FEBRUARY 1979

- antenna position display
- RTTY modulator
- crystal oscillators
- curve tracer
- noise blanker
- TTL logic probe

10/80-watt AMPLIFIER for 2 meters
HENRY RADIO'S "WORKHORSE"
THE 2K-4A

Never has a linear amplifier racked up so many hours of dependable operation for amateurs worldwide... operating at full legal power... hatt no other linear under every type of condition imaginable. Because the 2K-4A is built with the very best, heavy duty components available, it can loaf along at full legal power. It offers engineering and features second to no other linear on the market. The 2K-4A will put your signal on the air with greater strength and clarity than you ever dreamed possible.

Operates on all amateur bands, 80 thru 15 meters (export models include 10 meters) • Features two rugged Eimac 3-500Z grounded grid triodes • Pi-L plate circuit with silver plated tank coil • Resonant cathode-pi input circuit for finest linearity & maximum drive (tunable design permits operation on any frequency from 3.5 to 30 megacycles) • High efficiency toroidal filament choke • Built-in SWR bridge and relative RF output meter • Electrical reset overload relay • Double rugged band change switch with 20 amp contacts and solid straight-through mechanical linkage • Heavy duty bronze gear drive for resonance and load condensers • Conservative, heavy-duty 2800 volt DC supply • Resonant choke input filter for superb voltage regulation • Solid state rectifiers • Maximum legal input all modes. 2 KW PEP SSB, 1 KW CW, AM-FSK • Long life 50 amp mercury power relay • Feed around antenna relay • All aluminum cabinet to eliminate magnetic resonance • Double RF shielding

The 2K-4 is still available for export and military use

2KD-5

Another superb linear amplifier from Henry Radio designed and built to perform at peak level month after month year after year. Operates at full legal power continuous duty on all modes. The 2KD-5 is a 2000 watt PEP input (1200 watt PEP nominal output) desk model linear amplifier, covering the 80, 40, 20, and 15 meter amateur bands. Features two Eimac 3-500Z glass envelope triodes operating in a grounded grid circuit • Pi-L plate circuit with a rotary silver plated tank coil for greatest efficiency and maximum attenuation of unwanted harmonics • Full legal input in all modes. 2000 watts PEP input for SSB, 1000 watts DC input for CW-RTTY-AM Price $5795

1KD-5

A little less power, a little lighter. AND less expensive... but the 1KD-5 is a true Henry Radio linear amplifier, offering superior quality and dependability. It is designed to greatly boost the strength and clarity of your signal. Its heavy duty components guarantee years of trouble free, dependable performance.

The 1KD-5 is a 1200 watt PEP input (700 watt PEP nominal output) RF linear amplifier covering the 80, 40, 20, and 15 meter amateur bands (also 10 meters on units shipped outside the U.S.) Features an Eimac 3-500Z glass envelope triode • ALC circuit • DC relay system • Relative RF power meter • Pi-L plate circuit with a rotary silver plated tank coil • Cathode Pi input matching circuits • Conservative power supply with solid state rectifiers

Price $695

3K Commercial/Military Amplifier

A high quality linear amplifier designed for commercial and military uses. The 3K employs two rugged Eimac 3-500Z grounded grid triodes for superior linearity and provides a conservative three kilowatts PEP input on SSB with efficiencies in the range of 60%. This results in PEP output in excess of 2000 watts. It provides a heavy duty power supply capable of furnishing 3000 watts of continuous duty input for either RTTY or CW with 1200 watts output 3.5-50 MHz. Price $1945

4K Ultra*

Specifically designed for the most demanding commercial and military operation for SSB, CW, FSK or AM. Features general coverage operation from 30 to 30 MHz. Using the magnificent new Eimac 8877 grounded grid triodes, vacuum tune and load condensers, and a vacuum antenna relay, the 4K ULTRA represents the last word in rugged, reliable linear high power RF amplification. 100 watts drive delivers 4000 watts PEP input. Price $3250

*Not available for sale to amateurs in the U.S.

Export inquiries are invited

Export models of Amateur units available for 11 meter operation also

Henry Radio

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

Prices subject to change without notice
ALDA 103 is 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 uV 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!

Attention novices and fifteen meter fans: Now introducing the ALDA 103A operating 80-40-15 meters.

Contact your local dealer or the factory for details — prices shown below.

### GENERAL SPECIFICATIONS

- **Semiconductors:** 39 diodes, 23 transistors, 11 integrated circuits
- **Power:** Nominal 13.8 VDC input at 15 amps
- **Requirements:** Negative ground only
- **Power Consumption:** 3.414” x 9” wide x 12.12” deep (82.55 mm x 228.6 mm x 317.5 mm)
- **Dimensions:** 3.414” x 9” wide x 12.12” 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 7.5 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 0.26 dB
- **AF Response:** 500 to 2500 Hz
- **Spurious Radiation:** Better than 45 dB below 30 MHz, better than 60 dB above 30 MHz
- **Frequency Stability:** Less than 100 Hz drift per hour (from cold start at room temperature)
- **Microphone:** High impedance 3000 ohms
- **Receiver Sensitivity:** Better than 0.5 watts audio output for 0.5 µV input
- **Signal-to-Noise Ratio:** Better than 10 dB S+N/N for 0.5 µV input
- **Image Ratio:** Better than 60 dB
- **Interception Point:** Better than -50 dB
- **Selectivity Carrier Band:** 2.5 kHz — 6 dB, 5 kHz — 60 dB
- **Audio Output Power:** More than 3 watts
- **Audio Distortion:** Less than 5% at 3 watts

### Options & Accessories

- **Microphone** $14.95
- **Mobile Mount** $3.95
- **Noise Blanker** $39.95
- **Model No. PC 701** $39.95
- **Portable Power Supply — Model No. PC 801** $19.95
- **Dual Crystal Calibrator — Model No. PC 801** $19.95
- **Power Supply — Model No. ALDA PS 115** $199.95
- **Heavy Duty Power Supply — Model No. ALDA PS 130** $149.95

$495

**Suggested Retail Price**

**Options & Accessories**

- Microphone $14.95
- Mobile Mount $3.95
- Noise Blanker $39.95
- Model No. PC 701 $39.95
- Portable Power Supply — Model No. PC 801 $19.95
- Dual Crystal Calibrator — Model No. PC 801 $19.95
- Power Supply — Model No. ALDA PS 115 $199.95
- Heavy Duty Power Supply — Model No. ALDA PS 130 $149.95

**ALDA 103** is completely manufactured in the USA.
MFJ ENTERPRISES, INC.

NEW MFJ-940 VERSA TUNER II

For $69.95 you can match any coax line or random wire from 1.8 to 30 MHz. Up to 300 watts RF OUTPUT. Built-in SWR, dual range wattmeter. Six position antenna switch. Efficient airwound inductor.

When you buy MFJ you buy proven MFJ quality... and a one year unconditional guarantee.

$69.95

With the NEW MFJ-940 Versa Tuner II you can match your transmitter to any coax line or random wire continuously from 1.8 to 30 MHz. Up to 300 watts RF power OUTPUT. Works with all solid state (like Atlas) and tube rigs.

Tune out SWR on your dipole, inverted vee, random wire, vertical, mobile whip, beam, quad, any coax fed or random wire antenna. Operate all bands with just one antenna. Increase bandwidth of your mobile whip by tuning out SWR from inside your car.

A SWR and dual range wattmeter (300 and 30 watts full scale) lets you measure RF power output for simplified tuning.

Six position antenna switch on rear lets you select 2 coax lines direct or thru tuner, random wire, and tuner bypass for dummy load.

A new efficient airwound inductor (12 positions) gives you less losses than a tapped toroid for more watts out.

Compact size 8x2x6 inches fits easily in small corner of suitcase for easy traveling.

MFJ-900 ECONO TUNER matches coax, random wires. Full band coverage 1.8 to 30 MHz. Up to 200 watts RF OUTPUT. Efficient airwound inductor.

Use any transceiver, solid state or tubes. Increase antenna bandwidth. Operate all bands with any whip antenna. Tune out SWR on your mobile whip from inside your car.

Efficient airwound inductor gives more watts out than tapped toroid. SO-239 coax connectors for transmitter and coax. Binding post for random wire, ground. Compact 5x2x6 inches.

MFJ-901 Versa Tuner available. Same as MFJ-900 but has 4:1 balun for balanced lines. $49.95. Beware of imitators. Some are still copying our earlier models. MFJ has made major improvements.

For example, a new efficient airwound inductor gives you less losses than a tapped toroid for more watts out and plenty of inductance for full band coverage 1.8 to 30 MHz.

MFJ-16010 RANDOM WIRE TUNER lets you operate all bands — 1.8 to 30 MHz — with a simple random wire. Up to 200 watts RF OUTPUT.

Operate all bands — anywhere, with any transceiver — using a random wire and an antenna tuner small enough to carry in your hip pocket. Ultra compact 2x3x4 inches.

Operate from your apartment with a wall to wall antenna, or motel room with a wire dropped from a window. Enjoy ham radio on a camping or backpack trip with a wire thrown over a tree.

$39.95

$39.95

$29.95

FOR YOUR NEAREST DEALER OR FOR ORDERS

CALL TOLL-FREE 800-647-1800

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.

For technical information, order/repair status, in Mississippi, outside continental USA, call 601-323-5869.

Order By Mail or Call TOLL FREE 800-647-1800 and Charge It On

MFJ ENTERPRISES, INC.

P. O. BOX 494
MISSISSIPPI STATE, MISSISSIPPI 39762

More Details? CHECK — OFF Page 126
contents

12 two-meter fm power amplifier
Edward J. Paragi, WB9RMA

18 solid-state antenna position display
William K. Springfield, AE4A

26 phase coherent RTTY modulator
Francis E. Hinkle, K5PPh

32 charging ni-cad batteries
George A. Wilson, W1OLP

37 crystal oscillators
Donald W. Nelson, WB2EGZ

46 semiconductor curve tracer
Stuart Tuma, W1QXS

54 new approach to the noise blanker
Robert T. Hart, W5OJR

60 causes and cures of power-line noise
David L. Ingram, K4TWJ

66 digital techniques: gate structures and logic families
Leonard Anderson

70 field-strength and volt-ohm meter
Kenneth E. Powell, WB6AFT

78 HT-37 improvements
Alfred Wilson, W6NIF

83 TTL logic probe
Andrew B. White, K9CW

86 code speed counter
Louis C. Graue, K8TT

4 a second look
6 letters
126 advertisers index
98 new products
113 coming events
8 prestop
66 digital techniques
126 reader service
111 flea market
94 short circuits
118 ham mart
70 weekender
90 ham notebook
This year Amateur Radio may be facing one of its biggest challenges in 20 years. What I’m referring to, of course, is the World Administrative Radio Conference which will convene this fall in Geneva, Switzerland. Better known in ham circles as WARC 79, this conference of ITU member nations will consider all the high-frequency allocations, including those of Amateur Radio, broadcasting, maritime mobile, and the other radio services which require operating frequencies.

There are some Amateurs who would like you to believe that the high-frequency Amateur bands will be completely decimated at this conference — ravaged by the greedy big-money interests who covet our bands for their own selfish purposes — but I think that the people who are all too eager to promote that turn of events are either alarmists or poorly informed; probably both. Obviously, it’s impossible to forecast the outcome of WARC 79 at this point in time, but the Amateurs I’ve talked to who are officially involved with preparations for the conference are all cautiously optimistic that the high-frequency Amateur bands after WARC will be pretty much the same as they are now. And they are the ones who should know, not the purveyors of gloom and doom who apparently get their information from the Wizard of Oz — or some other equally unlikely source.

In the past, dozens of magazine articles have been written about the “terrible drubbing the Amateur Radio service has taken at every international frequency allocation conference.” If you carefully review the record, however, you’ll find that exactly the reverse is true; in every case American Amateurs have actually gained more high-frequency spectrum than they lost.

It is generally believed, for example, that at one time Amateurs had exclusive use of all wavelengths below 200 meters. That’s a fable which has been quoted so often it’s now accepted as fact. Actually, the 1912 regulation in question restricted all stations not involved in commercial traffic from going above 200 meters. That included all private, commercial, and experimental stations not transacting business or developing equipment for business purposes. Amateurs had no exclusive claim on “200 meters and down” — they shared that spectrum with virtually every other radio service. In fact, Amateur Radio stations at that time were required to specify their operating wavelengths, which were invariably 150, 175, or 200 meters — three spot frequencies below 200 meters.

In the early 1920s it became apparent that the 1912 law was hopelessly inadequate for the then existing conditions. More stations were on the air than ever before, the broadcast boom was well underway, and Amateurs had demonstrated the long-distance capabilities of the short waves. The scramble for short-wave territory was on, and every service was pushing for all the high-frequency spectrum it could get. To bring order to the ensuing chaos, a domestic radio conference was held in Washington in 1924; part of the outcome was the establishment of four harmonically-related Amateur bands: 160, 80, 40, and 20 meters. It’s important to remember that this was not an international agreement, however, nor in fact did it have the authority of law — it was purely a mutual agreement between the various radio services in the United States.

The 1927 International Radio Conference in Washington saw precious kHz shaved off the American 160, 40, and 20 meter bands, but in return we received an exclusive new band at 10 meters. Amateurs in Europe fared less well, and some will argue that American Amateurs now had to share 40 and 80 meters with the foreign broadcasters, but that was true before the 1927 conference convened. Compared with the spot frequencies given to Amateurs in 1912, the new international allocations were a vast improvement.

There was no change in the Amateur bands at the Madrid conference in 1932, nor at Cairo in 1938. The next conference was scheduled for Rome in the spring of 1942, but because of the war, the next International Radio Conference was not held until 1947, in Atlantic City. Amateurs lost some space on 160, 20, and 10 meters at Atlantic City, but we received a nice bonus in return: a brand new band at 15 meters. Hence, there was not a net loss at all, but a gain! Those are the same bands we are still using today.

In reviewing the record of high-frequency Amateur allocations, we have progressed from what was essentially spot-frequency operation in 1912, to 3485 kHz of high-frequency operating space in 1927, to 3500 kHz today. Based upon past performance, and the proven service of Amateur Radio to the public, I believe we have every reason to be optimistic about the future.
Imagine All The Places You Can Tuck ICOM's Remotable IC-280. (Think small.)

The IC-280 2 meter mobile comes as one radio to be mounted in the normal manner: but, as an option, the diminutive front one third of the radio detaches and mounts by its optional bracket, while the main body tucks neatly away out of sight. Now you can mount your 2 meter radio in pint-sized places that seemed far too cramped before.

Measuring only 2 3/4" h x 7" w x 3 3/8" d, the bantam-sized microprocessor control head fits easily into the dash, console or glove box of even the most compact vehicle. Or if those places are already taken by the rest of your "mobile shack," the IC-280 head squeezes into leftover nitches under the dash, overhead, under the seat or even on the steering column.

But don't be misled by the petite size of this subdivided radio: the IC-280 is jam packed with the latest state of the art engineering and convenience features. No scaled down technology here!

With the microprocessor in the detachable control head, your IC-280 can store three frequencies of your choice plus the dial, which allows you to select from four frequencies with the front panel switch without taking your eyes off the road. These frequencies are retained in the IC-280's memory for as long as power is applied to the radio, even when power is turned off at the front panel switch. And if power is completely removed from the radio the ±600 KHz splits are still maintained!

The IC-280 works frequencies in excess of the 2 meter band with ICOM's outstanding single-knob tuning, so you can listen around the entire band without fooling with three tuning knobs. With steps of 15 KC or 5 KC, the IC-280 puts rapid and easy frequency change at your single fingertip and instantly displays bright, easy to read LED's.

Available Options:
- Touch Tone pad/microphone combination, which fits the mic plug on the radio face with absolutely no modification
- 15° unassembled cable kit for long distance remote mounting of the detachable control head

IC-280
2 meter FM, 4 + MHz Mobile Transceiver

All ICOM radios significantly exceed FCC regulations limiting spurious emissions.
Specifications subject to change without notice.
**zip-cord feedlines**

**Dear HR:**

The article on "Zip-Cord Feedlines" published in the April 1978 issue prompts me to record, somewhat belatedly, my own experience on the subject. I have, for many years, happily used zip-cord feedlines particularly for temporary or semi-temporary antennas for use up to 21 MHz. I have always used the type with clear insulation, thinking that there was less chance of fillers absorbing the rf energy. I have to admit, though, that I have no concrete reason for this feeling, and I could be quite wrong. I have always used a simple antenna tuner and balun to couple the transmitter to the line, and, without exception, I have found the results to be gratifying. For example, I have quite recently used a 20-meter dipole slung between a tree and the chimney of my apartment building, about 20 feet high, fed by about 30 feet of Radio Shack loudspeaker wire (the heavy-duty type with stranded conductors) and driven by a Heath HW101. I have always been able to raise interesting stations, and have had a good number of enjoyable ragchews with European operators on single sideband.

The characteristic impedance of zip-cord is, of course, unknown. In my particular example I measured and, from standard formulae, estimated its impedance to be around 100 ohms. I think that this impedance presents as good a match to any "real" antenna at modest height with nearby structures as does any well-characterized coaxial cable. The unknown impedance presents a problem, however, when attempting to measure the line loss, for the line must (usually) be terminated. To get some idea of the loss on the 30-foot length, I tried the following experiments:

First, I terminated the line with a 110-ohm carbon resistor combination. I fed the line through my antenna tuner, and, in the coax feed between the transmitter and the tuner, I inserted my SWR bridge. I then loaded the transmitter on 14 MHz and adjusted the antenna tuner for minimum SWR on the coax; I was able to get it down to an indicated value of 1.1:1. Then I removed the terminating resistor and measured the SWR both with the far end of the line open and shorted. I tweaked the tuning for minimum SWR before taking the reading. The reverse power was so high in each case that it was not possible to get reliable readings. I estimated the SWR to be at least 10:1 (neglecting possible error in the bridge — the forward and reverse powers are about the same with an open or short circuit on the output of the device). This indicates that the total loss, one-way, in the tuner and feeder is on the order of 0.9 dB, and this is a worst-case figure. This is not comparable with RG-8/U coax, but for a simple system it is a figure that I can certainly live with.

**Tony Garratt-Reed, ex-G3VBZ/W1**

Malden, Massachusetts

**keyer memory**

**Dear HR:**

I read with interest the Ham Notebook correspondence from K9WGN in the August 1978 issue of ham radio concerning my programmable keyer memory accessory. While it may be true that his unit programs the memory chips properly by simply pulling the RW pin to + 5 volts, this is not good design practice. If you examine the data sheets for the 1101 (or any other static MOS RAM chip, for that matter) you will see that the RW pin should be pulsed only after the address is stable. The manufacturer's information for the 1101, in fact, recommends both the data and address inputs remain stable for at least 100 ns after the falling edge of the WRITE pulse. If the RW pin is held near + 5 volts during programming, there is a chance some undesired bits may be altered while the input memory address is changing. For these reasons I feel the 74121 monostable, U8, is justified.

K9WGN is correct in stating that you can substitute the 7493 for the 74193s I used in that design. However, since the 7493 is a negative edge triggered ripple counter, the inverter, U11B, should be eliminated.

**Andrew B. White, K9CW**

Urbana, Illinois

manned free-aircraft

**Dear HR:**

The Presstop of the October, 1978 issue is in error; the Double Eagle II was not the first free-aircraft to cross the Atlantic — it was the first **manned** free-aircraft to do so. The first free-aircraft to make the crossing was a high-altitude research balloon flown from Trapani, Sicily, in July, 1975, and brought down near Lexington, Kentucky after about 84 hours. Another balloon was flown from Sicily to Massachusetts in July, 1976. These balloons flew at an altitude of approximately 125,000 feet and had about 20 million cubic feet of capacity; they were launched and flown by National Scientific Balloon Facility personnel from Palestine, Texas for scientists from Italy, England, and Germany.

**Spencer Petri, WA5JCI**

Palestine, Texas

Dear HR:

I read with interest the Ham Notebook correspondence from K9WGN in the August 1978 issue of *ham radio* concerning my programmable keyer memory accessory. While it may be true that his unit programs the memory chips properly by simply pulling the RW pin to +5 volts, this is not good design practice. If you examine the data sheets for the 1101 (or any other static MOS RAM chip, for that matter) you will see that the RW pin should be pulsed only after the address is stable. The manufacturer's information for the 1101, in fact, recommends both the data and address inputs remain stable for at least 100 ns after the falling edge of the WRITE pulse. If the RW pin is held near +5 volts during programming, there is a chance some undesired bits may be altered while the input memory address is changing. For these reasons I feel the 74121 monostable, U8, is justified.

K9WGN is correct in stating that you can substitute the 7493 for the 74193s I used in that design. However, since the 7493 is a negative edge triggered ripple counter, the inverter, U11B, should be eliminated.

**Andrew B. White, K9CW**

Urbana, Illinois

manned free-aircraft

**Dear HR:**

The Presstop of the October, 1978 issue is in error; the Double Eagle II was not the first free-aircraft to cross the Atlantic — it was the first **manned** free-aircraft to do so. The first free-aircraft to make the crossing was a high-altitude research balloon flown from Trapani, Sicily, in July, 1975, and brought down near Lexington, Kentucky after about 84 hours. Another balloon was flown from Sicily to Massachusetts in July, 1976. These balloons flew at an altitude of approximately 125,000 feet and had about 20 million cubic feet of capacity; they were launched and flown by National Scientific Balloon Facility personnel from Palestine, Texas for scientists from Italy, England, and Germany.

**Spencer Petri, WA5JCI**

Palestine, Texas

Dear HR:

I read with interest the Ham Notebook correspondence from K9WGN in the August 1978 issue of *ham radio* concerning my programmable keyer memory accessory. While it may be true that his unit programs the memory chips properly by simply pulling the RW pin to +5 volts, this is not good design practice. If you examine the data sheets for the 1101 (or any other static MOS RAM chip, for that matter) you will see that the RW pin should be pulsed only after the address is stable. The manufacturer's information for the 1101, in fact, recommends both the data and address inputs remain stable for at least 100 ns after the falling edge of the WRITE pulse. If the RW pin is held near +5 volts during programming, there is a chance some undesired bits may be altered while the input memory address is changing. For these reasons I feel the 74121 monostable, U8, is justified.

K9WGN is correct in stating that you can substitute the 7493 for the 74193s I used in that design. However, since the 7493 is a negative edge triggered ripple counter, the inverter, U11B, should be eliminated.

**Andrew B. White, K9CW**

Urbana, Illinois
Instant recall.
(And 25 watts of power)

Kenwood's exciting 25-watt TR-7625 and optional RM-76 Microprocessor Control Unit...gives you the power you want plus outstanding channel memory and scanning capabilities.

...there's more! The TR-7625 has a lot of versatility for a 2-meter FM transceiver, and when teamed up with the RM-76 gives you a lot of rig. Check these features for both:

TR-7625 (only)
- Memory channel...with simplex or repeater (± 600 kHz transmitter offset) operation.
- Mode switch for operating simplex or for switching the transmit frequency up or down...or for switching the transmitter to the frequency you have stored in the TR-7625's memory (while the receiver remains on the frequency you have selected).
- Dual concentric knobs for fast, easy selection of any 2-meter frequency, in 100-kHz and 10-kHz steps.
- Full 4 MHz coverage (144.000-147.995) on 2 meters; 800 channels; 5-kHz offset switch, and MHz selector switch...for desired band (144, 145, 146, or 147 MHz).
- Digital frequency display (large, bright, orange LEDs).

TR-7625 WITH RM-76
- UNLOCK indicator...an LED that indicates transceiver protection when the frequency selector switches are improperly positioned or the PLL is not locked.
- Store frequencies in six memories (simplex/repeater).
- Scan all memory channels.
- Automatically scan up the band in 5-kHz steps.
- Manually scan up or down in 5-kHz steps (or fast tune).
- Set lower and upper scan frequency limits.
- Stop scan (with HOLD button).
- Clear scan (for transmitting).
- Adaptable to all MARS frequencies.
- Select repeater mode (simplex, transmit frequency offset (± 600 kHz or ± 1 MHz), or one memory transmit frequency).
- Scan for busy or open channel.
- Display indicates frequency (even while scanning) and functions (such as auto-scan, lower scan frequency limit, upper scan limit, and error, i.e. transmitting out of band).

See the new TR 7625 and optional RM-76 now at any Authorized KENWOOD Dealer!
AMATEUR RADIO FARED QUITE WELL in the FCC's WARC 79 proposal, as further details were made available in mid-December. The biggest gain was the addition of three new HF Amateur bands — 10.1-10.2, 18.066-18.168, and 25.11-25.21 MHz — as exclusively Amateur bands worldwide. A 50-kHz addition to 15 meters, making it 20.95-21.45, is also in the proposed U.S. position, along with a shift 50 kHz downward for 40 meters to make it an exclusively Amateur band worldwide from 6.95-7.25 MHz.

80 Meters Would Become exclusively Amateur from 3.5-3.9 MHz in Region 2, where it's now shared with fixed and mobile services, while 3.9-4.0 MHz would remain shared as at present. The 10-meter band would remain as is, worldwide.

The Proposed Bottom-60-kHz loss on 160 to AM broadcast would be somewhat tempered by a proposed worldwide allocation of 1860-1900 KHz exclusively for Amateurs with 1900-2000 KHz remaining shared with other services in Regions 2 and 3.

With Two Notable Exceptions, the higher frequency Amateur bands also fared well. The big exception was 220-225 MHz, proposed for a worldwide Maritime Mobile band with Amateurs a secondary user in Region 2 only. Radiolocation use of the band would be continued as is through 1990 and beyond. The other significant loss is the lower part of the 1215-1300 MHz band, with Amateurs bumped from the lower 25 MHz in favor of navigational satellites. The 1240-1300 MHz portion would remain as is, shared with Radiolocation. No changes appear to have been proposed for 50, 144, 420, or the other higher frequency Amateur allocations.

CONGRESSMAN MARTIN RUSSO was very pro-Amateur Radio when he was guest of honor at the Chicago FM Club's mid-December meeting. Rep. Russo affirmed his and Rep. Van Deerlin's belief in the importance of Amateur Radio to the United States, and said that if spectrum user fees (as proposed in Van Deerlin's rewrite of the Communications Act) are adopted Amateurs should be exempted. He also feels that the U.S. preparation for WARC is very good, and much of what we proposed will be adopted next summer.

Questioned About Charges that allowing FCC staffers to be Amateurs constitutes "conflict of interest," Russo responded that he felt quite the opposite. It was the "mind-expanding" hobby of Amateur Radio that provided many FCC staff members with the background and knowledge to do their jobs, he said, so that rather than being a detriment an Amateur license was a plus for a member of the FCC. Very encouraging words from an important Illinois Congressman.

AMATEURS HOLDING MORE than one callsign who wish to retain the call assigned to their secondary station when renewing must be sure to renew well before expiration. One West Coast contestant lost his prized 1x2 recently when his renewal application, complete with request to reassign his 1x2 to his primary (surviving) station license, arrived at Gettysburg a few days after the license expiration date. As his no longer renewable secondary license had expired, its 1x2 callsign was no longer his and thus could not, under the rules, be assigned to him.

A SERIOUS DROP IN BEGINNER interest in Amateur Radio has been reported in a number of parts of the country. Dealers in some areas say sales of code practice equipment and entry-level study materials have dropped quite significantly though this is certainly not universal and demand for higher grade study guides by already licensed Amateurs has seen little change.

The Drastic Drop In CB interest is the reason most cited for the downturn. When CB was hot many potential Amateurs discovered two-way radio as a hobby; moving into Amateur Radio when CB did not meet their expectations. At the same time the influx of new 27-MHz operators drove many previously satisfied CB hobbyists to Amateur Radio, simply to find room to operate. With those pressures gone, most of today's CBers seem content where they are.

WWV'S 20-MHz TRANSMITTER is back on the air after an absence of several years. Improving propagation is cited as the reason for its return to the air, with promises to remain on 20 MHz "as long as propagation conditions warrant."

UNUSUAL REPEATER INTERFERENCE in the Wyandotte, Michigan, 147.84-24 system was traced to a super-regenerative receiver in a nearby garage door opener. Quench frequency of the receiver detector was 600 KHz, and any strong nearby signal would cause the receiver to transmit signals of 600 KHz from that signal. They could be heard for several blocks. The door-opener manufacturer has been very cooperative, working with area Amateurs to determine what's causing the problem.

HENRY KANE, W2XKJ, OF CLIFTON, N.J., WON FIRST PRIZE in Ham Radio Horizons' just-ended sweepstakes, taking home a complete station that includes a TR-7, TTI-EX Tower, CushCraft beam, Hy-Gain vertical, and a Wilson 2-meter hand-held. The 200 Second-Place winners each won their choice of an MFJ accessory, while 250 copies of Radio Angels went to the third-place winners.
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) ........................................ $1195.00
DS-3000 KSR Version 2 (BAUDOT & ASCII only) ................................. $1195.00

Write for our latest catalog & RTTY guide.

For our Overseas customers:
see HAL equipment at:
Richter & Co.; Hannover
I.E.C. Interreco; Bissone
Vicom Imports; Auburn, Vic., Australia
Dollar thoughts to consider about the

DRAKE UV-3

UHF-VHF MULTIBAND FM SYSTEM

Only $795 for 3-Band UV-3

(That's just $265 per band — and fully synthesized on all three!)

How does the cost of the Drake system really compare to alternative methods of getting on 144-220-440 MHz fm?

A First of all, there is no direct comparison possible, because the Model 1346 Drake UV-3 is the only rig in the world offering 144-220-440 MHz fm in a single box — and it is fully synthesized on each band.

B The nearest comparison would be to add the suggested list prices of three separate units of competitive fm rigs presently available. It would work out approximately as follows (and you would end up with three separate units to power):

2 Meters (Synthesized to 5 kHz) ............. $ 449.00
220 MHz (Synthesized to 5 kHz) ............ 449.95
440 MHz (23 channels, crystal) ........... 349.00
Crystals (Assuming 20 per 440 MHz radio) 120.00

Total competitive price ............... $1367.95

But wait—even at those higher competitive prices you'd still be missing these features included in the UV-3:

1. Full synthesis on all three bands
2. Extra diode-programmable fixed channels on each band
3. Priority scan feature on each band
4. Everything in a single box!

For your homework, then, ponder the following—at a suggested amateur net of $795.00, the Model 1346 Drake UV-3 (144-220-440) is, to say the least, an incredible value. It gives you a real reason to trade UP!

NOW AVAILABLE: Complete UV-3 Service/Schematic Book . . . $25.00 each.

R. L. DRAKE COMPANY

540 Richard St., Miamisburg, Ohio 45342
Phone: (513) 866-2421 • Telex: 288-017

Prices and specifications subject to change without notice or obligation.
The 7-Line is a unique communications system

combining coordinated systems design with innovative engineering

When you select Drake products, you select designs that match visually and electrically — designs that work together as a complete unit.

Drake TR-7/DR-7 — Speaking of innovative engineering, did you know this transceiver re-introduces international shortwave listening to amateur radio? The receiver provides complete general coverage from 1.5 thru 30 MHz — no gaps and no range crystals needed. With the plug-in AUX-7 pc board, coverage can be extended from 1.3 MHz down to 0" MHz! Now that's general coverage!

The TR-7 transmits on all amateur bands 160 thru 10 meters, and can be programmed on any 8 additional 500 kHz ranges in the hf spectrum for legitimate out-of-band coverage such as MARS, Embassy, future band expansions, etc. Up to four positions of independent receive selectivity, combined with full pass-band tuning, allow tailored reception of cw, RTTY, ssb and afm. A special built-in low distortion a-m detector, with optional 6.0 kHz crystal filter, makes "SWL-ing" with stations such as BBC, VOA, etc, a genuinely pleasant surprise.

The special TR-7 receiver front end, with its high intercept point, means you can pick many weak amateur signals from amid the super-power shortwave broadcasters. These weaker stations could be completely lost with conventional receiver designs.

MATCHED ACCESSORIES — The 2kW Drake MN-270A Antenna Matching Network covers 160 thru 10 meters, features complete rf bypass and antenna selector switching, built-in rf wattmeter/VSFR bridge, and out-of-band coverage. With the E-1000 balun, balanced line and long wires may be accommodated along with coax feed systems. A 250 watt version is the MN-7. • The WH-7 Wattmeter has rf power scales from 20 to 2000 watts, and even a direct-reading VSWR scale. It's an accurate and convenient accessory for anyone's station. • The PS-7 Ac Power Supply can be switch-programmed for most primary voltages from 90 thru 264 volts. No soldering or jumpers necessary, it includes automatic protective circuitry for both voltage and current. Compare the weight of the PS-7 with other supplies, and you'll know it's real! • The RV-7 Remote VFO provides split frequency control for the TR-7 with a "spur" button for convenience. • Even tho the TR-7 has a built-in speaker, the addition of the MS-7 Speaker provides greater audio fidelity. • The custom-designed 7077 Dynamic Desk Mike provides proper impedance and audio characteristics for the TR-7; fully wired for VOX and PTT. • And don't forget the DL-300 / DL-1000 "Dry" Dummy Loads — they really are handy. • The EA-7 Cooling Fan can be installed on both the TR-7 and PS-7 for high ambient temperature environment or for continuous duty RTTY or SSTV applications.

Available soon — the new Drake L-7, 160 thru 10 meter*, 2 kW Wide Range Linear Amplifier.

*10-meter coverage on export units only

Prices and specifications subject to change without notice or obligation.

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

R. L. DRAKE COMPANY  540 Richard St., Miamisburg, Ohio 45342

Phone: (513) 866-2421  Telex: 288-017
It all began rather innocently. My good friend Jim Fisk, WB6YED (no relation to ham radio's editor), won a pair of Motorola HEP S3041 40-watt vhf power transistors at a prize drawing during the 1975 Dayton Hamvention. Several of us who were with him envied his good fortune, and we wondered what he would do with his new treasures. Months later, during a visit to Jim's home, I got my answer.

Jim had a 2-watt, hand-held fm transceiver he wanted to use in his car with a separate microphone. He envisioned a package that would produce either 10 or 80 watts output for 2 watts of drive, depending on his distance from the station he wanted to talk to. In addition, T/R switching had to be accomplished without a separate control line between the transceiver and the power amplifier. As Jim described what he was thinking of, I had the feeling he was going to ask me to tackle the job, which he did. Since he had been more than generous with his time and resources when I needed them, I was glad to help.

Putting together his requirements, I came up with the block diagram shown in fig. 1. The power amplifier had to have enough gain to produce roughly 80 watts output from 2-watts input; this amounts to 16 dB gain. A little more gain wouldn't hurt, because there are sure to be losses between the input to the entire circuit and the input to the power amp. The attenuator is switched into the circuit when low-power operation is desired. As it turned out, the attenuator wasn't that simple.

The requirement that transmit-receive switching...
be done without control lines necessitated the use of some type of rf-actuated T/R switch to put the power amp in the circuit during transmit operation. During receive the entire amplifier is simply bypassed with a coaxial line.

**circuit description**

I started the project by building the basic power amplifier. The HEP S3041 is equivalent to a 2N6084. A pair of 2N6084s at 150 MHz can be driven to 80 watts output with 25 watts input. This amounts to 5 dB gain; a driver capable of at least 11 dB gain is necessary to ensure a full 80-watt output from 2 watts of input. Since it suited my needs so well, I used the two-stage amplifier circuit and layout described in the Motorola Application Note AN-585, with as few differences as possible. A 2N6083 was used for the driver in the amplifier described in the application note. Lacking a 2N6083 I used a 2N6136, a 25-watt uhf device useful to over 500 MHz and readily available to me.

The initial attempt at the amplifier was a copy of the layout described in the application note (see fig. 2). It was unstable for all but low drive levels. Any output greater than a few watts was accompanied by a healthy spur approximately 5 MHz from the desired frequency and several other spurs of lesser amplitude, including one at 5 MHz. I had used a uhf device for the driver, and so this was not entirely unexpected.

The choke/bead combinations in the transistor base circuits are used to suppress spurious oscillations as well as to provide dc return paths for the bases. Ferrite beads are low-Q inductors at vhf and, as such, make excellent broadband chokes. At lower frequencies, such as the high-frequency bands, the resistance of the beads decreases while the inductance increases. The result is an increased Q. Uhf transistors exhibit tremendous gain in the high frequency region, and high Q circuits are an invitation for them to take off. The solution consists of adding 10-ohm resistors in shunt with the choke/bead combinations to guarantee a low Q at lower frequencies.

![fig. 1. Block diagram of the 10/80-watt amplifier for 2 meters. The switched attenuator is used to vary the drive level into the amplifier to switch between 10- and 80-watt power levels.](image)

Another addition to the circuit in the Motorola Application Note is the parallel tank circuit (L1 and C7) at the input to the amplifier. It helps reduce any second- and third-harmonic energy coming from the hand-held transceiver.

After tuning up the completed amplifier, I had 80 watts output for 1 watt of drive. This was more gain than necessary, since 2 watts were available. Rather than detune the amplifier, I decided to put some attenuation in the circuit for high-level operation. Using an input of 2 watts, 2.6 dB of attenuation results in an output of approximately 80 watts, while 10 dB of attenuation provides an output of approximately 10 watts.

The switched attenuator shown in fig. 1 is drawn schematically in fig. 3(A). It is a tee configuration in which PIN diodes are used to add or remove resistors that are in parallel with the elements of the attenuator. PIN stands for “P-intrinsic-N” and describes regions of P and N semiconductor material that have a piece of undoped or “intrinsic” silicon sandwiched between them. This construction gives the PIN diode its unique properties. For low-frequency signals, the device behaves like a conventional PN-junction diode. At uhf, the diode is a current-controlled resistor. For high-forward current, the series resistance is low. For low-forward current, the series resistance is high. Reverse biasing the PIN diode further raises its series resistance. An ideal PIN diode should not rectify rf, but in the real world these diodes do rectify and this must be dealt with in rf-switching applications.

For 80 watts of output, the series PIN diodes, CR5
fig. 2. Complete schematic diagram of the 10/80-watt amplifier including the basic power amplifier (with modifications) described in Motorola Application Note AN-585. Inductors with the suffix A are described in the Application Note. L1 is four turns of no. 36 (0.13-mm) AWG enameled wire wound on a 100k-ohm, 1/4-watt carbon resistor. CR1, CR2, CR5, CR6, CR7, and CR9 are Microwave Associates MA47047 PIN diodes, while CR8 is an MA47080. All resistors are 1/2-watt, 5 per cent tolerance carbon composition resistors, unless otherwise specified. For the capacitors M = mica, W = ceramic wafer, and C = ceramic chip. RFC6, RFC8, and RFC9 are 0.15-μH molded rf chokes with a Ferroxcube 56 590 65/3B bead on the ground lead. RFC7 is a Ferroxcube VK200 19/4B wideband ferrite choke, and RFC10 is ten turns of no. 14 (1.6-mm) AWG enameled wire wound on R21. K1 is a 6-Vdc, 500-ohm coil dry reed-type relay.
and CR6, are forward biased, and shunt PIN diode, CR7, is left off. For 10 watts of output the series diodes are left off while the shunt diode is forward biased. The calculated equivalents of the two conditions are shown in figs. 3(B) and 3(C). The resistor values for the attenuator were chosen so the impedance looking in either direction would be close to 50 ohms. It is important that a good grade of carbon-composition resistor be used for the elements in the attenuator that carry rf current, and also that leads are kept as short as possible. Because of stray elements, this type of attenuator becomes more difficult to construct as frequency is increased. Two meters is probably getting near the practical limit.

The last block in fig. 1 is the rf detector and T/R switch. The detector, CR3, is simply a rectifier with a low enough reverse recovery time to be effective at 150 MHz. The rectified rf signal is used to forward bias the relay driver, Q1, which in turn energizes K1 during transmit operation. The relay closes when approximately 0.7 watt of power is fed to the input jack of the amplifier. The relay contacts are used to switch the bias to the PIN diodes in the actual T/R switch. These PINs are CR1 and CR2 at the amplifier input, and CR8 and CR9 at the output.

For simplicity, a relay was used instead of solid-state bias switching. W9KHC pointed out in his article that the dc reverse bias on a PIN diode should be equal to the peak rf voltage across the PIN in question. For CR9, which is reverse biased during transmit operation, this would amount to 88 volts, assuming 80 watts is being delivered to a 50-ohm load. A higher load impedance would require a higher bias voltage. If a PIN diode rectifies when the reverse bias is not great enough, it will conduct and be destroyed due to excessive power dissipation. However, if the PIN diode bias line is just left open, any rectified current will tend to reverse bias the PIN and protect it. Open is the key word here. A set of open relay contacts is much better than a reverse biased switching transistor, which has some measurable leakage. Since the relay was employed, it eliminated the need for a high-voltage supply which would require an inverter for 12-volt mobile operation. With the arrangement shown, T/R switching is accomplished using the same dc supply that powers the amplifier.

