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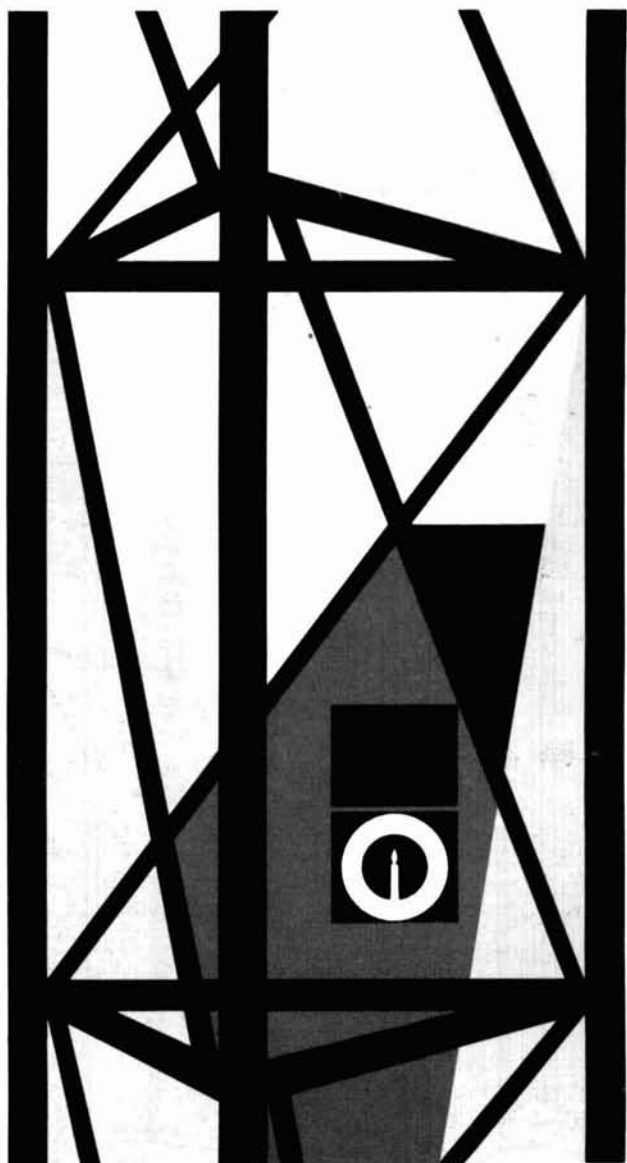
ham **radio**

magazine



DECEMBER 1976

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- and much more . . .



Now...more than ever--- the TEMPO line means solid value

Tempo VHF/ONE

the "ONE" you've been waiting for

No need to wait any longer — this is it! Whether you are already on 2-meter and want something better or you're just thinking of getting into it, the VHF/ONE is the way to go.

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The Tempo 6N2 meets the demand for a high power six meter and two meter power amplifier. Using a pair of Eimac 8874 tubes it provides 2000 watts PEP input on SSB and 1000 watts input on CW and FM. Completely self-contained in one small desk mount cabinet with internal solid state power supply, built-in blower and RF relative power indicator.

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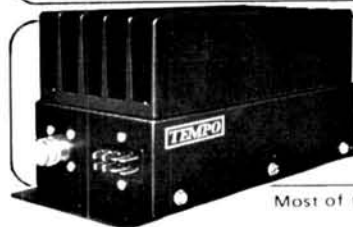


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MS-2, 4 channel scanning receiver for VHF high band, smallest unit on the market. MR-2, same size as MS-2 but has manual selection of 23 channels, VHF high band. MR-3, miniature 2-channel VHF high band monitor or paging receiver. MR-3U, single channel on the 400 to 512 UHF band. All are low priced, extremely compact and dependable.

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SOLID STATE VHF LINEAR AMPLIFIER. 144-148 MHz. Power output of 100 watts (nom) with only 10 watts (nom) in. Reliable and compact.



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\$ 59⁹⁵

LSP-520BX. 30 db dynamic range IC log amp and 3 active filters give clean audio. RF protected. 9 V battery. 3 conductor, 1/4" phone jacks for input and output. 2-3/16 x 3-1/4 x 4 inches.

LSP-520BX II. Same as LSP-520BX but in a beautiful 2-1/8 x 3-5/8 x 5-9/16 inch Ten-Tec enclosure with uncommitted 4 pin Mic jack, output cable, rotary function switch.

SUPER LOGARITHMIC SPEECH PROCESSOR

Up To 400% More RF Power is yours with this plug-in unit. Simply plug the MFJ Super Logarithmic Speech Processor between your microphone and transmitter and your voice is suddenly transformed from a whisper to a **Dynamic Output**.

Your signal is full of punch with power to slice through QRM and you go from barely readable to "solid copy OM".



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CWF-2BX Super CW Filter

By far the leader. Over 5000 in use. Razor sharp selectivity. 80 Hz bandwidth, extremely steep skirts. No ringing. Plugs between receiver and phones or connect between audio stage for speaker operation.

- Selectable BW: 80, 110, 180 Hz • 60 dB down one octave from center freq. of 750 Hz for 80 Hz BW
- Reduces noise 15 dB • 9 V battery
- 2-3/16 x 3-1/4 x 4 in. • CWF-2PC, wired PC board, \$18.95 • CWF-2PCK, kit PC board \$15.95



\$ 49⁹⁵

CMOS-8043 Electronic Keyer

State of the art design uses CURTIS-8043 Keyer-on-a-chip.

- Built-in Key • Dot memory • Iambic operation with external squeeze key • 8 to 50 WPM • Sidetone and speaker • Speed, volume, tone, weight controls • Ultra reliable solid state keying +300 volts max. • 4 position switch for TUNE, OFF, ON, SIDETONE OFF
- Uses 4 penlight cells • 2-3/16 x 3-1/4 x 4 inches



\$ 39⁹⁵

NEW

MFJ-16010 Antenna Tuner

Now you can operate all band — 160 thru 10 Meters — with a single random wire and run your full transmitter power output — up to 200 watts RF power OUTPUT.

- Small enough to carry in your hip pocket, 2-3/16 x 3-1/4 x 4 inches • Matches low and high impedances by interchanging input and output • SO-239 coaxial connectors • Unique wide range, high performance, 12 position tapped inductor. Uses two stacked toroid cores



\$ 29⁹⁵

SBF-2BX SSB Filter

Dramatically improves readability.

- Optimizes your audio to reduce sideband splatter, remove low and high pitched QRM, hiss, static crashes, background noise, 60 and 120 Hz hum
- Reduces fatigue during contest, DX, and ragchewing
- Plugs between phones and receiver or connect between audio stage for speaker operation
- Selectable bandwidth IC active audio filter
- Uses 9 volt battery • 2-3/16 x 3-1/4 x 4 inches



\$ 27⁹⁵

MFJ-200BX Frequency Standard

Provides strong, precise markers every 100, 50, or 25 KHz well into VHF region.

- Exclusive circuitry suppresses all unwanted markers • Markers are gated for positive identification. CMOS IC's with transistor output. • No direct connection necessary
- Uses 9 volt battery • Adjustable trimmer for zero beating to WWV
- Switch selects 100, 50, 25 KHz or OFF
- 2-3/16 x 3-1/4 x 4 inches



\$ 49⁹⁵

MFJ-1030BX Receiver Preselector

Clearly copy weak unreadable signals (increases signal 3 to 5 "S" units).

- More than 20 dB low noise gain • Separate input and output tuning controls give maximum gain and RF selectivity to significantly reject out-of-band signals and reduce image responses
- Dual gate MOS FET for low noise, strong signal handling abilities • Completely stable • Optimized for 10 thru 30 MHz • 9 V battery
- 2-1/8 x 3-5/8 x 5-9/16 inches



\$ 27⁹⁵

MFJ-40T QRP Transmitter

Work the world with 5 watts on 40 Meter CW.

- No tuning • Matches 50 ohm load • Clean output with low harmonic content
- Power amplifier transistor protected against burnout
- Switch selects 3 crystals or VFO input • 12 VDC
- 2-3/16 x 3-1/4 x 4 inches

MFJ-40V, Companion VFO \$27.95

MFJ-12DC, IC Regulated Power Supply,

1 amp, 12 VDC \$27.95



\$ 15⁹⁵

NEW

CPO-555 Code Oscillator

For the Newcomer to learn the Morse code.

For the Old Timer to polish his fist.

For the Code Instructor to teach his classes.

- Send crisp clear code with plenty of volume for classroom use
- Self contained speaker, volume, tone controls, aluminum cabinet • 9 V battery
- Top quality U.S. construction • Uses 555 IC timer
- 2-3/16 x 3-1/4 x 4 inches

TK-555, Optional Telegraph Key \$1.95

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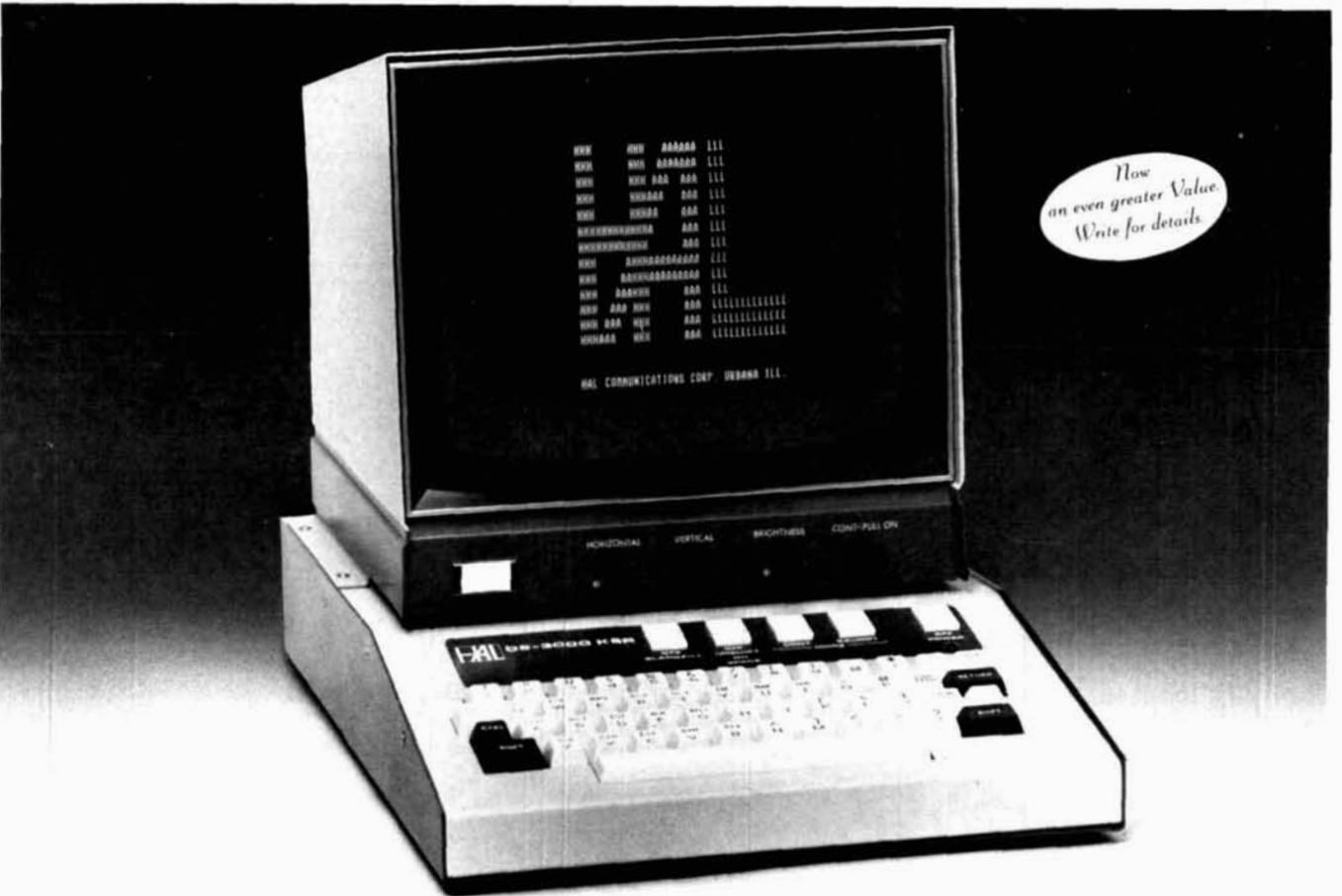
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Stay tuned for future programs.



The HAL ST-6000 demodulator/keyer and the DS-3000 and DS-4000 KSR/RO series of communications terminals are designed to give you superlative TTY performance today—and in the future. DS series terminals, for example, are re-programmable, assuring you freedom from obsolescence. Sophisticated systems all, these HAL products are attractively priced—for industry, government and serious amateur radio operators.

The HAL ST-6000 operates at standard shifts of 850, 425, and 170 Hz. The tone keyer is crystal-controlled. Loop supply is internal. Active filters allow flexibility in estab-

lishing different tone pairs. You can select AM or hard-limiting FM modes of operation to accommodate different operating conditions. An internal monitor scope (shown on model above) allows fast, accurate tuning. The ST-6000 has an outstandingly high dynamic range of operation. Data I/O can be RS-232C, MIL-188C or current loop.

The DS-3000 and DS-4000 series of KSR and RO terminals provide silent, reliable, all-electronic TTY transmission and reception, or read-only (RO) operation of different combinations

of codes, including Baudot, ASCII and Morse. The powerful, programmable 8080A microprocessor is included in the circuitry to assure maximum flexibility for your present needs—and for the future. The KSR models offer you full editing capability. The video display is a convenient 16-line format, of 72 characters per line.

These are some of the highlights. The full range of features and specifications for the ST-6000 and the DS series of KSR and RO terminals is covered in comprehensive data sheets available on request. Write for them now—and tune in to the most sophisticated TTY operation you can have today... or in the future.



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ham radio

magazine

DECEMBER 1976

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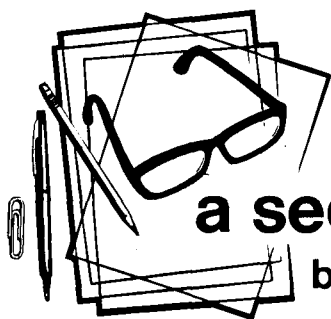
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a second look

by Jim Fisk

In looking back over the advances in IC technology that have occurred during the past several years, it's hard to realize that integrated circuits actually celebrated their 18th birthday this past summer. It was during the summer and fall of 1958 that Jack S. Kilby of Texas Instruments built the first integrated circuit. Other semiconductor companies had been working on ways to miniaturize solid-state electronic circuits, but most of these techniques used miniature components of one kind or another; Kilby was the first to use semiconductor material for both the active (transistors) and passive elements (resistors and capacitors) to build a complete circuit on a single piece of germanium.

His first circuits, a phase-shift oscillator and multivibrator, demonstrated the feasibility of this approach. Since, at that time, germanium was well established as a semiconductor material, and silicon was not, Kilby used germanium. On top of the germanium wafer were the contacts of the diffused transistors, junction capacitors, and resistors. A gold-plated metal frame protruded from the lower surface of the substrate, and thermally-bonded gold wires were used for connections between those elements not linked by the wafer itself.

Kilby's first circuits were large and irregular — at least by today's standards — and were considerably different from the precision ICs that are presently on the market. The photo masks and resists necessary to IC manufacturing were yet to be developed, so the patterns were hand painted on the semiconductor chip with black wax. Needless to say, the end product was rather crude looking (and huge by today's standards), but it worked.

About the same time Kilby was working on his first integrated circuits, Fairchild Semiconductor developed the *Planar* process — an innovation that is generally conceded to be the foremost semiconductor discovery of the 1960s. This process made semiconductors more reliable and cheaper to produce, as well as accelerating IC progress and acceptance.

Since these early developments, the number of circuits per unit area has increased and prices have plummeted. In 1962, a typical IC flip-flop chip was about 0.1 inch (2.5mm) square; by 1970 a similar circuit was one-tenth that size, and today the same circuit is even smaller. At the same time circuit size (and unit cost) were decreasing, circuit speed increased from audio to 1 MHz or so, then to 5 MHz, 15 MHz, and on up the scale. It was only a few short years ago that a 30-MHz frequency counter was only a dream — today 600-MHz counters are commonplace, and even higher count frequencies are available if you're willing to pay a small premium for the capability.

It wasn't all that long ago that I reported on this page that, "... you can now buy a dual flip-flop for a couple of dollars or a complete decade counter for about seven." And these were RTL devices, with maximum counting speeds in the low MHz range. The same issue carried ads for 709 op amps at \$3.98 and 711 dual comparators for \$4.98. A low-current voltage-regulator IC, if you could find one, cost ten dollars or more. Scanning through the ads in the back of this issue, you can now buy a 30-MHz decade counter for about 45 cents, a 709 op amp for 29 cents, and a 711 dual comparator for 39 cents — about one-sixteenth of their 1968 prices. Considering that the consumer price index has increased nearly 70 per cent during the same period of time, ICs have to be among the best buys of all time.

Although I've said it before, it's worth saying again that, with the sophisticated, low cost ICs that are on the market, it's possible for amateurs to build exotic electronic equipment that only large laboratories with big budgets could afford a few years ago — and some they couldn't afford at any price because the technology just wasn't available!

Jim Fisk, W1DTY
editor-in-chief

ICOM INTRODUCES THE REVOLUTION IN VFO TECHNOLOGY



Introducing the IC-245, 144-148 MHz FM Transceiver

The VFO Revolution goes mobile with the unique, ICOM developed LSI synthesizer with 4 digit LED readout. The **IC-245** offers the most for mobile on the market. The easy to use tuning knob moves accurately over 50 detent steps and assures excellent control as easily as steering the vehicle. With its optional adapter, the **IC-245** puts you into all mode operation on 12V DC power with a compact dash-mounted transceiver. In FM, the synthesizer command frequency is displayed in 5 KHz steps from 146 to 148 MHz, and with the side band adapter the step rate drops to 100Hz from 144 to 146 MHz. For maximum repeater flexibility, the transmit and receive frequencies are independently programmable on any separation. The **IC-245** even comes equipped with a multiple pin Molex connector for remote control.

The **IC-245** is a product of the revolution in VFO design, from its new style front panel, to its excellent mechanical rigidity and Large Scale Integrated Circuitry. Your **IC-245** will give you the most for mobile.

SPECIFICATIONS

GENERAL

Frequency Coverage Modes	*144.00 to 148.00 MHz FM (F3)
Supply Voltage	*SSB (A3J), CW (A1) DC 13.8V ±15%
Size (mm)	90H x 155W x 235D
Weight (kg)	2.7

TRANSMITTER

TX Output	F3 10W *A3J 10W (PEP), A1 10W
Carrier Suppression	40 dB or better
Spurious Radiation	-60 dB or less below carrier
Maximum Frequency Deviation	±5 KHz
Microphone Impedance	600 ohms

RECEIVER:

Sensitivity	*A3J, A1 0.5 microvolt input gives 10 dB S+N/N or better F3 0.6 microvolt or less for 20 dB quieting S+N+D/N at 1 microvolt input, 30 dB
Squelch Threshold	-8 dB or less (F3)
Spurious Response	-60 dB or better

SYNTHESIZER:

Frequency Range	144 MHz to 148 MHz
Step Size	5 KHz for FM *100 Hz or 5 KHz for SSB
Stability	per C in the range of -10 to +60 C, ±0.0000145% per C

* Valid with SSB Adapter only

THE BEGINNING OF THE ICOM VFO REVOLUTION!

VHF/UHF AMATEUR AND MARINE COMMUNICATION EQUIPMENT

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"N" PREFIXED TWO-LETTER CALLS are now available to any Amateur eligible for a 1x2 callsign. The release of N prefixes applies only to 1x2 callsigns at this time, though presumably the N prefix will also continue to be available when requested for special events stations.

"X" Suffix Callsigns, released in late October, increases total pool of 1x2 calls in each district by 676. Although the X suffix has traditionally indicated an experimental station in the United States, 1x2 X calls have not been issued since well before World War II so are not expected to cause any great confusion. Who's first for W1XX, Whiskey one Double Cross?

AMSAT'S ANNUAL MEETING drew about 75 people to Goddard Space Flight Center in October. JAIANG brought the prototype 2-meter to 70-cm transponder from JAMSAT, and reported about 500 Japanese Amateurs are users of OSCARs 6 and 7. The AMSAT 2-10 meter transponder for OSCAR A-OD is now ready for test.

OSCAR 6's Birthday was October 15 and AMSAT's longest lived bird is over four years old and still going strong. As the launch anniversary ended OSCAR 6 began its 18,300 orbit, a lot of miles and many thousands of contacts to its credit.

OSCAR 7 Also celebrated a birthday; it was a healthy two-years old November 15. N6V's Operation by the Jet Propulsion Laboratory's Amateur Radio Club was seen by millions of viewers on NBC's Today show. Featured during the outstanding segment was N6V's relaying of Mars photographs throughout the world via Amateur slow-scan TV.

The European Space Agency has announced approval of an Amateur Radio satellite launch on its experimental Ariane launch vehicle. A German-built OSCAR is scheduled to go aloft with Ariane's test flight B during December, 1979.

EXCELLENT RFI/EMI SURVEY article appeared in the September 20, 1976 issue of Electronic Design, should be "must" reading for any one seriously interested in the subject. Interference to as well as by communications equipment is included, and there's strong emphasis on FCC's increasing role in the problem area.

CB Is A Major cause of TVI/RFI complaints, of course, and in a recent discussion with FCC Chief Engineer Ray Spence he made the interesting observation that by far the majority of complaints of CB-caused interference was found to involve illegal power!

ITU SECRETARY-GENERAL MILI was the top brass at the dedication of United Nations' club station K2UN on October 21st. WIAW and 4U1ITU in Geneva joined in the inaugural ceremony, though K2UN's current antennas toward Europe leave much to be desired.

ARRL'S BICENTENNIAL CONTEST could become an annual affair, though under a different name. So many participants said they liked its format that League Communications Manager W1NJM has asked for comments.

AMATEUR NOVICE TRAINING PROGRAM currently has more than five times the enrollment it had last year - nearly 35,000 vs 6,000 in 1975. Unlike previous years, established classes continue growing with nearly zero dropout while newcomers appear after hearing about them from friends or on 27 MHz.

CARF WILL HAVE a headquarters office complete with Amateur station thanks to a grant of \$10,000 to the Kingston (Ontario) Old Timers' Amateur Radio Association. The office and Amateur station (VE3VCA) will be located at 370 King Street, West, in Kingston, but the mailing address will remain Box 356.

CANADIAN CB WILL EXPAND to 40 channels following the U.S.'s lead, but the General Radio Service operators won't be able to use their new channels until April 1. 40 channel radios for the Canadian market must be tested to tighter specs, but they can't be submitted for testing until after January 1. Commercial users presently operating on the new frequencies have the option of staying put or applying for a new assignment.

Whether A U.S. CBer entering Canada with a shiny new 40 channel radio before April 1 would have problems remains to be seen.

SEVERAL THOUSAND CB LICENSES issued around the beginning of 1976 apparently never reached the applicants. Areas affected include Zip Codes beginning with 0 through 8, and the problems ran from December through April. New licenses for the affected blocks are being printed and mailed; however, any licensee receiving one as a duplicate should discard it.

AMATEUR RADIO RELATED articles have been showing up in non-Amateur Radio publications with increasing frequency, but those not written by Amateurs often suffer from distracting inaccuracies. Ham Radio's editorial staff volunteers its services in reviewing future Amateur Radio articles for any non-Amateur publication that wishes to take advantage of the offer.

Does Your Transmitter Love Your Antenna?



If you're fighting the constant battle of limited band width, high SWR ratios, inefficient low-pass TVI filter operation due to high SWR you're not alone.

DenTron makes the Problem Solvers.

The DenTron tuners give you maximum power transfer from your transmitter to your antenna, and isn't that where it really counts?

Our Super Tuners (A. B. & E.) are the only tuners on the market that match everything between 160 and 10 meters. Whether you have balanced line, coax cable, random or long wire the DenTron Super Tuners will match the antenna impedance to your transmitter.

NEW: The Monitor Tuner (E.) was designed because of overwhelming demand. Hams told us they wanted a 3 kilowatt tuner with a built-in wattmeter, a front panel antenna selector for coax, balanced line and random wire. So we engineered the 160-10m Monitor Tuner. It's a life time investment at \$299.50

The DenTron 80-10 AT (D.) is a random wire, 80-10 meter tuner which is ideal for portable operation or apartment dwellers.

Every serious ham knows he must read both forward and reverse wattage simultaneously for that perfect match. So upgrade with the DenTron W-2 Dual in line Wattmeter. (C.)

The flexibility we build into our Tuners make any previous tuner you might have owned obsolete.

- A. Super Tuner 1KW PEP \$129.50
- B. Super Super Tuner 3 KW PEP \$229.50
- C. W-2 Wattmeter \$ 99.50
- D. 80-10 AT 500 W PEP \$ 59.50
- E. Monitor Tuner 3 KW PEP \$299.50

All DenTron products are made in U.S.A.

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- Advance Registration \$12.50 per person; with Hotel Sahara Late Show and two drinks \$23.00 per person or with Hotel Sahara Congo Dinner Show (entree Cornish Hen), no drinks \$30.00 per person. Tax and Gratuity included.
- Totie Fields and Bert Convy are scheduled entertainers in Hotel Sahara's Congo Room.
- Advance Registration must be received by **SAROC** on or before January 1, 1977.

The NATION'S TWELFTH ANNUAL LAS VEGAS PRESTIGE CONVENTION



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January 6-9, 1977

- **SAROC** Registration includes: registration tickets, admission to technical sessions, Friday cocktail party hosted by T. P. L. Communications and TRI-EX Tower Corp. with **SAROC**; Saturday cocktail party hosted by Ham Radio Magazine with **SAROC**; Hotel Sahara Buffet Brunch on Sunday, Tax and Gratuity.
- Hotel Sahara room rate for **SAROC** registered delegates \$17.00 per night plus room tax, single or double occupancy.
- Hotel Sahara room reservation request card will be sent to **SAROC** registered delegate.



Send your check or money order to **SAROC**, P. O. Box 945, Boulder City, NV 89005

KENWOOD'S TS-520

...worth waiting for!



Why wait any longer for a rig that offers top performance, dependability and versatility... the TS-520 has proven itself in the shacks of thousands of discriminating amateurs, in field day sites, in DX and contest stations, and in countless mobile installations.

Superb craftsmanship is evident throughout... in its engineering concepts as well as its construction and styling... craftsmanship that is a Kenwood hallmark.

Maybe the Kenwood TS-520 is the one you have been waiting for.

Kenwood offers accessories guaranteed to add to the pleasure of owning the TS-520. The TV-502 transverter puts you on 2-meters the easy way. (It's completely compatible with the TS-520.) Simply plug it in and you're on the air. Two more units designed to match the TS-520 are the VFO-520 external VFO and the model SP-520 external speaker. All with Kenwood quality built in.



TS-520 Specifications

MODES: USB, LSB, CW
POWER: 200 watts PEP input on SSB, 160 watts DC input on CW
ANTENNA IMPEDANCE: 50-75 Ohms, unbalanced
CARRIER SUPPRESSION: Better than -45 dB
UNWANTED SIDEBAND SUPPRESSION: Better than -40 dB
HARMONIC RADIATION: Better than -40 dB
AF RESPONSE: 400 to 2600 Hz (-6 dB)
AUDIO INPUT SENSITIVITY: 0.25 μ V for 10 dB (S+N)/N
SELECTIVITY: SSB 2.4 kHz (-6 dB), 4.4 kHz (-60 dB) CW 0.5 kHz (-6 dB), 1.5 kHz (-60 dB) (with accessory filter)
FREQUENCY STABILITY: 100 Hz per 30 minutes after warmup
IMAGE RATIO: Better than 50 dB
IF REJECTION: Better than 50 dB
TUBE & SEMICONDUCTOR COMPLEMENT: 3 tubes (2 x 6146B, 12BY7A), 1 IC, 18 FET, 44 transistors, 84 diodes
DIMENSIONS: 13.1" W x 5.9" H x 13.2" D
WEIGHT: 35.2 lbs.
SUGGESTED PRICE: \$629.00

VFO-520

Provides high stability with precision gearing. Function switch provides any combination with the TS-520. Both are equipped with VFO indicators showing at a glance which VFO is being used. Connects with a single cable and obtains its power from the TS-520. Suggested price: \$115.00.

SP-520

Although the TS-520 has a built in speaker, the addition of the SP-520 provides improved tonal quality. A perfect match in both design and performance. Suggested price: \$22.95.

TV-502

TRANSMITTING/RECEIVING FREQUENCY: 144.145.7 MHz, 145.0, 146.0 MHz (option).
INPUT/OUTPUT IF FREQUENCY: 28.0, 29.7 MHz
TYPE OF EMISSION: SSB (A3J), CW (A1)
RATED OUTPUT: 8W (AC operation)
ANTENNA INPUT/OUTPUT IMPEDANCE: 50 Ω
UNWANTED RADIATION: Less than -60 dB
RECEIVING SENSITIVITY: More than 1 μ V at S/N 10 dB
IMAGE RATIO: More than 60 dB
IF REJECTION: More than 60 dB
FREQUENCY STABILITY: Less than ± 2.5 kHz during 1.60 min after power switch is ON and within 150 Hz (per 30 min) thereafter.
POWER CONSUMPTION: AC 220/120V, Transmission 50W max., Reception 12W max., DC 13.8V, Transmission 2A max., Reception 0.4A max.
POWER REQUIREMENT: AC 220/120V, DC 12-16V (standard voltage 13.8V)
SEMI CONDUCTOR: FET 5, Transistor 15, Diode 10
DIMENSIONS: 6 $\frac{1}{2}$ " W x 6" H x 13 $\frac{1}{4}$ " D
WEIGHT: 11.5 lbs.
SUGGESTED PRICE: \$249.00

CW-520

500 Hz CW Crystal Filter. \$45.00.

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DX receiver

for the hf bands

This design features
four selectable front ends
and excellent dynamic range
to help you dig out
the weak ones

Today's erratic propagation conditions together with the tremendous increase in the number of amateur stations make DX operating much more difficult than, say, ten or fifteen years ago. In my case, using an SB220 linear amplifier and a four-element quad antenna, I had fair response to directional CQ DX calls only to become frustrated by adjacent-channel overload or interference in my receiver by strong local or short-skip stations.

The answer to this problem is a receiver with characteristics such as those in the design described in this article. Tests made on the 20- and 40-meter front ends of this design produced the data shown in **table 1**. Note that the dynamic range is 100 dB for both test conditions on 40 and 20 meters.

receiver front-end design

Conflicting requirements and tradeoffs were necessary to obtain a receiver with a wide dynamic range. Recent articles, studies, and experiments indicated that balanced mixers, together with selective rf tunable filters ahead of the first active device, represented effective means for diminishing third- through fifth-order intermodulation (IMD) and cross-modulation products.

I tried hot-carrier diode mixers using discrete diodes (monolithic packages weren't available) in both ring and cross configurations. It was an unsuccessful attempt, since low input-output impedances created matching problems and these mixers seemed to have an insatiable hunger for oscillator power.

The overall receiver noise factor is interrelated with the receiver passband; and in the mathematical formula, one term shows that it is also inversely proportional to the mixer gain. With the diode mixer, the receiver lacked sensitivity because of a conversion loss of almost 9 dB.

Without discrediting the hot-carrier diode mixer, better results were obtained by using the Motorola C6050G double-balanced integrated circuit and also selected pairs of the RCA 40673 dual-gate mosfet.

Occasionally, at certain antenna bearings, the combination of galactic, ionospheric, atmospheric, and man-made noise is below predicted levels; therefore an "in-out" rf amplifier would be justified. For higher-frequency bands, extremely good sensitivity is possible by using a balanced amplifier as in some vhf receivers.

Theoretically, this kind of arrangement should have a better noise factor, as somewhat more than 50% of internally generated random noise would be rejected in the common-mode operation, being cancelled in the balanced output circuit. The rf amplifier becomes a nuisance when the bands become crowded with strong signals exceeding S9+40 dB levels. Receiver gain compression occurs, along with numerous intermodulation products, indicating that it's time to turn off the rf amplifier! This is accomplished in this design by means of miniature reed relays.

Another unwanted phenomenon in mixers is so-called "reciprocal mixing." This mixing is a direct consequence of oscillator noise modulation. When a large interfering signal appears at the mixer input, the signal will mix with oscillator noise and, although the interfering signal may be out of the i-f passband, the noise so produced will be within the i-f passband.

Reciprocal mixing is measured by the amount of noise introduced by a closely spaced interfering signal;

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i.e., when the level of the interfering signal, expressed in dB above 1 μV and spaced 20 kHz away from the desired signal produces a reduction of signal-to-noise ratio by 10 dB.¹ Oscillator noise reduction is possible by a) careful elimination of unwanted spurious generation

Ultimately, reciprocal mixing reduces mixer dynamic range by raising its equivalent noise floor. As stated above, inherent oscillator noise modulation is also dependent on oscillator power; therefore, mixers working at high injection levels will be more affected.

table 1. Measured characteristics of the DX receiver 20- and 40-meter front ends.

receiver characteristic	40-meter band		20-meter band	
	rf ampl off	rf ampl on	rf ampl off	rf ampl on
Sensitivity for 10-dB s/n	0.5 μV (-119 dBm)	0.1 μV (-133 dBm)	0.2 μV (-127 dBm)	0.07 μV (-136 dBm)
third-order intercept point (dBm)	+23	+6	+15	+3
gain compression (dBm)	+10	-10	0	-15
dynamic range (dB)	100	100	100	100

on other frequencies, b) good dc filtering, c) good stability, and d) reducing oscillator power and narrowing oscillator bandwidth. Recommended low-noise oscillators are those consisting of differential amplifier integrated circuits with balanced output circuitry.

Front end. Four separate front ends are selected by rotary switch S1 (fig. 1). In this design resistors in the signal path were kept to a minimum as they are noise devices. Despite the cumbersome appearance, this setup allows individual band optimization and eliminates

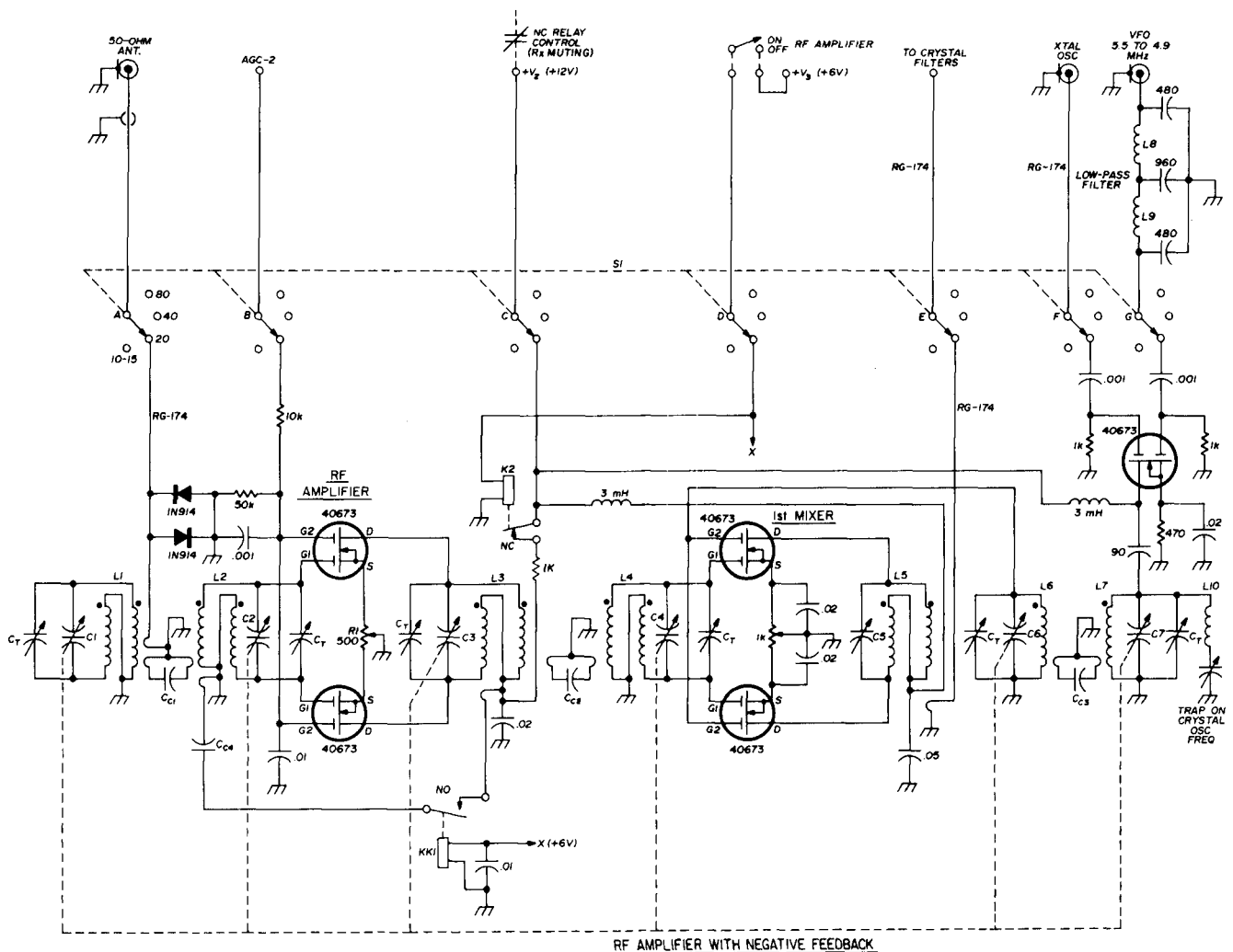
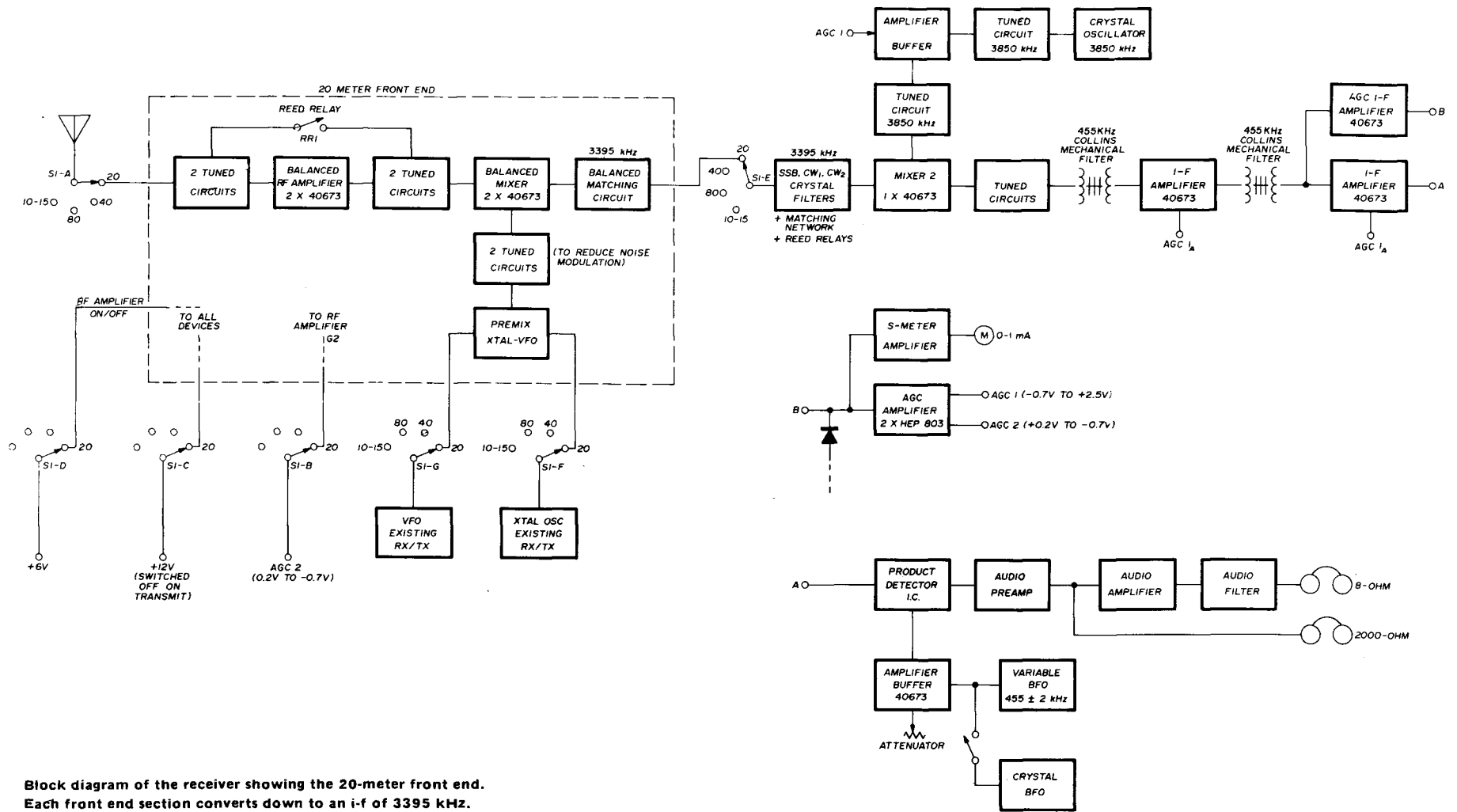


fig. 1 Schematic of the DX receiver front end, first mixer, and vfo. All links are one turn for an impedance of approximately 50 ohms. All trimmer capacitors are mica, 20 to 130 pF. L8, L9, 17 turns no. 24 AWG (0.5mm) on Amidon T-50-6 core. L5, 44 turns no. 28 AWG (0.3mm) wound 2 x 22 on Amidon T-50-6 core. The i-f is 3395 kHz.



