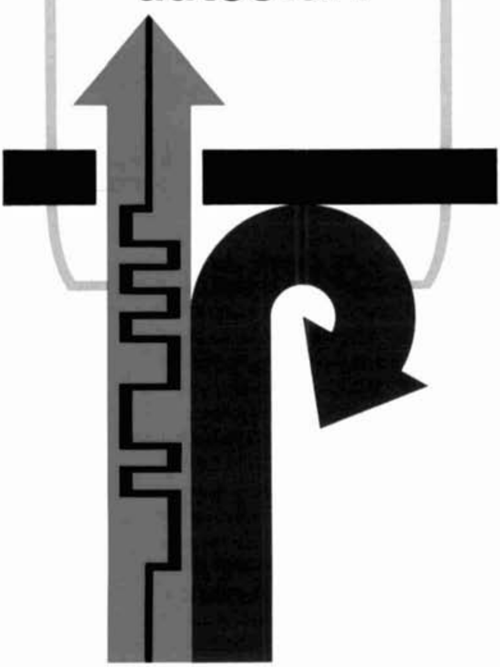
75 cents

focus
on
communications
technology . . .

ham radio magazine

JUNE 1973

digital RTTY autostart



this month

Savoy

BASSETT

High efficiency mobile and portable antennas for all amateur bands, CAP, MARS, CB, SECURITY, PUBLIC SERVICE, MARINE, AND GOVERNMENT USE.

- 2-6-10-15-20-40-75
- Identical size, cost, and appearance
- FULLY ADJUSTABLE TO FREQUENCY IN FIELD
- Low weight, low drag, high strength fiberglass
- Polished chrome brass standard ⅜-24 thread
- High gain collinear on 2 meters

MODEL DGA-2M
$29.50 postpaid
in U.S.A.

$3.75
Postpaid in U.S.A.

TYPE 900 A TYPE 901

HIGH ACCURACY CRYSTALS

FOR OVER 30 YEARS

Either type for amateur VHF in Regency, Swan, Standard, Drake, Vari-tronics, Tempo, Yaesu, Galaxy, Trio, Sonar, Clegg, SBE, Genave.

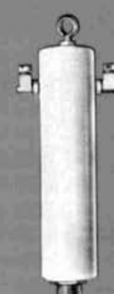
Quotes on request for amateur or commercial crystals for use in all other equipments.

Specify crystal type, frequency, make of equipment and whether transmit or receive when ordering.

BASSETT VACUUM TRAP ANTENNA SYSTEM
Complete packaged multi-band antenna systems employing the famous Bassett Sealed Resonators and Balun from which air has been removed and replaced with pure helium at one atmosphere. Operating bands are indicated by model designation.

MODEL DGA-4075 .... $59.50
MODEL DGA-204075 .. $79.50
MODEL DGA-2040 .... $59.50
MODEL DGA-152040 .. $79.50

BASSETT VACUUM BAL



The famous sealed helium filled Balun employed with the DGA Series Ante Systems. Solderless center insulator easily handles more than full legal po while reducing unwanted coax radiat Equipped with a special SO-239 type c connector and available either 1:1 or

MODEL DGA-2000-B ... $12.9
Postpaid in U.S.A.

CONTACT YOUR DISTRIBUTOR OR WRITE FOR DATA

Savoy Electronics, Inc

P.O. Box 7127 - Fort Lauderdale, Florida - 333
Tel: 305-566-8416 or 305-947-1191

More Details? CHECK—OFF Page 94

More Details? CHECK—OFF Page 94

June, 1973
volume 6, number 6

offices

Greenville, New Hampshire 03048
Telephone: 603-878-1441

ham radio magazine is
published monthly by
Communications Technology, Inc
Greenville, New Hampshire 03048

Subscription rates, world wide
one year, $7.00, three years, $14.00
Second class postage
paid at Greenville, N.H. 03048
and at additional mailing offices

Foreign subscription agents
United Kingdom
Radio Society of Great Britain
35 Doughty Street, London WC1, England

All European countries
Eskil Persson, SM5CJP, Frotunagrand 1
19400 Upplands Vasby, Sweden

African continent
Holland Radio, 143 Greenway
Greenside, Johannesburg
Republic of South Africa

Printed by Wellesley Press, Inc
Framingham, Massachusetts 01701, USA

ham radio is available to the blind
and physically handicapped on magnetic tape
from Science for the Blind
221 Rock Hill Road, Bala Cynwyd
Pennsylvania 19440
Microfilm copies of current
and back issues are available
from *University Microfilms*
Ann Arbor, Michigan 48103

Postmaster: Please send form 3579 to
ham radio *magazine, Greenville*
New Hampshire 03048

ham radio *magazine*

contents

a second look

by jim fisk

In July the United States Postal Service will issue a quartet of postage stamps saluting Progress in Electronics. The four stamps, which were announced at an IEEE luncheon in New York in late March, span electronics development from Marconi's turn-of-the-century spark coil to the transistor. The four multicolored stamps, in denominations of 6-, 8-, 11- and 15-cents, will be issued in New York City on July 10th.

