
<td>22-pin pcb .45 ww 1.25</td>
<td>2N3055 NPN .35</td>
</tr>
<tr>
<td>1N758A 10v .25</td>
<td>24-pin pcb .35 ww 1.10</td>
<td>2N3055 15A 60v .50</td>
</tr>
<tr>
<td>1N759A 12v .25</td>
<td>28-pin pcb .35 ww 1.45</td>
<td>T1P125 PNP Darlington .35</td>
</tr>
<tr>
<td>1N4733 5.1v .25</td>
<td>40-pin pcb .50 ww 1.25</td>
<td>LED Green, Red, Clear, Yellow .15</td>
</tr>
<tr>
<td>1N5243 13v .25</td>
<td>Molex pins .01 To-3 Sockets .45</td>
<td>D.L. 747 7 seg 6/8&quot; High comm. 10</td>
</tr>
<tr>
<td>1N5244B 14v .25</td>
<td>2 Amp Bridge 100-prov 1.20</td>
<td>XAN72 7 seg comm-ane (Red) .125</td>
</tr>
<tr>
<td>1N5245 15v .25</td>
<td>25 Amp Bridge 200-prov 1.95</td>
<td>MAN71 7 seg comm-ane (Red) .125</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MOS</th>
<th>- T T L -</th>
<th>TRANSISTORS, LEDS, etc.</th>
</tr>
</thead>
<tbody>
<tr>
<td>4000 .15</td>
<td>7400 .15</td>
<td>2N2223 14v 25a .25</td>
</tr>
<tr>
<td>4001 .15</td>
<td>7401 15</td>
<td>2N2907 25a 20</td>
</tr>
<tr>
<td>4002 .20</td>
<td>7402 20</td>
<td>2N3906 25a 15</td>
</tr>
<tr>
<td>4004 .39</td>
<td>7404 20</td>
<td>2N3055 25a 0.50</td>
</tr>
<tr>
<td>4006 .95</td>
<td>7406 25</td>
<td>2N3905 25a 0.35</td>
</tr>
<tr>
<td>4007 .35</td>
<td>7407 25</td>
<td>2N3055 25a 0.35</td>
</tr>
<tr>
<td>4008 .95</td>
<td>7408 25</td>
<td>2N3055 25a 0.35</td>
</tr>
<tr>
<td>4009 .45</td>
<td>7409 25</td>
<td>2N3055 25a 0.35</td>
</tr>
<tr>
<td>4010 .45</td>
<td>7410 25</td>
<td>2N3055 25a 0.35</td>
</tr>
<tr>
<td>4011 .20</td>
<td>7411 25</td>
<td>2N3055 25a 0.35</td>
</tr>
<tr>
<td>4012 .20</td>
<td>7412 25</td>
<td>2N3055 25a 0.35</td>
</tr>
<tr>
<td>4013 .40</td>
<td>7413 25</td>
<td>2N3055 25a 0.35</td>
</tr>
<tr>
<td>4014 .95</td>
<td>7414 25</td>
<td>2N3055 25a 0.35</td>
</tr>
<tr>
<td>4015 .35</td>
<td>7415 25</td>
<td>2N3055 25a 0.35</td>
</tr>
<tr>
<td>4016 .10</td>
<td>7416 25</td>
<td>2N3055 25a 0.35</td>
</tr>
<tr>
<td>4017 .10</td>
<td>7417 40</td>
<td>2N3055 25a 0.35</td>
</tr>
<tr>
<td>4018 .50</td>
<td>7420 15</td>
<td>2N3055 25a 0.35</td>
</tr>
<tr>
<td>4020 .85</td>
<td>7425 30</td>
<td>2N3055 25a 0.35</td>
</tr>
<tr>
<td>4021 .10</td>
<td>7430 25</td>
<td>2N3055 25a 0.35</td>
</tr>
<tr>
<td>4022 .85</td>
<td>7435 20</td>
<td>2N3055 25a 0.35</td>
</tr>
<tr>
<td>4023 .25</td>
<td>7440 30</td>
<td>2N3055 25a 0.35</td>
</tr>
<tr>
<td>4024 .75</td>
<td>7445 30</td>
<td>2N3055 25a 0.35</td>
</tr>
<tr>
<td>4025 .30</td>
<td>7450 30</td>
<td>2N3055 25a 0.35</td>
</tr>
<tr>
<td>4026 .95</td>
<td>7460 25</td>
<td>2N3055 25a 0.35</td>
</tr>
<tr>
<td>4027 .50</td>
<td>7470 30</td>
<td>2N3055 25a 0.35</td>
</tr>
<tr>
<td>4028 .95</td>
<td>7480 30</td>
<td>2N3055 25a 0.35</td>
</tr>
<tr>
<td>4030 .35</td>
<td>7490 30</td>
<td>2N3055 25a 0.35</td>
</tr>
<tr>
<td>4033 .15</td>
<td>7410 30</td>
<td>2N3055 25a 0.35</td>
</tr>
<tr>
<td>4034 .25</td>
<td>7500 30</td>
<td>2N3055 25a 0.35</td>
</tr>
<tr>
<td>4035 .12</td>
<td>7510 30</td>
<td>2N3055 25a 0.35</td>
</tr>
<tr>
<td>4040 .13</td>
<td>7520 15</td>
<td>2N3055 25a 0.35</td>
</tr>
<tr>
<td>4041 .69</td>
<td>7530 30</td>
<td>2N3055 25a 0.35</td>
</tr>
<tr>
<td>4042 .95</td>
<td>7540 30</td>
<td>2N3055 25a 0.35</td>
</tr>
<tr>
<td>4045 .95</td>
<td>7550 30</td>
<td>2N3055 25a 0.35</td>
</tr>
<tr>
<td>4046 .95</td>
<td>7560 30</td>
<td>2N3055 25a 0.35</td>
</tr>
<tr>
<td>4049 .45</td>
<td>7570 40</td>
<td>2N3055 25a 0.35</td>
</tr>
<tr>
<td>4050 .45</td>
<td>7580 40</td>
<td>2N3055 25a 0.35</td>
</tr>
<tr>
<td>4066 .95</td>
<td>7590 40</td>
<td>2N3055 25a 0.35</td>
</tr>
<tr>
<td>4069 .40</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>4071 .35</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>4081 .70</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>4082 .45</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>MC14409 14.50</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>MC14419 4.86</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>9000 SERIES</th>
<th>9301 .95</th>
<th>9503 .10</th>
</tr>
</thead>
<tbody>
<tr>
<td>9309 .95</td>
<td>9601 .45</td>
<td></td>
</tr>
<tr>
<td>9322 .75</td>
<td>9602 .45</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MICRO'S RAMS, CPUs, ETC.</th>
<th>74S188 3.00</th>
<th>712A .45</th>
</tr>
</thead>
<tbody>
<tr>
<td>74M314 3.00</td>
<td>74M316 3.50</td>
<td></td>
</tr>
<tr>
<td>2120.1 .15</td>
<td>2120.1 .15</td>
<td></td>
</tr>
<tr>
<td>2120.2-1 .15</td>
<td>TR1602 4.50</td>
<td></td>
</tr>
<tr>
<td>8080AD 12.00</td>
<td>TMS 4044-45N L14.50</td>
<td></td>
</tr>
<tr>
<td>8T13 1.50</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>8T23 1.50</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>8T24 2.00</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>8T38 1.00</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>21076-4 .A 4.00</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>2708 11.50</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>INTEGRATED CIRCUITS UNLIMITED</th>
<th>7889 Clairemont Mesa Boulevard, San Diego, California 92111</th>
</tr>
</thead>
<tbody>
<tr>
<td>(714) 278-4394 (Calif. Res.)</td>
<td>All orders shipped prepa</td>
</tr>
<tr>
<td>No minimum</td>
<td>Open accounts invited</td>
</tr>
<tr>
<td>Discounts available at OEM Quantities California Residents add 6% Sales Tax</td>
<td>All IC’s Prime/Guaranteed. All orders shipped same day received.</td>
</tr>
<tr>
<td>24 Hour Toll Free Phone 1-800-854-2211</td>
<td>American Express / BankAmericard / Visa / Mastercard CHARGE</td>
</tr>
</tbody>
</table>
KLM Transceivers
Amplifiers
Antennas

Force 5 80-10m 200w PEP Xcvr .......................... 1095.00
FS5 AC power supply .......................................... 249.95
FSSC Station console ............................................... 379.00