Block diagram of the receiver showing the 20-meter front end. Each front end section converts down to an i-f of 3395 kHz.

problems related to balanced circuitry switching. I was fortunate enough to obtain some surplus vhf six-gang split-stator variable capacitors. To prospective builders of this front end, I suggest the use of smaller units of the kind having a shaft extension on both sides, which could be mechanically ganged. A good substitution would be a matched set of varactors for an unbalanced arrangement.

Good tracking between rf input and pre-mixer output circuits is imperative since the 4-pole rf filter is very selective, particularly on the lower bands. On the

low values of CC3), while the upper quad could be saturated or unsaturated (our signal port). Recommended external biasing is:

$$(V6, V9) - (V7, V8) \geq 2 \text{ V}$$

$$(V7, V8) - (V1, V4) \geq 2.7 \text{ V}$$

$$(V1, V4) - (V5) \geq 2.7 \text{ V}$$

Filters. In accordance with modern receiver design practice, an ssb filter and two CW crystal filters are

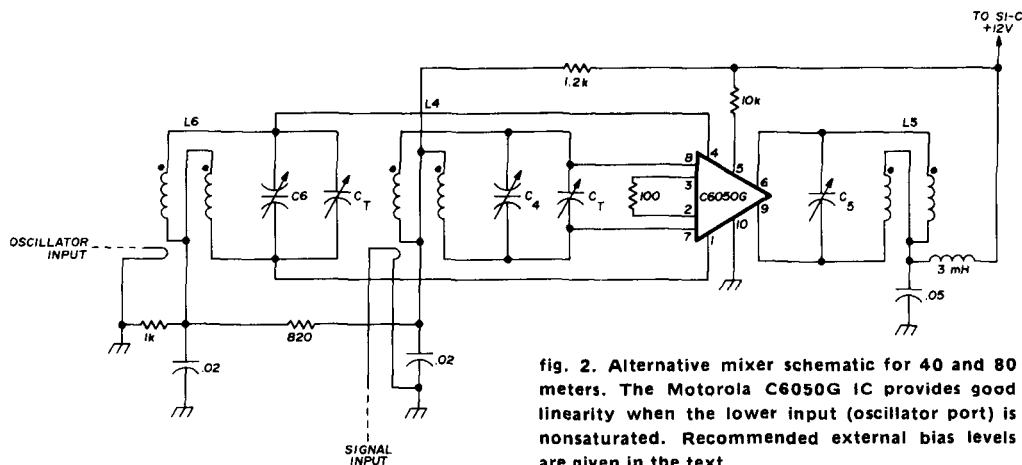


fig. 2. Alternative mixer schematic for 40 and 80 meters. The Motorola C6050G IC provides good linearity when the lower input (oscillator port) is nonsaturated. Recommended external bias levels are given in the text.

20-meter band with the rf amplifier off, measured filter response was 50 kHz wide at 20-dB down, which means that an unwanted signal 25 kHz away from the receive frequency is attenuated 20 dB. The frequencies shown in table 2 would be applicable to Kenwood or Heathkit lines, but the principle could be extended to other makes.

Mixer. The dual-gate 40673 mosfet mixer has lower third- and fifth-order products in its output when gate G2 remains nonbiased; however, gain is definitely lower. For best performance oscillator injection level was set at 300 mV.

Fig. 2 shows the 40- and 80-meter alternative mixer configurations. The Motorola C6050G double-balanced differential amplifier with emitter degeneration has good linearity when the lower input (i.e., our oscillator port) is nonsaturated (maximum 27-mV oscillator level — see

placed at the first mixer output through a matching network. Filter selection is accomplished by using remotely controlled miniature reed relays. Interelectrode capacitance of these reed relays is so minute that, when dc switching voltage is removed, signal feedthrough was measured at 120 dB down.

Fig. 3 shows the crystal filter arrangement. To obtain the above attenuation figure, filters were placed against a ground plane (double-clad printed circuit board, the face next to the filter grounded on one spot only). The second mixer is of classic design, and the local oscillator operates in a very stable mode. The second i-f strip is on 455 kHz and uses two Collins ssb mechanical filters.

Agc. An elaborate amplified agc system is derived from a separate uncontrolled i-f amplifier. One branch of this fast-rise, slow-decay agc system controls the i-f stages along with the local oscillator amplifier-buffer by

table 2. Coil and capacitor values for coverage between 3.5-28 MHz.

band (MHz)	frequency coverage (MHz) circuit 1 to circuit 4	circuits 6 and 7	vfo	xtal osc	L1 = L2 = L3 = L4 (turns)	coils and capacitors*				
						L6 = L7 (turns)	C1 = C2 = C3 = C4 (pF)	C6 = C7 (pF)	CC1 = CC2 (pF)	CC3 (pF)
3.5	3.5-4.0	6.895-	5.5-	12.395	2 x 20	2 x 16	10-30	8-20	800	90
		7.395	4.9		T-50-6					
7	6.9-7.9	10.295-	5.5-	15.895	2 x 14	2 x 12	10-30	8-20	470	51
		11.295-	4.9		T-50-6	L7 = 24T				
14	13.9-14.9	17.295-	5.5-	22.895	2 x 7	12T	10-30	8-20	350	330
		18.295	4.9		T-50-6	T-50-10				
21-28	20.5-30.0	23.895-	5.5-	29.895	2 x 5	8T	10-100	8-90	250	220
		33.395	4.9	36.895	T-50-10	T-50-10				
				37.395						

*No rf amplifier on 3.5 MHz. Rf amplifier on 7 MHz is unbalanced

Notes:

455 kHz i-f transformer:

A&B — primary impedance	$Z_p = 35k$	Radio Shack
secondary impedance	$Z_s = 6k$	"black core"
C — primary impedance	$Z_p = 60k$	"yellow core"
secondary impedance	$Z_s = 500k$	
D — primary impedance	$Z_p = 40k$	"white core"
secondary impedance	$Z_s = 1k$	

SSB crystal filter Trio 4 pole 2.2 kHz at -6 dB

CW-1 crystal filter Trio 4 pole .5 kHz at -6 dB

CW-2 crystal filter Heathkit .4 kHz at -6 dB

(CF = 3395.4 kHz)

Reed relays 6V miniature for PC board mounting

(Electronic Applications Co. 1A3A-H)

All resistors 1/4 watt

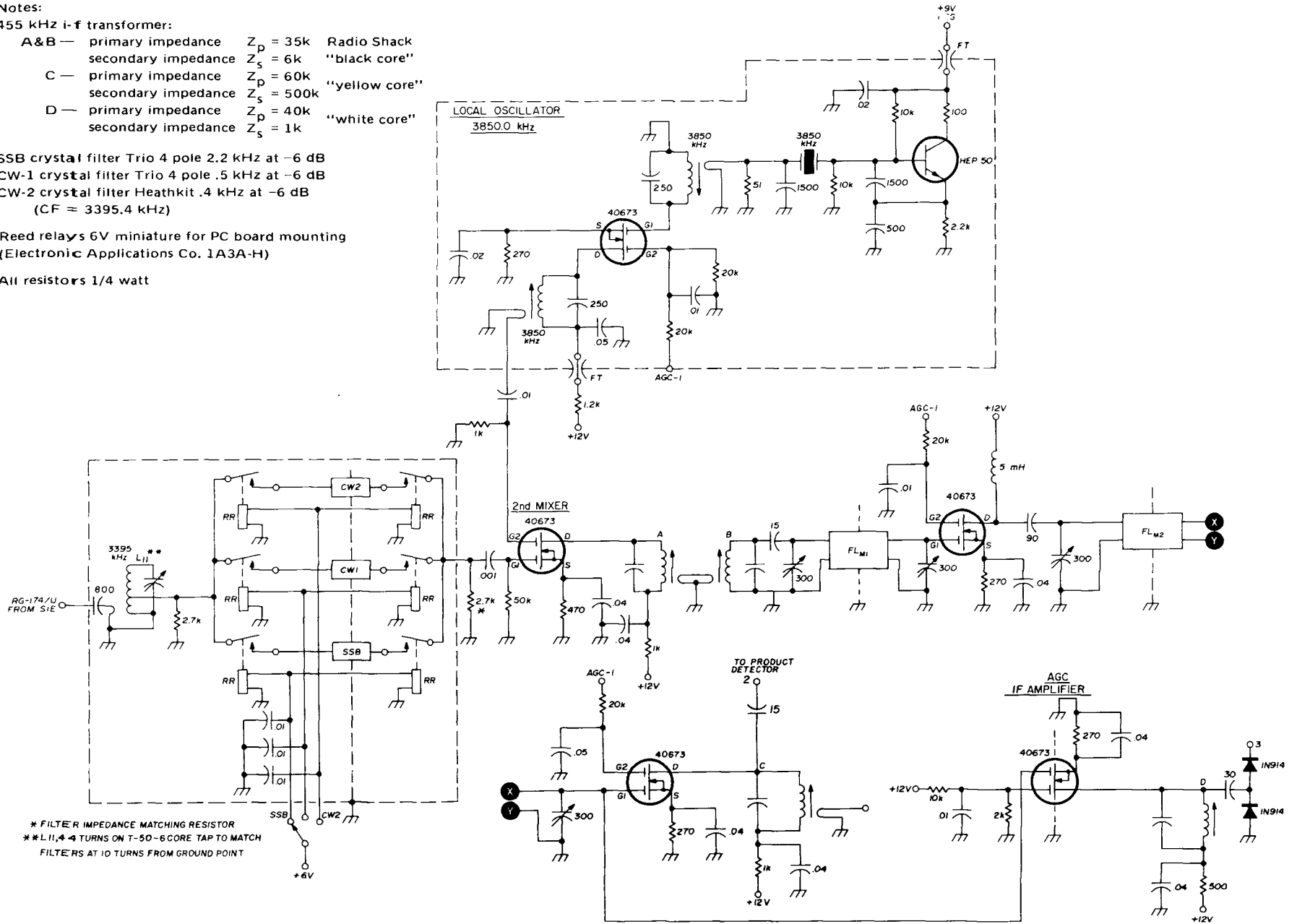


fig. 3. Crystal filter, local oscillator, second mixer, and agc amplifier schematic. Filter sections are selected by remotely controlled reed relays.

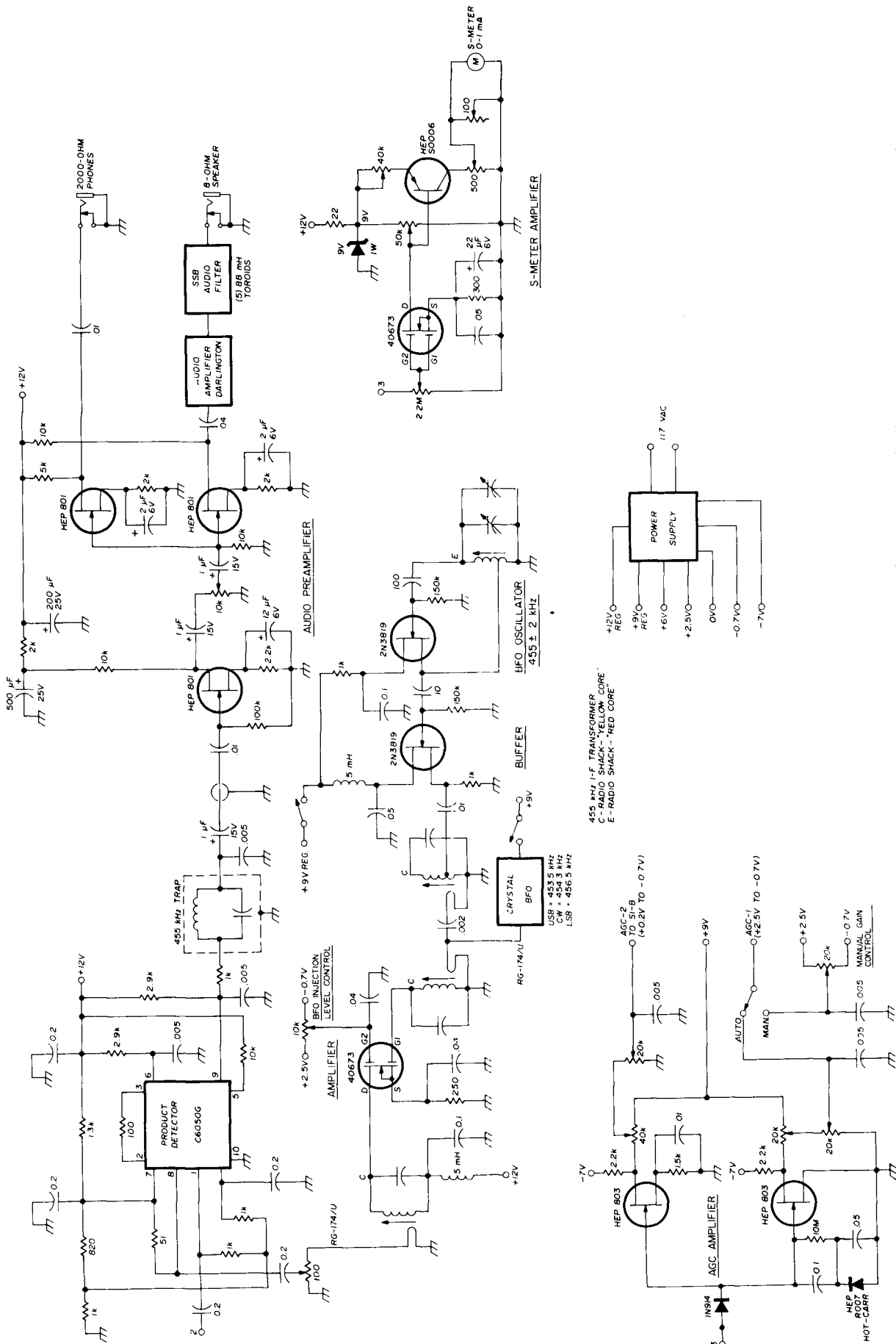


fig. 4. Product detector, bfo, agc, and audio circuits. The Motorola C6050G is used for the product detector, which produced excellent strong-signal rejection with decreased bfo injection voltage.

swinging voltages from +2.5 V (weak signals) to -0.5 V (strong signals). The second agc branch is threshold-biased and applied only to the rf amplifier over a restricted range, so that front-end linearity is not impaired. The receiver has a separate S-meter amplifier as shown in fig. 4. Minipotentiometers are used to calibrate the meter. Accuracy is within 3 dB, or one-half S-point.

Detector and bfo. The product detector and bfo are of particular interest. A very sensitive Motorola C6050G double-balanced IC makes a good product detector and requires a maximum of 300 mV bfo injection for the strongest signals.

The beat-frequency oscillator is variable within 455 \pm 2 kHz. Its output is amplified and filtered to supply the required maximum of 300 mV into a 50-ohm load at the product detector.

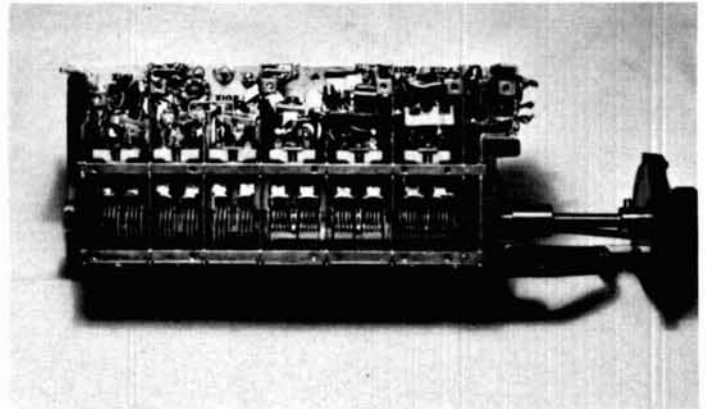
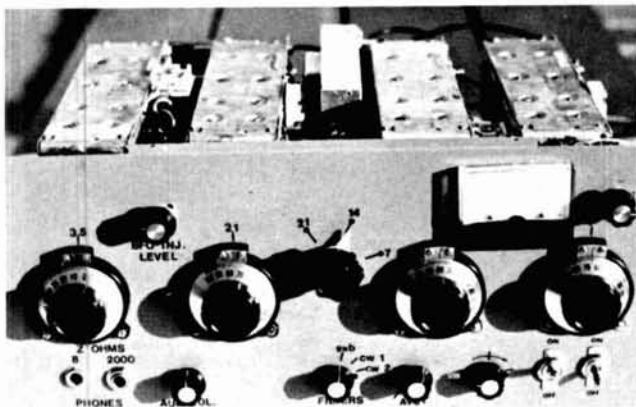
Theory says that, for minimum distortion a product detector requires carrier injection at least 10 times the level of the incoming signal at the input port. What would happen upon lowering that injection level? Decreasing the bfo level caused strong perturbing signals to become unreadable, while weak DX signals were still crystal clear. One helpful finding was that the audio output versus bfo level dropped about 10 dB faster for the stronger signal compared to the weak one.

A crystal bfo was incorporated for good transceive operation. This crystal bfo is used to calibrate the variable bfo. At times, the output from the product detector is extremely low; henceforth, a noiseless audio preamplifier is required. The receiver also employs a 5-toroid audio filter to alleviate inherent noise pickup when using an audio amplifier.

construction hints

This is an experimental receiver; appearance was secondary to conveniences such as avoiding stray noise pickup, rf feedback, and audio hum. It was constructed by degrees starting with the front end for the 20-meter band. Mosfet devices were first tested with respect to dynamic transconductance and dc for matching purposes. Each device was set up in an amplifier with a plug-in socket and identical rf signal levels were applied

Front view of the DX receiver with cabinet removed.



Typical receiver front-end arrangement. Capacitor stator plates are easily removable so that proper maximum-minimum capacitance is obtained for band coverage and precise tracking.

to both gates from a signal generator, while a vtvm was used to measure output level on a tuned circuit. A table was compiled, and devices showing close characteristics were paired. From 40 available devices I could select only three closely matched pairs, which leads to the conclusion that integrated mosfet circuits would be a far better choice.

tests and results

The 20- and 40-meter front ends were tested for sensitivity, IMD, gain compression, and dynamic range (table 1). Two powerful signal generators (most signal generators are not capable of delivering more than 100 mV into a 50-ohm load) were used, tuned 10 kHz apart, each at a level of +12 dBm, which becomes +6 dBm after the hybrid combiner. The spectrum analyzer indicated at this level an IMD of 35 dB on the 40 meter band.

acknowledgement

I wish to express gratitude to Serge Costin, WB2ZWJ, for his continuous technical advice in the design and construction of this receiver.

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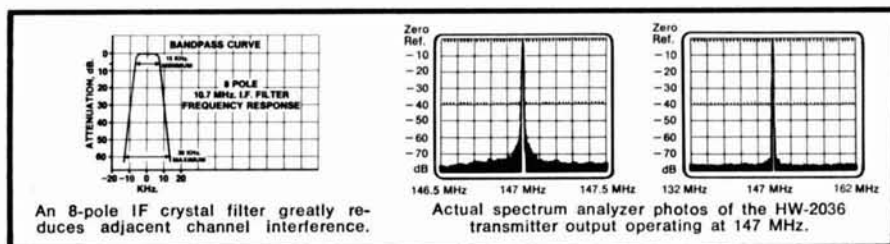
Operation is easier than ever! The front panel lever switches select any frequency in any 2 MHz segment of the 143.5 to 148.5 operating bands. You select the last four digits, three with lever switches which display the frequency directly and the last with a 5 kHz toggle switch which makes ALL 2-meter frequencies in the band available. If you inadvertently dial up an out-of-band frequency, the transmitter simply will not key.

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loop antennas

A discussion of small
loop receiving antennas
and details on
their construction
for the
low-frequency bands

Most amateurs use the same antenna for both receiving and transmitting. This makes a lot of sense on vhf, and on 10, 15 and 20 meters, but at the lower frequencies which are more susceptible to noise interference entering via the antenna (160, 80 and 40 meters), the small loop receiving antenna has some advantages in reducing the susceptibility to certain types of noise. This article will attempt to explain the loop's operation in the simplest possible terms and will describe several practical loop antennas which are suitable for amateur use.

The electric- and magnetic-field components of an incoming electromagnetic wave are at right angles to each other. The plane formed by these components is at right angles to the direction of wave arrival. With the wave polarization and the direction of wave travel shown in fig. 1, both the electric and magnetic field components excite current flow in the vertical portions of the simple unshielded loop. The current induced by the electric field is due to the difference in charge impinging along the length of the vertical elements, while the current due to the magnetic field is because of the motor-generator action of the vertical conductors cutting the lines of force in the magnetic field as it moves past the conductors.

The currents due to both field components are mutually in phase, and although neither the electric nor the magnetic field components can exist without the other in the radiated electromagnetic field, the loop antenna behaves identically with excitation from either or both field components.¹

While the voltage available at the terminals of a dipole is simply proportional to the current induced in the dipole, the voltage available at the terminals of a small loop is proportional to the *difference* between the

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Great Falls, Virginia 22066

currents induced in the two opposite vertical loop elements. No currents are *induced* in the top or bottom horizontal conductors connecting the vertical elements.

When the *axis* of the loop is pointing toward the signal source as in **fig. 1A**, the two vertical elements of the loop are excited at the same phase point of the wave front. Thus the current induced in both elements is of the same amplitude and phase, and flow in the same absolute direction (see **fig. 2**). However, the two currents are actually flowing in opposite directions with respect to a continuous, one-way travel around the loop, and therefore cancel each other, producing zero net voltage.

On the other hand, when the *plane* of the loop is pointing toward the signal source, as in **fig. 1B**, maximum voltage is produced because the two vertical elements are now in positions of maximum *difference* in phase relationship with the wave front, with the resulting difference between the currents induced in the vertical elements producing a maximum voltage. In fact **fig. 1B** shows that during the portion of the wave cycle when the field is changing most rapidly, the currents in the two elements are flowing in *opposite* absolute directions (one flowing upward and the other downward), with the result that both currents are actually flowing in the *same* direction around the loop, and are therefore mutually aiding instead of opposing as in **fig. 1A**. For orientations of the loop at angles in between the two just described, and in general, the voltage produced is proportional to the cosine of the angle formed between

Junction box for the square loop antenna containing 80/40 bandswitch, balun and tuning capacitor.

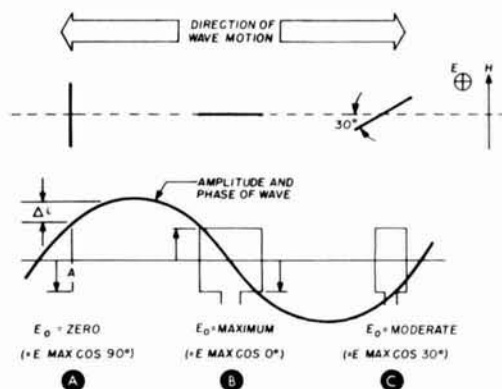
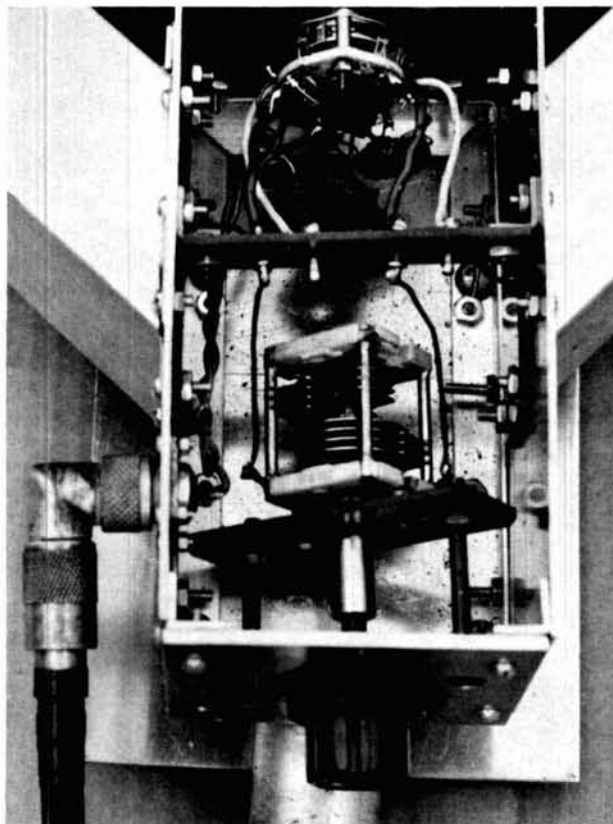


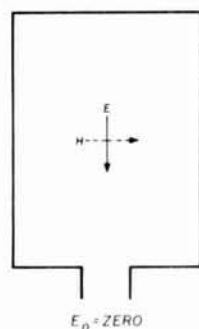
fig. 1. Directivity of the loop arises from the interception of the wavefront by each half of the antenna. In (A) the currents are of equal amplitude and phase, producing no net voltage difference at the output. In (B) the currents are at maximum amplitude and phase difference, producing maximum output voltage. In (C) the current difference between loop halves is moderate, producing a corresponding voltage difference at the output terminals. Voltage output is small for angles larger than 60 degrees.

the loop plane and direction of the wave propagation, as in **fig. 1C**. The resulting figure-eight radiation pattern is thus a perfect pair of circles tangent to one another as shown in **fig. 3**.

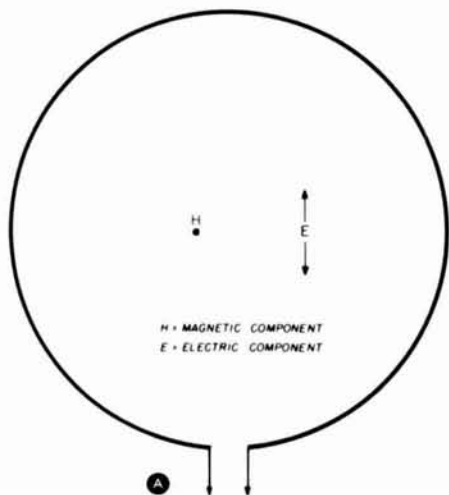
For several basic reasons, nearly all practical loop antennas are electrostatically shielded by means of an open-turn shield. One reason is that electrostatic shielding is a convenient way of achieving a capacitance balance between the two opposite halves of the loop and ground. Without this balance the figure-eight pattern would be distorted and the nulls misplaced and obscured. Second, the open-turn shield shown in **fig. 3** forms a balun, permitting the loop to feed an unbalanced load without upsetting the loop-to-ground balance. And third, electrostatic shielding renders the loop insensitive to the electric component of a passing wave. This has an insignificant effect on the reception of a wave propagated in the far field (radiation field). However, in the case of several types of man-made noise interference, the effect is to reduce the reception of the noise.

If the electrical disturbance producing the interfering noise is confined primarily to the *induction* field (as many such noise disturbances are), the electric compo-

fig. 2. Electric (E) and magnetic (H) components of a wavefront impinging upon a loop antenna, showing current flow in the loop. When the plane of the loop is parallel to the wavefront, as shown here, output voltage is minimum (see **fig. 1A**).



ment generally predominates over the magnetic field. Since the shielded loop is sensitive only to the magnetic field, there's a noticeable reduction in noise pickup as compared to that of a vertical dipole. Providing the desired signal is not arriving from the same direction as



out the loop of relatively equal amplitude and phase. This condition will produce the figure-eight pattern illustrated, but lengths in excess of this criteria will cause some pattern distortion. Reference 4 states that loops as large as 0.1 wavelength in diameter (0.314 wavelength

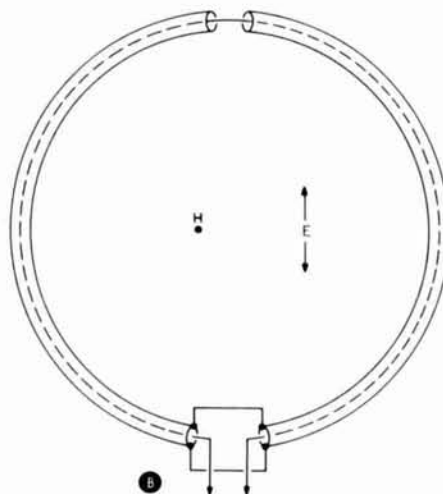
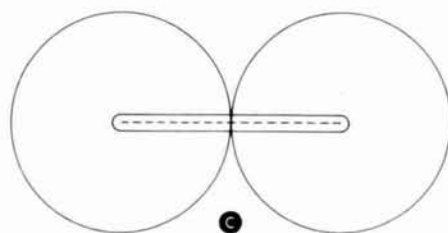


fig. 3. Unshielded loop antenna (A) and shielded loop antenna (B). There is no difference in the radiation patterns of the unshielded or shielded loop (C) if the output is balanced and if the capacitance to ground from both sides of the loop are equal. Loop pattern distortion results from these types of imbalances, and shielding the loop is one way of achieving the desired balance.



the noise, some additional reduction in noise interference level is also available due to the directivity of the loop radiation pattern. Simply pointing the axis of the loop in the direction of the noise will minimize the noise pickup, while the desired signal still arrives from a favorable angle on the directivity pattern.

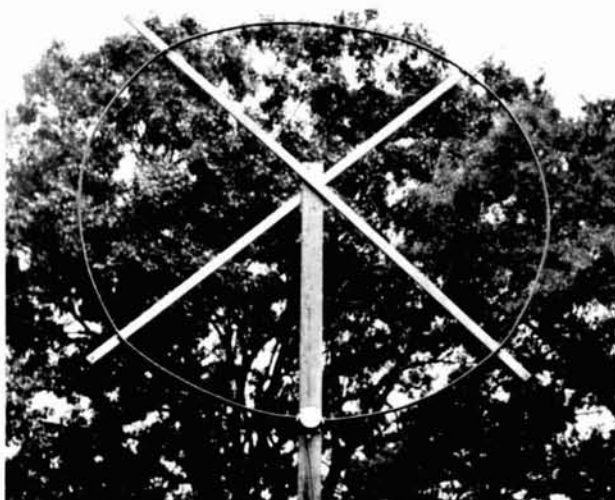
In general, atmospheric noise is propagated as a *radiation* field, generated by the electrical discharges that attend thunderstorms, both locally and throughout the world. Noise from an electrical storm concentrated in a single direction may be reduced by the directive properties of a shielded loop, but not by its insensitivity to the electric field. On the other hand, interference from precipitation static will be effectively reduced by the shielding properties of the loop because precipitation static is caused by an *induction* field localized directly around the receiving antenna.

The illustration of fig. 1 is greatly exaggerated. When a loop 6½ feet (2m) between legs is used on 80 meters, the maximum wavefront intercepted represents only a small fraction of the energy intercepted by a half-wavelength dipole. However, such a small antenna is still adequate for good signal reception.

References 2 and 3 state that a maximum wire length of about 0.08 wavelength will produce currents through-

circumference) can be used without serious pattern distortion. However, this reference is confined to aperiodic loops, while reference 2 deals with loops that are tuned, providing higher Q. The higher Q changes the current and phase difference in the loop wire, resulting

The coaxial loop of fig. 4 as built by the author.



in the shorter specified loop lengths (0.08 wavelength maximum).

The advantage of dual-band reception from a single loop further compromises the design criteria. For those who wish to retain the criteria of references 2 and 3,

towers and guy wires, etc., signals will be injected into a loop antenna from both the direct signal and re-radiation from these nearby structures. If such structures have high Q and are at or near resonance at the frequency of the exciting signal, their energy may approach that of

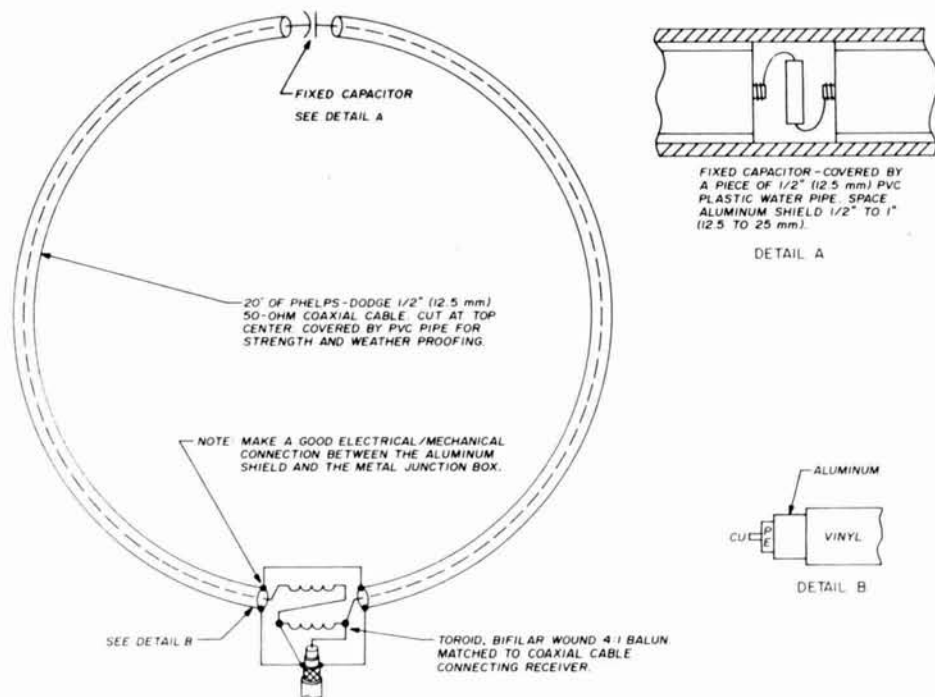


fig. 4. Single-turn coaxial loop antenna suitable for use on 80 and 160 meters. The toroid transformer balances the loop output to ground, whether shield is present or not. Typical dimensions are listed in table 2.

table 1 has been included. Corrections to table 2 must be made to compensate for this altered construction. Single-band designs would do well to follow the referenced design for maximum performance.

effects of nearby re-radiation

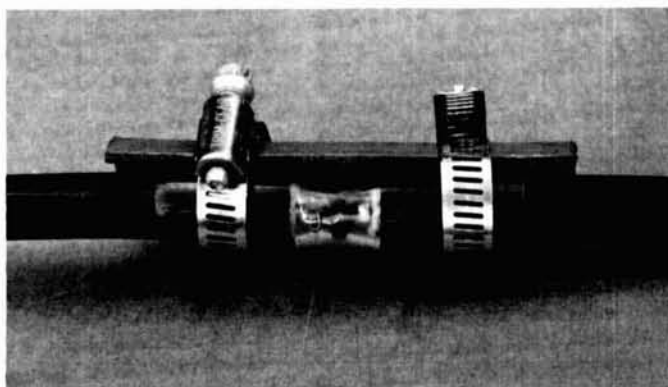
If there are metallic structures near the loop antenna of ample conductivity and size, such as power lines, homes with electrical wiring, water and furnace air-conditioning ducts and piping, as well as antennas,

the direct signal and cause appreciable deviation to the true bearing of the signal source. The resultant voltage induced into the loop will be the vector sum of the amplitude and phase of the multiple sources. Since the amateur is not generally interested in obtaining accurate bearings of signal sources, such deviation is relatively unimportant. What is of prime importance is the amplitude of the desired signal and, secondarily, the depth of

table 1. Maximum wire length for direction-finding loops as specified in references 2 and 3 (0.08 wavelength).

frequency (MHz)	wavelength (meters)	maximum wire length
1.8	166.7	43' 7" (13.28m)
1.9	157.9	41' 4" (12.60m)
3.5	85.7	22' 6" (6.86m)
3.6	83.3	21' 10" (6.67m)
3.7	81.1	21' 4" (6.49m)
3.8	78.9	20' 9" (6.32m)
4.0	75.0	19' 8" (6.00m)
7.0	42.9	11' 3" (3.43m)
7.1	42.3	11' 1" (3.38m)
7.2	41.7	10' 11" (3.33m)
7.3	41.1	10' 9" (3.28m)

Detail of the break in the coax at top of loop. See detail B in fig. 4.



the null available to reduce the strength of an interfering signal.