The 8-cent stamp of the series commemorates the transistor and shows transistors and other components mounted on a printed-circuit board. As we all know, the transistor revolutionized electronics, provided the basis for integrated circuits, and opened up the door to many new products, including modern digital computers, communications satellites and manned space probes.

The 6-cent stamp, intended for post cards, shows Guglielmo Marconi's famous spark coil and spark gap. Marconi, who often described himself as an "amateur," demonstrated in 1895 that by grounding the transmitter he could increase the distance over which an electrical wave could be transmitted. He accomplished this by greatly increasing the power of Hertz' spark-gap transmitter and devising a high, earth-connected antenna. One terminal of the spark gap was connected to ground while the other was connected to the antenna, thus increasing the amount of radiated energy.

With this transmitting system and a Branley coherer, he was able to send wireless messages over a distance of 1-1/2 miles in 1895. In 1901 he succeeded in sending a Morse signal, the letter S, from Poldhu, England to St. Johns, Newfoundland, and in 1903 he sent a complete telegraph message across the Atlantic. By 1907, the inventive Italian's findings had enabled a trans-Atlantic wireless service to be established between America and England, and in 1909 his success was crowned when he was awarded the Nobel Prize for physics. It is fitting that amateurs will be able to use the 6-cent Marconi stamp for sending their QSL cards within the United States.

The 11-cent airmail stamp shows Dr. Lee DeForest's Audion vacuum tube. In 1907 DeForest introduced the control grid to Fleming's two-electrode oscillation valve, making it possible to build electronic amplifiers and vacuum-tube transmitters. In 1915 Dr. DeForest used his Audion to transmit the human voice from Arlington, Virginia to Paris. Later, he developed the talking motion picture, facsimile and television.

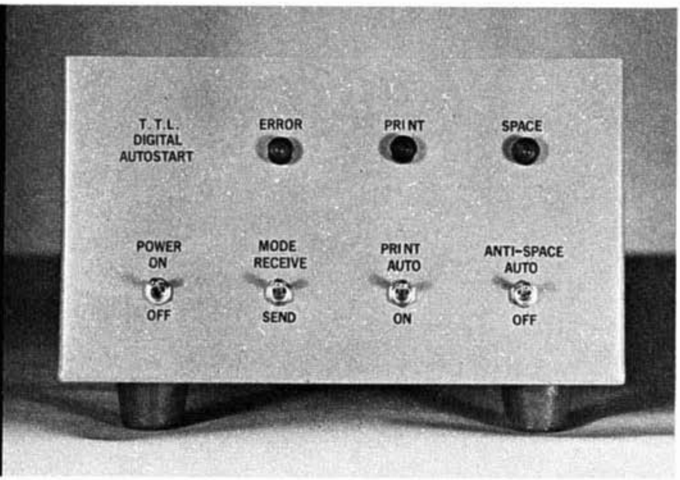
The 15-cent stamp for international surface mail features three nostalgic electronic elements — an early microphone, a gooseneck speaker and a vacuum tube — combined with a tv camera tube.

Radio amateurs desiring first-day cancellations may make requests to "Electronic Stamps, Postmaster, New York, New York 10001," enclosing proper remittance, with the request postmarked no later than July 10th. Price for the set of four stamps serviced is 40 cents. A specific stamp or stamps may be ordered for first-day cancellation.

Progress in Electronics

Jim Fisk, W1DTY
editor

More Details? CHECK—OFF Page 94



digital RTTY autostart

An automatic printer control that can be used with popular demodulators without disturbing existing circuits

Bert Kelley, K4EEU, 2307 South Clark Avenue, Tampa, Florida

Autostart is an automatic printer control system that turns on the printer to copy teletype signals and turns it off when the transmission ends. An ideal system should respond only to teletype signals and ignore noise, CW, or carriers on or near the operating frequency. This not only permits trouble-free automatic station monitoring but also makes manual operation easier.