**component selection**

Since the construction of this power amplifier involves relatively high power levels and frequencies, a discussion about the components used is in order. The PIN diodes used in the T/R switch and attenuator are general-purpose diodes for uhf work. They should have a low series resistance when forward biased, since they contribute directly to insertion loss. The MA-47047 typically has 1.5 ohms of resistance at 30 mA of forward bias, while the MA-47080 has a resistance of 0.45 ohms at 100 mA. In addition, the minority carrier lifetime should be roughly 10 times longer than the period of the lowest frequency in use. This prevents rectification if leakage occurs. The low-power PIN diodes used in the construction of this project were in a pellet-style case. The MA-47047 comes in a lead-style case similar to that of a signal diode. Either type will work — just keep lead lengths short. The MA-47110 could be substituted for the MA-47047.

PIN diode CR8 must have a high current rating because it carries the output power of the amplifier. It will get fairly warm and should be heat sinked directly to the output connector via C38. Transferring heat through a capacitor may seem unconventional, but it is accomplished with a wafer-style capacitor. Wafer capacitors are a truly leadless capacitor with a ceramic dielectric. They are especially well suited for bypass and coupling applications where tolerance is not critical. The 1000-pF units used in this project are little squares about 4.1 mm (0.16 inch) on a side and 0.76 mm (0.03 inch) thick. The two large surfaces are metallized with a silver compound so they can be sol-
dered. It is a good idea to handle the capacitor with fine tweezers so that oil from your hands doesn't make soldering difficult. For best results, the wafers should be soldered using a silver-bearing solder and a very small iron tip. Ordinary tin-lead solder is likely to leach away the silver and make soldering impossible. Alpha Metals is one company that produces a 62 per cent tin, 36 per cent lead, and 2 per cent silver solder.

Another uncommon capacitor used in the amplifier is the ceramic chip. Chip capacitors are made from a material similar to the wafer capacitor dielectric. They are small cubes approximately 2.5 mm (0.10 inch) on a side with a pair of opposite sides metalized to accept solder. These parts are available in tolerances as fine as ±1 per cent. In addition, they are also leadless and have very low loss. Due to their high Q (low loss), they are capable of carrying several amps of rf current where other types of capacitors would quickly go up in smoke. Since all of this comes at a price, chips were used only at the higher power levels in the amplifier.

A less expensive part is the capacitor made by Unelco which Motorola used in the application note. This is a silvered-mica type and is suitable for use at high power levels. It is physically quite large compared with the ceramic chip, but that is not a draw-back for most applications. To reduce the effect of lead inductance of higher value capacitors (which have low reactance), it is often possible to parallel two capacitors, as in the case of C25 and C26.

The coaxial cable used to bypass the amplifier on receive is a solid-jacket type used because it was available. Any good 50-ohm cable can be substituted.

**protection circuitry**

Many high-power, solid-state rf amplifiers have protection circuitry to reduce rf drive, or completely shut down the amplifier, when a high vswr is sensed. Since this amplifier was designed for a specific installation, the extra circuitry was not included. A load vswr of 2:1 or less should be adequate for the design.

Another circuit commonly associated with high-power amplifiers is a thermal protection circuit. These circuits sense high temperature, usually near the output stage devices, and act to reduce drive or shut the amplifier off. Since a substantial heatsink is used and two-way operation is always intermittent, this type of circuit is not justified. If the amplifier is to be operated for more than short periods of time and in a place where air circulation is restricted, some thought should be given to a thermal protection scheme.
Additional comments on circuit protection are given in ref. 3.

construction

No attempt was made to miniaturize the amplifier. With the cover in place, the assembly measures 7.6 \times 14.0 \times 15.9 \text{ cm} (3 \times 5.5 \times 6.3 \text{ inches}). The amplifier was built in "bread-board" fashion on a 10.2 \times 15.2 \text{ cm} (4 \times 6 \text{ inch}) piece of 1.6 mm (0.062 inch) thick epoxy-fiberglass, copper-clad board. Connections, which are isolated from ground, are made on miniature standoff insulators. This construction lends itself well to building power amplifiers, as it nearly eliminates \textit{rf} ground problems. The heatsink may be a little larger than necessary, at 3.8 \times 14.0 \times 15.2 \text{ cm} (1.5 \times 5.5 \times 6.0 \text{ inches}), but since size was not important, the extra area is cheap protection. Long pieces of wire and ferrite beads are held in place with RTV-type adhesive.

Parts placement follows the general layout of the amplifier pictured in Motorola Application Note AN-585.

The amplifier is easily installed in the trunk of a car and controlled from the driver's seat. A pair of wires and a switch are used to turn the power on. Use at least no. 14 (1.6-mm) AWG wire for the dc connection to reduce the voltage drop from battery to amplifier. The output power level is controlled by three wires and a single-pole, double throw switch. One of the three wires can be the +12 volt line that supplies the amplifier. Adding a coaxial cable to carry \textit{rf} from the hand-held transceiver to the amplifier completes the installation.

Placing the cover on the amplifier slightly detunes it. This is compensated for by slightly mistuning the trimmer capacitors by trial and error until the performance with the cover on is optimized.

purity of emissions

Since the completion of this project, the FCC has issued new requirements on transmitter spurious radiation. For transmitters and amplifiers operating between 30 and 235 MHz and having more than 25 watts of output power, all spurious emissions, including harmonics, must be at least 60 dB below the mean carrier level. The second harmonic of the carrier is the most important spurious output to be dealt with in this amplifier. Since at 80 watts output the second harmonic is already 50 dB below the fundamental, a simple pi or tee network after the amplifier will provide enough attenuation to meet the 60 dB requirement. A summary of the performance data from the amplifier test circuit (see fig. 4) is given in table 1.

acknowledgments

I would like to thank Bob Yankowiak for his patient technical assistance during the construction of the amplifier and the writing of this article. I would also like to thank George Johnson, K9ODF, for converting my color negatives to black and white prints for use in this article, and my wife Karen for typing the manuscript.

references


---

table 1. Performance data for the 80/10-watt amplifier at 147 MHz with the cover installed.

<table>
<thead>
<tr>
<th></th>
<th>low power</th>
<th>high power</th>
</tr>
</thead>
<tbody>
<tr>
<td>drive power</td>
<td>2 watts</td>
<td>2 watts</td>
</tr>
<tr>
<td>output power</td>
<td>7.2 watts into 50 ohms</td>
<td>74 watts into 50 ohms</td>
</tr>
<tr>
<td>current drain</td>
<td>4.0 amps</td>
<td>12.0 amps</td>
</tr>
<tr>
<td>2nd harmonic</td>
<td>40 dB</td>
<td>50 dB</td>
</tr>
<tr>
<td>3rd harmonic</td>
<td>44 dB</td>
<td>47 dB</td>
</tr>
<tr>
<td>input swr</td>
<td>1.6:1</td>
<td>1.4:1</td>
</tr>
</tbody>
</table>
Another approach for converting an antenna rotator to digitized readout, using discrete LEDs to show bearing segments.

The need for an improved indication of antenna heading is most apparent during contesting and DX chasing. Many operators have considerable difficulty relating the compass heading of the beam, as indicated on the typical antenna-rotator control box, to the location of a particular country on the globe.

Normally, a table, slide rule, or a chart is used to find the correlation between the prefix of a call and the beam heading. People have a general sense of where a country or area is, but they are less than adept at translating this sense into an angular heading.

I once saw a global display scheme using a balanced pointer driven by a pair of selsyns, one coupled to the mast on the tower and the other driving the pointer on a wall-mounted map. My goal was then established, to construct an electronic display using the existing analog voltage at the rotor control box.

A completely solid-state design using available low-cost components was a must, and the display had to be suitable for mounting at my operating desk. I considered several options for the construction and presentation of the display. Personal taste and the builder's skill are involved in making the choice; a simple and effective version is described which is suitable for any home craftsman with moderate skills.

**principles of operation**

The Ham II provides a 13-volt signal swing which drives a 1-mA meter, calibrated in degrees, to indicate antenna position. This voltage provides an ideal analog signal source for digitizing with a high-impedance CMOS A/D converter.

The Motorola MC14433 DVM chip was judged as most suitable for this display. It will accept a 0 to ±1.999 volt analog input voltage swing, and provides a binary-coded-decimal (BCD)/TTL compatible output. In addition, it has a self-contained clock and provides timing pulses to drive the TTL control logic and decoder drivers that make up the remainder of the display circuitry. Low-cost BCD-to-decimal drivers were chosen because of the display format.

The display background itself is a polar great-circle map of the globe divided into twenty 18-degree sectors. With a 0 to 1.99 volt input signal swing and a maximum 360-degree rotation, each sector corresponds to an increment of 100 mV. Each hemisphere corresponds to an increment of 1 volt of analog input signal. For example, as seen in fig. 1, sector 1 is displayed when the input potential to the MC14433 has any value from 0.0 to 0.1 volt. This corresponds on the map to the sector between 180 and 162 degrees in the S-SE quadrant of the Ham II meter scale. Likewise, sector II would be displayed when the input voltage is between 1.0 and 1.1 volts.

By W. K. Springfield, AE4A, 2607 Deerdell Lane, Reston, Virginia 22091
which corresponds on the map to the sector between 360 and 342 degrees in the N-NW quadrant of the scale. My rationale for choosing twenty 18-degree sectors was

1. the system fits the decimal system;
2. 18 degrees is roughly the beam width of many rotary antennas;
3. 18-degree sectors provide enough room for a beam to coast to a stop once the motor drive is stopped.

Fig. 1, the block diagram, and fig. 2, the schematic, show the signal and logic flow from the input of the A/D converter to the sector indicator. The analog signal between 0 and 2 volts is applied to pin 3, the analog input, from the voltage divider, R5, which accepts the 13-volt signal from the rotator. C3 and R7 are used to provide RFI immunity.

The encoded TTL data from U1 is available in a multiplexed form at the Qg through Q3 outputs. The A/D converter used in this indicator normally drives a four-digit multiplexed display, with the outputs Qg through Q3 acting as the data lines, while DS1 through DS4 are the corresponding digit-select lines. For example, when the right-most digit (LSB) is to be displayed, the DS4 line is high and the data appears in a BCD format on the Q lines. As the display is scanned, the appropriate digit-select line goes high with the correct BCD code for that digit appearing on the data lines.

The analog input to this IC is in the range of 0 to 1.999 volts. Therefore, the left-most digit will change between only 0 and 1. Or, it can be thought of as breaking the input voltage range into two segments, 0 to 0.999 and 1.000 to 1.999 volts.

In my display, the left-most digit, or MSB, provides the hemisphere data. That is, pin 6 of U2C (or Q3) is low for an input voltage to U1 with any value between 0.0 and +0.99 volt. This corresponds to an antenna heading anywhere in the S-E-N hemisphere. Conversely, pin 6 of U2C is high when the input voltage to U1 is any value between 1.0 volt and 1.99 volts. This corresponds to an antenna heading anywhere in the N-W-S hemisphere.

The hemisphere data from U6 is stored in latch U8B by clocking the data in during DS-1 time, and holding it through the complete scan cycle of the A/D converter. The latch outputs, pins 5 and 6 of U8B, gate the appropriate hemisphere decoder/driver, U6 or U7, through NAND gates U3, U4, U5B, and U5C. U8B is reset after the end of each A/D converter scan cycle by an "EOC" pulse from pin 14 of U1.

To derive the appropriate 18-degree sector within the hemisphere, the next most significant digit of the A/D converter is used. As previously mentioned, each sector has an incremental voltage width of approximately 100 mV, thus allowing ten sectors in a 1-volt increment. The next most significant digit represents the correct 100-mV segment with the
fig. 2. Schematic diagram of the solid-state antenna position indicator. Each output from the decoder is bypassed with a small disk ceramic capacitor to help eliminate noise problems (see text). C1 and C2 are mylar capacitors.
BCD value appearing during DS2 “time” at the output terminals.

During DS2 pulse, pin 18 of U1 is high. U2A and U2B act as a noninverting buffer which drives gates U3, U4, USB, and U5C. These gates in turn drive U6 or U7 to display the appropriate sector during DS2 time. Valid input data to U6 or U7 is in a low-level state. This is provided when all three inputs to the NAND gate driver are high. The outputs of U1 require the buffering because of the limited source/sink current capability of the CMOS circuitry.

With this scheme, any one of twenty sectors can be displayed. The DVM chip can provide A-to-D conversion on the hundredths and thousandths decimal value of input voltage and are presented to the multiplexed outputs during DS3 and DS4 time respectively. However, this capability is not used in the display application.

The frequency of the internal clock in the DVM module is determined by R1 and C1. With the values shown in fig. 2, the clock runs at approximately 66 kHz, giving a conversion time of 250 ms. In simple terms, the conversion time is the interval required for the DVM circuitry to measure the analog input, compare references, compensate, integrate, encode data, and develop the output signals for the “3-1/2” digits. In this display application only “1-1/2” digits are used. An individual sector is displayed with five LEDs. The LED in series with R8 is positioned at the center of the display, Kansas City, and is continuously illuminated. The remaining four LEDs are selected from the display electronics and illuminate the perimeter of the sector.

LEDs DA1/DB1, DA2/DB2, etc., are positioned on radial lines drawn on the polar map, which is the background of the display panel. These radial vectors start at the center of the map and are displaced by 18 degrees.

The LEDs designated DA are mounted at the midpoint of the radial, while the LEDs designated DB are positioned at the ends of the radials. Diodes designated DC are low-cost silicon switching or low-PIV rectifier diodes (1N4001s) grouped in pairs to form a negative-OR type gating circuit.

To illustrate, refer to fig. 4, where sector A is to be displayed. Either U6 or U7 has been gated on during DS2 time, depending on which hemisphere has been selected, to display one of the possible twenty sectors. Only one of the twenty output pins from U6 and U7 will be in a low-voltage or current-sink condition, as represented by the closed switch at output terminal B in the driver. Current flows through R8, the LED in the center of the map, the two parallel branches formed by DA1, DB1, DC2, and DA2, DB2, DC3, and the low-impedance path (closed switch) in the display driver. With all other driver outputs in a high-impedance state, no current will flow in any of the other radial branch circuits.

Since the LEDs are illuminated only during DS2 time (approximately 60 ms out of each 250-ms conversion period), the LED supply voltage had to be raised to a level of approximately 12 volts. The value
fig. 4. Diagram illustrating the current flow when sector 1 is selected. In this case, the appropriate output of the decimal driver is low, to sink current. The OR gates then determine which LEDs are conducting.

for R8 was chosen to give an average LED current of 25 to 30 mA, providing adequate illumination. Diode matching, to achieve uniform brilliance, has not been a problem. However, I suggest you order more display LEDs than needed and select the best ones.

As seen in fig. 2, bypass capacitors are shunted across each driver output. Any disk ceramic from 470 pF to 0.02 µF will work. These capacitors reduce the slope of the driver output signal during the switching transient. The cable between the display electronics and display panel acts as an antenna, and hiss was detected in my SB303 on 10 meters before the output lines were bypassed.

Except for the 12-volt transformer, C5, and R9, all components are mounted on the printed-circuit board. The transformer should be able to supply 300 mA. U1 requires a negative 5-volt supply, which is provided by C4, C6, R10, CR2, and the two-additional 1N4001s. The LM 342-5 provides a regulated, 5-volt supply for logic circuitry. The DVM module requires an external reference voltage of 2.0 volts which is provided by CR1, R3, and R4.

display panel construction

Many options are open in the construction and layout of the display panel, depending upon the creativity, skill, taste, and resources of the builder. A rather straightforward approach yielded the display shown in fig. 5. The printed-circuit board is mounted inside a 15 x 7.5 x 10 cm (6 x 3 x 4 inch) box-type interlocking chassis. The box should be mounted on the rear of the base to provide stability for the display panel and frame.

adjustment

Before inserting any of the ICs (especially U1), the +12, +5, -5, and the 3.2-volt reference should be checked. Then adjust R3 and R5 to the extreme counterclockwise position. Use a high-impedance voltmeter, 1 megohm or greater input (probe) impedance, when checking any terminal voltages on U1. Lower impedance voltmeters present a significant load to the circuitry resulting in erroneous readings. With U1 in the circuit, adjust R3 to provide +2.00 volts at pin 2 of U1. Temporarily jump a wire from a +5 volt supply point to the non-grounded rotator input terminal. Only sector 1 should be illuminated. Turn R5 clockwise about half way. The display should step through the 20 sectors as this is done, and only one sector should be illuminated at any one time. If the LEDs light out of sequence, check the cable wiring between the driver outputs and diode gates in the display panel. If a
series diode string on a radial vector does not light, check the diode gates, LEDs, and U6 or U7. If one hemisphere does not light, check U8, the appropriate input gates to the drivers U6 or U7, as well as the appropriate display driver.

With the above check-out completed, return R3 to the extreme counterclockwise position and disconnect the +5 volt jumper to R3. Attach a cable from the grounded terminal of R5 on the display electronics board to terminal 1 on the Ham II control box terminal strip, and another lead from the other side of R5 to terminal 3. Rotate the antenna to 198 de-
degrees in the S-SW quadrant. Approximately 13 volts should appear across R5 on the display input terminals. Carefully rotate R5 clockwise until just the 198 to 180 degree sector illuminates. Rotate the antenna back through a clockwise rotation and watch how the sectors on the map light up as the appropriate compass headings on the control box are passed. With minor adjustments of R3 and R5, tracking to within 10 degrees can be maintained throughout the entire antenna rotation. Linearity of the potentiometer in the rotator can cause minor variations.

I have not attempted to connect this display to makes of antenna rotors other than the Ham II. However, with the circuit explanation given, it should be easy to adapt this system to other rotators as long as there is more than a 0 to 2 volt analog signal swing available to drive the display electronics.

component procurement

All the ICs, with the exception of U1, the Motorola MC14433, are readily available from most supply houses. U1 was purchased through Circuit Specialists, Box 3047, Scottsdale, Arizona 85257, for under $15.00. With the influx of low-cost DVM kits, there should be lower costs for this item in the future. The total cost of the electronic components and printed circuit board came to less than $45.00. LEDs can be obtained at good prices when ordered in a quantity of 100 rather than on a per-diode basis.

I wish to express my appreciation to Dick Keil, N4JU, Bob Winter, WB4AYW, and Walt Short, N4SW, for their advice, and particularly to N4SW and K4GOK for their assistance in artwork preparation.

great-circle maps

For the past several years I have been offering computer generated great-circle bearing printouts which have been extremely popular with DX operators.* In a recent article in Ham Radio Horizons I discussed the use of these charts and also showed several great-circle maps. The great number of readers who inquired about obtaining azimuthal equidistant maps prompted me to complete work on a computer program I started several years ago to draw such maps.

The program itself is straightforward, but the database associated with it is truly staggering, consisting of almost 20,000 data elements. This is why I put off completing it for so long. The computer time required to process and draw each map is much more than that required for the standard great-circle printout, so the cost is slightly greater. The maps are printed on 11 x 14 inch paper; in addition to geographical data, all major political boundaries are shown, but no attempt has been made to label individual countries because of the enormous programming complexities it would entail, not to mention the additional cost.

I will supply custom-made azimuthal equidistant maps to interested Ham Radio readers according to the following price schedule:

$5.00  postpaid via 3rd class mail, worldwide
$5.75  postpaid via 1st class mail, USA, Canada, Mexico
$6.50  postpaid via Air Mail, worldwide.

*Computer generated charts for your station location are priced at $1.00 for surface mail or $2.00 for air mail, and list 660 distant locations along with bearings, distances, and return bearings.

when ordering your map, be sure to include your mailing address and the location for which the chart is to be made. If you live in a rural area or a town of less than 10,000 population, carefully describe your location with respect to other nearby towns so your latitude and longitude can be determined.

Bill Johnston, N5KR
1808 Pomona Drive
Las Cruces, New Mexico 88001

Computer-drawn great-circle map centered on Greenville, New Hampshire.

When ordering your map, be sure to include your mailing address and the location for which the chart is to be made. If you live in a rural area or a town of less than 10,000 population, carefully describe your location with respect to other nearby towns so your latitude and longitude can be determined.

Bill Johnston, N5KR
1808 Pomona Drive
Las Cruces, New Mexico 88001
Tri-Ex®

Puts the World at Your Fingertips

Get your antenna high enough with a TRI-EX tower and bring the world to you.

Receive signals which you have never heard before.

Send your call to other HAMS who have never heard you.

A TRI-EX tower will give you listening power, calling power, and stay-up power. That means durability.

Durability comes from TRI-EX's 25 years of building quality towers. These years of experience combined with the latest engineering knowledge and materials are used to design and build towers which stay up under the antenna loads and wind speeds specified. After manufacture our steel towers are hot-dipped in molten zinc (galvanizing). All exposed steel is covered inside and out -- including the inside of tubing.

Our aluminum towers are self-resistant to corrosion. TRI-EX TOWERS makes them all:
GUUED TOWERS, CRANK-UP TOWERS, FREE STANDING TOWERS, STACKED TOWERS.

And we will install a tower on your job site, on request.

Call, or write TRI-EX now for information on the right TRI-EX tower for you. We will send you our complete list of prices, delivery dates, installation information and the name of your nearest dealer. Call TOLL FREE.

Anywhere in the nation, dial:
1-800-421-4688

In California, dial:
1-800-252-0207, Extension 40

Tri-Ex
TOWER CORPORATION
7182 Rasmussen Avenue, Visalia, California 93277
phase coherent

RTTY modulator

Discussion of the need for using a phase-coherent AFSK system to generate FSK with a single-sideband transmitter

With amateur activity increasing on RTTY there is a growing need for a quality RTTY modulator and demodulator to interface between the station receiver and transmitter. Although some transmitters have provisions for a frequency shift key (FSK) input to the VFO circuitry, most do not. One of the standard means of producing an FSK carrier on the high-frequency bands is to insert pure tones into the audio input of an ssb transmitter. An audio FSK generator (AFSK) will produce an FSK signal when it is applied to a single-sideband, suppressed-carrier transmitter. However, there are limitations to this technique.

FSK problems and approaches

In RTTY circuits, there are basically two frequency shifts used, a narrow shift (170 Hz) and a wide shift (850 Hz). The only FCC requirement is that the shift be less than 900 Hz. The reason for a shift at all, of course, is to distinguish a mark from a space, thus conveying information. Using digital language, the mark and space may be redefined as a logic one or a logic zero. The definition of which frequency will be used as a mark (one) and a space (zero) must be compatible between all communicators, otherwise the shift will be inverted from the one expected. On the 20-meter band, for example, the mark frequency is normally defined as the higher of the two frequencies, while the space is the lower of the two. The mark and space frequencies are offset by 170 Hz.

The narrow-shift mode is almost always used on the high-frequency bands, while some amateurs use the wide shift on the vhf bands. Fig. 1A shows the ideal frequency spectrum of a narrow-shift FSK signal. The bandwidth due to the information rate is not shown, but it will be centered on each carrier frequency and will have the effect of widening the FSK signal spectrum. The information bandwidth depends on the speed at which the RTTY is sent, and it will not be considered here. Note in this figure that the mark frequency is exactly 14.097875 MHz, while the space frequency is exactly 14.097705 MHz. This would be a narrow-shift FSK signal, since the difference is 170 Hz.

If the frequency determining unit in the transmitter is appropriately modified, a frequency shift of 170 Hz is easily attained. As an example, an oscillator may be modulated by using a varicap to generate the required FSK signal. An alternate method, however, would be to modulate a single-sideband transmitter with pure sine wave tones. Theoretically, in an ssb suppressed-carrier transmitter, (SSB-SC), if a single frequency is used to modulate the transmitter, a single frequency appears at the output of the transmitter. When in the upper-sideband mode, the frequency that appears is the sum of the modulating frequency and the suppressed-carrier frequency, or the suppressed-carrier frequency minus the modulating frequency when in the lower-sideband mode. By changing the audio frequency, a signal can be generated which is FSK modulated in step with the audio signal. Although the signal fed into the transmitter is AFSK, the signal generated by the transmitter is a true FSK signal; only one rf frequency exists at a time at the output.

There are certain demands put on the transmitter

By Gene Hinkle, K5PA, 12412 Mossy Bark, Austin, Texas 78750
when either FSK or AFSK is used. If FSK is implemented by modifying the VFO, then the short-term and long-term stability of the shift circuits must be considered. Since the frequency-determining section of a transmitter is being modified, the circuits must not cause drift in the oscillator that will make the selected frequency unstable. For instance, if a dc potential is used to vary the capacitance of a varicap diode, the dc may have an ac ripple component. This ripple, from a poorly filtered dc power supply, will cause fm modulation to appear on the shifted-carrier frequency. This is certainly not desirable. Also, any temperature drifts in the dc control circuits or in the varicap diode response will cause a frequency change to occur in the fsk carrier frequencies. Care must be exercised to ensure that any modifications do not influence the stability of the oscillator.

With AFSK modulation applied to a transmitter, another set of problems appear. Fortunately, these problems are not associated with the stability of the VFO, since it is not modified. However, the quality of the ssb generation (carrier suppression, sideband suppression, and sideband filter response) is important. In a SSB-SC system, a double-sideband signal is first generated with the carrier suppressed. Normally, a sharp filter is used to pass only the desired sideband, either the upper or the lower. Because of this method, the unwanted sideband will be present, along with the carrier, although suppressed to a large degree (see fig. 1B). When operating an SSB-SC transmitter as an FSK generator, care must be exercised to ensure that the carrier is properly balanced out, and, in addition, the unwanted sideband is adequately filtered. Carrier null is probably the worst culprit, since balance circuits will change with time. The balance should be periodically checked, otherwise a continuous carrier will be present along with the FSK information.

The sideband filter response is important because of the distortion present in the modulating frequency. Although a sine wave modulating frequency is prescribed, it is extremely difficult to attain. Even if a perfect (no harmonics) sine wave were used, any nonlinearities in the audio stage would introduce some distortion into the modulation. For example, if a frequency of 2125 Hz is used to modulate the transmitter, the sideband filter should suppress the second, third, and other high-order harmonics. Fig. 1C shows the effect of insufficient harmonic suppression when a mark or space frequency is being transmitted. As was mentioned earlier, even a pure sine wave injected into the transmitter audio input will end up distorted because of preamplifier nonlinearities. This preamplifier induced distortion will be reduced somewhat due to the response of the sideband filter. If a low audio frequency is used for the mark or space, the second and third harmonic may fall into the passband of the sideband filter. If, on the other hand, the mark and space frequencies are chosen to be high enough in the response band of the filter, the sideband filter will reject the harmonic energy created by signal distortion.

The importance of undistorted wave forms is clear when considering the frequency spectrum of an FSK signal. Too much distortion and the harmonic content is more than the filters can adequately remove. Thus, steps should be taken to ensure that a reasonably clean modulating waveform is applied to the audio input of the transmitter. At the time of the frequency shifts, the phase transitions from one frequency to the other should not contain discontinuities which would contain energy at frequencies other than the space or mark frequencies. This basi-

---

**Fig. 2.** Diagram of coherent and incoherent frequency shifts. The incoherent shift results in sinewave distortion during different parts of the cycle, while a coherent frequency shift has a smooth phase transition, resulting in less distortion.
cally means that all space and mark frequency changes should be done smoothly (see fig. 2). One way to guarantee this is to always change phases at a zero-crossing of the signal. Using this approach, the audio modulating signal will always change frequency at the same phase point in all information transitions.

and higher-order odd harmonics cause distortion. The lowpass filters are designed to attenuate the third harmonics by 40 dB. The third harmonic of a squarewave is normally 10 dB lower than the fundamental, so this additional 40 dB should put the third harmonic 50 dB below the fundamental. Of course, in practice, this may not be obtained, but the low-

A block diagram of an AFSK generator is shown in fig. 3. The generator begins with an oscillator set to twice the needed frequency. When a mark or space is needed, the oscillator's frequency is adjusted for the proper frequency change. A divide-by-two circuit generates the correct frequencies for the AFSK output waveform, with a lowpass filter removing objectional harmonic energy from the square wave — resulting in a near sine wave output.

Because a square wave is used, the even harmonics theoretically do not exist. Thus, only the third pass filter response coupled with the bandpass response of the sideband filter in the transmitter should give satisfactory suppression of all harmonics. It should be noted that the mark and space frequencies chosen (2125 and 2295 Hz) must be within the response of the sideband filter in the transmitter. Otherwise, these frequencies will be attenuated.

There is nothing magic about these modulating frequencies. Frequencies of 1800 and 1970 (170 Hz shift) could have been used. However, the receiver demodulator must be matched to these same fre-

fig. 3. Block diagram of an AFSK generator capable of coherent frequency shifts. Lowpass filters reduce the harmonic content to acceptable levels.

fig. 4. Schematic diagram of the AFSK generator described in the text. The active filter removes harmonic energy while the flip-flop synchronizer only allows phase coherent frequency shifts to occur. All parts associated with the 555 oscillator should have a low temperature coefficient to reduce frequency drift due to temperature change.
quency pairs. This assumes that the receiver-transmitter combination operates on the identical frequency.

**circuit description**

A circuit which reflects the block diagram just discussed is shown in fig. 4. The ubiquitous 555 astable will guarantee a 50 per cent duty cycle. The other half of this dual-D flip-flop is used as the input data synchronizer. The mark or space input will affect the frequency of the 555 only when the output of the divide-by-two changes state. Thus, all frequency shifts are synchronized by one well-defined phase point in the oscillator's period. The divide-by-two cir-

oscillator is used as the frequency generator. Two miniature potentiometers are used to adjust the mark and space frequencies (actually twice the required frequencies). By inputting a logical one or zero, transistor Q1 turns on, changing the RC time constant. For the 555 oscillator, the frequency of oscillation is:

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

where \( R1 \) is the parallel combination of the resistors used for frequency setting. Normally, the frequency of the 555 is set to twice the mark and space frequencies. U2 is used as a divide-by-two circuit which circuit is easily disabled, creating a convenient method of gating the oscillator. This is useful for gating the oscillator off and on to a CW identification. Q2 and Q3 simply buffer the input, which inhibits the divide-by-two. U3 and U4 are used as a dual-stage, active lowpass filter. These filters each have a two-pole Butterworth response. Each lowpass response results in a 40 dB per decade roll-off characteristic. In tandem the responses add, yielding and overall 80 dB per decade response. The lowpass filters use inexpensive 741-type operational amplifiers. The last output of the filter is attenuated by R3. This potentiometer can be adjusted to set the output drive level feeding the audio input of the transmitter.
The circuits are powered from a 12- to 15-volt dc source. The voltage reference for the oscillator section, however, is regulated by a three-terminal regulator to ensure that voltage fluctuations will not influence the frequency of oscillation. Even though the 555 oscillator has a specified 0.1 per cent volt tolerance to power supply change, I have found it best to regulate the power source to remove any problems with errors due to this change. If you use a well-regulated power supply, the 7805 three-terminal regulator may be omitted and a jumper wire installed.

Layout of the circuit is not critical since only audio frequencies are generated. A printed-circuit-board foil pattern is shown in fig. 5. The power bus should be filtered to remove dc transients which might be propagated from other circuits attached to the same power source. A typical power supply is shown in fig. 6A. Also shown is a circuit which may be used to convert a TTY current loop to the proper voltage for driving the modulator input. For those who wish to duplicate this modulator, a circuit board is being made available.*

Adjustment

Once the circuit is constructed, checkout is relatively straightforward. A 12-15 volt power supply should be connected between the power input and ground. Since the “shift direction” is jumper programmable, one or the other polarity for the shift direction should be selected. If needed, a single-pole double-throw switch could be used to remotely select the shift direction. Assuming pin 12 is selected for the shift direction and no “Data-in” signal is present, Q1 will be turned off. With Q1 off, the “Low-Adj” potentiometer should be adjusted for an output frequency of 2125 Hz. This frequency can be measured at the FSK signal output port, or monitored at pin 2 of U2. Once the frequency is brought into the proper range, “Data-in” should be connected to a logic one level. Q1 will now turn on, and the “High-Adj” potentiometer should be adjusted for an output frequency of 2295 Hz.

If no signal appears at the output or at pin 2 of U2, measure the level at pin 6 of U2. It should be at ground potential when no “Gate” signal is present. If it is not at ground potential, Q2 and Q3 may be the wrong type or inserted improperly. If the frequency cannot be adjusted to the proper range, Q1 may be at fault. Since C1 determines the timing, only a high-quality capacitor should be used. Any temperature drifts of this capacitor will create a proportional drift in the oscillation frequency. Although a 0.01-μF capacitor is shown, slight variations of this value are permissible due to the use of potentiometers for determining the frequency. However, extreme variations may not work because of the limited range of the potentiometer adjustment. Therefore, if the frequency will not adjust to the exact frequency needed, try using another capacitor for C1. If all else fails, a smaller-value capacitor could be paralleled with C1 to “fine tune” the frequency.

After the oscillations are set to within the tolerance wanted, go back and check the frequencies as the “Data-in” line is switched from a logic one to a logic zero. The “Gate” signal input can next be checked by connecting a logic one voltage to the input. The output oscillations should cease. Note, if the opposite logic polarity is needed for the disable gate input (logic zero for disable), Q2 and R4 can be eliminated, but be sure to jumper between the collector and base of Q2. This is why two transistors are used in the Signal Gate circuit, to allow for the option of inverting the gate signal.

I should mention that the 4013 dual flip-flop is a CMOS device. Thus, care should be exercised when handling the unit because static buildup can damage the sensitive MOS input transistors. Also, beware of bargain basement CMOS devices. I have seen some ICs purchased from outlets which by no means met specifications. All outputs should swing from the power supply potential, for a logic one, to practically ground potential, for a logic zero. This assumes no current is being “sourced” or “sunk” by the outputs. If the CMOS device does not meet this simple criterion, send it back; it is defective.

I hope this will clarify the AFSK approach for generating FSK with single-sideband equipment. The pitfalls to avoid should be recognized for compliance with FCC regulations and for reducing interference on the amateur bands.

---

*A predrilled, single-sided printed circuit board is available for $5.00 post-paid from I/O Engineering, 12412 Mossy Bark, Austin, Texas 78750.

**Ham Radio**
Hy-Bander VHF Mobile Antennas combine broad bandwidth with high efficiency. 5\% wave design provides low angle radiation for maximum gain. The exclusive Hy-Gain ratchet foldover will adjust through a 180° arc. The ratchet will hold its whip position even at 150 mph. Hy-Gain's high-powered ceramic magnet grips the vehicle's surface at speeds up to 120 mph. Hy-Gain's use of a fiberglass printed circuit loading coil insures incredible tuning accuracy for low VSWR. PC board technology provides up to 50\% more surface area for improved conductivity.

19.95 Magnetic
Model 287

15.95 Trunk Lip
Model 286
time-current charging
of nickel-cadmium batteries

Time-current charging: a technique for quickly charging nickel-cadmium batteries

Want to charge sealed, nickel-cadmium batteries quickly and safely? The dump, time-current charging method is not new, but it seems little known by many people using nickel-cadmium batteries in electronic equipment.

Sealed nickel-cadmium cells may be charged and discharged at very high rates (high currents), if certain rules are observed. When discharging, overheating of the cells should be avoided. Not letting them get too hot to handle is a safe rule. (Note: Cells used in portable soldering irons are effectively short circuited by the low-resistance soldering element; for short periods, they may supply hundreds of amperes without damage.)

In the case of charging, the same rule applies — with one major limitation. This limitation is that high currents must be avoided when the cell is near or above full charge. When above full charge, the cell will produce gas if it is charged at a rate above 10 per cent of its (one hour) ampere-hour (A-H) rating. In most cases, this is the recommended slow-charge rate and is the rate that can be used for prolonged periods of overcharging without apparent damage.*

Open cells are not an altogether different matter. Most of this article applies also to that type of cell. However, the following items are important if you use open cells. Always open the filler vent when charging; do not trust any automatic vent that may be provided. Unless the cell has leaked, add only distilled water to bring the electrolyte back to the proper level. Charge the cell until it freely "outgasses"; that is, until many bubbles start to rise in the electrolyte. The dump, time-current charging method can be used with open cells. However, since the gas pressure problem does not exist and a good "full

*If you are going to trickle charge batteries during idle periods, a rate of 1 per cent of ampere-hour rate would probably be more reasonable.

fig. 1. The dump circuits in this diagram can be varied to suit any situation. If the batteries are not soldered into the circuit, a simple battery holder, with dumping resistors soldered across the terminal, can be used. A voltmeter can be used to measure the cell voltages. Discharge each cell to about 0.5 volt; at 0.5 volt, the cell has less than 5 per cent of its full charge.

By George A. Wilson, W1OLP, 318 Fisher Street, Walpole, Massachusetts 02081
charge" indicator does exist, the method is not very useful.

**time-current charging**

The basics of this system are to first completely discharge the cell and then to recharge it to less than 100 per cent full charge with a known high current for a specific length of time. It may be used at this point, or, if full capacity is required, charging may continue at the normal 10 per cent rate.

To avoid reverse charging, it is very important that fast discharging be done individually on each cell. If you are working with a battery of cells, a jig must be made to separately discharge the cells. Even at normal discharge rates, care must be taken not to discharge cells connected in series. In some cases, the discharged cells are reverse-charged and frequently become reverse-polarized. When this occurs, the cell will not recharge in the normal manner; it will retain its reverse polarity. Sometimes the cell can be brought back to normal polarity by giving it a massive charge in the proper direction. Typically, half-ampere cells are charged at rates of several amperes for a few minutes. This “cure” works in many cases, but the reliability of the cell is questionable from that point on.

**dumping**

Discharging (or dumping) can be safely accomplished at four times the rated one hour A-H current. Typically, a four A-H cell can be safely discharged at 16 amperes. In this case, a full charge will take about fifteen minutes to dissipate. If the cell is less than fully charged, correspondingly less time will be required. Satisfactory values of resistance for several popular nickel-cadmium cell sizes are given in table 1. The circuit for discharging single or multiple cells is shown in fig. 1.

![Circuit Diagram for Dumping](https://via.placeholder.com/150)

**charging**

Charging is most effectively done with the cells connected in series. This allows a single charger to put the same charge current through all of the cells simultaneously (see fig. 2). Charging can be done at currents as high as 50 times the one-hour ampere-hour rating of the cell; a 150-mA cell can be charged at 7.5 amperes. The charging time is calculated as follows:

\[
time = \frac{A-H \text{ rating}}{\text{charging current}}
\]

\[
= \frac{0.150 \text{ A-H}}{7.5 \text{ A}}
\]

\[
= 1.2 \text{ minutes}
\]

This short a time, however, is an extreme that should be avoided because of the timing accuracy required. Missing by a few seconds could lead to an accident. A misrating on the cell could be equally dangerous. If you choose a rate of five times the A-H rating, the time would be 12 minutes and the time tolerances become reasonable. Plus or minus one minute will result in about 10 per cent of full charge.

At any rate of charge, the 100 per cent charge time may be calculated using the previous formula. Although the prime advantage of the dump, time-current charge method is speed, somewhat slower discharge and charge rates will tend to be safer than high rates, which may ruin a battery if care is not used. I strongly recommend that a timer be used to turn off the charger, rather than trusting the clock-watching method.

**acknowledgement**

The assistance of Mr. E. L. Williams in the preparation of this article is gratefully acknowledged.

**bibliography**


---

```
charge indicator does exist, the method is not very useful.

**time-current charging**

The basics of this system are to first completely discharge the cell and then to recharge it to less than 100 per cent full charge with a known high current for a specific length of time. It may be used at this point, or, if full capacity is required, charging may continue at the normal 10 per cent rate.

To avoid reverse charging, it is very important that fast discharging be done individually on each cell. If you are working with a battery of cells, a jig must be made to separately discharge the cells. Even at normal discharge rates, care must be taken not to discharge cells connected in series. In some cases, the discharged cells are reverse-charged and frequently become reverse-polarized. When this occurs, the cell will not recharge in the normal manner; it will retain its reverse polarity. Sometimes the cell can be brought back to normal polarity by giving it a massive charge in the proper direction. Typically, half-ampere cells are charged at rates of several amperes for a few minutes. This “cure” works in many cases, but the reliability of the cell is questionable from that point on.

**dumping**

Discharging (or dumping) can be safely accomplished at four times the rated one hour A-H current. Typically, a four A-H cell can be safely discharged at 16 amperes. In this case, a full charge will take about fifteen minutes to dissipate. If the cell is less than fully charged, correspondingly less time will be required. Satisfactory values of resistance for several popular nickel-cadmium cell sizes are given in table 1. The circuit for discharging single or multiple cells is shown in fig. 1.

![Circuit Diagram for Dumping](https://via.placeholder.com/150)

**charging**

Charging is most effectively done with the cells connected in series. This allows a single charger to put the same charge current through all of the cells simultaneously (see fig. 2). Charging can be done at currents as high as 50 times the one-hour ampere-hour rating of the cell; a 150-mA cell can be charged at 7.5 amperes. The charging time is calculated as follows:

\[
time = \frac{A-H \text{ rating}}{\text{charging current}}
\]

\[
= \frac{0.150 \text{ A-H}}{7.5 \text{ A}}
\]

\[
= 1.2 \text{ minutes}
\]

This short a time, however, is an extreme that should be avoided because of the timing accuracy required. Missing by a few seconds could lead to an accident. A misrating on the cell could be equally dangerous. If you choose a rate of five times the A-H rating, the time would be 12 minutes and the time tolerances become reasonable. Plus or minus one minute will result in about 10 per cent of full charge.

At any rate of charge, the 100 per cent charge time may be calculated using the previous formula. Although the prime advantage of the dump, time-current charge method is speed, somewhat slower discharge and charge rates will tend to be safer than high rates, which may ruin a battery if care is not used. I strongly recommend that a timer be used to turn off the charger, rather than trusting the clock-watching method.

**acknowledgement**

The assistance of Mr. E. L. Williams in the preparation of this article is gratefully acknowledged.

**bibliography**


---

```
charge indicator does exist, the method is not very useful.