If installed with the axis of the loop horizontal, only signals from the horizon i.e., low angle or ground wave, will produce the deep nulls shown. Signals from higher vertical angles will not have their wave front parallel to

lated covering that will provide strength to this point of the loop will be satisfactory, but it should also provide a weatherproof seal to keep moisture out of the break. Before placing the cover on the break, check for peak performance on your desired portion of the band. I used a grid dipper in the shack and tuned its signal in on the

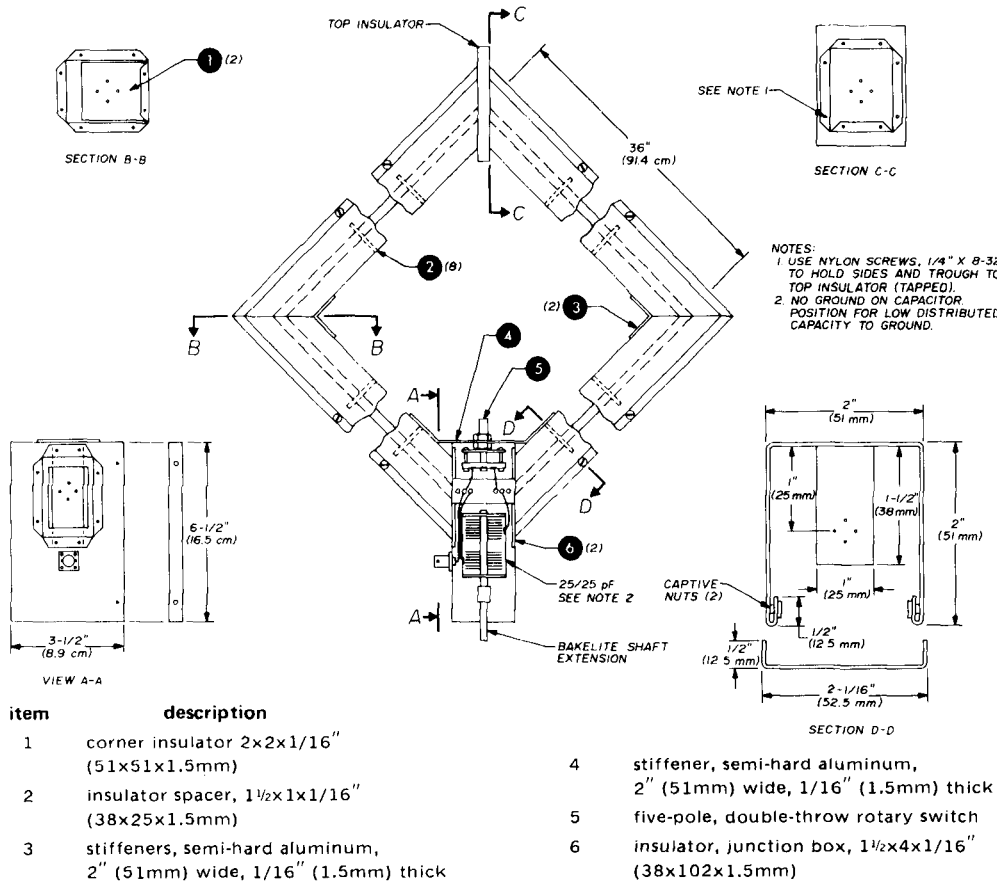


fig. 5. Double-turn, square-loop antenna for 40, 80 and 160. Typical loop dimensions and tuned-circuit components are listed in table 2.

the plane of the loop and even though the azimuth is correctly set, the signal received will still be appreciable.* Therefore, do not expect many signals to show an extremely sharp null unless provision is made to tilt the loop axis in elevation as well as azimuth.

As shown in fig. 4, a practical loop antenna may be built from a single turn of coaxial cable. The shield must be broken as previously explained to remove the "shorted turn" effect. A loop so configured will almost completely shield the electric component of the wave. To insure retention of the figure-eight pattern the two halves of the loop must maintain symmetry as closely as possible.

Detail B of fig. 4 shows the method used to insert a capacitor between the ends of the inner conductor as well as providing spacing of the outer shield. Any insu-

receiver. I noted each frequency for S-meter reading, then substituted various fixed capacitors (and combinations) to center the required bandpass.

An alternate construction method is shown in fig. 5. This illustration should provide most of the required construction details. The stiffeners at the junction box, J, and the two side corners were added to reduce the floppiness that existed without them. An even number of turns is required for symmetry since both the inductor and the capacitor are located in the junction box. Two turns (33 inches or 83.8cm on a side) are adequate for 80 and 160 meter operation. For 40 and 80 meters, two turns (16 inches or 40.6cm on a side) would comply with the design criteria of reference 1. For single-band operation, the lengths given in table 2 provide an optimum signal-to-noise ratio and should result in maximum performance.

The tuneup procedure for the square loop is similar to that for the circular loop. Using a length of coaxial cable with a loop at the end attached to the output

*This feature of the loop enhances its ability to null out interfering signals, particularly local ground waves or electrical noise, while still maintaining reception of skywave signals. Editor

connector, the grid dipper is used to get the resonant frequency of the system near that required. (Caution: The grid dipper will also show a dip at the resonant length of the coaxial cable used.) Vary the number of turns on the primary of the toroid and the fixed paralleling capacitor until the loop shows peak pickup

I have substituted an alternate coupling network shown in fig. 6 that provides slightly better pickup and higher loaded Q. It has been incorporated in all loops shown in figs. 4, 5 and 6. Table 3 lists the required components.

The Hula-Hoop was separated, and the twinlead inserted. The loop is then spirally covered with folded

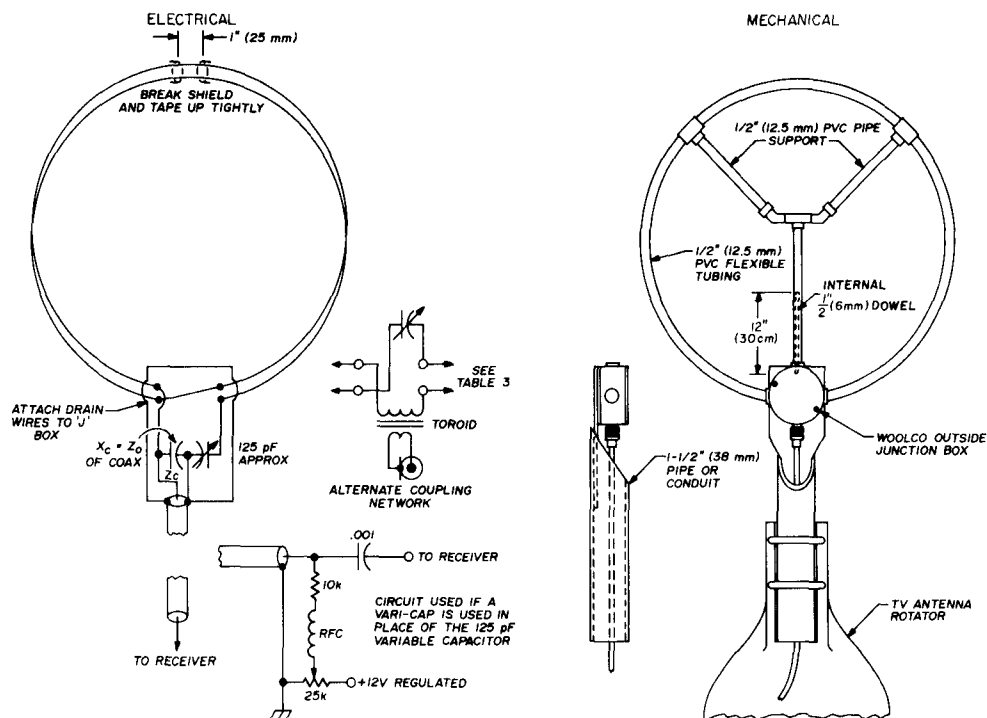


fig. 6. The Hula-Hoop designed by W5DS. The alternate coupling network is suggested. Component values for the coupling network are given in table 3.

near your favorite spot in the band. Then position the loop where it is to be permanently mounted, with the required length of coaxial cable to connect it to the receiver, and inject a grid dipper signal into it. Plot the S-meter reading for each frequency. Adjust the inductor and capacitor until the bandpass is centered on the desired frequency.

(two layers, 3-inches or 76mm wide) heavy-duty aluminum foil with a number-15 (1.5mm) aluminum drain wire to provide connection for the foil shield. This was then continuously taped with vinyl electrical tape for weatherproofing. The aluminum wire is connected to the junction box to provide a path to ground for currents induced by the electric component of the wave.

table 2. Wire lengths and tuning capacitors used in the loops of figs. 3 and 4.

	frequency (MHz)	loop size	wire length	number of turns	toroid turns		capacitor (pF)	
					primary	secondary	variable	fixed
coaxial cable loop	1.8 MHz	8'3" (2.5m)	26' (7.9m)	1	20/20 balun		0	500
	3.8 MHz	6'3" (1.9m)	20' (6.1m)	1	10/10 balun		0	125
square loop	1.8 MHz	36x36" (91x91cm)	48' (14.6m)	4	40	8	15-15	0
	3.5 MHz	36x36" (91x91cm)	24' (7.3m)	2	24	6	15-15	40
	7.0 MHz*	36x36" (91x91cm)	24' (7.3m)	2	12	7	15-15	75

*This loop built before reading references 2 and 3 so wire is considerably longer than 0.08 wavelength. Although it works fine, the design criteria of those references is recommended.

A third arrangement is shown in fig. 6. It was suggested by Bob Edlund, W5DS, who has named it the "Hula Hoop Loop" due to the basic material used to support the loop wires. A single-turn of TV twinlead is used to provide a two-turn loop when series connected.

I used a 10-foot (3-meter) length of 1/2 inch (12.5mm) PVC tubing in place of the Hula-Hoop. This in turn is supported by 1/2 inch (12.5mm) PVC water pipe and fittings to form a Y-shaped support for the loop. A 1/2-inch (12.5mm) wooden dowel, boiled in beeswax, was

inserted into the vertical member of the Y support, terminating in the junction box to increase strength against wind torque at this point. The coupling networks shown will provide a good match between the loop and the coaxial line to the receiver.

In an attempt to remotely tune the loop a voltage-

In all loop configurations and couplers I tested there is a loss of about two S-units of signal pickup with respect to the vertical radiator I use for transmitting on 40 and 80 meters. Some of the weaker signals are then below the noise level of the receiver. A low-noise front-end preamplifier/preselector, similar to that described

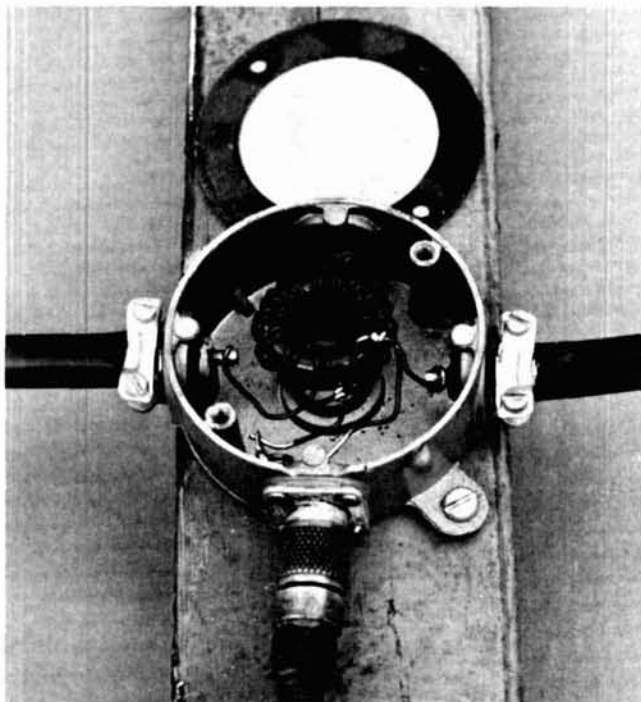
table 3. Components for the alternate coupling network shown in fig. 5.

frequency	twinlead length	loop diameter	approximate capacitance		toroid primary turns	secondary turns
			(pF)	type		
1.8 MHz	20' (6.1m)*	3'3" (99.1cm)	150	T106-2	14	8
3.5 MHz	10' (3.0m)	3'3" (99.1cm)	110	T68-2	12	7
7.0 MHz	5' (1.5m)	1'7" (48.2cm)	75	T56-2	10	6

*Two turns (be sure capacitor is centered in loop).

variable capacitor (varicap) was substituted for the capacitor in the loop-coax coupling network. John Venters, K4UR, suggested, and provided, a silicon planar epitaxial diode (ITT type BA163) which, when reverse biased with 1 to 12 volts dc, provides a capacitance range of 10 to 260 pF. However, when feeding the varicap via the rf coaxial line with the required rf chokes to isolate the dc from the rf, the loaded Q dropped to about 10 (indicating the introduction of some form of undesired loss resistance). The convenience such a device would provide is worth further investigation; however, still to be found is a way to use the varicap and retain high Q. With the coupling networks shown, the loaded Q is in the vicinity of 75. This provides a 50-kHz bandwidth (at the 6 dB points) which is adequate on 80 meters if you operate near one spot most of the time.

The 4:1 balun for the coaxial loop, mounted in the Woolco junction box.



recently in QST⁵ provides about 20 dB gain and puts the signal back up where the receiver can detect even the weakest signals.

conclusions

Comparing the loops against my "Five Band, Tower Antenna System"⁶ for receiving, I get about five S-units reduction of man-made noise and precipitation static,* with only a loss of a couple of S-units of signal pickup.

Since the radiation resistance of such a small loop on the wavelengths involved is less than one ohm, it would make a very poor transmitting radiator.

*Atmospheric noise is propagated entirely by the radiation field so it cannot be reduced by using a shielded loop antenna. Precipitation static which is due to wind-blown rain, on the other hand, is an induction field and can be reduced by using a shielded loop.

Editor

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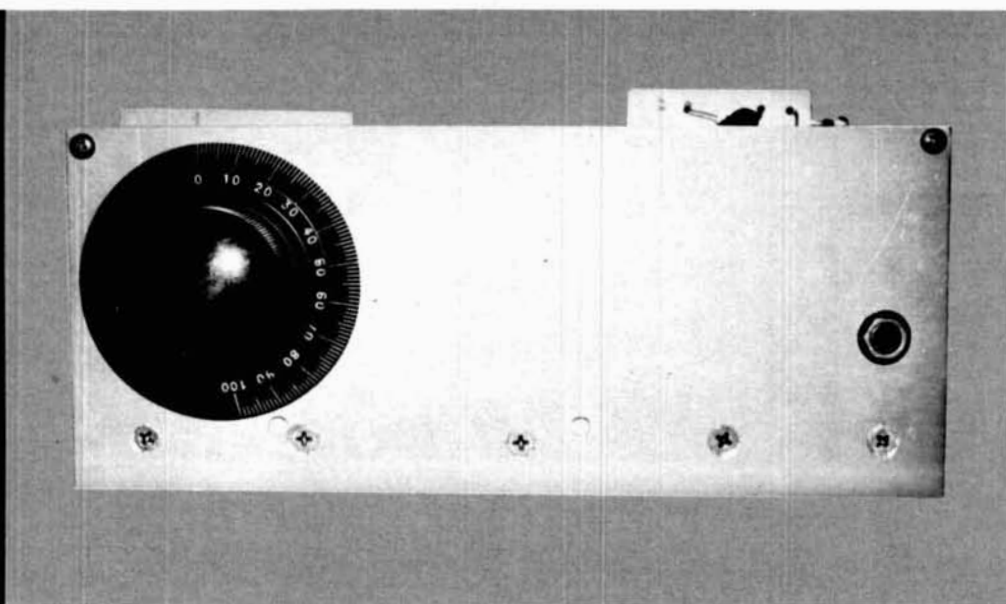
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QRP transmitter for 7-MHz CW

This little rig
is still in
the low-power class,
but it will make
a big difference
on the crowded
40-meter band

The amateur radio literature over the past several years has described numerous solid-state QRP transmitters. Most of these transmitters have been in the power range of milliwatts, some a little higher and a few as high as 5 or 10 watts. These articles have made significant contributions to the development of better solid-state transmitters and have also kept interest high in building and testing such transmitters. The authors wish to thank all who have published their circuits and designs, thus enabling others to experiment and build designs of their own.

The CW transmitter described here is not just another low-power rig. It has some features that make it interesting, very inexpensive to build and, using a twenty-cent transistor in the final stage, it provides 20 to 30 watts input. The CW note is a pure delight to hear. All the transistors, which cost from twenty to fifty cents, are easily obtainable from Poly Paks, Radio Shack, and many surplus radio parts dealers.

The transmitter can be duplicated easily as it contains no critical circuits. It is built on five pieces of perf board, although etched PC boards would be the best construction approach. One such transmitter, built into a transceiver, has worked into most of the U.S., parts of Europe, and Australia.

power supplies

Before discussing the transmitter circuits, we'll talk about power requirements. A power supply must deliver

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the quality and quantity of current and voltage required by the transmitter or problems will occur such as instability, poor performance, burned-out transistor, chirps, and key clicks.

This transmitter uses two separate power supplies. The first is a 12-volt, well-filtered and regulated supply capable of delivering up to 1 ampere. The transmitter will require about 250 mA from this supply. Reference 1 describes the power supply we used. The second supply powers the final amplifier transistor. It's a very useful power supply for transistor experimentation and test work, providing a well-regulated output to about 3 amperes at variable voltages between 5-30 volts. Its three transistors can be purchased for less than a dollar each. This power supply could be updated with an IC voltage regulator, but the circuit of reference 2 was used and is recommended.

circuit description

The transmitter has five stages, fig. 1. The vfo and doubler run continuously when the transmitter is keyed. The keyed stage, buffer amplifier Q5, Q6, operates in class C. Although collector voltage is present on this stage during operation, it has no rf output until the key is closed. Power to the vfo, doubler, buffer, amplifier, and driver is supplied by the 12-volt supply. The final

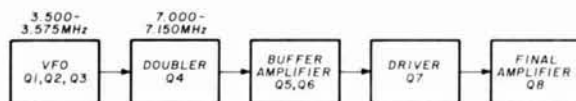
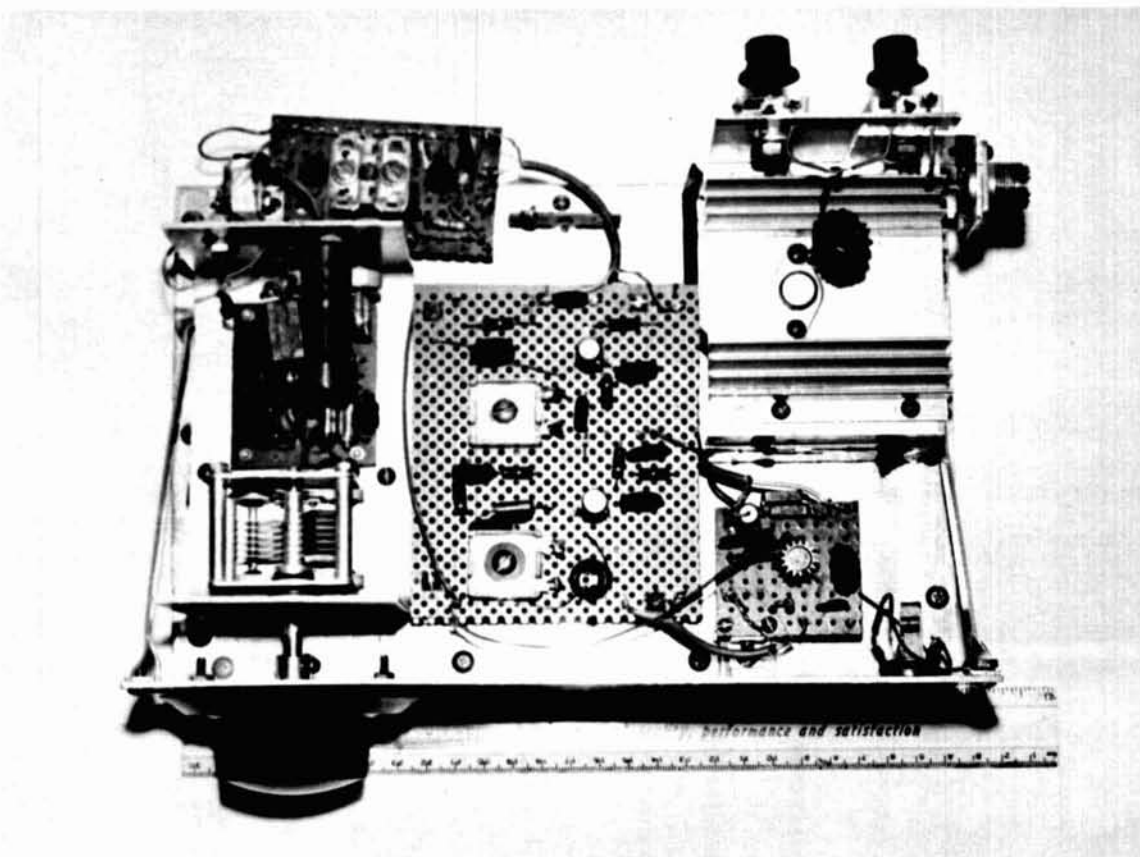


fig. 1. QRP transmitter block diagram. Eight low-cost transistors provide 2-30 watts input power for beefing up your CW signal on 40 meters.

amplifier, which also operates in class C, is powered by the variable 5 to 30 volt supply. Voltage to the other stages must be turned off during receive so you can hear the other fellow in your receiver.

Variable-frequency oscillator. The vfo (fig. 2) is straightforward, using an fet in a Colpitts configuration followed by an amplifier stage and an emitter follower for isolation. The vfo tunes 3.5-3.575 MHz. If you wish, you can make it tune the entire 75-meter band and have as much bandwidth as desired. This circuit has little bandwidth, however, as we're concerned with only 125 kHz of the 40-meter band, including the Novice portion.

The significant feature of this vfo is that frequency doubling from 3.5 to 7 MHz is used. This technique avoids pulling effects on the vfo frequency when keying the transmitter. The note you hear is the note that goes out over the air — crisp, clean, and chirpless. A 6.8-volt



The completed QRP 7 MHz CW transmitter. Vfo section is at left with the frequency doubler mounted at its rear. Buffer amplifier and doubler are shown at right, with the final amplifier removed from the chassis.

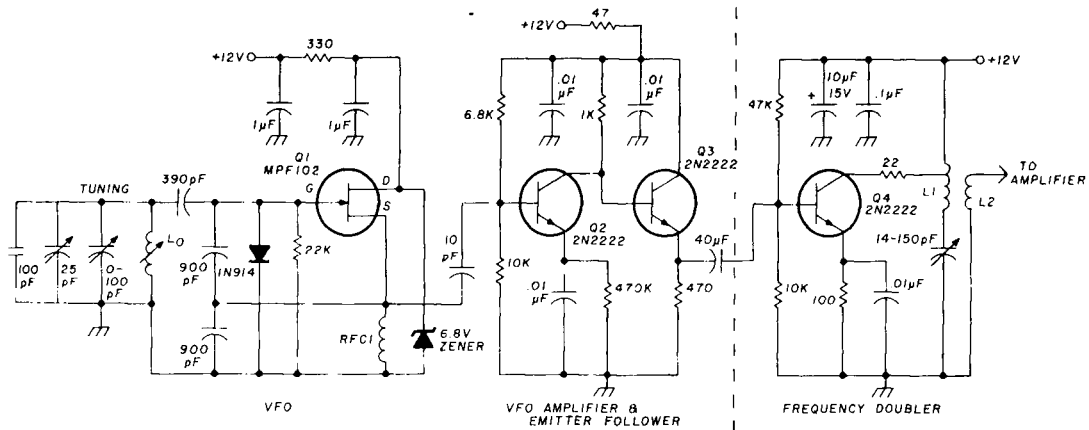


fig. 2. Vfo and frequency-doubler schematic. Circuit provides a stable, harmonic-free output to drive succeeding stages.

zener in the drain of Q1 and a high-speed switching diode in its gate ensure low harmonic content in the vfo output. The 1N914 acts as a clamp on the positive-going half cycle of the oscillator signal, thus preventing Q1 from reaching an operating point where high harmonic content may occur. Although many other transistors could have been used for the vfo amplifier, emitter-follower and doubler, the 2N2222 was chosen on the basis of performance and low cost.

Buffer amplifier. In this stage we begin to get a lift in rf output. Fig. 3 shows the circuit, which uses two 2N3053s in class B. The 2N3053 will easily dissipate the power, provided it has a proper heatsink. The 12-volt supply to the collector must be well bypassed, and ferrite-bead chokes must be used on the collector leads. This is the keyed stage: the 2N3053 emitters aren't grounded until the key is closed. The component values shown in fig. 3 will permit this stage to function as a

stable amplifier. Neutralization wasn't found to be necessary.

Driver. The driver is the simplest of all the stages. It operates as a class-C amplifier. The reliable 2N3053 is also used here, and it *must* be installed in a heatsink, otherwise it will be zapped. If this occurs, the 12-volt power supply will draw excessive current.

Final amplifier. So far we've been concerned with stages resonant at 3.5 or 7 MHz. In the final amplifier stage, however, we must think not only of having a 7-MHz resonant output circuit but must obtain an output impedance close to 50 ohms to match the antenna feedpoint impedance.

The final amplifier (fig. 3) also operates in class C. The input circuit to Q8's base uses a tuned-T network, and the collector output circuit uses a pi network so that the amplifier output impedance will be near 50 ohms. Rf

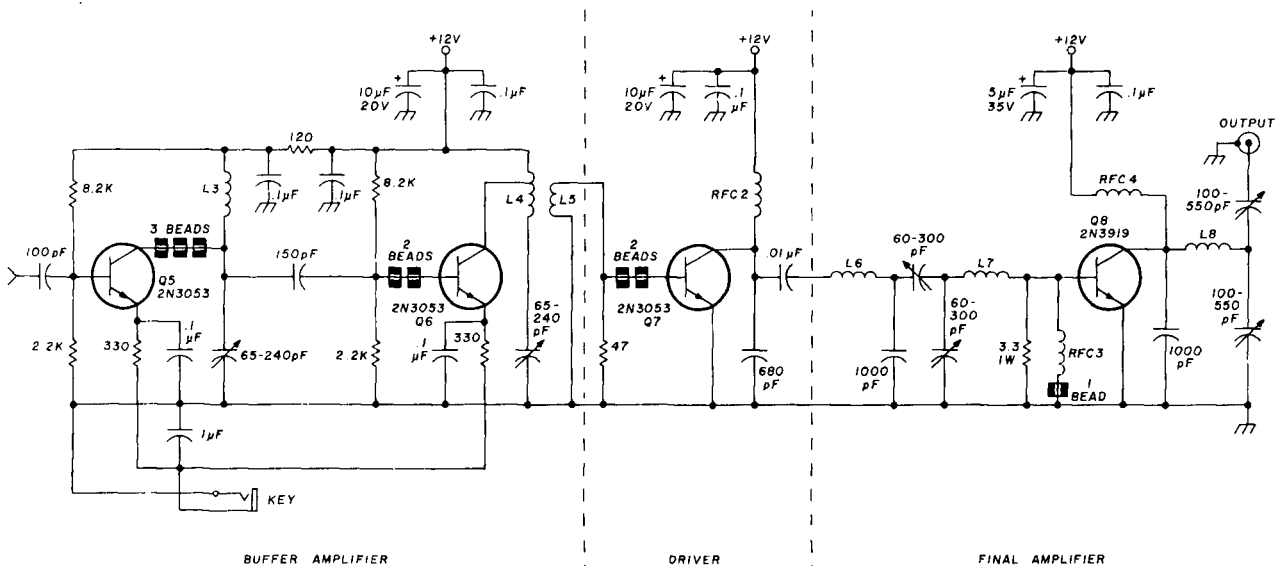


fig. 3. Buffer amplifier, driver, and final amplifier schematic. Note the use of toroid coils for resonant circuits and liberal use of ferrite beads for decoupling.

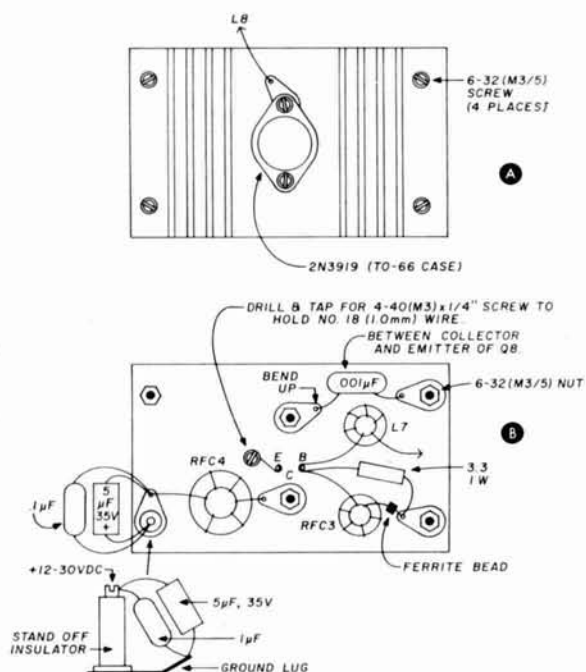


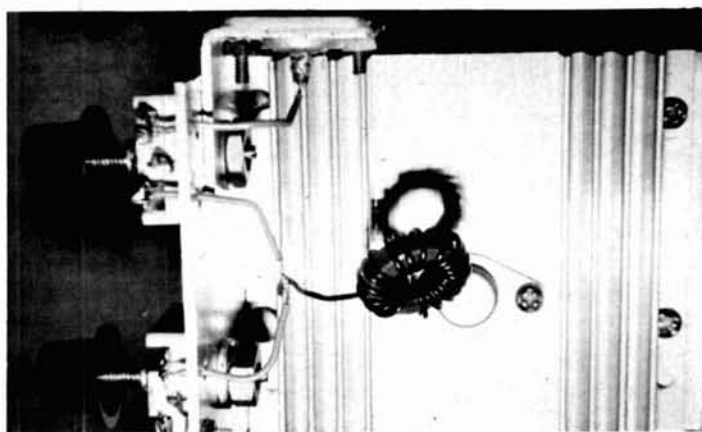
fig. 4. Construction details for the final amplifier. Sketch A shows mounting of the 2N3919 in its heatsink; B shows under-chassis wiring and parts location.

bypassing and rf chokes are important. This stage is built on a heavy aluminum heatsink, so the transistor barely gets warm while dissipating nearly 30 watts. It's hard to find a low-cost transistor on today's market to beat this one (Fairchild 2N3919 or Poly Paks 92CU1234). One word of caution: when testing you *must* use a 50-ohm dummy load. Adequate drive must be provided to this stage before it will function. References 3 and 4 are suggested for further reading.

construction

As mentioned earlier, the transmitter is built on five perf boards. Prepunched boards may be obtained from

Close-up view of the final amplifier. L8 is shown wound on the toroid.



such as Vector T-28 or flea clips (Lafayette Radio 198302) work well on this board. Arrange the parts on the board for a symmetrical layout, bearing in mind the necessity for short rf leads and adequate bypassing. Avoid crowding and try to keep dc voltage wiring isolated physically from circuits carrying rf voltages. Install a wire around the board periphery to serve as a ground plane for connecting all circuits to be grounded; this will avoid ground loops and feedback problems. The nice thing about perf-board construction is that you can rearrange parts until you're satisfied with the layout without touching a soldering iron.

table 1. Construction data for the inductors used in the QRP transmitter.

RFC 1	1 mH (not critical)
RFC 2	60 or 70 turns no. 28 (0.3mm) enamelled wire on T50-2 toroid core (Amidon). Fill core with wire.
RFC 3	25 turns no. 28 (0.3mm) enamelled wire on T50-2 toroid core (Amidon)
RFC 4	75 turns no. 28 (0.3mm) enamelled wire on T68-2 toroid core (Amidon)
L0	40 turns no. 26 (0.4mm) enamelled wire close wound on 1/2 in. (12.5mm) O.D. slug-tuned coil form
L1	27 turns no. 28 (0.3mm) enamelled wire on T50-2 toroid core (Amidon), tapped 7 turns from plus end of coil
L2	3 turns no. 22 (0.6mm) enamelled wire over L1
L3	21 turns no. 28 (0.3mm) enamelled wire on T50-2 toroid core (Amidon)
L4	27 turns no. 28 (0.3mm) enamelled wire on T50-2 toroid form (Amidon), tapped 7 turns from plus end of coil
L5	3 turns no. 22 (0.6mm) enamelled wire over L4
L6	14 turns no. 22 (0.6mm) enamelled wire on T50-2 toroid core (Amidon)
L7	14 turns no. 22 (0.6mm) enamelled wire on T50-2 toroid core (Amidon)
L8	17 turns no. 22 (0.6mm) or no. 18 (1.0mm) enamelled wire on T68-2 toroid core (Amidon)

Plastic transistor sockets are used for all devices except the final-amplifier transistor, which is packaged in a TO-66 case and mounted directly on a heavy heatsink. Coil data is provided in table 1. Fig. 4 shows parts layout for the final-amplifier stage. Note that this stage is built on a separate chassis, which includes the heatsink for the 2N3919 (fig. 5). The sketches in fig. 5 also provide overall dimensions for the frame that contains the five chassis.

test equipment

A few essential instruments will be needed for testing and making measurements. A vtvm with an rf probe capable of measuring up to 25-30 volts will be needed. The Heath Company stocks one that is a good buy, or if you want to build one a description appears in reference 5. Another useful item is the absorption frequency meter, also described in reference 5. A grid-dip meter is needed to determine resonant frequencies of toroid coils

and LC circuits. To save headaches later on, all toroid LC circuits should be tested before wiring them into the stages to ensure they are resonant and cover the proper frequencies.

A dummy load capable of handling about 8 watts is needed. It can be made by paralleling four 200-ohm, 2-watt resistors or some other combination of resistors

can in one or two more steps obtain an input of 25-30 volts at 700-850 or more mA. Thus at 30 volts at 850 mA you are putting 25.5 watts into the final transistor and will obtain 8 or more watts output. You can calculate your output power from E^2/R by measuring the rf voltage across the 50-ohm dummy load — pretty good performance for a few inexpensive transistors.

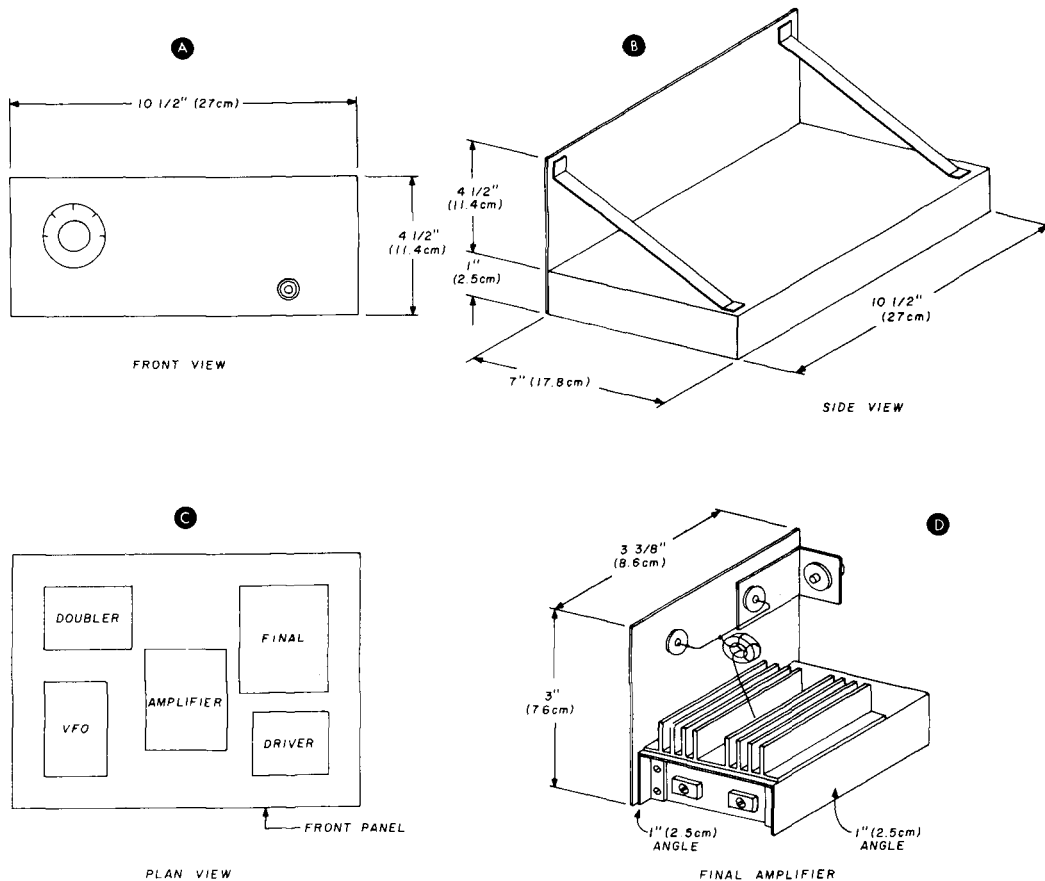


fig. 5. Dimensions and layout of the QRP transmitter. Sketches A through C show details of the main chassis; D shows the final amplifier arrangement.

to give 50 ohms and a power capacity of 8 watts or more.

When you complete construction of a stage, it should be tested with respect to the preceding stage. When you reach the last stage, be sure it has adequate rf drive. Connect the 8-watt dummy load to the SO239 output connector. You are now ready to test the completed transmitter.

Starting with 12 volts on the final-amplifier transistor, key the transmitter and tune all stages for maximum rf output using the vtm probe. Two precautions: be sure your rf probe will handle 30 volts and *don't* test without dummy load. It's best to peak the final amplifier stage first, work back to the vfo, then repeak the final stage. Now you can release the key and advance the final-amplifier voltage to 20 volts. Key the transmitter and peak the four capacitors in the final. By working incrementally and peaking the final stage each time, you

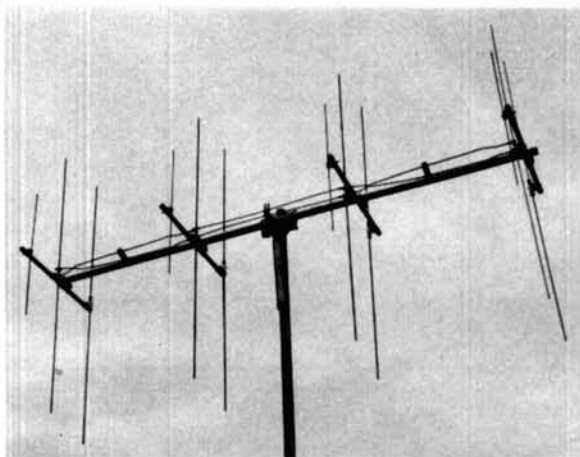
When you connect the transmitter to the antenna, all you'll have to do is peak the capacitors in the final pi network for a maximum output. A tuning indicator is required here, such as an swr indicator. If there is a high swr, better antenna efficiency will be obtained with an antenna tuner.