Most autostart systems now in use[1,2] are carrier operated with one exception.[3] The equipment responds to any carrier at or near the mark frequency as well as to a signal divided in time between mark and space frequencies (RTTY signal). Some circuits have a refinement called anti-space, which measures the time a signal occupies the space frequency. If this time is substantially longer than an RTTY character, the printer is placed in mark-hold. This feature offers some protection against CW stations on the space frequency and prevents the printer from running open at any time. Although these demodulators may be complex, they still depend on the selectivity of the receiver, additional audio filters, and the duty cycle of the received signal for what discrimination they have against unwanted signals. Carriers, slow CW, and sometimes noise will turn on the printer.

autostart features

The new digital autostart system described here has the following features:

1. Positive discrimination is obtained between teletype and any other mode. The circuit checks the start and stop pulses (previously done by K5ANS).[3] However, it also checks each of the five RTTY bits that comprise the letter encoding. Since each letter is checked seven times, it is more difficult for a non-RTTY signal to escape detection by the digital logic.

2. The unit features easy, one-connection design adaptable to demodulators such as the popular ST-3, -4, -5[4] or -6 without disturbing existing circuits.

3. Inexpensive popular TTL integrated circuits are used. Circuit boards are available.*

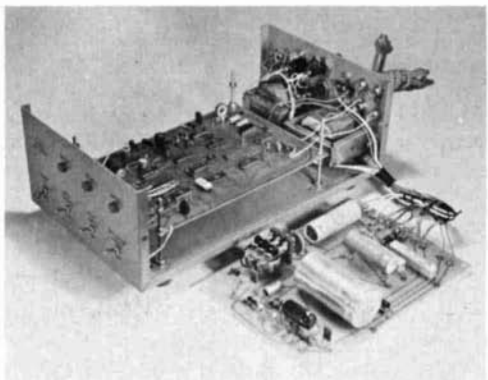
4. The digital logic, motor-control circuits, power supplies, and teletype loop circuits are contained in one package. This simplifies construction by eliminating the need for adapting to any existing power supply, loop, or motor-control circuits.

Some of the TTL logic circuits used in the autostart are shown in **fig. 1.** One package, U1, is Motorola RTL; the rest are Texas Instruments or equivalent 7400N series TTL logic.

operating principles

Teletype letters are sent as a series of timed pulses that have on and off conditions similar to digital logic pulses. A start pulse, which is always a space, is followed by five coded pulses or bits, which make up the letter. These bits are followed by a stop pulse, which places the printer in mark-hold ready for the next letter. This form of transmission is ideally suited to examination by digital methods.

The start pulse is a 22-ms spacing condition at 60 wpm. This pulse turns on a timing circuit, or clock, which generates



View of disassembled unit.

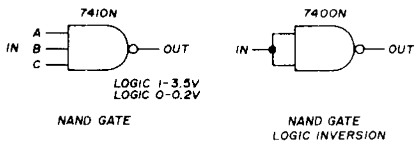
pulses in synchronism with the incoming signal. Each start and stop pulse is verified for polarity by the logic, and the five information bits are placed in storage and examined a moment later to determine if any change has occurred between the stored bit and the incoming signal. This decoding takes place in the center of each 22-ms interval and no change should occur. If a change occurs, an error pulse is generated. Four TTL NAND gates detect errors from (a) false starts due to noise or CW, and (b) defective stop pulses due to CW. The two storage error detectors detect changes in timing or polarity in the incoming signal. These errors are added and trigger a pulse stretcher connected so that it discharges a capacitor each time it fires.

Meanwhile, the same capacitor is charged by pulses from a similar circuit

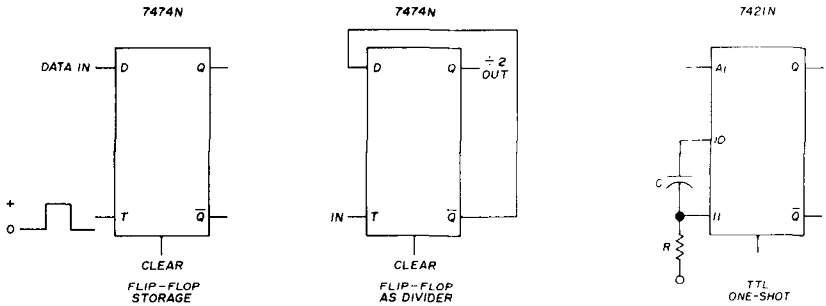
*A set of two epoxy, plated, undrilled circuit boards are available from K4EEU for $12.00 postpaid in the USA. A complete parts kit, less boards, may be obtained from Truman Boerkoel, K8JUG, Stotts-Friedman Company, 108 North Jefferson, Dayton, Ohio 45402. Write for free parts and price list.