Multi-2700, 2m FM/SSB/CW Xcvr .......................... 756.00
Multi-2700 Service Manual ...................................... 10.00
TX4X/432 MHz OSCAR transverter .......................... 189.95
Multi-1:1 23 ch 10w 2m FM Xcvr/4 ch scan ....... 375.95
501.6 MHz SSB/FM/CW Xcvr ................................ 695.00
Multi-UII 23 ch 10w 450 MHz Xcvr/7 ch scan .... 179.95
Echo 70 CM 432 MHz SSB/CW Xcvr .................. 449.95

Amplifier Freq. Input Output
PA2-25B 2m FM 2w 25w $69.95
PA4-708L 2m FM/SSB 4w 70w 189.95
PA1-408L 2m FM/SSB 15w 109.95
PA1-408BL 2m FM/SSB 15w 80w 179.95
PA1-160BL 2m FM/SSB 15w 160w 259.95
PA4-140BL 2m FM/SSB 45w 140w 219.95
PA7-20BC 220 FM 4w 70w 189.95
PA5-160BC 220 FM 15w 60w 164.95
PA5-120BC 220 FM 45w 120w 299.95
PA5-40C 450 FM 4w 40w 169.95
PA5-35CL 450 FM/SSB 15w 35w 154.95
PA5-110CL 450 FM/SSB 15w 110w 279.95

ANTENNAS
144-14.4 2m 4 element. $18.95
144-14.8 2m 8 element. 28.95
144-1612 2m 12 element. 43.95
144-1614 2m 14 element. 49.95
144-1616 2m 16 element. 54.95
144-15012 2m circular, 12 element. 54.95
144-15016C 2m circular, 16 element. 67.95
342-168 432 MHz 16 element. 45.95
144-1450 2m 1.1 sleeve balun. 14.95
144-1450N As above. with 4 N connectors 15.95
140-1502N 2m coupler/power divider 2.5 ant. 19.95
140-1504N 2m coupler/power divider 4 ant. 26.95

All other KLM products not listed here are available on special order.

AMATEUR ELECTRONIC SUPPLY®
4828 West Fond du Lac Avenue
Milwaukee, Wisconsin 53216
Phone (414) 442-4200

BRANCH STORES:
28940 Euclid Avenue; Wickliffe, Ohio 44092
Phone: (216) 585-7388
621 Commonwealth Ave.; Orlando, Fla. 32803
Phone: (305) 894-3238

Note: Branch Stores are set up to handle Walk-in business or telephone orders only. They do not have facilities to respond to written inquiries.

NEW 1978 EDITION
AMATEUR RADIO EQUIPMENT DIRECTORY

The most complete directory of Amateur Radio Equipment ever published. The all new 1978 Edition includes specifications, pictures, and prices of transceivers, transmitters, receivers, amplifiers, power supplies, transverters, antennas, tuners, towers, meters, microphones, keyers, VFO's, preamps, test gear, etc. etc. No ham library will be complete without a copy of the 1978 Amateur Radio Equipment Directory.

$4.00 Postpaid (U.S.)
Canada $5.00, Foreign (Air) $7.00
KENGORE CORP. Dept.HR
9 James Avenue
Kendall Park, N. J. 08824

SEND FOR YOUR COPY TODAY

PHIL WB4WLM
WB4WLYS

EXPERIENCE the Ultimate
in Scanners

The Touch™

by Regency

$329 LIST our price

$279.00

LAFAYETTE RADIO ELECTRONICS

1811 HWY 17-92, MAITLAND, FL. 32751
305-831-2271

ASSOC. STORE

ALL BAND TRAP ANTENNAS!

ALL 5 BAND OPERATION - ONLY ONE
NEAT SMALL ANTENNA. FOR CONGESTED
HOUSING AND APARTMENT DWELLERS!
LIGHT, NEAT - ALMOST INVISIBLE!

COMPLETE: Ready to plug in with 30 ft. Dacron and
support cord. 80-40-20-15-10 meter bands----102 ft. with 90 ft. RG59U coax - connector - Model 996B .... $49.95
40-20-15-10 meter bands----54 ft. with 50 ft. RG6U coax - connector - Model 1001B .... $49.95
20-15-10 meter bands ---- 26 ft. with 50 ft. RG59U coax - connector - Model 1007B .... $47.95

Send only $5.00 (cash, check, or credit card) and pay postage plus CO2 postage or SEND FULL PRICE
FOR POST PAID DEL. IN USA (Canada is $5.00 extra) or by MAIL OR PHONE with Bank
American Visa - Master Charge - or AM EXP. Give number and exp. date. Ph 1-305-236-6353
week days. We ship in 2-3 days. INFLATION? PRICES MAY INCREASE - SAVE ORDER NOW
INFO AVAILABLE FROM: WESTERN ELECTRONICS Dist. AH-4 Kearney, Nebraska, 68847

THIS IS IT

MODEL 4431 THRULINE®
RF DIRECTIONAL WATTMETER
with VARIABLE RF SIGNAL SAMPLER - BUILT IN
AUTHORIZED WEBSTER DISTRIBUTOR

Webster
115 BELLARMINE
ROCHESTER, MI 48063
CALL TOLL FREE
800 - 521-2333
IN MICHIGAN 313 - 375 0420

AMATEUR ELECTRONIC SUPPLY®
4828 West Fond du Lac Avenue
Milwaukee, Wisconsin 53216
Phone (414) 442-4200
BRANCH STORES:
28940 Euclid Avenue; Wickliffe, Ohio 44092
Phone: (216) 585-7388
621 Commonwealth Ave.; Orlando, Fla. 32803
Phone: (305) 894-3238

Note: Branch Stores are set up to handle Walk-in business or telephone orders only. They do not have facilities to respond to written inquiries.

For all makes Amateur HF Trans-
Mittters - Transceivers - GUARAN-
TEED FOR 2.000 WATTS PEP. POWER.

COMPLETE: Ready to plug in with 30 ft. Dacron and support cord. 80-40-20-15-10 meter bands----102 ft. with 90 ft. RG59U coax - connector - Model 996B .... $49.95
40-20-15-10 meter bands----54 ft. with 50 ft. RG6U coax - connector - Model 1001B .... $49.95
20-15-10 meter bands ---- 26 ft. with 50 ft. RG59U coax - connector - Model 1007B .... $47.95

Send only $5.00 (cash, check, or credit card) and pay postage plus CO2 postage or SEND FULL PRICE
FOR POST PAID DEL. IN USA (Canada is $5.00 extra) or by MAIL OR PHONE with Bank
American Visa - Master Charge - or AM EXP. Give number and exp. date. Ph 1-305-236-6353
week days. We ship in 2-3 days. INFLATION? PRICES MAY INCREASE - SAVE ORDER NOW
INFO AVAILABLE FROM: WESTERN ELECTRONICS Dist. AH-4 Kearney, Nebraska, 68847
The Synthacoder 509 represents the first of a totally new generation of frequency synthesizers, based on the latest advances in CMOS-LSI techniques. "Matrix Modules", which contain programming diodes, make adding new channels a cinch. Simply snap the leads on the diodes not needed, plug it in, and you are On The Air! Our unique interface design allows you to use your existing crystal positions even though the synthesizer has been installed. The Synthacoder is also easily adapted for Scanning and External Frequency Control. To sum it up—We are sure that you will find the new Synthacoder 509 Everything You Want in a 220 MHz synthesizer—And at a Price Comparable to Crystals!

* SIMPLE TO INTERFACE - Three wires and no holes!
* FULL COVERAGE - 220-225 MHz in 20 kHz steps
* MATRIX PROGRAMMABLE - No more crystals
* EXCLUSIVE "MATRIX MODULES" - Program in seconds
* FULL MODE CONTROL - Simplex, Repeater, Reverse
* LOW POWER CMOS - Draws only 60 ma
* FULLY ASSEMBLED AND CALIBRATED - Not a kit
* FITS MIDLAND, COBRA, and CLEGG 220 MHz transceivers

YES, I would like to purchase a Synthacoder for my 220 radio. Enclosed please find my $129.95 (price includes postage and handling). California residents add 6% sales tax.