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VHF DX

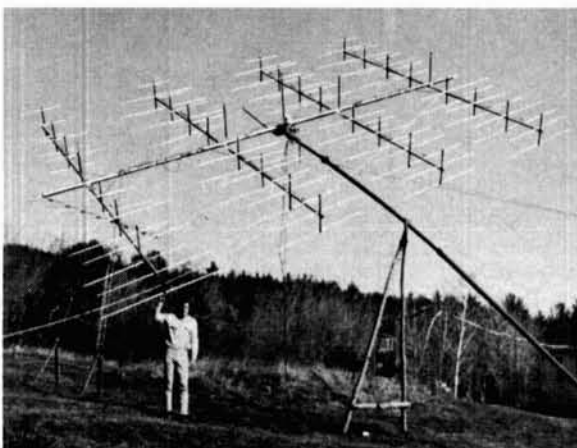
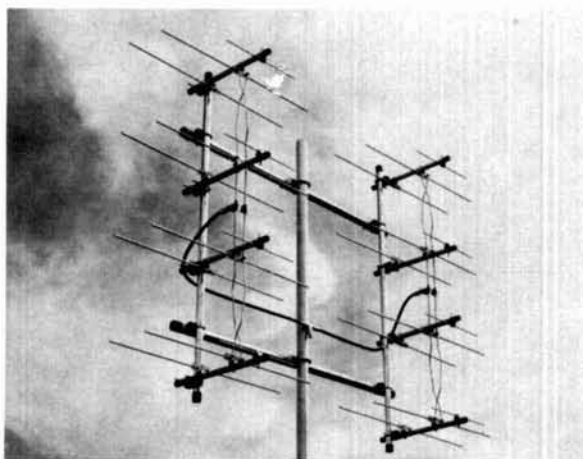


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Dave Olean, K1WHS, with his 160 Element DX-Array and Polar Mount EME System

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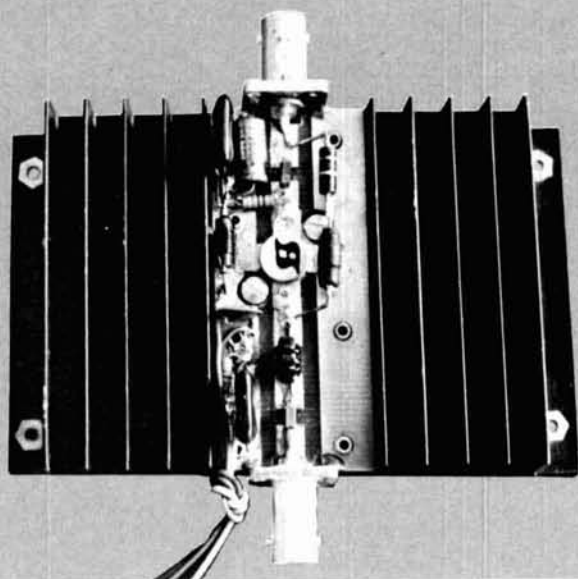
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mospower fet as a broadband amplifier

A new type of
power transistor provides
linear performance
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without switching

The *Mospower* fet introduced by Siliconix* in late spring, 1976, is undoubtedly the most revolutionary semiconductor in decades and one that will open up exciting new applications heretofore impossible with bipolar transistors. Switching of 1-ampere in less than 4 nanoseconds is commonly accomplished with this new power mosfet. Among the many new features is one in particular that will interest those who seek wide dynamic range: a linear transfer characteristic! Imagine too a transistor that can double for either a linear power amplifier or a wide dynamic range, low noise, small-signal, front-end transistor!

Other features of the *Mospower* device are typical for field-effect transistors and would be especially desirable for bipolar transistors. As with all fets, there is no

thermal runaway nor secondary breakdown, and no minority-carrier storage time. The latter opens up interesting applications for class-D (switching) amplifiers. Additionally, the *Mospower* fet can accept any vswr — open or short — at any phase angle without debilitating effects. This enhancement mode, N-channel, mosfet can be operated in any class (A, AB, B, or C) without requiring a bias supply.

Unlike the usual mosfet, which is *planar* in construction, the *Mospower* fet is a four-layered vertical structure shown in **fig. 1**. This drawing compares, somewhat oversimplified, the fundamental differences between MOS, DMOS and VMOS — which is the generic name for the *Mospower* structure. Common to both MOS and DMOS (but not VMOS) is the singular disadvantage which affects their power handling capabilities: the geometry requires massive area to handle the necessary current. A further disadvantage of MOS and DMOS lies in their inability to accept high voltages. In the *Mospower* fet the current travels vertically, the source being on top while the drain is the bottom of the chip. In this vertical structure there are four layers whose dimensions are controlled by diffusion processes rather than by the less precise photolithographic methods common to planar (MOS) technology.

VMOS construction offers high current densities, high source-to-drain breakdown capability, and low gate-to-drain feedback capacitance, which makes the *Mospower* fet a great device for hf and vhf applications. Probably the most attractive aspect of this revolutionary semiconductor is its inherent linear transfer characteristic. In conventional mosfet (and jfet) devices this transfer characteristic is closely identifiable to a square-law

By Ed Oxner, Siliconix, Inc., 2201 Laurelwood Road, Santa Clara, California 95054

*Mospower is a trademark of Siliconix, Incorporated.

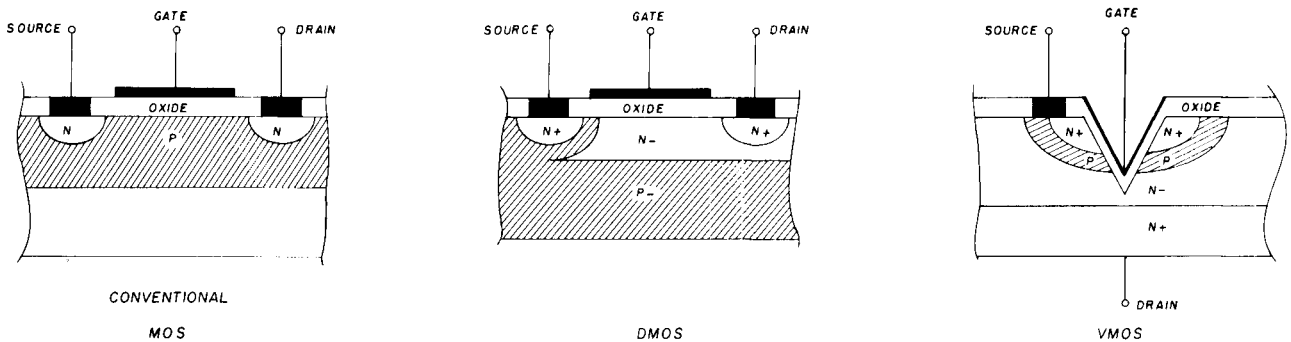


fig. 1. Fundamental differences in enhancement-mode MOS structures.

response; that is, the drain current is proportional to the square of the gate-to-source voltage. However, in the VMOS structure the short channel causes the drain current to be linearly proportional to the gate-to-source voltage. Fig. 2 is a transfer characteristic which shows this effect.

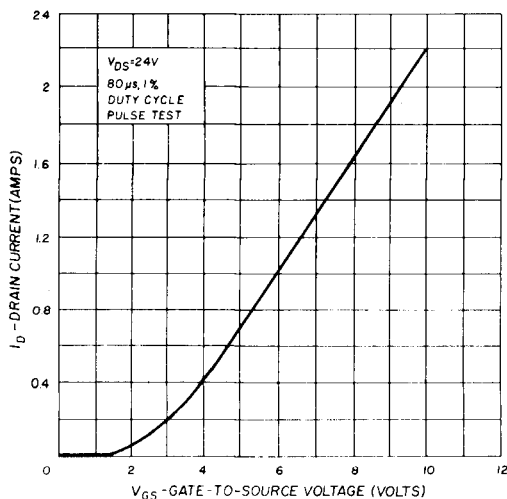
mospower vhf fet

The Siliconix VMP4 is packaged in the popular flange-mount, "opposing-emitter" (in this case, opposing-source) stripline configuration. This transistor is capable of saturated output power approaching 20 watts at 160 MHz. The performance shown in fig. 3 represents the available *saturatc.* output power versus frequency when both the input and output impedances of the VMP4 are conjugately matched (but *not* in the circuit described in this article). The input and output impedances (in the common-source configuration) are particularly well-suited for wideband amplifier service with *complete stability*. Unlike bipolar power semi-conductors these impedances are affected very little by drive levels.

the circuit

Simplicity is an understatement for the wideband

fig. 2. Transfer characteristic of the VMOS structure.



power amplifier shown schematically in fig. 4 and in the photo of the finished amplifier. Unlike many claims for broadband performance, this amplifier, by virtue of a negative feedback circuit, performs with flat gain response (± 0.5 dB) over its entire operational bandwidth.

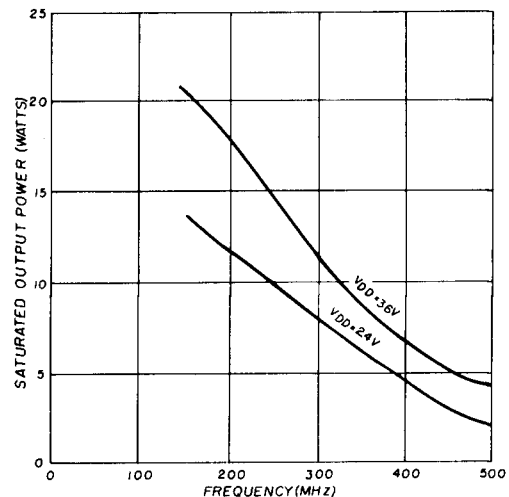


fig. 3. Showing the output power (saturated) versus frequency of the Siliconix VMP4. This assumes that the input and output impedances are matched. Drive power is 1 watt, drain current is 0.8 amp.

Two interesting features are immediately apparent in the circuit diagrams: first, the simple 4:1 transformer for broadband input matching and, second, effectively no matching circuit at the output. My philosophy is, "Why use parts if they're really not necessary?" The drain circuit needs no further complication. Some readers may question the wisdom of such an over-simplistic design, especially in light of the familiar equation

$$R_o = \frac{(V_{cc} - V_{sat})^2}{2P} \quad (1)$$

where R_o = output impedance, V_{cc} = drain supply voltage, V_{sat} = saturated drain-to-source voltage, and P = output power.

However, using this formula and making a few first-order assumptions, we can arrive at some near 50-ohm values

for the drain load impedance; for example

$$R_o = \frac{(25 - 3)^2}{2 \times 4} = 60.5 \text{ ohms}$$

To reach the lowest operational frequency requires a ferrite core with reasonably high permeability, but in this design 6 meters was my low-end goal and the 220-MHz band uppermost, so an operational bandwidth extending from 40 to 265 MHz was chosen. Only one circuit trick was required to reach the upper frequency objective and in reality it wasn't so much a circuit trick as a careful selection of component. I do not recommend the use of a commercially available molded 0.15 μH feedback inductor — manufactured inductors appear to exhibit too much distributed capacitance for this application. I used 6 to 8 turns of no. 30 AWG (0.25mm) enameled wire on a $\frac{1}{2}$ -watt, 1-megohm resistor. If you have an inductance bridge you can wind the choke to 0.15 μH , otherwise you may need to experiment. Using a commercially molded choke will severely reduce the upper-frequency limit.

About the only difficult aspect in building this circuit is preparing the double copper-clad board to accept the flange-mounted stripline transistor. Careful layout and cutting is required. As with any rf layout be sure to connect both copper foils (top and bottom) together, either with small eyelets or what-have-you. Additionally, remember that the *Mospower* fet is MOS and has an unprotected gate, so don't handle it without first being absolutely sure that you are not carrying a static charge. Stay off rugs and out of crepe-sole shoes until you've got the transistor soldered into your circuit. Once in the circuit you're free to do anything you want to with your amplifier.

Since this transistor operates with healthy currents it is absolutely necessary to mount the flange to a suitable heatsink. The large one shown in the photo is an over-design but it does emphasize that a heatsink is necessary. As is typical with any heatsink, you should use a suitable silicon grease or thermal compound between the flange and the sink.

A second precaution common to any high-current load is to avoid current-carrying molded chokes that may vaporize when the power is applied. I have found, quite by accident, that generally speaking, values of inductance *less than* 0.22 μH will hold up with currents of 1.5 amp or less. Further proof of reliability in regard to this construction is that I have built four identical amplifiers and all performed equally well.

An interesting aspect of this wideband amplifier is that performance does not seem dependent upon whether you use it for a small-signal amplifier, say in the microwatt area of a front-end receiver design, or for medium power (1 to 2 watts) amplification, possibly to excite a linear final amplifier.

Of special interest to those advocates of wideband amplifiers will be the observation that in a *Mospower* fet amplifier the wideband noise is literally unmeasurably low! For an example, this VMP4 (and any other VMP device) offers excellent small-signal noise figures. A typical value of 2.4 dB at 146 MHz is easy to achieve

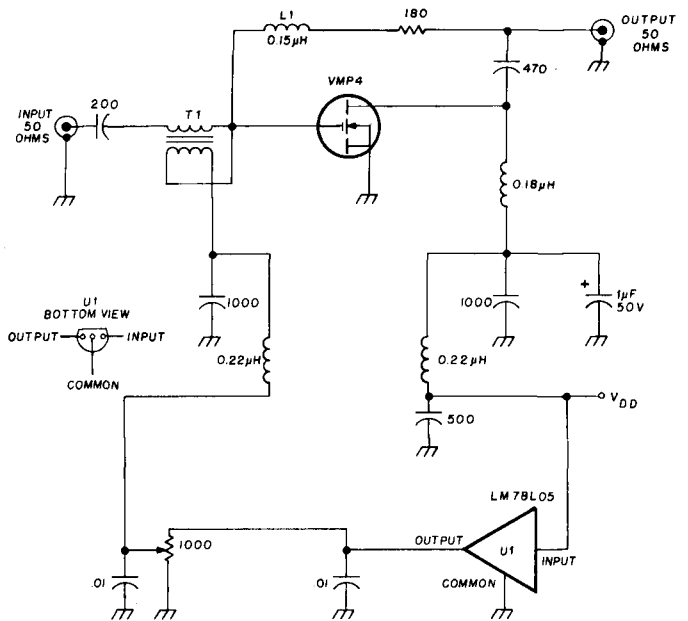


fig. 4. Simplicity is the keynote in this broadband amplifier. L1 should not be a molded choke; see text for winding information. T1 is 4 turns no. 22 AWG (0.6mm) twisted pair on an Indiana General F625-9Q2 toroid core.

with a properly matched input circuit. However, it should be pointed out that this particular circuit using the 4:1 matching transformer is *not* properly matched for optimum small-signal noise figure; that was *not* the objective in the first place. Bandwidth for two power levels is shown in fig. 5. With 1-dB compression occurring at an input level of +23 dBm, the +27 dBm input level is understandable under compression, hence the lower gain figure.

Two-tone, third-order intermodulation performance at both the 100-mW and the 1-watt output levels is displayed in fig. 6 as intercept point (IP). This point was calculated with reference to a single-tone output, using the formula

$$IP (dB) = P_{out} (dB) + \frac{P_{imd} (dB)}{2} \quad (2)$$

When calculating the intercept point, or when comparing specifications between devices, care must be

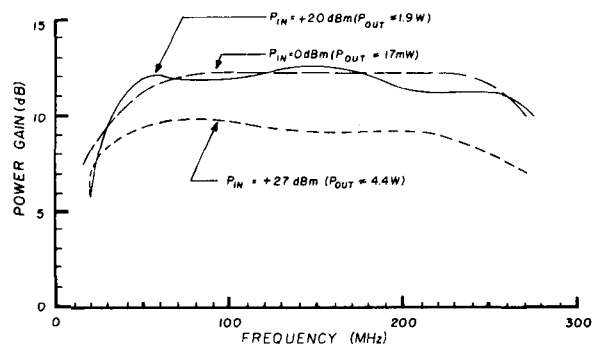


fig. 5. Power gain versus frequency curves at different levels of drive. The +27 dBm curve is above the compression point, therefore the gain is lower.

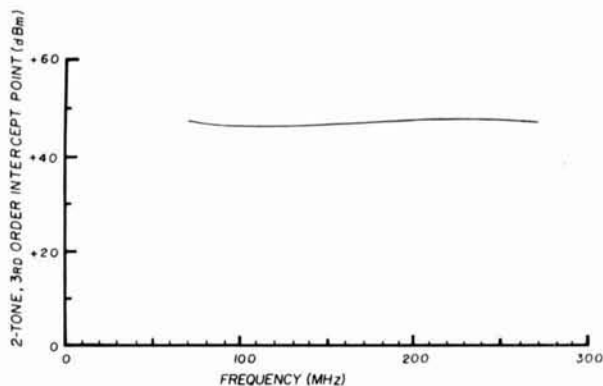


fig. 6. Two-tone, third-order intercept point for the Siliconix VMP4 power fet. V_{dd} is 26V, I_d is 0.4A. Intercept point was referenced to a single tone. Power levels were 100 mW and 1 watt.

taken to know how the numbers were obtained. Some manufacturers may use the PEP output as a reference; others may use average power. A more conservative rating may be obtained by using the single-tone output as a reference, as in fig. 7.

Another interesting feature of the VMP4 *Mospower* fet is that it is not sensitive to load mismatch; there is no need to panic if you disconnect the output cable during testing or tuning. Should a slip occur during a tweaking session, sparks may fly from the metal tool, but when things have calmed down again, the fet will still be ready for action. *Mospower* fets appear to have three funda-

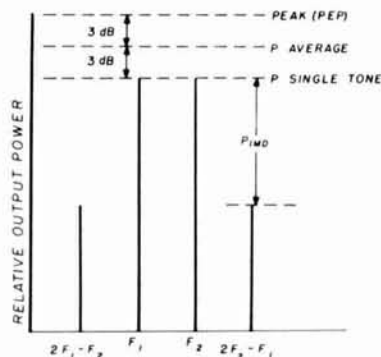


fig. 7. Three common methods of rating IMD performance. The most conservative uses a single-tone output as a reference.

mental advantages; very easy to match; extremely rugged; and can be operated in parallel without complications.*

The VMP1 is available for \$7.85 each; the VMP4 is priced at \$20 each (plus postage and handling charge). California residents please add 6% sales tax. For complete ordering information, write to Ed Oxner, Siliconix, Incorporated, 2201 Laurelwood Road, Santa Clara, California 95054.

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*Circuits for using *Mospower* fets (VMP1) in single and parallel configurations were given in the September, 1976, issue of *ham radio*, page 10.

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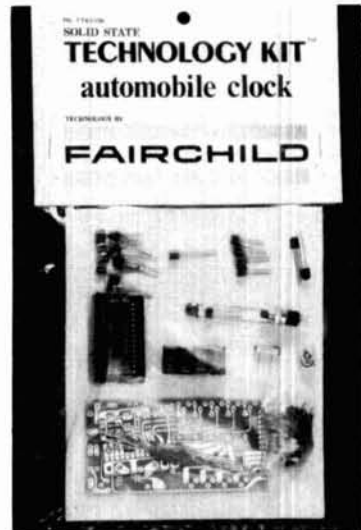
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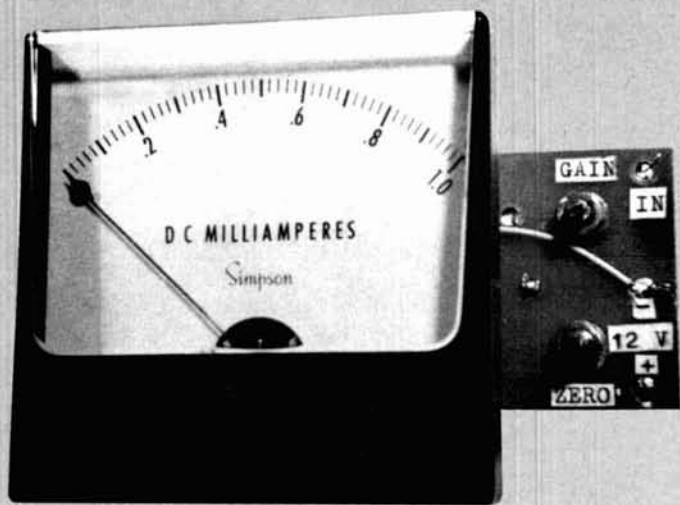
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electronic meter amplifier

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in simple circuit
turns dc milliammeter
into dc microammeter

My ham radio budget was seriously threatened recently when circumstances called for use of a 0-100 μ A microammeter. Reference to the radio wholesale catalog immediately discouraged the purchase of a new meter. However, a 0-1 mA milliammeter recently acquired at a reasonable price was available from the parts cabinet. The question was, could a 0-1 mA meter, with the aid of a dc amplifier, substitute for a 0-100 μ A microammeter?

The following description answers the question in the affirmative.

circuit description

A Motorola MPF102 junction fet is used as the active element of a dc amplifier, as illustrated in **fig. 1**. There are many other types of fets that can be used, including mosfets, depending upon what is available in the junk box. The MPF102 is inexpensive and can provide current gains of over 50 dB in this meter bridge circuit. The maximum full-scale sensitivity of the circuit is approximately 2.0 microamperes. For example, two volts fed to the circuit through a 500k source impedance provides a full-scale meter reading. The 500k gain control is used to set the circuit sensitivity to the desired value.

Parts for the meter amplifier are assembled on a piece of 3/32-inch (2.5mm) thick epoxy fiberglass board. The assembly is attached directly to the rear of the meter by the two meter terminals. I used 1/4-inch (6.5mm) brass eyelets equipped with solder lugs and spaced to match the meter terminals. All other terminals are 1/8-inch (13mm) brass eyelets, mounted in 1/8-inch (13mm) holes drilled in the fiberglass board and rolled over with the aid of a center punch and a hammer. Location of the

By Norman J. Foot, WA9HUV, 293 East Madison Avenue, Elmhurst, Illinois 60126

holes is not critical, but the general layout shown in the photographs can be followed.

Allen-Bradley type-G potentiometers are used for gain and zero-set purposes, primarily because they were available, but standard size potentiometers can be used just as well. The potentiometers are mounted on the right-hand side of the board for accessibility. After the meter and amplifier assembly have been mounted behind a panel, adjustments are made through screwdriver access holes.

adjustment

Adjustment of the meter amplifier is relatively simple. First, with no signal at the input, adjust the

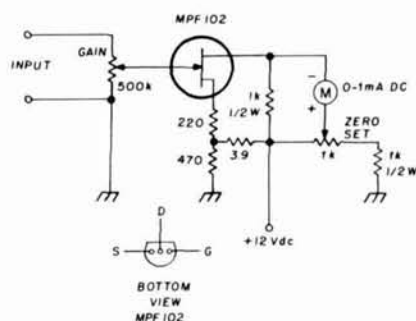
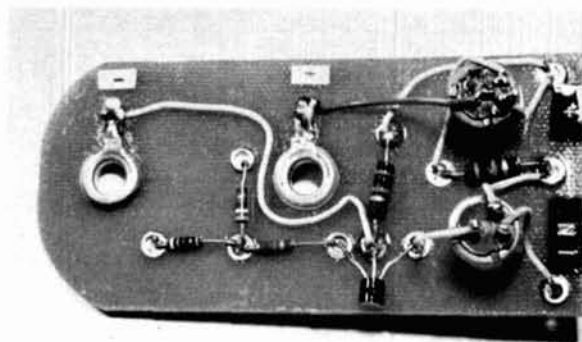
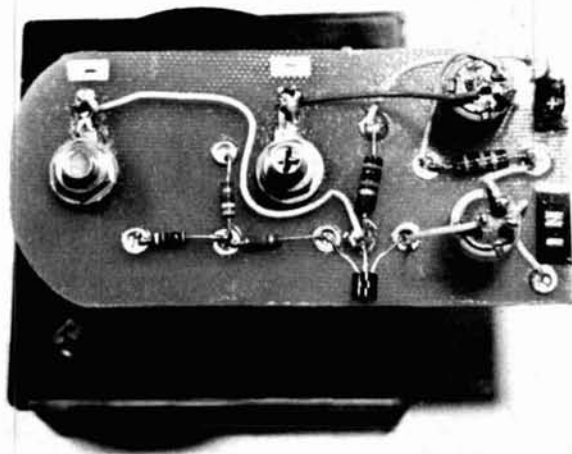


fig. 1. Schematic diagram of the meter amplifier circuit. All resistors are 1/4 watt unless otherwise noted.

zero-set control for zero meter current; then connect the signal to the input and adjust the gain to the desired value. If the source includes a dc offset voltage, it is possible to compensate by properly offsetting the zero-set control.

At my station, the dc meter amplifier is used in conjunction with an rf detector attached to the forward-coupled arm of a 20 dB directional coupler. Since the detector operates in its linear region, the 0-1 mA meter reading is approximately proportional to the

B. Finished circuit board shown mounted to back of meter, held in place by the meter terminals. Neat, simple.



C. Circuit board uses eyelets for component-mounting and convenient tie-points for wiring. Large eyelets are for meter terminals.

current flowing in the main line of the coupler (except at the bottom end of the scale). The meter was calibrated by comparing its reading with an rf power meter borrowed for the purpose. The power meter was connected to the output end of the directional coupler, as shown in fig. 2.

Once the scale is calibrated there is no further need for the wattmeter, and antenna power may be read directly from the meter scale with the aid of a calibration chart. In the example given in fig. 2, the full-scale power reading is 1.0 watt. Higher power levels can be monitored with the same setup by using directional

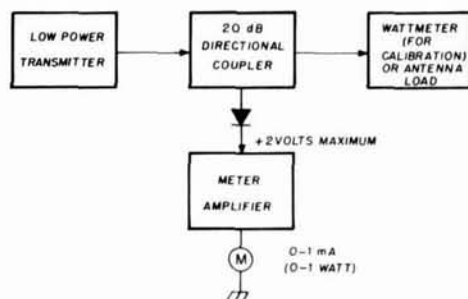


fig. 2. Block diagram showing application of the dc meter amplifier as a sensitive rf wattmeter. In this case 0-1 mA meter reads out 0-1 watt with 20 dB directional coupler (see text).

couplers having higher coupling values. For example, the full-scale power reading would be 100 watts if a 40 dB directional coupler were used.

The dc meter amplifier can also be used as a high impedance dc voltmeter, with a range of 0-1 volt, for example. If the meter amplifier is connected to the avc line in a receiver, it can serve as an S-meter.

references

1. Norman J. Foot, WA9HUV, "Fet Tone Keyer," *QST*, October, 1969, page 103.
2. *Motorola Semiconductor Handbook*, 5th edition, Motorola Semiconductor Corporation, Phoenix, Arizona, page 7-465.

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ASCII-to-Morse code translator

Sit back and type
near-perfect Morse
with this interface
between keyboard
and transmitter

I suppose every amateur at one time or another has wanted an easy way to send perfect code. The bug, and later the electronic keyer, have to a large degree solved the problem of sending good code. The ultimate way, however, would be to bang out the letters on a typewriter keyboard at any speed while the code is being sent out at some preselected speed. Not only is this nice and easy for you, but the fellow on the other end

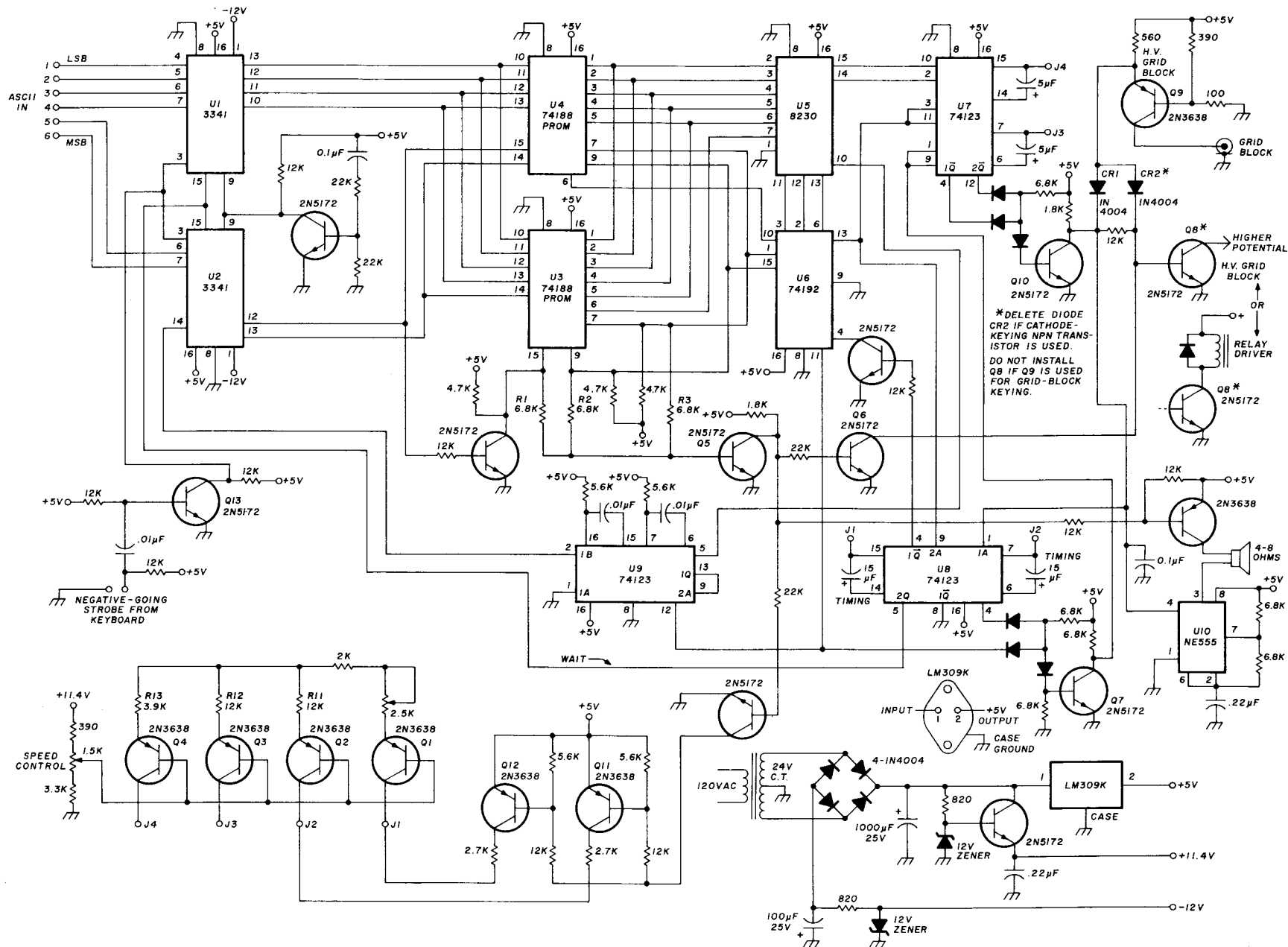
probably wouldn't complain when he hears your good code. This idea certainly isn't new, but if you've checked lately you know that a commercially produced unit with memory costs about \$400, and that's just about out of everyone's price range. This project may just change all that since its unit with memory and keyboard should cost about \$120.

code conversion

The initial problem is changing the ASCII code to Morse, but that by no means is the end because Morse characters vary in length from 1 to 6 bits. Since programmable read-only memories (ROMs) are readily available, they're used in this circuit to convert the 6-bit ASCII keyboard output to a special code that includes the Morse letter and its bit length in binary code. The actual code in the memories is not terribly important and is not discussed as most amateurs have no easy way of programming the memories.

Example: The letter R appears at the outputs of the PROMs as (110)00010, where the binary number in parentheses is the bit length (3) of the letter and the right-hand portion is the letter, starting from right to left. Zero is a dot; 1 is a dash. Even though the PROMs can be programmed, I recommend they be purchased

By Robert Morley and Dave Scharon, 2145 East Drive, St. Louis, Missouri 63131



*DELETE DIODE CR2 IF CATHODE-KEYING NPN TRANSISTOR IS USED.
DO NOT INSTALL Q8 IF Q9 IS USED FOR GRID-BLOCK KEYING.

fig. 1. ASCII-to-Morse code translator schematic. U3 is the numeric memory; U4 is alphabetic memory. U1 and U2 are Fairchild 3341 FIFO memories. All resistors are 1/4 watt, 10%. Capacitors larger than 1 µF are electrolytics. All diodes not otherwise marked are 1N914 or equivalent.

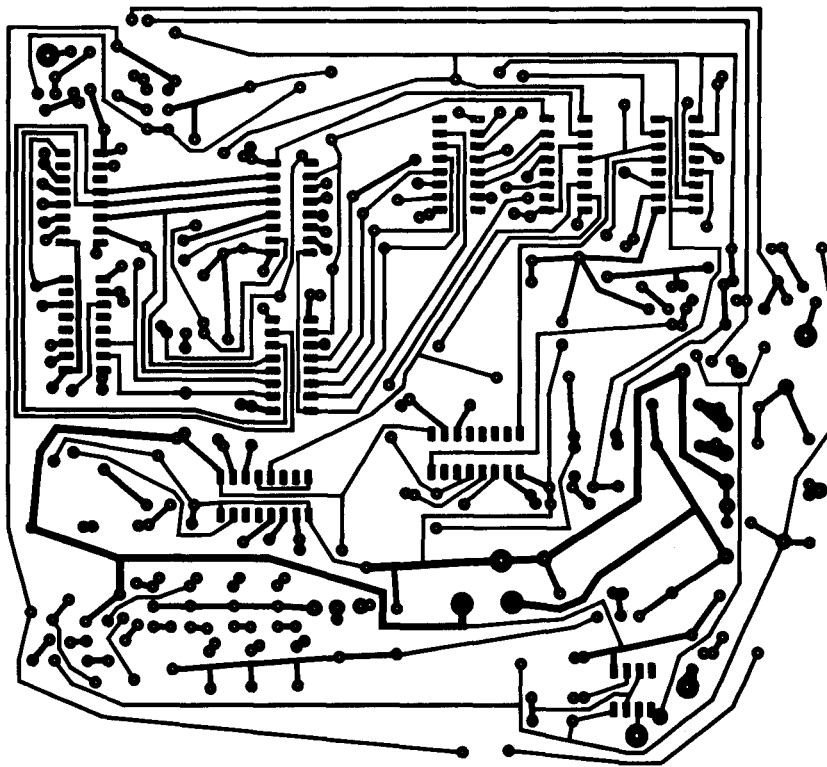


fig. 2. Printed-circuit board layout.

preprogrammed from the supplier listed in the article, because if one mistake is made, that's it. The supplier guarantees correct preprogramming.

The circuit (fig. 1) contains two PROMs. One includes all the alphabet (U4) and the other the numbers and punctuation (U3). Most of the Morse code is represented on a regular ASCII keyboard by its equivalent key except as follows:

key	Morse
<	end of message
>	end of work
=	wait
() either key	parentheses

This is done because all letters have the 6th bit of ASCII data low and numbers and punctuation high. The 6th bit is used to switch from one PROM to the other. The first 5 bits of both PROMs (U3 and U4) are wired together and connected to U5, an 8230, which is an 8-line to 1-line multiplexer. The last bits address U6, a 74192 up/down counter, which clocks through the bits of Morse letter by selecting the proper lines into U5. The output of U5 determines if a dash or dot is to be fired. The dash or dot is formed by U7, a 74123 dual one-shot. After the dash or dot is formed, the falling edge of the NEEDED \bar{Q} outputs fires a space one-shot, U8, whose timing is equivalent to a dot. U8 clocks the counter on the pulse rising edge, which selects the next bit of the letter and triggers the dot or dash on the falling edge.

This trigger circle continues until U6 reaches the 000 state. At this time the borrow line of U6 (pin 13) is used to inhibit the dot-dash one-shot, U7, and also fire one-shot U8 to produce a wait between characters equivalent to a dash. This one-shot output is used to bring up the next piece of data in the first-in, first-out (FIFO) memories, U1 and U2.

speed control

It is obviously desirable to have some means to vary the speed of the device, and for simplicity's sake we have chosen one-shots for our dots-dashes and wait timing. Tracking control of the speed would be nearly impossible with variable resistors, as it would take a 4-ganged pot and the control would be nothing close to linear. Current sources, however, make control easy as well as fairly linear. The current sources are controlled by one pot and feed each of one-shots, U7 and U8, at points J1, J2, J3, and J4. These current sources are made up of pnp transistors Q1, Q2, Q3, Q4, in a sort of upside-down emitter follower arrangement. Current control results in good 10:1 speed control.

input buffer

This portion consists of some very interesting circuits, which are the FIFO memories. The input and output are completely asynchronous, which means that data may be entered at any rate independent of the rate at which data is being clocked out by the code generator. As the data is clocked out of the FIFO memory, it is entered

into the two PROMs consisting of U3 and U4. If the keyboard has inverted ASCII, a 7404 ahead of U1 and U2 can be used.

keying circuit

The \bar{Q} outputs of U7, the dot-dash one-shot, are NEEDED through a discrete-component NAND gate including Q10. This circuit also drives a high-voltage npn

will normally occur at the end of the last character and the end of the H that the space sends, will equal seven dots. This was done by eliminating the space time and one wait time: much greater current is switched in through Q12 and Q11 to the space and wait one-shots while the H is being sent. This action eliminates the time taken up by the three spaces and one wait, which very nearly equals seven dots of time between words.

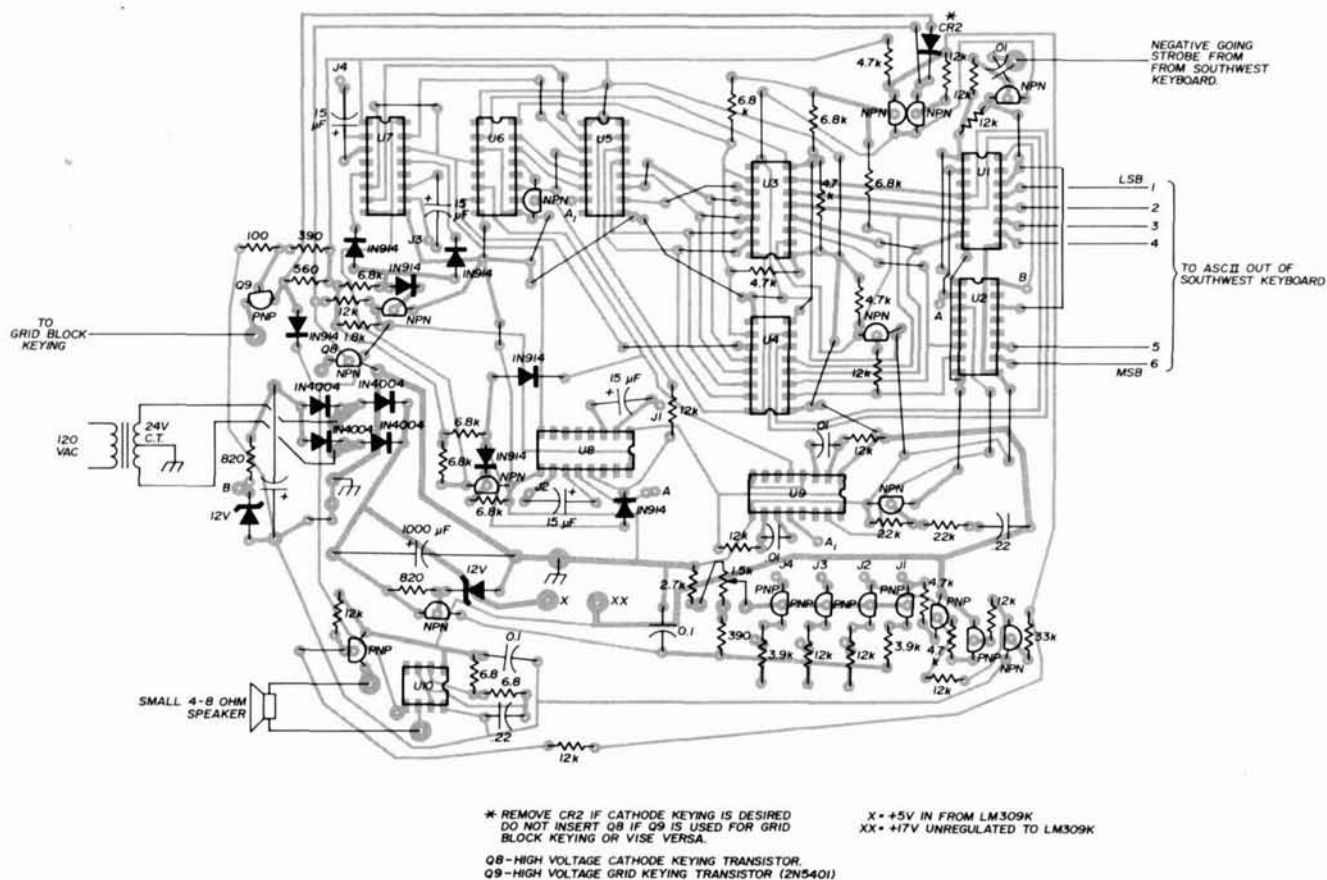


fig. 3. Component side of PC board.

transistor, Q8, for cathode keying and a pnp, Q9, for grid-block keying. The transistors selected here must handle the voltage and current of your transmitter. (This information can be found in the transmitter manual.) Grid-block keying will probably be the most widely used. A good value for the transistor would be 200 volts at 100mA. The NAND output, collector of Q10, also switches a sidetone oscillator made from a NE555, IC10.

space timing

One function that required a trick was the space timing, which is a necessity when the buffer memory is used. This problem required a resistor-transistor OR gate consisting of R1, R2, R3, Q5, Q6, which allows the circuit to function but inhibits the output and sidetone oscillator to simulate the proper space length. When the space bar is hit, a Morse H will be sent. Since good code requires 7 dots between words, something must be done to this H so that its time, plus the two wait dashes that

Any ASCII keyboard will do the job, but be sure it has a bounceless stobe that appears after the data is set up. A good keyboard for this purpose is available.* The circuit is set up for a negative-going strobe into Q13's base. An error key was considered, but when using the buffer chances are you'll be a few characters ahead before you realize an error has been made, and an error signal here would be meaningless. The unit won't make an error itself, so errors should be very rare.