triggered by pulses that pass examination by both the false start (FS) detector and the character gate. A circuit monitors the voltage level across this storage capacitor and turns on the printer when the voltage exceeds approximately 1.9 volts. With noise input to the teletype demodulator, errors spilling out of the four gates keep the capacitor charged at about 1 volt. When a signal appears, the capacitor will charge high enough to turn on the printer within the time required for eight charac-

fig. 1. Logic functions of some of the TTL circuits used in the digital autostart.



A, and B and C must be at logic 1 to get logic O output. For any other combination output stays at logic 1



Type D flip-flop used as storage device. When cleared, Q̄ is at logic 1 and Q is at logic 0. Status of data at D input is transferred to Q output at positive-going edge of toggle pulse and is held in storage regardless of further changes in date input until cleared, or at next positive-going edge of new toggle pulse

Type D-flip-flop used as divider. By connecting Q̄ to D input, device may be operated as a divider

A_1 input normally is positive and triggers the multivibrator when driven to ground. The positive output pulse appears at Q output and is inverted at Q̄. Length of pulse increases with value of capacitor and/or resistor. The IC has an internal 2k timing resistor at pin 9, which may be connected to 5V or another resistor between pin 11 and the 5 V supply

ters to pass. Usually no useful print is lost due to this turn-on requirement, since most operators open each transmission with several surplus characters such as blanks, line feeds, spaces, or duplication of call letters. At machine speed, the printer will turn on in less than 1.3 seconds — probably faster than most operators could reach for a manual start switch. Shutdown is equally positive: about three characters are printed in rapid succession before printer lockup.

design considerations

Emphasis was placed on RTTY versus other mode discrimination rather than print evaluation. The printer will turn on whenever the logic recognizes an RTTY signal. This action may be through, or spaced between, interference. Under these conditions garbled copy may be printed, as if the printer were operated manually. Print evaluation was considered impractical, and the low threshold was chosen because garbled signals will often contain enough accurate print so that the substance of a message can be understood.

A dividing line must exist between print and nonprint, or what constitutes a recognizable RTTY signal. This grey area is particularly troublesome when propagation conditions are marginal; fading conditions make ordinary autostarts cycle on and off. Therefore a print hysteresis circuit was developed, so that evaluation standards are changed once the system goes into print. The printer will continue amounts of distortion – up to 40 percent in a well-adjusted printer[5] (see **fig. 2**). The print selectors operate during the middle 4.4 ms of each 22-ms interval at a point established by rangefinder adjustment. Print evaluation should take place at this time. The TTL autostart evaluates the signal *inside* the 4.4-ms interval (actually for only 2.5 ms).

storage circuit

The memory-capacitor storage circuit is the result of considerable experimentation. Several circuits were tried with digital-counter storage. These circuits have two operational deficiencies for this application. First, they have a finite capacity. When this capacity is exceeded, these counters start over at zero count rather than when a high amount of errors have accumulated that should be in storage. Second, there is no relationship with time. A carrier on the mark frequency can lock up the count indefinitely and keep the teletype motor running, yet the transmitting station may have stopped typing long ago. No doubt there are more complex methods of solving this problem.

One of my principal objectives was to keep the autostart as simple as possible consistent with required performance. A simple memory capacitor error storage circuit proved to be the solution. It will