**time-current charging**

The basics of this system are to first completely discharge the cell and then to recharge it to less than 100 per cent full charge with a known high current for a specific length of time. It may be used at this point, or, if full capacity is required, charging may continue at the normal 10 per cent rate.

To avoid reverse charging, it is very important that fast discharging be done individually on each cell. If you are working with a battery of cells, a jig must be made to separately discharge the cells. Even at normal discharge rates, care must be taken not to discharge cells connected in series. In some cases, the discharged cells are reverse-charged and frequently become reverse-polarized. When this occurs, the cell will not recharge in the normal manner; it will retain its reverse polarity. Sometimes the cell can be brought back to normal polarity by giving it a massive charge in the proper direction. Typically, half-ampere cells are charged at rates of several amperes for a few minutes. This “cure” works in many cases, but the reliability of the cell is questionable from that point on.

**dumping**

Discharging (or dumping) can be safely accomplished at four times the rated one hour A-H current. Typically, a four A-H cell can be safely discharged at 16 amperes. In this case, a full charge will take about fifteen minutes to dissipate. If the cell is less than fully charged, correspondingly less time will be required. Satisfactory values of resistance for several popular nickel-cadmium cell sizes are given in table 1. The circuit for discharging single or multiple cells is shown in fig. 1.

![Circuit Diagram for Dumping](https://via.placeholder.com/150)

**charging**

Charging is most effectively done with the cells connected in series. This allows a single charger to put the same charge current through all of the cells simultaneously (see fig. 2). Charging can be done at currents as high as 50 times the one-hour ampere-hour rating of the cell; a 150-mA cell can be charged at 7.5 amperes. The charging time is calculated as follows:

\[
time = \frac{A-H \text{ rating}}{\text{charging current}}
\]

\[
= \frac{0.150 \text{ A-H}}{7.5 \text{ A}}
\]

\[
= 1.2 \text{ minutes}
\]

This short a time, however, is an extreme that should be avoided because of the timing accuracy required. Missing by a few seconds could lead to an accident. A misrating on the cell could be equally dangerous. If you choose a rate of five times the A-H rating, the time would be 12 minutes and the time tolerances become reasonable. Plus or minus one minute will result in about 10 per cent of full charge.

At any rate of charge, the 100 per cent charge time may be calculated using the previous formula. Although the prime advantage of the dump, time-current charge method is speed, somewhat slower discharge and charge rates will tend to be safer than high rates, which may ruin a battery if care is not used. I strongly recommend that a timer be used to turn off the charger, rather than trusting the clock-watching method.

**acknowledgement**

The assistance of Mr. E. L. Williams in the preparation of this article is gratefully acknowledged.

**bibliography**

GET MORE THAN YOU BARGAIN FOR

at a TEN-TEC franchised dealer

Buying amateur radio equipment is more than looking for the best price. It's all the extras you get from an involved, active dealer who has your best interests at heart—a TEN-TEC franchised dealer.

**FREE HELP — GOOD ADVICE**
Investing in amateur radio equipment is a substantial move in personal finances, so it pays to get all the advice and help you can. Your TEN-TEC dealer has been franchised because he's the kind of expert we want to serve you—knowledgeable, honest, willing to spend the time you need to make the right decision.

**FULL LINE DISPLAY**
There's no substitute for a first-hand look and trial when it's time to select your new gear. And your TEN-TEC dealer has our major models on display—even the manuals for each so you can check out every detail, every specification.

**FAST DELIVERY**
Part of the joy of buying anything is taking it home with you. Once you've made up your mind, there's usually no need to wait for delivery with a TEN-TEC dealer. He will either have your model in stock (if it is an established one), or be among the first to receive new products.

**FAIR PRICES**
Your TEN-TEC dealer is in business to make a living. His best price will be a fair price—one that is satisfactory to both of you. That way he will stay in business to provide all the services you want... new products, stores of needed items for emergencies, help for beginners, and just being there when you need him.

**FREE WARRANTY SERVICE**
The TEN-TEC warranty is one of the most liberal in amateur radio, simple to understand, and fair. And your TEN-TEC dealer is ready to provide complete warranty service to your satisfaction—most of the time without your having to return anything to the factory.

**AFTER WARRANTY SERVICE**
Your TEN-TEC dealer won't forget about you if trouble arises. He's right there with the facilities to get you back on the air quickly. And he does it all at reasonable cost.

You can count on your TEN-TEC dealer—he's franchised by the TEN-TEC factory because he's a man who is ready to help—to give you more than you bargain for.
There's a franchised TEN-TEC dealer near you...

Alabama
Long's Electronics, Birmingham
Younce Electronics, Mobile

Arizona
The Ham Shack, Phoenix

California
Ham Radio Outlet, Anaheim
Henry Radio, Anaheim
Ham Radio Outlet, Burlingame
The Base Station, Concord
Fontana Electronics, Fontana
Cohoon Amateur Supply West, Lompoc
Loomis Electronics, Loomis
Henry Radio, Los Angeles
Dave's TV-CB & Stereo, Mentone
Vineyard Amateur Radio Sales, Oxnard
Electronics Emporium, San Diego
Ham Radio Outlet, San Diego
Quermet Electronics, San Jose
Shaver Radio, Santa Clara
Ham Radio Outlet, Van Nuys

Colorado
Burstin-Applebee Company, Denver
CW Electronics, Denver

Connecticut
Hatry Electronics, Hartford
Thomas Communications, Newington

Delaware
Delaware Amateur Supply, New Castle

Florida
Ray's Amateur Radio, Clearwater
Sunrise Amateur Radio, Ft. Lauderdale
N & G Distributing Company, Miami
Amateur Electronic Supply, Orlando
Contemedia Communications Systems, Tallahassee

Georgia
ZZZ Electronics Incorporated, Atlanta
Radio Wholesale, Columbus

Hawaii
Delco's-Hawaii, Aiea

Idaho
Action Supply Company, Boise
Ross Distributing Company, Preston

Illinois
Magnus Electronics, Chicago
Organs & Electronics, Lockport
Spectronics Incorporated, Oak Park
Klaus Radio, Peoria

Indiana
Lakeland Electronic Supply, Angola
Kryder Electronics, Ft. Wayne
Graham Electronic Supply Inc., Indianapolis
Electrocom Industries, South Bend
Radio Distributing Company, South Bend
Hoosier Electronics, Terre Haute

Iowa
Hi Incorporated, Council Bluffs
Bob Smith Electronics, Ft. Dodge

Kansas
Associated Radio Communication, Overland Park
Electronics Inc., Salina
Amateur Radio Equipment Co., Wichita

Kentucky
Cohoon's Amateur Service, Hopkinsville
Mobile Communications, Louisville

Maryland
The Comm Center, Laurel
Electronics Int'l. Service Corp., Wheaton

Massachusetts
C. B. Wilkins Company, Greenfield
Tufts Radio Electronics, Medford

Michigan
Purchase Radio Supply, Ann Arbor
Radio Supply & Engineering Co., Detroit
Omar Electronics, Durand
Radio Parts Incorporated, Grand Rapids
Ferris Radio, Hazel Park
H. R. Electronics, Muskegon

Minnesota
Electronic Center Incorporated, Minneapolis

Mississippi
Electronic World Incorporated, Pascagoula
Communication Services, Philadelphia

Missouri
Heny Radio Butler, Butler
Burstin-Applebee Company, Kansas City
Ham Radio Center Inc., St. Louis
Mid Com Electronics, St. Louis

Montana
Congley Radio Supply, Billings

Nebraska
Communication Center, Lincoln
Omaha Amateur Center, Omaha

Nevada
Communications Center West, Las Vegas

New Hampshire
Evans Radio Incorporated, Concord
Evans Radio Inc., Nashua
Evans Radio Incorporated, Portsmouth

New Jersey
Atkinson & Smith, Eatontown
Radios Unlimited, Somersett

New York
Adirondack Radio Supply, Amsterdam
Caledonia Community Outfitters, Caledonia
Ham Bone, Dewitt
Grand Central Radio, New York
Jr's CB Radio Supply, Rochester
Radio World, Rome
Ham Shack Electronics, Watertown

North Carolina
Georgetown Communications, Asheville
Bi-Comm, Greensboro
Step Electronics, Otto
Bob's Amateur Radio Center, Salisbury

Ohio
Amateur Electronic Supply, Cleveland
Amateur Radio Sales & Service, Columbus
SREPSCO Electronics, Dayton
Mariana Radio & TV Supply Inc., Marietta
Ken-Mar Industries, North Canton
Universal Amateur Radio Inc., Reynoldsburg
Richard Brock, Shaker Heights

Oklahoma
Oklahoma Ham Shack, Oklahoma City
Radio Store, Oklahoma City
Radio Incorporated, Tulsa

Oregon
Oregon Ham Sales, Albany
Portland Radio Supply, Portland

Pennsylvania
Supelco Inc., Bellefonte
Clegg Communications, Lancaster
Tydings Company, Pittsburgh
Electronic Exchange, Souderton
Hamtronics, Trevose
Ham Bauger Inc., Willow Grove

Rhode Island
Bluebon Marine, Cranston

South Carolina
ANR Electronics, Newberry

South Dakota
Burgard Amateur Center, Watertown

Tennessee
John Franklin Enterprises, Chattanooga
Anson, Madison
Germonton Amateur Supply, Memphis

J-Tron, Springfield

Texas
AGL Electronics Incorporated, Dallas
Electronics Center Inc., Dallas
Electronic Service Company, Elemendorf
Hardin Electronics, Fort Worth
Tracy's Electronics, Ft. Worth
Andy Electronics, Houston
Masdon Electronics, Houston
Multi Communications, Houston
J-T Electronics, Plano
Jay Huckabee Company, Snyder
Jung & Perkins Corporation, Tyler

Virgin Islands
Electronics Unlimited Inc., St. Thomas

Virginia
Arcade Electronics Inc., Annandale
P&t Electronics, Norfolk
Radio Communications Company, Roanoke

Washington
Amateur Radio Supply Company, Seattle
Consumer Communications, Seattle

Wisconsin
Amateur Electronic Supply, Milwaukee

Canada
R & S Electronics, Dartmouth, Nova Scotia
Hamtraders Incorporated, Downsview, Ontario
WSI Sales Company, Kitchener, Ontario
C. M. Peterson Company Ltd., London, Ontario
Jac-Tenna Electronique, Tracy, P Quebec

Franchised Dealer List as of December 1978.
DSI INSTRUMENTS INC.

DSI INTRODUCES
THE FIRST FULL LINE OF FREQUENCY COUNTER ACCESSORIES

Performance You Can Count On

DON'T SCRAP THAT OLD FREQUENCY COUNTER

600 MHz PRESCALER ÷ BY 10 WITH BUILT IN PREAMP
• 10 MV @ 150 MHz & 250 MHz
• 50 MV @ 450 MHz
• INCLUDES 115VAC SUPPLY
• OPERATES ON 8-12 VDC
• RUGGED CAST ALUMINUM CASE
• READY TO USE ON ANY COUNTER

SUPER PRE-AMP
15 DB PRE-AMPLIFIER
20 MHz TO 800 MHz
• OUTSTANDING AS A PROBE AMPLIFIER
• INCREASE SENSITIVITY OF A COUNTER WITH 100 MV to 12 MV TYP.
• INCLUDES 115VAC SUPPLY
• OPERATES ON 8.2-13.5 VDC
• RUGGED CAST ALUMINUM CASE

69.95
MODEL PS-600

69.95
MODEL PA-800

RTTY-PL-AUDIO
AUDIO SCALER
• x10, x 100 MULTIPLIER
• .01 Hz RESOLUTION WITH 1 SEC GATE TIME
• 20 MV SENSITIVITY 10 Hz to 10 KHz
• HI Z INPUT 1 MEG OHM
• A MUST FOR PL REEDS, RTTY AND LOW AUDIO WORK WHERE ACCURACY IS MANDATORY

49.95
MODEL AS-100X

PROTECT YOUR COUNTER
T-TAP
160 METERS TO 450 MHz
• POWER LEVELS — 1 WATT TO 250 WATTS
• USE IN LINE WITH TRANSCEIVER
• LOW LOW LOSS
• PROVIDES LEVEL OUTPUT TO COUNTER AT ALL POWER LEVELS
• USE IN LINE WITH DUMMY LOAD OR ANTENNA
• RUGGED CAST ALUMINUM CASE

32.95
MODEL T-100

ALL UNITS ARE FACTORY ASSEMBLED, TESTED AND CARRY A FULL 1 YEAR WARRANTY.
SEE YOUR LOCAL DEALER
OR
CALL TOLL FREE (800) 854-2049
California Residents add 6% State Sales Tax and Call Collect (714) 565-8402
7914 Ronson Road No. G, San Diego, CA 92111
quartz crystals — gems for frequency control

A misunderstood hero of the electronics world is the quartz crystal. Quietly it awaits your command to put your transmitter on frequency, to reject all but one sideband, or to select one rare CW signal sandwiched between adjacent kilowatt signals. What is the secret of quartz? Can an amateur operator zero-adjust his crystal oscillator, or is he stuck with a bad crystal? How do these pieces of quartz operate in an oscillatory circuit? It’s hoped that this article will answer some of your questions and help you in procuring and designing circuits with that celebrated mineral.

the quartz crystal — some background

Quartz technology is based on its piezoelectric property. The application of an electric field causes certain substances to oscillate; conversely, the application of a mechanical force or vibration causes substances to generate an electric field, known as the piezoelectric effect. Quartz is useful as an electrical oscillator operating in a very narrow frequency band. The precise frequency, activity, and temperature characteristics are determined by the position and angle of cut on the crystal.

The old concept that the quartz crystal is a standard of frequency was born in an age of less-critical applications. Old timers knew that the crystal was much more accurate and repeatable than any LC circuit. Because they didn’t have to multiply 18 times and trigger a repeater, it’s easy to see how the legend of quartz stability became exaggerated.

The basis for stability in quartz is its high inductance and low capacitance, resulting in extremely high Q. In an 8-MHz crystal unit, for example, the Q might be 150,000 while the Q of a typical LC combination at that frequency is about 300. Yet a crystal’s frequency may be pulled; and in time, it will drift.

equivalent circuit

The simplest and most commonly used equivalent circuit of the crystal is shown in fig. 1. \( L_1, C_1, \) and \( R_1 \) are the primary components which determine frequency and Q. These are referred to as the motional components and their parameters can’t be measured directly. \( C_0 \) represents the electrode capacitance, the mounting-structure capacitance, and holder or case capacitance. \( C_0 \) the static capacitance, affects the crystal operating frequency, but to a lesser degree than \( C_1 \). \( C_0 \) can be measured by a capacitance bridge across the terminals. As you may expect, the capacitance of the circuitry, shown as another parallel capacitance, \( C_L \) would also have an effect on the crystal working frequency. The equation for the working frequency is

\[
F_W = \frac{1}{2\pi \sqrt{L_1 \left[ \frac{C_1(C_0 + C_L)}{C_1 + C_0 + C_L} \right]}} \tag{1}
\]

With the help of a calculator, you can determine how much the crystal is pulled by the oscillator circuit. By changing the circuit loading, the crystal may be pulled (within limits) for fine tuning or fm applications.

mode of operation

The classic crystal reactance curve, (fig. 2), is useful in demonstrating the relationship of different operating frequencies. At two points the reactance is zero; i.e., the crystal looks purely resistive. The lower of these frequencies is the series-resonance frequen-

By Don Nelson, WB2EGZ, 9 Green Ridge Road, Voorhees, New Jersey 08043
cy, \( (F_S) \); while the higher frequency is the anti-resonance-frequency, \( (F_A) \). The resistance is low at series resonance and high at anti-resonance. The range of frequencies between is known as the natural bandwidth of the crystal. Anti-resonance is a very unstable point, and for amateur purposes, may be forgotten.

Parallel resonance is commonly recognized as the band of frequencies between \( F_S \) and \( F_A \), although classic crystal theorists have another definition. You may think of this band as the range where the crystal will operate if a capacitor is placed in parallel with it. At \( F_S \) the capacitance will be infinite; at \( F_A \), the capacitance will be zero. Practical limits are between 15 pF and 50 pF, where poor stability exists at the low-capacitance end and reduced activity degrades the high end. When ordering a crystal, you must specify series resonance or parallel resonance at a specified load capacitance.

There's a lot of confusion about crystal loading. Responsibility for this confusion falls directly onto the quartz-crystal industry, whose members have never acted together to educate users. Guidance committees have recommended that we consider the crystal operation in the positive-reactance mode when above series resonance and in the negative-reactance mode when below series resonance. This recommendation is technically correct and allows us to discuss a useful range of operation (below \( F_S \)) of the crystal, which is not usually considered.

In fig. 3, the crystal is in a feedback circuit from collector to base. A trimmer capacitor in series shifts the point on the reactance curve where the crystal operates, thus providing a frequency trim. The capacitor has a negative reactance so the crystal is shifted to operate in the positive reactance region of the curve (fig. 2).

The series trimmer does not mean the crystal is

fig. 4. In this example the crystal operates into a complex load at series resonance. L1, C1, and C2 balance the crystal at zero reactance. Capacitor C1 fine tunes center frequency. Tank circuit L2, C3 doubles the output frequency. Circuit operates as an FM oscillator-doubler.

fig. 5. Examples of vibration modes and mounting structures. Note that the quartz supporting structures are fastened at points of least motion (nodes).
operating at series resonance. It is said to be operating in the parallel-resonant mode with a load capacitance approximately equal to the trimmer value. If an equivalent circuit were drawn, you could see that the trimmer would be the parallel load. By placing the capacitor in series, you isolate the crystal from other circuit reactances, enabling the trimmer to tune more effectively than in the parallel connection.

Oscillators using fundamental crystals usually operate in the positive-reactance mode with a trimmer for exact tuning. One reason for operating this way is seen when the trimmer is removed, leaving only the crystal in the feedback circuit. The crystal should operate at series resonance, but circuit reactance will usually pull it slightly off frequency.

In fig. 4 the crystal operates at series resonance into a complex load. $L_1$, $C_1$, and $C_2$ balance the crystal at zero reactance. Capacitor $C_1$ fine-tunes center frequency. The tank circuit, $L_2$, $C_3$, doubles the output frequency. As the audio signal varies $C_2$ capacitance, the crystal will operate alternately in the positive, then the negative-reactance mode.

Deviation per volt of modulation is greater at series resonance than it would be into a capacitive load (positive-reactance operation). It would be even more desirable to operate this circuit completely in the negative-reactance mode because of more favorable deviation per volt (see fig. 2). The average amateur would have a problem designing a circuit for the negative-reactance mode because he must order his crystal at a higher frequency than the design frequency. Crystal manufacturers do not calibrate their crystals to tune into an inductive load. A second, and stickier, problem is that one manufacturer's crystals are more easily pulled than others. Plainly, some crystals won’t work in a design acceptable for another crystal.

Using a small inductor in series with the crystal is usually a practical way to lower the frequency slightly. It’s the only way to lower a crystal frequency operating at series resonance. A trimmer capacitor, also in series, can be used for fine tuning. Inductor values will depend on the crystal frequency but will be microhenries or fractional microhenries for 1-20 MHz crystals. As suggested before, not all crystals of the same frequency will shift equally. There’s a limit to how much each crystal can be pulled and still operate reliably. It’s good practice to see if the oscillator will start and maintain oscillation under extremes of temperature and voltage.
practical circuits using fundamental-mode crystals

Some practical circuits using fundamental-mode crystals follow. These circuits were chosen to demonstrate a point and should be good for reference. All are believed to be workable although I have not built all of them.

1. Y1 is H, NT, or E cut.
2. C1 in series with the crystal may be used to adjust the oscillator output frequency. Value may range between 200pF and 0.04µF; or may be a TRIMMER capacitor and will approximately equal the crystal load capacitance.
3. X values are approximate and can vary for most circuits and frequencies; this is also true for resistance values.
4. Adequate power supply decoupling is required; local decoupling capacitors near the oscillator are recommended.
5. All leads should be extremely short in high frequency circuits.

Low-frequency oscillator — 10 kHz-150 kHz.

100-kHz standard oscillator. CR1, CR2 stabilize output.

Standard oscillator for 1 MHz.

1-MHz fet oscillator and buffer. Circuit exhibits less than 1-Hz frequency change over a VDD range of 3-9 volts. Stability is attributed to mosfets and caps.

Stable VXO using 6- or 8-MHz crystals uses capacitor and inductor to achieve frequency pulling on either side of series resonance.
Schmitt trigger provides good squaring of output, sometimes eliminating need for an extra output stage.

Crystal-controlled oscillator. This circuit, described in reference 1, oscillates without the crystal. With the crystal in the circuit the frequency will be that of the crystal. Circuit has good starting characteristics even with the poorest crystals.

1-20 MHz oscillator. Circuit operates on fundamental frequency of the crystal selected without a tank circuit. It provides noninverting output. \( V_{BB} \) is 1.2 volts, available from the IC; \( V_{EE} \) is \(-5.2\) volts. Second section of IC is connected as a Schmitt trigger driving the third section, connected as a buffer, to give good square-wave output suitable for use as a clock driver.

device construction

The natural classification of crystal resonators is according to frequency. The frequency range covered commercially by quartz-crystal units may be taken as a few hundred Hz to over 250 MHz. Use is made of several cuts and patterns of motion (modes). Three common modes of vibration are: flexural, extensional, and shear. Fig. 5 illustrates these modes and typical mounting techniques.

The designations of certain quartz-crystal vibrators with some of their principal characteristics are summarized in Table 1. At lower frequencies there are advantages to using one vibrator design over another. Tolerance, activity, and temperature characteristics exemplify the need for choosing. Above 1 MHz most crystals are AT cuts. In general, the choice of cut is that of the manufacturer based on the specification.

temperature characteristics

Most crystals in amateur service are AT cuts, as our needs are primarily above 1 MHz. A notable exception is the 100-kHz calibrator crystal, which is likely to be an ET cut. Excellent temperature stability and aging are attributed to the AT-cut resonator because of its high \( Q \) and cubic temperature curve. In Fig. 6A a family of AT-cut temperature curves is depicted. The difference between these curves is determined by a change in the angle of cut of the quartz of only a few minutes of arc.
A manufacturer first determines the precise angle that will give the best temperature characteristic commensurate with users’ needs. He then determines the crystallographic axes of the quartz and cuts it in the appropriate orientation. Several cuts are illustrated in fig. 7.

The temperature characteristics of low-frequency cuts are usually parabolic, as shown in fig. 6B. Many of these can be adjusted with respect to the temperature of the turning point; but tolerances are poorer than the AT types. For greatest accuracy in any type of crystal, proportional control ovens, operating at the crystal’s turning point, are used.

**Overtone crystal units**

Crystals with frequencies higher than 20 MHz are usually overtone types, although fundamental-type crystals have been made at as high as 35 MHz. Overtone crystals are distinguished from fundamental crystals by their design, which is to operate at an odd harmonic of the crystal basic frequency. It’s generally practicable to excite AT- and BT-cut plates into third, fifth, seventh, and ninth harmonics of the fundamental frequency; hence a 10-MHz crystal can be vibrated at approximately 30 MHz, 50 MHz, 70 MHz, and 90 MHz. The relationship between overtone and fundamental frequencies is approximately, but never exactly, equal to the integer expressing the harmonic order.

To use the overtone crystal most effectively it’s important to know the following characteristics:

1. A tuned circuit must be used with the crystal to excite it into the desired harmonic mode. If the Q of this circuit is too low, improper operation of the crystal will result. The designer must also take care that no other resonances are present that may excite the crystal into another mode.

2. Overtone crystals are designed for operation at series resonance. Because of the narrow bandwidth and low motional capacitance, these crystals are not suitable for fm or for variable-crystal oscillators. Phase-lock operation is practical, however.

3. The characteristics of a crystal such as temperature coefficient and equivalent resistance apply only to the design frequency. These properties are different for fundamental operation or other harmonic orders.

**Practical overtone crystal oscillators**

Some useful overtone oscillator designs are shown below, and on the facing page.

![Diagram of overtone crystal oscillator](image)

This oscillator is designed for overtone crystals in the 20-100 MHz range operating in the third and fifth mode. Operating frequency is determined by the tuned circuit.

![Diagram of practical overtone crystal oscillator](image)

Design for high reliability over wide temperature range using fifth and seventh overtone crystals. Inductor in parallel with crystal causes antiresonance of crystal $C_0$ to minimize loading. Technique is commonly used with overtone crystals.
Typical Butler oscillator (20-100 MHz). An fet should be used in the second stage; circuit is not reliable with two bipolar. Sometimes two fets are used. Frequency is determined by LC values.

Overtone oscillator with crystal switching. Similar circuits electronically switch the crystals. The large inductive phase shift of L1 is compensated for by C1. Overtone crystals have very narrow bandwidth, therefore the trimmer has a smaller effect than for fundamental-mode operation.

Overtone oscillator using Motorola MECL devices. Frequency range is 20 MHz-100 MHz, depending on crystal frequency and tank-circuit tuning. The tank, C1, L1, is tuned to select the proper overtone mode. C2 compensates phase shift of the IC. More details are given in reference 2.

Fifth-overtone oscillator isolates the crystal from the dc base supply with an rf choke for better starting characteristics.

50 MHz-150 MHz overtone oscillator uses a 2N918.
**effects of drive level**

The level of drive imposed on an oscillator crystal is usually specified in terms of the power dissipated in it. Ideally, the crystal oscillator should be regarded as a source of stable frequency, but in practice it must also be considered as a source of power.

Changes in drive level will affect the resonator frequency; therefore, it's important for the manufacturer to know the drive level of the oscillator circuit for calibration of the crystal. Crystals operated at high drive levels will become unstable, sometimes jumping frequency into a spurious mode. Excessive resonator heating may cause a permanent shift in frequency or possibly fracture the quartz. The NT resonator is particularly vulnerable to fracturing. A good rule is to operate the crystal at the lowest drive level compatible with good starting characteristics.

The old WWII surplus pressure-type crystals use larger pieces of quartz than their modern counterparts. As might be expected, these can withstand higher drive levels. You may also find that pressure-type crystals can be pulled in frequency more easily than modern units because their motional capacitance, $C_I$, is higher.

**aging**

Like mountain dew, most crystals improve with time. Just after the crystal is manufactured, there are stresses, which when relieved, change the crystal frequency. Most manufacturers age the crystal by temperature cycling or high-temperature aging until the worst changes have occurred. You’ll then experience slower drift. In many applications, the drift is negligible but is present. The most stable crystals are those in the 4-5 Mhz range.

Aging can be positive or negative, depending on which factors are present in a particular unit. Migration of small particles within the crystal holder is usually blamed for frequency changes. If these dirt particles land on the crystal, its frequency decreases. These particles are present despite the most rigorous cleaning procedures. Metal-cased, gas-filled crystal units will usually age negatively. Some crystals are evacuated rather than gas filled. These units are cleaner and have better aging characteristics but lower drive level ratings. Evacuated units may age higher in frequency because some of the plating is vaporized. You won’t find these crystals on the surplus market; they are mentioned here as a point of interest.

**tips on using crystals**

The great enemy of quartz is drift. Old pressure types have been known to fail because of particles from the rubber gasket, which may have deteriorated. Careful cleaning with alcohol or similar solvent will bring these crystals back to life. The same procedure will probably increase the frequency of a unit that hasn’t failed. Most certainly it will increase crystal activity.

This trick isn’t practical with solder-seal holders, but then these units are much more reliable. Don’t open the holders on the solder seal units or you’ll find that the frequency has changed. This is because of a change in pressure and of gases surrounding the quartz element. Besides the frequency change, reliability is compromised by the introduction of dirt.

Sometimes an oscillator crystal is used in a filter application, but performance will not always be satisfactory. Special designs are used for filter crystals. These crystals have lower activity and are virtually free of spurs (unwanted modes). In oscillator service, the presence of unwanted modes is not as critical as in filter service, where broadband energy will excite all modes.

There are many uninvestigated facets of the quartz crystal. While some people still claim crystal manufacturing is akin to witchcraft, this is just not so. A few years ago, natural quartz, which was mined in Brazil, was used for all U.S. crystals. Synthetic quartz made in the U.S. has been improved to the point where it’s now used in all but the most critical applications.

Natural quartz still has higher $Q$. Synthetic quartz has the advantage of perfect crystalline structure and uniform size. The use of natural quartz incurs much waste — rarely is there a fully perfect crystal, and small structures may not be practical for cutting. Crystallography is certainly a science not fully investigated but one we should study.

**references**


**bibliography**


**ham radio**
THERE IS A DIFFERENCE IN QUARTZ CRYSTALS

For more than a quarter century, International Crystal Mfg. Co., Inc. has earned a reputation for design and capability in manufacturing and marketing precision electronic products.

The market for International crystals is world wide. With a full range of types and frequencies available, International is a major supplier to the commercial and industrial crystal market.

International’s leadership in crystal design and production is synonymous with quality quartz crystals from 70 KHz to 160 MHz. Accurately controlled calibration and a long list of tests are made on the finished crystal prior to shipment.

That is why we guarantee International crystals against defects, material and workmanship for an unlimited time when used in equipment for which they were specifically made.

Orders may be placed by Phone: 405/236-3741 • TELEX: 071-347 • CABLE: Incrystal • TWX: 910-831-3177 • Mail: International Crystal Mfg. Co., Inc., 10 North Lee, Oklahoma City, Oklahoma 73102.

Write for information.
It's not just a transistor tester — it's a versatile instrument that can be used for checking and designing electronic circuits under static and dynamic conditions.

**features**

The semiconductor curve tracer/ analyzer is as versatile as your imagination yet is economical and simple to build. It can be used for checking as well as designing electronic circuits under both static and dynamic conditions. It can also be used to determine parameters of signal and power transistors, unijunction transistors, field-effect transistors, silicon-controlled rectifiers, and triacs.

Most diodes can be analyzed, including signal and power devices, zeners, protection diodes, bias diodes, point-contact diodes, hot-carrier diodes, and light-emitting diodes.

**By Stuart Tuma, W1QXS, 17 Briggs Street, Melrose, Massachusetts 02176**
Another feature of the instrument is that of checking photocells made of cadmium sulfide or cadmium selenide. With appropriate adapters, the instrument can also be used to check integrated circuits.

The analyzer is not restricted only to semiconductor devices. It can also be used to check the piezoelectric effect of quartz crystals under various circuit conditions and to check the design of amplifier as well as oscillator circuits. In electrical circuits, the analyzer can be used to check the sensitivity and internal resistance of D'Arsonval meters and galvanometers as well as the sensitivity of relays, including the popular reed relay. With proper adapters, low-power vacuum tubes can also be checked.

theory of operation

As a transistor curve tracer, the unit is designed so that the oscilloscope vertical input measures the voltage across a 100-ohm resistor to ground, which is used to measure collector current. The oscilloscope, having a vertical sensitivity of 0.1 volt per division across 100 ohms, gives 1 mA per division. Should you desire to increase the current per division, you can use 1 volt per division, thus giving 10 mA per division, and so on. Fig. 1 shows the basic circuit.

The oscilloscope horizontal deflection is used to measure collector-emitter voltage. The oscilloscope is calibrated to read 1 volt per division. Since the horizontal amplifier input is not directly calibrated, it will be necessary to use the sweep voltage, which is approximately 9 volts peak pulsating direct current. This gives a value of 1 volt per division horizontal deflection for 9 divisions. Now we have a method of checking both voltage and current from our 60-Hz sweep signal supplied by the 6.3 VAC source.

The emitter-base circuit has a separate supply — a 1.5-volt battery for the base bias. Higher bias voltage can be added to the emitter and collector circuit if desired. The base-current circuit employs a 50-microampere meter movement (which has an internal resistance of 1000 ohms). This circuit will read 50 microamperes (no shunt), 0.55 milliamperes with a 100-ohm shunt, and 5.05 milliamperes with a 10-ohm shunt.

The meter is protected by two silicon diodes (fig. 2), which I found to have a forward-bias-voltage drop of 0.4 volt. The voltage drop across a 50-microampere meter, full scale, having a resistance of 1000 ohms, should be 0.05 volt. This gives good protection for the meter.

Most silicon diodes have about 0.6 volt forward bias, so other types of diodes could be used. However, check the diode's forward-bias voltage before you install it. You can do this by connecting the diode in series with a 1000-ohm resistor and a 1.5-volt battery. Measure the voltage drop across the
diode when the diode is conducting. This voltage should be 0.6 volt or less.

A 0.001-μF capacitor is connected across the meter for still more protection from rf coming through the line or from some other external source. The meter circuit is further protected by a 1/4-ampere fuse.

The base-emitter current of the transistor under test is controlled by a 10-k pot (R5, fig. 2) and a voltage divider (R3, R4) in series with the 1000-ohm resistor (R2) and the meter. This gives a maximum current of about 1.5 mA.

construction

A schematic of the curve tracer/analyzer is shown in fig. 3. A parts list is given in table 1. The sketch of fig. 3 shows parts layout on the front panel.

wiring

Wiring was easy. I used a pencil-type soldering iron, a good grade of solder, and a clean, tinned soldering tip. The circuit was connected with 0.4-mm (no. 26 AWG) hookup wire. The reversing (inverting) switches were wired first. External connecting leads were added for future wiring. All components were mounted on the top panel and wired as shown in fig. 2. The extended leads were then soldered to the proper binding posts. I used one strand of 0.08-mm (AWG no. 40) wire for the 1-ampere fuse on the external binding post. I used shielded wire for the oscilloscope tracer switch and scope output.

The five terminal posts on the top front panel were made for plug-in adapters on which you can mount various “TO” sockets for transistors or a module-type socket for testing other devices. Note that different load resistances can be added to the emitter circuit as well as to the collector circuit. This allows you to build prototype circuits before putting them into a breadboard circuit. If desired, a solderless breadboard adapter can be used.

mechanical details

The top and bottom panels were made of two pieces of plastic 152 mm (6 inches) square. The sides were made from 6.4-mm (1/4-inch) plastic channel molding, 51 mm (2 inches) wide, obtained from a local lumberyard dealer. These pieces were cut to form the four sides. I used small metal screws to put it together. Parts were laid out in a convenient order. (Mark or etch parts locations on the top and side panels.)

The top panel required a 38-mm (1-1/2-inch) diam-

<table>
<thead>
<tr>
<th>component</th>
<th>description</th>
<th>approximate cost</th>
<th>source</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1</td>
<td>1.5 volt battery type AA</td>
<td>$0.20</td>
<td>Lafayette Radio</td>
</tr>
<tr>
<td>banana plugs</td>
<td>(screw mounting) M3.5 (6-32) (pkg of 10)</td>
<td>3.40</td>
<td>Lafayette Radio</td>
</tr>
<tr>
<td>binding posts</td>
<td>5 way (pkg of 6)</td>
<td>1.69</td>
<td>Lafayette Radio</td>
</tr>
<tr>
<td>C1</td>
<td>.001 μF 1000V ceramic</td>
<td>0.15</td>
<td>Lafayette Radio</td>
</tr>
<tr>
<td>CR1, CR2, CR3</td>
<td>1A 600 PIV silicon diodes (pkg of 3)</td>
<td>1.19</td>
<td>Lafayette Radio</td>
</tr>
<tr>
<td>F1, F3</td>
<td>1/4-A 3AG fuses (pkg of 5)</td>
<td>1.05</td>
<td>Lafayette Radio</td>
</tr>
<tr>
<td>F2</td>
<td>see text</td>
<td></td>
<td></td>
</tr>
<tr>
<td>meter</td>
<td>50 μA (99PS1146V)</td>
<td>6.95</td>
<td>Lafayette Radio</td>
</tr>
<tr>
<td>R1</td>
<td>100 ohm 1W 10% composition</td>
<td>0.20</td>
<td>Lafayette Radio</td>
</tr>
<tr>
<td>R2</td>
<td>1000 ohm 1/2W 10% composition</td>
<td>0.15</td>
<td>Lafayette Radio</td>
</tr>
<tr>
<td>R3</td>
<td>100 ohm 1/2W 10% composition</td>
<td>0.15</td>
<td>Lafayette Radio</td>
</tr>
<tr>
<td>R4</td>
<td>10 ohm 1/2W 10% composition</td>
<td>0.15</td>
<td>Lafayette Radio</td>
</tr>
<tr>
<td>R5, S5, S8</td>
<td>500-k pot with two SPST switches (center off)</td>
<td>2.09</td>
<td>Lafayette Radio</td>
</tr>
<tr>
<td>S1, S6</td>
<td>SPDT 3A 125V mini toggle switches (center off)</td>
<td>1.39 ea.</td>
<td>Poly Paks</td>
</tr>
<tr>
<td>S2, S3, S4</td>
<td>DPDT 3A 125V mini toggle switches</td>
<td>1.96 ea.</td>
<td>Poly Paks</td>
</tr>
<tr>
<td>S7</td>
<td>SPST momentary mini switch</td>
<td>0.79</td>
<td>Lafayette Radio</td>
</tr>
<tr>
<td>T1</td>
<td>6.3V ct 1A or equivalent</td>
<td>3.75</td>
<td>Lafayette Radio</td>
</tr>
</tbody>
</table>

$25.25

The top panel required a 38-mm (1-1/2-inch) diameter hole to mount the meter. I found that an old pencil soldering iron was just the thing for this, since the plastic melts at a very low temperature. I used a pipe reamer for the finishing touches. I made a 9.5-mm (3/8-inch) hole for the potentiometer. I used a
smaller reamer for the finishing touches. I used the same reamer for the 6.4-mm (1/4-inch) holes for mounting the switches.

I painted the inside of the top and bottom panels flat black. I used 5-mm (3/16-inch) holes to mount the binding-post terminals. The terminal posts were spaced 19 mm (3/4 inch) apart. I constructed the instrument so it would plug into my Conard oscilloscope. However, with proper external leads, this analyzer should fit into any standard oscilloscope.

There are probably a thousand and one uses for this instrument. I’ve listed only a few, but enough so you’ll become familiar with its use, both as a curve tracer and analyzer. I’m sure you’ll find other uses, and I’d like to hear from you in this regard.

testing transistors

Plug the curve tracer into the proper oscilloscope inputs. The vertical output goes to the oscilloscope vertical input, and the horizontal output goes to the oscilloscope horizontal input. Ground the curve tracer to the oscilloscope ground.

| **pnp transistors**. Set up the oscilloscope as follows: |
|----------------|-------------|-------------|
| **quantity**   | **setting** | **measurement** |
| vertical gain  | 0.1 V/division | 1 mA/division |
| horizontal gain | 9 divisions (with transistor in circuit) | approximately 1 V/division (peak) |
| horizontal sweep source | external |
| intensity | normal |
| focus | normal |

Set up the curve tracer as follows (see fig. 3):

- scope-tracer: tracer
- diode-trans: trans
- AC sweep: pushbutton released
- C NPN-PNP: PNP
- B NPN-PNP: PNP
- 4-1/2V-EXT-9V: 9V (peak)

Switch meter to 50 microamperes or to a convenient current rating. Set BASE CURRENT counter clockwise (CCW). Be sure that jumpers are connected between emitter-to-emitter-load and between collector-to-collector load terminal posts (fig. 2).

Connect the test transistor to the proper input terminals or into a transistor plug-in adapter. Turn the BASE CURRENT control until the current begins to increase. Note the variation of the trace. Increase the trace two or three divisions and note the increase in the base-bias current (record this reading). Increase the collector current until one more division is obtained. Again, record the base-bias reading. From the data taken, the transistor beta and alpha gain can be determined as shown below.

The beta gain is determined by taking the variation of the collector current and dividing it by the variation of the base bias current. Example:

\[
\text{beta gain} = \frac{\Delta \text{collector current}}{\Delta \text{base bias current}}
\]

The alpha gain is equal to the beta gain divided by the beta gain plus 1. Example:

\[
\text{alpha gain} = \frac{\text{beta gain}}{\text{beta gain} + 1} = \frac{100}{100 + 1} = 0.99
\]

Fig. 4 shows the relationship of collector current, collector voltage, and base bias for a typical pnp transistor (type 2N252).

| **NPN transistors.** The setup for npn transistors is the same as for pnp transistors, except that the emitter and base **NPN** and **PNP** switches are both set to the **NPN** position. The curve on the oscilloscope may have to be recentered. The curve will be in the opposite direction as shown below. |
|----------------|-------------|-------------|
| **quantity**   | **setting** | **measurement** |
| vertical gain  | 0.1 V/division | 1 mA/division |
| horizontal gain | 9 divisions (with diode in circuit) | approximately 1 V/division (peak) |
| horizontal sweep source | external |

testing diodes

Set up the oscilloscope as follows:

- vertical gain: 0.1 V/division
- horizontal gain: 9 divisions (with diode in circuit)
- horizontal sweep source: external
Set up the curve tracer as follows:

**switch position** | **switch to**
---|---
scope-tracer | tracer
diodetrans | diode
AC sweep | pushbutton released
C NPN-PNP | NPN
B NPN-PNP | not in circuit
4-1/2V-EXT-9V | 9V (peak)
base-current meter | not in circuit
shunt | not in circuit
base-current control | not in circuit

Connect the diode cathode to terminal post **E** and the diode anode to terminal post **C**. Note the L-shaped pattern. To give better diode action press AC SWEEP. This shows when the diode is not conducting.