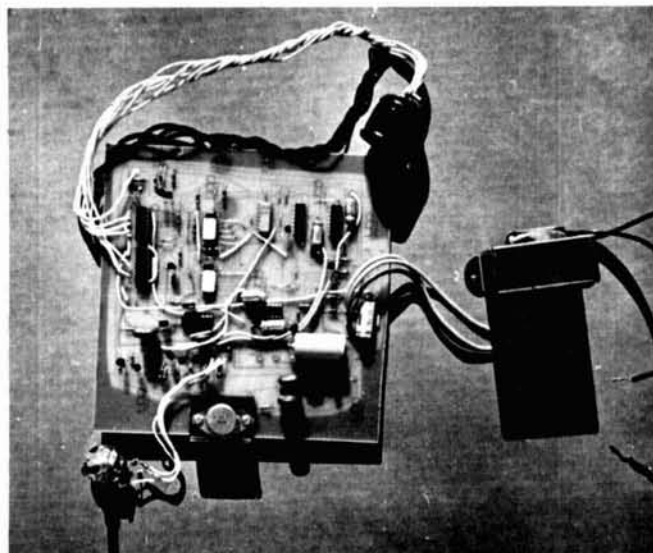
construction

Point-to-point wiring could be used, but a PC board would make assembly easier.† If you prefer to make

*South West Technical Products, 219 West Rhapsody, San Antonio, Texas 78216. (Keyboard kit about \$40.00.)

†Circuit boards, 3341 FIFOs, the 8230 and PROMs are available for \$60.00 from Scharon Fabricators, 2145 East Drive, St. Louis, Missouri 63131.

your own, fig. 2 provides a full-size etched board layout; the component side of the board is shown in fig. 3. Wiring isn't critical, but care should be taken to ensure proper wiring so none of the integrated circuits will be damaged when the power is turned on. This advice applies particularly to the ROMs and FIFO memories, as they are more expensive than regular TTL integrated circuits.



Printed circuit board for translator chassis showing parts arrangement.

Earlier, the type of possible keying was mentioned. An npn transistor in the Q8 position can be used to key a relay (fig. 1). A diode should be placed in reverse across the relay coil to prevent voltage spikes.

The transistors in the circuit aren't critical except for the high-voltage transistors mentioned earlier. The 5-volt power supply is an LM309K. The 3341 FIFOs are MOS integrated circuits, and even though they're internally protected, care should be taken when handling them.

testing and operation

The capacitors used to set the timing on the one-shots for creating the dots, dashes and spaces will never have exact values, therefore resistors R10, R11, R12, R13 may have to be trimmed to get perfect dot-to-dash ratios. Points are available on the board to add these resistors, but in most cases this should not be necessary.

Connect a speaker to the sidetone oscillator and apply power to the unit after the keyboard has been properly attached. (See fig. 1 for the LSB-MSB keyboard locations.) At this point hit one of the keys on the keyboard and listen for the proper code from the sidetone oscillator. If the proper code isn't heard, check the circuit carefully and if an error is found, try again. Set the speed control as slow as possible, type in a message, then sit back and listen to the code; it should now be ready to put on the air.

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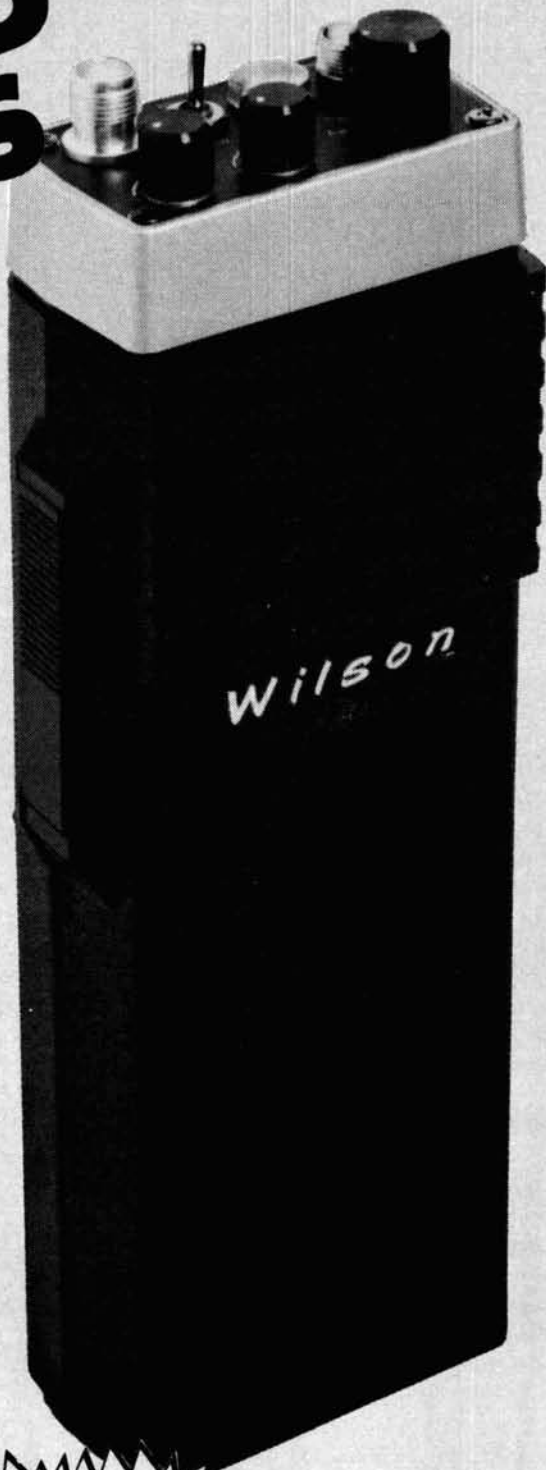
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the ladder network

An analysis of the ladder network using the method of "continued fractions"

If you happen to have an old three-gang tuning capacitor lying idle, the addition of a few resistors and a couple of inexpensive transistors will produce a phase-shift oscillator such as shown in fig. 1: no coils, no fixed capacitors, no variable resistors. This is no precision signal generator but is useful as a handy source of rf signals and has a large tuning range. With 2500-ohm resistors in the ladder network it covers about 250 kHz to 2.5 MHz. With higher resistances the range will be less. Transistors such as the 2N4996 or 2N4274 work well, with 3000 or 4000 ohms between ground and the second collector.

analysis

The main purpose of this article, however, is to show how any ladder network (including the one in the oscillator of fig. 1) can be analyzed in a purely routine fashion by the use of a not-too-familiar branch of mathematics called "continued fractions." The analysis applies to ladders composed of any number of elements, each of which can be anything you want. By suitably choosing these elements, the ladder can be made to become not only a phase shifter but also a bandpass, lowpass, or highpass filter; an impedance matching network; an attenuator; or a lumped-constant transmission line.

The input end of the ladder can be a series element to which a constant voltage, E , is applied or a shunt element fed by a constant current, I . The final element can be a shunt element across which the output voltage, e , is taken, or it may be a series element, the current in which i is the output.

For the moment, however, let us concentrate on the case of six elements arranged as shown in fig. 2 where the z s are the impedances of the series elements and the y s are the admittances of the shunt elements. For this network there are two elegantly simple formulas: the output voltage, e , is $\frac{E}{p_6}$ and the input impedance is $\frac{p_6}{q_6}$.

Of course these formulas are useful only when p_6 and q_6 have been expressed in terms of the various impedances and admittances in the ladder. How this is done in a systematic manner requires quite a bit of explanation, but proofs will be omitted so that only

what is necessary to operate the mathematical mechanism will be explained. We start by putting all the elements of the ladder in this peculiar-looking form:

$$z_1 + \frac{1}{y_2 + \frac{1}{z_3 + \frac{1}{y_4 + \frac{1}{z_5 + \frac{1}{y_6}}}}}$$

This expression is called a "simple continued fraction" containing six quantities. Its value is the input impedance of the ladder, although you may not be able to see it offhand. Any such continued fraction can be reduced to the ratio of two expressions involving the z s and the y s, the numerator of this ratio being called p with appropriate subscript, while the denominator is called q . If there had been only one element in the ladder we would have $p_1 = z_1$ and $q_1 = 1$. If there had been two elements we would have $p_2 = z_1 y_2 + 1$ and $q_2 = y_2$. But when there are quite a few elements, the reduction to p s and q s would be very laborious were it not for the fact that the theory of simple continued

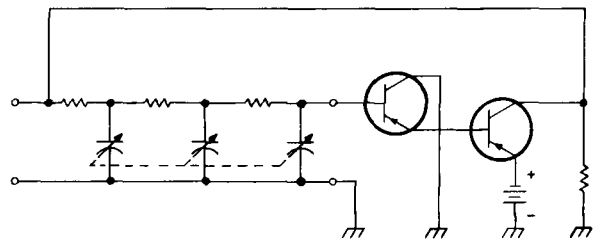


fig. 1. Phase-shift oscillator using ladder-network principle. Capacitor is a three-gang variable; transistors can be types such as the 2N4996 or 2N4274. Oscillator covers about 250 kHz to 2.5 MHz frequency range.

fractions gives us a rule for building up from one p to the next and from one q to the next. The rule is that every new p is equal to the previous p multiplied by the element having the same subscript as the new p , plus the p which is two places behind the new p . Thus, $p_3 = p_2 z_3 + p_1$ and $p_4 = p_3 y_4 + p_2$ and so on. By the use of this rule a table of p s can be built up without any real thinking. And the same rule applies to the q s starting with the two q s given above. It is not difficult, merely somewhat lengthy, to find the value of p_6 in general terms. But it becomes much easier if we don't make all the elements different. For example if we choose all the z s in fig. 2 to be equal resistances, R , and all the y s to be equal susceptances j/x , where X is the capacitive reac-

By Walter van B. Roberts, K4EA, 6330 Manasota Key Road, Englewood, Florida 33533

tance of one section of the tuning capacitor, then p_6 works out to be

$$\left(1 - 5 \frac{R^2}{x^2}\right) + j \left(6 \frac{R}{x} - \frac{R^3}{x^3}\right)$$

From this it is evident that when $R/X = \sqrt{6}$ the imaginary part vanishes and the value becomes -29 . In other words, the phase has been shifted 180 degrees and the output voltage is 1/29 of the input. Hence if the output voltage is amplified 29 times or more and then fed back to the ladder input, oscillation will occur, as in fig. 1.

the general case of n elements

The foregoing seems sufficient explanation to make the transition to the general case of n elements obvious. Fig. 3 gives all the information needed to grind out a solution for any ladder with any number of elements of any kind, provided the rule for building up the p s and q s is remembered. But it must be emphasized that the present method does not get around the necessity for writing out lengthy expressions when many different

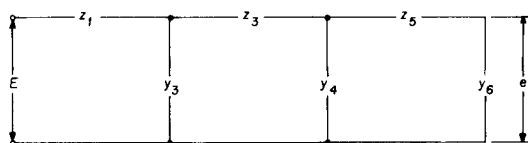


fig. 2. Ladder model using six elements. Network analysis is made in terms of impedances and admittances of the series and shunt elements.

elements are used. What it does do is provide a routine that can be followed without any brainwork other than to be careful not to make simple mistakes.

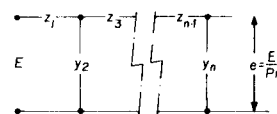
example

Before attempting to use the material of fig. 3 for anything complicated, however, it's a good idea to get the feel of the mechanism by trying it out on something easy, which can be checked by other methods. For example, in fig. 2 if all the elements are equal resistors, R , it will be found that the output voltage is 1/13 of the input voltage, regardless of the size of R , and that the input impedance is 13/8 times R . Incidentally it may be of interest to note that if the number of resistors is increased much beyond six in the network just discussed, the input impedance approaches a constant value

$$\frac{1 + \sqrt{5}}{2} R$$

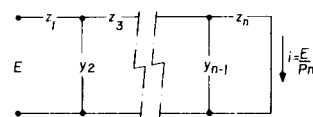
Finally, although it should be obvious, the reason that no consideration has been given to ladders with constant voltage applied to a first shunt element, or with constant current fed into a series first element, is that in both these cases the first element becomes functionless. In the first case the input shunt element would merely draw useless extra current from the source of constant voltage, while in the second case the series first element

INPUT TO SERIES ELEMENT
INPUT IMPEDANCE = p_n/q_n



The impedance fraction:

$$z_1 + \frac{1}{y_2 + \frac{1}{z_3 + \frac{1}{y_4 + \text{etc.}}}}$$



Its p s and q s are:

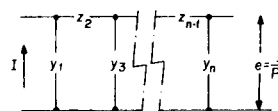
$$\begin{aligned} p_1 &= z_1 \\ p_2 &= y_2 z_1 + 1 \\ p_3 &= z_3 y_2 z_1 + z_3 + z_1 \\ p_4 &= y_4 z_3 y_2 z_1 + y_4 z_3 + y_4 z_1 + y_2 z_1 + 1 \end{aligned}$$

and so on

$$\begin{aligned} q_1 &= 1 \\ q_2 &= y_2 \\ q_3 &= z_3 y_2 + 1 \\ q_4 &= y_4 z_3 y_2 + y_4 + y_2 \end{aligned}$$

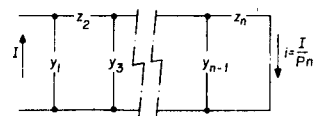
and so on

INPUT TO SHUNT ELEMENT
INPUT ADMITTANCE = p_n/q_n



The admittance fraction:

$$y_1 + \frac{1}{z_2 + \frac{1}{y_3 + \frac{1}{z_4 + \text{etc.}}}}$$



Its p s and q s are the same as at left with z and y interchanged:

$$\begin{aligned} \text{so } p_1 &= y_1 \\ p_2 &= z_2 y_1 + 1 \end{aligned}$$

and so on

fig. 3. Data for solving any ladder network of n elements using the method of "simple continued fractions."

would merely require more voltage in the source of constant current. In neither case would the first element play any part in the performance of the ladder. That would be determined solely by elements beyond the first. Thus fig. 3 covers all actual performance possibilities.

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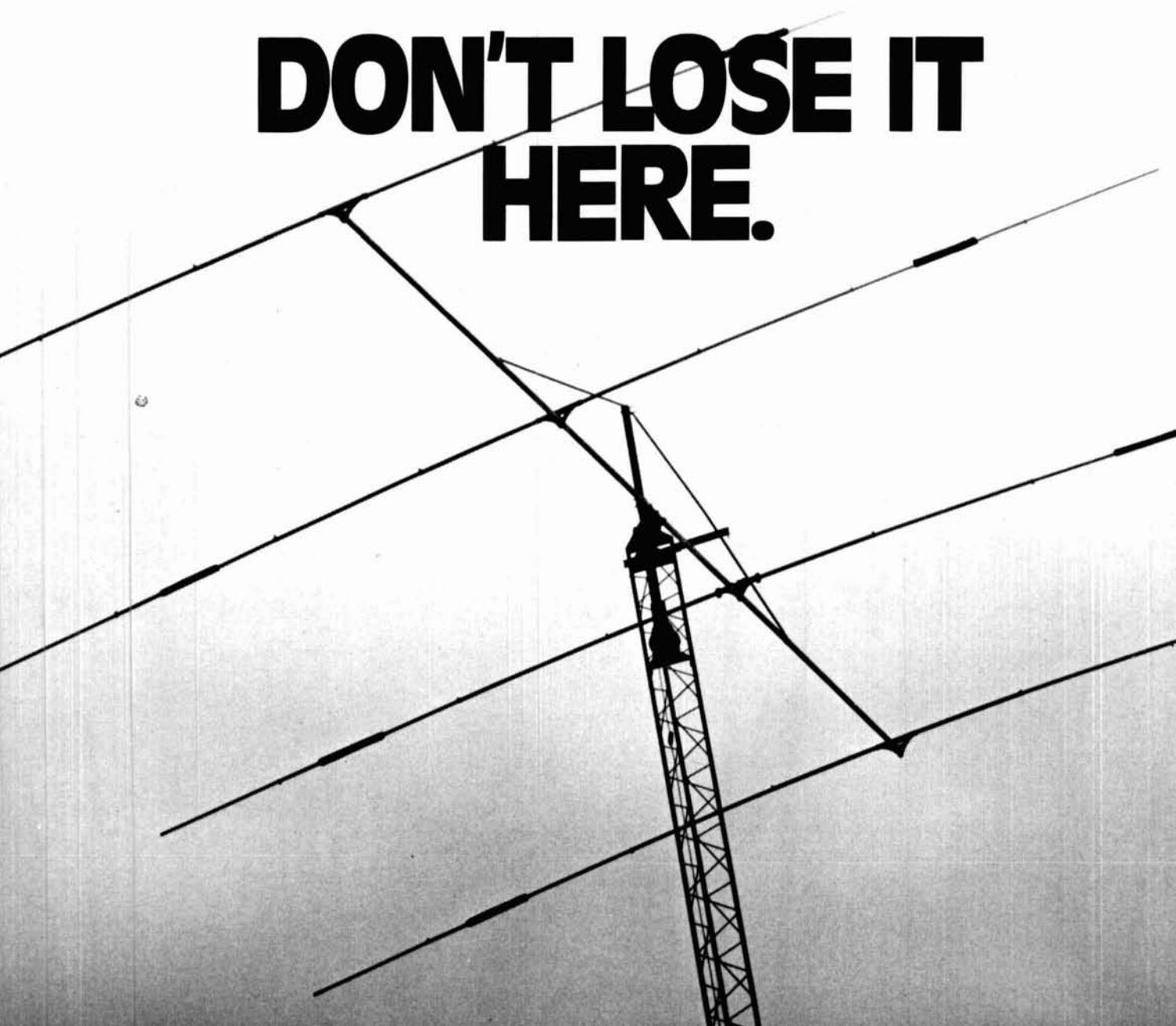
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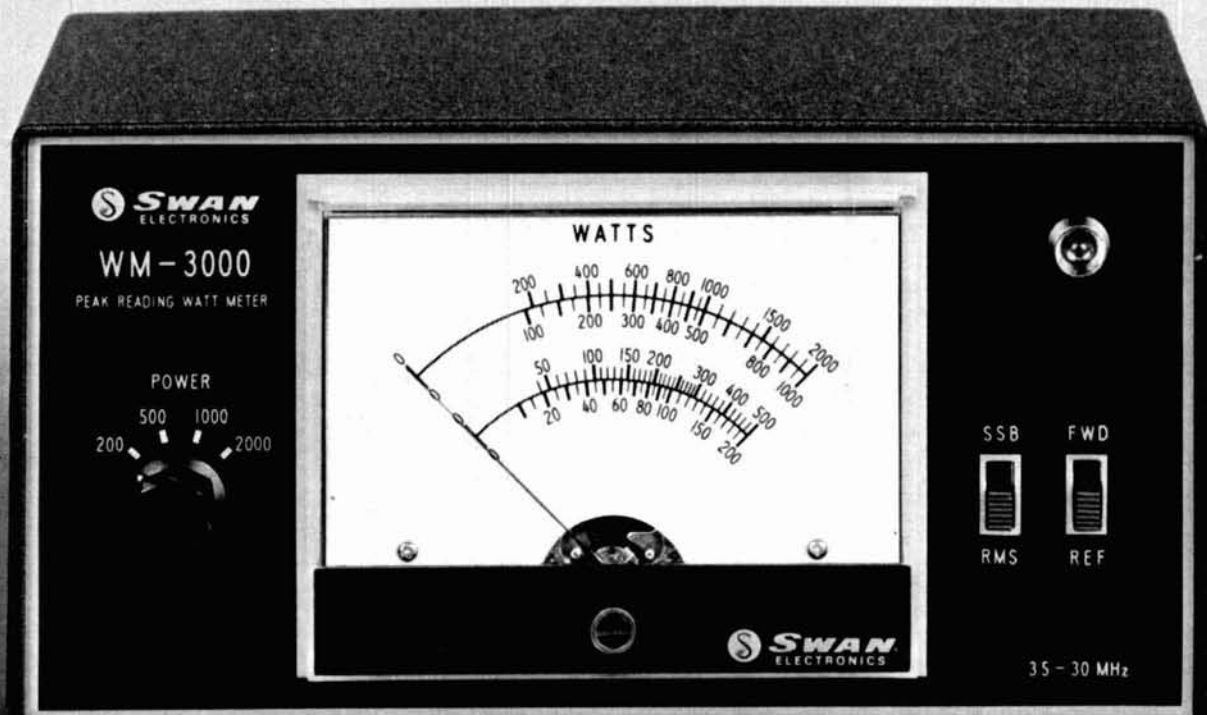
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Joe Carr, K4IPV

resurrecting the old war horse: new hope for the old receiver

If you walk through the flea market of any reasonably sized hamfest, it's likely that you will turn up any number of middle age receivers, often at bargain-basement prices. Models such as the venerable Hallicrafters SX-28A (which WA4EPI toted up the side of Bull Run Mountain on Field Day), SX99, SX-100, SX-101, and any of a long series of HQ-series Super Pro receivers by Hammarlund seem to be in evidence. Receivers, especially general-coverage types, manufactured prior to the late 1960s are in poor favor among hams because they lack the gloss of the newer technologies, may be a little troublesome when tuning single sideband (but not necessarily), and don't seem to fit well into the decor of our current transceiver-oriented radio stations. If, however, you are a new novice, a pre-novice wanting W1AW code practice and something to fiddle with, a young adult with a family budget battered by kids, mortgage and a car payment or two, or even an oldtimer with a luxury station, such old war-horse receivers can be a real bargain for use as a standby receiver, the main station receiver, or something to putter around with to learn some shirt sleeve electronics. The kicker is that — they frequently don't work properly.

As I pointed out in my troubleshooting article in the June issue, in most cases receiver troubleshooting is not the terrible chore it is made out to be. To be sure, there are some terrific problems that require a good technician and a lab full of equipment to solve but the vast majority are of a more mundane nature. In this article, I will address those problems that are peculiar to reworking or repairing old, supposedly worn-out, radio receivers which were the big guns of another era. After all, one person's trash may well be another's treasure.

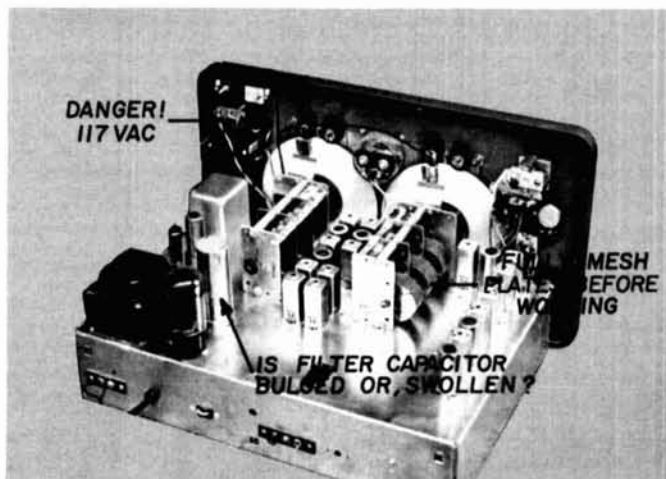
By Joseph J. Carr, K4IPV, 5440 South 8th Road, Arlington, Virginia 22204

Consider my own case. After ten years of apartment living, my wife and I bought a little duplex house and settled into suburban living. While Bonnie fiddled with draperies and furniture placement, Yours Truly was scheming to erect something that had been denied me for all those years: *an antenna*. The next requirement to be met was an old DX-60B belonging to a co-worker and the purchase of a new receiver — until the prices made it apparent that I wasn't going to have a new receiver for a long while. An old friend who never really got into amateur radio was more than willing to part with his old Hammarlund HQ-145X which he had purchased new when Eisenhower was President. It only partially worked, but the price was well below its apparent market value. A decade and a half of improper storage had taken its toll.

The first thing to do when "auditioning" a receiver of this vintage is to make an operational check, preferably before making the purchase. Turn it on and operate the controls. Determine exactly what is, or is not, working properly. Keep in mind that most receivers which have been in storage for any length of time will not be in the best of working order. If the radio works on *any* band, then the set is a good candidate for resurrection. If, on the other hand, it does not work on any band, it is a lesser candidate but that doesn't mean it should be completely ruled out. To be sure, it may require a more extensive evaluation, but the fact that nothing goes "beep" when you tune across the ham bands should reduce the price quite a bit.

Once you have acquired the monster it may have to be repaired. But first, let it run (*not* unattended) for several hours a day over the course of a few days to a week. The heat from the filaments tends to drive out any accumulated moisture, and turning the receiver on for short periods allows the electrolytic capacitors to wake up and start working again. My own HQ-145X had a rather bad audio hum when I first inspected it, but the

fig. 1. The chassis of a reclaimed communications receiver, such as this HQ-145X, may have several points with lethal potentials — unplug the receiver before working on it. Examine the electrolytic capacitors for bulges or a swollen appearance. Make sure the variable capacitor plates are fully meshed before you begin working.



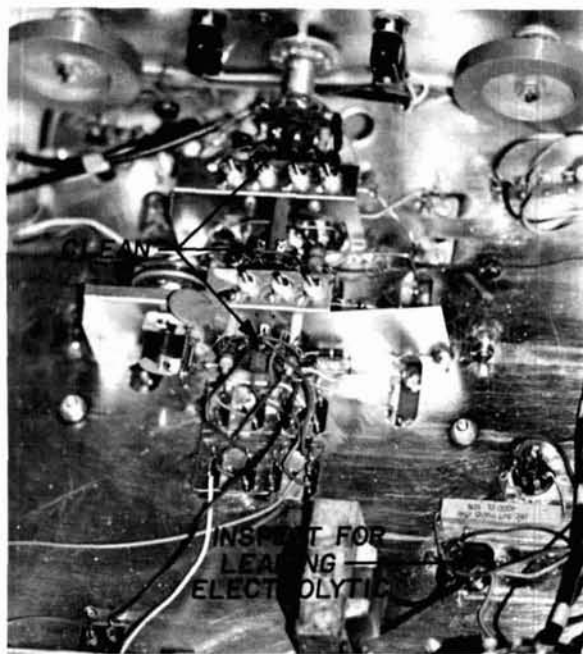


fig. 2. The bandswitch is a main area of difficulty and may need cleaning with a degreaser or a pencil eraser. Examine the bottom of the electrolytic filter capacitor for signs of electrolyte leakage.

hum disappeared in a few days after the electrolytics had reformed. In addition to the audio hum there were a number of other problems:

1. No high band (10 to 30 MHz) and only a scratching sound was heard on these frequencies when the main tuning dial was turned.
2. Occasional oscillation and a rather constant microphonic condition. Oscillation seemed frequency dependent and was at its worst on the special 20 BS band (a modified 10 to 30 MHz band unique to the HQ-145X series).
3. Noisy control potentiometers.
4. Noisy bandswitch.
5. All other rotary switches noisy and/or intermittent.

After the receiver had been burned in for almost a week, I was ready for the next step: cleaning and an additional inspection of the innards. Fig. 1 shows the HQ-145X with the cabinet removed. At this point I feel it's important to caution you that lethal voltages exist on several points inside the receiver. Raw 117 Vac, direct from the power mains, is present on the clock motor in the upper lefthand corner. Unplug the receiver until power is actually needed and discharge the filter capacitors. Also, at this point, be sure to fully mesh the capacitor plates (tune receiver to low end of the dial) so that they will not be damaged as you work. If the capacitor plates are left unmeshed as those in fig. 1, then damage is almost certain.

The first step in cleaning the receiver is to remove the layer of dust that inevitably collects on any electronic chassis. Use either a 1- to 2-inch (2.5 to 5cm) paint brush

or an air gun, if available. Don't ever use steel wool on an electronic chassis — the small particles can really gum up the works. Although aesthetic considerations and your early training may dictate that you clean every nook and cranny don't be too vigorous in the vicinity of the main tuning capacitor. Dust between the plates can cause trouble and is hard to completely remove.

The next phase of the job is to replace any burned-out lamps, then clean the potentiometers and the rotary switches. The switch wafers and pots can be cleaned with almost any of the spray-can electronic contact cleaners, even the cheapies sold through mailorder and walk-in retail outlets. Be sure to spray each switch wafer separately and try to get spray inside each potentiometer. Immediately after spraying it is wise to vigorously operate the control or switch through its entire range for several seconds. In many cases, though, badly neglected rotary switches, especially those that have been totally unused for years, will have corrosion bad enough (it's black and the spray doesn't cut it) that the spray treatment is insufficient. For switch wafers in that condition I recommend an ordinary pencil eraser applied directly to the contact surface. It is usually best, especially in the vicinity of the bandswitch where moved wires can mean changed alignment, to hold the eraser steady and move the contacts underneath it. Don't forget the portion of the wiper contact surface directly underneath the fixed contacts (see fig. 3). That is, after all, where most of the trouble is.

The initial cleaning just described completely solved problems 3, 4 and 5 on my list and made a dent in problem 1 and now I could hear activity on 20 meters and 15-MHz WWV! The 20BS oscillations remained, as did the scratching on 10 through 30 MHz as the main tuning dial was turned. I also noted that a frequency dependent oscillation had appeared on the 10 to 30 MHz band. This can be a little frightening. If you are cognizant of receiver problems you probably agree that troubleshooting *tunable* oscillations is a lot like trying to



fig. 3. Be sure to clean the portion of the switch wiper contact surface that is underneath the fixed contacts. This can be done by rotating the switch while holding the eraser between two contacts.

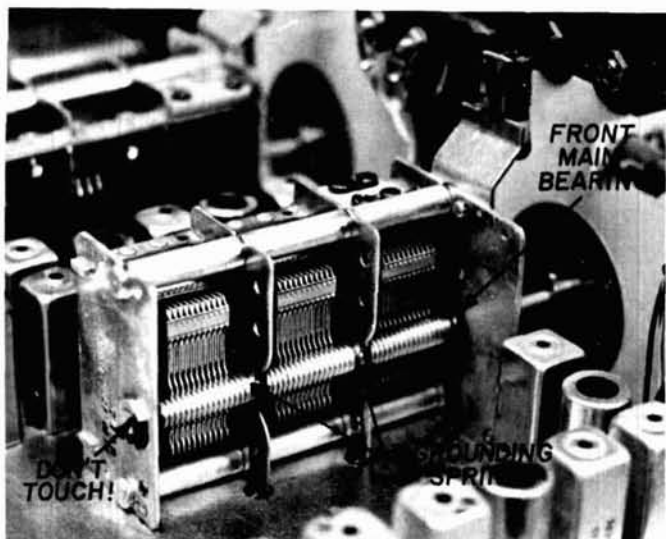


fig. 4. Instability and oscillation results from dirt and corrosion under the rotor ground springs and front main bearing. Clean and relubricate. See text for precautions.

skin an amoeba. I have seen amateur and professional technicians alike (including myself) work for hours, and even days, on such problems. Before looking for open suppressor grids, open screen bypass capacitors, or agc capacitors, you must consider other causes that are peculiar to the neglected receiver.

There are two general causes of oscillation and microphonic conditions on such receivers and they are both spelled *CRUD*. In some cases, it is found that crud on the chassis forms undecoupled feedback paths between stages. Use a Freon-based degreaser or, as an undesirable alternative if you must, that popular concoction consisting of a quart of *Lestoil* with a pinch of ammonia and acetone added, to clean the chassis. Be sure to concentrate on the underside of the chassis and take care not to slop that concoction inside i-f/rf transformers and on to the variable capacitors. The second type of crud is dirt and dried grease in the main bearing and underneath the rotor grounding springs of the main tuning capacitor (see fig. 4). The cleaning should be done with a tiny jeweler's screwdriver or a relay cleaning tool. Carefully burnish the frame and the spring until clean.

The front main bearing race is a circular track filled with ball bearings. Clean this out using a virgin solvent

such as Freon TF (I use Miller - Stephenson MS-180). *Do not* use foam contact cleaners or any television type cleaner that leaves a residue. Also, do not trust the labels on some products. Actually test the spray for a residue. Even with a cleaner such as MS-180 use it sparingly and avoid hitting the capacitor plates if possible (it *is*). After the bearing race is clean, re-lubricate it with a white grease such as Lubriplate (available at most electronic supply houses). Use a single dab on the main race and a microdab underneath each grounding spring. Clean the spring over the rear main bearing but otherwise leave that bearing alone. Under no circumstances should you attempt to adjust the tension screw associated with the rear bearing. It is unlikely that the capacitor will ever work properly if you do. Cleaning the main tuning capacitor and the bandspread tuning capacitor (in a similar manner) completely cured problem 2 and what was left of problem 1.

Once all of the cleaning is done you may worry about replacing components. Of course, if the radio does not work up to snuff then some troubleshooting may be in order. Chances are good, though, that the cleaning will restore normal operation, assuming that the radio had been retired in good working order.

Examine all electrolytic capacitors. If any are bulged out or appear swollen, replace them. Also examine the electrolytics for signs of electrolyte leakage. Look for fluid, either a loose, clear stuff or a thick syrup-like type or (more often) a dry powder that will be some color between off-white and dusky brown. Any of these symptoms mark the capacitor for replacement — don't leave a bad electrolytic in the set! If only one section of the multisection power supply filter capacitor is open do not be tempted by the poor advice, given by some people, to bridge a good capacitor across the bad section. That is only a diagnostic tool and is such poor practice that it ought to be scorned. That open section may short someday (sooner than you might think) and then you can kiss your filter choke and rectifier goodbye.

Examine all of the other capacitors in the set. On paper types look for the wax end plugs being either missing or in poor shape. On the types with a black plastic body look for fluid and cracks in the plastic. Ceramic capacitors may be chipped or cracked but, for the most part, survive well. Replace paper capacitors with a good grade of dipped mylar capacitor such as the

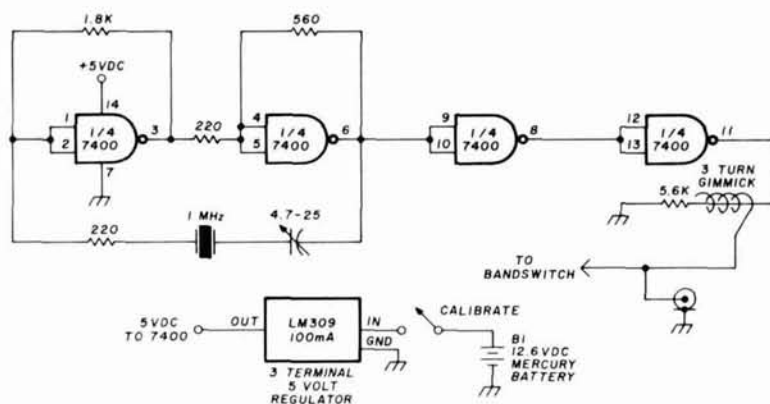


fig. 5. 1-MHz crystal calibrator using TTL logic. The regulator is in the TO-5 can, a 100 mA version of the LM309.

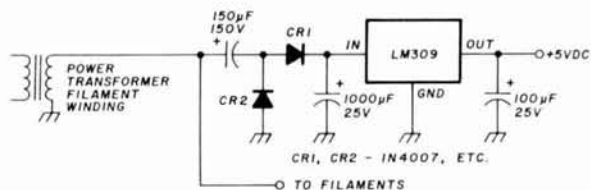


fig. 6. Suggested power supply for the crystal calibrator using the receiver's filament supply.

Sprague Orange Drop. Ceramic and mica types should be replaced with identical units.

Examine all of the carbon composition resistors for signs of overheating, burning, or cracking. Use only a good, new replacement. In this present context let me pass along some advice from my own experience: patronize a quality dealer and buy some good, new, replacement parts. This advice comes from trying bargain, hamfest castoff or surplus parts in one too many circuits! They are good for pittering around, but receiver servicing is really serious work. Incidentally, it won't cost over \$10 to \$15, even if almost all of the capacitors and resistors in the set are bad, which is unlikely.

You will also want to test the tubes from your reclaimed treasure. Use a tube tester, even if it is in a drug store or supermarket. These are simple emission testers but will quickly spot the gross loss of gain and internal shorts. Replace bad tubes with either new tubes recently acquired or those hamfest types known to be new military or commercial surplus. I have used a lot of new, surplus JAN tubes over the past two decades and honestly believe that the number of "bad-off-the-shelf" was actually less than those purchased at commercial outlets.

Once your receiver has been repaired and everything works properly, you may want to turn your attention to adding to (or changing) the instrument to fit your own needs. In my case, I activated an old irritation and replaced the three-screw terminal strip used as an antenna connector with a SO-239 coaxial connector. Also added was a binding post connected directly to chassis ground. The receiver which I had acquired lacked a crystal calibrator so one was added. Since I couldn't find a Hammarlund calibrator designed for the HQ-145, one had to be built. You have several alternatives here. You could duplicate the original and plug it into the appropriate socket or hard wire it to the socket. That has the advantage of using the front-panel *calibrator* switch to turn it on. After an inspection of my junk box I chose a 1-MHz TTL calibrator shown in fig. 5. Although mine is battery powered, you could power it from the receiver power supply as shown in fig. 6. The filament drain of the tube in the optional Hammarlund calibrator was about 300 mA and that is more than sufficient reserve to run the TTL integrated circuits.

After all else is done and you know that the radio is going to work, take some mild, soapy, household cleaner and gently clean the front panel. That "new" appearance will give you a psychological boost that is well earned.

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to permit rapid changing
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or bandwidth or both

Perhaps the most popular active audio filters used to improve CW reception are those manufactured by MFJ Enterprises.* The CWF-2 model is an 8-pole filter with selectable fixed bandwidths of 80, 110, and 180 Hz around a center frequency of 750 Hz, as shown in fig. 1. MFJ's other filter, the CWF-3, is a smaller version of the CWF-2, providing a 4-pole filter with 110 and 180 Hz bandwidths.

After using the CWF-2 unit for awhile, I wanted to vary the filter center frequency and bandwidth independently to suit my own preferences. In addition, an article by W6AGW outlined the minimum criteria for the filter bandwidth and center frequency as a function of code speed.¹ Although several articles have described the design and construction of CW filters, I decided to

modify my unit rather than build a new one, since the components of the individual stages are already matched to give the same center frequency.