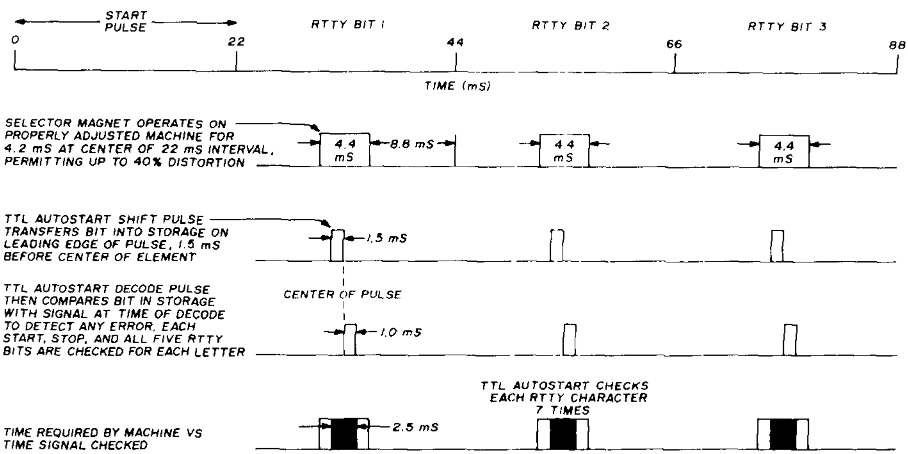


fig. 2. Timing relationship of pulses showing sequence of operation.

to copy a signal that may deteriorate from the initial condition. Full anti-space protection is retained as well as positive printer control at the end of transmission. The printer motor does not cycle on and off unless copy is lost completely. This, of course, reduces loss of copy due to the eight character turn-on requirement.

distortion

An autostart system should not reject signals the printer is capable of copying. If it does, it adds errors of its own to the copy. In a practical system, the received signal is subject to varying amounts of distortion during transmission and reception due to a variety of causes – keyboard adjustment, relays, the demodulator, filters, and signal conditions, to name a few. Fortunately, the machine is mechanically designed to handle large