Enclosed__$\:_____

\[\text{I'LL BITE! Please send more info.} \]
\[\text{I'M HOOKED! Please RUSH my Synthacoder.} \]

Name: ____________________________
Address: ____________________________
City: ____________________________
State: _______ Zip: _______

Check One:
\[\Box\] Check
\[\Box\] Master Charge
\[\Box\] BankAmericard

Credit card #: ____________________________
Expiration date: ____________________________

Signature: ____________________________

More Details? CHECK – OFF Page 126
MAY 20, 21, 1978

Monroe County Fairgrounds
Route 15A and Calkins Road
Rochester, New York

HUGE INDOOR AND OUTDOOR FLEA MARKETS
OUTDOOR FLEA MARKET RUNS CONTINUOUSLY FROM FRI. NOON.
$1.00 PER SPACE

SEE LATEST EQUIPMENT BY THE NATION'S LEADING MANUFACTURERS
FCC EXAMS FORUMS, SEMINARS LADIES' PROGRAMS AWARDS BANQUET

Hotel Headquarters
ROCHESTER MARriott Inn
(Route 15 at Thruway Exit 46)
P.O. BOX 9912 ROCHESTER, NY 14623 716-359-1800
Call or Write Hotel Direct for Reservations

Hamfest Admission:
$3.50 in advance.
$4.00 at the door.

combination Registration and banquet
only $12.00 in advance.
Advance sale closes May 13

Exhibitors call Ash Palmer, K2EAW at 716-338-2180 days only. For other info call 716-424-1100 days only, or write: Rochester Hamfest, Box 1388, Rochester, NY 14603.

WANTED FOR CASH

4CX150 4CX1000 4-65 4-250
4CX250 4CX1500 4-125A 4-400
4CX300A 4CX3000 4-1000
4CX350A 4CX5000 304TL
4CX10,000 5CX1500

Other tubes and Klystrons also wanted. See last month for other items available.

The Ted Dames Company
308 Hickory St. Arlington, N.J. 07002
(201) 998-4546 Evenings (201) 998-6475

SYNTHESIZERS

We have the worlds largest selection of synthesizers for receivers, transmitters and transceivers. For complete details see our 1/3 page ad in the April 1976 issue of this magazine or call or write for additional information. Phone orders accepted between 9 AM and 4 PM EDT. (212) 468-2720

VANGUARD LABS
196-23 JAMAICA AVENUE
HOLLIS, N. Y. 11423

HUGE INDOOR AND OUTDOOR FLEA MARKETS
OUTDOOR FLEA MARKET RUNS CONTINUOUSLY FROM FRI. NOON.
$1.00 PER SPACE

SEE LATEST EQUIPMENT BY THE NATION'S LEADING MANUFACTURERS
FCC EXAMS FORUMS, SEMINARS LADIES' PROGRAMS AWARDS BANQUET

Hotel Headquarters
ROCHESTER MARriott Inn
(Route 15 at Thruway Exit 46)
P.O. BOX 9912 ROCHESTER, NY 14623 716-359-1800
Call or Write Hotel Direct for Reservations

Hamfest Admission:
$3.50 in advance.
$4.00 at the door.

combination Registration and banquet
only $12.00 in advance.
Advance sale closes May 13

Exhibitors call Ash Palmer, K2EAW at 716-338-2180 days only. For other info call 716-424-1100 days only, or write: Rochester Hamfest, Box 1388, Rochester, NY 14603.

WANTED FOR CASH

4CX150 4CX1000 4-65 4-250
4CX250 4CX1500 4-125A 4-400
4CX300A 4CX3000 4-1000
4CX350A 4CX5000 304TL
4CX10,000 5CX1500

Other tubes and Klystrons also wanted. See last month for other items available.

The Ted Dames Company
308 Hickory St. Arlington, N.J. 07002
(201) 998-4546 Evenings (201) 998-6475

SYNTHESIZERS

We have the worlds largest selection of synthesizers for receivers, transmitters and transceivers. For complete details see our 1/3 page ad in the April 1976 issue of this magazine or call or write for additional information. Phone orders accepted between 9 AM and 4 PM EDT. (212) 468-2720

VANGUARD LABS
196-23 JAMAICA AVENUE
HOLLIS, N. Y. 11423

DUPLEXERS
NEW! VARI-NOTCH™ A state of the art design for the suppression of transmitter noise. A combination of the deepest notch, lowest loss, best passband roll-off.

The first 8½” high rack mount that provides 90 db at 0.5 MHz frequency separation, 144-174 MHz band at 125 watts.

5¼” high rack mount models for 144-174 MHz, 220MHz, 406-512 MHz, 890-960 MHz. Frequency spacings to 0.5 MHz and power to 400 watts VHF.

Band Pass, Notch, and Mobile duplexers are also available.

Write for detailed specifications, and for information on our convertible filter and expandable multiplexer lines.

TX RX SYSTEMS, INC., P.O. Box 105, 8625 Industrial Parkway, Angola, N.Y. 14006 Phone: 716-549-4700

WANTED FOR CASH

4CX150 4CX1000 4-65 4-250
4CX250 4CX1500 4-125A 4-400
4CX300A 4CX3000 4-1000
4CX350A 4CX5000 304TL
4CX10,000 5CX1500

Other tubes and Klystrons also wanted. See last month for other items available.

The Ted Dames Company
308 Hickory St. Arlington, N.J. 07002
(201) 998-4546 Evenings (201) 998-6475

SYNTHESIZERS

We have the worlds largest selection of synthesizers for receivers, transmitters and transceivers. For complete details see our 1/3 page ad in the April 1976 issue of this magazine or call or write for additional information. Phone orders accepted between 9 AM and 4 PM EDT. (212) 468-2720

VANGUARD LABS
196-23 JAMAICA AVENUE
HOLLIS, N. Y. 11423

DUPLEXERS
NEW! VARI-NOTCH™ A state of the art design for the suppression of transmitter noise. A combination of the deepest notch, lowest loss, best passband roll-off.

The first 8½” high rack mount that provides 90 db at 0.5 MHz frequency separation, 144-174 MHz band at 125 watts.

5¼” high rack mount models for 144-174 MHz, 220MHz, 406-512 MHz, 890-960 MHz. Frequency spacings to 0.5 MHz and power to 400 watts VHF.

Band Pass, Notch, and Mobile duplexers are also available.

Write for detailed specifications, and for information on our convertible filter and expandable multiplexer lines.

TX RX SYSTEMS, INC., P.O. Box 105, 8625 Industrial Parkway, Angola, N.Y. 14006 Phone: 716-549-4700

WANTED FOR CASH

4CX150 4CX1000 4-65 4-250
4CX250 4CX1500 4-125A 4-400
4CX300A 4CX3000 4-1000
4CX350A 4CX5000 304TL
4CX10,000 5CX1500

Other tubes and Klystrons also wanted. See last month for other items available.

The Ted Dames Company
308 Hickory St. Arlington, N.J. 07002
(201) 998-4546 Evenings (201) 998-6475

SYNTHESIZERS

We have the worlds largest selection of synthesizers for receivers, transmitters and transceivers. For complete details see our 1/3 page ad in the April 1976 issue of this magazine or call or write for additional information. Phone orders accepted between 9 AM and 4 PM EDT. (212) 468-2720

VANGUARD LABS
196-23 JAMAICA AVENUE
HOLLIS, N. Y. 11423
UNADILLA REVCO

"WZVS"

ANTENNA COILS

*W-40 I 0

e ...

TWO METERS

Crystal Company

Motorola HT 220 Crystals

in Stock!

Novice Crystals (Specify Band Only)

In Stock: Standard 1 Icom 1 Heathkit

Ken I Clegg I Regency I Wilson I VHF Eng.

Drake - and others

$4.50

Lifetime Guarantee: indicate make/model, xmit. frequency,
rec. frequency.

Why Waste Watts? SWR - 1A $29.95

SWR-1 guards against power loss! If you're not pumping out all the power you're paying for, our little SWR-1 combination power meter and SWR bridge will tell you so. You read forward and reflected power simultaneously, up to 1000 watts RF and 1:1 to infinity VSWR at 3.5 to 150 MHz.

Got it all tuned up? Keep it that way with SWR-1. You can leave it right in your antenna circuit.

TELEX

PROFESSIONAL HEADPHONES
& HEADSETS

Name Call

Address

City State Zip

Order:

FREE Gift With Every Order!

Credit card # Card expiration date

Master Charge

Prices FOB Medford MA. MA residents add 5% sales tax.

Minimum $3.00 for shipping & handling on ALL ORDERS. Orders $1200.00 & over deduct 5%.