For checking 5-volt zeners, install a 3900-ohm resistor in series with the emitter load and emitter terminal post. This allows about 10 milliamperes of current flow through the zener. (For checking other types of zeners, a different load resistor must be employed.) Connect the diode cathode to the emitter terminal and the diode anode to the collector terminal post. The oscilloscope and curve analyzer are set up exactly as in the diode setup. For higher-voltage zeners, **EXT** input can be used with a Variac or variable AC voltage source.

**testing photocells**

Photocells made from cadmium sulfide or cadmium selenide working on the principle of photo conductivity can be checked with the analyzer by using the base-bias circuit. The photocell has only two leads and can be attached to **E** and **B** on the curve analyzer. As the light increases on the photocell, the circuit conductivity also increases. Using the circuit as shown, the conductivity of the photo cell can be obtained.

This circuit can also be used as a photographic light meter.

**testing D'Arsonval meters**

This circuit can measure characteristics of meters with a sensitivity of 10 microamperes to 5 milliamperes full scale. This is done by connecting the meter under test to terminal posts **E** and **B** (fig. 3). Increase the current flow with the **BASE CURRENT** control until the meter reads full scale. Note the sensitivity of the unknown meter in amperes. To determine the internal resistance, connect a decade box or a 500-ohm pot across the meter under test. When the shunt resistance decreases the full-scale reading to one-half scale, measure the resistance of the 500-ohm pot to the center arm. This should give the meter's internal resistance.

**crystal-oscillator checker**

The crystal-oscillator checker uses an N-type junction fet (RS2035) field-effect transistor, which can be obtained for about one dollar. An equivalent type could be used. The module is wired as shown. It is installed into the curve tracer across the **E** and **C** terminals. Using a 50-µF filter across the supply input to the module as shown, the dc input is about 9 volts. The circuit works very well for checking quartz crystals as low as 100 kHz to as high as 15 MHz.

Set the oscilloscope as follows:

<table>
<thead>
<tr>
<th><strong>quantity</strong></th>
<th><strong>measurement</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Vertical gain</td>
<td>1V/division</td>
</tr>
<tr>
<td>Horizontal sweep</td>
<td>1 mS/division</td>
</tr>
<tr>
<td>Horizontal mode</td>
<td>internal</td>
</tr>
</tbody>
</table>

Set all other controls to normal position.

Set the curve tracer as follows:

**switch position** | **switch to**
---|---
scope-tracer | scope
diodetrans | not in circuit
AC sweep | pushbutton released
C NPN-PNP | not in circuit
switch position switch to:
B NPN-PNP
4-1/2V-EXT-9V
not in circuit
9V (peak)

Connect the crystal to crystal terminal on the module. The module output should be connected to the

some other uses

The curve tracer/analyzer can be used for checking other devices. Presented below are the results of some tests I’ve run on junction fets, unijunction transistors, silicon-controlled rectifiers, and triacs. The setup instructions for the scope and analyzer are as in the previous examples.

gate voltage vs source current

oscilloscope:
quantity position measurement
time base 10 divisions 10 divisions
amplitude 1 V/division 100 divisions

Horizontal
1 V/division
2 divisions

Horizontal external
sweep

curve tracer:
switch position switch to:
scope-tracer tracer
diode-trans diode
AC sweep pushbutton released
C NPN-PNP NPN
4-1/2V EXT 9V 4-1/2V
B NPN-PNP NPN
base-current 5 mA
meter shunt
base control
adjust to proper gate voltage vs source current

Connect fet as shown below. Use external voltmeter to measure gate voltage vs source current.

unijunction transistors
oscilloscope:
quantity position measurement
time base 10 divisions 10 divisions
amplitude 1 V/division 100 divisions

Horizontal
1 V/division
2 divisions

Horizontal external
sweep

curve tracer:
switch position switch to:
scope-tracer tracer
diode-trans diode
AC sweep pushbutton released
C NPN-PNP NPN
4-1/2V EXT 9V 4-1/2V
B NPN-PNP NPN
base-current 5 mA
meter shunt
base control
adjust for gate and B1 voltage with external meter
Connect unijunction device to curve tracer as shown using a 0-5-volt dc meter. Measure trigger voltage between gate and B1.

**silicon-controlled rectifiers**

- Oscilloscope:
  - **Position**: 1V/division, 3V/division, external
  - **Measurement**: 10 mA/division, 9V

**curve tracer**:
- **Switch position**: scope-tracer, diode-trans, AC sweep, C NPN-PNP, B NPN-PNP, 4-1/2V EXT 9V
- **Switch to**: tracer, diode, pushbutton (AC), PNP, not in circuit, 9V

Connect scr as shown in circuit below; anode to (E) and cathode to (C). Use a 1.5-volt battery in series with a 10k-ohm variable resistor as a variable voltage source for gate and anode. With a separate voltmeter measure the gate-anode trigger voltage. Note current flow through the scr.

**triac-controlled rectifiers**

- Oscilloscope:
  - **Position**: 1V/division, 3V/division, external
  - **Measurement**: 10 mA/division, 9V

Connect as shown in circuit below using external R-C network. Measure gate voltage between emitter terminal and gate. Note ac current flow.

**final remarks**

I’ve presented the results of my work in trying to improve the lot of the home builder who likes to work with semiconductors. No doubt you’ll come up with other uses for the basic instrument, and I’d like to hear from you. If you have any suggestions or questions, please send them to me in a self-addressed, stamped envelope, and I’ll be glad to reply.

*Ham radio*
Before you make the choice of a new hand-held, ask about these important features:

1. Is the case fiberglass reinforced Lexan©?
2. Are the batteries convenient for carrying extras?
3. Is the capacity sufficient for a day's operation?
4. Is there a method for conserving battery life when high power is not required?
5. Does it fit your hand comfortably?
6. Do you have a choice of charging methods?
7. Do you have an ample choice of accessories to back up your radio?

If you can answer 'yes' to all of the above, then you've made the obvious choice.

You want a Wilson Mark IV hand-held... and accept no substitute for it!

Wilson hand-helds have been known world-wide for exceptional quality and durable performance. That's why they have been the best selling units for years.

The Mark Series of miniature sized 2-meter hand-helds continues the tradition of dependability and operation, but in an easier to use, more comfortable to carry size.

The small compact size battery pack makes it possible to carry one or more extra packs in your pocket for super extended operation time. No more worry about loose cells shorting out in your pocket, and the economical price makes the extra packs a must.

Conveniently located on top of the radio are the controls for volume, squelch, accessory speaker mike connector, 6 channel switch, BNC antenna connector and LED battery condition indicator.

MARK IV: = 1 & 4.0 watts

SPECIFICATIONS:
- Range: 144-148 MHz
- 6 Channel Operation
- LED Battery Condition Indicator
- Individual Trimmers on TX and RX Xtals
- Rugged Lexan® outer case
- Switchable Hi-Lo Power
- Current Drain: RX 15 mA
- TX - Mark IV: 900 mA Hi, 400 mA Low
- 12 KHz Ceramic Filter and 10.7 Monolithic Filter included.
- 10.7 MHz and 455 KHz IF
- Spurious and Harmonics: more than 50 dB below carrier
- BNC Antenna Connector
- .3 Microvolt Sensitivity for 20 dB Quieting
- Uses special rechargeable Ni-Cad Battery Pack
- Rubber Duck and one pair Xtals 52/52 included
- Weight: 19 oz. including batteries
- Size: 6" x 1.770" x 2.440"
- Popular accessories available: Wall Charger, Mobile Charger, Desk Charger, Leather Case, Speaker Mike, Battery Packs, and Touch Tone™ Pad.

To obtain complete specifications on the Mark IV, along with Wilson's other fine products, see your local dealer or write for our Free Amateur Buyer's Guide.

Wilson Electronics Corp.
4288 South Polaris Avenue • P. O. Box 19000 • Las Vegas, Nevada 89119
Telephone (702) 739-1931 • TELEX 684-522
the ultimate noise blanker

Conventional noise-blanker designs overlook the effectiveness of the blanking switch — here’s a new approach to the problem using fm techniques.

**Noise blankers are commonly incorporated into hf communications receivers but use less than a perfect switch and switch-control timing. This article presents a new concept for a noiseless i-f switch that allows a very effective impulse noise blanker to be constructed. The fundamental concept of noise blankers is also reviewed.**

**Conventional noise-blanker design**

All noise blankers operate on the principle that a separate noise receiver listens in a no-signal portion of the spectrum (typically 30-35 MHz) especially for the purpose of receiving noise pulses. The detected pulses are processed and applied to a blanking switch in the communications receiver i-f strip to momentarily interrupt the signal path during the noise pulse period.

**Design considerations**

Typically, the noise pulse has a duration of only a few microseconds. If allowed to pass through the communications receiver, several factors cause the pulse to be stretched, including narrow filters and saturation. If the blanker operates properly, the noise pulse is removed with negligible effect on the communications signal.

The major limitation in previous designs has been the effectiveness of the blanking switch itself. Most have a limited on/off ratio and introduce switch-transient noise as well. A typical blanking system block diagram is shown in fig. 1.

For proper operation, timing is an important factor. The blanking switch should open the signal path for the pulse period only. If the switch is open too long, unnecessary distortion of the signal occurs. If the switch is not open during the complete pulse period, a portion of the noise pulse will leak through.

By Ted Hart, W5QJR, Harris Corporation, P.O. Box 37, Melbourne, Florida 32901
This aspect does not receive proper attention in typical designs.

The design of the noise receiver must include adequate bandwidth to ensure proper processing of narrow pulses to enable accurate control of the blanking switch. Also, the time delay through the noise receiver must be sufficiently shorter than the delay through the communications receiver front end to enable pulse shaping and control before application of the control signal to the blanking switch. Delay through the receiver is a function of the i-f bandwidth. In practice, it has been found that the use of standard 10.7 MHz fm i-f transformers in the noise receiver is the best choice. Adequate delay in the communications receiver (ahead of the switch) is normally realized in the first i-f section.

Optimum design of a communications receiver suggests a multipole narrow bandwidth i-f filter immediately following the first mixer. Conversely, a multipole filter has significant time delay and stretches the noise pulse width ahead of the blanking switch. Although this is undesirable from a purely technical viewpoint, the effect is negligible and can be ignored.

If the blanking is located in the receiver after a substantial amount of gain, saturation of the i-f amplifier may result (especially under weak-signal conditions.

---

**fig. 3.** Blanking-switch isolation can be achieved by misaligning the conversion frequency during the blanking period. The amount of frequency shift can be determined by comparing the shape factors of the first and second i-f filters.

---

**fig. 4.** A practical noise-receiver schematic using the technique described for taming switch action.

---

NOTES, UNLESS OTHERWISE SPECIFIED
1. CAPS ARE 0.001µF
2. RESISTORS ARE 4.7k
3. TRANSISTORS ARE 2N3053
4. DIODES ARE 1N4148
5. CAPACITANCE IS IN µF
6. ALL RESISTORS ARE 1/4W
7. FREQUENCY INDICATED BY EACH INDUCER IS ALIGNMENT VALUE
8. R80-R86 ARE TEST POINTS TPI-177

---

**fig. 4.** A practical noise-receiver schematic using the technique described for taming switch action.
Looking for a mobile antenna that goes on easily, looks super... and performs like gangbusters! Then you should take a squint at the Larsen Küilrod Antenna. It's the cool one.

Yes, the fact is that Larsen Küilrod Mobile Antennas are built differently for a communications difference you can HEAR. You can easily prove it to yourself with this simple touch test:

Apply 100 watts of power for a full minute or so to a competitive brand Antenna A, B or C... any brand with the usual stainless steel whip. Then turn off the power and feel the antenna... carefully. It'll likely be hot, even hot enough to raise a blister.

Now put a Larsen Küilrod to the same test. Surprise! That's right... no heat! The power has gone into communicating—not heating. The Larsen isn't called the Küilrod for nothing.

Larsen Antennas fit all styles of mobile mounts and cover Amateur frequencies from 10 meters through the 440 MHz band.

Write for antenna catalog and name of Larsen dealer nearest you.

Larsen Antennas
1161 1 N.E. 50th Ave. P.O. Box 1686
Vancouver, WA 98663
Phone: 206/573-2722

in Canada write to:
Unit 101
283 E. 11th Avenue
Vancouver, B.C. V5T 2C4
Phone: 604/872-8517

*KGrod is a Registered trademark of Larsen Electronics, Inc.

with no agc). Slow recovery is normally associated with saturation, hence extreme amounts of effective pulse stretching may occur. However, typical i-f blanking switches must operate at relatively high signal levels, since the noise introduced by the switch is proportional to the signal level at which they operate. If the blanking switch is located immediately after the first i-f filter, signal levels will typically be in the microvolt region.

**a new switch**

Switching transients can be eliminated by using a frequency modulation technique. With reference to fig. 2, note that when a command signal from the noise receiver is applied to a frequency-shift network associated with the second local oscillator in a dual-conversion communications receiver, the mixer output will be at a frequency other than that required to transfer the signal from the first i-f to the second i-f. In other words, if the time of the command signal occurs at exactly the time the noise pulse propagates through the first i-f and is applied to the mixer, the noise pulse energy will leave the mixer at a frequency other than that of the second i-f.

Since there is no amplitude noise (switching-transient noise) associated with the frequency shift, no switching noise due to the blanking action will occur when the signal path is momentarily interrupted.

The amount of required frequency shift may be determined by comparing the shape of the first and second i-f filters (see fig. 3) and misaligning the conversion frequency during the blanking period to achieve the desired switch isolation. Typically, a few kHz will be adequate. Normally, the second local oscillator can be frequency modulated by tens of kHz with no adverse effects.

In practice, the addition of a small capacitor and switching diode to a receiver second local oscillator implements the desired switch. If the second local oscillator is crystal controlled, it must be replaced with an oscillator that can be frequency modulated.

**results**

Performance of the fm switch blanking system is astonishing, compared with conventional systems. An hf mobile receiver operating at a busy intersection had no noticeable ignition noise interference with the switch operating. With the switch disabled, communications was impossible.

A complete schematic of a practical noise receiver is included in fig. 4. For a particular application, the pulse delay network may require component value changes depending on the delay in the first i-f filter of the communications receiver.
HEATHKIT® Amateur Radio Gear... with the quality that measures up!

Hand-Held 2-Meter Transceiver with a full 2 watts power
VF-2031

Hand-Held 2-Meter Transceiver with banded. All Solid-State CW/SSB power
SB-104A

Heathkit Amateur Radio equipment has long been the favorite of Hams the world over because it provides the performance, specifications, dependability and long-term reliability that Hams are looking for. It should. It's designed by Hams, for Hams. For more than 25 years, Heath has been making fine Amateur Radio equipment. It's no surprise that Hams have come to expect Heath's experience and knowledge to translate into some of the finest equipment around.

For instance, our new VF-2031 2-meter Transceiver. It's portable, practical and it gets you on two with a clean, clear signal that really gets out! It has a minimum 2 watts out, separate speaker and microphone for outstanding audio quality, eight crystal-controlled channels and 600 kHz offset for a total of 8 receive and 24 transmit channels for real 2-meter versatility. A complete list of options includes auto-patch and tone encoders, external mike and holster-style leather carrying case. And at just $189.95 in kit form, we don't think you'll find a better all-around hand-held!

Then there's our world-famous SB-104A, a superior SSB/CW transceiver, the "heart" of any first-class station. Totally broadband, all solid-state, with TRUE digital readout - it's THE transceiver for the serious Amateur. And now, with its completely re-engineered front-end receiver board and transmitter IF, which are supplied factory assembled and tested, you can get on the air faster and better! For just $699.95, and a few evenings of kitbuilding, you'll have a rig that compares with equipment costing hundreds of dollars more! And, of course, there's a full line of accessories to add convenience and versatility to your SB-104A station.

There's more for the Ham at Heath.

FREE HEATHKIT CATALOG
Send for yours today!

Read about our entire line of Amateur Radio Equipment including linears, 2-meter amps, antennas, mikes, wattmeters and more! If coupon is missing, write Heath Company, Dept. 122-500, Benton Harbor, MI 49022.

*Prices are mail order net F.O.B. Benton Harbor, Michigan. Prices and specifications are subject to change without notice.
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 1.5" • $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 West Taft Avenue, Orange, CA 92667
(800) 854-0547. California residents use: (714) 998-3021
power-line noise — the cause and cure

Discussion of the steps necessary to locate power-line noise, starting with in-house noise sources and ending with utility-pole-generated noise

Power line noise can be one of the most exasperating forms of irritation experienced by amateurs living in or near metropolitan areas. This problem, which can drive active operators beyond the point of sanity in record time, is characterized by a long-term arcing-type sound similar to that produced by loose antenna or high-voltage connections. Usually, this noise will be apparent (in varying amounts) on the 80- through 10-meter amateur bands. Many cases of line noise arcing or radiation, however, expand this field of interference to include the frequencies associated with television and the a-m broadcast radio. The magnitude of power-line noise interference varies with each case. Sometimes this "hash noise" can be tolerated, but occasionally it approaches an S-9 level and must be eliminated. Since many amateurs find themselves in an awkward position during such times, this article will present an informal guideline which may be used to help eliminate this electrical plague.

clean house first

Many noise interference situations prove to be created by sources other than commercial power lines. Thus, your own house should be in order. Check all antenna connections and transmission lines, being highly critical of any metallic objects that could come in contact with guy wires or antennas. Remember, too, that rain may cause items like wood or cloth to act as conductors. Next, check the plugs and line cords on equipment in your house, being particularly suspicious of appliances used in the kitchen. For example, bad electrical igniters, as found in many gas ranges, can create a surprising amount of interference on the ham bands. While this type in-

By Dave Ingram, K4TWJ, Eastwood Village 1201 South, Route 11, Box 499, Birmingham, Alabama 35210
terference can be reduced by installing a bypass on each side of the ac line to ground, that doesn’t eliminate the problem. The defective element should be replaced. Likewise, water heater thermostats, electric blankets, and heater tapes (used for wrapping outdoor water lines during winter months) should also be checked by temporarily disconnecting their ac power. Assuming the noise interference still exists, you are now ready for the Sherlock Holmes phase of locating this electrical villain.

locating the villain

If you have a directional antenna, it can be used to determine the approximate direction of your interference. An accurate “fix” on this noise is usually obtained by searching for a null, rather than a peak. Once the approximate direction of the noise has been determined, try mobilizing in that area while listening for interference peaks on a portable rig. A two-meter sideband transceiver is particularly convenient for such ventures. Fm handi-talkies should not be used for these tests, since they should be unaffected by a-m (line noise) variations. (While a portable a-m radio could be used for location techniques, its susceptibility to normal radiation from every power line and pole makes its indications very unreliable.) When using this method, you should travel a reasonable distance beyond the point of maximum noise pickup to ensure that you’ve definitely located the source. While not common, it’s quite possible that a remotely generated noise may be propagated along the power lines with a peak occurring right at your door. Using the S meter on your rig for indication, try walking the area of the noise source to pinpoint the interference to a specific pole, transformer, meter box, or home.

Next, study the line noise for several days, and try relating it to various weather and time situations. Noise that is more apparent on warm days than cold days, and disappears during periods of rain, is often caused by loose line clamps or cracked insulators on power poles. Noise that is more apparent during heavy-load evening hours is often caused by leaky transformers or defective heating devices. Thoroughly investigate the area around the apparent source of noise during the day and night, looking for frayed wires swinging in the breeze, small animals that may have become trapped between high tension lines, or a visible arcing near transformers or pole-top mounted insulators. However, don’t climb power poles to shake wires, or viciously swing grounding lines to power poles. You could be electrocuted if a loose or corroded connection suddenly broke.

Assuming you have now determined the line-noise producing area and confined it to, say, three or four poles, you’re almost ready to notify the local power company. Before doing so, however, reinvestigate the whole area and make notes on which poles have transformers and fuses. These fuses are approximately 51 cm (one foot) long, and swing into mounts near the top of the pole. The local power company can disconnect these fuses ("drop lines") to locate the discrete points and elements creating interference.

call for help

Your first call to the power company will probably be stopped by the front desk, so, explain your situation, describe the noise-producing area and your detection methods. Leave your name and telephone number so their engineer can contact you before visiting the trouble area. This prescheduled meeting is particularly advantageous for tracking down periodic line-noise problems. There’s nothing to be gained by looking for arcing insulators, for example, during or after a mild rain. When the power company’s task force arrives, repeat the results of your investigation and monitor, with your mobile or portable gear, as each line is broken or checked. The power company will usually proceed with matters beyond this point, repairing whatever elements are found to be creating interference. Be sure to note the name of the power company.
company employees repairing the line noise, so you can sidestep the front desk should future problems arise.

Many times, amateurs become "trapped" with front-desk executives (who've never heard of Amateur Radio, and know even less about line noise) and can't get line-noise problems resolved. Don't despair. Somewhere in their organization is a communications department — and often one or two radio amateurs. Not only are these people usually sympathetic and understanding, they usually handle special problems like line-noise interference. This group usually has its own array of elaborate noise-locating gear. Often, one or two of these men work exclusively on line-noise problems, because situations that create line noise often also create problems that lead to power outages. Yes, you may actually be helping your community when reporting line-noise interference to the local power company. Naturally, television reception will improve when "white dots in the picture" disappear, and a-m radio reception is better without its "frying sound." But you also illustrate that neighborhood amateurs can help eliminate, rather than create, interference.

Many noise interference problems, when located, prove to be created by customer-use devices like doorbell transformers and thermostats. Fortunately, most power companies are quite helpful and understanding in locating these troubles. Their step-by-step method for locating these noise sources usually involves sequentially "dropping" various lines and evaluating the effect on the noise. As previously mentioned, a battery-powered, high-frequency (or 2-meter) rig is highly beneficial during these tests.

The danger of experimentation with high-tension power lines by unauthorized personnel (that's you!) cannot be overemphasized. Today's amateurs have learned to respect high voltage in the shack; the number one killer is now outdoor power lines and large antennas. Instant retirement results when these two items are placed together. Don't take chances. Stay clear of problem areas during tests, and don't stand where lines could accidentally break and fall on you.

Here is a synopsis of the more common power-line noises and their causes:

1. Constant noise during the heat of the day, intermittent noise at night, no noise during rain: Cracked insulators or loose clamps on pole. This noise is predominant during summer months.
2. Constant noise during rain, intermittent noise during light mist: Small object or animal caught between high voltage lines.
3. Constant noise in a specific direction: Power transformers or home-user devices.

checklist for line-noise corrections

1. Check your own home area by disconnecting the main circuit breaker while monitoring noise on a battery-powered rig. If noise stops, reconnect the main breaker and switch off power to each area of your home until the noise again disappears. Then pinpoint source.
2. Use directional antennas and portable/mobile gear to isolate the noise-producing area.
3. Relate noise interference to time and weather conditions.
4. Call the power company and arrange to be at home when they disconnect service to various areas.
5. As confirmation of power-line (as opposed to atmospheric) noise, the power company may elect to temporarily cut all power to an area. Monitor the results on your mobile gear.
6. Be patient and persistent. A quiet band is worth the wait and effort.

ham radio
Braced against the elements as only Swan can do it! Even hurricane winds to 100 MPH can’t lower the boom on your operations.

The Swan TB3HA Tri-Bander:
a really heavy-duty 20-15-10 meter beam. 3 solid elements, all working on all bands. With a VSWR of 1.5:1 or better at resonance, plus a full 2000-watt PEP rating, our TB3HA is built to work up a storm!

Strongest fittings available: this you’ve got to see. Exclusive cast-aluminum braces grasp tubes at every joint, spreading stress over an 11¾” span. Compared to slipshod U-bolt plates—no contest!

Reinforced by super specs, TB3HA’s one tough competitor:

- 8dBi average forward gain.
- 20-22 dB front to back ratio.
- 16” turning radius.
- Longest element: 28’2”.
- 18’ boom, optimum spacing.
- Direct 52 Ohm coaxial feed.
- Wind load @ 80 mph: 110 lbs.
- 44 lbs. net weight.
- Swan Credit Card accepted.

Available at your local Swan dealer, you can start operating tri-band from a position of real strength—because TB3HA is Swan-engineered to work under pressure!

Write for free brochures on Swan’s Vertical and Mobile Antennas.

Please rush full information on Swan’s Heavy Duty Tri-Band Beam Antennas:

☐ 3-element TB3HA
☐ 4-element TB4HA

Name:
Address:
City:
State: Zip:

Swan ELECTRONICS
305 Airport Road, Oceanside, CA 92054
Phone: (714) 757-7525
Swan’s continuing commitment to product improvement may affect specifications and prices without notice.
Kenwood's TS-820S has everything the Amateur Operator could want in a quality rig.

Time proven over thousands of hours of operating time, the Kenwood TS-820S has become the preferred rig for those individuals interested in high reliability. And, the TS-820S has every feature any Amateur could want for operating enjoyment, on any band, from 160 through all of 10 meters...plus an RF speech processor in the transmitter, IF shift and sharp filters in the receiver. All combine to give optimum performance under all conditions.

You can always tell who's running a TS-820S. Its superb quality stands out from all the other rigs on the band... and when the QRM gets heavy the TS-820S's adjustable RF speech processor, utilizing a 455-kHz circuit to provide quick-time-constant compression, will get the message through. RF negative feedback is applied from the final to the driver to improve linearity, and third-order products are at least -35 dB. Harmonic spurious emissions are less than -40 dB and other spurs are less than -60 dB.

RF input power is 200 W PEP on SSB, 160 W DC on CW, and 100 W DC on FSK. Receiver sensitivity is better than 0.25 \( \mu \)V for 10 dB S/N.

The TS-820S from Kenwood! See it today at your nearest Authorized Kenwood Dealer.
Covers the range.

Kenwood's TS-700SP...
A time proven rig that now covers the new repeater subband (144.5 to 145.5 MHz).

TS-700SP features all of the fine attributes of the TS-700S: A digital frequency display, receiver preamp, VOX, semi-break-in, and CW sidetone. Of course, it's all mode, 144-148 MHz, VFO controlled... and Kenwood quality throughout.

FEATURES:
- 4 MHz band coverage (144 to 148 MHz).
- Automatic repeater offset capability on all FCC authorized repeater subbands, including 144.5-145.5 MHz.
- Simply dial receive frequency and radio does the rest... simplex, repeater, or reverse. Same features on any of 11 crystal positions.
- Transmit/receive capability on 44 channels with 11 crystals.
- Operates all modes: SSB (upper and lower), FM, AM and CW.
- 3 watts on AM.
- Digital readout with "Kenwood Blue" digits.
- Receiver preamp.
- Built-in VOX.
- Semi-break-in on CW.
- CW sidetone.
- All solid-state.
- AC and DC capability.
- 10 watts RF output on SSB, FM, CW.
- 1 watt FM low-power switch.
- 0.25 µV for 10 dB (5 + N) N SSB/CW sensitivity.
- 0.4 µV for 20 dB quieting FM sensitivity.

Get all the details and see the TS-700SP now at your nearest Authorized Kenwood Dealer!

KENWOOD
...pioneers in amateur radio
TRIO-KENWOOD COMMUNICATIONS INC.
1111 WEST WALNUT/COMPTON, CA 90220
gate structure and logic families

The first part of this series explained the basic gate as a component. This part will examine the internal gate structure of TTL and CMOS, similarities and differences, as well as loading. A typical TTL two-input NAND gate is shown in fig. 1.

Multiple emitters may seem strange, but they are easily made in integrated circuits. They are the key to NAND-gate operation. When any emitter of Q1 is pulled down to less than +0.4 volts, its emitter-base junction is forward biased via R1. Collector-emitter junction voltage is then low enough to cut off Q2 and Q4. Output voltage goes high, since Q3 is conducting by forward bias from R2. R3 limits output current.

Q1 is nearly cut off when all emitters are at +2.4 volts or higher. Full cutoff is not achieved, since the internal structure is arranged to forward bias the base-collector junction; this allows Q2 to conduct by the forward bias through R1. Q3 cuts off and Q4 will conduct because of the Darlington connection to Q2. The collector-emitter junction of Q4 will then saturate at less than 0.4 volts.

TTL outputs will sink more current at low output levels (electron flow from ground to output) than they can source at high outputs (flow from output to supply). This fits the input requirements for devices connected to the output. Input current at high levels is one-fortieth of the low level current. Output current biasing is set for this 40:1 ratio and fan-out is usually set for driving ten inputs with one output.

fig. 1. Simplified schematic diagram of the two-input, TTL NAND gate. In the open-collector version, R2, R3, Q3, and the diode are omitted, leaving the collector of Q4 open.

By Leonard H. Anderson, 10048 Lanark Street, Sun Valley, California 91352

Fig. 2 shows the equivalent gate function in a CMOS device. The insulated-gate FETs reduce input current to nanoamperes, primarily from leakage. Gate resistors are seldom internally used, allowing all inputs to present a high input impedance.

The N- and P-type FET arrangement in a CMOS gate will determine function. If one input is low, the appropriate parallel-connected P-type (Q5 or Q6) will conduct and make the output high. The low input overrides any high input by cutting off one of the series-connected N-types (Q7 or Q8). All inputs must be high for the series path to ground; the NAND RULE is satisfied.

Output sink and source current capability is nearly the same at either level; it varies with supply voltage. A-Series CMOS will work at 3 to 15 volt supplies; B-Series goes to 18 volts. The output FETs do not fully saturate, so exact voltage level is load dependent. Data sheets must be consulted for exact values.

Rearrangement of N- and P-types allows a greater range of functions than with TTL. Inverting the series and parallel connections will form a NOR. Other possibilities exist, and CMOS devices are available with a greater range of functions.

important differences

The high input impedance of the CMOS implies the
capability of driving hundreds of inputs from one input. This would be true if it were not for package and circuit capacitance. Capacitance and output FET characteristics limit loading. Capacitance also limits TTL, but to a lesser extent. Input current at dc limits TTL.

Input and output level symmetry allows CMOS to be biased for linear, small-signal operation. This is impossible with TTL. A Schmitt trigger must be used with TTL for inputs having slow rise and fall times.

Input threshold voltages are fixed in TTL. This is primarily due to saturated bipolar transistor operation from a fixed supply. CMOS level thresholds are approximately one quarter of supply maximum for a low and three quarters of supply minimum for a high.

CMOS devices are more susceptible to noise pickup due to their high input impedance. Circuit layouts must be carefully done. TTL is more tolerant to noise, but high input levels are still affected; this can be seen from typical TTL characteristics given in table 1.

Total circuit current of CMOS is less than TTL. CMOS current demand is influenced by switching speed, i.e., charging and discharge of the circuit capacitance. Supply current increases with increasing logic switching frequency. It is also true for TTL but to a lesser extent. TTL input current masks most of that effect.

Bipolar transistors in TTL allow faster switching speeds. FETs are becoming faster as discrete devices, but CMOS designs retain low power and slower transistors. CMOS is good for portable battery-powered equipment, but note that most such equipment is slow speed.

The NAND gate output of fig. 1 is called a totem-pole, from the appearance of Q3 on top of Q4. Most outputs are of the totem-pole variety, but a few are open-collector. Since, in normal operation, Q3 conducts little current, this transistor, R2, R3, and the diode can be deleted, using an external pull-up resistor to the supply line for source current. This is the open-collector version.

**open-collector applications**

TTL chip transistors have relatively low breakdown voltages. Redesigning just the output transistor into an open-collector chip (Q4 in fig. 1) allows driving high-voltage devices such as relays and neon lamps.

Another function is the wired-OR depicted in fig. 3. This takes advantage of the NAND's active-low input. Several open-collector outputs can be wired to a single input, giving an equivalent OR function. The OR symbol with connecting dot is purely symbolic. No specific open-collector symbol exists.

Why use a wired-OR? One reason is economy, another the number of available packages per board. If you don't have room for a NAND equivalent OR gate, but do have an input, the wired-OR will do the job. Open-collector outputs are slightly slower than totem-poles, so be wary in high-speed circuits.

**three-state wired-OR**

A modification of the totem pole output was

table 1. Typical TTL gate characteristics.

<table>
<thead>
<tr>
<th></th>
<th>medium speed</th>
<th>conventional high speed (H)</th>
<th>conventional low speed (L)</th>
<th>schottky low (LS)</th>
<th>schottky medium (S)</th>
</tr>
</thead>
<tbody>
<tr>
<td>maximum output source current in microamperes (I_{OH}) when output is high*</td>
<td>400</td>
<td>500</td>
<td>200</td>
<td>400</td>
<td>1000</td>
</tr>
<tr>
<td>maximum input sink current in milliamperes (I_{OL}) when output is low*</td>
<td>16</td>
<td>20</td>
<td>3.6</td>
<td>8</td>
<td>20</td>
</tr>
<tr>
<td>maximum t_{PLH}, nanoseconds</td>
<td>22</td>
<td>10</td>
<td>60</td>
<td>15</td>
<td>4.5</td>
</tr>
<tr>
<td>maximum t_{PHL}, nanoseconds</td>
<td>15</td>
<td>10</td>
<td>60</td>
<td>15</td>
<td>5</td>
</tr>
<tr>
<td>maximum input source current in microamperes when input high*</td>
<td>40</td>
<td>50</td>
<td>10</td>
<td>20</td>
<td>50</td>
</tr>
<tr>
<td>maximum input sink current in milliamperes when input low*</td>
<td>1.6</td>
<td>2</td>
<td>0.18</td>
<td>0.4</td>
<td>2</td>
</tr>
<tr>
<td>nominal input pull-up resistor, kilohms</td>
<td>3.9</td>
<td>2.7</td>
<td>39</td>
<td>18</td>
<td>2.7</td>
</tr>
</tbody>
</table>

*High level output voltage minimum is 2.4 for conventional TTL, 2.7 for Schottky (V_{OH}). Low level output voltage maximum (V_{OL}) is 0.4 for conventional, 0.5 for Schottky. High-level minimums and low-level maximums apply to inputs also.

*Actual high-level circuit voltage may be any value between minimum and the supply voltage, depending on output loading.
designed by National Semiconductor, called TRI-STATE by them and three-state by others. The design has the good points of both totem pole speed and the ability to wire-OR.

A control line is added to enable the output or outputs. An enabled output behaves like the totem pole. A disabled output appears as a high impedance. Three-state outputs can be wired in parallel and are fast, but need the extra control. Such outputs are ideal for computer bus lines. Bus lines are parallel data lines carrying information in either direction.

Both three-state and open-collector output devices require some precaution during circuit design. Data books should be consulted for the fine details.*

**unused inputs**

All inputs must be connected somewhere. An unused TTL input will automatically assume a high state if left open (leakage in Q1 of fig. 1). It is poor practice to tie it high by an open connection; impedance is higher and noise might sneak in. Tie the unused input to 

---

fig. 3. Symbolism used to denote a wired-OR configuration using open-collector NAND gates.

---

or ground, depending on the desired function. Gate inputs can be paralleled. A parallel connection increases logic-1 current, but logic-0 current is the same.

Unconnected CMOS inputs can assume either state due to the inherently high impedance, leakage, and construction. They must be tied to either 

---

or ground. Removable circuit boards should have potentially open inputs connected to ground through a 100-270k resistor. This trick will protect the input from possible static surges when disconnected.

**CMOS handling precautions**

Unmounted CMOS devices may be damaged by static electricity; an unfelt static charge is enough. Unused devices should be kept in anti-static containers or pushed into conductive plastic foam. Such foam is usually black, somewhat hard, and will read a few kilohms on an ohmmeter.

*The Texas Instruments TTL Data Book is available from Ham Radio’s Communications Bookstore, Greenville, New Hampshire 03048, for $4.95 plus $1.00 postage.

---

Everything on the workbench should be grounded, including an aluminum work-area plate. Use a grounded-tip, three-wire soldering iron. Strap together and ground all powered test equipment; this should be done anyway, since it is possible to get a lethal shock from some test gear.

Avoid all plastic-fiber clothing if possible. Ground yourself through a one megohm resistor (two megs with 220-volt mains) and flimsy wire. The resistor is a precaution against lethal shock current. The flimsy wire should break if you slip. All this may seem overcautious, but is standard industrial practice. Ask yourself how many expensive CMOS devices you can afford to lose from a static zap.

**TTL variations**

There are five different versions of TTL, identifiable by one or two letters after the 54 or 74. No letter means the original and is called medium speed. An L identifies low power and low speed. An H stands for high speed and high power. However, these two versions are being phased out of new designs in favor of Schottky versions.

LS, or low-power Schottky, is as fast as medium speed, with only slightly more power demand than L versions. S is as fast or faster than H and takes no more power than medium speed. Differences are internal and you need only consult data sheets for application. Schottky inputs are to bases of grounded-emitter input stages. This and added clamping diodes make them different from ordinary TTLs.

Schottky versions are recommended for new designs. A lot of standard TTLs are available at low prices and should work just well, except in very fast circuits.

**PMOS and NMOS**

This family group started before CMOS. PMOS was the first, using P-type MOS (usually junction FETs). PMOS devices need two or three supply voltages, but have inputs and outputs compatible with CMOS and most TTL devices. They find use as microprocessor memory chips; CMOS handling precautions should be observed.

NMOS uses N-type MOS and most devices use only 5-volt supplies. Again, the inputs and outputs are compatible with both CMOS and TTL. The Motorola 6800 microprocessor devices are almost entirely NMOS. NMOS is less sensitive to static shock, but it won’t hurt to be cautious.

The next article in this series will go into the importance of propagation delay and discuss flip-flops.
Introducing the first price breakthrough in amateur radio equipment in a decade!

$388
ATLAS 110 TRANSCEIVER

- Self-contained power supply and speaker
- All solid state
- Covers 10-80 meters
- 20 watt input power (250 watt model available)
- SSB and semi-break-in CW with sidetone

True, it doesn't have all the bells and whistles, but it does two things extremely well: It does an excellent job of receiving. It does an excellent job of transmitting. On both SSB and CW.

Compare the performance of the Atlas 110 with any other equipment on the market, and see for yourself: it is truly a high performance transceiver in every respect.

And it costs only $388.

Also available is the Model 110 Special, which includes RIT, CW Filter, and RF Gain Control.

Both the 110 Standard and the 110 Special transceivers are available with either 20 watt or 250 watt power input rating. (250 watt model requires a separate AC power supply.)

The receive portion of the 110 transceiver is also available separately, as the Atlas RX-110 receiver. The TX-110 transmit module may be added later.

20 W MODEL 110 STANDARD TRANSCEIVER . . . $388
20 W MODEL 110 SPECIAL* TRANSCEIVER . . . $428
250 W MODEL 110 STANDARD TRANSCEIVER . . . $478
250 W MODEL 110 SPECIAL* TRANSCEIVER . . . $518
PS-110H AC POWER SUPPLY . . . . . . . . . . . . . $ 89
(required with 250 watt transceiver)

*Includes RIT, CW filter, RF Gain Control.

For complete details see your Atlas dealer or drop us a card and we'll mail you a brochure with dealer list.

ATLAS RADIO INC.
417 Via Del Monte, Oceanside, CA 92054
Phone (714) 433-1983
combination field strength meter and volt-ohmmeter

Whether you want a weekend project or would like to get your club involved, here's a project that can be used to teach theory, construction practice, and troubleshooting while providing a basic piece of test equipment. The FSVOM is a combination field strength meter and volt-ohmmeter. It evolved as part of a training program for prospective amateurs. The objective was to make learning fun by providing a balance of theory and practice. My hope was that the finished product would provide a degree of confidence and encourage home construction, rather than being something that would end up on the shelf, like the old "two-transistor super" often used as a first project. In this respect, the FSVOM has been a success.

I don't think anyone need have any qualms about building this unit; there are no exotic or hard-to-find parts. Calibration is minimal. If you don't have facilities for etching the printed circuit board, an etched and drilled board (see parts list) is available. It's an easy weekend project for the experienced builder, and an excellent learning experience for the neophyte.

the FSVOM

The unit is a basic VOM, with the added feature of a field strength meter. It has a sensitivity of 20k ohms per volt, so that most readings will agree with standard-notation schematics. Circuit loading is minimal. The controls and meter scales are designed to minimize operator error. Only one voltage/current scale and one resistance scale are on the meter face, and only one set of jacks is used, so there's very little chance of error. I find the FSVOM much easier to use than many conventional units with their many scales and ranges.