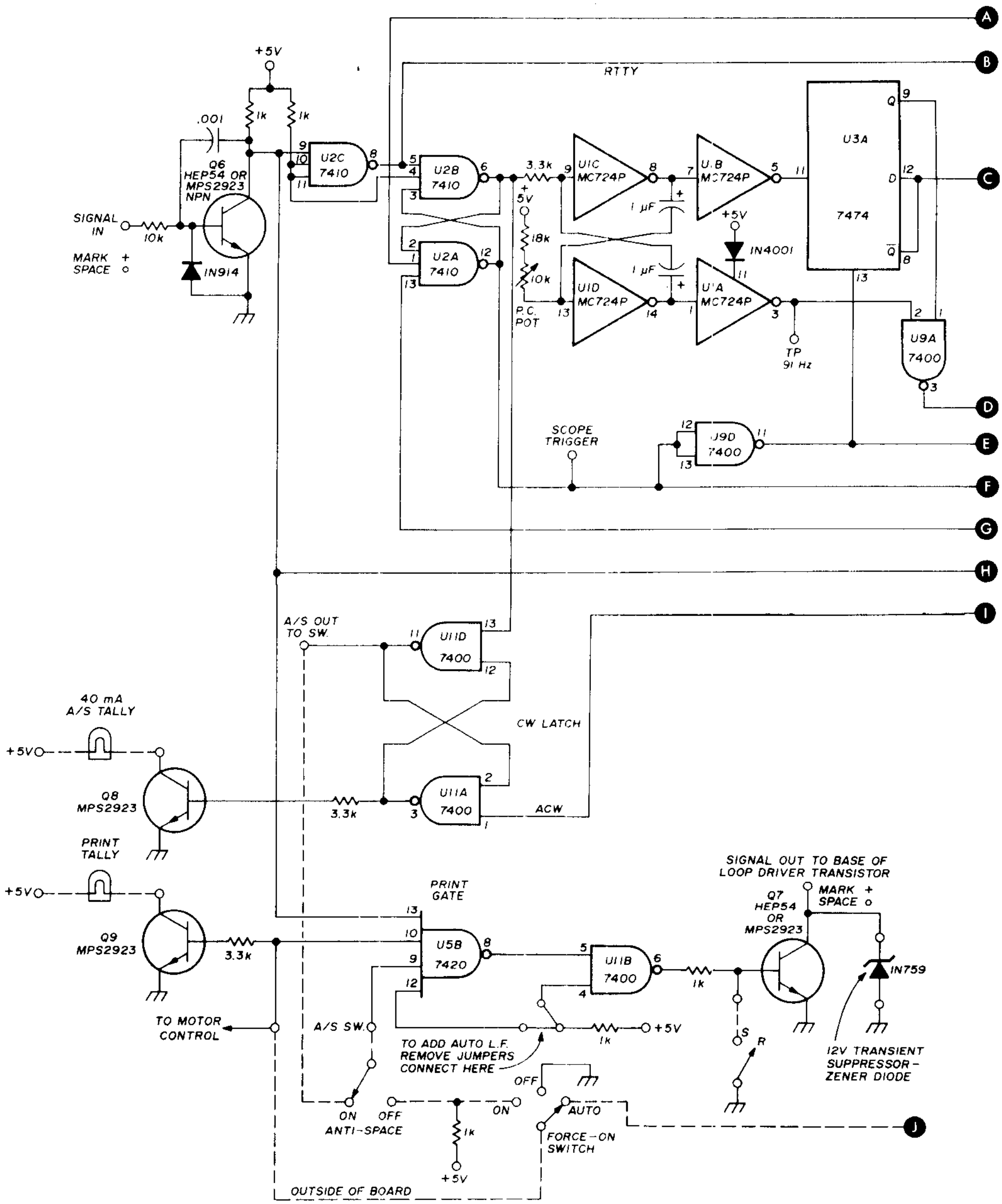
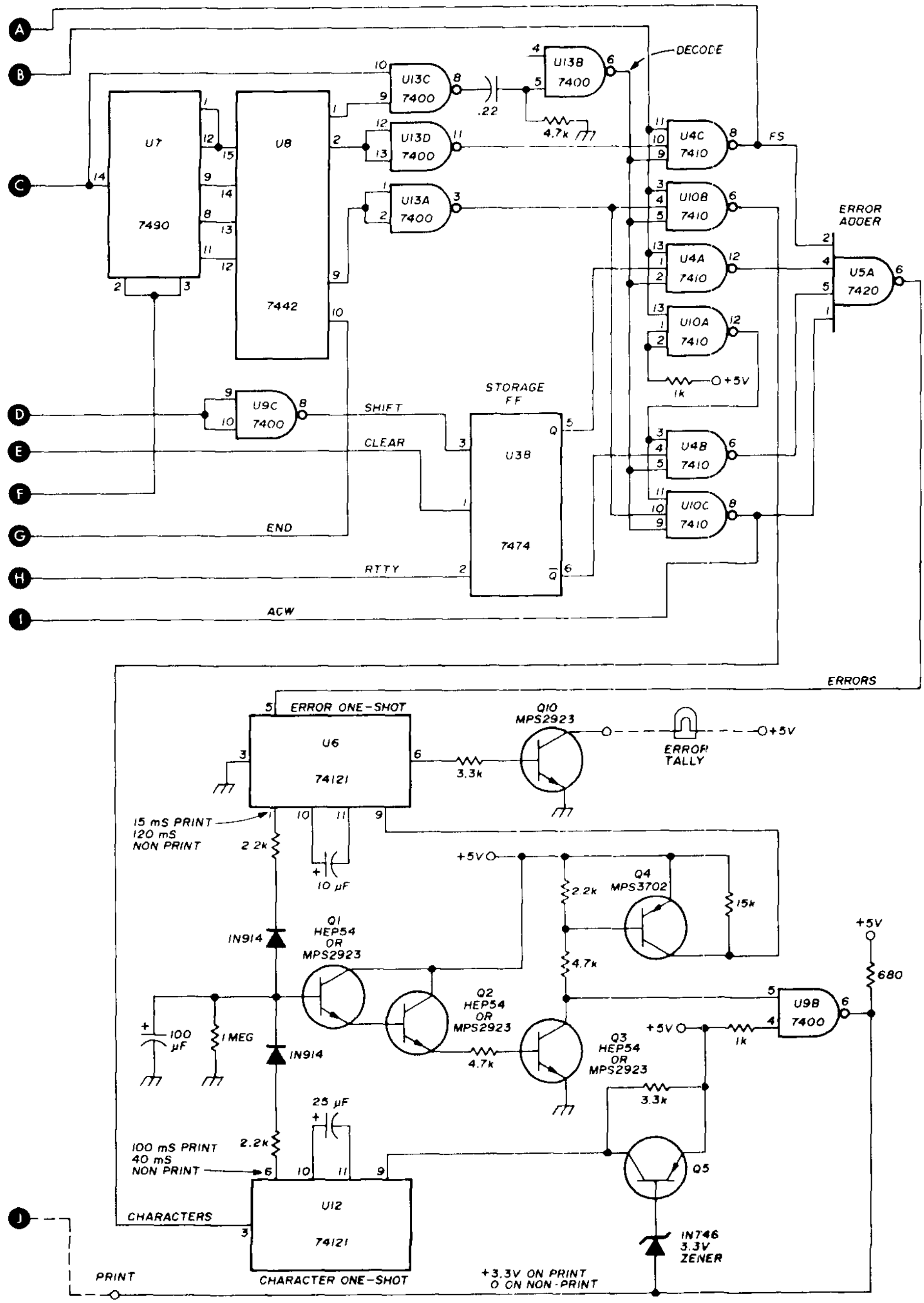


fig. 3. Logic diagram of autostart circuit board with input and output transistors.