Tufts Radio Electronics • 209 Mystic Avenue • Medford MA 02155 • (617) 395-8280

More Details? CHECK — OFF Page 126

April 1978 111
CALL TOLL FREE
1-800-228-4097
for Quality Ham Radio Products at Discount Prices

YAESU SUPER DEALS
- limited supply

DEAL #1
Buy a Yaesu FT-301 (dial) for only $769.00
and you get a FP-301 AC Power Supply and a
CW Filter absolutely FREE. Total Value $966.00
SAVE $197.00

DEAL #2
Buy a Yaesu FT-301d (digital) for only $935.00
and you get a FP-301 AC Power Supply and a
CW Filter absolutely FREE. Total Value $1132.00
SAVE $197.00

Call for similar savings on all these excellent lines

Communications Center
The Radio Store
443 N. 48th, Lincoln, Nebraska 68504
In Nebraska Call (402) 466-8402

VHF-FM RECEIVER
Compact — High Performance
LOW COST KIT Model 144-5
Sensitivity under .15 µV SINAD

$59.95

ACCESSORIES

Handsome Compact Aluminum Case $9.95
Speaker/Control Kit $19.95

Electrode Signal Products, Inc.
2250 G Landmeier Rd., Elk Grove, IL 60007 (312) 364-0080

Also models for 29, 50, 220 and 440 MHz

ENERGY CRISIS SOLVED!
Personal energy source! Get positive RF on DX targets with
World Record Breaking antenna that won W4TVF the ORF
ARC 1,000,000 Watt Award.

THE JOYSTICK VFA
Variable freq. and gain line antenna omnidirectional Harmonic
free radiation on all bands 160 thru 10. MARS and receive
on all EC & SW.

1000 miles of glowing reports in our files. The VFA in use today
in over 50 MARS circles world wide...

SYSTEM 'A' $75.00
250W P.E.P. at Receiving Only

SYSTEM 'B' $89.00
500W P.E.P. & Aux. Improved Q-Sector Receiver

Air Mail cost included. Each system 3 sections easily
assembled to make 5' 6" high. Matching ATU. Not only
will you save space but you will save $$$ as present field excha
and by buying direct UKtrained. Rush your order.

PARTRIDGE (HR)
ELECTRONICS LTD.
Broadstairs, Kent, England
Tel. Thanet 62535

$179.95

Kenwood
Hy-Gain
ICOM

RADIO WORLD
CENTRAL NEW YORK'S FASTEST
GROWING HAM DEALER

FT-101E
ICOM IC-211

Featuring - Yaesu, ICOM, Drake, Atlas, Den-
tron, Ten-Tec, Swan, Regency, Standard, T
tempo, KLH, Hy-Gain, Mosley, Larsen, Midland, Wilson, Southwest Tech Products.
We service everything we sell. Write or call for
quote. YOU WON'T BE DISAPPOINTED.
We are just a few minutes off the
I-80 Freeway (1-90) - Exit 32.
This symbol is important to amateur radio... present and future. Watch for it.

ARMA STATEMENT OF PURPOSE

The Radio Amateur Manufacturers Association is an organization comprised of individuals and companies whose products are intended to be sold to amateur radio operators throughout the world. As a representative group of importers, exporters, manufacturers and dealers in amateur equipment, ARMA is the official spokesman for this highly specialized industry, and has a vested interest in the fostering of continued growth of the radio amateur service, worldwide.

To further these goals, ARMA disseminates information from its headquarters on various proposals and actions that may affect its members, represents the industry in meetings, and on various committees to develop a favorable public attitude toward amateur radio, directs and advises the industry as to its best interests, and interprets industry wide technical standards as required. ARMA supports amateur radio worldwide through club, government and industry liaisons.

MEMBERSHIP ROSTER

CLEGG COMMUNICATIONS CORP.  ICOM EAST, INC.
COMMUNICATIONS POWER, INC.  KLM ELECTRONICS, INC.
COWAN PUBLISHING CORP.  LUNAR ELECTRONICS
DENTRON RADIO CO., INC.  73 MAGAZINE
GENERAL LINEAR SYSTEMS  SPECTRONICS, INC.
HAL COMMUNICATIONS CORP.  SWAN ELECTRONICS
HAM RADIO PUBLICATIONS  TEN-TEC, INC.
HY-GAIN ELECTRONICS CORP.  TRIO-KENWOOD COMMUNICATIONS, INC.
HAM RADIO CENTER, INC.  VHF ENGINEERING
DIGITAL ELECTRONICS INC.  WESTCOM ENGINEERING
SUPEREX ELECTRONICS CORP.  YAESU ELECTRONICS CORPORATION
RADIO WORLD, INC.  MIDLAND INTERNATIONAL CORP.
RUSH ELECTRONICS, INC.  THE BASE STATION, INC.
THE RADIO PLACE  AMERICAN RADIO RELAY LEAGUE
SPECTRUM COMM.  ANIXTER-MARK
EHRHORN TECH. OPERATIONS  ATLAS RADIO COMPANY
PAL ELECTRONICS  CIR INDUSTRIES, INC.

Comments and suggestions are invited from companies and individuals concerned with the present and future status of amateur radio. Such correspondence and requests for membership information should be referred to: Bernard Tower, Sec. Yaesu Electronics Corporation, 15954 Downey Avenue, Suite #19, Paramount, CA 90723

More Details? CHECK—OFF Page 126
Please don’t squeeze the Feather Touch. Kantronics Feather Touch keyer

Why keep wrestling with the mechanics in your electronic keyer? The Kantronics Feather Touch keyer has moved the "state-of-the-art" in electronic keying years ahead! By engineering a truly electronic, electronic keyer, we’ve eliminated the most cumbersome part of sending Morse code: the adjusting and readjusting of mechanical connections.

The Feather Touch responds to your lightest touch, freeing you from slapping, sloshing or squeezing. Order your Feather Touch now, or write for information and a list of authorized dealers.

At Kantronics, we think sending Morse code should be an art, not an effort.
Superior Quality and Construction at a price you can afford.

Tristao is a pioneer, years of designing and manufacturing show in structural performance and practical pricing. Certified welded construction; sandblasted surfaces; hot-dipped galvanized; heavy duty for capacity, strength, safety. Send for FREE Catalog.

Dealer Inquiries always invited.

Self-supporting or Guyed TOWERS

C2 SERIES
Self-supporting 38' to 84' for most tri-band beams in 60 mph winds. Equipped with heavy duty winch.

CTL SERIES
Guyed crank-up 18' thru 105' for tri-band beams to 8 sq. ft. Takes EDR HAM II and similar rotors. Complete installation packages available.

TRISTAO MAST MASTER
Self-supporting Rotating - Crank-up

SUPER AND STANDARD MINI-MASTS
Supports 10 sq. ft. antenna in 50 mph winds. Self-supporting. With winch and cable. Models from 40' to 67'.

FULL-LINE OF MINI-MAST ACCESSORIES

NEW EXCLUSIVE ROTOR BASE
For standard CDE or others including HAM II. Entire mast is rotated from ground level.

CUSTOM TOWERS BUILT TO YOUR SPECIFICATIONS
Masts priced from $198.50

TRISTAO TOWER
Division of Palmer Industries, Inc.
415 E. 5th St. - P.O. Box 115
Hanford, CA 93230 / Ph. (209)582-9016
Send me your complete catalog.

Name
Address
City
State, Zip

Send me FREE Catalog.

More Details? CHECK—OFF Page 126

INTRODUCES THE VERSATILE NEW

HR-312

More Channels...at the flip of a switch
Unlock the unique mode switch and 12 channels become 144

More Sensitivity, Less Interference
.25 μV Sensitivity plus 75 db adjacent channel selectivity and 70 db image rejection

More Power Out
35 watts nominal with a minimum of 30 watts across the band

... for a lot less $269.00

Amateur Net

© 1976 Regency ELECTRONICS, INC. 7707 Records Street Indianapolis, Indiana 46226

THE FM LEADER

2 METER 220 MHZ
6 METER 440 MHZ

send for FREE Catalog.
### Alabama

**LONG'S ELECTRONICS**  
2808 7TH AVENUE SOUTH  
BIRMINGHAM, AL 35202  
800-633-3410  
Call us Toll Free to place your order

### Hawaii

**HAM RADIO OUTLET**  
999 HOWARD AVENUE  
BURLINGAME, CA 94010  
415-342-5757  
Visit our stores in Van Nuys and Anaheim.

**QUEMERT ELECTRONICS**  
1000 SO. BASCOM AVENUE  
SAN JOSE, CA 95128  
408-998-5900  
Serving the world's Radio Amateurs since 1933.

### Illinois

**ERICKSON COMMUNICATIONS, INC.**  
5935 NORTH MILWAUKEE AVE.  
CHICAGO, IL 60646  
312-631-5181  
Hours: 9:30-9 Mon. & Th.; 9:30-5 Tu, Wed, Fri.; 9-3 Sat.

**KNALSD ORADIO, INC.**  
8400 NORTH PIONEER PARKWAY  
PEORIA, IL 61614  
309-691-4840  
Let us quote your Amateur needs.