This article describes several modifications that can be made to either the CWF-2 or -3 to permit rapid changing of filter center frequency, bandwidth or both.

basic design

Although W7EIJ² and WA1JSM³ have presented the design steps for such a filter, it is nevertheless worthwhile to briefly summarize their results to better understand what components may be changed. Since each op-amp section (a 2-pole bandpass) is identical to the others, it is only necessary to present the basis for a single stage, as shown in fig. 2, used for Q_s less than 10 to minimize ringing. Calculation of component values begins with the selection of C and the choice of center frequency, f_o ; stage gain, A_o , at the center frequency; and Q , so that

$$R_3 = \frac{Q}{\pi f_o C} \quad (1)$$

$$R_1 = \frac{R_3}{2A_o} \quad (2)$$

$$R_2 = \frac{R_1 R_3}{4Q^2 R_1 - R_3} \quad (3)$$

For the basic filter section, $f_o = 750$ Hz, $A_o = 1.32$, and $Q = 4.24$, so that the input impedance is R_1 . The bandwidth, Δf , is the frequency difference between the upper and lower -3 dB points, or

$$\Delta f = f_h - f_L \quad (4)$$

where

f_h = frequency of the upper -3 dB point

f_L = frequency of the lower -3 dB point

*MFJ Enterprises, P.O. Box 494, Mississippi State, Mississippi 39762

By Howard M. Berlin, K3NEZ, 2 Colony Boulevard, Apartment 123, Wilmington, Delaware 19802

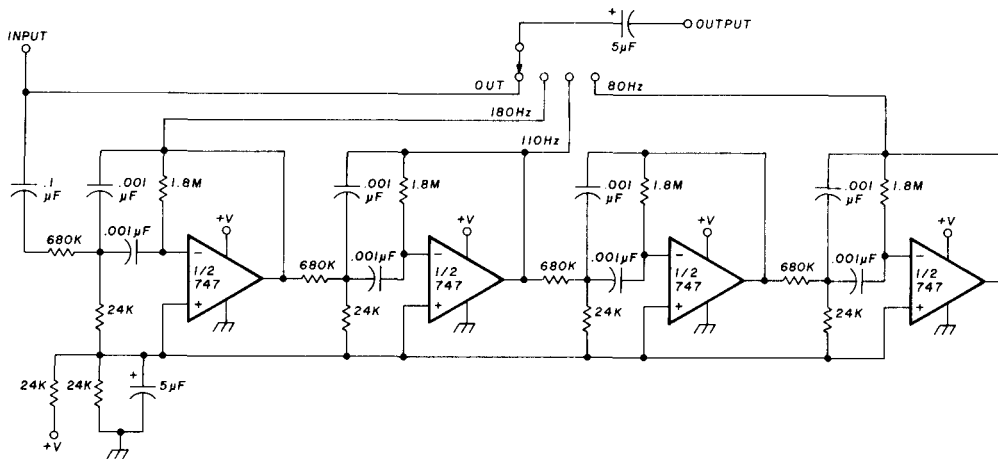


fig. 1. Schematic of the MFJ Enterprises Model CWF-2 CW filter featuring selectable bandwidths of 80, 110, and 180 Hz centered on 750 Hz.

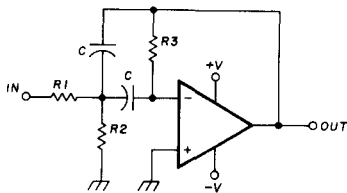


fig. 2. A single-stage, 2-pole bandpass filter section. The calculations of component values for changing filter center frequency and bandwidth are based on this circuit.

The center frequency, in terms of f_h and f_L , is thus

$$f_o = \sqrt{f_h f_L} \quad (5)$$

and

$$Q = \frac{f_o}{\Delta f} = \frac{\sqrt{f_h f_L}}{f_h - f_L} \quad (6)$$

The main disadvantage with the circuit of fig. 2, as well as most op-amp circuits, is the need for a dual-polarity power supply. To permit operation with a single-polarity supply, the circuit shown in fig. 3 is used, with two resistors of equal value for proper biasing. For the MFJ filters 24k resistors are used, and it's only coincidental that they are numerically equal to R2. In fact, other values could have been used for R.

modification 1

From eqs. 1 through 3, it can be shown that the center frequency of the single-stage circuit can be changed to a new frequency, f_o' , without changing A_o or Q by merely changing R_2 to R_2' , so that

$$f_o' = f_o \sqrt{\frac{R_2'}{R_2}} \quad (7)$$

Therefore, by using a dual-element potentiometer with series resistors, each combination being equal to R_2' , it is then possible to smoothly vary the filter center frequency with two fixed bandwidths using the CWF-3 model. With the components shown in fig. 4, the center frequency could be varied from 280 to 1590 Hz with only a 1% variation in either A_o or Q. If the CWF-2 unit is used, a quad-element potentiometer is required for the three selectable bandwidths.

modification 2

If it's desired to smoothly vary the filters bandwidth without varying center frequency, the feedback circuit of fig. 5, as suggested by MFJ, can be used with either unit. Only the first stage (180-Hz bandwidth) is held intact while rewiring one of the other op-amp sections. With the component values shown, it was possible to vary the bandwidth from 75 to 150 Hz at the 750-Hz center frequency. Consequently, the filter Q changed from 5 to 10.

modification 3

This final modification is a combination of the previous two and permits the greatest degree of flexibility. You can now select either fixed bandwidths of 180 and 110 Hz or a variable bandwidth with both bandwidths

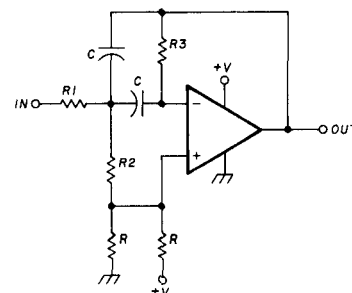


fig. 3. Alternative form of the basic filter stage for use with a single-polarity power supply.

having adjustable center-frequency capability. Using the CWF-2 unit the first two sections are untouched, while one of the remaining op-amp sections is changed. The final circuit is shown in fig. 6.

helpful hints

When soldering on the MFJ printed circuit board, be extremely careful not to overheat the copper laminate, otherwise the copper will separate from the board.

As pointed out by Lancaster in his recently published *Active Filter Cookbook*,⁴ ordinary multiple-element potentiometers, particularly the snap-together types,

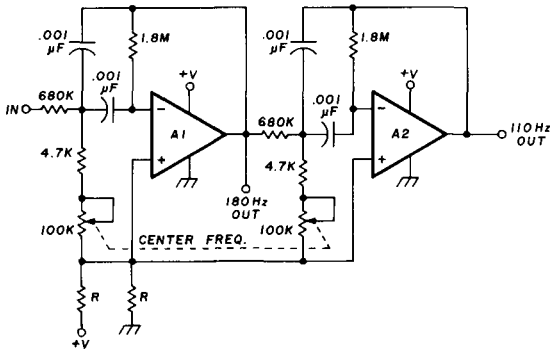


fig. 4. Schematic of the variable center frequency filter with fixed bandwidth. A variation between 280-1590 Hz of center frequency is possible with the two 100-k pots.

have problems. The first is that the resistance behavior is very uncertain at the extremes of pot rotation, since the electrical rotation is somewhat shorter than the mechanical rotation. Also, tracking between the elements should be 5 percent or better.

One inconvenience is linearity; that is, a linear center frequency vs pot rotation change. This is also a problem

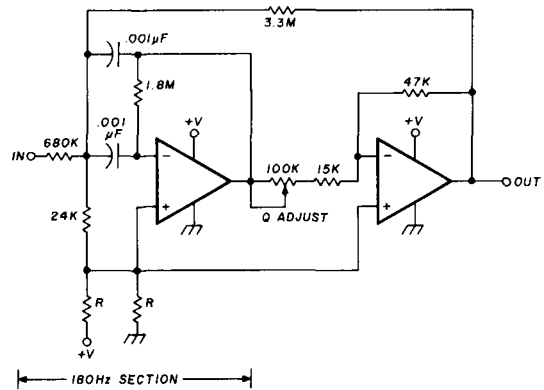


fig. 5. Circuit for varying the MFJ filter bandwidth without varying center frequency. The 180-Hz section is kept intact; the other section is changed as shown to provide bandwidth variation between 75-150 Hz at the 750-Hz center frequency. Filter Q is thus changed from 5 to 10.

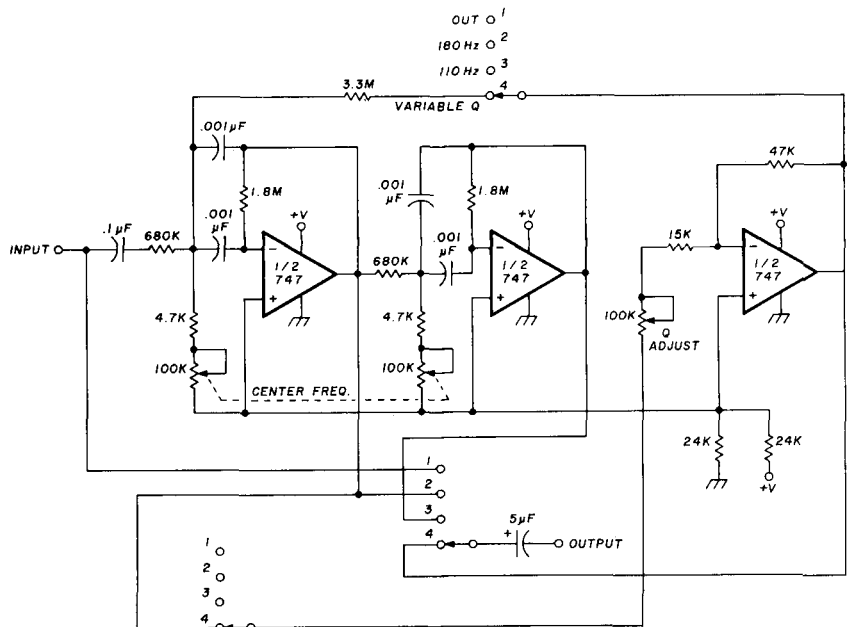
with most integrated-circuit keyers.⁵ If a linear taper pot is used, the center frequency will change drastically at one end with very little pot rotation. A reverse-log taper should be used for best results; however, multiple-element reverse-log types are both hard to find and expensive.

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fig. 6. The CWF-2 filter incorporating modifications to permit the greatest degree of flexibility. Circuit features either fixed bandwidths of 180 and 110 Hz or optional variable bandwidth with adjustable center frequency.



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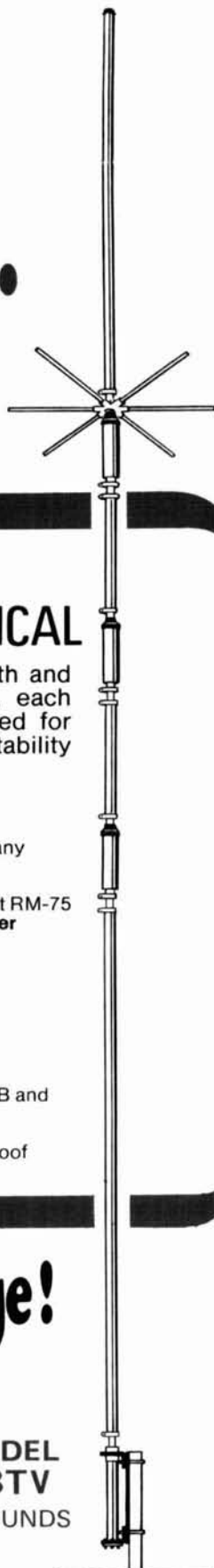
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RTTY performance

and signal-to-noise ratio

A good case is presented for using low-frequency shift in amateur RTTY systems

Although most RTTY systems on the high-frequency amateur bands use the low-frequency shift of 170 Hz, a few use a shift of 850 Hz. In addition to more mutual interference with CW stations, performance with regard to signal-to-noise ratio (s/n) is not as good with the wider frequency shift. When selective fading is present, the lower-frequency shift will also perform better, as is well known.

The signal-to-noise performance can be shown by using the following formula:

$$\frac{s}{n} = 1.73 \frac{D}{f} \cdot \frac{C}{N} \sqrt{\frac{B}{2f}} \quad (1)$$

where s = signal voltage at output of discriminator and lowpass filter

n = rms noise voltage at output of discriminator and lowpass filter

D = deviation of the carrier from the center to one side (one-half the frequency shift)

f = audio frequency range following the discriminator and lowpass filter

By Leland E. Thompson, K6SR, 14851 Devonshire Avenue, Tustin, California 92680

B = frequency band preceding the limiter (it is assumed that a bandpass filter is used)

C = carrier voltage in frequency-band B before limiter

N = rms noise voltage in band B

Assuming a speed of 60 words per minute, the following values can be placed in eq. 1:

$$B = 250 \text{ Hz}$$

$$f = 28 \text{ Hz}$$

$$D = 85 \text{ Hz (total frequency shift is 170 Hz)}$$

Then $s/n = 31.2 \text{ dB}$ (when C/N is 10 dB).

Threshold in wideband fm systems is considered to exist when C/N is 10 dB. In narrowband systems such as those considered here, the threshold is not as sharply defined, and good performance can be obtained with this ratio several dB lower. The s/n of 31.2 dB is 11 or 12 dB more than necessary for satisfactory performance.

The following values can be used in eq. 1 for wide-shift systems:

$$B = 850 \text{ Hz}$$

$$f = 28 \text{ Hz}$$

$$D = 425 \text{ Hz (850 Hz total shift)}$$

The $s/n = 50.2 \text{ dB}$ (when C/N is 10 dB). This value of s/n is far higher than necessary, and it decreases fast as C/N drops below 10 dB. Since N is 5.3 dB higher because of the wider frequency band, C must also be 5 dB higher. With a fading signal, the wideband system will start producing errors before the narrow system will.

Although there may be a slight advantage in reducing the shift below 170 Hz, band B would have to be reduced by using a narrower filter, and stability would then become more of a problem.

Equal performance should be obtained with the phase-locked RTTY terminal unit described by Webb.^{1,2} In this case, band B is determined by the phase-locked-loop bandwidth and f is determined by the low-pass filter, as in the previous system.

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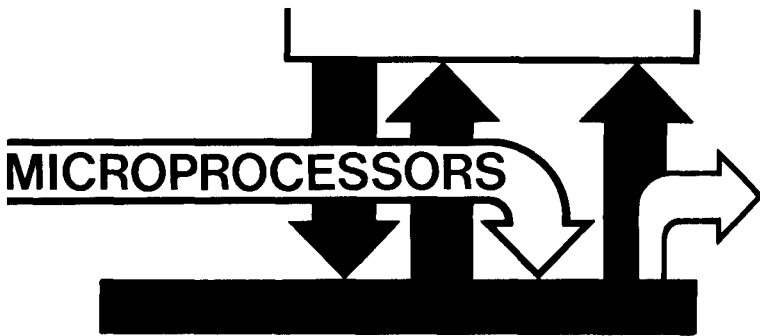
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microcomputer interrupts

This month's column is the first of several that will focus upon the concept of an *interrupt*. When used in the context of a computer, an interrupt can be defined as the suspension of normal program execution in order to handle a sudden request for *service*, i.e., assistance, by the computer. At the completion of interrupt service, the computer resumes the interrupted program from the point where it was interrupted.¹ This specific use of interrupt is consistent with the general meaning of the term: to stop a process in such a way that it can be resumed.

A given computer will typically communicate with a variety of external I/O "devices." If a minicomputer is used, it may communicate with a teletype or alphanumeric keyboard, a CRT display, a printer, a floppy disk, and perhaps one or more laboratory instruments. If it is a microcomputer, it may communicate with smaller devices — (motors, solid-state relays, push-button switches, display lights) within a larger machine or instrument. When used as a replacement for discrete logic devices in a complex digital circuit, a microcomputer may communicate with other TTL integrated circuit chips such as latches, flip-flops, and three-state buffers.

When communicating with external I/O devices,² microcomputers can operate in two general modes, *polled* and *interrupt*. Polling is the periodic interrogation of each I/O device that shares a communications link to a microcomputer to determine whether it requires servicing. A microcomputer sends a poll that has the effect of asking the selected device, "Do you have anything to transmit?", "Are you ready to receive data?", and similar questions. When a microcomputer services a polled device, it simply exchanges digital information with the device in a manner that is prescribed by software in a subprogram or subroutine called a *software driver*.

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

Mr. Larsen, Department of Chemistry, and Dr. Rony, Department of Chemical Engineering, are with the Virginia Polytechnic Institute and State University, Blacksburg, Virginia. Mr. Jonathan Titus is President of Tychon Inc., Blacksburg, Virginia.

In a polled operation, the microcomputer sequences through the devices tied to the microcomputer, looking for individual devices that need servicing. When it finds a device that requires service, sequencing stops and a software driver services the device. Once it is finished, the microcomputer continues checking the devices. Polled operation is most useful with relatively slow devices that do not require frequent service, do not require attention from the microcomputer for excessive periods of time, or can wait to be serviced. Advantage is taken of the difference in speed of operations in the microcomputer and operations in the I/O device. Most common I/O devices are much slower than microcomputers. For example, in 100 ms (teletypewriter response time) an 8080A-based microcomputer can execute approximately 20,000 instructions when operated at a clock rate of 2 MHz. Although a microcomputer may give you the impression that it is doing several things simultaneously, this is only an illusion since it can manipulate data much faster than most I/O devices can respond to changes in data. *A single computer can perform only one task at a time.*

In interrupt operation, the microcomputer juggles the demands of the external I/O devices. There is a distinction between slow devices that require infrequent servicing and high-speed devices that demand the attention of the microcomputer for most of the time. The most appropriate description for interrupt operated systems is that they are *asynchronous*, i.e. they lack a common synchronizing signal and therefore give rise to generally unexpected or unpredictable program execution within the microcomputer. An *asynchronous device* is a device in which the speed of operation is not related to any frequency in the system to which it is connected.³ The use of asynchronous devices is the rule rather than the exception.

There can exist *priority* in interrupt operation. All I/O devices can be ordered in importance so that some devices take precedence over others. In contrast, there is usually no priority in polled operation. Once a device is serviced, it waits its turn until all other devices are sequenced and, if necessary, also serviced. The time between the interrupt request by a device and the first instruction byte of the software that services it is known as the *interrupt response time*. For a high-speed device that has high priority, the response time can be very short, less than a millisecond. For a low-speed device that has low priority, the response time is variable, since it depends upon the demands placed upon the microcomputer by all higher priority devices.

Three commonly used microcomputer interrupt techniques are the *single-line interrupt*, the *multilevel interrupt*, and the *vectored interrupt* (fig. 1). In the

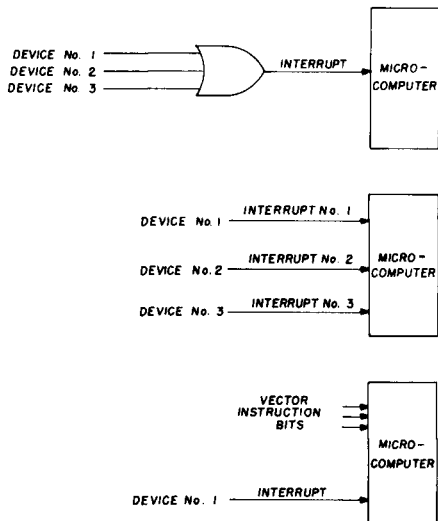


fig. 1. Schematic diagram of three different interrupt techniques, the polled interrupt (top), multilevel interrupt (middle), and vectored interrupt (bottom).

single-line interrupt technique, multiple devices must be OR connected to a single interrupt line to the microcomputer. Once an interrupt signal is received, all of the interrupt devices are polled to determine which one caused the interrupt. It is possible to assign software priorities to the various interrupting devices, so that the first device polled that needs service is the one that receives the attention of the microcomputer. A common term used for the part of a program that polls interrupt devices is a *flag checking routine*. We shall discuss the concept of a flag in a subsequent column. At the moment, consider a flag to be a single-bit memory that indicates when an operation has been completed or when a condition has been attained.

In the multilevel interrupt technique, there are several interrupt lines to the microcomputer, each line being tied to a separate I/O device flag. The microcomputer does not need to poll the devices to determine which one caused the interrupt. This is done internally within the microprocessor chip. Depending upon the nature of the microprocessor chip, this can be a very fast interrupt technique, but it is somewhat difficult to expand.

vectored interrupt

A vectored interrupt causes a direct branch by the microcomputer to that part of the program that services the interrupt. This interrupt technique requires external integrated-circuit chips to supply the memory address of the *interrupt service routine* as well as to set the priority. With the 8080A microprocessor chip, eight different service routine addresses can be readily specified, although one of these addresses coincides with the reset address for the microprocessor, location zero. If you are interested in vectored interrupts, we encourage you to

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consider the Intel 8259 programmable interrupt controller, which became available commercially in July, 1976.

The use of interrupts should be considered very carefully. More complicated software is invariably required. For example, you will generally have to save the status of the microprocessor chip at the time that the interrupt occurred. This means placing the contents of the accumulator, the flags, and the registers into a specified region of memory from which they can be retrieved at a later time, after the interrupting device has been serviced. Pay attention to priorities. Make certain that devices that require high priority and need immediate servicing are given the highest priority. Other devices, such as teletypes, should be low priority. Also, if you attempt to do too much with an interrupt system, you might find that your microcomputer becomes "interrupt bound," which means that the microcomputer is only working on the main task, which it should be doing while only infrequently servicing interrupt requests.

To end this column, we would like to provide one example of an interrupt system. Assume that your microcomputer is performing mathematical computations on 7-bit ASCII numbers that are entered via a UAR/T chip⁴ that is connected to a Teletype operated at 110 Baud, or ten ASCII numbers per second. The exchange of data between the microcomputer and the UAR/T can be performed in 20 to 30 microseconds, which leaves 99.97 ms left for the microcomputer to do other things. With the Intel floating point package, for example, each floating-point multiplication or division can be performed in 2 to 5 ms with an 8080A-based microcomputer operating at 2 MHz. Sixteen-bit binary multiplications and divisions can be performed even faster. Therefore, it is appropriate for you to consider that the main task of the microcomputer is to perform such computations, and that 0.05 to 0.10 percent of the time the microcomputer can devote its attention to servicing the interrupting teletype. The less attractive alternatives are for the microcomputer to either poll the UAR/T or else to wait for a change of state of the UAR/T data ready or transmitter buffer empty flags.

Interrupts are also effective for use with devices that provide data to a microcomputer but which have no buffer of their own to store it. Existing data must be removed from the device and stored in the microcomputer quickly before a new data word can be generated by the device. One example of such a device is an analog-to-digital converter (ADC) in which the conversions are clocked by an external clock at repetitive time intervals.

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binaural synthesizer for audio signals



Hildreth Engineering Company announces its new Binaural Synthesizer, a device for producing a stereo audio output from a monaural audio input.

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The model 400 Binaural Synthesizer is available as a complete unit (less batteries) for \$29.95, as a partially assembled unit including an assembled and tested PC board for \$17.95, or as a kit which includes a predrilled, plated, glass-epoxy PC board with instructions for \$6.95. All prices postpaid.

The model 400 provides a sharp 24 dB per octave channel separation, four poles in each channel, for a good stereo effect. The unit employs 741 integrated-circuit op amps rather than multiple units for simple, easy-to-find attachment points. The PC board contains extra traces for resistor trimming, if desired. The cross-over frequency is 750 \pm 50 hertz, input impedance is 2000 ohms, and the unit may be powered from any supply that will provide negative or positive voltage between 4 and 15 volts dc. In operation, the synthesizer typically draws 5 to 10 milliamperes.

Additional information may be obtained by writing to Hildreth Engineering Company, Post Office Box 3, Sunnyvale, California 94088, or by using the *check-off* on page 142.

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A frequency multiplication factor of 12 allows you to use thicker, high stability crystals (one set of 146.52 simplex crystals supplied). Audio is enhanced through use of separate speaker and microphone elements. And there's an internally adjustable mic preamp. Something you won't find anywhere else.

The Hy-Gain 3806 hand-held is backed by a complete line of superb accessories. Including AC and DC chargers. Carrying case. External antenna adapter cable. And a Nicad power pack that's so over-engineered you won't over-extend it. Even in the most adverse conditions.

The pack is completely sealed in its own tough ABS case. Protected against over-charging. And contact shorting. It has 30-40% more in-use capacity than competitive units.

Soon we'll have a Touch-Tone™ pad available for the 3806. It'll fit flush in the back panel. Because we designed it specifically for the 3806.

The Hy-Gain 3806 2-meter, 6-channel FM hand-held. It gives you the performance you want. Without costing a lot. Available locally through your Hy-Gain dealer. See it and our more than 300 other fine products soon.

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We keep people talking.

Hy-Gain Electronics Corporation 8601 Northeast Highway Six; Lincoln, NE 68505

ramsey electronics



new mobile clock kit \$25.95

6 Digit .33" LED - 12 or 24 Hour

Here's a completely self-contained handsome digital clock for any 12 volt dc application. Small size (4 1/4"x2"x2") and rugged extruded aluminum case makes this clock ideal for mobile usage. Unique features such as ceramic resonator .01% accuracy, Polaroid lens filter and display blanking contribute to the value of this kit.

Colors available: Black, Gold, Silver, Bronze, Blue (specify)

110 Volt Version (uses 60 Hz line) \$22.95
 110 Volt Alarm (12 HR only) \$24.95
 Time base only (use with any clock) \$4.95

FM WIRELESS MIKE KIT

Transmit up to 300' to any FM broadcast radio. Sensitive mic. input requires crystal, ceramic or dynamic mike. Runs on 3 to 9V. Small one inch square size.
Complete Kit \$2.95

LED BLINKY KIT

A great attention getter which alternately flashes 2 Jumbo LEDs. Use for name badges, buttons, or warning type panel lights. Runs on 3 to 9 volts.
Complete Kit \$2.95

SIREN KIT

Produces police-type wail of siren at toy volume. Runs speaker from 3-45 Ohms to 200 mW output. Requires power source of 3 to 6 volts. A neat toy for the kids.
Complete Kit \$2.95

600 MHz PRESCALER

Extend the range of your counter to 600 MHz. Works with most any counter. Completely assembled and tested. Choice of ± 10 or ± 100 , specify with order.
\$59.95



POWER SUPPLY KIT ± 15 V, +5 V

A complete bench supply! Dual tracking regulator provides adjustable ± 6 to 15 Volts at 100 mA, while a stable 3 terminal regulator produces 5 V at 1 Amp. Novel 2 transformer design permits 110/220 V operation. Complete with all parts except case and cord.
PS-3 Power Supply Kit \$14.95

TRANSFORMER SALE

LINE CORD TYPE

12 V ac 175 mA
 short cord (6-10") ... 99¢
 long cord (72") \$1.69



PC LUG MOUNT 10V, 400mA
 ideal for home brew clocks \$1.49

5 VOLT REGULATORS

Both feature: 7 to 30 V input range, thermal shutdown and short circuit protection.

7805/340-5 98¢
 1 Amp T0-220
 LM-309K.....\$1.19
 1 Amp T0-3

741 OP-AMP SPECIAL 10 for \$2.00

Take advantage of a special one time deal on factory prime mini-dip op-amps. These were house numbered for Xerox Corp., but also have the 741 number printed on them. This is the LOWEST price in the USA!

DECADE COUNTER \$2.95 PARTS KIT

● 7490A ● CURRENT LIMIT RESISTORS
 ● 7475 ● .43" LED READOUT
 ● 7447 ● HOOK-UP INSTRUCTIONS

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 LM-565 PLL75
 MC-145875
 7490A59
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 74143 3.50
 MC4024VCO 1.95

FERRITE BEADS with info and specs 15/\$1.00
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ness of 0.085 inch (2mm) and sells for only \$5.50. Write Continental Specialties Corporation, 44 Kendall Street, Post Office Box 1942, New Haven, Connecticut 06509, or Box 7809, San Francisco, California 94110, or use check-off on page 142.

range of HP counter extended to vhf and uhf



Designed with the needs of the communications industry in mind, this new Hewlett-Packard Model 5305B Frequency Counter plug-on covers frequency bands from 50 Hz to 1300 MHz. In addition to all mobile communications bands, the counter's range includes TACAN/DME and ATC radar transponders as well as am and fm broadcast bands and vhf and uhf television bands.

The 5305B operates with the 8-digit 5300B mainframe. Sensitivity is 20 millivolts rms in both channels over the full bandwidth. A high resolution mode for tone measurements to 10 kHz improves resolution by 1000. Automatic gain control is included on both channels, plus a manual attenuation control on the high frequency channel.

A first for a counter is a probe power output to drive an accessory preamplifier. The Hewlett-Packard Model 10855A Preamp boosts sensitivity of the counter by 22 dB (x10). Adding an antenna and tunable filter to the preamp lets the user receive "on-the-air" signals for carrier measurements.

U.S. price of the Hewlett-Packard Model 5305B is \$900, the Model 5300B mainframe is \$460, and the Model 10855A Preamp is \$225. Delivery for any of these units is 30 days.

For additional information contact Inquiries Manager, Hewlett-Packard Company, 1501 Page Mill Road, Palo Alto, California 94304; telephone (415) 493-1501, or use check-off on page 142.

KENWOOD

...the Pacesetter in Amateur Radio



**Discover
the luxury
of 4 MHz**

TS-700A

Kenwood's TS-700A offers the ultimate promise of 2-meters... more channels, more versatility, tunable VFO, SSB-CW... and Kenwood quality.

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



TR-7400A NEW...AVAILABLE IN DECEMBER

KENWOOD'S EXCITING NEW 2-METER MOBILE TRANSCEIVER •
All solid state • Synthesized phase lock loop (PLL) • Power output: 25 or 10 watts (high or low selectable) • 6 digit LED frequency display • Full coverage 144-148 MHz, 800 channels in 5 KHz steps • 600 KHz repeater offset • Continuous tone-coded squelch (CTCS) for transmit and receive or transmit only with tone elements optional • Tone burst (tone elements optional) • Kenwood dependability and value built in.

TR-2200A

Kenwood's high performance portable 2-meter FM transceiver... completely transistorized, rugged and compact. 12 channel capacity • Telescoping removable antenna • External 12 VDC or internal ni-cad batteries • 146-148 MHz frequency coverage • 6 channels supplied • Battery saving "light off" position • Hi-Lo power switch (2 watts-400mW).



TR-7200A

Kenwood's superb 2-meter FM mobile transceiver. Designed to withstand the most severe punishment while providing consistently excellent performance. Packed with features like the PRIORITY function... Put your favorite crystals in channel 7, and the 7200A switches there with the push of a button... no matter what channel you are on. 146-148 MHz coverage, 22 channels, 6 supplied. Completely solid state.

The perfect companion to the TR-7200A is the PS-5 AC/DC power supply. Together they provide an efficient and handsome base station. Complete with a digital clock and automatic time control feature built in.

KENWOOD'S TS-820 *the Pacesetter*

Kenwood's well deserved reputation for fine craftsmanship and superb performance has never been more evident than in the TS-820. As a result of a host of innovative features being brought together, the 820 offers a degree of versatility, performance and pleasure second to none.

The Kenwood TS-820 is destined to be the world's new standard of excellence in amateur radio for years to come... a true "Pacesetter".



VFO-820

The VFO-820 is a solid state remote VFO designed exclusively for use with the Kenwood TS-820 Pacesetter. The VFO-820 has its own RIT circuit and control switch. It is fully compatible with the optional digital display in the TS-820. The perfect extra to any Pacesetter station.

RF MONITOR • Built-in monitor circuit allows you to hear your own voice by sampling the RF signal. Especially useful for adjusting the RF Processor.

NOISE BLANKER • The TS-820 uses an efficient noise blanker circuit, another Kenwood exclusive. A special crystal filter assures unsurpassed efficiency in eliminating unwanted pulse noises.

DIGITAL HOLD • A single pushbutton switch offers the operator unprecedented versatility. The digital hold circuit will lock the counter and display at any frequency, but will allow the VFO to tune normally. Ever wanted to return to a certain spot on the band and forgotten the frequency? That won't happen again with the new digital hold feature on the Kenwood TS-820.

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

IF SHIFT • The IF SHIFT control varies the IF passband without changing the receive frequency. This "IF shift" control is located on the front panel and provides excellent unwanted signal reject control or "pass band tuning." The 820 moves the signal across the IF pass band not the pass band across the signal.

RF ATTENUATOR • Easy, one touch activation of the attenuator supplies 20 dB of padding on receive.

VOX • A voice-activated microphone circuit is built into the TS-820 with VOX GAIN, ANTIVOX, and VOX DELAY controls placed on the front panel for convenient adjustment any time.

Features

160 METERS • Full band coverage

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

RF NEGATIVE FEEDBACK • The linearity of the TS-820's final amplifier stage is now one of the best on the air. Third order intermodulation products are 35 db or greater below the output signal. RF Negative Feedback from the PA plate circuit to the driver cathode permits a high degree of linearity at the high power level of the final tubes.

FULL METERING • During receive, an easy to read meter functions as an S-meter. The same meter displays ALC level, plate current, RF output, and plate voltage during transmit. Includes COMP setting for adjusting the compression level of the built-in speech processor.

FINAL AMPLIFIER • The TS-820 is completely solid state except for the driver (12BY7A) and the final tubes. Rather than substitute TV sweep tubes as final amplifier tubes in a state of the art amateur transceiver, Kenwood has employed two husky S-2001A (equivalent to 6146B) tubes. These rugged, time-proven tubes are known for their long life and superb linearity. The input power of the TS-820 is conservatively rated at 160 W DC, 200 W PEP. Tubes run cool with the aid of a noiseless fan (standard) mounted on the rear panel. The above tube and power combination minimizes the possibilities of TVI and helps to maintain the Kenwood reputation for excellent audio quality.

DIGITAL READOUT DG-1 • (optional) A digital counter display can be employed as an integral part of the VFO readout system. Counter mixes the carrier, VFO, and first heterodyne frequencies to give exact frequency. Figures the frequency down to 10 Hz and digital display reads out to 100 Hz. Both receive and transmit frequencies are displayed in easy to read, Kenwood Blue digits.

DRS DIAL • Includes the same satin-smooth planetary drive found on other fine Kenwood models plus special, high-precision gears to add a new "monoscale" feature for easier frequency readout. LSB, USB, and CW operating frequencies can be accurately read from the same pointer.

HEATER SWITCH • The filaments of the three vacuum tubes may be turned off during periods of "receive only".

CW AUDIO CHARACTERISTICS • During CW reception, a special filter is used to alter the audio frequency response to provide a more comfortable, easy to copy tone.

HIGH STABILITY VFO • The VFO, heart of any SSB transceiver, is an exclusive Kenwood design using FET technology.

Other features include:

- Built-in 25 kHz calibrator*
- Built-in speaker*
- CW Sidetone and semi-break in*
- Rear panel terminals for linear amplifier, IF OUT, RTTY, and XVTR.
- Handy phone patch IN and OUT terminals



the TS-520

Why wait any longer for a rig that offers top performance, dependability and versatility... the TS-520 has proven itself in the shacks of thousands of discriminating amateurs, in field day sites, in DX and contest stations, and in countless mobile installations. Superb craftsmanship is evident throughout... in its engineering concepts as well as its construction and styling... craftsmanship that is a Kenwood hallmark.

Maybe the Kenwood TS-520 is the one you have been waiting for.



*Fine accessories
designed to increase
the versatility of your*

TS-520

SP-520

The SP-520 is an external speaker designed for use with the Kenwood TS-520. The SP-520 can be used in place of the transceiver's built-in speaker for better readability. The speaker's cabinet matches the TS-520 front panel to provide a clean looking integrated station.

VFO-520

The VFO-520 is a solid state remote VFO designed to match the TS-520 perfectly. It allows VFO controlled cross channel operation when connected to the transceiver. A built-in RIT circuit, with an LED indicator, permits receiver incremental tuning.

TV-502

The TV-502 transverter puts you on 2-meters the easy way. Simply plug it in and you're on the air. Operates in the 144.0-145.7 MHz frequency range with a 145.0-146.0 MHz option. The TV-502 is completely compatible with the TS-520 and the TS-820.

KENWOOD'S *"Twins"*



Kenwood developed the T-599D transmitter and R-599D receiver for the most discriminating amateur.

The R-599D is the most complete receiver ever offered. It is entirely solid-state, superbly reliable and compact. It covers the full amateur band, 10 through 160 meters, CW, LSB, USB, AM and FM.

The T-599D is solid-state with the exception of only three tubes, has built-in power supply and full metering. It operates CW, LSB, USB and AM and, of course, is a perfect match to the R-599D receiver.

If you have never considered the advantages of operating a receiver/transmitter combination... maybe you should. Because of the larger number of controls and dual VFOs the combination offers flexibility impossible to duplicate with a transceiver.

Compare the specs of the R-599D and the T-599D with any other brand. Remember, the R-599D is all solid state (and includes four filters). Your choice will obviously be the Kenwood.



*The newest
and best
in world listening*

KENWOOD'S **R-300**

Dependable operation, superior specifications and excellent features make the R-300 an unexcelled value for the shortwave listener. It offers full band coverage with a frequency range of 170 KHz to 30.0 MHz • Receives AM, SSB and CW • Features large, easy to read drum dials with fast smooth dial action • Band spread is calibrated for the 10 foreign broadcast bands, easily tuned with the use of a built in 500 KHz calibrator • Automatic noise limiter • 3-way power supply system (AC/Batteries/External DC)... take it anyplace • Automatically switches to battery power in the event of AC power failure.

HS-4

The Kenwood HS-4 headphone set adds versatility to any Kenwood station. For extended periods of wear, the HS-4 is comfortably padded and is completely adjustable. The frequency response of the HS-4 is tailored specifically for amateur communication use. (300 to 3000 Hz, 8 ohms).



MC-50

The MC-50 dynamic microphone has been designed expressly for amateur radio operation as a splendid addition to any Kenwood shack. Complete with PTT and LOCK switches, and a microphone plug for instant hook-up to any Kenwood rig. Easily converted to high or low impedance. (600 or 50k ohm).

TRIO-KENWOOD COMMUNICATIONS INC.
116 EAST ALONDRA/GARDENA, CA 90248

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...pacesetter in amateur radio

SAVE UP TO 50% ON PARTS.

Hobbyist or professional, there are probably a lot of circuits you build just for the fun of it. And a lot you'd like to build, but never get around to.

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

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

Now, assembling, testing and modifying circuits is as easy as pushing in—or pulling out—a lead. IC's, LED's, transistors, resistors, capacitors... virtually every kind of component... connect and interconnect instantly via long-life, nickel-silver contacts. No special patch

MODEL	NO. OF TIE-POINTS	14-PIN DIP CAPACITY	SUGG LIST *	OTHER FEATURES
PB-6	630	6	\$15.95	Kit — 10-minute assembly
PB-100	760	10	19.95	Kit — with larger capacity
PB-101	940	10	29.95	8 distribution buses, higher capacity
PB-102	1240	12	39.95	Large capacity, moderate price
PB-103	2250	24	59.95	Even larger capacity, only 2.7¢ per tie-point
PB-104	3060	32	79.95	Largest capacity, lowest price per tie-point
PB-203	2250	24	75.00	Built-in 1% regulated 5V, 1A low-ripple power supply
PB-203A	2250	24	120.00	As above plus separate 1/2-amp +15V and -15V internally adjustable regulated outputs

*Manufacturer's suggested list
Prices and specifications subject to change without notice

cords or jumpers needed—just lengths of ordinary #22-30 AWG solid hookup wire.