not overflow, uses a minimum of components, and has the bonus feature of an idle line turn-off. If no typing occurs for about one minute the capacitor discharges and the printer goes off. This feature accommodates the slowest typists but turns off the printer when stations send only call letters then start tuning up on frequency.

operation

During standby, in mark hold, a positive voltage will appear at the input jack (**fig. 3**). The start pulse starts the clock



oscillating at 91 Hz. U8 then generates pulses that coincide with the start and stop pulse (see **fig. 4**). Seven shift pulses are generated in U9, which shifts each incoming pulse into storage. The decode pulse generator, U13, generates seven 1.0-ms positive-going pulses positioned near the center of each 22-ms interval.

Five TTL NAND gates examine the signal. Since they operate in a similar

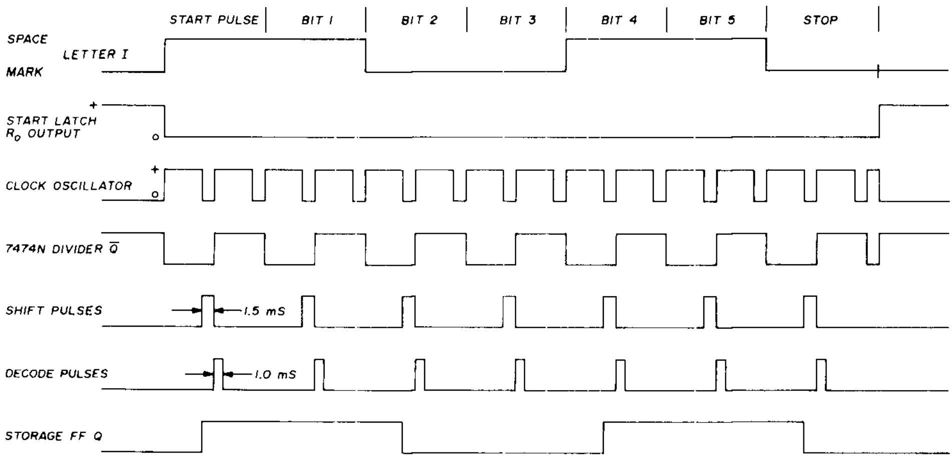


fig. 4. Waveforms of logic circuits during formation of the letter I.

manner, only one gate will be explained. One section of the three-section gate, U4, checks the start pulse. Normally the voltage at U4-8 will remain positive and will not change unless all inputs to this gate are positive at the same time.

At the start pulse the reset/set (R/S) latch, U2, sets; the clock starts; and its pulses advance in synchronism with the incoming signal, so that U8-2 is low at the same time the incoming signal is low at U4-11. U13 is connected as an inverter, so U4-10 becomes high. At the center of the 22-ms interval the decode pulse from U13-6 becomes positive. If, at this time, the incoming signal is valid RTTY, the start pulse will be low at the base of Q6, high at the collector, and low at U2-8, which is connected to U4-11. As long as U2-8 stays low, there will be no output from U4. But if the clock had been turned on by a noise pulse, the polarity of the input signal would probably be different at this time; and, since all three inputs to U4 are positive, a negative-going pulse would appear at U4-8, resetting latch U2-1 and stopping the clock.

This pulse at U4-8 is too short to see on most oscilloscopes since it lasts only long enough to reset the fast TTL logic. It may be lengthened, for verification purposes, by temporarily tacking a 1-μF capacitor between U4-8 and board ground.

When the decode pulse ends, the false start (FS) gate is disabled for the rest of the character. The other four gates require a positive decode pulse and two other positive voltages for any change in the output. Since the gate outputs are all positive, the output of U5-6 is normally low.