### Indiana

**HOOSIER ELECTRONICS, INC.**  
P.O. BOX 2001  
TERRE HAUTE, IN 47802  
812-238-1456  
Ham Headquarters of the Midwest.  
Store in Meadows Shopping Center.

### Iowa

**BOB SMITH ELECTRONICS**  
RFD #3, HIGHWAY 169 and 7 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
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
313-395-5660
10001 Chalmers, Detroit, MI 48213, 313-371-9050.

Minnesota
ELECTRONIC CENTER, INC.
127 THIRD AVENUE NORTH
MINNEAPOLIS, MN 55401
612-371-5240
ECI is still your best buy.

PAL ELECTRONICS INC.
3452 FREMONT AVE. NORTH
MINNEAPOLIS, MN 55412
612-521-4662
The Midwest's Fastest Growing Ham Dealer.

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.
443 NORTH 48 ST.
LINCOLN, NE 68504
800-228-4977
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".

RADIOS UNLIMITED
1760 EASTON AVENUE
SOMERSET, NJ 08873
201-469-4599
New Jersey's newest complete Amateur Radio center

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.

GRAND CENTRAL RADIO
124 EAST 44 STREET
NEW YORK, NY 10017
212-682-3869
Drake, Atlas, Ten-Tec, Midland, Hy-Gain, Mosley in stock

Ohio
AMATEUR RADIO SALES & SERVICE INC.
2187 E. LIVINGSTON AVE.
COLUMBUS, OH 43209
614-236-1625
Antennas for all services.

UNIVERSAL AMATEUR RADIO, INC.
1260 AIDA DRIVE
REYNOLDSBURG, (COLUMBUS) OH 43068
614-866-HAMS
Drake, Yaesu, Ten-Tec, KDK, Wilson, DenTron, Tempo, Sigma.

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
ARTCO ELECTRONICS
302 WYOMING AVENUE
KINGSTON, PA 18704
717-288-8585
The largest variety of semiconductors in Northeastern 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.

April 1978
ALL-MODE VHF amplifiers

FOR BASE STATION & REPEATER USE

<table>
<thead>
<tr>
<th>MODEL</th>
<th>INPUT</th>
<th>OUTPUT</th>
<th>PRICE</th>
</tr>
</thead>
<tbody>
<tr>
<td>V70</td>
<td>10-20W</td>
<td>60-70W</td>
<td>929.0</td>
</tr>
<tr>
<td>V71</td>
<td>15W</td>
<td>60-70W</td>
<td>932.0</td>
</tr>
<tr>
<td>V130</td>
<td>26-40W</td>
<td>110-130W</td>
<td>838.0</td>
</tr>
<tr>
<td>V131</td>
<td>5-15W</td>
<td>110-130W</td>
<td>941.0</td>
</tr>
<tr>
<td>V136</td>
<td>110-130W</td>
<td>941.0</td>
<td></td>
</tr>
<tr>
<td>V180</td>
<td>15-20W</td>
<td>180-200W</td>
<td>952.0</td>
</tr>
</tbody>
</table>

Universal 19" Rack Mount

* All units: Harmonics exceed 60 dB specification of FCC RBO 20777
* 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

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.

DIPOLE ANTENNA CONNECTOR

K-ENTERPRISES

Frequency Counters
Power Supplies
Precalcders
Amplifiers
Marshall & Peaking
Frequency Standards
Generators

K-ENTERPRISES

FRONT PAGE OF PAMPHLET: FOR ALL YOUR AMATEUR NEEDS

ATLAS
CUSHCRAFT
DENTRON

Remember, your dealer is responsible for warranty repairs during warranty period.

Mail Orders accepted. N. Y. residents add sales tax.

Transmitter sales to licensed amateurs only.

DENCO COMMUNICATIONS CENTER

1728 EAST 2nd STREET
CASPER, WY 82601
307-234-9197

Sales, service to Wyoming and the Northern Rockies.

BUDGIE MFG. CO.

PO BOX 917, RANINOA, CA 92065

PHONE: 714-549-0878

* KENWOOD FT-101E

More Details? CHECK OFF Page 126
There's nothing like it.

**RADIO AMATEUR *callbook***

Respected worldwide as the only complete authority for radio amateur QSL and QTH information.

The U. S. Callbook has over 300,000 W & K listings. It lists calls, license classes, names and addresses plus the many valuable back-up charts and references you come to expect from the Callbook.

Specialize in DX? Then you're looking for the Foreign Callbook with almost 300,000 calls, names and addresses of amateurs outside of the USA.

**U.S. Callbook** $14.95

**Foreign Callbook** $13.95

Order from your favorite electronics dealer or direct from the publisher. All direct orders add $1.50 for shipping. Illinois residents add 5% Sales Tax.

---

Our portable 2-meter radio goes anywhere you do!!!

**Wilson ... WE-800**

800 channel - synthesized 1 and 12 Watt RF Output

Anywhere you go... camping, boating, sporting events, ham-fests... or just "talking around town" in your car, the small and lightweight WE-800 portable is with you. Designed as an all-purpose 12 watt mobile or 1 watt portable unit, it's loaded with features to satisfy even the most discriminating amateur.

"800" is for channels, from 144-148 MHz in 5 KHz steps, up or down 500 KHz for your local repeater. There are also provisions for 5 pre-programmed frequencies of your choice.

Additional features: • Operates on rechargeable internal Nicad batteries (not included) • Built-in S-meter/output indicator • Hi-Lo power switch • Connectors for external antenna, speaker and power • Mounting bracket/handle, flex rubber antenna and 12 VDC power cord furnished.

**GENERAL SPECIFICATIONS:**

- Frequency Range: 144,000 - 147.995 MHz • No. of Channels: 799 @ 5 KHz or 399 @ 10 KHz • Operating Mode: Direct frequency modulation • Type of Communication: Simplex or transceiver offset 1-600 kHz • Operating Voltage: 13.6 VDC negative ground (10 to 15 VDC range) • Current Drain: Transmit: 290 mA @ 1 watt output, 2.6amps @ 12 watts output. Receive: 45 mA squelched, 250 mA at full AF rated output • Antenna Impedance: 50 ohms nominal • Size: 8 1/4 x 6 3/4 x 1 3/8 inches (209.6 x 171.5 x 47.6 mm) • Weight: 1 lb. 15 oz. (6.8 Kgl) • Built-in S-meter • Frequency Determination Method: C-MOS phase-locked loop • Offset Option: 5 optional offset TX options also available.

**PERFORMANCE SPECIFICATIONS:**

**TRANSMITTER:** • RF Output: Hi-12W, Lo-1W • Frequency Stability: 0001% -10°C • 00015% -20°C • Local Oscillator: Simplex, 21.4 MHz, Offset +500 kHz, 22 MHz, -600 kHz, 20.8 MHz (Options for two more offsets other than 500 kHz) • Harmonics & Spurious: More than 70 dB below carrier • Deviation: ± 5 kHz • Audio Response: +1 dB 1 - 3 dB of 6 dB/ Octave response characteristics from 300 to 3000 Hz.

**RECEIVER:** • Receiving System: Double conversion Superhet • First Local Oscillator: PLL output of (F-21.4 MHz) • First IF: 21.4 MHz (with a ceramic filter) • Second IF: 455 kHz (with ceramic filter) • Stability: 0001% - 10°C • Sensitivity: 3 uV for 20 dB quieting + Squelch Sensitivity: 2 uV + Spurious & Image Rejection: Better than 80 dB • Intermodulation: 40 dB, Selectivity: ± 6 kHz at 3 dB, ± 15 kHz at 0 dB • Channel Spacing: 15 kHz • Audio Output: 2 W (10% distortion to 4 ohms)

For the "best" in amateur antennas, crank up tower and 2 meter radio equipment, depend on WILSON... demand it from your nearest amateur dealer.

**Wilson Electronics Corp.**

P.O. BOX 19000 • LAS VEGAS • NEVADA • 89119 • (702) 739-1931 • TELEX 684-522

NEW AMATEUR DEALERS NEEDED IN CERTAIN AREAS...

**WRITE FOR DETAILS!!!**

More Details? CHECK — OFF Page 126

**April 1978**
April 28, 29, 30,
At Hara Arena,
Dayton, Ohio
This year's Dayton Hamvention promises to be the biggest and best yet!

Start with more exhibit and flea market space than before. Then: • informative programs • new products • technical sessions • ARRL and FCC forums • special and group meetings • ladies' programs • transmitter hunts • total value of prizes exceeds $15,000.

Top it all off with the Grand Banquet, Saturday evening April 29.

If you have registered within the last 3 years you will receive a program and information brochure in March.