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

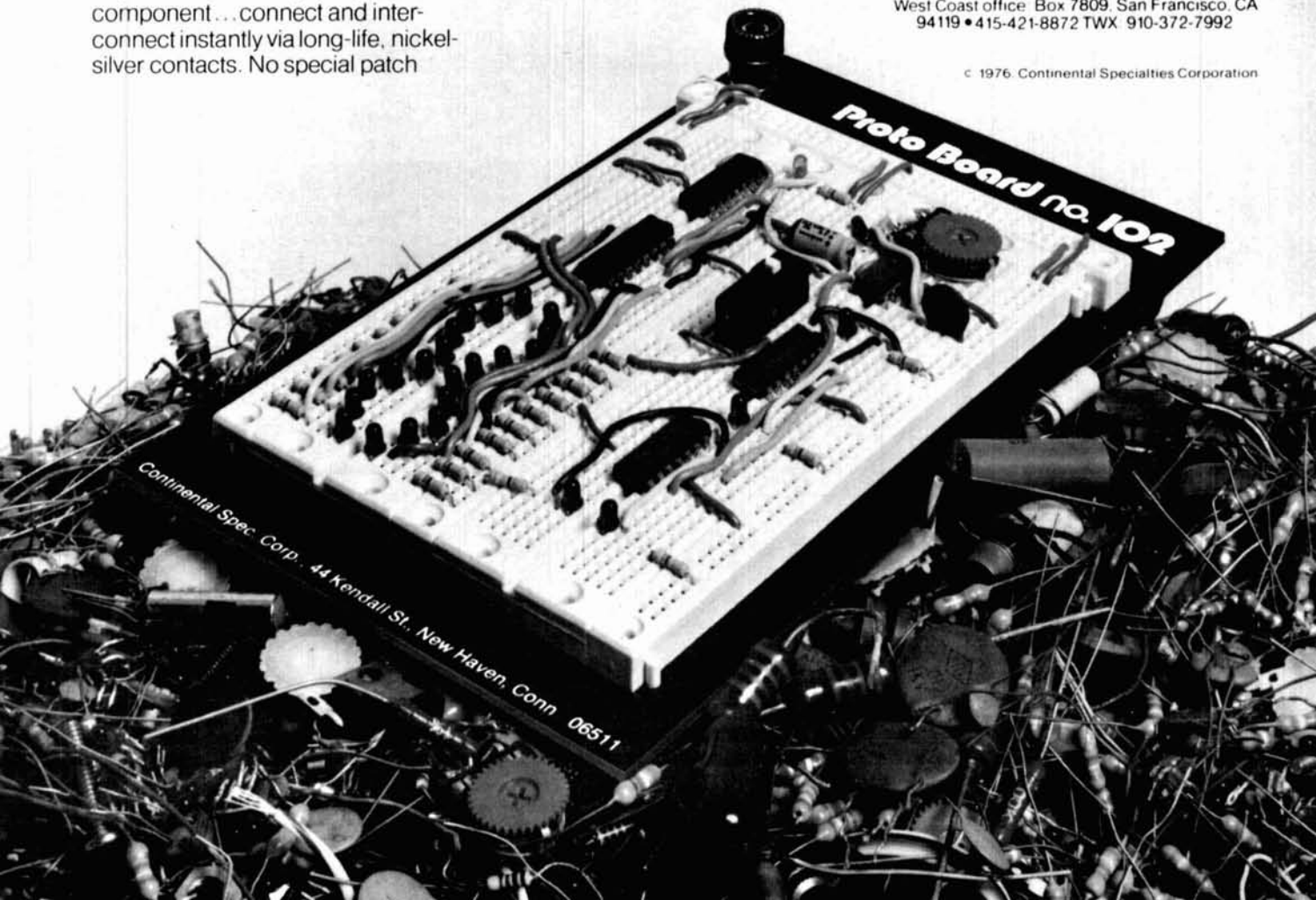
Before you invest in your next project, invest in a CSC breadboard. See your dealer or order by phone: 203-624-3103 (East Coast) or 415-421-8872 (West Coast)—major charge cards accepted. You've got nothing to lose... and a lot to gain.

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⊙ **More Channels...at the flip of a switch**

Unlock the unique mode switch and 12 channels become 144

⊙ **More Sensitivity, Less Interference.**

.25 μ V Sensitivity plus 75 db adjacent channel selectivity and 70 db image rejection

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35 watts nominal with a minimum of 30 watts across the band

... for a lot less

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Amateur Net



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THE FM LEADER →

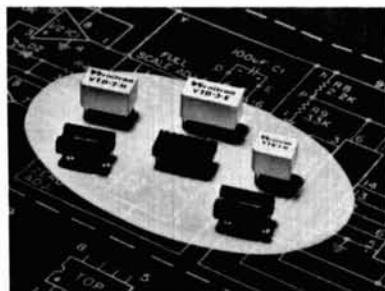
2 METER 

220 MHz 

6 METER 

440 MHz 

miniature ceramic filter for communications receivers



Vernitron Piezoelectric Division recently introduced a new series of low-cost miniature VTD ceramic ladder filters designed to meet the needs of modern double conversion systems.

The small size of the VTD filters and their high stopband rejection, make them particularly suitable for hand-held transceivers, CB equipment, police scanners and commercial two-way radios.

These compact, highly sensitive ceramic filters are fully compatible with transistorized amplifier circuitry, as well as with ICs in am and fm sets. They plug into 14- or 16-pin DIP sockets or mount directly on PC boards, and provide maximum design flexibility.

Vernitron has designed the new VTD Series of ceramic ladder filters in three model groups. VTD-1 models offer 40 dB bandwidth and stopband of 25 to 27 dB; VTD-2 models offer 50 dB bandwidth and stopband of 30 to 40 dB; and VTD-3 models offer 60 dB bandwidth and stopband of 40 to 45 dB. The VTD-1 and VTD-2 filters plug into a 14-pin dip socket and the VTD-3 filter plugs into a 16-pin dip socket.

For more information and Data Sheet 940 write Mark Rickman, Vernitron Piezoelectric Division, 232 Forbes Road, Bedford, Ohio 44146; telephone (216) 232-8600, or use *check-off* on page 142.

Sinclair offers free brochure for amateurs

Sinclair Radio Laboratories — the company known for quality and innovation in the radio antenna systems equipment market for over 25 years —

6 Digit LED Clock Kit - 12/24 hr.

\$995 QTY. 12
ea. OR MORE

\$1095 QTY.
ea. 6-11

\$1195 QTY.
ea. 1-5

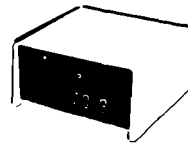
- KIT INCLUDES**
- INSTRUCTIONS
 - QUALITY COMPONENTS
 - 50 or 60 Hz OPERATION
 - 12 or 24 HR OPERATION

6-LED Readouts (FND-359 Red, com. cathode)
1-MM5314 Clock Chip (24 pin)
13-Transistors
3-Switches
6-Capacitors
5-Diodes
9-Resistors
24-Molex pins for IC socket

LARGE .4" DIGITS!
ORDER KIT #850-4
AN INCREDIBLE VALUE!

"Kit #850-4 will furnish a complete set of clock components as listed. The only additional items required are a 7-12 VAC transformer, a circuit board and a cabinet, if desired."

Printed Circuit Board for kit # 850-4 (etched & drilled fiberglass)\$2.95
Mini-Brite Red LED's (for colon in clock display) pkg. of 5 1.00
Molded Plug Transformer 115/10 VAC (with cord) 2.50
NOTE: Entire Clock may be assembled on one PC Board or Board may be cut to remote display.
Kit # 850-4 will fit Plexiglas Cabinet II.



PLEXIGLAS CABINETS

Great for Clocks or any LED Digital project. Clear-Red Chassis serves as Bezel to increase contrast of digital displays.

Black, White or Clear Cover

CABINET I
3"H, 6 1/4"W, 5 1/2"D

CABINET II
2 1/2"H, 5"W, 4"D

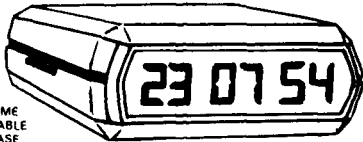
ANY SIZE / COLOR **\$6.50** ea. **2/*12.**

RED OR GREY PLEXIGLAS FOR DIGITAL BEZELS

3"x6"x1/8" **95¢** ea. **4/*3**

MOBILE LED CLOCK

12 OR 24-HOUR OPERATION
12 VOLT AC or DC POWERED FOR FIXED OR MOBILE OPERATION.
SIX JUMBO .4" DIGITS!
KIT OR ASSEMBLED



MODEL 2001

ACCURATE TIME WITH ADJUSTABLE XTAL TIME BASE

Approx. Size:
1 1/4" H x 4" W x 4 1/2" D

BATTERY BACK-UP FOR POWER FAILURE OR TRANSPORTING FROM HOUSE TO CAR, ETC.

- 6 JUMBO .4" RED LED'S BEHIND RED FILTER LENS WITH CHROME RIM.
- SET TIME FROM FRONT VIA HIDDEN SWITCHES • 12/24-Hr. TIME FORMAT
- STYLISH CHARCOAL GRAY CASE OF MOULDED HIGH TEMP. PLASTIC
- BRIDGE POWER INPUT CIRCUITRY - TWO WIRE NO POLARITY HOOK-UP
- OPTIONAL CONNECTION TO BLANK DISPLAY (Use When Key Off in Car, Etc.)
- TOP QUALITY PC BOARDS & COMPONENTS - EXCELLENT INSTRUCTIONS

KIT #2001: COMPLETE KIT (Less V. Battery) **29⁹⁵** EA. 3 OR MORE **\$27⁹⁵** EA. 115 VAC Power Pack #AC-1 **\$2⁵⁰** EA.

ASSEMBLED UNITS W/ WIRING & TESTED (LESS V. BATTERY) **\$39⁹⁵** EA. 3 OR MORE **\$37⁹⁵** EA. Assembled Units May Be Mixed With Kits for Qty. Price

JUMBO RED LED'S 12/\$1.00 50/\$3.95

6 Digit-LED Clock-Calendar-Alarm Kit

This is a complete, top of the line, Kit for the person that wants the best. Some of the many features and options are: 12/24 time, 28-30-31 day calendar, alternates time (8 sec) and date (2 sec) or can display time only and date on demand, 24 hr alarm - 10 minute snooze, alarm set indicator, 50/60 HZ. line operation or use with Xtal time base (#TB-1), built in OSC for battery back-up / AC failure, Aux. timer. Large digits.

Kit #7001B 6-.4" Digits Man-64 **\$39.95**
Kit #7001C 4-.6" Digits & 2-.3" (seconds) **\$42.95**

Kits are complete (less cabinet) including PC boards, power supply, IC socket, 9 switches, 16 transistors and all parts required for above features and options (Ideal fit in Cabinet I above).

60 HZ.

XTAL TIME BASE KIT

Will enable Digital Clock or Clock-Cal. Kits to operate from 12VDC. Uses MM5369 and 3.58MHz. XTAL. Req. 5-15VDC/2.5 MA. 1"x2" PC Board. Easy 3 wire hookup Accuracy: +- 2 PPM

#TB-1 [adjustable] Complete kit \$4.95 ea
Wired & Cal. \$9.95 ea

PRINTED CIRCUIT BOARDS for CT-7001 Kits sold separately with assembly info. PC Boards are drilled Fiberglass, solder plated and screened with component layout. Specify for #7001B or #7001C (Set of 2) \$7.95

JUMBO DIGIT CLOCK KIT

A complete Kit (less Cabinet) featuring: six .5" digits, MM5314 IC, 12/24 Hr. time, 50/60 HZ., Plug-Transformer, Line Cord, Switches, and all Parts. (Ideal Fit in Cabinet II) **\$19⁹⁵** 2/*38.
Kit #5314-5

JUMBO DIGIT CONVERSION KIT

Convert small digit LED clock to large .5" displays. Kit includes 6-.5" LED's, Multiplex PC Board & easy hook-up info. Kit #JD-1CC For common Cathode **\$9⁹⁵** ea. 2/*19.
Kit #JD-1CA For common Anode

Fairchild Super Digit FND-359

4" Char. Ht. 7 segment LED. RED Com. Cath. Direct pin replacement for popular FND-70. **95¢** ea, **10/\$8.50**
100/\$79.00

SET OF 6 FND-359 WITH MULTIPLEX PC BOARD **\$6.95**

25 AMP BRIDGE **\$1.95** ea.
3/\$5.00

100 PIV

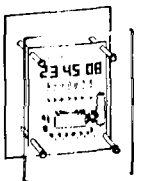
TELEPHONE FORMAT KEYBOARD BY Chomerics

2-1/4"x3" 5/32" thick **\$4.95**

6/*28.

SEE THE WORKS CLOCK KIT Clear Plexiglas Stand

- 6 Big .4" digits
 - 12 or 24 hr. time
 - 3 set switches (back)
 - Plug transformer
 - All parts included
- Plexiglas is Pre-cut & drilled. Size: 6"H, 4 1/4"W, 3"D



A SUPER LOOKING CLOCK!

Kit #850-4-CP **\$23⁵⁰** ea. 2/*45.

7-SEG LED COMMON CATHODE

COLOR	HT. DEC PT. PR. EA.
FND-359 RED	4" RHDP \$.95
FND-503 RED	5" RHDP \$1.35
DL-750 RED	6" LHDP \$2.95
XAN-654 GREEN	6" NDP \$2.95
XAN-664 RED	6" NDP \$2.95

COMMON ANODE

DL-747 RED	6" LHDP \$2.95
XAN-72 RED	3" LHDP \$1.25
XAN-81 YELLOW	3" RHDP \$1.75
XAN-351 GREEN	3" RHDP \$1.50
XAN-361 RED	3" RHDP \$1.50
XAN-362 RED	3" LHDP \$1.50
XAN-662 RED	6" NDP \$2.50
XAN-692 RED	6" NDP \$2.50

Form Inexpensive Sockets 100 for \$1.25 Reel of 1000 - \$8.50

MOLEX PINS

SCHOTTKY TTL		UART		EXAR		OP AMPS	
74S00 \$.35	300 \$.09	AYS-1013 \$ 6.95		XR 2556 \$ 1.75	3/10 DIP		
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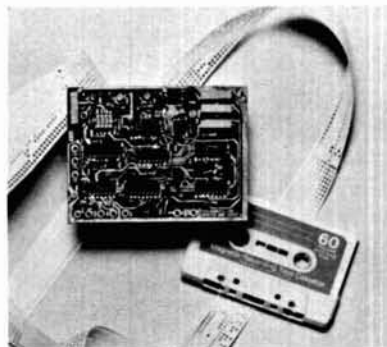
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Electronic Product Associates announces the availability of a new, low-cost audio cassette/TTY/CRT adapter which allows any serial TTL or MOS output to simultaneously interface a low-cost audio cassette player via frequency shift keying (Byte Standard) up to 300 Baud and to a standard RS232 CRT and a 20 mA current loop TTY. The adapter also simultaneously decodes Byte Standard fsk data from low-cost audio cassette players and from 20 mA current loop TTY and RS232 CRT. Audio cassette information is decoded by a proprietary phase-locked-loop system developed by EPA which is said to be the most reliable method available for transferring digital data to and from low-cost audio cassette players. The Model TCC3 is 4½x3¼ inches

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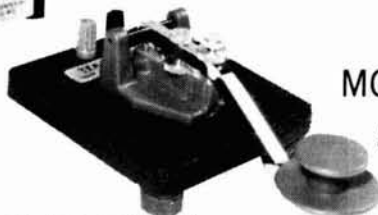
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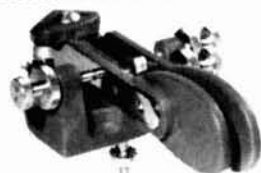
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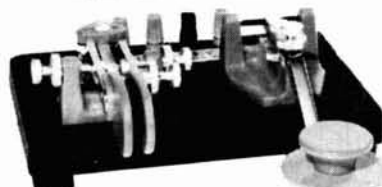
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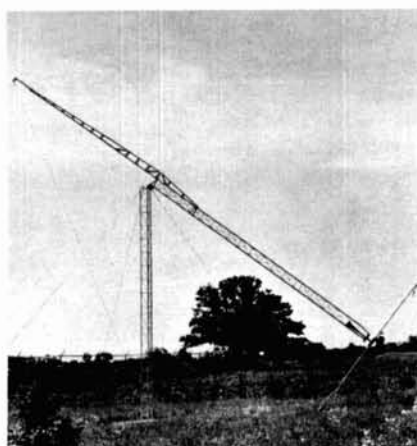
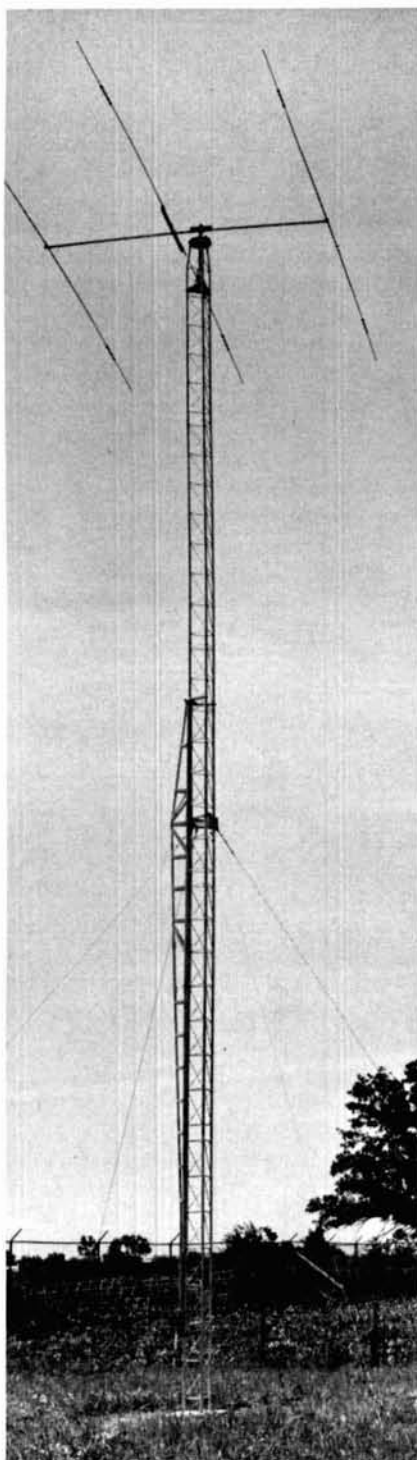
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For additional information, write Electronic Product Associates, Inc., 1157 Vega Street, San Diego, California 92110; telephone (714) 276-8911 or use *check-off* on page 142.

IC Zener has one-ohm dynamic impedance

National Semiconductor Corporation recently announced a new reference diode with a dynamic impedance two orders of magnitude less than that of discrete Zener diodes. The LM129 linear IC, 6.9-volt, reference diode operates over a 0.5 to 15mA current range, allowing it to replace a wide variety of discrete devices and improve circuit performance. An important feature of the LM129 is that all operating characteristics of the reference are essentially independent of operating current.

The heart of the linear integrated circuit is a new sub-surface-breakdown Zener that yields a very low noise and highly stable breakdown. Long-term stability is typically 20 ppm while noise is guaranteed to be less than 20 μ V. Active circuitry around the Zener buffers external current changes to give a one-ohm dynamic impedance.

According to Robert C. Dobkin, inventor of the LM129, this new IC Zener will greatly simplify bias circuitry needed to make a reference. Normally, a precision current source is needed to bias reference Zeners; however, with the LM129, only a single resistor is needed.

The new reference is available in selected temperature coefficients from 0.001% to 0.01% per degree C for use in a zero to 70 degree C, or -55 to 125 degree C temperature range. The new IC is packaged in either a TO-46 hermetic transistor package or a plastic TO-92 package.

Pricing for the LM129AH (0.001% per degree C, -55 to 125 degree C) reference is \$15.00 in quantities of one hundred, and the LM329DZ (0.01% per degree C, zero to 70 degree C) reference is \$0.75. Delivery of both IC reference

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diodes is from stock. For additional information, including typical circuit applications and wiring diagrams, write Roy Twitty, National Semiconductor Corporation, 2900 Semiconductor Drive, Santa Clara, California 95061; telephone (408) 737-5287, or use *check-off* on page 142.

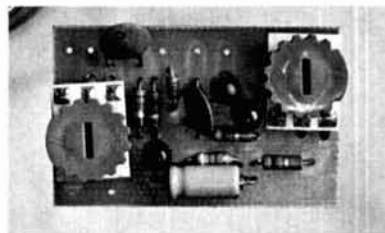
B&K-precision issues new 40-page catalog

A new 40-page catalog describing B&K-Precision test instruments has just been released.

Among the new "cost effective" instruments in this catalog are a 30 MHz scope, a 15 MHz scope and a 5 MHz scope. A new low-cost 3-1/2 digit multimeter is also being introduced for the first time. Other devices described in the catalog include frequency counters, signal generators, semiconductor and transistor testers and numerous other test instruments.

The catalog is available without charge by writing directly to Mr. Paul Mangione, B&K-Precision, Dynascan Corporation, 6460 W. Cortland, Chicago, Illinois 60635; telephone (312) 889-9087, or use *check-off* on page 142.

Touch-tone pad



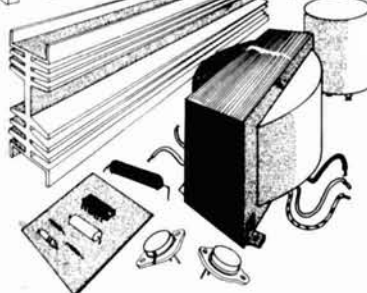
Touch-toners, if you've been looking for a neat way to interface a touch-tone pad with your two-meter rig, Trevor Industries may have just the device you need. The "Trevorface" has an adjustable audio output level and, each time a tone button is depressed, automatically keys your transmitter for any desired period of time up to several seconds. The printed-circuit board with components is small enough to find a home inside the enclosure of any but the smallest hand-held rig and measures only 3/8x1 1/2x2 inches (10x32x51mm). The design was developed nearly four years ago for the TR-22 by W2EUP who

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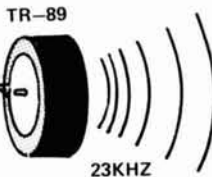
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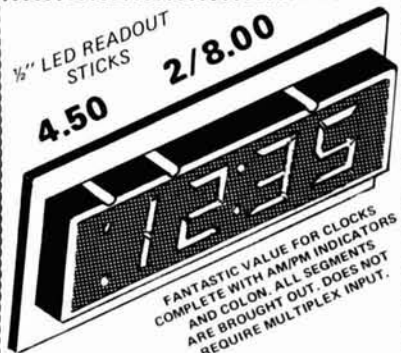
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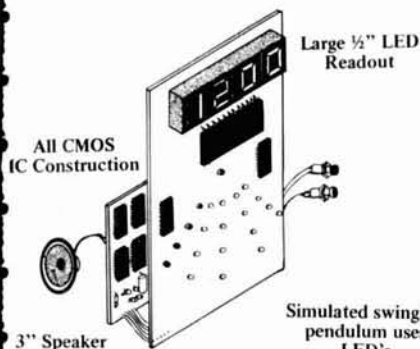
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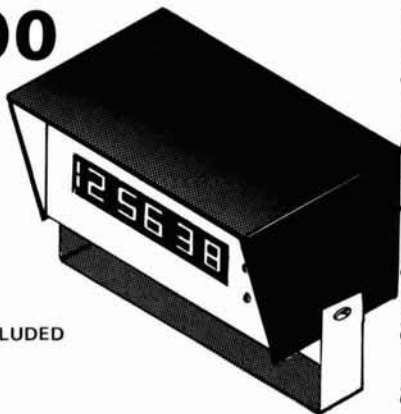
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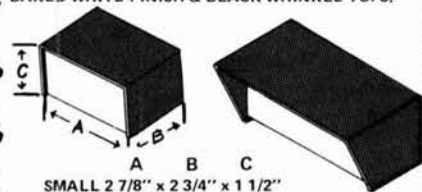
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ham radio operating guide

Most amateurs like to be known as good operators, and The American Radio Relay League has just introduced a new book that will help the newcomer and brush up the old timer's operating habits. *The ARRL Ham Radio Operating Guide* is an easy-to-read manual for introducing the reader to the many and varied operating practices that exist throughout amateur radio.









The book is written by experts in each of the fields covered and answers questions faced by beginners in any phase of ham radio: What's the best Novice daytime DX band? What crystal frequencies should you order for your new fm transceiver? In the 75-meter phone band, where are Australian stations most likely to be found? When will an amateur satellite be in range of your station? What is the WAJA award? How long should you make each transmission when trying to call another station by meteor scatter?

The guide contains ten chapters: Getting Started, Message Handling, Contests, DX, Awards, Repeaters, Flea Power, Communicating Visually, VHF/UHF, Searching for New Horizons, Oscar.

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SYN II Kit . . . 2 meter synthesizer, transmit offsets programmable from 100 KHz - 10 MHz, (Mars offsets with optional adapters) . . . 169.95 SYN II . . . same as above, wired and tested . . . 239.95	WALKIE TALKIES 	
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2 finger-grip pointer knobs 2" diam. white indented
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3 SO-239 coax chassis connectors. Tunes 52 ohm or 52-300-600* or random wires

1 heavy inductance for 10-15-20-40-80 meters
6 pvc stand-offs, 4 for condensers and 2 for inductance
1 HD switch for band catching 10 thru 80 meter coverage
1 pig 12-gauge tinned round wire
Cabinet included — Apollo "Shadow Boxes" M Kit includes schematic. Recommend parts layout.
INFO NOTE *377 OHM and **600 OHM "Open wire spaced ladder line" air dielectric. *53 x wire diam. **84 x wire diam. info only — not supplied.

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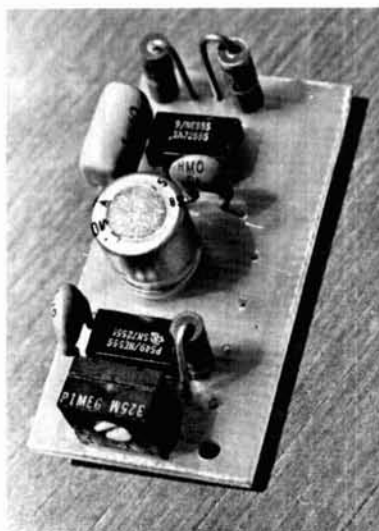
appliance noise filter



Cornell-Dubilier has announced a new and efficient filter, the CBBS-1, for electrical interference produced by hot combs, blenders, electric shavers and similar appliances. Simply plug the Cornell-Dubilier CBBS-1 into the wall socket and then plug the noisy appliance into the CBBS-1. All annoying electrical noise which hampers radio and TV reception is removed. The unit is lightweight, highly reliable, (handles 5 amperes), and is built to resist the effects of heavy household usage.

For additional information, contact William Carlson, Cornell-Dubilier, 150 Avenue L, Newark, New Jersey 07101, or use *check-off* on page 142.

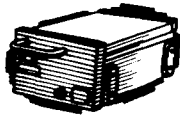
new repeater time-out timer



A new integrated circuit timer for repeater time-out use has been announced by Timekit.® All circuitry of Timekit's Model TG970 time-out timer is on a printed-circuit board measuring only 1x2 inches (25.4x50.8mm) that should fit inside most transceiver enclosures. External

CHRISTMAS GOODIES

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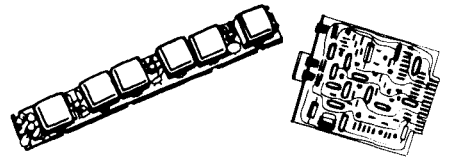
T43GGV...WB..w/accs	\$48.00
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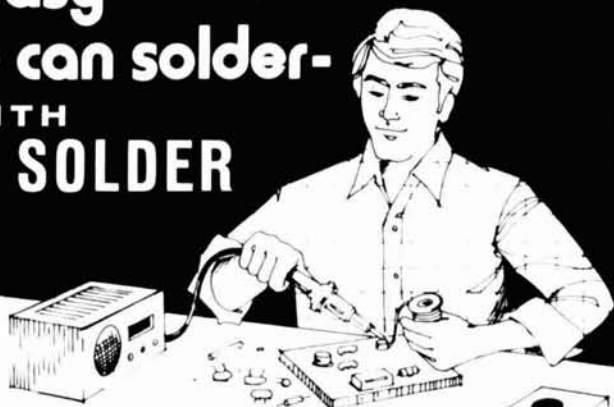
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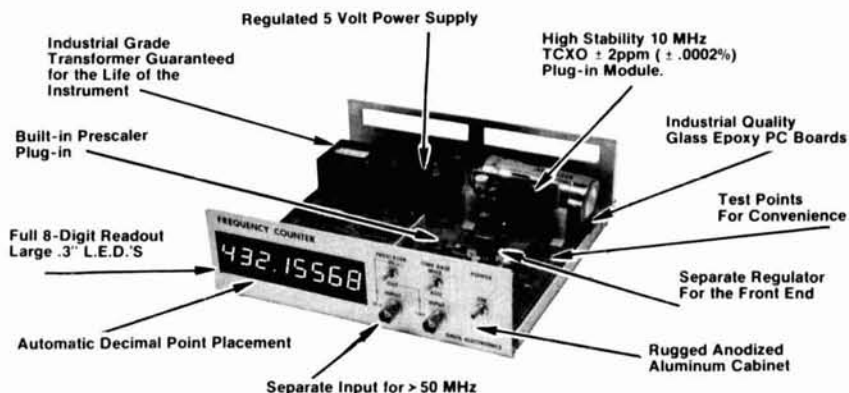
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connections to the TG970 are 13 volts dc, PTT, ground and output.

When the microphone button is pressed (or when the COR is energized) a timing cycle continuously variable from 10 seconds to 30 minutes is activated. At the conclusion of the cycle, that is, at time-out, the TG970 produces a 13-volt, 2 Hz pulse train which can be used to flash an LED, activate a beeper or excite a Timekit Model TG3 oscillator designed for attachment to the TG970 board. The oscillator will pulse an external speaker at 2 Hz with a 1000 Hz note. Timer reset is immediate with no false triggering, and is immune to rf.

The TG970 is priced at \$7.95 wired and tested, or \$6.50 in kit form. The TG3 is priced at \$4.50 wired and tested, or \$4.00 in a kit.

For additional information, write Timekit, 23715 Mercantile Road, Cleveland, Ohio 44122; telephone (216) 464-3820, or use *check-off* on page 142.

solderless coaxial connector

The Bunker Ramo RF Division has introduced a PL-259-type Amphenol connector that provides instant and simple termination of RG-58A/U coaxial cable without solder, special tools, or adapters. Designated Amphenol 85-58FCP (for field crimp plug), the new, reusable connector has application in both fixed and mobile stations wherever coaxial cable termination must be made.

To complete a termination, the user simply strips the coaxial cable and pushed the connector parts onto the center conductor and braid. The contact is squeezed at the tip to secure the center conductor; but, if reuse is desired, the contact can be soldered. No braid soldering, braid combing, special crimping tools, or special adapters are needed. The result is a fail-safe, fast termination that eliminates faulty interconnections. Another advantage of the solderless termination is the absence of overheating during assembly and consequent damage to the cable itself. The Amphenol 83-58FCP offers performance equal to that provided by standard Amphenol 83-1SP-type uhf connectors, and at the same price.

At the heart of the solderless connecting mechanism is a body assembly featuring a hollow barrel with a barbed

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GENAVE!



**GTX-1 or
GTX-1T
HAND-HELD
2-Meter FM
Transceiver**

CHECK THESE FEATURES:

- All Metal Case
- American Made
- Accepts standard plug in crystals
- Features 10.7 MHz crystal filter
- Trimmer caps on TX and RX crystals
- 2.5 watts output
- Battery holder accepts AA regular, alkaline or nicad cells
- Mini Handheld measures 8" high x 2.625" wide x 1.281" deep
- Rubber ducky antenna. Wrist safety-carrying strap included
- 6 Channels
- Factory direct to You

Accessories Available:

- Nicad Battery Pack
- Charger for GTX-1 battery pack
- Leather carrying case
- TE-III Tone Encoder for auto patch

GTX-200-T



2-meter FM, 100 channel combinations, 30 watts with factory installed tone encoder (Incl. 146.94 MHz)

\$249⁹⁵

GTX-200



2-meter FM, 100 channel combinations, 30 watts (Incl. 146.94 MHz)

\$199⁹⁵

GTX-10-S



2-meter FM, 10 channels, 10 watts (Xtals not included)

\$149⁹⁵

GTX-2



2-meter FM, 10 channels, 30 watts with pushbutton frequency selector (Incl. 146.94 MHz)

\$189⁹⁵

2-meter FM, 6-channel, 3.5 watts Hand-Held

***\$249⁹⁵**



**TO
NE
ENCODER PAD**
Plug in installation on most amateur transceivers

Same as GTX-1, plus factory installed Tone Encoder
*(Bat. not incl.)

***\$299⁹⁵**

TE-II

\$49⁹⁵

TE-I
\$59⁹⁵

**GTX-I
GTX-IT**



HURRY!

Use This
Handy
Order
Form



4141 Kingman Dr., Indianapolis, IN 46226
Phone-in orders accepted (317+546-1111)

NAME _____
ADDRESS _____ CITY _____
STATE & ZIP _____ AMATEUR CALL _____

Payment by:
 Certified Check/Money Order Personal Check
C.O.D. Include 20% Down

Note: Orders accompanied by personal checks will require about two weeks to process.
20% Down Payment Enclosed. Charge Balance To:

BankAmericard # _____ Expires _____
 Master Charge # _____ Expires _____
 Interbank # _____ Expires _____

IN residents add 4% sales tax: \$ _____
CA residents add 6% sales tax: \$ _____
HR All orders shipped post-paid within continental U.S.

- GTX-200-T **\$249⁹⁵**
- GTX-200 **\$199⁹⁵**
- GTX-10-S **\$149⁹⁵**
- GTX-2 **\$189⁹⁵**
- GTX-1 **\$249⁹⁵**
- GTX-IT **\$299⁹⁵**
- Ringo Ranger ARX-2 6db 2-M Base Antenna **\$299⁹⁵**
- Lambda/4 2-M and 6-M Trunk Antenna **\$299⁹⁵**
- TE-I Tone Encoder Pad **\$59⁹⁵**
- TE-II Tone Encoder Pad **\$49⁹⁵**
- PS-1 AC Power Supply for use with all makes of transceivers 14 VDC—6 amp and the following standard crystals @ \$4.50 each _____
Non-standard crystals @ \$6.50 each: _____

ACCESSORIES FOR GTX-1 and GTX-1T

- PSI-18 Optional Nicad battery pack **\$29⁹⁵**
- PS-2 Charger for GTX-1(T) battery pack **\$39⁹⁵**
- GLC-1 Leather carrying case **\$12⁹⁵**
- TE-III Tone Encoder (for use with GTX-1) **\$49⁹⁵**

Add \$4 per Radio for Shipping, Handling, and Crystal Netting.

PRESTO!

Your counter becomes a digital display!

Like magic, Hufco's Digi-Dial Adaptor turns any frequency counter into an absolutely accurate digital display! Inexpensively! With continual display of both transmit and receive frequencies — as fast as you turn your transceiver dial!

With the Digi-Dial Adaptor your counter easily adapts to Yaesu, Tempo, Drake C Line, Collins, Kenwood and other transceivers. (Tell us which other brand you have. We'll tell you if the adaptor fits.)

Operation requires only a connecting cable to the transceiver VFO plug. Translates VFO output to 2 through 2.5 MHz. No internal connection or modifications necessary! Complete instructions included.

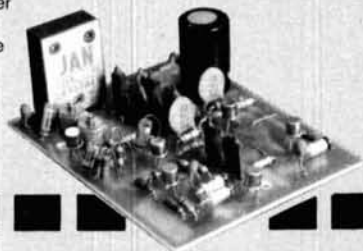
No frequency counter? Get both the Digi-Dial Adaptor and a frequency counter from Hufco. We have counters starting as low as \$45.95!

DIGI-DIAL ADAPTOR

39.95

kit form

\$49.95 assembled



Quick!
Order yours today!

Please rush me:

Digi-Dial Adaptor

\$39.95 kit form - \$49.95 assembled

Check or money order enclosed.

Complete data on Hufco frequency counters

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Address _____

City/State/Zip _____

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JUST IN TIME FOR CHRISTMAS

SENSITIVE DUAL GATED MOSFET — TWO-METER PRE-AMP

High S/N Ratio
Small & Compact
Works on 12 volts
D.C. and can be
mounted inside
transceiver



EASY TO INSTALL!

Brings in those weak signals.

\$11.99

KIT

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ASSEMBLED

HW-202 SCANNER



\$29.95 Assembled

ELECTRONIC KEYS



\$16.97

Assembled

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Kit

(ALL PRICES POSTPAID IN U.S.)



SANDLIN ELECTRONICS ENGINEERING

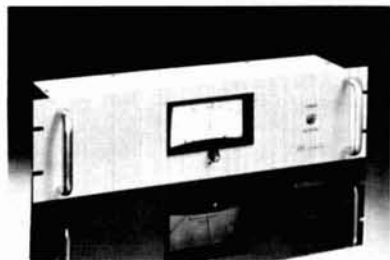
P. O. Box 909 • Jackson, Tennessee 38301

(Tennessee Residents Add Sales Tax)

end. After the cable is stripped, the slotted outer ferrule and coupling nut are slid onto the cable. Then the body assembly is pushed onto the cable dielectric but under the braid. The coupling nut is then slid over the body assembly, and the outer ferrule is pushed forward until it traps the cable braid against the rear flange of the body assembly. The ferrule then seats automatically. The resulting termination passed a 35-pound pull test.

For additional information about Amphenol 83-58FCP solderless connectors, contact Bunker Ramo RF Division, 33 East Franklin Street, Danbury, Connecticut 06810, or use *check-off* on page 142.

Bird Wattcher monitors rf power



Bird Electronic Corporation recently announced its new Series 3162 rf power monitor/alarm Wattcher,® designed to warn of rf power drop-off below a set level to conform with FCC part 21.107 requirements. This fast-acting (50 millisecond) unit can be used, for example, at a mobile terminal site to measure forward power, reflected power (with a momentary-contact front-panel switch), and to obtain VSWR and optimum system data during routine maintenance. It is then left in the line to feed back a signal in response to the transmitter being keyed, indicating whether it is on the air and with sufficient power.

The series 3162 is available for operation at all telephone company communications frequencies and power levels; for example, 2-512 MHz and 1-500 watts. It is available in either a 12-volt dc model or a 117-volt ac model. A typical 12-volt model is priced at \$595.00.

For additional information, write Bird Electronic Corporation, 30303 Aurora Road, Cleveland (Solon), Ohio 44139; telephone (216) 248-1200, or use *check-off* on page 142.

The proof of the pudding is in the eating.



The proof of Triton IV is in owner satisfaction.

Here's some of the proof . . .