The FSVOM contains four functions: field strength, resistance, current, and voltage. A multiplier (range) switch provides four ranges, X1, X10, X100, and X1k, for each function with the exception of the field strength function, which has an independent sensitivity control. The multiplier scheme allows the use of a single meter scale. The reading is then multiplied by the factor set into the range switch. A separate meter scale is used for the resistance function, which is nonlinear. Dc voltages are read at full-scale ranges of 0.5, 5, 50, and 500 volts. Dc current is read at full-scale ranges of 0.5, 5, 50, and 500 milliamperes. Resistance center-scale readings of 18, 180, 1800,

By Ken Powell, WB6AFT, 6949 Lenwood Way, San Jose, California 95120

Front panel showing labels and parts layout.
and 18,000 ohms are available. Field strength is read on a relative scale of 0-50. The FSVOM is powered by a 1.5-volt cell and is fully portable.

circuit description

The FSVOM schematic looks a bit complex because of the switching functions; but when broken down into the four separate functions, as depicted in fig. 1, each is quite simple and each is an exercise in Ohm's law. The fundamental component is the meter movement, and each function is the application of 50 μA to the meter through series, parallel, or combinations of resistance values. You can readily see why this would make a good training project.

Fig. 1A depicts the basic voltage-measuring function. In this configuration we have the meter and voltage-calibration resistor in series to form a total circuit resistance of 10k ohms. Applying 0.5 volts across this series circuit yields a current of 50 μA and full-scale deflection of the meter. Smaller voltages will, of course, yield lower readings because of the reduced current flow in the series circuit. With the range switch in the X10 position, additional resistors will be added to the series circuit to form a total resistance of 100k ohms.

The application of 5 volts across the 100k series circuit will again yield a current of 50 μA through the meter movement, causing full-scale deflection. This process is repeated again for the X100 and X1k ranges, each time increasing the series resistance of the meter circuit by a factor of ten and increasing the voltage required for full-scale meter deflection by a factor of ten. This very simple circuit forms the voltage measuring portion of the FSVOM.

Fig. 1B shows the basic current-measuring circuit. In this function we have the meter movement and current-calibration resistor in series to form a total circuit resistance of 5k ohms. In contrast to the voltage-measuring circuit, where we used series resistors to achieve the desired ranges, we now switch resistors in parallel with the metering circuit to change ranges. The meter movement and calibration resistor form a 5k-ohm circuit and would require 0.25 volt applied across this circuit for a full-scale meter deflection. In effect, we're using this 0.25-volt, full-scale voltmeter to read the voltage drop across each shunt resistor as current from the circuit under test passes through the shunt resistor selected by the range switch.

In the voltage-measuring function, we increased the resistance values in proportion to the voltage being measured. In the current-measuring function, we decrease the resistance values as we select high ranges. Once again, our objective is 50 μA full-scale on the meter. The same scale and multiplier factors are used in the current-measuring function as in the voltage function.

Fig. 1C depicts the basic ohmmeter circuit. As with the previous circuits it's a matter of controlling the amount of current through the meter movement, but in this function things get a bit turned around.
Fig. 1D is the basic circuit of the field-strength-meter function. In this function the positive input jack is the antenna input, and the rf voltage picked up by the antenna is rectified by the germanium diode. The output is applied to the meter movement. A sensitivity control shunts the meter to allow adjustment over a wide range of field strengths. Since the field-strength function is a relative reading, no special scale is used.

The overall schematic is shown in fig. 2. It's a composite of the four individual function diagrams shown in fig. 1. The only components added are the two silicon diodes across the meter to prevent damage from overload. After looking over the individual diagrams, it's easy to understand the composite.

### Table 1. Parts list for the FSVOM.

<table>
<thead>
<tr>
<th>Part</th>
<th>Quantity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>meter</td>
<td>90 μA</td>
<td>RS-22-051</td>
</tr>
<tr>
<td>switch S1</td>
<td>3 pole</td>
<td>4 position, Centralab PA-2007</td>
</tr>
<tr>
<td>switch S2</td>
<td>3 pole</td>
<td>4 position shorting, Centralab PA-2006</td>
</tr>
<tr>
<td>control, FS Sens</td>
<td></td>
<td>100k linear taper, RS-271-092</td>
</tr>
<tr>
<td>control, Ohms Zero</td>
<td></td>
<td>50k linear taper, RS-271-1716</td>
</tr>
<tr>
<td>trimmer, I Cal</td>
<td>5k</td>
<td>RS-271-217</td>
</tr>
<tr>
<td>trimmers, R Cal &amp; E Cal</td>
<td>10k</td>
<td>RS-271-218</td>
</tr>
<tr>
<td>jacks, input</td>
<td></td>
<td>Nylon, RS-274-662</td>
</tr>
<tr>
<td>holder, battery</td>
<td>1.5V AA</td>
<td>Cell, RS-270-1432</td>
</tr>
<tr>
<td>rf choke</td>
<td>2.5 mH</td>
<td>Miller 6302</td>
</tr>
<tr>
<td>case</td>
<td>178 x 152 x 76 mm (7 x 6 x 3 in.)</td>
<td>Mod-U-Box 3-7-6</td>
</tr>
<tr>
<td>resistors</td>
<td>½ W</td>
<td>5%</td>
</tr>
<tr>
<td>PC board, etched &amp; drilled</td>
<td></td>
<td>J. Oswald, 1436 Gerhardt Ave., San Jose, California 95125. 84.00 prepaid. (5 or more at 83.00). Residents add sales tax.</td>
</tr>
<tr>
<td>RCA resistors and cases</td>
<td></td>
<td>available from Quement Electronics, 1000 S. Bascom Ave., San Jose, California 95100.</td>
</tr>
</tbody>
</table>

This should be a boon if trouble with the unit is ever encountered.

### Construction

The first step is to drill or punch the holes in the case, using care not to mar the finish on the case (see fig. 3). Next, apply all the labeling to the case using Datak Letraset #K61 dry-transfer lettering. After labeling, apply two light coats of clear finish such as Datak or Krylon to protect the lettering.

While the case is drying remove the plastic front cover from the meter movement and carefully remove the meter face, which is secured by two Phillips screws. Using the periods from the K61 Letraset, change the meter scale numbers 10 through 50 to read .10 through .50, as shown in fig. 4. Now, using the red lines and numerals from Datak Letraset K19, add the resistance scale to the meter face. This two-
fig. 5. Foil side of the FSVOM PC board.

fig. 6. Component mounting.
color scheme will make the resistance scale easily discernible. Apply a light coat of protective spray to the meter face. Allow the meter face to dry, reassemble the meter, and mount all the front panel components to the panel half of the case.

A parts list for the FSVOM is shown in table 1. The PC board should be etched and drilled as in fig. 5 and the components mounted as in fig. 6. Next, solder the interconnecting wires to the PC board as in fig. 7, leaving the wires about 305 mm (12 inches) long and in three groups: S1, S2, and panel components. Mark the far end of the wires with wire-markers or masking tape so they can be identified later.

Mount the completed PC board to the case with the wires extending toward the front. Lay the front panel face down in front of the PC board, and connect the premarked wiring to the panel components. Cut the wires to length after identifying them.

This type of prewiring saves wear and tear on the wires, as the PC doesn’t have to be turned over time and again to connect the individual wires. When the wiring is done, the panel should fold back into the case and the wiring should fold neatly into place. The wiring should be laced or spot-tied for neatness. Double check to be certain that the wiring is not pinched in the edges of the case. This completes the construction. Don’t button up the case yet.

calibration

The first step in calibration is to zero the meter with its zero-adjusting screw. This is best done with the meter in its normal operating position. Next, install the battery, set the function switch to OHMS...
Wiring details between PC board and panel.

and the range switch to X10. Leave the range switch in the X10 position for the remainder of the calibration procedure. Short the input terminals and adjust the 0 ZERO control to read 0 on the meter’s resistance scale. Remove the short from the input terminals and put a 180-ohm resistor across the terminals. Adjust the R calibration trimmer for a reading of 0.25 (half scale) on the upper meter scale. This coincides with 180 ohms on the lower, or resistance, scale of the meter.

Switch the function switch to the current (I) position and place 300 ohms (two 150-ohm resistors) in series with a 1.5-volt battery across the input terminals. Adjust the I calibration trimmer for a full-scale reading of 5 mA (0.50 × 10).

Switch the function switch to the VOLTAGE position and place two 1.5-volt batteries in series across the input terminals. Adjust the E calibration trimmer for a reading of 3 volts (0.3 × 10). This completes the calibration procedure. Now you can fire up your rig and check out the field-strength function.

closing remarks

While I can’t make any great claims of accuracy for the FSVOM, it’s more than adequate for amateur use. As you probably know, most commercial meters use 1 per cent resistors and much more sophisticated circuitry. But the FSVOM is very easy to use and will provide a degree of satisfaction in that you know what’s going on inside the little meter when you use it.

As a club project, it’s fun and gets amateurs involved in areas we generally don’t explore. As a useful device, it’s hard to beat. When you’ve finished building this one you will have explored just about all phases of home-brew construction, from PC boards to rotary switches to meter movements. The experience gained on this little project should pay off well on all future building efforts.

ham radio
“Fantastic!” is the word K2TK uses in summarizing the performance of the new Fox-Tango 8-pole 250 Hz CW crystal lattice filter in comparison with that of his standard 4-pole Heath unit. “Remarkably free from ringing...exceptional ultimate rejection...superior shape factor...easy installation...” are other quotes from his enthusiastic report. While gratifying, his remarks come as no surprise — he merely echoes those of hundreds of satisfied Yaesu and Kenwood purchasers of Fox-Tango filters who have decided to up-grade their present sets instead of purchasing new ones at today’s inflated prices.

Fox-Tango filters are designed to match the mounting holes in the most popular Heath rigs like the HW-101, SB-301, etc., exactly. For the others, the drilling of a few small holes will pose no problem for Heath owners who have “built their own” K2TK mounted his new 250 Hz unit in the space reserved for an AM filter in his SB300 thus making use of existing front panel controls for selecting either of his two CW filters. For those whose models lack this facility, it will be easy to improve mechanical or electromagnetic switching arrangements if dual filters are desired. Of course, for those satisfied with one filter, installation usually consists of tightening two nuts and soldering two connections.

Our complete line of filters is listed below. Note that we offer both 250 and 400 Hz bandwidths for Heath rigs. Although the latter appears to be the same as the standard Heath CW filter, the difference in 8-pole performance has to be heard to be believed. The 400 Hz unit is ideal for routine CW operation even though it lacks the needle-sharp response (and critical tuning requirements) of the 250 Hz filter.

All units are $55 except as indicated. Order with confidence — satisfaction is guaranteed.

<table>
<thead>
<tr>
<th>Big</th>
<th>Filter No.</th>
<th>TF</th>
<th>Used for</th>
<th>Center freq kHz</th>
<th>No. of Poles</th>
<th>Band Width</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>321958</td>
<td>CW</td>
<td>3179.3</td>
<td>8</td>
<td>250 Hz</td>
<td>Sharp unit for DX and contest work</td>
<td>Use instead of standard 600 Hz unit</td>
<td></td>
</tr>
<tr>
<td>321959</td>
<td>CW</td>
<td>3179.3</td>
<td>8</td>
<td>500 Hz</td>
<td>Use instead of standard 600 Hz unit</td>
<td>Same as standard XF-305 unit, $45</td>
<td></td>
</tr>
<tr>
<td>321960</td>
<td>SS</td>
<td>3180</td>
<td>8</td>
<td>2.4 kHz</td>
<td>For narrow SS to reduce QRM</td>
<td>Substitutes for XF-304A pole in early units</td>
<td></td>
</tr>
<tr>
<td>321961</td>
<td>AM</td>
<td>3180</td>
<td>8</td>
<td>10 kHz</td>
<td>For use in speech processor</td>
<td>Same as standard XF-303 unit, $45</td>
<td></td>
</tr>
<tr>
<td>323160</td>
<td>CW</td>
<td>3179.3</td>
<td>8</td>
<td>250 Hz</td>
<td>Sharp unit for DX and contest work</td>
<td>Use instead of standard 600 Hz unit</td>
<td></td>
</tr>
<tr>
<td>325679</td>
<td>CW</td>
<td>3179.3</td>
<td>8</td>
<td>500 Hz</td>
<td>Use instead of standard 600 Hz unit</td>
<td>Same as standard XF-305 unit, $45</td>
<td></td>
</tr>
<tr>
<td>325680</td>
<td>CW</td>
<td>3179.3</td>
<td>8</td>
<td>1000 Hz</td>
<td>Use instead of standard 600 Hz unit</td>
<td>Same as standard XF-305 unit, $45</td>
<td></td>
</tr>
<tr>
<td>325690</td>
<td>AM</td>
<td>3180</td>
<td>8</td>
<td>2.5 kHz</td>
<td>For narrow SS to reduce QRM</td>
<td>Substitutes for XF-304A pole in early units</td>
<td></td>
</tr>
<tr>
<td>325691</td>
<td>AM</td>
<td>3180</td>
<td>8</td>
<td>10 kHz</td>
<td>For use in speech processor</td>
<td>Same as standard XF-303 unit, $45</td>
<td></td>
</tr>
<tr>
<td>325700</td>
<td>CW</td>
<td>3180</td>
<td>8</td>
<td>250 Hz</td>
<td>Sharp unit for DX and contest work</td>
<td>Use instead of standard 600 Hz unit</td>
<td></td>
</tr>
<tr>
<td>325710</td>
<td>CW</td>
<td>3179.3</td>
<td>8</td>
<td>500 Hz</td>
<td>Use instead of standard 600 Hz unit</td>
<td>Same as standard XF-305 unit, $45</td>
<td></td>
</tr>
<tr>
<td>325800</td>
<td>CW</td>
<td>3179.3</td>
<td>8</td>
<td>1000 Hz</td>
<td>Use instead of standard 600 Hz unit</td>
<td>Same as standard XF-305 unit, $45</td>
<td></td>
</tr>
<tr>
<td>325810</td>
<td>CW</td>
<td>3179.3</td>
<td>8</td>
<td>2.5 kHz</td>
<td>For narrow SS to reduce QRM</td>
<td>Substitutes for XF-304A pole in early units</td>
<td></td>
</tr>
<tr>
<td>325820</td>
<td>CW</td>
<td>3179.3</td>
<td>8</td>
<td>10 kHz</td>
<td>For use in speech processor</td>
<td>Same as standard XF-303 unit, $45</td>
<td></td>
</tr>
<tr>
<td>325920</td>
<td>CW</td>
<td>3180</td>
<td>8</td>
<td>250 Hz</td>
<td>Sharp unit for DX and contest work</td>
<td>Use instead of standard 600 Hz unit</td>
<td></td>
</tr>
<tr>
<td>325930</td>
<td>CW</td>
<td>3179.3</td>
<td>8</td>
<td>500 Hz</td>
<td>Use instead of standard 600 Hz unit</td>
<td>Same as standard XF-305 unit, $45</td>
<td></td>
</tr>
<tr>
<td>325940</td>
<td>CW</td>
<td>3179.3</td>
<td>8</td>
<td>1000 Hz</td>
<td>Use instead of standard 600 Hz unit</td>
<td>Same as standard XF-305 unit, $45</td>
<td></td>
</tr>
<tr>
<td>326020</td>
<td>CW</td>
<td>3180</td>
<td>8</td>
<td>2.5 kHz</td>
<td>For narrow SS to reduce QRM</td>
<td>Substitutes for XF-304A pole in early units</td>
<td></td>
</tr>
<tr>
<td>326030</td>
<td>CW</td>
<td>3179.3</td>
<td>8</td>
<td>10 kHz</td>
<td>For use in speech processor</td>
<td>Same as standard XF-303 unit, $45</td>
<td></td>
</tr>
<tr>
<td>326040</td>
<td>CW</td>
<td>3179.3</td>
<td>8</td>
<td>250 Hz</td>
<td>Sharp unit for DX and contest work</td>
<td>Use instead of standard 600 Hz unit</td>
<td></td>
</tr>
<tr>
<td>326050</td>
<td>CW</td>
<td>3179.3</td>
<td>8</td>
<td>500 Hz</td>
<td>Use instead of standard 600 Hz unit</td>
<td>Same as standard XF-305 unit, $45</td>
<td></td>
</tr>
<tr>
<td>326060</td>
<td>CW</td>
<td>3179.3</td>
<td>8</td>
<td>1000 Hz</td>
<td>Use instead of standard 600 Hz unit</td>
<td>Same as standard XF-305 unit, $45</td>
<td></td>
</tr>
<tr>
<td>326070</td>
<td>CW</td>
<td>3180</td>
<td>8</td>
<td>2.5 kHz</td>
<td>For narrow SS to reduce QRM</td>
<td>Substitutes for XF-304A pole in early units</td>
<td></td>
</tr>
<tr>
<td>326080</td>
<td>CW</td>
<td>3179.3</td>
<td>8</td>
<td>10 kHz</td>
<td>For use in speech processor</td>
<td>Same as standard XF-303 unit, $45</td>
<td></td>
</tr>
<tr>
<td>326090</td>
<td>CW</td>
<td>3179.3</td>
<td>8</td>
<td>250 Hz</td>
<td>Sharp unit for DX and contest work</td>
<td>Use instead of standard 600 Hz unit</td>
<td></td>
</tr>
<tr>
<td>326100</td>
<td>CW</td>
<td>3179.3</td>
<td>8</td>
<td>500 Hz</td>
<td>Use instead of standard 600 Hz unit</td>
<td>Same as standard XF-305 unit, $45</td>
<td></td>
</tr>
<tr>
<td>326110</td>
<td>CW</td>
<td>3179.3</td>
<td>8</td>
<td>1000 Hz</td>
<td>Use instead of standard 600 Hz unit</td>
<td>Same as standard XF-305 unit, $45</td>
<td></td>
</tr>
<tr>
<td>326120</td>
<td>CW</td>
<td>3180</td>
<td>8</td>
<td>2.5 kHz</td>
<td>For narrow SS to reduce QRM</td>
<td>Substitutes for XF-304A pole in early units</td>
<td></td>
</tr>
<tr>
<td>326130</td>
<td>CW</td>
<td>3179.3</td>
<td>8</td>
<td>10 kHz</td>
<td>For use in speech processor</td>
<td>Same as standard XF-303 unit, $45</td>
<td></td>
</tr>
</tbody>
</table>

To avoid error due to similarity of some filter numbers, specify desired unit completely when ordering. Include make and model of set, filter number, and center frequency.

Diode Switching Boards permit easy mounting (without drilling) of up to two crystal filters of any type in addition to those for which the manufacturer provides space. These boards will accommodate any of the filters listed except Heath. Specify make of set with which board is to be used. $20 airmail postpaid.

VISA and Master Charge accepted.

**HEATH CW Ops**

**NEW!** Join the YAESSU-KENWOOD CROWD!

**250 & 400 Hz 8-pole xtal filters**

**WIN YOUR BATTLE AGAINST QRM**

**GET THE BEST AND SAVE**

**ONLY $55**

**AIRMAIL POSTPAID**

**OVERSEAS ADD $3**

**February 1979**

**Distributor Inquiries Invited**

**Affordable quality is the Davis difference.**

**Davis Electronics**

**636 Sheridan Drive, Tonawanda, N.Y. 14150 - 716/874-5848**

**More Details? CHECK - OFF Page 126**
WE PUT THE
FUN IN A-5
WITH THE NEWEST, MOST COMPLETE, FAST SCAN TV TRANSMITTER AVAILABLE!

Now, you can have an EYEBALL QSO without leaving your shack.
The new TVX 10 has solid state modular construction using an all new high stability, low spurious transmitter. A true linear class AB amplifier. Wide band video modulator that passes high quality color. Switchable, narrow band audio modulation of video carrier or 4.5 MHz wide band audio subcarrier.

SPECIFICATIONS
Output power: 10 watts peak
Video frequency: 439.25 uHz stock (420-470 MHz special order)
Video carrier stability: .0005%
Spurious outputs: down 60 db
Video input: 1-2 volts p-p @ 75 ohms
Audio input: 100 mv RMS @ 600-5K ohms
Audio deviation video carrier: 15 KHz max.
Audio deviation 4.5 MHz subcarrier: 100 KHz max.

Complete, wired & tested . . . . $399.95

AVAILABLE ONLY AT THESE AUTHORIZED DEALERS

CALIFORNIA
C & A Electronic Enterprises, Carson, CA 90745, Ph. 213-834-5868
Telecom Electronics, San Jose, CA 95121, Ph. 408-274-4479
Zackit Corporation, Vallejo, CA 94590, 707-664-6676

COLORADO
A.E.S. Communications, Colorado Springs, CO 80909, Ph. 303-475-7050

NEVADA
Communications Center West, Las Vegas, NV 89106, Ph. 702-647-3114

NEW YORK
Barry Electronics, New York, NY 10012, Ph. 212-925-7000
Delmar Electronics, W. Babylon, LI, NY 11704, Ph. 516-420-1234
VHF Communications, Jamestown, NY 14701, Ph. 716-664-6346

OHIO
Universal Amateur Radio, Reynoldsburg, (Columbus) Ohio 43068
Ph. 614-866-4267

OKLAHOMA
Derrick Electronics, Broken Arrow, OK 74012, Ph. 918-251-9923

VHF engineering
DIVISION OF BROWNIAN ELECTRONICS CORP.
Prices and specifications subject to change without notice.
improving the HT-37 ssb transmitter

The Hallicrafters HT-37 is still around and has many excellent features — here are some ideas for upgrading this venerable old rig.

Of all the equipment manufactured by the Hallicrafters Company, perhaps the most popular was the HT-37 transmitter-exciter. It uses the phasing system for single-sideband generation, which is a good method if the phase-shift networks are properly adjusted. Once set, however, these phase shifters rarely need adjustment. The rig is as stable as a rock and the ssb audio quality compares well with that from filter-type circuits.

This article is presented for HT-37 users who might wish to improve its operation with some minor modifications. For the purist who wants better sideband suppression, an easy modification appears in reference 1, which shows how to install a filter-type sideband generator. If you’re happy with the as-built HT-37 sideband generator but wish to make a couple of other simple modifications to improve efficiency and increase power-transformer life, you might be interested in the comments that follow.

Automatic Level Control (ALC) allows you to operate at higher audio levels without overloading the transmitter, which causes interference to nearby stations. With an ALC circuit added to the HT-37, more emphasis is given to lower-frequency speech components, and the higher dynamic range (louder) speech components won’t overdrive the final-amplifier stage. Such overdriving creates splatter, “buckshot,” and a broader signal.

You’ll need the following parts for the ALC-circuit addition:

- **Resistors**
  - 1 50k composition, 1/2 watt
  - 1 10k composition, 1/2 watt

- **Capacitors**
  - 2 0.1 μF paper, 200V working
  - 1 0.25 μF paper, 200V working
  - 1 0.001 μF ceramic 200V working

- **Miscellaneous**
  - 2 1N2070 or 1N2071 silicon diodes, 400V PIV
  - 2 solder-lug terminal strips
  - 90 cm (3 ft) small plastic-covered shielded cable

**Procedure**

1. Remove both top and bottom halves of cabinet.
2. Remove side rail from chassis left side.
3. Remove cover from the audio section to gain access to the audio gain control, R110.
4. Remove the direct connection between R110 and ground. Install a 0.1-μF capacitor between these points.

By Alf Wilson, W6NIF, 1068 Arden Drive, Encinitas, California 92024
5. Solder one end of a 50k resistor to the former grounded terminal of R110, then connect the center wire of a 51-cm (20-inch) length of small shielded cable to the other end of the 50k resistor. Ground the cable shield to a convenient point inside the audio compartment. The revised audio section will then be as shown in fig. 1.

![fig. 1](image_url)

fig. 1. As-built appearance of the HT-37 (see text).

6. Feed the free end of the shielded cable through a hole in the audio-section cover shield. Replace the cover shield onto the chassis.

7. Replace the side rail removed from the chassis.

8. Using a solder-lug terminal (4 or 5 lugs), build the ALC circuit shown in fig. 2. Be sure to use a terminal strip with a grounded mounting lug at one outer end.

![fig. 2](image_url)

fig. 2. The ALC circuit built from instructions in the article.

9. Solder the outer end of the shielded cable coming from the audio section to point A in fig. 2. Attach another piece of shielded cable, about 51-cm (20-inches) long, to point B in fig. 2.

10. Remove the nut from one of the four machine screws securing the antenna coax fitting to the chassis rear apron. Mount the ALC assembly just constructed on the machine screw, replace the nut, and tighten securely. Of course, a grounding lug should be used to mount this assembly onto the coax connector.

11. Near the bottom of the final-amplifier 6146 tube sockets you’ll find a solder-lug strip where R19 (1k) is connected to rf choke L13, which in turn is connected to the 6146 grids.

![fig. 3](image_url)

fig. 3. As-built appearance of the HT-37 (see text).

Before performing the next step, note that two green wires are connected to R19 as shown in fig. 3. Now proceed as follows:

12. Remove both green wires from point X in fig. 3. Leave them free for now.

13. Mount two 10k resistors and a 0.001-µF ceramic bypass capacitor on a 4-lug terminal strip, as shown in fig. 4.

14. Next mount the assembly just completed under one of the self-tapping screws that hold the lid onto the shield can next to the 6146 sockets. (This is merely a suggestion; use any mounting position that seems convenient.)

15. Connect the two green wires lifted in step 12 to point C (fig. 4) and run a new wire from point D (fig. 4) to R19 (point X in fig. 3).

16. Connect point E to the shielded cable coming from point B in fig. 2. The final-amplifier wiring will now appear as in fig. 5.

17. Dress the new shielded cables as close as possible to the chassis. Check all wiring for errors. This completes the installation of your new ALC circuit.

A schematic of the complete ALC circuit is shown in fig. 6. I suggest you recheck the 6146 bias voltage to ensure it hasn’t changed. It should be -49 Vdc.

**power-transformer protection**

The HT-37 seems to have a history of power-transformer failure. I’ve talked to several HT-37 owners who have had to replace the transformer because of a short circuit either in the secondary windings or between primary and secondary windings. It’s pretty hard to find an exact replacement for the HT-37 power transformer today, although at least one source of help appears in the amateur ads in which a transformer rebuilding service is offered.

In any event, it’s possible to preclude catastrophic failure of the power transformer by simply adding an autotransformer, such as a Variac, in the primary voltage circuit of the HT-37.

HT-37 owners will note that, when the OPERATION switch is turned from OFF to STANDBY, a distinct "thung" sound will be heard if the peak of the ac primary voltage occurs at time of switch turn-on. This means that a surge of voltage is presented to the power transformer primary at the instant of switch turn-on.

Why not eliminate this surge by using an autotransformer in the transformer primary? With the OPERATION switch in the OFF position, turn the autotransformer to zero, then gradually advance the autotransformer control until the proper ac input voltage is presented to the power-transformer primary. An ac voltmeter should, of course, be connected across the power-transformer primary.

Another cause of power-transformer failure, according to many HT-37 owners, is sheer carelessness...
the **W6TOG**
**RECEIVER MODIFICATION KITS**
INCREASE SELECTIVITY • IMPROVE SENSITIVITY
LOWER INTERNAL NOISE
IMPROVE NOISE BLANKER OPERATION
COMBAT BLOCKING FROM LOCAL SIGNALS

<table>
<thead>
<tr>
<th>Brand</th>
<th>Kit</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>TS-520</td>
<td>FT-101</td>
<td>$27.50</td>
</tr>
<tr>
<td>TS-520S</td>
<td>FR-101</td>
<td>$32.50</td>
</tr>
<tr>
<td>TS-820</td>
<td>FT-301</td>
<td>$34.50</td>
</tr>
<tr>
<td>R-999</td>
<td>FT-901</td>
<td>$34.50</td>
</tr>
<tr>
<td>TR-599/909</td>
<td>FT-910</td>
<td>$34.50</td>
</tr>
</tbody>
</table>

**EXPLICIT INSTRUCTIONS MAKE MODIFICATION A CINCH**

**IT'S MAGIC...**
**IT'S "MAGICOM"**
**PROCESSOR MODIFICATION KIT**
IMPROVES AUDIO PUNCH
IMPROVES PROCESSED SPEECH QUALITY
Converts TS-820 / 820S speech processor from RF compressor to RF clipper $27.50
RF speech processor for TS-520 / 520S $42.50
The "MAGICOM" RF processor module provides up to 6dB increase in output with smooth, clean, non-distorted audio and more penetration for those pile-ups.

**ENDORSED BY W6TOG AND BIG GUN DXers WORLD WIDE**

the **W6TOG**
**INTERNAL ELECTRONIC KEYER**
FOR ALL AMATEUR TRANSMITTERS OR TRANSCEIVERS USING GRID BLOCK KEYING
- No holes mounting with TS-820 Series
- C-MOS DESIGN — Dot and dash memory — full iambic or manual operation.
- Simple installation $49.50

**THE S-F REJEKTOR FILTER**
AN INTEGRATED CIRCUIT
ACTIVE BANDPASS FILTER
FOR PROCESSED RECEIVER AUDIO
- Separate active filter elements for CW and SSB audio output stage
- 8 ohm input and output impedance
- Headphone jack for convenience
- ON-CW: from 500 Hz to 100 Hz, variable
- ON-SSB: 2 Khz fixed bandwidth
- Rejects unwanted signal better than 60 dB
- Designed for today's transceivers or yesterday's older equipment $49.50

Acknowledgment
The material on adding ALC to the HT-37 was taken from a paper by W6NCK and K0TYO. This paper was included with the instruction manual for my HT-37, which I purchased second hand. I built the circuit and it is an improvement over the original HT-37 design. Any credit for this improvement should go to W6NCK and K0TYO.

Reference
OSCAR HEADQUARTERS

SSB TRANSMITTING CONVERTERS

FEATURES:
- Linear Converter for SSB, CW, FM, etc.
- A fraction of the price of other units
- 2W p.e.p. output with 1 MW of drive
- Use low power tap on exciter or attenuator pad
- Easy to align with built-in test points

Frequency Schemes Available:

<table>
<thead>
<tr>
<th>MODEL</th>
<th>RF RANGE</th>
<th>I-F RANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>X2V-1</td>
<td>28-30 MHz</td>
<td>144-148 MHz</td>
</tr>
<tr>
<td>X2V-2</td>
<td>28-30 MHz</td>
<td>144-148 MHz</td>
</tr>
<tr>
<td>X2V-3</td>
<td>28-30 MHz</td>
<td>144-148 MHz</td>
</tr>
<tr>
<td>X2V-4</td>
<td>28-30 MHz</td>
<td>144-148 MHz</td>
</tr>
</tbody>
</table>

ONLY $59.95!

VHF Linear PA's

- Use as Linear or Class C PA's
- For X2V-2 Xmtg Converters, 750 Exciter, or any 2W Exciter

LPA 2-15 Kit $59.95
- 15W out (Linear) or 20W (Class C)
- Solid State T/R Switching
- Models for 6M, 2M, or 220 MHz

T80 UHF POWER AMP

- Broadband PA
- No Tuning Required
- Class C PA
- 430-470 MHz
- 13-15W Output
- 200 mW Drive

Model T80-450 $79.95 Wired & Tested

VHF RECEIVING CONVERTERS

LET YOU RECEIVE OSCAR AND OTHER EXCITING SIGNALS ON YOUR PRESENT HF RECEIVER!

MODEL | RF RANGE | I-F RANGE |
-------|----------|-----------|
C28    | 28-32 MHz| 144-148 MHz|
C30    | 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| 26-30 MHz |
C220   | 220-222 MHz| 28-30 MHz |
C222   | 222-224 MHz| 28-30 MHz |
C423   | Special| Inquire About Other Ranges |

ONLY $34.95

UHF RECEIVING CONVERTERS

- 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

MODEL | RF RANGE | I-F RANGE |
-------|----------|-----------|
C432-2 | 432-434 MHz| 28-30 MHz |
C432-4 | 432-436 MHz| 144-146 MHz|
C432-5 | 435-437 MHz| 28-30 MHz |
C432-7 | 427-25 MHz| 61-25 MHz |
C432-9 | 439-25 MHz| 61-25 MHz |

ONLY $34.95

VHF & UHF FM RECEIVERS

- 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

R79 6-channel VHF Receiver Kit for 2M, 6M, 10M, 220 MHz, or com/1 bands........ $69.95
Optional at filter for 100 dB adj shan 10.00

R99 UHF Receiver Kit for any 2 MHz segment of 380-520 MHz band.................. $89.95

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

Specify Band When Ordering
- Deluxe vhf model for applications where space permits. 1-1/2 x 3". Models available to cover any 4 MHz band in the 26-230 MHz range. 17 Vdc. 2 stages ideal for OSCAR. 20 dB gain. Dielectric transient protection. Easily tunable.

P8 Kit $10.95
P16 Wired $21.95

Specify Band

P15 Kit $18.95
P35 Wired $34.95

- Covers any 6 MHz band in the UHF range of 380-520 MHz.
- 20 dB gain. 2 stages. Low noise.

NEW FM/CW EXCITER KITS

BUILD YOUR OWN GEAR FOR MODULAR STATIONS, REPEATERS, & CONTROL LINKS
- Rated for Continuous Duty
- Professional Sounding Audio
- Built-in Test Aids

T50 Six Channel, 2W Exciter for 2M, 6M, or 220 MHz (Specify band).............. $49.95
T50U Six Channel, 1W Exciter for 430-450 MHz u/f operation........................ $49.95

IT'S EASY TO ORDER!
CALL OR WRITE NOW FOR FREE CATALOG OR TO PLACE ORDER!

PHONE 716-392-9430. (Electronic answering service every night and weekends)
Use credit card, c.o.d., check, m.o.
Add $2.00 shipping & handling.

IN CANADA, order from Communications Plus, 3880 Cote Vertu St-Laurent, Quebec or phone 514-337-7255. Add 38% to cover duty, tax, and exchange.

Note New Address and Phone No.

hamtronics, inc.
65c MOUL RD • HILTON, NY 14468

**Dealer Inquiries Invited**

More Details? CHECK — OFF Page 126
NOT A KIT

the microcomputer controlled appointment clock

A NEW SOLUTION FOR SOME OLD PROBLEMS
Your spouse will never be upset with you for missing a birthday.
Your business associates will be pleased when you're never late for appointments.
Your doctor will be confident that you are taking your medication at the time prescribed.

FOR THE BUSY EXECUTIVE
Controls length of business meetings.
Reminds you 10 minutes ahead of time to prepare for meeting and get you to your desk just in time. Reminder of wife's birthday. Reminder to catch plane for important business trip.

FOR THE HOMEMAKER
Reminder to take meal out of oven at dinner time. Reminder of tennis dates and hair dresser appointments.

FOR THE MOTHER

FOR THE SENIOR CITIZEN

FOR THE STUDENT
Timer for chemistry lab, lab test. Timer for solving problems or preparation for exams.

FOR THE GOURMET COOK
Alarms to tell you when to start next step in meal preparation. By programming the timer alarm, you'll know just when each course of an elaborate meal must be prepared so everything will be ready at the same time. Helps you keep track of recipe timing.

FOR THE SALESMAN
Stores up to 30 future appointments — easy to see at the touch of a key when next appointment is scheduled.

FOR THE PHOTOGRAPHER
Timer for photographic development chain. Can insert red digital display filter to avoid damaging film.

FOR THE ATTORNEY
Records client's time charges, meetings, phone calls, research. Timer with built-in pause capability provides accurate way of timing speech presentations.

FOR THE SECRETARY
The secretary's best friend. Remembers to remind the boss of key appointments. Times length of phone calls.

Regular Price $79.95
Introductory Offer By Hal-Tronix only $69.95

THE ONLY CLOCK OF ITS KIND — NONE CAN COMPARE!!

HAL-TRONIX
P. O. BOX 1101
SOUTHGATE, MICH. 48195

Send 15¢ stamp or S.A.S.E. for information and flyer on other HAL-TRONIX products.
To phone order in 1-313-285-1782.
VISA and Master Charge accepted.

July 28 thru August 10, 1979
Have trouble finding time to study for Upgrading?
Do it on your vacation at the Oak Hill Academy Amateur Radio Session
20 years of successful teaching
Two weeks of intensive code and theory starting at your level.
Classes from Novice thru Amateur Extra
• Expert instructors
• Friendly surroundings
• Excellent Accommodations

More Details? CHECK — OFF Page 126
Design of a simple yet high-performance logic probe using three low-cost integrated circuits

Have you constructed a frequency counter or keyer that didn’t work when you first turned it on? Has some piece of equipment that uses TTL integrated circuits failed recently? If you answer yes to either of these questions, you’ve been in a situation in which a logic probe could have been very useful. This article describes a simple TTL logic probe that can be constructed for less than $5. Yet its performance equals that of units costing as much as $45.

operation

The logic probe is to the digital designer what the VOM is to the electrician. With a single touch, the probe displays the logical state or condition of the selected circuit connection. A well-designed probe will indicate an open circuit, a good logic 1 or 0 state, and whether a pulse train is present. This tool enables the digital experimenter to follow signals through the various logic gates and circuit components until the faulty part or wiring error is isolated.

The logic probe has three LEDs of different colors

By Andrew B. White, K9CW, 102 Franklin Street, Urbana, Illinois 61801
mounted near the probe tip. After the probe’s +5 volt and ground connections are made to the circuit under test, the tip can be touched to any point carrying a TTL signal. If the point is less than about 0.7 volts, the 0 (green) LED will be the only one energized. If the test point is 2.4 volts or greater, only the 1 (red) LED will come on. If the selected circuit is oscillating between 1 and 0, the red and green LEDs will show the relative duty cycle of the oscillation, and the PULSE (yellow) LED will pulsate or will seem to be continuously on.

The advantage of a special pulse indicator can be seen when considering a normally low or 0 signal with 200 nS high pulses every 200 mS. Since the signal is high for only a small fraction of the total period, the probe’s green LED will seem to be always on and the red LED always off. However, each of the pulses is stretched to about 0.5 second and displayed on the yellow LED. Thus, the green and yellow LEDs on together indicate the presence of the narrow, high pulses.

If the line is an open circuit, has a resistance of more than about 4000 ohms to ground, or has a voltage level between 1.0 and 2.4 volts, neither the high nor low LED will be energized. An unterminated TTL input will be displayed in this fashion. A summary of the logic probe’s operation, with various input waveforms, is shown in fig. 1.

circuit description

The schematic diagram of this logic probe, as illustrated in fig. 2, consists of three sections: the high-level detector and red LED driver (Q1 and Q2), the low-level detector and green LED driver (U1A and U1B), and the pulse detector and yellow LED driver (U2 and U3). Q1 functions as a threshold detector, which will turn on with an input voltage of greater than about 2.4 volts. The threshold level is determined by the three silicon diodes connected between the emitter of Q1 and ground. Each diode exhibits a forward-biased voltage drop of about 0.7 volts. When Q1 turns on, Q2 is forced on, connecting the +5 supply voltage to the anode of CR3, turning on the red LED.

The low-level threshold detector uses one section of a 74LS02 and a silicon diode. Without this additional diode voltage drop, the green LED would be energized at about 1.4 volts. With the diode, the input voltage has to be below 0.7 volts before pin 1 of U1A will go low, turning on the green LED. Notice that between the upper and lower thresholds neither CR1 nor CR3 will be energized.

The pulse detection circuit employs a dual D-type flip-flop and a monostable multivibrator to stretch the input pulse length. The detection of a valid 0 or 1 level is signaled, respectively, by U1 pin 4 or the cathode of CR3 going high. Either of these conditions causes one of the outputs of U2 to go high, forcing pin 13 of U1 low, which triggers the monostable and turns on the yellow LED, CR2, for about 0.5 seconds. As long as the output of the monostable is high, both flip-flops remain cleared. The D-type flip-flops are used to insure that U3 is properly triggered. The trigger pulse must be at least 200 nS long and cannot stay low, since that would hold CR2 on.

The 74LS74 shown will respond to pulses as narrow as 25 nS.

---

fig. 1. Graphical summary of the indicating LEDs for various input states. When connected to a floating input, none of the LEDs will be on.

fig. 2. Schematic diagram of the logic probe. All resistors are 1/4 watt; CR4, CR5, CR6, and CR7 are IN4148 or equivalent small-signal diodes.
A logic probe should not excessively load the circuit under test. This probe will sink only about 25 \( \mu A \) when the input is +5 volts. With a 0-volt input, the circuit input current is about \(-200\ \mu A\). In the worst case, this probe would represent one LSTTL load. In addition, the probe will "catch" pulses shorter than 100 nS in duration.

**construction**

The circuit layout for this device is not critical. Fig. 3 illustrates one printed circuit board layout design and parts placement for the logic probe. The overall board dimensions are 3.3 \( \times \) 10.2 mm (1.3 \( \times \) 4 inches). You could use point-to-point wiring on a circuit board with holes on a standard 2.5 mm (1 inch) grid instead. The probe tip can be made from 16 AWG (1.3 mm) tinned-copper wire or a small brass nail. The +5 and ground inputs should be connected to clip leads so they may be easily connected to the circuit supply voltage source. Standard TTL chips may be substituted for the LS devices shown, but the circuit loading will be increased.