Admission $3 in advance, $4 at the door.
Saturday night banquet $8 per person.
Flea Market space $5 to $8 per space depending on number of spaces. At door only. Make check payable to: Dayton Hamvention, P.O. Box 44, Dayton, Ohio 45401.

For special hotel/motel rates and reservations information write to above address. Inquiries: call 513-854-4126.

See you at the world's largest Ham Convention!

D & V RADIO PARTS

MILITARY SURPLUS WANTED
Space buys more and pays more. Highest prices ever on U.S. Military surplus, especially on Collins equipment or parts. We pay freight. Call collect now for our high price. 201 440-8787.
SPACE ELECTRONICS CO.
div. of Military Electronics Corp.
35 Ruta Court, S. Hackensack, N.J. 07606

NEW ELECTRONIC PARTS
IC'S - TRANSISTORS - PRINTBOARDS - RESISTORS
CAPACITORS - DIODES - SWITCHES - CONNECTORS
VOLTAGE REGULATORS - CABINETS - HEAT SINKS
FUSES & MUCH MORE - STAMP BRINGS CATALOG

SPECIALS
KEYBOARD ENCLOSURES
TWO SIZES W D H PRICE
14 8.3 3 $13.50
14 11.3 3 $14.50

BLUE BASE SPECIFY WHITE OR BLACK TOP

BREADBOARD KIT $10.75.

Shipping Included

NuData Electronics
3942 E. Madison St., Mount Prospect, Illinois 60056

For Faster Service!
New!
Better than a pet rock!

Kantronics Freedom VFO

With almost 350,000 licensed amateurs on the air, variable frequency operation isn't a luxury, it's a necessity.

If you've tried to operate a rock-bound transmitter on the HF bands today, you know there must be a better way. There is. The Kantronics Freedom VFO will drive the high impedance oscillator tubes of transmitters like the HW-16, DX-60, DX-35 and other "oldie-but-goodies."

The Freedom VFO sets you free to roam from 3.650 to 3.750 MHz and 7.000 to 7.200 MHz.

Give your pet rocks to a trusted friend and order a Freedom VFO today. Or write us for information and a list of authorized Kantronics dealers.

Order now!

KANTRONICS
The Lightweight Champs

1202 East 23rd St
Lawrence, Kansas 66044
Telephone 913-842-7745

Larsen...
the coolest antenna in town
gives you the hottest performance!

Since the first Larsen Antenna was introduced some 15 years ago, this basic fact has not changed: Larsen Mobile Antennas are designed and built to outperform.

With the introduction of the Larsen exclusive Külrod whip, this superior performance is a fact more than ever.

We're not going to confuse you with details on metallurgy, radiation resistance, plating systems and all that. Instead we suggest that you make this simple test:

Take any antenna other than a Larsen... one with a regular unplated 17-7 PH stainless steel (.100/.050) tapered whip. Apply a good husky signal to it... 100 watts, for, say, a full minute. Then, power off, feel the antenna. Careful! Burn blisters aren't pleasant.

Next... try a Larsen Külrod Antenna. Put it to the same test.

Amazing isn't it!

That's our story. Heat means power... power that isn't radiated... power you shouldn't throw away. With the Larsen Külrod, power goes into communicating instead of heating the antenna. That's why you can HEAR the difference.

Larsen Antennas are available to fit all styles of mounts and to cover Amateur frequencies from 6 meters through 450 MHz. Write for complete catalog and list of dealers nearest you.

Larsen Antennas
11611 N.E. 50th Ave.
P.O. Box 1686
Vancouver, WA 98663
Phone: 206/573-2722

In Canada write to:
Canadian Larsen Electronics, Ltd.
1340 Clark Drive
Vancouver, B.C. V5L 3K9
Phone: 604/254-4936

* Külrod is a Registered Trademark of Larsen Electronics, Inc.

More Details? CHECK-OFF Page 126
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:

<table>
<thead>
<tr>
<th>CORE SIZE</th>
<th>MIX 2 u=10</th>
<th>MIX 6 u=8.5</th>
<th>MIX 12 u=4</th>
<th>PRICE USA</th>
</tr>
</thead>
<tbody>
<tr>
<td>T200</td>
<td>120</td>
<td>1.90</td>
<td>1.50</td>
<td>2.25</td>
</tr>
<tr>
<td>T206</td>
<td>135</td>
<td>1.50</td>
<td>1.50</td>
<td>2.25</td>
</tr>
<tr>
<td>T80</td>
<td>45</td>
<td>1.50</td>
<td>1.50</td>
<td>2.25</td>
</tr>
<tr>
<td>T68</td>
<td>45</td>
<td>1.50</td>
<td>1.50</td>
<td>2.25</td>
</tr>
<tr>
<td>T50</td>
<td>45</td>
<td>1.50</td>
<td>1.50</td>
<td>2.25</td>
</tr>
<tr>
<td>T25</td>
<td>45</td>
<td>1.50</td>
<td>1.50</td>
<td>2.25</td>
</tr>
</tbody>
</table>

RF FERRITE TOROIDS:

<table>
<thead>
<tr>
<th>CORE SIZE</th>
<th>MIX Q1</th>
<th>MIX Q2</th>
<th>MIX Q3</th>
<th>PRICE USA</th>
</tr>
</thead>
<tbody>
<tr>
<td>F-240</td>
<td>125</td>
<td>1.50</td>
<td>1.50</td>
<td>2.25</td>
</tr>
<tr>
<td>F-125</td>
<td>125</td>
<td>1.50</td>
<td>1.50</td>
<td>2.25</td>
</tr>
<tr>
<td>F-87</td>
<td>100</td>
<td>1.50</td>
<td>1.50</td>
<td>2.25</td>
</tr>
<tr>
<td>F-50</td>
<td>100</td>
<td>1.50</td>
<td>1.50</td>
<td>2.25</td>
</tr>
<tr>
<td>F-37</td>
<td>100</td>
<td>1.50</td>
<td>1.50</td>
<td>2.25</td>
</tr>
<tr>
<td>F-23</td>
<td>100</td>
<td>1.50</td>
<td>1.50</td>
<td>2.25</td>
</tr>
</tbody>
</table>

Chart shows uH per 100 turns.
FERRITE BEADS:

2x $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

122 April 1978

MORE COMPUTER ITEMS

"8K ECONORAM II" kit
$135, 3 kits for $375,
assembled and tested $155.
This is the board that thousands of owners
swear on, not at. There are hits of reasons
such as: unique addressing options, reliability, full buffering,
fast access time, a full set of sockets—but probably the most
popular feature is the price, which is
all the more remarkable because of the high level of
goodness. One owner reviewed this board in the 1.77
issue of Byte, calling it, "If you’re not
convinced by now that the ECONORAM II is one of the
best memory boards on the market today, you
really have to be one tough cookie—either that or you
work for someone else who makes memory boards.

12K ECONORAM VI": $235
We proudly welcome our newest memory
board family member. Designed from the
ground up for full compatibility with the
Heath Company H8. Organized as two indepen-
dent blocks, one 8K block and one 4K. Has the
same basic features as our ECONORAM II—
all static design, switch selected and buffered.
4Ks for all 9's. full buffering, plus the required
hardware and edge connector to mate mechanically
with the H8. You can have our 12K board for the
price of the Heath Company’s 8K....with the per-
formance you have come to expect from products
carrying the ECONORAM trade mark.

A Message:

Now you can have the quality of Godbout prod-
ucts and the convenience of local shipping
without the added cost. All our electronic
modules stock a number of our items, from individual
components to complete board kits.
We always welcome new dealers. If you have a
store and want to know more about adding these
popular products to your line, write or phone and ask
for our dealer package.

Finally, it's time to add that even if appropriate op-
terations such as ourselves have been amazed and
delighted at the response to our computer kits. We
thank you very much for your support (and your pa-
tience during our period of hardest expansion), and it
will enable us to keep you excited with more new
products in the months ahead.

SEMICONDUCTOR SUPERMART

FREQUENCY COUNTER CHIPS
7207A $5.75
7208 $15.95
9368 $2.50
71496 $1.95
5.24288 MHz Xtal $6.95
95190 $9.25
11590 $15.25

VOLTAGE REGULATOR SPECIAL

POSITIVE OR NEGATIVE

YOUR CHOICE ONLY .99 EA.