K4EME — This is my second TRITON IV. They are excellent xceivers! **WA8ICK** — Luv it. Dynamite! **W9NXU** — I am very thrilled with this unit, it is great. I think you have scooped the field. **WA0AYA** — I like CW and full break-in. (Beautiful) **K3TFU** — I love the unit. **WA3VEZ** — Rig is just great. Combined with your service makes a super transceiver. **WN0SED** — Beautiful radio to use. Magnificent CW filter! Just a pure joy. **W8IIT** — I have had my TRITON IV for two months and am delighted with it. **YN1MBV** — It is a very nice rig. **W3GTX** — New features very welcome. **W0BYC** — Bought one of the first TRITON II, like it so well I updated it with a TRITON IV. **W2TBK** — It is absolutely fantastic. **W800PI** — I am pleased with the rig. **WA3GJA** — Very-very-nice. Good audio quality. **W5ZBC** — The most outstanding rig I have ever used. **K8CJQ** — Excellent rig, Good filters. **W7BKK** — Very happy . . . getting excellent quality reports. **W2CET** — Power-signal reports good. **WB2UEH** — I like the compactness and appearance. **VE3IBK** — An excellent rig with superior receiving quality. **K4IVM** — I think it is tops. **WA4LOG** — I've become so used to dip, peak and adjust, this TRITON is a beautiful new experience. **KL7IHW** — Easy to set up—works great. **K4JXD** — Seems to be very FB rig. **WA7KHE** — Fantastic performance. Thanks for a fine rig. **WB4BPG** — No problems—fine rig. **VE1BZ** — Good work. **W9HQT** — Receiver better than expected, CW break-in is super. **WOAP** — Tremendous transceiver. I appreciate your engineering. **WA2ZRO** — Wonderful. **K0SFV** — Real nice rig. You thought of almost every feature and built it in. **KQ9DQ** — Beautiful. **W80JQ** — Beautiful radio; however, your ads do not do justice to the radio. **WN5SOH** — Very sophisticated—Easiest tuning rig ever. Very glad I bought it. **K30JV** — Very impressed. **W4LZP** — Very good results. Put out 100 watts as good as 300 watt rigs. **WA4DQY** — I think the TRITON IV is great. **W6QXN** — Appreciate full CW break-in. **W0INH** — Enjoy light weight. **VE3CYK** — I am extremely pleased with the clarity of receiver and after putting rig on the air, received unsolicited compliments on the audio quality of the transmitter. **K4PHY** — Was 3rd in USA, first in fourth district in WWCQ contest. **W8RYU** — Own Argonaut. Both fine rigs. **W4CDA** — Compact, light weight, good engineering. **WB2WZG** — TRITON IV is the most versatile CW/SSB radio I have ever used. **WB2FMV** — Outstanding. Highly pleased with performance. **WA8ACZ** — A real nice rig. I have owned about every other make. **W5EKG** — Works nicely. **WB4ECO** — I tried this rig, a pleasure to operate. **WA4YRK** — Excellent reports on audio. **WB8NKB** — Wonderful. **W9QPQ** — An excellent rig. Love it. **W8SOP** — Makes running SSB nets a real breeze. Also good on CW nets. **WL7IRT** — Fantastic rig. **W4MDB** — Has rekindled my interest and enthusiasm in Amateur Radio to an extent I hadn't thought possible. It far out distances any competitive product at any price. **W6EYR** — Very nice. Been a ham for 45 years and now solid state perfection. **W2RPH** — Excellent rig. **WN0TDK** — TRITON IV is a fabulous piece of equipment. **W5VIW** — Very nice rig **WB2LQF** — Wow! **W9JCV** — Tnx for giving us a FB piece of equipment made in the USA. **W8GHO** — Very pleased. **K4KXB** — Seems to have everything desired. **W4SZ** — A pleasure to operate. **W2FKF** — Greatest rig I ever had. So far in a month 34 QSO's without one miss. Been a ham since 1922. **W4GVC** — Nothing but complements. **WB9EZE** — Well pleased with performance and simplicity of operation. **K4ETI** — Rig is great. **WB8CNV** — Man—! what a rig. I've had this call since 1929. Never saw anything like it and I've seen them all! **WB2MZU** — Seems like everything the S----- O--- was supposed to be at one third the price. **WN0VHE** — I think it is a very good rig. **WB9FTD** — Break-in CW is very impressive. **K0CBA** — I believe it is one of the finest HF transceivers on the market. I can't tell you how pleased I am with the noise blanker. I can get on the air from my home station again for the first time in a few years. Other rigs with noise blankers just didn't hack it. **WA7YHW** — I am very pleased with this equipment. It is certainly of high quality. **W7IIA** — Excellent equipment. **WBORWA** — Couldn't be more pleased with it. It certainly has performed beautifully and is all I expected and more. **WB4QJT** — Like it very much — keep up the good work. **WN1YVX** — Really impressed with looks and performance. **W0NC** — Very FB rig. Performs up to specifications, an excellent design. **K8PBZ** — Already have TRITON II and IV. **W7KD** — This little "T-4" is smooth as silk . . . I've received some very flattering reports about transmitter voice quality and the CW operation is the greatest. **WN8TTO** — I found that the TRITON IV was the best rig on the market for around \$800. I love it! **W2JBK** — It is absolutely fantastic. **W8FEI** — Am amazed at receiver performance. I thought I had a top notch receiver with the H-----! **W1FYM** — Your guarantee is refreshingly proper. **W8MOK** — Sure makes a guy look twice at his old tube type gear. **W1TFS** — Finest CW ever, CW selectivity very good. **WB6IVR** — Very satisfied with TRITON IV. Just what I was looking for to use on my yacht. Thanks. **WA8ONP** — Also have a TRITON II. I am pleased that Al Kahn and the good guys at TEN-TEC thought of the CW operator! **W2EMX** — Excellent Amateur gear meets and exceeds advertised claims. **W0AMJ** — It looks like there is nothing left to be desired. It is beautiful. **W6SE** — The receive function is outstanding. It is superb in transmit. **W1BV** — In love with this fantastic gem. It's so easy and a pleasure to operate. **W6ASH** — Very happy with performance. Particularly impressed with full break-in and light weight. **WA0IMS** — By far the best rig I have ever operated. I am glad I decided on the TRITON IV and not one of the other transceivers on the market. **WA8HQO** — Thank you gentlemen.

Add your name to the growing list. See your TEN-TEC dealer or write for full details.



TEN-TEC, INC.
SEVIERVILLE, TENNESSEE 37862
EXPORT: 5715 LINCOLN AVE., CHICAGO, ILL. 60646

TS-1 MICROMINIATURE ENCODER-DECODER

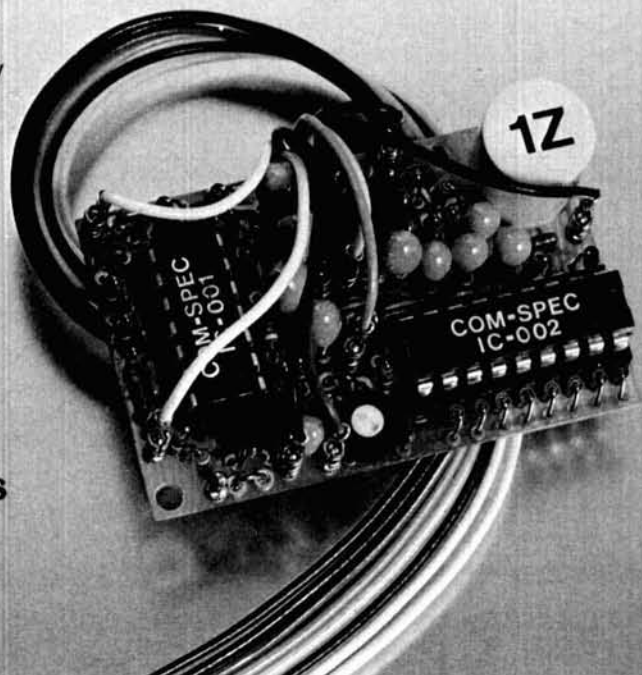
- Available in all EIA standard tones 67.0Hz-203.5Hz
- Microminiature in size, 1.25x2.0x.65" high
- Hi-pass tone rejection filter on board
- Powered by 6-16vdc, unregulated, at 3-9ma.
- Decode sensitivity better than 10mvRMS, bandwidth, ± 2 Hz max., limited
- Low distortion adjustable sinewave output
- Frequency accuracy, ± 25 Hz, frequency stability ± 1 Hz
- Encodes continuously and simultaneously during decode, independent of mike hang-up
- Totally immune to RF

Wired and tested, complete with K-1 element

\$59.95

K-1 field replaceable, plug-in, frequency determining elements

\$3.00 each



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BREA, CALIFORNIA 92621
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**some people
talk power-
we
deliver it.**



VHF Class C
Power Amplifiers

- Superb Craftsmanship
- State of the Art Performance
- Full One Year Warranty

MODEL P15A1 — 1-3 W input 12-25 W output. 13.6 V at 2 Amps, 100% duty cycle, solid state switching for only \$55 ppd.

MODEL P50A1 — 1-3 W input 40-60 W output. 13.6 V at 8 Amps, 85% duty cycle, COR switching w/LED indicator, spurious output filter. All for just \$139.

MODEL P50A1OC — 2-18 W input, 14-60 W output. 13.6 V at 7 Amps, 100% duty cycle, COR switching w/LED indicator, spurious output filter. It's yours for \$98 ppd.

Contact any of the following dealers for complete information on the M-Tech Engineering line:

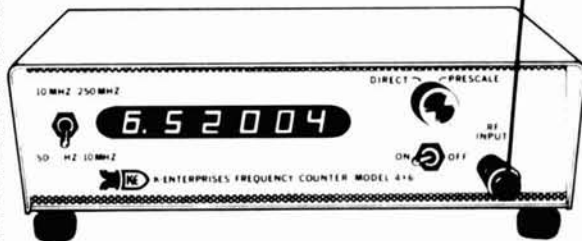
Spectronics, Inc., Oak Park, Ill. 312-848-6778
Hobby Industries, Council Bluffs, Iowa 712-323-0142
Universal Service, Columbus, Ohio 614-221-2325
Adirondack Radio Supply, Amsterdam, N. Y. 518-842-8350
Arcade Electronics, Annandale, Va. 703-256-4610
Electronic Exchange, Souderton, Pa. 215-723-1200
Williams Radio Sales, Colfax, N. C. 919-993-5881
VHF Communications, Jamestown, N. Y. 716-664-6345
Electronics Int'l Svc. Co., Wheaton, Md. 301-946-1088

M-Tech Engineering, Inc.

Box C, Springfield VA 22151 (703) 354-0573

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50 HZ—250 MHZ \$270.00

300 and 500 MHZ PRESCALERS

FREQUENCY STANDARDS

MARKER and PEAKING GENERATORS

POWER SUPPLIES AMPLIFIERS

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Box 410 (N.W. of town)

FAIRLAND, OK 74343

We thought you might be interested in a 2-meter, synthesized, VHF-FM transceiver featuring 800 frequencies in 5KHz steps, variable RF output from 1 to 25 watts, 4 front panel selectable splits, a discriminator meter, and a price tag below five hundred dollars.

TRANSMITTER SPECIFICATIONS

Frequency Range: 144 to 148MHz. **Front Panel Frequency Splits:** Simplex, +0.6MHz, -0.6MHz, +1MHz, -1MHz. **Frequencies:** 800 (5KHz separation). **Modulation:** 16F3 \pm 5KHz for 100% at 1,000Hz. **RF Power Output:** 1-25 Watts, variable. **Frequency Stability:** Within \pm 0.001% from -20°C. to +60°C. **Hum & Noise:** Better than -30dB 2/3 rated system deviation at 1,000Hz. **Antenna Impedance:** 50 Ohms. **Switching:** Solid-state type. **Spurious & Harmonic:** At least 60dB below rated carrier power. **Microphone:** Tumer, low impedance. **Audio Frequency Response:** 300Hz to 3,000Hz, referred to +1, -8dB of 6dB/Octave de-emphasis curve. **Audio Distortion:** Less than 7% at 1,000Hz, 2/3 system deviation. **Frequency Display:** 6 digit, 7 segment HP LED. **Optional Accessory:** Plug in touch-tone encoder - \$50.

RECEIVER SPECIFICATIONS

Frequencies: 143 to 148.995MHz. **Usable Sensitivity (12dB sinad):** 0.35uV @ 50% audio. **Quieting Sensitivity (20dB):** 0.5uV minimum. **Squelch Threshold Sensitivity:** 0.25uV minimum. **Squelch Limit Sensitivity:** 2.0uV or less. **Modulation Acceptance Bandwidth:** \pm 7.5KHz minimum. **Adjacent Channel Selectivity:** 70dB minimum. **Spurious Response Attenuation:** 70dB minimum. **Intermodulation Attenuation:** 60dB minimum. **Local Oscillator Frequency Stability:** \pm 10 parts per million. **Audio Output Power:** 4.0 Watts into a 4 Ohm load @ less than 10% distortion. **Audio Frequency Response:** +2dB to -8dB from the standard 6dB per Octave de-emphasis from 300Hz to 3,000Hz. **Hum & Noise:** -50dB squelched and -30dB unsquelched. **Chassis Size:** 7 $\frac{1}{8}$ "W x 2 $\frac{5}{8}$ "H x 10"D.

SO, WE BUILT ONE FOR YOU.



Face plate also available in black.

The S 225 by AMCOMM[®]
An American Communications Corporation.

730 WEST McNAB ROAD · FORT LAUDERDALE, FLORIDA 33309

a revolutionary concept in kit building...

THE PROGRAMMABLE CLOCK KIT! \$27.95



SYSTEM 5000 is the first full-feature timepiece available in programmable form. After the circuit has been assembled and tested, all that is necessary is to add the appropriate switches and jumpers to easily program the system for the desired functions. The system may be expanded or reprogrammed at any time.

This represents a revolutionary concept in adaptability and flexibility. Build an Alarm/Clock/Calendar or a full feature Desk or Radio Station clock. Use the DUPLICATE TIME REGISTER to monitor GMT, another time zone, or as an elapsed timer. Add the optional relay to control AC or DC accessories. The possibilities are limited only by your imagination.

features

TIME OF DAY REGISTER • DUPLICATE TIME REGISTER • FOUR YEAR CALENDAR - month/day or day/month format • ALARM WITH SPEAKER TONE OUTPUT • ADDITIONAL ALARM - use for "his and hers" alarm or activate an accessory at a preset time • 10 MINUTE SNOOZE & "ID" REMINDER • 3 FUNCTION ALARM OUTPUT SELECT - tone, relay, or relay then tone • ONE HOUR DOWN COUNTER • BRIGHT FLUORESCENT DISPLAY - 5" blue or green digits with AM/PM • AUTOMATIC DISPLAY DIMMING • POWER FAILURE INDICATION • 12 & 24 HOUR DISPLAY • BLINKING OR STEADY COLON • SIMPLE FORWARD AND REVERSE TIME SETTING •

DIRECT DRIVE ELIMINATES RFI • SINGLE 9 VOLT BATTERY BACKUP • DISPLAY SECONDS CONTROL • HOLD AND RESET CONTROLS • 50/60 HZ OPERATION • 700 WATT RELAY OUTPUT OPTIONAL

SYSTEM 5000 includes all components, 2 time setting switches, and complete assembly and programming manuals. Switches for additional functions and relay are not included but are available as options. Case not included. Specify blue or green display.

RELAY OPTION - \$4.00

Includes 700 watt relay and all interface components. Will control AC or DC accessories such as appliances, stereos, etc.

SWITCH OPTION - \$3.75

Contains 4 black SPST pushbuttons, 2 black DPDT pushbuttons, and 2 black SPST slide switches. Programs all major features.

Send your check or money order today for fast delivery. Add \$1.00 per clock to cover shipping and insurance. Money back guarantee on all products if not fully satisfied. N.J. residents add 5% sales tax. Use your Master Charge or BankAmericard. Phone orders accepted.

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A bright Fluorescent display provides easy to read numbers that brighten and dim automatically according to the light. The clear Acrylic tube with Acrylic or Hardwood end blocks gives these clocks a unique look of simple elegance. AM/PM & power failure indication. Seconds display button. 3 1/2" x 3 1/2" x 5 1/4". 50/60 HZ

Specify blue or green display, 12 or 24 hour time, and choice of Hardwood - Walnut, Zebrawood, or Rosewood.

FACTORY ASSEMBLED - 1 YEAR WARRANTY
EC 2001 Solid Acrylic "Time Capsule" \$59.95
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Econo-line



- Quality for an Economy Price
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- Linear Switch (FM/SSB)
- Broad Band

Model	Input	Output	Typical	Frequency	Price
702	10W-20W	50W-90W	10W in/70W out	143-149MHz	\$139.00
702B	1W- 5W	60W-80W	1W in/70W out	143-149MHz	\$169.00

Now get TPL COMMUNICATIONS quality and reliability at an economy price. The solid state construction, featuring magnetically coupled transistors and a floating ground, gives you an electronically protected amplifier that should last and last.

The Linear Bias Switch allows you to operate on either FM or SSB. The 702 and 702B are exceptionally well suited for 2-meter SSB. Typical power output levels as high as 100W PEP can be achieved with the proper drive.

The broad band frequency range means that your amplifier is immediately ready to use. No tuning is required for the entire 2-meter band and adjacent MARS channels on TPL's new *Econo-line*.

See these great new additions to the TPL COMMUNICATIONS product line at your favorite radio dealer.

TPL

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Export: EMEC Inc., 2350 South 30th Avenue, Hallandale, Fla. 33009



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MODELS IN STOCK INCLUDE:

BTL 8TH MT 25 MT15
GENAVE: ALL MODELS
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REGENCY HR6 HR28
MICRO-COM LINE
HEATHKIT HW 202
STANDARD SR-C826-MA

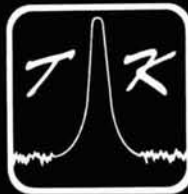
A GREAT IDEA FOR CHRISTMAS! WE'VE BEEN TOLD THAT THE DIFFERENCE BETWEEN A MAN AND A BOY IS THE PRICE OF HIS TOY. IF THIS IS TRUE, PORTA-PAK IS A MAN'S TOY WITH THE BOY'S TOY PRICE! PORTA-PAK MAKES YOUR MOBILE FM TRANSCEIVER A POWERFUL PORTABLE. THE PORTA-PAK IS A TOTALLY PORTABLE PERFORMANCE PACKAGE THAT WILL KEEP YOU IN TOUCH WITH WHAT IS HAPPENING. WHETHER YOUR COMMUNICATIONS NEED IS FOR BUSINESS OR PLEASURE PORTA-PAK WILL DO THE JOB. DELUXE PORTA-PAK HAS A 4.5 AHR CAPACITY AND THE SUPER PORTA-PAK HAS A 9 AHR CAPACITY.

THE PORTA-PAK INCLUDES THE CASE, BATTERY, AND CHARGER. GEL-CELL IS THE POWER SOURCE. GG-1245 IN STOCK FOR SAME DAY SHIPMENT: DELUXE \$67.50 + \$1.75 SHIPPING. THE SUPER. \$88.00 + \$2.75. GEL-CELL BATTERY ONLY \$29.20 + \$1.75. RUBBER DUCKIE ANTENNAS \$1.00. L.E.D. BATTERY CONDITION INDICATOR \$5.00.

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the BRIMSTONE 144

2 METER FM TRANSCEIVER



THE FIRST AND STILL THE ONLY 2 METER TRANSCEIVER THAT OFFERS IT ALL!

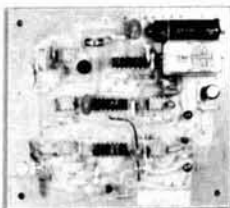


Size 9 1/2" x 10 1/2" x 3 1/4"

- No crystals to buy.
- Complete band average 143 to 149.99 MHz, 142 MHz optional.
- Independent transmit/receive frequency control, yet simplex with the flip of a switch.
- Autopatch, tone burst and sub-audible tone capability by simply plugging in the desired module.
- Very low transmitter spurious output. Some manufacturers have demonstrated their inability to eliminate unwanted spurious outputs. The Brimstone has demonstrated that non-harmonic spurious output at least - 70dB below the

- rated power output is possible when the radio is properly designed and constructed.
- The Brimstone 144 is designed for an unprecedented degree of component accessibility and plug-in modularity.
- The only amateur 2 meter FM transceiver with a TWO YEAR WARRANTY.

We have changed our company name to **TEC-KAN, Inc.** and at this time we are offering a special Fall Sale Price on the Brimstone 144. Check with your dealer on the Fall Special and ask for the 6 page full color brochure.



REPEATER AND AUTOPATCH CONTROL MODULE RPT CM-4

If you are planning a repeater and need a control circuit, we have just what you need! Complete control of repeater as well as the autopatch. Local or remote control. If you are using telephone line control for your repeater the RPT CM is ideal because it uses an opti-coupler for complete line isolation and low voltage, low current control.

If you are using the TKI SCAP-3D, you can call your autopatch line number and the RPT CM will automatically answer and connect you allowing you to send tones over the phone to turn the repeater on or off, or access the autopatch and communicate through the repeater over the autopatch phone line.

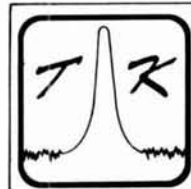
When calling the repeater on the autopatch line, you have 20 seconds to either access the autopatch or turn the repeater off or on. If the proper codes are not sent within 20 seconds the RPT CM automatically disconnects.

If you call the autopatch number, hang up, wait 30 seconds and call the number again, the repeater transmitter will be keyed and a tone sent each time the phone rings, thus signaling a mobile operator to access the autopatch. If there is no one available to access the patch, it will automatically disconnect after 30 seconds of ringing.

It also features a COR "Hold" circuit, which is adjustable from 1 to 5 seconds, and automatic "time out" timer, that resets each time the receiver COR drops. No need to wait for the repeater to drop out to reset the timer.

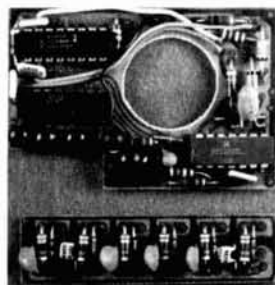
If you are planning a repeater, all you need is a good transmitter and receiver and the TKI RPT CM Control Module.

Price \$79.95



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HANDI-TALKIE SCANNER KIT SK1402

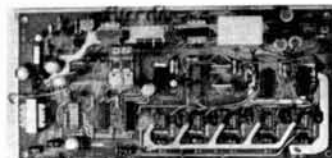


Six Channel Cmos Scanner Kit has provisions to include Mostek Touch-Tone Encoder Chip. Features dwell and normal operation. "Dwell" mode monitors each channel that has a signal on it for 8 seconds. "Normal" monitors in conventional manner. Manual operation locks out the scanner.

Includes LED channel indicators, schematic and installation instructions. Designed for Wilson 1402SM Talkie.

Scanner Kit Model SK1402 \$49.95
Includes Touch-Tone Encoder Chip Model SK1402TE \$58.95

Digi-Tran Pad, when ordered with Scanner Kit \$7.50



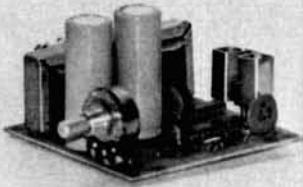
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AUTOPATCH SCAP-3D FEATURES

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- 4 sec. time limit on access.
- Anti-falsing tone decoders.
- AGC with 30 Db dynamic range on all inputs and outputs.
- 3 digit on-off control of repeater or other devices.
- Remote inhibit or disconnect of autopatch as well as remote "off" function.
- Monitor amplifier allows monitoring all signals going into and out of the repeater.
- Adjustable level controls on all inputs and outputs.
- Jumpers on circuit board and frequency control pots on tone decoders allow field programming of access codes.
- Adjustable time out function. Patch will automatically disconnect in 30 to 90 seconds after it is accessed if no carrier is received.
- 90 days warranty.
- High quality tantalum and polyester capacitors used in tone decoder circuits to provide reliable low drift performance.
- Rugged G10 glass epoxy circuit board.
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- Reverse polarity protection on supply line.
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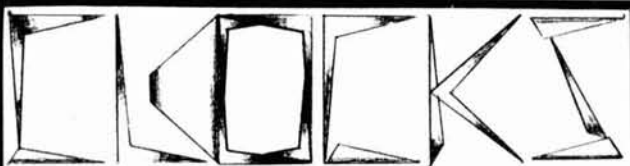
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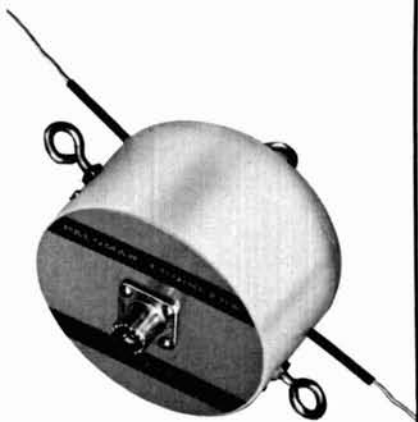
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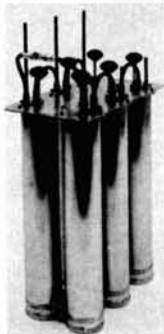
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F-91X	6.5v to 40v at 300 ma.	2.72
N-51X	Isolation 115vac at 35va.	2.80
Model D-2	6.5v at 3.3 amps	4.95
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C-912-034	22vct at 200 ma.	
	11v at 250 ma.	1.49
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2N2857	1.80	2N3950	26.25	2N5643	20.70
2N2876	12.35	2N3961	6.60	2N5641	4.90
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2N3824	3.20	2N5216	47.50	2N6096	19.35
2N3866	1.09	2N5583	5.60	2N6097	28.00
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NEW YORK: The Kings County Repeater Association, will hold an indoor flea market on Sunday, December 19, 1976 from 9 a.m. to 4 p.m. Located at 910 Union St., Brooklyn, N. Y. (at Grand Army Plaza). Sellers \$3, buyers \$1. Children free. Refreshments available. Talk in on 146.43 and 146.52.

S O W P CHRISTMAS QSO PARTY. The Society of Wiretess Pioneers will conduct a membership on-the-air QSO Party on the weekend of December 18 and 19, 1976. The Party will cover the full 48-hour GMT period and will be the first "voice" Party scheduled by the Society. The purpose of the affair will be to give members an opportunity to meet one another and to pass along their season's greetings, etc. There will be no formal exchange requirements and no need to submit logs. All members with a phone capability are encouraged to participate. The call will be CQ SOWP. While there will be no certificates awarded, everyone who takes part will be a winner by having an opportunity to renew old friendships, establish new ones and to continue a camaraderie developed over the years. Suggested frequencies for the affair are 25 kHz (±) 5 kHz up from the low end of the general class phone portion of each amateur band.

Stolen Equipment

STOLEN on 8-20-76 in a San Francisco parking lot, one Tempo VHF 1-2 meter transceiver #5728 one Western Electric Touch Tone pad. Reward — contact K6RMM, Shel Kurtzman, 1-213-344-0878, 19436 Topham St., Tarzana, CA 91356.

ONE Collins 75A-3 SN#910, one Heathkit (Apache). Stolen from: Robert E. Kelley W5VFU, 3400 Brook Dr., Oklahoma City, OK 73119.

DRAKE TR-22 2 meter transceiver SN. 640139. Beige trimline, TT Handset. Magnet mount quarter wave antenna. Stolen from Rick Simpson, KØUZP, 303-471-2059, 2723 Rigel Drive, Colorado Springs, Colo. 80906.

WILSON T1402 S/M 2 meter handi-talky SN OR6427. Stolen from: James Hettle, PSC #1, PO Box 2493, Peterson AFB, Colo. 80914.

YAESU FR-101SDIG, HF Digital Receiver. SN. 6C31339. Yaesu FL101, HF Digital Transmitter. SN. GE306276. Stolen from: Associated Electronics Service, 303-475-7050, 404 Arrawana, Colorado Springs, Colo. 80909.

STOLEN FROM GENAVE RADIO Expo '76 booth in Chicago, Sept. 18-19, 1976: One GTX-1T Handie-Talkie S/N 10-59. Anyone with information is requested to contact Genave, 4141 Kingman Drive, Indianapolis, Ind. 46226. 317 546-1111.

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HP160B (USM105) 15mHz scope with
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HP166B (Mil) Delay sweep for above 1/30
HP185A Sampling Scope 1gHz 186B
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HP571B-561B Digital clock/rcdr 2/45

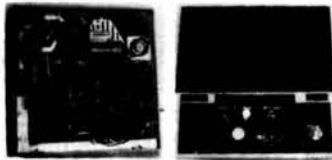
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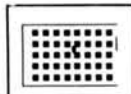
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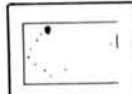
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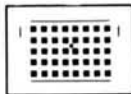
A CHALLENGE TO PLAY.



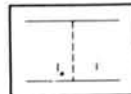
WIPE OUT I



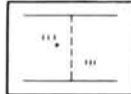
HANDBALL



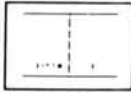
WIPE OUT II



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PRO MATCH



MATCH

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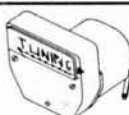
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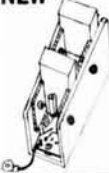
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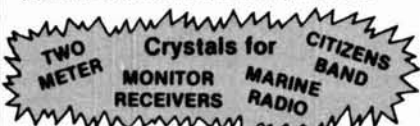
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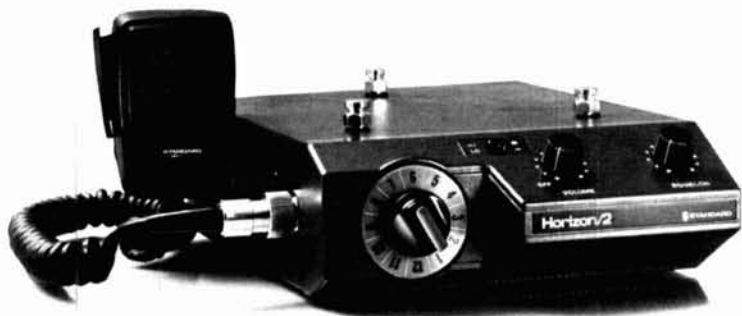
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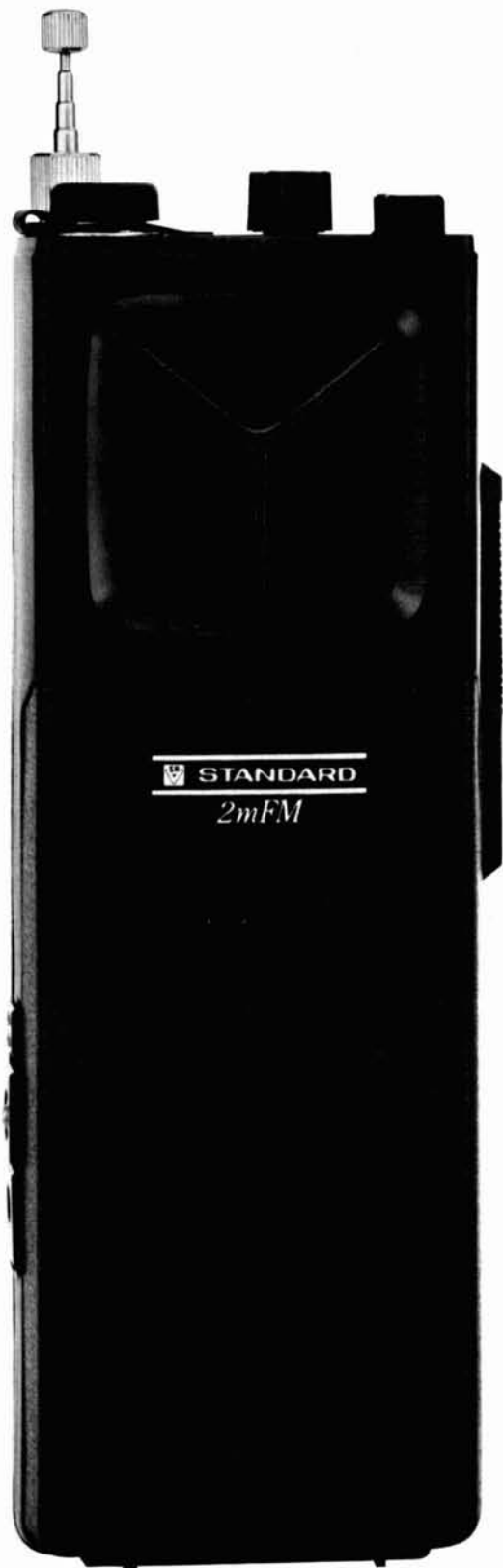


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
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
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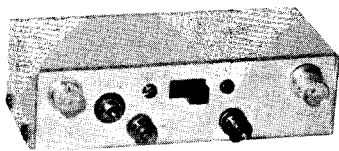
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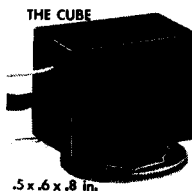
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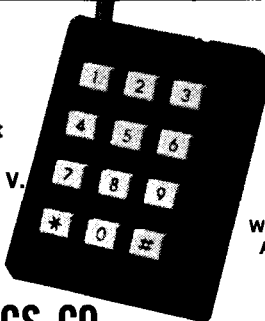
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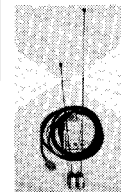
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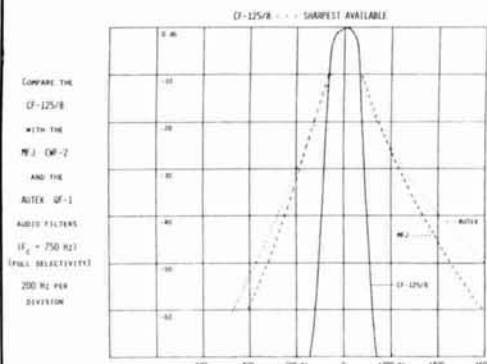
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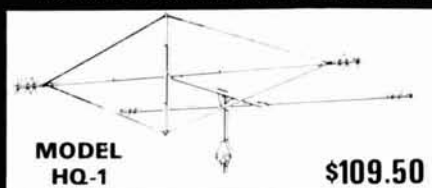
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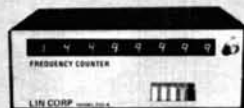
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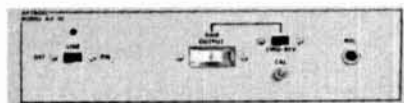
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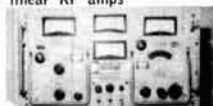
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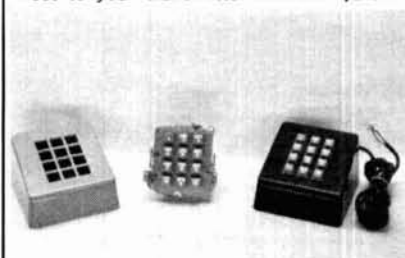
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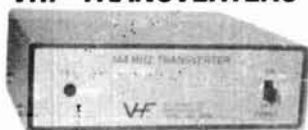
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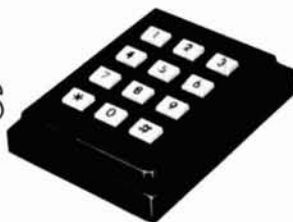
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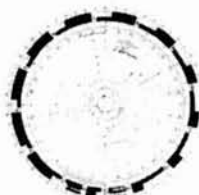
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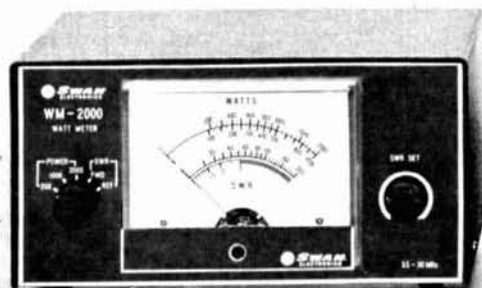
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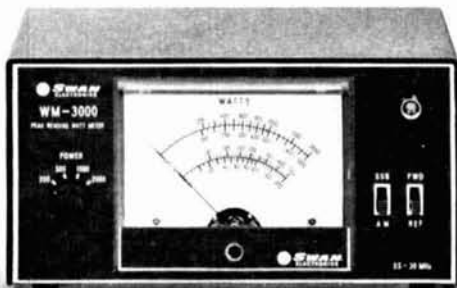
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Isaiah 7:14 740-687 BC

But thou Bethlehem, though thou be little among the thousands of Judah, from you shall come forth one who is to be ruler in Israel, whose origin is from old, from ancient days.

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NEW TESTAMENT

“... the angel Gabriel was sent from God to a city of Galilee, to a virgin betrothed to Joseph, of the house of David; and the virgin's name was Mary... The angel said to her “Do not be afraid Mary, for you have found favor with God. And behold, you will conceive in your womb and bear a son, and you shall call his name Jesus.”

Luke 1:27-31 70-90 AD

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Mathew 2:4-5 60-70 AD

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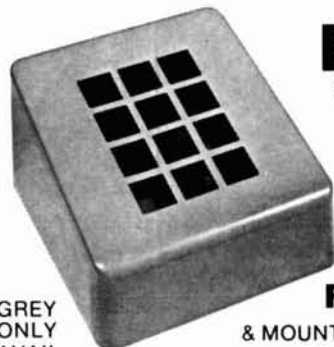
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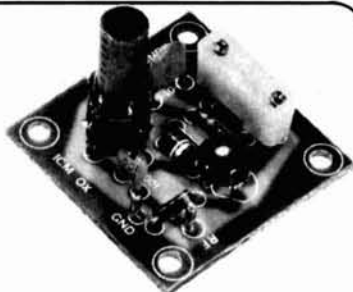
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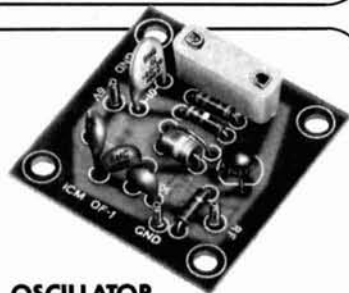
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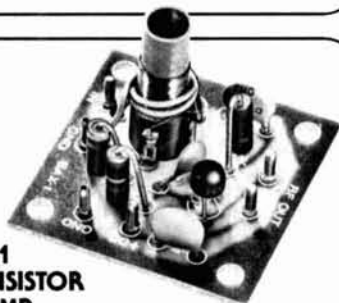
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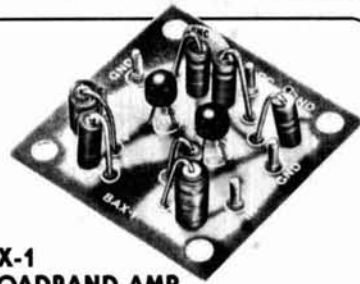
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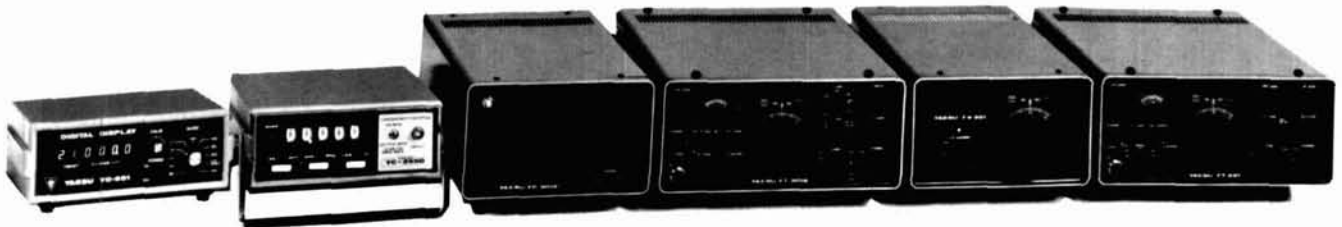
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