I have found a logic probe to be a valuable aid in debugging TTL projects. After you use one, you may wonder how you were able to get along without it!
Do you dislike counting up the words and doing the arithmetic to check your code speed? If so, then you need a code speed counter. All it takes is an ordinary frequency counter and a couple of ten-cent ICs.

In many cases, a frequency counter can be set up to count for one second, performing the latch and reset function during the next 0.2 second. By inserting a divide-by-four counter (7493) in the clock circuit, the counter will then count for four seconds instead of one second.

fig. 1. Wiring diagram of the one-shot multivibrator used to convert the sine wave into a pulse for the counter. Pin 2 connects to the output of the wave shaper, while pin 13 goes to the counting circuit.

The goal is to have the counter count the number of key downs during a four-second interval. This will be approximately the code speed in words per minute. A dot or dash from the speaker terminals is, in many cases, a 700 to 1200 Hz sine wave. It is necessary to generate a positive pulse from each character. To do this, insert the retriggerable monostable shown in fig. 1 before the counter’s input.

performance

Using a piece of graph paper, find out exactly what readouts the modified counter will produce. In fig. 2, the word Paris is represented in code. If you assume the speed is 12 wpm, then each dit is 0.1 second long. The counter reads 0 until the first four seconds have passed. It will then read out 12, since 12 key downs occurred during that time. Those key downs sent during the 0.4 second of the latch and reset cycle are ignored by the counter. The 12 will remain on display until the next four seconds have passed, then read out the number of key downs during that period, and so on.

If you plug the counter into the speaker jack and tune in the W1AW code practice, you’ll find that the counter produces readouts which are very close to the announced speeds. On the faster speeds, 20 wpm or more, the counts tend to be low. This is because at faster speeds more words will occur during the four-second count period, and the counter does not make any allowance for the seven-baud spaces between words.

A very useful operating aide is provided by connecting the input of the 7490 counters to one of the decimal points in the readout. This makes it possible to see the dits and dahs which are being counted. By watching the blinking decimal point you can tell when interference is messing up the count. Using the gain control on the receiver you can tune out the interference, if the desired signal is strong enough. Just turn down the volume until only the desired signal is visually evident. You can also tell, by watching the flashes of the decimal point, which four-second intervals are representative of the speed being sent, and ignore counts of intervals containing long pauses or interference.

fig. 2. Diagram of the standard 50-baud word PARIS.

If you don’t have a counter which you wish to modify, then you can build the code counter from scratch by adding the above modifications to any of the plans which have appeared in the literature.

The code speed counter will add another element of enjoyment to operating CW. It will also give you an easy way to check on your progress if you’re trying to build up your code speed.

By Louis C. Graue, K8TT, 624 Campbell Hill Road, Bowling Green, Ohio 43402
NEW! NEW! NEW! KDK

FM2016A

Manufactured by one of the world's most distinguished Avionics manufacturers, Kyokuto Ltd.

All Solid State-CMOS PL digital synthesized - No Crystals to Buy! 5KHz steps - 144-149 MHz-HUGE ¾” LED digital readout PLUS MARS-CAP and MULTIPLE OFFSET BUILT IN.

- 5 MHz Band Coverage - 1000 Channels (instead of the usual 2 MHz to 4 MHz-400 to 800 Channels)
- 4 CHANNEL RAM IC MEMORY WITH SCANNING AND AUTO TRANSMIT
- MULTIPLE FREQUENCY OFFSETS
- ELECTRONIC AUTO TUNING - TRANSMIT AND RECEIVE
- INTERNAL MULTIPURPOSE TONE OSCILLATOR
- RIT
- RF ATT
- DISCRIMINATOR METER - 16 Watts Output-
- Unequaled Receiver Sensitivity and Selectivity - 15 POLE FILTER, MONOLITHIC CRYSTAL FILTER AND AUTOMATIC TUNED RECEIVER FRONT END, COMPARE!

- Superb Engineering and Superior Commercial Avionics Grade Quality and Construction Second to None at ANY PRICE.

INTRODUCTORY PRICE

$359.00

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

SHOWN WITH OPTIONAL pP-800 MICRO PROGRAMMER

- 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 carriers
- MONITOR LAMPS 2 LED's on front panel indicate (1) incoming signal-channel busy, and (2) Transmit
- FULLY REGULATED INTEGRAL POWER SUPPLY Operating voltage for all 9v circuits independently regulated. Massive Commercial Hash Filtered
- MODULAR COMMERCIAL GRADE CONSTRUCTION: 3 Unitized modules eliminate stray coupling and facilitate ease of maintenance
- ACCESSORY SOCKET: Fully wired for touch tone, phone patch, and other accessories. Internal switch connects receiver output to external 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 selectivity - COMPARE!
- HIGH/LOW POWER OUTPUT: 16 watts and 1 watt. switch selected. Low power may be adjusted anywhere between 1 and 16 watts. Fully protected - short or open SWR
- RF ATT: Live right next to King Kong Repeater and can't operate? With the 2016A You Can - Just flick the RF ATT switch. Only the 2016A has this feature
- OTHER FEATURES: Dynamic Microphone, built in speaker, mobile mounting bracket, external 5 pin accessory jack, speaker jack, and much, much more. Size 2½ x 7½ x 9½. All cords, plugs, fuses, microphone hanger, etc. included. Weight 5 lbs.

AMATEUR-WHOLESALE ELECTRONICS

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

U.S. DISTRIBUTOR

DEALER INQUIRIES INVITED

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

February 1979
NEW — NEW — NEW from DATA SIGNAL

TOUCH TONE® MICROPHONE
DataCoder 5

JUST LOOK AT THESE FEATURES:
- Tough “Mobile Environment” Microphone
- Positive-Action Tactile Keys
- High-impedance Ceramic or 500-Ohm Dynamic Cartridge
- Adjustable Tone Balance and Output Level
- “Positive Hold” Easy Lift Hanger
- For Vehicle or Hand-held Portable Use
- Complete...Not a Kit...$39.00

*Touch-Tone is a registered trade name of AT&T

MINIATURE ENCODERS
DTM


SUB-MINIATURE ENCODERS

MODEL SME — Smallest available Touch Tone Encoder. Thin only 0.5” 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 $29.00, with your choice of 12- or 16-digit Digigran keyboard. SME (less keyboard) $24.00

DATA SIGNAL, INC.
2403 COMMERCE LANE
ALBANY, GEORGIA 31707, 912-883-4703

Be sure to ask about our new keyers and CW memory for CW buffs.

ALUMA TOWERS
4 Ft. Crank-Up
Model T-40-H

HIGHEST QUALITY
MADE IN ALUMINUM
* TELESCOPING
(CRANK UP)
* GU增添了
* TILT OVER MODELS
QUALITY MADE

Excellent for

HAM
COMMUNICATIONS
MANY MODELS MFG.

Towers to 100 feet. Specials designed & made. See dealer or send for free catalog.

ALUMA TOWER CO.
BOX 2999-R
VERO BEACH, FLA. 32960
PHONE (305) 567-3423

CURTIS LSI’s help you

speak MORSE

* 8044: Keyer-On-A-Chip* (Replaces 8042), $14.95
* 8044-3: IC,PCB,Socket,Manual ........ 24.95
* 8044-4: Semi-Kit .......................... 54.95
* 8045: Morse Keyboard-On-A-Chip IC ... 59.95
* 8045-1: IC,PCB, FIFO, Sockets, Manual 89.95
* 8045-2: Semi-Kit .......................... 159.95
* 8046: Instructokeyer-On-A-Chip IC .... 49.95
* 8046-1: Semi-Kit .......................... 79.95
* 8047: Message Memory-On-A-Chip IC ... 39.95
* 8047-1: IC,PCB, RAM, Sockets, Manual ... 69.95
(add $1.75 an above for postage and handling)

EX-430; CMS Keyer* (Feb ’76 OES) ........ 124.25
IR-440A; Instructokeyer* (Mar ’76 OES) .... 224.95

*New with dash memory as standard

System 4000 Ham Computer (see Jan ’76 OES) (write)

Curtis Electro Devices, Inc.
(741) 884-3138
Dox. 4090, Mountain View, CA 94040

QUARTZ CRYSTALS
“IN A HURRY”
SINCE 1970

CRYSTALS AVAILABLE FOR:
- CB - Synthesizers
- Amateur - HF, VHF, UHF
- Industrial
- Scanner
- Marine - LB & VHF
- Conversion Crystals
- Special Attention to R & D.
- Micro-processor Types.

DISCOUNTS AVAILABLE TO DEALERS & MANUFACTURERS

CALL “BONNIE” FOR PRICES & DELIVERY

VISA & MASTER CHARGE

CAL CRYSTAL LAB, INC.
1142 N. Gilbert Street
Anaheim, CA 92801
(714) 991-1580

More Details? CHECK—OFF Page 126
YOU ASKED FOR IT
YOU GOT IT

DSI
QUIK-KIT®

50 HZ TO 550 MHZ COUNTER KIT
95% ASSEMBLED 100% TESTED
Performance You Can Count On

FREQUENCY COUNTER APPLICATION:
- Ham Radio — Two Way Radio — CB
- Audio Amplifier & Receiver Repair
- Computer Maintenance & Construction
- A Must for TV & PLL Repair

$99.95
MODEL 3550K
includes built-in
Pre-Amp & Prescaler

DSI OFFERS THE BEST OF TWO WORLDS...
An unprecedented DSI VALUE... in a high quality, LSI Design, 50 HZ to 550 MHZ frequency counter kit. And, because it's a DSI innovation, you know it obsoletes all competitive makes, both in price & performance.

With 98% of the assembly completed by DSI, you are only one hour away from solving all of those difficult bench problems, from adjusting 60 HZ clock-time bases to setting the frequency of a 468 MHZ Mobile Radio.

FACT: Every 3550 QUIK-KIT® PC board is factory assembled and tested before shipment. FACT: The problems of bad LED's, IC's, and Capacitors are a thing of the past. FACT: No manufacturer except DSI offers a 550 MHZ frequency counter with... 8 digits, .5 in. LED's, TCXO, 1HZ resolution and a one year warranty on parts for under $100.00. FACT: We do not know how long we can hold this low, low price. GO WITH THE LEADER... BUY A DSI FREQUENCY COUNTER KIT TODAY. SAVE TIME & MONEY AND BE ASSURED IT WILL WORK THE FIRST TIME.

DSI — GUARANTEED SPECIFICATIONS
Time Base TCXO 1PPM 65° to 85°F
Freq. Range 50HZ to 550MHZ incl. two SO239 inputs
Resolution 1HZ to 55MHZ, 10HZ to 550MHZ
Gate Time 1 sec & 1/10 sec with Auto Decimal Point
Display 8 digits, .5 inch LED with Leading Zero Blanking
Sensitivity 25MV @ 25MHZ, 150MHZ, 250MHZ,
75MV @ 450MHZ

Power Batt., 12VDC @ 300Ma, 110VAC (with AC-9)

3550K Kit .................. $99.95
T-101 Ant. .................. 3.95
AC-9 AC Adp. ............... 7.95
Shipping, Handling, Ins. ....... 10.00

3550W Wired ................. 149.95
T-101 (incl.) ................. NC
AC-9 (incl.) ................ NC
Shipping (incl.) ............ NC

CALL TODAY TOLL FREE: (800—854-2049) Cal. Res.
CALL (800—542-5253) TO ORDER OR RECEIVE
MORE INFORMATION ON DSI'S FULL PRODUCT
LINE OF FREQUENCY COUNTERS RANGING FROM
10HZ TO 1-3GHZ

TERMS: MC - VISA - AE - Check - M.O. - COD in U.S. Funds. Orders outside of USA & Canada, please add $20.00 additional to cover air shipment. California residents add 6% Sales Tax.

DSI INSTRUMENTS, INC.
7924 Ronson Road, Dept. G, San Diego, CA 92111
quick connection

An effective, inexpensive way to connect wire to a pole or pipe is to use a regular automobile hose clamp. These clamps come in various sizes and are available at most service stations.

For outside installations, stainless-steel clamps should be used. The area of the pole that comes in contact with the clamp and wire should be free of dirt and grease. Clean the pole with steel wool or very fine sandpaper. Be sure to wipe off any dust from sanding.

After the clamp is secured to the pole, it should be taped with plastic electrical tape for weather protection. I've employed this method to connect a grounding wire to a ground rod of small diameter, and it proved very successful.

Jim DiSpirito, AB9Q

remote crystal switching

With the rising theft rates of mobile equipment, it is becoming increasingly attractive to mount vhf radios in the trunk. However, such an arrangement can present problems if you normally use a large number of channels. In a conventional remote-switching system, the relays or diodes, which are used to switch crystals, are selected by a simple rotary switch in the control head. A separate conductor, from the control head to the radio, is required for each channel. However, the use of a large multiconductor cable can be avoided by implementing a simple binary encoder/decoder system. By using binary coding, only four conductors are needed to select sixteen channels, or five conductors for thirty-two channels. Such a system has been incorporated in my mobile installation, which was built around a modified Genave chassis.

The control-head circuit for the first ten channels (0 through 9) is shown in fig. 1. Of course, this can be expanded to any number of channels. Binary encoding is accomplished through the use of 1N4148 or equivalent steering diodes. If you have trouble finding a rotary switch with enough positions, you might try using a toggle switch to control the most significant bit. In this way, an 8-position rotary switch and a toggle switch can select sixteen channels.

As for decoding circuitry, there are a number of decoder ICs on the market, with a variety of specifications. The user should select one which is best suited to his particular application. The 7445 and 74145 ICs are BCD-to-decimal decoders with open-collector outputs, suitable for driving reed-relay switching.

If diode switching is used, the 7442 BCD-to-decimal decoder or 74154 4-line to 16-line decoders will work well. A 4-line to 16-line decoder may also be built from two 7442s and an inverter as shown in fig. 2. This illustration shows the decoder/diode driver currently being used in my mobile installation. This configuration is suitable for use with oscillators in which the crystals are selected by grounding. The 7442s were used instead of a 74154 because they happened to be available. TTL inputs normally float to a high logic level if left unconnected. The four 150-ohm resistors pull down the inputs to approximately ground.

fig. 1. Schematic diagram of binary encoding circuit in the control head. The diodes provide steering such that the four lines to the radio receive the correct binary coding.
potential, unless a positive voltage from the control head is present. The reason for using this method is to provide relatively low-impedance inputs to the decoder to insure immunity to rf pickup and other extraneous signals. To be on the safe side, all four lines should also be bypassed with 0.01- or 0.005-μF capacitors at the decoder.

Inverters of the 7404 type provide a positive voltage and enough current to turn the diodes fully on. Diode current is set by the 82-ohm resistors. Larger-value resistors were initially tried, but they did not allow adequate diode current to flow. As a result, the receiver oscillator output was diminished, which in turn caused a small reduction in receiver sensitivity. A value of 75 or 82 ohms allows adequate current to flow, while remaining well within the current limitations of the diodes.

Notice that no rf chokes or bypass capacitors are required in the vicinity of the crystals or switching diodes, unlike some circuits appearing in the handbooks. A decoder could probably be designed without inverters on the outputs, but rf chokes would very likely be necessary to isolate the crystals from each other. With prices being what they are, it would be considerably cheaper to use hex-inverter ICs for isolation rather than rf chokes.

Binary channel addressing is readily adapted to more sophisticated digital control applications. For example, the radio can be converted into a scanner simply by adding a gated clock oscillator and a 7493 4-bit binary counter. The binary format is also well suited to microprocessor control.

Binary coding circuits have seen continuous service in my mobile installation since late 1974, first with DIP reed-relay crystal switching and more recently with diode switching. They have proven to be rugged and reliable, and have added considerable flexibility to the mobile system design.

J. Lee Blanton, WA8YBT

solid-state rectifiers in the Collins 516-F2

Not long after acquiring my present Collins station, I experienced a problem in the power supply which was directly traced to a cracked high-voltage rectifier tube socket. The socket becomes brittle after some years of use. This is primarily due to the large amount of heat generated by the rectifier tubes. Of prime concern though, is the power transformer which might be damaged due to such an occurrence; they are expensive to replace.

Rather than simply replacing the socket, I decided to eliminate the heat source by substituting plug-in solid-state rectifiers for the tubes. This requires a minimum amount of work since both the 5U4 and 5R4 were replaced by SS-5R4 units purchased from United Page Incorporated. Another procedure, which was suggested by the Collins Service Department, is the use of four Semtech SCH-5000 diodes (CPN 353-0425-010), two diodes replacing each rectifier tube. These are hard-wired to the tube sockets underneath the chassis.

In each instance it would be a good idea to disconnect the rectifier filament leads, insulate and tie them back out of the way, although I ran my unit for some time after installing the plug-in units without doing so. The filament leads are not needed and removing them eliminates one more source of possible trouble. Also, the bias should be re-adjusted to obtain the proper resting plate current since all voltages will have increased about 10 per cent.

Paul Pagel, N1FB
**CRYSTAL FILTERS and DISCRIMINATORS**

**9.0 MHz FILTERS**

- **XF9-A** 2.5 kHz SSB TX $40.65
- **XF9-B** 2.4 kHz SSB RX/TX $55.10
- **XF9-C** 3.75 kHz AM $59.30
- **XF9-D** 5.0 kHz AM $59.30
- **XF9-E** 12.0 kHz NBFM $59.30
- **XF9-M** 0.5 kHz CW (4 pole) $41.50
- **XF9-NB** 0.5 kHz CW (8 pole) $73.45

**9.0 MHz CRYSTALS** (Hc25/1u)

- **XF900** 9000.0 kHz Carrier $4.75
- **XF901** 8998.5 kHz USB $4.75
- **XF902** 9001.5 kHz LSB $4.75
- **XF903** 8999.0 kHz BFO $4.75

**VHF and UHF FILTERS**

**OCAR-J FILTERS**

- Supress 2m Tx Third Harmonics. Low 2m loss (0.5 dB typ.). High loss at 435 MHz (30/40dB).
- **MM200-5** 30 dB min. atten. $29.95
- **MM200-7** 40 dB min. atten. $39.95

**RECEIVE CONVERTERS**

- **MODELS FOR ALL BANDS 50 MHz THROU 1296 MHz. LOW NOISE OP. TIONS AT 432 MHZ.**

**STANDARD I.F. 10M. I.F. OPTIONS 6M & 2M AVAILABLE**

- **POWER OUTPUT 12V D.C.**
  - Shipping: $2.50
- **MMc50** N. F. 2.5 db typ. $59.95
- **MMc144** N. F. 2.8 db typ. $59.95
- **MMc220** N. F. 3.0 db typ. $69.95
- **MMc432** N. F. 3.6 db typ. $69.95
- **MMc432S** N. F. 3.0 db typ. $69.95
- **MMc438/ATV** Ch2 or Ch3 IF $19.95
- **MMc1296** N. F. 8.5 db typ. $89.95

**ANTENNAS** (FOB CONCORD, VIA UPS)

- **144-148 MHz J-SLOTS**
  - **8 OVER 8 HORIZONTAL POL. +12.3 dbd** $50.65
  - **8 BY 8 VERTICAL POL.** $59.95
  - **8 + 8 TWIST 8xY/2M** $52.45

- **420-450 MHz MULTIBEAMS**
  - 48 EL. GAIN +15.7 dbd $74.95
  - 8 EL. GAIN +18.5 dbd $79.95

**SHIPMENTS**

- **200-250W carrier AM** $54.95
- **300W PEP AM** $79.95

**MODEL 2C5M** $499.00

- **CBnaaa Industries, Inc.** 1145 Bellamy Rd., Scarborough, Ontario M1H 1Y5
- **Export: EMEC Inc.** 2550 South 30th Avenue, Hollywood, Florida 33020

---

**STATE OF THE ART**

**by K.V.G.**

**NEW**

**VHF and UHF FILTERS**

**ELIMINATE IMDBS**

- **PSF145** 145 MHz Carrier $54.95
- **PSF432** 432 MHz Carrier $43.95
- **PSF1296** 1296 MHz Carrier $43.95
- **PSF1691** 1691 MHz Carrier $45.95

**RECEIVE CONVERTERS**

- **MODELS FOR ALL BANDS 50 MHz THRU 1296 MHz. LOW NOISE OPTIONS AT 432 MHZ.**

**STANDARD I.F. 10M. I.F. OPTIONS 6M & 2M AVAILABLE**

- **POWER OUTPUT 12V D.C.**
  - Shipping: $2.50
- **MMc50** N. F. 2.5 db typ. $59.95
- **MMc144** N. F. 2.8 db typ. $59.95
- **MMc220** N. F. 3.0 db typ. $69.95
- **MMc432** N. F. 3.6 db typ. $69.95
- **MMc432S** N. F. 3.0 db typ. $69.95
- **MMc438/ATV** Ch2 or Ch3 IF $19.95
- **MMc1296** N. F. 8.5 db typ. $89.95

**ANTENNAS** (FOB CONCORD, VIA UPS)

- **144-148 MHz J-SLOTS**
  - **8 OVER 8 HORIZONTAL POL. +12.3 dbd** $50.65
  - **8 BY 8 VERTICAL POL.** $59.95
  - **8 + 8 TWIST 8xY/2M** $52.45

- **420-450 MHz MULTIBEAMS**
  - 48 EL. GAIN +15.7 dbd $74.95
  - 8 EL. GAIN +18.5 dbd $79.95

**SHIPMENTS**

- **200-250W carrier AM** $54.95
- **300W PEP AM** $79.95

**MODEL 2C5M** $499.00

- **CBnaaa Industries, Inc.** 1145 Bellamy Rd., Scarborough, Ontario M1H 1Y5
- **Export: EMEC Inc.** 2550 South 30th Avenue, Hollywood, Florida 33020

---

**1/4 KILOWATT LINEAR AMPLIFIER**

TPL proudly presents the first true power 1/4kW SSB/AM, FM or CW solid state 2 meter linear amplifier. A remote control plug allows you to operate with the amplifier ON or OFF, or in SSB/AM, FM or CW from the dashboard.

- **POWER INPUT:** HARMONIC ATTENUATION:
  - 5-20W Carrier FM or CW
  - 20W PEP maximum SSB or AM
- **POWER OUTPUT:**
  - 200-250W carrier FM or CW
  - 300W PEP SSB or AM
- **FREQUENCY RANGE:**
  - 144 to 148 MHz
  - 1250.1340 MHz
  - 1650.1750 MHz
- **DUTY CYCLE:**
  - FM 50% @ 150W
  - SSB 60% @ 150W
  - 50% @ 250W
- **Model 3002** $499.00
  - can be ordered for repeater application for additional information contact

**TL COMMUNICATIONS INC.**

1324 W. 135TH ST., GARDENA, CA 90247 (213) 538-9614

Canada: Lenbrook Industries, Ltd., 1145 Bellamy Rd., Scarborough, Ontario M1H 1Y5

Export: EMEC Inc., 2550 South 30th Avenue, Hollywood, Florida 33020

---

**START THE NEW YEAR WITH A COPY OF GREGORY ELECTRONICS NEW 1979 CATALOG**

**Gregory Electronius**

The FM Used Equipment People.

---

**Si**

Spectrum International, Inc.
Post Office Box 1084
Concord, Mass. 01742, USA

---

**More Details? CHECK — OFF Page 126**
FREQUENCY COUNTER KIT
Outstanding Performance
Incredible Price
$89.95

SPECIFICATIONS:
Frequency range 6 Hz to 60,600 Hz with CT-600 option
Resolution 1 Hz at 100 Hz
Readout 8 digit 0.4" High LED direct readout in mm/s
Accuracy adjustable to ppm
Stability 0.02% over 10 to 40°C temperature compensated
Input: BNC 3 megohm 20 pF direct 50 ohm with CT-600
Load: 50VAC maximum, all modes
Sensitivity: less than 5000 Hz/5000 Hz to 60 Hz
Power: 110 VAC 5 Watts or 12VDC 400 ma
Size: 6 1/4" x 4" x 2" high quality aluminum case 2 lbs
I/O: 13 units all socketed

Catch-Off

CAR CLOCK

The UN-KIT, only 5 solder connections!
Here's a super-looking rugged and accurate car clock which is a snap to build and install. Clock movement is completely assembled—readily soldered in 3 wires and 2 switches takes about 15 minutes' assembly. A bright, clear, automatic-brightness control photocell assures you of a highly readable display day or night. Comes in a satin-finished, anodized aluminum case which can be attached by 5 different ways using 2 sided tape. Choice of silver, black or gold case. (Specify)
DC-3 kit 12 hour format $22.95
DC-3 kit 24 hour $29.95
110V AC adapter $5.95

Under dash car clock

12-24 hour clock in a beautiful plastic case. Features 6 jumbo LEDs high accuracy (min. max.) easy 3 wire hookup: display blanks out with ignition and super instructions. Optional dimmer automatically adjusts display to ambient light level.
DC-11 clock with mtg bracket $27.95
DM-1 dimmer adapter 2.50

FREQUENCY COUNTER KIT

CT-50

The CT-50 is a versatile and precision frequency counter which will measure frequencies to 60 MHz and up to 600 MHz with the CT-600 option. Large scale integration, CMOS circuitry and solid-state display technology have enabled this counter to meet the demands of amateur units selling for over three times as much. Low power consumption (typically 300-400 ma) makes the CT-50 ideal for portable battery operation. Features of the CT-50 include a large digit LED display, RF shielded metal case, easy push-button operation, automatic reset circuitry, sockets 16 chip controls, IC chip component protection to 50 volts to ensure against accidental burnout or overload. And, the best feature of all is the easy assembly. Clear, step-by-step instructions guide you to a finished unit you can rely on. Order yours today!

CT-50, 60 MHz counter kit $89.95
CT-50WT 60 MHz counter wired and tested $114.95
CT-600, 600 MHz scaler option add $19.95

CAR CLOCK

The UN-KIT, only 5 solder connections!
Here's a super-looking rugged and accurate car clock which is a snap to build and install. Clock movement is completely assembled—readily soldered in 3 wires and 2 switches takes about 15 minutes' assembly. A bright, clear, automatic-brightness control photocell assures you of a highly readable display day or night. Comes in a satin-finished, anodized aluminum case which can be attached by 5 different ways using 2 sided tape. Choice of silver, black or gold case. (Specify)
DC-3 kit 12 hour format $22.95
DC-3 kit 24 hour $29.95
110V AC adapter $5.95

PLUNDER

Under dash car clock

12-24 hour clock in a beautiful plastic case. Features 6 jumbo LEDs high accuracy (min. max.) easy 3 wire hookup: display blanks out with ignition and super instructions. Optional dimmer automatically adjusts display to ambient light level.
DC-11 clock with mtg bracket $27.95
DM-1 dimmer adapter 2.50

PRESCALER

EXPREL

Extend the range of your counter to 600 MHz. Works with any counter. Includes 2 trigger circuits plus 2 jumpers for super sensitivity. Typically 20 mv at 150 MHz. Specify 10 or 100 ratio
PS-1B, 600 MHz prescaler kit $55.95
PS-1BK, 600 MHz prescaler kit 49.95

FM WIRELESS MIKE KIT

Transmits up to 900' to any FM broadcast radio any type of mike. Runs on 2 AA or 9V type FM-2 has added sensitive mike preamp stage. FM-1 kit $29.95
FM-2 kit $49.95

COLOR ORGAN/MUSIC LIGHTS

See music come alive! 3 different levels of color change—individual adjustable. Drives up to 300W Great for parties, band music clubs and more.
Complete kit ML-1 $7.95

LED BLINKY LIGHT

A great attention getter which alternates 2 LEDs to produce 6 LED colors. Use for name badges, buttons, warning gadgets, etc. Anything. Runs on 15 volts.
Complete kit BL-1 $2.95

VIDEO MODULATOR KIT

Converts any TV to video monitor Super stable tunable over ch 5-46. Runs on 5-15v accepts std video signal. Unit on the market.
Complete kit VD-1 $6.95

TONE DECODER

A complete tone decoder on a single PC board. Features 400-5000 Hz adjustable range via 20 turn pot, voltage regulation 567 IC, (Useful for touch tone decoding, tone burst detection, etc) Can also be used as a stable tone oscillator. Runs on 5 to 12 volts Complete kit TD-1 $5.95

POWER SUPPLY KIT

Complete triple regulated. For use with VD-1 and TD-1. Complete kit PS-3 $5.95

SUPER SLEUTH

A sensitive amplifier which will pick up a pin drop at 1 foot. Great for monitoring baby's / Tomcat or other special purpose. 2 Wms output runs on 6 to 15 volts. Uses 9/169v speaker Complete kit SB-1 $9.95

SIREN KIT

Produces upward and downward chirp which is characteristic of police sirens. 3000-12000 circuits Run on 15 volts. 3-45 mv speaker Complete kit SM-3 $2.95

PHONE ORDERS CALL

(716) 271-6847

ramsey electronics
BOX 4072, ROCHESTER, N. Y. 14610

More Details? CHECK — Off Page 126

February 1979 Page 93
short circuits

- 500-watt power supply

The article by WA6PEC, December, 1977, ham radio, page 30, contains a drafting error in fig. 1. There should not be a connection between the collector and base of Q3.

- tone-burst generator

The tone-burst generator by WA5KPG described on page 68 of September, 1977, ham radio contains an error in fig. 1. The junction of the 1N914 and R2 should not be connected to the PTT line, but only to C3.

active bandpass filters

The article on active bandpass filters (December, 1977, ham radio, page 49) contains some errors in the equations. An errata sheet is available by sending a self-addressed, stamped envelope to either the author or ham radio.

admittance, impedance, and circuit analysis

In Anderson’s article in the August, 1977, issue, there’s a glaring typographical error in the second sentence of the right-hand column on page 76. This should read, “if \( R = 10 \text{ ohms} \), then \( G = 0.1 \text{ mho} \).” There should be no minus sign in front of the 0.1 mho.

- 10-GHz broadband antenna

In the article on the broadband 10-GHz antenna which appeared in the May, 1977, issue of page 40, the chart of optimum feed beamwidth (fig. 3) is incorrectly labelled. The ordinate should be labelled as feed angle, not half-angle. Therefore, the simple antenna should be used with reflectors with focal length to diameter ratios, \( f \), between 0.3 and 0.6. Thanks go to N6TX for spotting the error.

- digital frequency counter

The counter article on page 22 in February, 1978, ham radio contained some drafting errors. The 9368 IC in figs. 2 and 3 should have \( V_{cc} \) connected to pin 16 instead of pin 11. Also in fig. 3, the short across the crystal should be omitted. In all cases, the collector resistor for the 2N5179 is 1000 ohms.

A circuit board layout of fig. 3 is now available from the author; a paper print is available by sending him a self-addressed, stamped envelope. A film negative is also available from the author for $5.00.

- ssb phasing systems

On page 58 of the January, 1978, issue, issue VK2ZTB states that an 88 mH toroid consists of two 44 mH coils. This is incorrect — an 88 mH toroid consists of two 22 mH coils connected in series. Thanks to N3GN for spotting the error.

- 30-MHz low-noise preamp

Coil winding instructions for the low-noise 30-MHz preamplifier in the October, 1978, issue, which were inadvertently left out of fig. 1, are as follows:

- L1 (0.77 \( \mu \text{H} \); 17 turns no. 28 (0.3 mm) wound on Micrometals T-25-6 powdered-iron toroid
- L2 (1.0 \( \mu \text{H} \)) 20 turns no. 28 (0.3 mm) wound on Micrometals T-25-6 powdered-iron toroid
- RFC (10 \( \mu \text{H} \)) 20 turns no. 28 (0.3 mm) wound on FT-230-06 ferrite bead

- active filters

The letter regarding active filter design (see Comments, ham radio, June, 1978, page 102) contained an erroneous equation. The value for \( R2 \) is determined from the following equation:

\[
R2 = \frac{1}{(2\pi - (G/Q)\times C\times f \times 2\pi}
\]

- spectrum analyzer filters

The two ceramic 10.7 MHz filters used in the spectrum analyzer described in the June, 1977, issue of ham radio (FL401 and FL501) are no longer available from Vernitron. Just before the production line was shut down, however, one of the employees was able to obtain 25 matched pairs which he is offering to readers who wish to build the spectrum analyzer; the price is $6.50 per pair, plus postage. Write to William Bowen, 1939 Green Road, Cleveland, Ohio 44121. The only other source for comparable ceramic filters is the Murata Corporation in Marietta, Georgia.

- semi-precision voltage calibrator

The digital voltmeter calibrator on page 68 of the July, 1978, issue of ham radio contains an incorrect statement. The input resistance of the precision rectifier circuit is actually 10k ohms, instead of the value of between 5 and 65 megohms specified in the article. To correct this problem, fig. 1 shows a simple voltage follower that can be inserted between S1 and the input to the precision rectifier. This will eliminate the loading effect on the reference voltage source and has negligible effect on the overall accuracy.

- general purpose vhf receiver

A capacitor was deleted from the schematic diagram shown in fig. 2 of the general purpose vhf receiver published in the July, 1978, issue of ham radio (see page 19). A 22-pF capacitor should be inserted between the gate of the MPF102 and the rotary contact of switch S1F.

- R-4C product detector

In the October, 1978, issue of ham radio, the schematic diagram of the new product detector for the R-4C shown on page 94 contains an incorrect component value. The 0.01-\( \mu \text{F} \) capacitor in series with pin 3 of the TL442 should actually be a 0.1-\( \mu \text{F} \) capacitor. In addition, the two inputs for the TL442 are actually taken only across one-half of the transformer’s secondary.
NEW! EXCITING! BREAKTHROUGH!

YAESU FT 901DM Transceiver & Accessories

$1,459.00
Speaker/Patch 74.00
CW Filter 45.00
FV-901 VFO 415.00

CALL FOR QUOTES ON:

YAESU
FT901 DM  TS820S
FT625  TS520S
FT225  TR7400A

KENWOOD

ALDA. AMCOMM, ETO ALPHA

TEMPHO VHF ONE PLUS

OMNI-J ANTENNAS

Model OJA-146
TWO METER AMATEUR BAND 146-148MHz
- NO GROUND PLANE REQUIRED
- USE FIXED. MOBILE, OR PORTABLE
- 5 dB GAIN OVER ISOTROPIC IN MOST MOBILE APPLICATIONS
- OVERALL LENGTH: LESS THAN 84 INCHES
- COLLAPSIBLE TO 22 INCHES. MAY BE PACKED IN SUIT CASE FOR THOSE OUT-OF-TOWN TRIPS
- STEEL WHIP AND ADAPTER INCLUDED FOR MOBILE AND FIXED APPLICATIONS
- VSWR: LESS THAN 1.2:1

PRICE $39.95 UPS Prepaid
220 MHz — $37.95 450 MHz — $37.95

CALL FOR FAST QUOTES
SPECIAL ORDERS WELCOME

GROUNDHOG GOODIES

OMNI-J & heavy duty magnet mount complete $49.95
TEXI W-51 FT Self Support Tower (Reg. $325.00)
Your Cost: (F.O.B. Californial $725.00
Tenna 99FT Antennas 144/166el
RIW 432/19el $59.95
KLITZING VHF-UHF Amplifiers
2M 10W in — 100W Out $198.00
432 10W in — 50 W Out $198.00
BIRD 43 & Slugs, UPS Paid Stock
Microwave Modules 432-285. UPS Paid $329.00
Telrex TBS68M. In Stock $415.00
NEW Palomar Engr Transceiver Preamp $89.50
Banche Paddies $39.95, Chrome $49.95
ETO 76 Amplifiers Stock
Lunar 6N/4M200 In Line Preamps $49.95
Luna 2M Amp 10:80 with Preamp. UPS Paid $189.95
Janel OSA 5 $41.95
CDE HAM-3 $129.00, HAM-X $249.00
VHF Engrs. blue line amps Stock
Cetron 572B $29.50

AMPEREX 6146B ........................................ $7.95
Motorola HEP 100 $29.99 ea.
Mallory 2.5A1000 PIV Epoxy Diode $0.19 ea.
Aerovox 1000PF/500V Feed thru $1.95
GE 6146B or 8950 $7.95

NEW BELDEN 9405 (1/16) 1/16 B-wire Rotor Cable
heavy duty for long runs $0.26/ft.
8448. Std. 8-wire Rotor $0.16/ft.
9888. double shield RG8 Foam $0.39/ft.
8214. RG8 Foam $0.25/ft.
8237. RG-8 $0.21/ft.
8267. RG-213 $0.25/ft.
Amphonol Silver Plate PL259 $0.59
TIMES: 1/8. Foam Hardline $0.60/ft. Connectors $15.00 ea.
BERKTEK RG-8X. 50 ohm. KW $0.16/ft.
Consolidated HD-18 Ga Gaith Towem. 10 Sec $29.95
Robot "Slow Scan" Now In Stock
Alliance HD73 Rotor $109.95
Teletower. self support - 55 ft/w breakover $499.00

THIS MONTH'S SPECIAL
ICOM IC280 — $395.00
DENTRON A1000 Amplifier — $319.00
BEARCAT 250 — $299.00

The 'Tonna' You've been hearing about

144/146 MHz SWR: 1.2:1
50 ohms Horiz./Vert.
length 6.4 m. Wt. 4.4 kg.
Side lobe attenuation — superb
Horizontal aperture — 2 x 16" (-3 dB)
Vertical aperture — 2 x 17" (-3 dB)
$79.95
9 Element 144-146 .......................... $39.95
4 Element 144-146 .......................... $32.95

MADISON ELECTRONICS SUPPLY. INC.
1508-D McKinney • HOUSTON. TEXAS 77002
713/658-0268
R-X Noise Bridge

All Palomar Engineers products are made in U.S.A. Since 1965, manufacturers of Amateur Radio equipment only.

- Learn the truth about your antenna.
- Find its resonant frequency.
- Adjust it to your operating frequency quickly and easily.

If there is one place in your station where you cannot risk uncertain results it is in your antenna.

The Palomar Engineers R-X Noise Bridge tells you if your antenna is resonant or not and, if it is not, whether it is too long or too short. All this in one measurement reading. And it works just as well with ham-band-only receivers as with general coverage equipment because it gives perfect null readings even when the antenna is not resonant. It gives resistance and reactance readings on dipoles, inverted Vees, quads, beams multiband trap dipoles and verticals. No station is complete without this up-to-date instrument.

Why work in the dark? Your SWR meter or your resistance noise bridge tells you only half the story. Get the instrument that really works, the Palomar Engineers R-X Noise Bridge. Use it to check your antennas from 1 to 100 MHz. And use it in your shack to adjust resonant frequencies of both series and parallel tuned circuits. Works better than a dip meter and costs a lot less. Send for our free brochure.

The price is $49.95 in the U.S. and Canada. Add $2.00 shipping/handling. California residents add sales tax.

Fully guaranteed by the originator of the R-X Noise Bridge. ORDER YOURS NOW!

Palomar Engineers
Box 455, Escondido, CA 92025 - Phone: [714] 747-3343

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.

We welcome Mastercharge or VISA

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

HAM REPEATER AUTOPATCH

Offer your club COMPLETE emergency communications

Commercial quality, gold plated contacts, plug in, epoxy glass PC boards. 12 volt DC or 115 volt AC operation - Power supply included. Four digit access - Single digit releases - field programmable. Hybrid network - No switching required. FCC certified telephone line coupler. Auxiliary "In Use" contacts supplied. Land line "call-in" signalling control contacts provided.

Price complete $498 + $3 shipping & handling. Master Charge. Bank money order, or certified check acceptable.

Accessories: CES-300 powered tone pad - $50 BUS-COM Soft-touch telephone powered mike/pad element - $34.95.

M E

MONROE ELECTRONICS, INC.
410 House Ave., Lyndonville, N.Y. 14098

More Details? CHECK — OFF Page 126
The all-solid-state Model 2000 simplifies assembly. Complete kit includes a rugged high-impact and high-quality components. Our clear, step-by-step manual automatic zeroing case ideal for both test-bench and field use.

The amazing Sabtronics 2000 is the choice of both professionals and hobbyists. It's the only portable/bench DMM that offers so much performance for such an astonishing low price.

You get basic DCV accuracy of 0.1% ± 1 digit; 5 functions giving 28 ranges; readings to ±1999 with 100% overrange; overrange indication; input overload protection: automatic polarity; and automatic zeroing.


**Model 8100 Frequency Counter Kit**
- Range: 20Hz to 100MHz
- High Sensitivity
- Resolution to 0.1Hz

Now you can forget about price/performance trade-offs when you select a frequency counter. In Sabtronics' Model 8100 kit you get all the characteristics of superior performance at a low, affordable price.

This frequency counter, employing LSI technology, has the performance and input characteristics you demand: guaranteed frequency range of 20Hz to 100MHz (10 Hz to 120MHz typical); selectable hi/lo impedance; superior sensitivity; selectable resolution and selectable attenuation. Plus an accurate time base with excellent stability.

An 8-digit LED display features gate activity indicator, leading zero suppression and overflow indicator. You would expect to find all these features only on high-priced instruments — or from Sabtronics' advanced digital technology.

**Model 2000, 3½ Digit DMM Kit**
- 5 Functions, 28 Ranges
- Basic DCV Accuracy: 0.1% ± 1 Digit

The amazing Sabtronics 2000 is the choice of both professionals and hobbyists. It's the only portable/bench DMM that offers so much performance for such an astonishing low price.