7805 7905 $5.50
7806 7906
7808 7908
7812 7912
7815 7915
7818 7918
7824 7924

ALSO

7805 5V, 5 amp
7812 12V, 5 amp

ZENER DIODES (1-WATT)
3 FOR $1.00

1N4733A 1W, 5.1V 1N4743A 1W, 13V
1N4734A 1W, 5.6V 1N4744A 1W, 15V
1N4736A 1W, 6.2V 1N4746A 1W, 16V
1N4737A 1W, 6.8V 1N4747A 1W, 18V
1N4738A 1W, 8.2V 1N4748A 1W, 20V
1N4759A 1W, 9.1V 1N4749A 1W, 24V
1N4704A 1W, 10V 1N4750A 1W, 27V
1N4741A 1W, 11V 1N4751A 1W, 30V
1N4742A 1W, 12V 1N4752A 1W, 33V

TRANSISTORS - FETS

2N5179 $1.75
2N5403 $1.55
9010 $1.25
2N6081 $0.60
2N6082 $1.15
2N6084 $1.35
2N5858 $4.95
2N5550 $6.95
2N5591 $10.95
MR249A $10.25
MR245A $15.55
MR901 $4.50
MR902 $4.50

CIRCUIT SPECIALISTS CO.
BOX 3047
SCOTTSDALE, AZ 85257

Terms: C.O.D. add 10%. Allow 1% shipping, extra handling.
10% off "OCTopus" orders (355 min) call 615-562-0636, 24hrs. C.O.D. or with check address.

Send our flyer for
Godbout

BILLS GODBOUT ELECTRONICS
BOX 250, OAKLAND AIRPORT, CA 94614

More Details? CHECK — OFF Page 126
I

1 all your VHF Varacolor Send ANTENNAS 88 EL. Decade Prc-Selector 48 EL. 1250.1340 MHz 8XY/2M 8 OVER 8 J-SLOT MMt432-144 Output Power 10 W PEP 8 Drive, 10 1650.1750 MHz 1691-LY UHF LOOP MMt432-AN Shippnng: Specifications:

32 MHz CRYSTAL FILTERS AND XTAL DISCRIMINATORS OSCILLATOR CRYSTALS 9 kHz TO 150 MHz Write for Details

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/BBM-88 MULTIBEAM and operate direct into OSCAR 7 mode B. Write for application note.

Specifications:
Output Power: 10 W PEP
Drive, 10 Meters: 15 W max
Receiver N.F.: 3.0 dB typ
Receiver gain: 30 dB typ
Pre-Power: 12 V D.C.
Shipping: $3.50

MMt432-28 MKA $249.95
MMt432-50 $249.95
MMt432-ATV $249.95
MMt432-144 $119.95
MMt432-144 $119.95

AMTENNAS
8 OVER 8 J-SLOT 13.7 dB d 8 BY 8 VERTICAL POL. 8XY/2M $41.95

420-450 MHz MULTIBEAMS

48 EL. GAIN +15.7 d 70/BBM-48 $47.95
88 EL. GAIN 18.5 d 70/BBM-88 $73.50

UHF LOOP YAGIS
26 LOOPS GAIN 12.0 dBI 1290-1340 MHz 1296-LY $56.95
1650-1750 MHz 1691-LY $83.95

Send 20¢ (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

More Details? CHECK — OFF Page 126

Canadian Industries, Ltd., 1145 Bellamy Rd., Scarborough, Ontario M1V 1H5
Export: EMEC Inc., 2350 South 70th Avenue, Hallandale, Florida 33009

April 1978 123

Spectrum
International, Inc.
Post Office Box 1084
Concord, Mass. 01742, USA
This MFJ RF Noise Bridge... lets you adjust your antenna quickly for maximum performance. Measure resonant frequency, radiation resistance and reactance. Exclusive range extender and expanded capacitance range gives you much extended measuring range.

Order from MFJ and try it — no obligation. If not delighted, return it within 30 days for a refund (less shipping). This bridge is unconditionally guaranteed for one year. To order, simply call us toll free 800-647-8660 and charge it on your VISA or Master Charge or mail us a check or money order for $49.95 plus $2.00 for shipping and handling.

Don't wait any longer to enjoy maximum antenna performance. Order today.

MFJ ENTERPRISES
P. O. BOX 494
MISSISSIPPI STATE, MS. 39762
CALL TOLL FREE ... 800-647-8660
For technical information, order and repair status, in Mississippi, call 601-323-5869.
REPEATER USERS — Stay in Touch — with DSI

UNIVERSAL

The Data Signal TTP Series of keyboard encoders is used to generate the standard 12 or 16 DTMF digits. The encoders provide fully automatic transmitter keying and feature a delayed Transmit Ready light, an interdigit timer, and a built-in audio monitor. Features also include all solid-state, crystal-controlled, digitally-synthesized tones and an optional internal mount Automatic Number Identifier (ANI).

TTP-1 (12-digit) $59.00
TTP-2 (16-digit) $69.00


*Touch-Tone is a registered trade name of AT&T.

TOUCH-TONE® ENCODERS

AUTOPATCH — Ready to go!

A Complete Autopatch facility that requires only a repeater and a telephone line. Features include single-digit access/disconnect, direct dialing from mobile or hand-held radios, adjustable amplifiers for transmitter and telephone audio, and tone-burst transponder for acknowledgement of patch disconnect.

RAP-200 P. C. Card $199.50
RAP-200R Rack Mount $249.50

SUB-MINIATURE ENCODERS

MODEL SME — Smallest available Touch Tone Encoder. Thin, only .05" thick, keyboard mounts directly to front of hand-held portable, while sub-miniature tone module fits inside. This keyboard allows use of battery chargers. Price $34.50, with your choice of keyboards.

DATA SIGNAL, INC.
2403 COMMERCE LANE
ALBANY, GEORGIA 31707, 912-883-4703

The Leader in the Northwest!

ATLAS ICOM KENWOOD YAESU

NEW from KENWOOD!

KENWOOD Transceiver TS-520S 160 thru 10M $739. (less DG-5)

ICOM Transceiver 2M FM SSB IC 211 $749.

YAESU Transceiver FT-301, 160 thru 10M $769.

Other locations:
(Walk-in customers only)
Bellevue - 12001 N. E. 12th
Everett - 6920 Evergreen Way

ABC
COMMUNICATIONS
17550 15th AVE. N.E.
SEATTLE, WASH. 98155
206-364-8300

VISA
MasterCard

TO PLACE ORDER CALL TOLL FREE IN STATE OF WASH.
1-800-562-7625

April 1978
AGL Electronics

AGL would like you to CONSIDER KENWOOD

For example, the AT-200: a new and versatile accessory that belongs in every station. The AT-200 is an antenna tuner, but it’s also much more — it’s an antenna switch, an SWR bridge, and an on-line wattmeter. The AT-200 reduces the clutter and increases the operating efficiency of your station.

How about the SP-820, an external speaker designed for use with the Kenwood TS-520 and TS-820 transceivers, in place of the internal speakers. The SP-820力争 separates, selectable tone filters to attenuate high or low-frequency response inputs, and two-channel, selectable headphone outputs switchable through the tone filters.

SP-820
AT-200

AGL also takes great pride in stocking these other great lines of Amateur radio equipment.