You get basic DCV accuracy of 0.1% ± 1 digit; 5 functions giving 28 ranges; readings to ±1999 with 100% overrange; overrange indication; input overload protection: automatic polarity; and automatic zeroing.


**Special Offer! Save $25.00**

If you order both the frequency counter and DMM kits now, you pay only $144.90 including shipping and handling. You save $25.00 off the combined regular low price of $169.90. Order both kits now. This special offer good for a limited time only.

*Special offer good in USA only.

Making performance affordable.

**BRIEF SPECIFICATIONS:**
- Frequency Range: 20Hz to 100MHz guaranteed. (10Hz to 120MHz typical) • Sensitivity: 15mV RMS, 20Hz to 50MHz (10mV typical); 25mV RMS, 50MHz to 100MHz (20mV typical)
- Selectable Impedance: 1MΩ/25pF or 50Ω • Attenuation: X1, X10 or X100 • Accuracy: ±1Hz plus time base accuracy • Aging Rate: ±5ppm/yr. • Temperature Stability: ±10ppm, 0°C to 40°C
- Resolution: 0.1Hz, 1Hz, 10Hz selectable • Display: 8-digit LED, overflow indicator, gate activity indicator • Overload Protection
- Power Requirement: 9-15 VDC @ 330mA

**BRIEF SPECIFICATIONS:**
- DC volts in 5 ranges: 100 µV to 1kV • AC volts in 5 ranges: 100 µV to 1kV • DC current in 6 ranges: 100 nA to 2A • AC current in 6 ranges: 100 nA to 2A • Resistance: 0.1Ω to 20Ω in 6 ranges
- AC frequency response: 40 Hz to 50kHz • Display: 0.36" (9.1mm) 7-segment LED • Input Impedance: 10MΩ • Size: 8"W × 6.5"D × 3"H (203 × 165 × 76 mm) • Power requirement: 4.5-6.5 VDC

**Special Offer expires Feb. 28, 1979.**

Sabtronics International Inc. 13426 Floyd Circle Dallas, Texas 75243
HR-2

- Yes, I want to take advantage of your special $25.00-off offer. *
- Please send Model 8100 Frequency Counter Kit(s) @ $89.95 ea $
- Please send Model 2000 Frequency Counter Kit(s) @ $89.95 ea $
- Please send Model 2000 DMM Kit(s) @ $89.95 ea $

Texas residents add sales tax Total enclosed $

* USA only. CANADA: $6.50. FOREIGN: $19.00 AIRMAIL.
new DenTron amplifier

DenTron Radio Company is proud to announce a revolutionary new linear amplifier for the Amateur frequencies, the GLA-1000. Incorporating four D-50A (6L6G) final-amplifier tubes, the GLA-1000 is rated at 1200 watts PEP ssb and 1000 watts CW input. It features a black scale multimeter for monitoring of critical currents and voltages, complete compatibility with any exciter or transceiver, front-panel bypass switch, transmit indicator light, and a built-in relative power monitor for easy tune up. The GLA-1000 is compact, ideal for portable or fixed operation. It is shipped ready for 117 Vac power, with 80 to 15 meter frequency coverage (and most MARS frequencies just outside the Amateur bands). FCC Type Acceptance has been granted. Suggested retail price is $379.50. The GLA-1000 is now available at DenTron dealerships worldwide. Write DenTron Radio Company, 2100 Enterprise Parkway, Twinsburg, Ohio 44087.

LP-1 logic probe

The Logical Force™ is what Continental Specialties Corporation calls its line of digital test instruments, which includes their new model LP-1 hand-held digital logic probe.

The LP-1 derives its power from the circuit under test. Its 0.1-megohm input impedance minimizes circuit loading. An on-probe switch selects either TTL/DTL or HTL/CMOS family logic levels. Then separate on-probe LEDs light to indicate HIGH and LOW logic states.

A built-in pulse stretcher briefly flashes a third PULSE LED on the positive- or negative-going leading edge of a single pulse as short as 50 ns; the PULSE LED flashes for pulse trains up to 10 MHz. In addition, the relative brightness of the HIGH and LOW LEDs can be used to estimate duty cycle.

A built-in switch-selected pulse memory latches the PULSE LED on whenever a pulse is intercepted, aiding the probe's versatility in troubleshooting intermittent glitches.

A number of probe tip and power cable accessories are optionally available. The LP-1, complete with an application and instruction manual, carries a manufacturer's suggested retail price of $44.95.

Motorola microwave transistors

Motorola has introduced a new series of microwave transistors that combine state-of-the-art performance, a variety of packaging options, and a major breakthrough in pricing for the uhf market. Intended for low- to medium-power amplification, the new transistor series features high gain (up to 15 dB at 0.5 GHz) and a very low noise figure (typically 2 dB at 0.5 GHz and 10 mA). Prices range from a low of $1.40 (in chip form) to a high of only $7.50 (hundred-up) for high-reliability applications.

The transistor series encompasses five device types, a basic chip and four package options, with optimized specifications and pricing for a wide variety of applications.

Available in unencapsulated form for hybrid application, the basic chips achieve their high-performance characteristics from fine-line geometry, ion-implanted arsenic emitters, and gold top metalization.

Gold top metalization prevents metal migration due to the high-current densities in the fine metal lines required for high-frequency operation. Ion implantation facilitates precise control of dopant densities and gradients. The use of arsenic dopant results in a higher $f_T$ and corresponding improvement in noise figure, compared with the more conventional processing.

The high current, low noise figure, and high-$f_T$ performance of the BFR96 series of transistors makes them eminently suitable for broad-
band vhf/uhf linear amplifier and oscillator applications.

Low-cost package options offer the basic chip in two types of plastic packages, the three-leaded MACRO-T package (BFR96), and the four-leaded MACRO-X package (MRF961). These are particularly well suited for MATV/CATV applications.

The MACRO-T package has become an industry standard and adapts the BFR96 to existing board layouts and designs. The four-leaded MACRO-X package offers a 2.5 dB higher gain, due to lower parasitics resulting from opposed-emitter lead construction, at no increase in price.

The metal/ceramic, hermetic strip-line MRF962 package is intended for use in equipment that is subject to particularly hostile environmental conditions and when high reliability is required. This low parasitic microwave package enables the MRF962 to be specified for operation up to 2 GHz and gives typically a 6.0 dB higher power gain compared with the same die in a MACRO-T package at 500 MHz. The metal/ceramic package allows higher power dissipation than the plastic case.

The higher dissipation rating and hermeticity of the MRF965, in its TO-46 package, allows its use in high gain vhf/uhf Class C amplifier applications up to 400 milliwatts output power. This is in addition to the Class A linear applications discussed for the other package options.

An important feature of this series of devices is a four-part data sheet with common-emitter S-parameters at two levels of $V_{CE}$, three collector currents, and six frequencies from 100 MHz to 1500 MHz. More information on the BFR96 series may be obtained by writing to Motorola Semiconductors, Post Office Box 20912, Phoenix, Arizona 85036.

appointment clock

Hal-Tronix has announced the availability of TimeTrac, a micro-

CUSHCRAFT IS THE HF MULTIBAND ANTENNA COMPANY.

Cushcraft manufactures a full range of high-frequency antennas which are performance engineered for the most discriminating amateur. For the amateur who demands top performance in a multiband Yagi beam there's the incomparable ABT-34 three-band beam for broadband, high-gain coverage on 10, 15 and 20 meters.

And for the Amateur with limited antenna space and budget who wants reliable, multiband radio communications there are three Cushcraft multiband verticals to choose from: the three-band ATV-3 for 10, 15 and 20; the four-band ATV-4 for 10, 15, 20 and 40 meters; and the ATV-5 for low VSWR five-band performance from 80 through 10 meters.

Cushcraft high-frequency antennas are quality engineered for top performance; they are often imitated, but never duplicated.
NEW...CoaxProbe*...NEW
Coaxial RF Probe for Frequency Counters and Oscilloscopes That Lets You Monitor Your Transmitted Signal Directly From the Coax Line.

Only $12.95
plus .50 postage

FINALLY! A RF PROBE that lets you connect into your coax cable for frequency measurements and modulation waveform checks directly from the transmitter.

JUST CONNECT THE CoaxProbe* into your transmission line and plug the output into the frequency counter or oscilloscope. Insertion loss is less than .2db so you can leave it in while you operate.

A NECESSITY IN ANY WELL-ORGANIZED HAM SHACK, the CoaxProbe* eliminates "jerry-rigging" and hassles when tapping into the coax line is desired.

A SPECIAL METHOD OF SAMPLING keeps output relatively constant with a wide variation of power. Power output of 8 watts gives .31v out, while 800 watts will give 1.8v out. (rms 3-30 mhz.) 2000 watts pep rating too!

*Trademark of CoaxProbe Co. for rf sampling device.

If not available at your local dealer, please contact us directly.

ASTRON CORPORATION
1971 SOUTH RITCHIE ST., SANTA ANA, CA 92705 (714) 835-0682

FREE SURPLUS CATALOG

Hobbyists, educators, technicians, and dealers alike are sure to be interested in the new Surplus Electronics catalog just published by Etco Electronics, because almost every item in it doesn't fit the usual concept of "surplus."

A look through the catalog will reveal an amazing variety of items, ranging from parts and components and test equipment to educational, industrial, and consumer equipment acquired from leading manufacturers.

The prices are always very low — in many cases only a small percentage of the normal price — because Etco's items come from surplus inventories, overstocks, and bankruptcies.

Get a copy of this fascinating cata-

More Details? CHECK — OFF Page 126
compact power microphone

With today’s generation of home-based communications operators having severe space limitations, Robins Industries has introduced a compact base-station power microphone with features usually found in larger and more expensive units.

This new power microphone is specially designed for Amateur and CB ssb transceivers. It incorporates a built-in, solid-state preamplifier to improve the modulation percentage figure of the transceiver. Low and high ends of the speech-frequency band are adequately attenuated to increase intelligibility. A full-width, press-to-talk bar switch, with positive locking mechanism, facilitates continuous operation. A minimum/maximum sliding gain control is clearly indicated.

The cardioid (uni-directional) polar pattern helps to screen out unwanted background noises when transmitting. Output level is rated at −36 dB at 1000 Hz, with an amplifier gain of 30 dB.
ALL STEAM -- NO POWER?
NOW ADD MORE POWER TO YOUR MOBILE
WITH A POWER AMPLIFIER.
NOW AVAILABLE! KITS and WIRED & TESTED
UNITS IN STOCK. READY FOR SHIPMENT!!
"creative electronics"
p.o. box 7054
marietta, georgia 30065
PHONE (404) 971-2122 OR (800) 241-4547 TOLL FREE OUTSIDE OF GA.
ASK FOR NEIL OR JUDI
DEALERS & DISTRIBUTORS FOR:
VHF ENGINEERING
POWER AMPLIFIERS
FOR FM AND LINEAR
POWER SUPPLIES
15 AND 25 AMP
HAMTRONICS
POWER AMPLIFIERS
LINEAR
PREAMPS
ALSO AVAILABLE IN STOCK A COMPLETE
SELECTION OF VHF ENGINEERING AND
HAMTRONICS ITEMS.

STEP UP TO TELREX
WITH A
TELREX "BALUN" FED-"INVERTED-VEE" KIT
THE IDEAL HI-PERFORMANCE
INEXPENSIVE AND PRACTICAL TO INSTALL LOW-FREQUENCY
MONO OR MULTIPLE BAND, 52 OHM ANTENNA SYSTEM

Telrex "Monarch" (Trapped) I.V. Kit
Duo-Band / 4 KWP I.V. Kit $63.50
Post Paid Continental U.S.
Optimum, full-size doublet performance, independent of ground conditions! "Balanced-Profile", low radiation angle, high signal to noise, and signal to performance ratio! Minimal support costs, (existing tower, house, tree). A technician can resonate a Telrex "Inverted-Vee" to frequency within the hour! Minimal S/W/R is possible if installed and resonated to frequency as directed! Pattern primarily low-angle, Omni-directional, approx. 60 DB null at ends! Costly, lossy, antenna tuners not required! Complete simplified installation and resonating to frequency instructions supplied with each kit.

For technical data and prices on complete Telrex line, write for Catalog PL 7 (HRH)

For further information, contact Charles Condike, Robins Industries Corp., 75 Austin Blvd., Commack, New York, 11725.

new bird amateur wattmeters

The Models 4360 and 4362 HAM-MATE directional wattmeters are designed specifically for the Amateur Radio service. The 4360 covers the 1.8-30-MHz range (200 and 2000 watts) and the 4362 is for use in the 140-180-MHz range, which includes the popular 2-meter band. 4362 has 25 and 250-watt scales. The design of the HAM-MATEs is basically that of all Bird THRULINE® rf wattmeters, except that they do not use plug-in elements. Instead, the sensing element is permanently installed in the line section and is rotatable from the front panel to provide the choice of reading either forward or reflecting power.

Both wattmeters are dual-range to allow measurement of both low and high power, and the meter reads directly in watts, with the high range being read on the upper arc and the low range on the lower arc. The down-scale portion of each range is expanded for easier reading. The average power output of CW, a-m, fm, and ssb transmitters can be measured with ease, and the wattmeters can be left in the line to allow continuous monitoring of the power output. The HAM-MATE wattmeters are especially useful during the tune-up of an Amateur transmitter.
microprocessor controlled 2-meter FM transceiver

The TR-7600 2-meter FM mobile transceiver with memory and an optional RM-76 microprocessor control unit (which provides six memories and various scanning functions) have been introduced by Trio-Kenwood Communications, Inc., of Compton, California.

This new transceiver provides full 4-MHz coverage (800 channels) on 2 meters and includes a memory channel. It operates on simplex (same transmit and receive frequencies) or repeater (plus or minus 600-kHz transmitter offset) modes. Furthermore, the memory can be used to provide a transmit frequency for accessing a repeater with a nonstandard frequency pair. The TR-7600 also features a digital frequency display with large, bright-orange LEDs. Another LED, called an “unlock” indicator, shows transceiver protection when the frequency selector switches are improperly positioned or the PLL has malfunctioned. Selecting frequencies with the TR-7600 is fast and easy with its dual concentric knobs, 5-kHz offset switch, and MHz-selector switch.

Power output is switchable between 10 watts and 1 watt (adjust-
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 radioteletypewriter 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 3500 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, autostart with solid-state motor switching, antispace, 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.

Electrocom INDUSTRIES
1105 N. IRONWOOD DRIVE, SOUTH BEND, INDIANA 46615
Telephone: (219) 232-2743

THE PERFECT COUPLE! - HMR's REPEATER & CONTROLLER

HMR now offers a full line of repeaters for every band and versatile companion controllers which were developed to meet every amateur and commercial application. Customer acceptance and in field reliability has been so good that we now give a full two year warranty on all our amateur products. Write us and we will be glad to send you all the details.

HMR COMMUNICATIONS, INC., ARD, WEST NEWTON, PA 15089

able from 1 to 10 watts). The TR-7600 is ideal for mobile use and comes with the MC-305 noise-cancelling dynamic microphone. The optional RM-76 Microprocessor Control unit allows the TR-7600 to perform many interesting new functions. Using the RM-76 keyboard, the Amateur can select any 2-meter frequency (including MARS on 143.95 MHz simplex), store frequencies in six memories, automatically scan up the band in 5-kHz steps, manually scan up or down in 5-kHz steps, set lower and upper scan frequency limits, scan for busy or open channel, reset scan to 144 MHz, stop scan, cancel scan (for transmitting), and select repeater mode. The RM-76's digital display indicates frequency (even while scanning) as well as functions (such as autoscanning, lower scan frequency limit, upper scan limit, error, and call channel).

The TR-7600 will have a suggested list price of $375.00. For more information see your authorized dealer or contact Trio-Kenwood Communications, Inc., 1111 West Walnut Street, Compton, California 90220.

Micro Duster cleaning gas

Chemtronics Inc., a major manufacturer of chemical products, recently introduced Micro Duster, a new product that permits compressed-gas dusting of delicate instruments and assemblies. The product contains pure, moisture-free, nonflammable and nontoxic filtered gas, providing controlled removal of dust, lint, oxide particles, and the like without depositing harmful contaminants. Micro Duster has a broad range of applications, including mechanical and electrical miniature assemblies, audio components, computer tapes and heads, clean-room areas, timepieces, business machines, camera lenses and other optics, plus film negatives, and slides.

A single 425-gram (15-oz.) can of Micro Duster produces over 1800
one-second compressed-gas bursts, or 25 to 30 minutes of continuous dusting. Spraying in short bursts until contaminants are dislodged is recommended for most efficient use. The product comes with an extension tube for pinpoint applications. For precision application in harder-to-reach areas, Micro Duster may be used with Chemtronics’ Vibra-Jet attachment which provides extended range with a 30 cm (12-inch) rigid probe on the end of a 66-cm (26-inch) flexible tube.

The product, which contains 100 per cent laboratory controlled, guaranteed pure, inert gas, is available in 425-gram (15-ounce) cans with a suggested retail value of $2.50. It is sold only through Chemtronics distributors. For more information, including the location of local distributors, contact Chemtronics Inc., 45 Hoffman Avenue, Hauppauge, New York 11787.

**Outlet-strip catalog**

Multiple outlet strips are useful when your circuit design calls for a safe method of adding hardware for testing and experimental work. SGL Waber Electric offers a catalog of 85 new UL-listed multiple outlet strips. The catalog also gives detailed descriptions and specs covering 240 multiple outlet strips and 15 wheeled carriers that are widely used in industrial, commercial, and military fields. Also given in the catalog are examples of typical operation, custom designs, and ordering information.

The 85 new UL listed strips use a unique mounting method and provide circuit-breaker protection against overloads and short circuits. All SGL Waber Electric multiple outlet strips are rated at 15 amperes, 125 volts ac, 60 Hz. That’s 1875 watts, continuous duty. Write for the free catalog. Address your letter to SGL Waber Electric, 300 Harvard Ave., Westville, New Jersey 08093, or phone (609) 456-5400.
**EIMAC**

World's finest:
- Power tubes
- Sockets and socket parts
- Chimneys, plates and caps, etc.

Whitehouse has all the parts for your homebrew amplifier . . . EIMAC and more.

**FREE CATALOG upon request**

Call to order Eimac (603) 673-7724

---

**FT-227 "MEMORIZER" OWNERS: SCANNER KIT**

- Selectable sweep width (up to full band)
- Scans only the portion of band you select
- Scans at the rate of 200 kHz per second
- Switch modification on mike allows you to scan past, or lock on, any occupied frequency
- Complete kit with detailed instructions
- Installs inside rig; no obtrusive external connections
- Rig can easily be returned to original condition whenever desired
- Scans to preset limits and reverses
- Automatic bypass of locked frequency in 3-1/2 seconds unless you press lock-on switch

Kit $34.95 preassembled and tested $54.00

IC-22S Scanner Kits also available

Kit $34.95, $54.00 assembled

dealer inquiries invited

**AED ELECTRONICS**

750 Lucerne Rd., Suite 120
Montreal, Quebec, Canada H3R 2H6

TEL. 514-737-7293

---

**AED Electronics scanner**

Owners of the popular Yaesu FT-227R two-meter transceiver can now use their rigs in the scanning mode, as a result of the recent introduction of a new scanner by AED Electronics in Montreal, Quebec. The AED scanner is available either in kit form or fully wired and tested, and makes use of the FT-227R digital readout to indicate frequency. The scanner kit is furnished with schematic, board layout diagram, and complete wiring and assembly instructions that use the well-known, step-by-step method of construction aids. Included with the kit are a double-sided glass epoxy circuit board, silk-screened for component location and predrilled to accommodate the component leads. Thirty-five components, including two ICs (with sockets) and a miniature switch are furnished. The board can be wired in about three hours; it measures 1.3 x 10.2 cm (0.5 x 4 inches). It fits inside the case of the FT-227, alongside one of the chassis rails, and is connected into the circuit by eleven lead wires. Because of the CMOS circuitry, the scanner draws very little current. The scanner operates in the manner of a sampler, moving up a predetermined portion of the band in 10-kHz steps until it reaches the upper limit, whereupon it reverses and scans back down the band. When a signal appears, the scanner pauses for three seconds and then moves on, unless the operator toggles the mini-switch on the microphone case to lock the scanner to the busy channel. The operator may select any 1-MHz portion of the band to be scanned, and also may select frequency range and delay. Once the SCAN-OPERATE switch is released, the scanning function continues. A convenient feature is the ability of the scanner to be used with the Heathkit encoding microphone, or with the standard Yaesu mike that comes with the rig. The AED scanner kit sells for $34.95; the preassembled and tested version
sells for $54. Please include $1.50 for shipping and handling. For more information on this and other products, write AED Electronics Ltd., 750 Lucerne Road, Montreal, Quebec, Canada.

Yaesu 6-meter transceiver

With the six-meter Amateur band heading into an era of world-wide DX similar to that enjoyed by hams in the 1950s, Yaesu Electronics announces the availability of their new all-mode, six-meter transceiver, the FT-625R.

The transceiver offers USB, LSB, A-M, CW, and fm, with 25 watts ssb PEP, 25 watts fm or CW, and ten watts ssb output.

An rf speech processor is built in and a 600-Hz CW filter is available as an option, as is the memory storage unit, which allows recall of any frequency with just the flick of a switch. The memory unit is ideal for watching a beacon or calling frequency during marginal openings.

Digital readout is accurate to 0.1 kHz. Analog readout is the model FT-625R, at slightly less cost, is better than 1 kHz. VOX, PTT, semi-breakin CW with sidetone, and a clarifier for receive or transceive are all included in the circuitry. For fm repeater use, the transceiver features standard ±1 MHz repeater offset, programmable tone-burst encoder, squelch, and a discriminator zero-center meter. Alternative repeater splits may be accommodated through an optional crystal or the optional memory unit.

A built-in power supply accommodates all line voltages with taps for 100/110/120/200/220 and 234 Vac, 50/60 Hz, or DC voltages from 11.5 to 18 Vdc, negative ground at 5.7 amps transmit and 0.7 amps receive.

For a detailed, four-color brochure, see your nearby authorized Yaesu dealer or write to Yaesu Electronics Corporation, P.O. Box 498, Paramount, California 90723.
The new SST T-4 Ultra Tuner Deluxe matches any antenna—coax fed or random wire on all bands (160-10 meters). It uses your dipole, vertical, beam, etc. It works with any transceiver.

Tune out the SWR on your antenna for more efficient operation of your rig. One antenna can even be used for all bands. The SWR on mobile whips can be tuned out from inside your car.

An easy-to-read two color meter scale provides convenient indication of SWR for easy tuning. A back panel antenna switch allows you to select between two coax fed antennas, a random wire, or tuner bypass.

The SST T-4 Ultra Tuner Deluxe is compatible with any rig—solid state or tube. It's compact size (9" x 2 1/2" x 5") makes it ideal for mobile, portable, or home operation. Features an attractive bronze finished enclosure and exclusive SST styling.

Features:
- Matches any antenna - coax fed or random wire. 1.8-30 MHz.
- 900 watt output power capability.
- SWR meter.
- Antenna switch on back panel.
- Efficient tapped inductor.
- 208 pf. 1000v. capacitors for flexible, reliable operation.
- Johnson binding posts. Four SO-239 connectors.
- Made in USA.

Compare features, quality, and price—SST antenna tuners are your best value. This is our seventh year of manufacturing compact antenna tuners. Available now at your SST dealer or order direct—information on following page.

only $69.95
WANTED FOR CASH

490-T Ant. Tuning Unit
(Also known as CU1658 and CU1669)
Highest price paid for these units. Parts purchased.

618-T Transceiver
(Also known as MRC95, ARC94, ARC102, or VC102)

Accessories

SST T-3
Mobile Impedance Transformer

$19.95

SST DL-1 K4RLJ Dummy Load

$17.95

SST AS-1 Antenna Switch

$11.95

Random Wire Antenna Tuner

SST T-2 Ultra Tuner

Tunes out SWR on any coax fed antenna as well as random wires. Works great on all bands (80-10 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 efficient tapped inductor and specially made capacitors for small size: 1/2" x 2" x 1/4". Rugged, yet compact. Negligible line loss. Attractive bronze finished enclosure. SST-299 coax connectors are used for transmitter input and coax fed antennas. Convenient binding posts are provided for random wire and ground connections.

TO ORDER:

Send a check or money order—or use your Master Charge or VISA card. COD and credit card orders are also accepted by phone. Simply give us your card number and expiration date. Our phone order desk is open at most hours for your convenience and so that you can take advantage of the very low before/after hour phone rates.

GUARANTEE:

All SST products are unconditionally 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.

ELECTRONICS
P.O. Box 1, Lawndale, Calif. 90260
(213) 376-5867

DCO, INC.
10 Schuyler Avenue
No. Arlington, N.J. 07032
(201) 998-4246

Call (213) 376-5867 or 379-5672 to order
C.O.D., VISA or Master Charge

or send to: SST Electronics,
P.O. Box 1, Lawndale, Calif. 90260

Please add $3 for shipping and handling ($6 Air mail Worldwide). California residents, please add sales tax. $1 charge for COD.

Name__________________________
Street_________________________
City___________________________
State__________________________
Zip____________________________
Models Desired: Total Enclosed

Charge to: VISA D.M.C. C.O.D.
Card #_____________________
Exp. Date_____________________

More Details? CHECK—OFF Page 126

February 1979

109
flea market


WEATHER STATION. Have your own station for your club? Used fasmicke recorder available in perfect working condition. It gives all weather chart plus satellite image of cloud cover. Only $500 plus come and get it. Contact Frank Borek (313) 761-2300 ext. 233 (days), or (313) 231-2177 (evenings).

PORTA PAK the accessory that makes your mobile really portable. $67.50 and $88.50. Dealer inquires invited. P.O. Box 67, Somers, Wisc. 53371.

FREE CATALOGS: P.C. Boards from artwork or magazine. 36c a sq. in. Also artwork, drills, parts and kits. Hauck Electronics, 1926 Fairavens Avenue, Pittsburgh, PA 15216.

STAR-TRONICS monthly picture flyer is full of parts and pieces for the builder. Cheap. Quality. U.S. only. Star-TRONICS, Box 683, Minniville, OR 97128.


MOBILE IGNITION SHIELDING provides more range with no noise. Available most engines. Many other suppression accessories. Literature. Estes Engineering, 930 Maritime Dr., , WA 98025. 

STAMP BRINGS USED HAM GEAR list - Lewalski, Apt. 17, 2717 Wyandotte, Las Vegas, NV 89102.

RECONDITIONED TEST EQUIPMENT for sale. Catalog $.50. Walter, 2607 Nielce, San Pablo, CA 94906.

FOR SALE: HW-8: $100; HP 606C Signal Generator, 10-480 MHz, built-in crystal calibrator: $600; R939A Receiver and manual: $500. All F.G. Champagne, Jr. Tancig, WBYF1, P.O. Box 397, Sidney, ID 83550.

HAM STATION EQUIPMENT plus test equipment. Send SASE to Len, W2ZTL, 22 Abbott Rd., Waltham, MA 02154.

ROHN TOWERS — Buy worldwide Distributor 25G sections $35.97 each - 45G sections $54.89 each. 100 foot tower kit $628.22. 48 foot fold over tower $515.50, freight paid - 40 foot free standing BX $171.97. — Hill Radio, 2503 E.G. Road, Bloomington, IL 61701, (309) 653-2141.


SELLING: An extensive collection of magazines, books, catalogues, and other materials pertaining to amateur radio 1905 to present. Complete sets of QG, 73, Ham Radio, and more manuals. Many first editions, textbooks, handbooks, ARRL publications. Also GST 1921 to present complete. Many loose issues of rare journals. Also antique radio tubes and parts and parts. Send SASE for list to: Richard Kampf, 9 Black Birch Lane, Scarsdale, New York 10583.

QLS CARDS 500/$10. 400 illustrations, specimen. Bowman Printing, Dept. HR, 743 Harvard, St. Louis, MO 63130.

ELECTRONIC KEYERS, Code practice oscillators, car alarms. FREE catalog sheets. Globalman, WPBHA, Box 246HR, El Toro, CA 92630. (714) 533-4400.

ELECTRONIC BARGAINS, CLOSEOUTS, SURPLUS! Parts, equipment, stereo, industrial, educational. Amazing values! Fascinating items unavailable in stores or catalogs anywhere. Unusual FREE catalog. ETCO-012, Box 762, Plattsburg, NY. 12901. SURPLUS WANTED.

TELETYPE EQUIPMENT for beginners and experienced operators. RTTY machines, parts, supplies. Beginner’s special. Model 15 Printer and demodulator $139.00. Dozen black ribbons $6.50; case 40 rolls $111.60 perf. tape. All new $17.50 FOB. Atlantic Surplus Sales, 3730 Nautilus Ave., New York 10583.

FM-300 RTTY Modem, the complete TU and AFSK generator on one board. Just the modem featured Sept ’78 Ham Radio. Complete documentation $2.00. FM-300 Modem or RP-400 Power Supply board just $21.25. Complete FM-300 or RP-400 kit less PROM $17.25. PROM programmed with your call $17.00. WA6DNR Eclipse Communications, 5 Westwood Drive, San Rafael, CA 94901.

EZ deals are the best! Try me and see for Yaesu, Drake, KLM, Scan, Comstar, Shorten, VHF Intercom, CDE, Hustler, Wilson and more. Call, see or write W2E, Bob Smith Electronics, RDF 3, Hwy 169 & 7, Fort Dodge, IA 50501. (515) 576-3969.

More Details? CHECK — OFF Page 126
You're just a few digits away from name brand radio equipment - AT DISCOUNT PRICES!

CALL TOLL FREE
1-800-228-4097
Communications Center
443 N 48th Street
Lincoln, Nebraska 68504
In Nebraska Call (402) 466-8402

1-800-634-6227
Communications Center West
1072 N Rancho Drive
Las Vegas, Nevada 89106
In Nevada Call (702) 647-3114

We carry all major lines of Antennas at Discount Prices

OUR NEW HOURS
at Lincoln store only

SAME DAY SHIPPING ON MOST ITEMS

1-800-228-4097
Communications Center
443 N. 48th, Lincoln, Nebraska 68504
In Nebraska Call (402) 466-8402

More Details? CHECK — OFF Page 126
Oscillator for even more versatility. The effects generator and pots to program the Texas Instruments 78447 Sound Chip, the board provides banks of Mini DIP switches and pots to program the various combinations of the SFL Oscillator, VCO, Noise, One Shot and Envelope Controls. Another IC is used to implement an Adjustable Pulse Generator. Level Comparator and Multiplex Oscillator for even more versatility. The 3½" by 5" printed circuit board features a prototype area to allow for user-added circuitry. Easily programmed to duplicate Explosions, for Guns, Steam Trains, or an almost infinite number of other sounds, the unit has a multitude of applications. The $16.95 price includes Assembly Manual, Programming Charts, and 76477 Chip specifications (speaker not included). Available from stock.

POWER SUPPLY KIT  
PS-14  
Better than 300V lead and inter regulation  
Short Circuit Protected  
Overcurrent limiting  
Adjustable Current Limiting  
Built-in fan  
All parts supplied including heavy duty transformer  
Quality printed circuit board  
REVIEWED IN 7/78 73 MAG.  
15A CONT. 20A INT. 42.95

OVERVOLTAGE PROTECTION KIT  
6.95  
Provides cheap and easy protection for expensive equipment  
This voltage is adjustable from 3 to 100 volts  
Overvoltage protection circuit is 20A slow and works with all domestic AC supplies  
Works equally well with 117 or 230 volt AC supplies  
For use with existing PC boards with 117 or 230 volt AC supplies  
LIMITED QUANTITY  
EMITTER RESISTORS  
HARD TO FIND VALUES  
Makes a great gift  
2.95

NEW ITEMS  
WY-2444 Soldering Iron Gift Set: 2 1/2"  
Tubing 49.95  
S2424 1000 high quality antenna wire: 20'  
Cable 1995  
W+FM3400 5 Watt 10w 40 watts  
W+FM3500 1 Watt 10w 40watts  
FM3500 8 Watt 40watts  
FM3505 4 Watt 40watts  
FM3520 2 Watt 40watts  
FM3530 1 Watt 40watts  
FM3540 5 Watt 40watts  
FM3550 10 Watt 40watts  
FM3560 20 Watt 40watts  
FM3570 30 Watt 40watts  
FM3580 40 Watt 40watts  
FM3590 50 Watt 40watts  
FM3600 60 Watt 40watts  
FM3610 80 Watt 40watts  
FM3620 100 Watt 40watts  
FM3630 150 Watt 40watts  
FM3640 200 Watt 40watts

5 DIGIT ZULU CLOCK KIT  
All clock is a clock to help you keep track of the time!  
Includes everything necessary to build a clock with a time in the form of "ZULU."  
It's a great idea for your home or office to keep track of the time.  
$19.95

COMING EVENTS  
MICHIGAN: The 9th Annual Livonia Amateur Radio Club's Swap Shop, Sunday, February 25, 1979, 8:00 AM to 4:00 PM, (new) Churchill High School, Livonia, Michigan. Table spaces and refreshments available, and optional entry fee. Sunday, February 10 starting at 9:00 AM. Swift Creek United Methodist Church, Livonia, Michigan 48150.

REMINDER  
For the next few weekends will encourage greater participation for additional interest and point-scoring purposes, while the separate weekends will encourage greater participation. Keep an eye on QWNA NEWS for frequencies, confirmation texts, and related contest rules and guidelines.
OVER 50 BRANDS IN STOCK
- KENWOOD • SWAN • KDK • DENTRON
- MOSLEY • WILSON • YAESU • DRAKE
- LARSEN • BENCHER • PIPO • BEARCAT
- B & W • DATONG • ICOM • PANASONIC
- ARRŁ PUBLICATIONS • ALLIANCE • MFJ
- CUSHCRAFT • TRAC • MICROLOG • CDE
- FINCO • DSI • DAYBURN INSULATORs
- BIRD • ASTATIC • HAM KEY • REGENCY
- HUSTLER • SAXTON • TEN TEC • AMECO
- AMCOMM • CALL BOOK • KLM • TEMPO
- ROHN • BUTTERNUT • Plus Many More!

NEW AND USED EQUIPMENT
"Get on our used equipment mailing list"

TRADES WELCOME
"The best allowances anywhere"
"We buy good used SSB gear"

FREE CATALOG
"Prices of all major manufacturers"

SAME DAY U.P.S. SHIPPING
"Just a phone call away"

COMPLETE RADIO SERVICE SHOP
"Mail Order Repair Service"
- Fast Efficient Service • We Repair All Brands
- All Work Guaranteed • Amateur Extra/First Class Licenses • Send Us Your Defective Equipment U.P.S. Collect • Free Shipping Both Ways If Work Is Done
- Most Repairs Done and Shipped Within 7 Days

OUR FINE REPUTATION SPEAKS FOR ITSELF
"YOU SHIP IT WE FIX IT"

Call or Write for your super quote today!

THOMAS COMMUNICATIONS
95 Kitts Lane, Newington, Conn. 06111
"Near ARRL Headquarters"

Connecticut Residents Call:
(203) 667-0811

OPEN MON.-FRI. 10-6 • THURS. 10-8 P.M. • SAT. 10-4
EASY DIRECTIONS: Rt. 15 South — 2 blocks past McDonald's
(Berlin Turnpike)
OHIO: The Mansfield Mid-Winter Hamfest/Auction February 11, 1979 at Richland County Fairgrounds, Mansfield, Ohio. Prizes, fine market, auction. Large heated building. Open 8:00 AM. Talk-in 146.3/4.94 MHz. Tickets $1.50 in advance, $2.00 at the door. For information, advance tickets, and table reservations contact: Harry Frierich, KBHF, 120 Homewood, Mansfield, Ohio 44906 or phone (419) 529-2801 or (419) 524-1441.

IOWA: Annual Davenport Radio Amateur Club Hamfest February 25, 1979 at the Masonic Temple in Davenport. Admission $2.00 advance, $2.50 at the door. Talk-in on 2888 and 52 simplex. Refreshments and tables available. For information and tickets, SASE to John S. Birmingham, WBI2CC, 2202 Brown St., Davenport, Iowa 52804.

PENNSYLVANIA: 7th Annual Lancaster Hamfest Sunday, Feb. 18, 1979 at the Guernsey Sales Pavilion, U.S. Rt. 30 & PA Rt. 986, Lancaster, PA. Boox open at 8:00 AM, prize drawing at 2:00 PM. Admission $3.00. Table reservation $2.00. New, larger indoor flea market area. Food and soft drinks available. Talk-in 146.01/61.

FLORIDA: The St. Petersburg Deep Space Station Hamfest January 19, 10 AM to 4 PM. Admission $5.00. Table reservations $2.00. A new indoor market area. Refreshments and tables available. Tickets available at KB1X, Box 120, St. Petersburg, FL 33733 or KB1X, 1201 Old Tampa Trail, St. Petersburg, FL 33710. For more information, write to KB1X, 1201 Old Tampa Trail, St. Petersburg, FL 33710.

OHIO: Cuyahoga Falls Amateur Radio Club's 25th Annual Hamfest March 3, 10 AM to 4 PM. Admission $2.00. Tickets available at KB9RS, W8YD, Hamfest Chairman, 334 Magnolia Ave., Akron, OH 44301. For more information, write to KB9RS, W8YD, Hamfest Chairman, 334 Magnolia Ave., Akron, OH 44301.
**DIODES/ZENERS**

<table>
<thead>
<tr>
<th>QTY.</th>
<th>1N914</th>
<th>100v</th>
<th>10mA</th>
<th>0.05</th>
</tr>
</thead>
<tbody>
<tr>
<td>1N4005</td>
<td>500v</td>
<td>0.08</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1N407</td>
<td>1000v</td>
<td>1A</td>
<td>0.15</td>
<td></td>
</tr>
<tr>
<td>1N4148</td>
<td>75v</td>
<td>10mA</td>
<td>0.05</td>
<td></td>
</tr>
<tr>
<td>1N4733</td>
<td>5.1v</td>
<td>1 W Zener</td>
<td>0.25</td>
<td></td>
</tr>
<tr>
<td>1N753A</td>
<td>6.2v</td>
<td>500 mW Zener</td>
<td>0.25</td>
<td></td>
</tr>
<tr>
<td>7N758A</td>
<td>10v</td>
<td>0.25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7N759A</td>
<td>12v</td>
<td>0.25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7N759C</td>
<td>18v</td>
<td>0.25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2N544B</td>
<td>14v</td>
<td>0.25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2N545B</td>
<td>15v</td>
<td>0.25</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**SOCKETS/BRIDGES**

- 8-pin pcD .20 ww .35
- 14-pin pcD .20 ww .40
- 16-pin pcD .20 ww .40
- 18-pin pcD .25 ww .95
- 20-pin pcD .35 ww .95
- 24-pin pcD .35 ww .95
- 28-pin pcD .45 ww 1.25
- 40-pin pcD .60 ww 1.25
- Molex pins .01 To-3 Sockets .25

2 Amp Bridge 100-prv .95
25 Amp Bridge 200-prv 1.50

**TRANSISTORS, LEDs, etc.**

- 2N2222 (2N2222 Plastic, 10) .15
- 2N2222A .15
- 2N2907A PNP .19
- 2N3906 PNP (Plastic Unmarked) .10
- 2N3909 NPN (Plastic Unmarked) .10
- 2N3054 NPN .45
- 2N3055 NPN 15A, 60v .60
- TIP122 PNP Darlington 1.95
- LED Green, Red, Clear, Yellow 1.5
- D.L747 7 seq 5/8" High comande 1.95
- MAN76 7 seq cam-omite (Red) 1.25
- MAN361 7 seq cam-omite (Orange) 1.25
- MAN82A 7 seq cam-omite (Yellow) 1.50
- MAN74 7 seq cam-cathode (Red) 1.50
- FND399 7 seq cam-cathode (Red) 1.25

**9000 SERIES**

| QTY. | 9301 | 9322 | 9309 | 9601 | 9316 | 1.10 | 9602 | 0.45 |

**MICRO'S, RAMS, CPU'S, E-PROMS**

<table>
<thead>
<tr>
<th>QTY.</th>
<th>8T13</th>
<th>1.50</th>
<th>21078-4</th>
<th>4.50</th>
</tr>
</thead>
<tbody>
<tr>
<td>8T23</td>
<td>1.50</td>
<td>2114</td>
<td>9.50</td>
<td></td>
</tr>
<tr>
<td>8T24</td>
<td>2.00</td>
<td>2613</td>
<td>6.25</td>
<td></td>
</tr>
<tr>
<td>8T97</td>
<td>1.00</td>
<td>2708</td>
<td>10.50</td>
<td></td>
</tr>
<tr>
<td>74S188</td>
<td>3.00</td>
<td>2716 D.S.</td>
<td>34.00</td>
<td></td>
</tr>
<tr>
<td>148</td>
<td>1.25</td>
<td>2716 (S)</td>
<td>62.50</td>
<td></td>
</tr>
<tr>
<td>1487</td>
<td>1.25</td>
<td>2753 (S)</td>
<td>23.95</td>
<td></td>
</tr>
<tr>
<td>1702A</td>
<td>4.50</td>
<td>3242</td>
<td>10.50</td>
<td></td>
</tr>
<tr>
<td>AM9040</td>
<td>4.00</td>
<td>4116</td>
<td>11.50</td>
<td></td>
</tr>
<tr>
<td>MM5134</td>
<td>3.00</td>
<td>6890</td>
<td>7.95</td>
<td></td>
</tr>
<tr>
<td>MM5136</td>
<td>3.50</td>
<td>8000</td>
<td>7.50</td>
<td></td>
</tr>
<tr>
<td>MM537</td>
<td>3.50</td>
<td>8212</td>
<td>2.75</td>
<td></td>
</tr>
<tr>
<td>MM569</td>
<td>2.95</td>
<td>8214</td>
<td>4.95</td>
<td></td>
</tr>
<tr>
<td>TR1602B</td>
<td>3.95</td>
<td>8216</td>
<td>3.50</td>
<td></td>
</tr>
<tr>
<td>UPO114</td>
<td>4.95</td>
<td>8224</td>
<td>3.25</td>
<td></td>
</tr>
<tr>
<td>Z80A</td>
<td>22.50</td>
<td>8228</td>
<td>6.00</td>
<td></td>
</tr>
<tr>
<td>Z 80</td>
<td>17.50</td>
<td>8251</td>
<td>7.50</td>
<td></td>
</tr>
<tr>
<td>Z8010</td>
<td>5.10</td>
<td>8253</td>
<td>18.50</td>
<td></td>
</tr>
<tr>
<td>74HC14</td>
<td>1.45</td>
<td>8256</td>
<td>1.65</td>
<td></td>
</tr>
<tr>
<td>74HC245</td>
<td>1.75</td>
<td>TMS 4044</td>
<td>9.95</td>
<td></td>
</tr>
</tbody>
</table>

**INTEGRATED CIRCUITS UNLIMITED**

7889 Clairemont Mesa Blvd., San Diego, California 92111
24 Hour Toll Free Phone 1-800-854-2211
(714) 278-4394 California Residents 1-800-542-6239
CABLE ADDRESS ICUSD

**SPECIAL DISCOUNTS**

- $35-$99 10%
- $100-$300 15%
- $301-$1000 20%

**CUSTOMER ADDRESS**

**STREET ADDRESS**

**STATE**

**ZIP**

**PHONE**

**CHARGE CARD**

**AE Visa**

**BA Master**

**EXP. DATE**

**C.O.D. WILL CALL**

**UPS POST NET**

**NET 10th of the MONTH**

**PD #**

**ALL ORDERS SHIPPED PREPAID**

- NO MINIMUM
- COD ORDERS ACCEPTED
- ALL ORDERS SHIPPED SAME DAY

**OPEN ACCOUNTS INVITED**

- California Residents add 6% Sales Tax

- PRICES SUBJECT TO CHANGE WITHOUT NOTICE

We accept American Express / Visa / BankAmericard / Master Charge

**INTEGRATED CIRCUITS UNLIMITED**

7889 Clairemont Mesa Blvd., San Diego, California 92111
24 Hour Toll Free Phone 1-800-854-2211
(714) 278-4394 California Residents 1-800-542-6239
CABLE ADDRESS ICUSD
Ham Radio's guide to help you find your local Ham Radio store.