INDEX

ABC Communications ...... 125
 ABC Electronics .......... 125
 ALDA Communications .. 37
 Aldelco .......... 104
 Aluma Tower Co. .... 162
 Amateur Electronic Supply . 108
 Amateur Wholesale Electronics . 80, 81
 Antler Antenna . 88
 Army ........ 113
 Atlantic Surplus Sales . 106
 Atlas Radio .... 69
 R. H. Bauman Sales Co. . 94
 Budweig Mtg. Co. .... 118
 Bullet . 100
 Burbank Electronics . 106
 CFP Communications .... 120
 CW Electronic Sales Co. ... 98
 Circuit Specialists ..... 58, 59
 Continental Specialties ... 79
 Crystal Banking Co. ... 102
 Cushcraft .... 70, 71
 DBW Radio Parts .... 102
 DSI Instruments .... 76, 77
 Dames Communications Systems ... 94
 Dames, Ted .... 125
 Data Signal, Inc. ... 94, 124
 Davis Electronics .... 94, 124
 Dayton Hamvention .... 120
 Denriltron Radio Company . 121
 Drake Co., R. L. ... 42, 43, 84
 Ethernet Systems .... 107
 Electromatic Industries . 96
 Electronic Distributors .. 88
 Electronic Equipment Bank . 115
 Electronic Sales Products ... 112
 Engineering Specialists ... 109
 Erickson Communications . 104
 FT Accessoris .... 120
 Fulcrum Manufacturing Co. . 78
 G & B Electronics .... 86
 Gray Electronics .... 106
 Gregory Electronics ..... 121
 Gulf Electronics .... 101
 Hal Communications Corp. ... 52, 53
 Ham Radio .......... 97
 Ham Radio’s Communications Bookstore ... 78, 86, 89
 Hamtronics, Inc. .... 91
 Heath Company .... 33
 Henry Radio Stores .... Cover II
 Icom .... 5
 Ingrid’s, Circuitized Limited ... 167
 International Crystal . 85
 James Electronics .... 103
 Jan Cystals .... 88
 Jones, Martin P. & Assoc. . 114
 K Enterprises .... 118
 Kantronics .... 114, 121
 Kigurop Corp .... 138
 Kino Kwik Communications, Inc. ... 8, 9, 64
 Kister Solder .... 86
 Klaus Radio, Inc. .... 86
 Lafayette Radio Electronics . 94, 108
 Lien Screen Ax... 121
 Long’s Electronics .... 128
 Lyle Products .... 96
 M & F Enterprises .... 2, 124
 Madison Electronic Supply ... 96, 99
 NuData Electronics .... 120
 Oak Hill Academy Amateur Radio Session ... 88
 Optonics .... 49
 Palomar Engineering .... 83, 122
 Parrish (BHF) Electronics .... 112
 Paper Communications .... 90
 Poinciana, Circuit Products . 94
 PIF Power Labs .... 118
 Radio Amateur Callbook ... 90, 91
 Radio Systems Technology, Inc. ... 96
 Radio World .... 112
 Ramsey Electronics .... 115
 Regency Electronics .... 115
 Rochester Hamfest .... 83
 Rockwell International, Collins Group ........ 1
 SST Electronics .... 99
 Secentric .... 92
 Sherwood Engineering .... 92
 Siepm Electronics Co. .... 106
 Solid State Time .... 118
 Space Electronics .... 120
 Spectronics .... 95
 Spectra International .... 123
 TPL Communications .... 123
 TX RX Systems, Inc. .... 116
 Ten Tec .... 87
 Trabue Tube .... 115
 Tuft’s Radio Electronics .... 111
 VHF Engineering, Div. of Brownian .... 89
 Vandal Labs .... 110
 Varian, Elmac Division .... Cover IV
 Website Associates .... 88
 Werner & Werner .... 98
 Western Electrics .... 89
 Whitehouse, G. R. & Co. .... 98
 Wilson Electronics .... 96
 Yasei Electronics Corp. .... Cover III

More Details? CHECK — OFF Page 126
ETO builds every ALPHA Linear Amplifier to run maximum legal power NTL* with high efficiency on all bands and in all modes. *(No Time Limit)

QST says it: ALPHA 374

- "(ALPHA 374 is) an amplifier fully capable of continuous operation at the legal power limit ... hardly larger than the average ssb transceiver."
- "... no-tune-up ... high power operation requires no more adjustment than that involved in operating the exciter."
- "... there is no need to worry about whether the tubes or the power supply can handle a full kilowatt."
- "At no time ... including two contest weekends when it was subject to constant use ... did the writer feel that the amplifier capabilities were even close to being taxed." (QST, April 1975, p. 42-45.)

QST says it: ALPHA 76

- "Typically excellent ETO construction techniques ... in the (ALPHA) 76."
- "The transformer ... is a 1.5 KVA continuous-service unit."
- "The unit runs cool and quiet."
- "The ALPHA 76 more than exceeds harmonic attenuation [requirements.] ... Third-order products are approximately 40 dB down ..."
- "... 1 kW cw input provides excellent efficiency ..."
- "Output efficiency as measured in the ARRL laboratory was better than 60% for both 2000 watts PEP and 1000 watts cw input on all bands." (QST, January 1978, p. 35-36.)

FIRST CLASS IS 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
KENWOOD TS-820S transceiver
The NEW Kenwood TS-820S features a factory installed digital frequency readout. • 160 thru 10 meter coverage • Integral IF shift • RF speech processor • VOX • Noise blanker • PLL • Built-in 25 KHz calibrator • CW side tone & semi-break-in • IF OUT, RTTY, & XVT • Phone patch IN and OUT terminals.
1098.00 is list price. Call Toll-Free for quote.

KENWOOD TR-7500 2m FM transceiver
The NEW TR-7500 has the features you need! Check these: • PLL synthesized • 100 channels (88 pre-programmed, 12 extra diode programmable) • Single knob channel selection • 2-DIGIT LED frequency display • Powered tone pad connection • Helical resonators • 10 watts HI output, 1 watt LOW output. Available very soon! Call us for quote.
299.00 list price. Call for quote.

KENWOOD TS-520S SSB transceiver
TS-520S features: • 160 thru 10 meter coverage • Optional DG-5 frequency display (on top of unit) • New speech processor with audio compression amplifier • Built-in AC power supply (DC-DC converter, optional) • RF attenuator • Provision for separate receive antenna & phone-patch.
739.00 list price. Call for quote.

KENWOOD TR-7400A 2m FM transceiver
Features: • CTCS provisions, encode and decode • 25 watt output RF • Solid-state final stage • LED readout • PLL gives 800 discrete channels • Repeater offset circuit • PLL unlock protection circuit • MOS FET.
399.00 list price. Call for quote.

KENWOOD SP-820 speaker
Now you can have an external speaker in your shack that's designed just for your TS-820S transceiver. Matching appearance, plus built-in selectable tone filters. 2 channel selectable headphone output switchable through the tone filters.
49.00 Call for yours today.

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.

Long’s Electronics
MAIL ORDERS: P.O. BOX 11347 BIRMINGHAM, AL 35202 • STREET ADDRESS: 2806 7TH AVENUE SOUTH BIRMINGHAM, ALABAMA 35233
BOARDS INSIDE CABINET
1 CARR OSC unit
2 VOX unit
3 AF unit
4 IF unit
5 Filter unit
6 Noise Blanker/RF Processor
7 Rectifier unit
8 Rectifier unit
9 Power XFMR
10 Final Amplifier unit
11 VCO unit
12 TUNE control
13 PLL unit
14 RF unit
15 Counter Display unit
16 FM unit

FRONT PANEL CONTROLS
A Vox gain
B Carrier level/keyer speed
C Audio Peak Frequency system
D MODE switch (SSB, CW, FSK, AM, FM)
E Crystal calibrator/Noise blanker
F Rejection tuning/variable IF passband tuning
G Frequency memory system
H Digital plus analog frequency readout
I Band switch (160-10 meters + WWV/JY receive)
J Clarifier control
K RX/TX Clarifier selector
L RF Processor level
M RF attenuator
N TUNE control (Places transmitter in ‘TUNE’ condition for ten seconds, then returns to ‘receive’ condition to protect final tubes from excessive key-down time)
The first three of a new family of power tubes are available today from EIMAC. These ceramic-metal triodes provide the high power, gain and efficiency of tetrodes, along with long life and reliability up into the UHF spectrum.

EIMAC can supply cavity or cavity design guidance for these tubes in CW as well as pulse service. Because of the circuit simplicity of triodes, this EIMAC family allows the circuit designer to take full advantage of simple cavity design. No tricky screen bypass capacitors or critical isolation circuits are required.

Look at the numbers:

<table>
<thead>
<tr>
<th>Type</th>
<th>Typical CW Performance Data</th>
<th>Maximum Ratings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Gain</td>
<td>Power Output</td>
</tr>
<tr>
<td>3CX400U7</td>
<td>13.5dB</td>
<td>225W</td>
</tr>
<tr>
<td>3CX600U7</td>
<td>14.0dB</td>
<td>445W</td>
</tr>
<tr>
<td>8938</td>
<td>12.8dB</td>
<td>1570W</td>
</tr>
</tbody>
</table>

For full information, contact Varian, EIMAC Division, 301 Industrial Way, San Carlos, California 94070. Telephone (415) 592-1221. Or call any of the more than 30 Varian Electron Device Group Sales Offices throughout the world.

EIMAC delivers triode simplicity with tetrode performance at UHF.
Send for your copy of the world's largest selection of quality electronic products in easy-to-build, money-saving kit form! Nearly 400 kits in all — all with Heath's world-famous assembly manuals that take you step-by-step from unpacking to final plug-in.

Please rush me my personal copy of the new Heathkit catalog.

I am not on your mailing list.

Name ____________________________
Address ____________________________
City ____________________________ State ______
PD-126 Zip ____________
HAM RADIO Dept. 122-400
Send for your Free Heathkit Catalog

Complete descriptions and specifications of nearly 400 electronic kits including:
- stereo components
- auto, marine, and aircraft accessories
- digital clocks
- weather instruments
- Amateur Radio
- color TV
- personal computers
and lots more!

HEATH COMPANY
Benton Harbor MI 49022