Alaska

RELIABLE ELECTRONICS
3306 COPE STREET
ANCHORAGE, AK 99503
907-279-5100
Kenwood, Yaesu, DenTron, Wilson, Atlas, ICOM, Rohn, Tri-Ex.

Arizona

HAM SHACK
4506-A NORTH 16TH STREET
PHOENIX, AZ 85016
602-279-HAMS
Serving all amateurs from beginner to expert. Classes, sales & service.

KRYDER ELECTRONICS
5520 NORTH 7TH AVENUE
NORTHERN AZ. SHOPPING CTR.
PHOENIX, AZ 85013
602-249-3739
Your Complete Amateur Radio Store.

POWER COMMUNICATIONS
6012 NORTH 27TH AVE.
PHOENIX, AZ 85017
602-242-6030
Arizona's #1 Ham Store. Kenwood, Drake, ICOM & more.

California

HAM RADIO OUTLET
999 HOWARD AVENUE
BURLINGAME, CA 94010
415-342-5757
Visit our stores in Van Nuys and Anaheim.

QUEMENT ELECTRONICS
1000 SO. BASCOM AVENUE
SAN JOSE, CA 95128
408-998-5900
Serving the world's Radio Amateurs since 1933.

SHAVER RADIO
3550 LOCHINVAR AVE.
SANTA CLARA, CA 95051
408-247-4220
Atlas, Kenwood, Yaesu, KDK, Icom, Tempo, Wilson, Ten-Tec.

Connecticut

THOMAS COMMUNICATIONS
95 KITTIS LANE
NEWINGTON, CT 06111
800-243-7765
203-667-0811
Call us toll free - See our full page ad in this issue.

Delaware

DELAWARE AMATEUR SUPPLY
71 MEADOW ROAD
NEW CASTLE, DE 19720
302-328-7728
Delaware's largest stock of amateur radio equipment & accessories.

Florida

AGL ELECTRONICS, INC.
1800-B DREW ST.
CLEARWATER, FL 33515
813-461-HAMS
West Coast's only full service Amateur Radio Store.

AMATEUR RADIO CENTER, INC.
2805 N.E. 2ND AVENUE
MIAMI, FL 33137
305-573-8383
The place for great dependable names in Ham Radio.

MARC'S CENTRAL EQUIPMENT CO., INC.
18451 W. DIXIE HIGHWAY
NORTH MIAMI BEACH, FL 33160
305-932-1818
See Marc, W4JAS, for complete Amateur Sales & Service.

RAY'S AMATEUR RADIO
1590 US HIGHWAY 19 SO.
CLEARWATER, FL 33756
813-333-1416
West coast's only dealer: Drake, Icom, Cushcraft, Hustler.

Illinois

AUREUS ELECTRONICS, INC.
1415 N. EAGLE STREET
NAPERVILLE, IL 60540
312-420-8629
"Amateur Excellence"

ERICKSON COMMUNICATIONS, INC.
5456 N. MILWAUKEE AVE.
CHICAGO, IL 60630
Chicago - 312-631-5181
Illinois - 800-972-5841
Outside Illinois - 800-621-5802
Hours: 9:30-5:30 Mon, Tu, Wed & Fri.; 9:30-9:00 Thurs; 9:00-3:00 Sat.

SPECTRONICS, INC.
1009 GARFIELD STREET
OAK PARK, IL 60304
312-881-7777
One of America's Largest Amateur & SWL Stores.

Indiana

KRYDER ELECTRONICS
GEORGETOWN NORTH SHOPPING CENTER
2810 MAPLECREST AV.
FORT WAYNE, IN 46815
219-484-3739
Your Complete Amateur Radio Store.

Kansas

POWER COMMUNICATIONS
6012 NORTH 27TH AVE.
PHOENIX, AZ 85017
602-242-6030
Arizona's #1 Ham Store. Kenwood, Drake, ICOM & more.

Massachusetts

TEL-COM, INC.
675 GREAT RD. RT. 119
LITTLETON, MA 01460
617-486-3040
The Ham Store of New England you can rely on.

TUF'S RADIO ELECTRONICS
209 MYSTIC AVENUE
MEDFORD, MA 02155
617-395-8388
New England's friendliest ham store.

Michigan

ELECTRONIC DISTRIBUTORS
1960 BECK STREET
MUSKEGON, MI 49441
616-726-3196
Dealer for all major amateur radio product lines.

Dealers: YOU SHOULD BE HERE TOO!
Contact Ham Radio now for complete details.
Missouri

HAM RADIO CENTER, INC.
8340-42 OLIVE BLVD.
ST. LOUIS, MO 63132
800-325-3636
For Best Price and Fast Delivery
Call toll free 1-800-325-3636

Nebraska

COMMUNICATIONS CENTER, INC.
443 NORTH 48 ST.
LINCOLN, NE 68504
800-228-4097
Kenwood, Yaesu, Drake and more
at discount prices.

Nevada

COMMUNICATIONS CENTER WEST
1072 RANCHO DRIVE
LAS VEGAS, NV 89106
800-634-6227
Kenwood, Yaesu, Drake and more
at discount prices.

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".

METUCHEN RADIO
216 MAIN STREET
METUCHEN, NJ 08840
201-494-8350
New and Used Ham Equipment
WA2AET "T" Bruno

RADIOS UNLIMITED
1760 EASTON AVENUE
SOMERSET, NJ 08873
201-469-4599
New Jersey's newest
complete Amateur Radio center

New York

AM-COM ELECTRONICS INC.
RT. 5
NORTH UTICA, SHOPPING CTR.
UTICA, NY 13502
315-732-3656
The Mohawk Valley's Newest &
Largest Electronics Supermarket.

GRAND CENTRAL RADIO
124 EAST 44 STREET
NEW YORK, NY 10017
212-682-3869
Drake, Atlas, Ten-Tec, Midland,
Hy-Gain, Mosley in stock

HAM-BONE RADIO
3206 ERIE BLVD., EAST
SYRACUSE, NY 13214
315-446-2266
We deal, we trade, all major brands!

RADIO WORLD
ONEIDA COUNTY AIRPORT
TERMINAL BLDG.
ORISKANY, NY 13242
Toll Free 800-448-7914
NY 315-337-2622
Res. 315-337-0203
New & Used Ham Equipment.
See Warren K21XN or Bob WA2MSH.

Ohio

AMATEUR RADIO
SALES & SERVICE INC.
2187 E. LIVINGSTON AVE.
COLUMBUS, OH 43209
614-236-1625
Antennas for all services.

Oklahoma

KRYDER ELECTRONICS
5526 N.W. 50TH
MACARTHUR SQ. SHOPPING CTR.
OKLAHOMA CITY, OK 73122
405-789-1951
Your Complete Amateur Radio Store

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.

Pennsylvania

ELECTRONIC EXCHANGE
136 N. MAIN STREET
SOUDERTON, PA 18964
215-723-1200
Demonstrations, Sales, Service
New/Used Amateur Radio Equip.

"HAM" BUERGER, INC.
68 N. YORK ROAD
WILLOW GROVE, PA 19090
215-659-5900
Delaware Valley's Fastest Growing
Amateur Radio Store

HAMTRONICS, DIV. OF
TREVOSOE ELECTRONICS
4033 BROWNSVILLE ROAD
TREVOSE, PA 19047
215-357-1400
Same Location for 30 Years.
Call Toll Free 800-523-8998.

Tennessee

GERMANTOWN AMATEUR SUPPLY
3203 SUMMER AVE.
MEMPHIS, TN 38112
800-238-6168
No monkey business. Call
Toll Free.

Texas

AGL ELECTRONICS
3068 FOREST LANE, SUITE 309
DALLAS, TX 75234
214-241-6414 (within Texas)
Out-of-State, Call our toll-free
number 800-527-7418.

HARDIN ELECTRONICS
5635 E. ROSEDALE
FT. WORTH, TX 76112
817-461-9761
Your Full Line Authorized
Yaesu Dealer.

TRACY'S ELECTRONIC MODULE
5691 WEST CREEK DRIVE
FORT WORTH, TX 76133
817-292-3371
We Handle and Service
All Major Lines.

February 1979
119
NOW YOU CAN design and produce your own printed circuit boards.

IT'S EASY. Photo positive method. No darkroom required.

LESS THAN 2 HOURS to produce a p.c. board direct from magazine article.

KIT INCLUDES materials to make 4 p.c. boards direct from magazine article. Add $1 for COD. S.A.S.E. for details.

HI-Q BALUN

- For dipole, yagis, inverted vee, dipoles & quad
- For full legal power & more
- Puts power in antenna
- Broadbanded 3-40Mhz.
- Small, light, weather-proof
- 1:1 Impedance ratio
- Replaces center insulator
- Helps eliminate TVI
- Fully Guaranteed

Van Gorden Engineering
BOX 21305, S. EUCLID, OHIO 44121

$9.95 ppd.

D & V RADIO PARTS

VARIOUS & TRIMMER CAPACITORS-OF CHOICE-AIR WOUND COILS-TUNING-FIELD TRANSFORMERS-TUNING CAPACITORS-Подробнее & COUPLINGS-TRANSFORMER COMPONENTS.

No minimum order-low coat shipping.

First class stamp for complete copy, 12005 w., SARL, FREDONDA, MICHIGAN 48131

Duns #01-048-6066
Cash plus shipping paid for clean late model Motorola GE, RCA mobiles. Base Stations, Accessories. We also sell used and reconditioned equipment. For further information contact:

Jesse La Fleur
The Communications Center
1629 Wyoming
El Paso, Texas 79902
(915) 545-1133

Call for cash quotation 16 years of fair dealing

HOW IT FEELS TO HAVE A HEART ATTACK

The way a heart attack feels can vary. So how can you be sure that what you’re feeling is really a heart attack?

By remembering this.

If you feel an uncomfortable pressure, fullness, squeezing or pain in the center of your chest (that may spread to the shoulders, neck or arms) and if it lasts for two minutes or more, you could be having a heart attack. Severe pain, dizziness, fainting, sweating, nausea or shortness of breath may also occur. Sharp, stabbing twinges of pain are usually not signals of a heart attack.

Your survival may depend on getting medical attention as quickly as you can. Call the emergency medical service immediately. If you can get to a hospital faster in any other way, do so.

Don’t refuse to accept the possibility that you are having a heart attack. Many heart attack victims do just that. They say it’s indigestion or tension. They worry about embarrassment. They often wait three hours or longer before getting help.

But before those three hours are up, one out of two is dead.

Remember what you’ve just read. The time might come when your life will depend on it.

The American Heart Association

WE’RE FIGHTING FOR YOUR LIFE
"LINEAR" or "LINEARIZED"

An ancient amateur proverb has it that, "Garbage in, garbage out." Or, "What happened to my signal?"

One reason why our Linearized amp/preamp combos are the fastest selling amps in the amateur market is the improved linearity our units exhibit in the SSB mode. To be LINEAR, the amplifier's output signal must be an exact reproduction of the input signal, with only the power level changed. A good measure of an amp's linearity is seen in the sidetone products. If the signal is excessively wide, the amplifier is not being run in a linear mode. Overdrive is a most common cause of splatter.

A good test for yourself is to note the change in output power as the input power is doubled. If a 3W input doubled (3 dB change) to 6W shows a change in the output power of say 25W to 50W, the amplifier is operating well within its linear range. If the 3 input change only shows a 2 dB change (1.7 times), the amplifier is just entering its non-linear operating area. If the change is much less than 2 dB, be assured your signal will be heard many KHz away.

LINEARIZED AMPLIFIERS
Power ranges from 50 to 250 watts, frequencies from 50 MHz to 220 MHz.
RECEIVING PREAMPS
Medium and high gain models now available for frequencies 28 to 450 MHz.

Another self-test for your SSB is to observe the output power levels. A whistle, or CW carrier gives a reference signal tone power of say 80W. While talking normally, the power reading should be around 15% to 25% the single tone reading (about 20-25W here). If the average voice reading is much higher than this 15%-25% the single tone reading, again your neighbors may be getting a lot away with the CW. Remember, too, that splatter power is subtracting from your signal power. That one reason our 80W amps usually outperform other 160W units under weak signal conditions. Our amp has less wasted power creating splatter noise and the reduced distortion products make the signal easier to read when under weak conditions.

A Class A amplifier is the most linear, and for output power, the most costly. At lunar, we strive to produce the best possible linear amplifier for the money. We are the originators of the LINEARIZED process, and our amplifiers exhibit this in operation by the very small amount of side-splat produced when compared to other amps on the market. All of our amplifier/preamp combo features (another Lunar innovation) feature the LINEARIZED process. Others may attempt to copy us. But would you want a copy when you have the original? Don't be misled by price alone. You do get what you pay.

To paraphrase the August '78 DST review of our preamps, "...no other commercially available preamps can match the (Lunar)..." We put no less effort into our other products either. Quality does go in, before the name goes on. We stand behind our products with a full year limited warranty to boot.

See our lines at our nearest Lunar dealer (see December '78 ads for listing), or drop us a line for our latest brochure.

Lunar would like to hear from you as to what products you think we ought to be providing for you. Drop us a line with your ideas.

Louis Anciaux
WB 8NMT

Barry Electronics...

Your One Source for Amateur Radio Gear

MIRAGE AMPLIFIERS $169.95

We also have:
- ANTENNAS FOR HF & UHF
- ROTORS
- POWERS
- REPEATERS
- MICROPHONES
- KEYS & KEYS
- TUBES and much, much more

SEASONS
GREETINGS
JUST CALL OR WRITE FOR THE BARRY PRICE:
YES, WE HAVE EIMAC Tubes & Chimneys, and YAESU Replacement
Tubes in stock!
BARRY PRICE:
BEFTER STILL...
STOP IN!!

WE STOCK THESE FAMOUS NAME BRANDS

AEV
ALDA
ANTENNA
SPECIALISTS
ATLAS
B & W
BIRD
COLLINS
CUSHCRAFT
DSI
DENTRON

DRAKE
EIMAC
E-Z WAY
HY-GAIN
ICOM
KDK
KLM
MIRAGE
MOSLEY
NEWTRONICS

ROBOT
ROHN
STANDARD
SWAN
TEN-TEC
TRI-EX
VHF
ENGINEERING
WILSON
YAESU

BARRY ELECTRONICS
512 BROADWAY
NEW YORK, N.Y. 10012
(212) 925-7000
The U. S. Callbook has nearly 350,000 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 285,000 calls, names and addresses of amateurs outside of the USA.

U.S. Callbook $15.95
Foreign Callbook $14.95
(Plus Shipping)

Order from your favorite electronics dealer or direct from the publisher. All direct orders add $1.75 for shipping. Illinois residents add 5% Sales Tax.

RADIO AMATEUR CALLBOOKS

Respected worldwide as the only complete authority for radio amateur QSL and QTH information.

-- Amateur Extras --

LICENSE PLATES
□HN-LP Highway Hams unite! Fastest this 6" x 12" fiberglass license plate above or below an existing license plate, or use it in place of a front or back plate where state law permits. Another great gift item from HRCB. License Plate $5.95

HOMEBREW MUGS
Next time you and your friends slug down some homebrew, put it in your very own HOMEBREW mug from HRCB. You can even have your name and call printed right on it. It's even suitable for hot chocolate! Buy yourself or friends one of these high-quality 14 oz. ceramic mugs for Christmas.
□HN-M Homebrew Mug $8.95
□HN-MC Custom imprint of name and call $12.95

PERSONALIZED DESK PEN
□UDP Give your office desk or operating table a touch of elegance with this useful and decorative desk pen set. The heavy opalescent marble base can be personalized with precision engraving. Set includes pen with brushed gold finish.
Heat Sensitive Transfers $8.95

HEAT SENSITIVE TRANSFERS
Looking for a new pen? Apply these colorful iron-on transfers to any cotton based garment. Join the 1 wrist movement and tell everyone you're a ham. These easy-to-apply transfers make unique gift items at prices anyone can afford.
□HN-T1 "Ham Radio Freq" $1.95
□HN-T2 "Ham It Up" $1.95
□HN-T3 "One World" $1.95

DESK STANDARD
□DUS This classic executive-style standard gives your desk a distinguished look. Engraved with name and/or call, polished 100% brass nameplate complements the solid walnut base which has a beautiful hand-rubbed finish. Hand-crafted quality for a very good price! $9.95

Include name and/or call instructions with order.

Send check, money order or charge card information plus $1.00 shipping to:

Ham Radio's Bookstore
Greenville, NH 03048

Moving?

If possible let us know four to six weeks before you move and we will make sure your HAM RADIO Magazine arrives on schedule. Just remove the mailing label from this magazine and affix below. Then complete your new address (or any other corrections) in the space provided and we'll take care of the rest.

Here's my new address:

Name
Address
City

Affix Label Here

More Details? Check—Off Page 126
WE KNOW YOU WANT THE VERY BEST!

In a market already over crowded by others, all making claim to being "THE BEST", we knew we had to be better. COMMUNICATOR I our 6 channel, 3 watt handheld, and COMMUNICATOR II our 800 channel synthesized 25 watt mobile offer all the features of the “BEST” — and a few extra, including our one year warranty and a toll free 800 number answered by other hams who speak your language.

PACE COMMUNICATOR - THE VERY BEST!

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

"RUBBER DUCKIES" FROM G & C Communications
A MUST FOR 2-METER HAND HELED

J. W. Miller Division
BEL Industries
19070 REYES AVE. • P.O. BOX 5825
COMPTON, CALIFORNIA 90224

MAXI TUNER SOLVES ANTENNA PROBLEMS

SWR & Power Meters
Models CN-720 and CN-620
From DAIWA CORPORATION

Simultaneous direct reading SWR, Forward Power and Reflected Power
Frequency Range: 1.8-150 MHz
(REF 400200 Watts)
Input/Output Impedance: 50 Ohm
Dimensions: 180 x 120 x 130 mm;
7x 4.75 x 5 in.
185 x 75 x 97 mm; 6.5 x 3 x 4 in.

Write for literature.

J. W. Miller Division
BEL Industries
19070 Reyes Ave. • P.O. Box 5825
Compton, California 90224

"RUBBER DUCKIES" FROM G & C Communications
A MUST FOR 2-METER HAND HELED

Model Description Price
GC-1 5/16" Knurled Stud Fins. $6.50
GC-2 BNC Connector: Motorola and others $6.50
GC-3 TNC Connector for Wilson 1403 $9.98
GC-4 PL-259 Connector $6.50
GC-5 Type F Connector fits Wilson 1402 and Tempo $9.50
Equipment made in USA by OEM MFRS. Send to:
G & C COMMUNICATIONS
730 Cottonwood, Lincoln, NE 68510
Add $1.00 for handling and shipping (Dealer and OEM RFO's Welcome)

MAXI TUNER SOLVES ANTENNA PROBLEMS

THE FINEST

ANTENNA TUNER AVAILABLE

- Present 50-75 Ohm Receiver Load to Your Transmitter Using Virtually Any Antenna System
- Improved Ultimate Transmatch Circuit MATCHES Coax, Random Wire and Balanced Antennas
- Continuous 1.7-30 MHz Coverage
- 229-203 Rotary Inductor (8 uH)
- Rugged Cast Aluminum Tuner Counter
- Handles 3 KW PEP
- Heavy Duty Balance
- Velocity-Smooth & to 1 Vernier Tuning
- 0-100 Logging Scale on Capacitors
- Available in Kit Form or Assembled
- One Year Factory Warranty
- Use with your present SWR meter or wattmeter.
- Custom Vacuum Capacitor Designs and Individual Components Available

Call or Write for Pricing, Spec Sheet, and FREE Amateur Market Antenna Tuner Comparison Chart That Tells It Like It Is!

P. O. Box 11
Ladysmith, WI 54848
(715) 534-2971

More Details? CHECK — OFF Page 126
FM and REPEATERS FOR THE RADIO AMATEUR
by the ARRL Staff

AR-FM This is a revised and updated version of the mobile operator's favorite. This new edition features the latest in FM technology, and design theory, highlighted by microprocessor control circuitry and a phase-lock loop 2-meter transceiver. More on FM — receivers, transmitters, antennas and repeater operation. If you are into FM, get this book today! 176 pages. ©1978
Softbound $5.00

THE ARRL ANTENNA ANTHOLOGY
by the ARRL Staff

AR-AA This brand new book pulls together a wide selection of antenna articles from QST. Written for Amateurs of all levels and interests. Projects include phased arrays, verticals, Yagi's... even the VHF Quagi! Detailed instructions and full illustrations make this a real useful book for any antenna buff. 152 pages. ©1979.
Softbound $4.00

BAND-AIDS
by James E. Dorsch, WD8AE

CC-BA The author subtitles his book "Radio Amateur Operators' Handiest Handbook", and for good reason. This is one of the finest homespun-style books around. It contains such handy operating aids as maps, time-zones, abbreviations. IACO word list, OSCAR frequencies, third-party agreement information, international prefix lists and many more of those useful items we all need from time to time.
In the non-operating category, Band-Aids contains useful material on Metric conversions, resistor (and other component) color coding, schematic-diagram symbols, telephone touch-tone frequencies, nomographs, and many useful formulas. All spiralbound in a special heavy duty edition designed to withstand many years of tough station duty. Get your copy now! 110 pages. ©1978.
Spiralbound $7.95

CALLBOOKS FOR 1979

CB-US 1979 United States Callbook If you're active you need this brand new Callbook with over 40,000 new licensed radio amateurs and more than 100,000 listing changes. This Callbook is the biggest ever — 40,000 new licensees, and more than 100,000 listing changes. This callbook is the biggest ever — 374,487 licensed radio amateurs. Keep up with all the new 1 x 2 and 2 x 1 calls which are ever-increasing. Boldface calls, names, addresses, license class — all in easy-to-read 8½ x 11 format which became so popular last year. 992 pages. Softbound $15.95

CB-F 1979 Foreign Callbook With over 295,000 calls listed, this is a must for any DXer. Almost 25,000 new licensees included PLUS 84,822 listing changes. 900 pages.
Softbound $14.95

Callbook Shipping Charges
Please include $1.75 for shipping and handling whether you order one or both editions! Give full street address (no box numbers please) so we can ship to you via UPS to expedite delivery.
FEATURES

UPGRADING TO EXTRA? TRY THESE STUDY AIDS...

Ham Radio Publishing Group's

Integrated Code Training System

Here's a selection of code practice tapes from Ham Radio's Integrated Code Training System — chosen specifically for the Amateur who is studying for the Extra Class license exam. Now you can have the kind of high quality code practice that best fits you.

Each tape $4.95, 2/$8.95, 3/$12.95.

STRAIGHT CODE SERIES

Here are two different straight code tapes consisting of randomly generated six character groups sent at different speeds. These tapes are excellent for building both speed and accuracy needed for the FCC exam as well as contesting. DXing, traffic handling and code proficiency awards.

□ HR-STC2 15wpm code for 50 min. 22.5wpm code for 35 min.
□ HR-STC3 25wpm for 20 min. 30wpm for 20 min. 35wpm for 20 min. 40wpm for 20 min.

Hi/Lo

On this unique tape, characters are sent at a 22.5wpm rate, but with character spacing equivalent to varying speeds between 5 and 13wpm. If your code speed has gone down since you passed the general exam, you can now practice copying 22.5wpm without constantly getting behind.

□ HR-HLC2 22.5/5wpm code for 20 minutes 22.5/7.5wpm code for 20 minutes 22.5/10wpm code for 20 minutes 22.5/15wpm code for 20 minutes

QSO SERIES

Here's the best practice for the FCC Extra Class exam. Both QSO tapes are reproductions of actual on-the-air CW contacts, similar in content to the FCC code exams. The first to build speed and accuracy and the second to develop proficiency at a higher speed than encountered in the exam. Master these tapes and face the Extra Class exam without fear.

□ HR-QSO1 90 minutes of 25 QSOs sent at 15wpm
□ HR-QSO2 90 minutes of 30 QSOs sent at 22.5wpm

AMECO RADIO AMATEUR THEORY COURSE

by Martin Schwartz, W2OSH

□ 102-01 A complete, simplified home study theory course in radio, covering the requirements for the Novice, Technician and General Classes of Radio Amateur Operator licenses. Contains 14 lessons, 3 study guides and over 400 FCC-type multiple-choice questions, similar in content and format to the actual FCC test — all under one cover. Latest Revised Edition. 320 pages. ©1974. Softbound $4.95

□ 17-01 Extra Class. 64 pages. ©1974 (rev.). Softbound $1.50

AMECO AMATEUR LICENSE GUIDES

by Martin Schwartz, W2OSH

Each of these useful books contains a sample FCC-type examination, plus the FCC study questions along with easy-to-understand answers. The questions are grouped according to subject for easier study.

□ 16-01 Advanced Class. 64 pages. ©1970 (rev.). Softbound $1.50

□ 17-01 Extra Class. 64 pages. ©1974 (rev.). Softbound $1.50

ELECTRONIC COMMUNICATION (3rd Edition)

by Robert L. Shradar

□ MH-57138 This book is absolutely the finest book of its kind available anywhere. This is THE complete book for all license preparation — Novice through Extra plus all commercial licenses and endorsements. All the information you need as well as practice questions and check-up quizzes. Adaptable for self-teaching or classroom use. "Electronic Communication" is a book any Radio Amateur should own and use. 793 pages. ©1975. Hardbound $18.95

Amateur Radio's Finest!

LOG BOOK from The Ham Radio Publishing Group

□ HR-LB Ham Radio's brand new Log Book is a tool you just can't do without. With over twice as many entries as other log books, this log gives you room for more than 2,000 contacts. There's sharp rating too for all FCC-required information, plus extra space for the name and address of each station you contact. For DX contests, there is a consistent 30 entries per page for easy counts. In addition there is handy frequency spectrum chart showing the exact designation of each nixie band plus a listing of all worldwide Amateur prefixes currently in use. And, it's all spiralbound to be flat on your operating table. This is unquestionably the best log book value anywhere! 8 1/2 x 11 80 pages ©1978. Spiralbound $1.50

BIND 'EM & FIND 'EM

Don't let your valuable issues of HAM RADIO get dog-eared or scattered who knows where! Get a handsome, durable binder from HRB.

HAM RADIO BINDERS

Beautiful buckram binders complete with date labels. Available in our new large size to accommodate HAM RADIO's hefty issues.

□ HR-8DL Each/$9.95, 3/$17.95

Prices subject to change without notice.

Ham Radio's Bookstore, Greenville, NH 03048
INDEX

AED 719
ALC 653
Alliance 700
Als 580
Am, Rad. Center 638
Amateur Unit CB Funk* 74
Amateur Wholesaler 644
Atlas 198
Bar* 003
Bird 017
Budwig 233
Bullet 328
Cal Crystal 798
Commercial Electronics 705
Clegg 227
Coax Probe 726
Communications Center 534
Comm. Research 713
Comm. Spec. 590
Cont. Spec. 346
Creative Elec 751
Crystal Banking 117
Curis Electro * 004
Cuscharf *
DAB Radio *
DCG 324
DSI 656
Dames Comp 561
Data Signal 270
Davis Elect 322
Dmrtron 289
Drake *

E.T. O. 603
Elec, Elect. Research Virginia *
Elsco 758
Excel Circuits 535
Fox Tango 657
G & C C 754
GLB 152
Gl Enterprises *
Gray 665
Great Lakes 732
Gregory 7
group Ill 701
Gulf 635
Hall* 062
HMR 735
H. R. B. 160
Hamtronics, New York 246
Health 060
Henry 062

*Please contact this advertiser directly.

Limit 15 inquiries per request.

February, 1979

Please use before March 31, 1979

 Tear-off and mail to HAM RADIO MAGAZINE — "check-off"
Greenville, N. H. 03048

NAME ...

CALL ...

STREET ...

CITY ...

STATE ... 

ZIP ...

NOW, LIST THE EQUIPMENT YOU WANT IN THE SPACES PROVIDED BELOW, CUT OUT THIS AD, AND SEND IT TO US WITH YOUR NAME, ADDRESS AND TELEPHONE NUMBER. WE WILL WRITE % OR CALL % (CHECK ONE) YOU BACK AS SOON AS POSSIBLE WITH THE MADISON QUOTE.

(HINT: DON'T GO BELOW OUR COST)

WE HAVE AN IN-DEPTH STOCK AND LARGE INVENTORY OF MAJOR LINES AND ACCESSORIES.

WRITE IN YOUR BEST QUOTE FROM THE "800 GANG."

MADISON SUPER BOWL BUYS

AED Electronics ..................... 106
ALC & A Communications .......... 1
Alliance Mfg. Company .......... 79
Allstar Tower Co. ............... 68
Amateur Radio Center .......... 108
Amateur Unit CB Funk .......... 114
Amateur Wholesale Electrical .... 157
Astron Corporation .......... 100
Atlantic Sales .......... 120
Athena Radio .......... 69
Barry Electronics .......... 121
B. H. Bauman Sales Co. ......... 114
Budwig Mfg. Co. .......... 122
Bullet .......... 114
Cal Crystal Lab, Inc. .......... 88
Clegg ......... 96
Cradle Probe* .......... 380
Communications Center ........ 113
Communication Research, Inc. .... 107
Communications Suppliers .......... 193
Creative Electronics .......... 102
Crystalbanking .......... 146
Curtis Electric Devices ........ 88
Cashcraft .......... 99, 101
D & B Radio Parts .............. 76
DCO, Inc. .............. 109, 116
DE Instruments ............ 36, 89
Danes Communications Systems .... 112
Data Signal, Inc. ............ 88
Davis Electronics .............. 76
Drake Co., R. L. ......... 10, 11
Ehrenfried Technological Operations .... 127
Electronics Industry .......... 64
Electronic Research Corp. of Virginia .... 103
Excel Circuits .......... 120
Fox Tango Corporation .......... 76
G & B Communications .......... 123
GLB .......... 96
GL Enterprises .......... 76
Gray Electronics .......... 116
Great Lakes Amateur Supply Company .... 122
Gregory Electronics .......... 92
Group III Sales Company .......... 92
Gulf Electronics .......... 111
Hal Communications Corp. ........ 9
HMM Communications Corp. .... 104
Haltron .......... 82
Ham Radio Bookstore .......... 120, 122, 124, 125
Hamtronics, Inc., Rochester, NY .... 121
Health Company .......... 57
Henry Radio Driwers ........ 108
Hillcrest Engineering .......... 105
Hy Gain Electronics ........ 31
Ilcom .......... 5
Integrated Circuits Unlimited .... 39
International Crystal .......... 15
Jam Electronics .......... 110
Jan Crystals ............. 82
Jones, Martin P. & Assoc. .... 76
Jr, Kenwood Communications Inc. .... 69
Klaus Radio, Inc. .......... 105
Larsen Antennas .......... 56
Long's Electronics .......... 128
Lunar Electronics .......... 121
MFJ Enterprises .......... 2
Madison Electronic Supply .......... 95, 126
Microwave Filter, Inc. .......... 94
J. W. Miller Division, Bell Industries .... 120
Milo Associates .......... 108
Monroe Electronics, Inc. .......... 96
Oak Hill Academy Amateur Radio Session .... 82
Palomar Engineering .......... 90
Pathcom ......... 123
RF Power Components .......... 123
RfW Products .......... 116
Radio Amateur Callbook .......... 122
Radio World .......... 167
Ramsey Electronics .......... 93
S & F Amateur Radio Service .... 80
SSJ Electronics .......... 108, 109
Sabletronics International, Inc. .... 97
Securiton .......... 114
Shaw Engineering .......... 121
Slep Electronics .......... 112
Space Electronics .......... 120
Spectrum International .......... 92
Swaal Electronics .......... 63, 116
TFL Communications .......... 92
Tetex Laboratories .......... 102
Tec \nTelecommunications Center ........ 120
Thomas Communications, Inc. .... 115
Tri Ex Tower Corporation .......... 106
VHF Engineering, Div. of Brownian .... 77
Van Gordon Engineering .......... 120
Vanguard Labs .......... 56
Vander Lab .......... 27
Varni, Emac Division ........ 107
Webster Associates .......... 92
Weinshenker .......... 122
Western Electronics .......... 107, 121
Wholehouse, G. R. & Co. .......... 98
Wilson Electronics .......... 53
Yasu Electronics Corp. ........ 98
Sure you can buy a cheaper linear . . .
But is that really what you want?

You can buy a so-called "maximum legal power" linear for quite a bit less than the price of an ALPHA. What makes the ALPHA worth more . . . or the other model less?

TALK TO AN ALPHA OWNER — Notice how scarce used ALPHA's are? Owners are rarely willing to part with them, and will be delighted to tell you why.

CHECK ETO's TWO-YEAR (limited) WARRANTY — Others give you 90 days. But EIGHT TIMES as much protection is only part of the ALPHA warranty story; there's also a clear message about durability.

NO ALPHA 76/374/77D OWNER HAS EVER BURNED UP A POWER TRANSFORMER, despite our No Time Limit (NTL) full power key down rating. Maybe it's because our '76A transformer is nearly TWICE the size of those in competitive desk-top amplifiers and is cooled by ETO's full-cabinet, ducted-air system to boot.

LOOK INSIDE AN ALPHA — the difference in quality and ruggedness is conspicuous. Big coils . . . axial-flow ceramic triodes thoroughly cooled by a centrifugal blower . . . yet ETO's new acoustic-isolation blower system makes the ALPHA 76A series now even quieter than ever before.

EFFICIENCY, versatility, ease of operation, resale value — the story of ALPHA superiority goes on. Before you decide on a new linear, get all the details from your dealer or ETO direct. And ask for our free guide. "Everything You Always Wanted to Know About (Comparing) Linears . . . But Didn't Know Whom to Ask." Finally, do talk to an ALPHA owner . . . look for him on top of the nearest pile-up.
ICOM IC-280 remotesensible 2m FM mobile
Freq 144.90-148.11 MHz 10 watts Hi. 1 watt adj. Low • Power requirements 13.8 VDC at 2.5 amps • Main PLL control head may be detached and remotely mounted • With microprocessor, stores 3 frequencies • Easy to read LED's.
449.00 list Call for quote.

KENWOOD TR-7600 The radio that remembers
Full 4 MHz coverage (144.00-147.996), 800 channels. 10 watts RF output/1 watt low, memory channel w/simplex or repeater offset & LED. With the optional RM-76 select any 2m freq. store freq. auto stop on first busy or open channel, scan memories
375.00 list Call for quote.

KENWOOD TR-7400A
2m FM transceiver
449.00 list Call for quote.

YAESU CPU-2500RK
2m FM transceiver
Full 4 MHz coverage in 5 KHz steps 144-148 MHz • 4 memory channels may be programmed • Built-in scanner • Keyboard mic allows for remote control of memories & dial frequencies • Also serves as an auto patch encoder • Output 3 watts/25 watts
585.00 list Call for quote.

YAESU FT-227RA
One knob channel selection for 800 channels. freq. 144-148 MHz 4-digit LED, fully synthesized frequency control, selectable 10 watt Hi/1 watt Low output, 4 memories, touch control on mic for scanning, scan selectable for clear or busy channels.
399.00 list Call for quote.

SHAKESPEARE Antler A-280
magnetic mount
2m mobile antenna
A high Q base loading coil is silver plated copper. Stainless steel spring enclosed in fiberglass. Wave design 3dB gain with a power rating in excess of 500W. Includes connector, 20' of coax cable and base.
24.95 Call for yours today.

ANTLER A-280
2m mobile antenna
The A-280 is as close to the ideal antenna as you can get w/precision tuned coil 47' tapered 17-7 stainless steel whip VSWR less than 1.3 • Certified 3 dB gain Magnetic mount has roof-top stability to withstand winds up to 100 MPH
29.95 Call for yours today.

Long's Electronics
MAIL ORDERS: P.O. BOX 11347 BIRMINGHAM, AL 35202 • STREET ADDRESS: 2808 7TH AVENUE SOUTH BIRMINGHAM, ALABAMA 35233
Remember, you can Call Toll Free: 1-800-633-3410 in the 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.
3+1+1 = 227

MODERN MATH ??

NO

YAESU'S NEW

FT-227RA

(220 MHz Version - FT-127RA)

3 simplex memories
1 programmable split (up to 4 MHz)
1 dial set frequency (± 600 KHz)

All this versatility plus...

- Remote up/down scanning from the microphone
- 800 PLL synthesized channels in 5 KHz steps
- Built in programmable tone burst
- Hi/low power selection 10/1W
- Status lamps indicate "On Air" and "Channel Busy"
- Superior cross modulation, overload and image rejection characteristics
- Protection against high VSWR and reversed supply polarity

YAESU ELECTRONICS CORP., 15954 Downey Ave., Paramount, CA 90723 (213) 633-4007
YAESU ELECTRONICS Eastern Service Ctr., 3812 Princeton-Glendale Rd., Cincinnati, OH 45246
Kenwood chooses EIMAC for trouble-free service.

The new heavy-duty Kenwood TL-922A linear amplifier provides 2 kW PEP input for SSB service and 1 kW input for CW, RTTY, and SSTV operation.

Kenwood chose two EIMAC 3-500Z high-mu triodes to do the job. With a total of 1000 watts anode dissipation, the two 3-500Zs coast along to provide trouble-free, long-life service.

For more information
Send for the EIMAC Quick Reference catalog covering the complete line of EIMAC products and for the 3-500Z Data Sheet. Learn why the important manufacturers of communication equipment choose EIMAC. Varian, EIMAC Division, 301 Industrial Way, San Carlos, California 94070. Telephone (415) 592-1221. Or contact any of the more than 30 Varian Electron Device Group Sales Offices throughout the world.

What's your pleasure?

DX chasing? Traffic nets? RTTY? Rag chewing? SSTV? The EIMAC 3-500Z provides the power when you need it, with ample safety margin. Value wise amateurs always look for the EIMAC power tube for reliability. And equipment manufacturers, such as Kenwood, choose EIMAC for leadership in power tube technology.

varian