The incoming teletype signal is also applied to U3-2, the storage flip-flop. It is placed in storage by the positive-going edge of the shift pulse from U9-8, and the

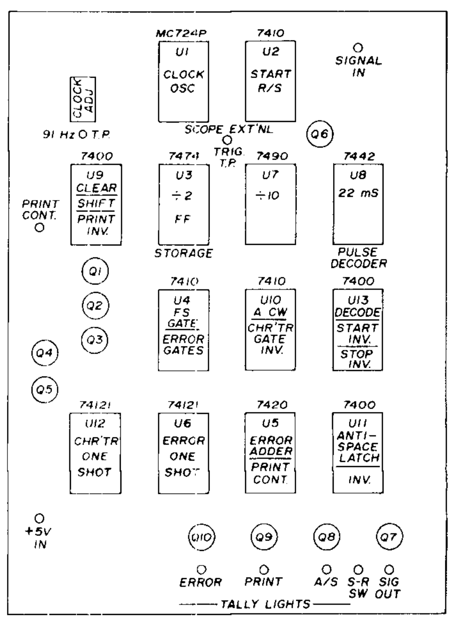


fig. 6. Logic board package layout.

signal status appears at U3-5, the Q output. This stored signal is used for comparison with the input signal to detect any changes.

The incoming teletype signal is also connected to U5-13, the print gate, which gates the signal to the following printer magnet circuit, or places the printer in mark-hold. If we assume the logic has passed an incoming signal as valid and places the system into print, then U9-6

a second board. Q7's collector load resistor is on this second board as well as the power supplies, motor control, and loop circuitry (**fig. 5**). This loop is similar to that of the ST-6 and has the advantages of magnet overdrive, freedom from relays, and positive-negative FSK. The motor-control circuit is operated from the same voltage that turns on U5-10, the print gate. The diode and small capacitor at Q11 base provide a motor turn-off delay to keep the motor running for a short time between transmissions.

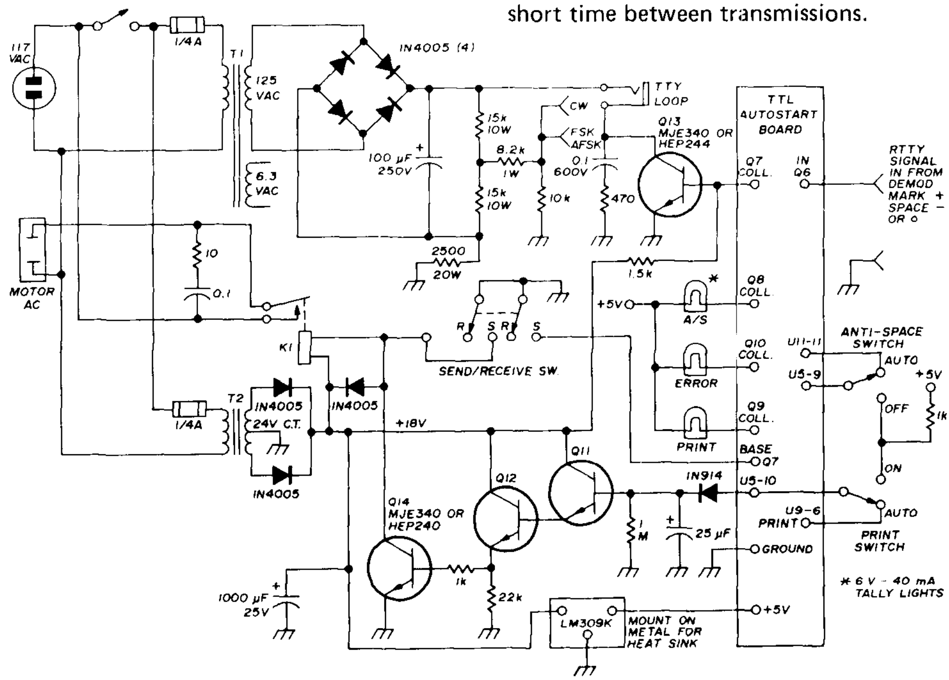
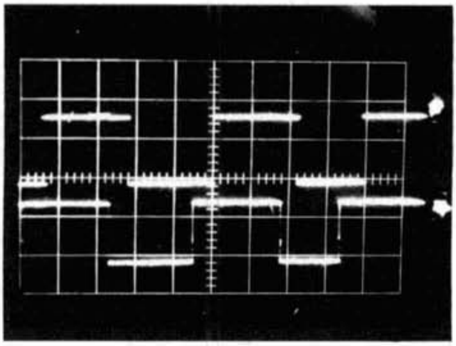


fig. 5. Schematic diagram of power supply and motor control circuitry. Relay K1 is a Potter and Brumfield dpdt KA11DG, 12-volt coil, or Olsen SW-557. Q11 and Q12 are HEP54, 2N2222, MPS2423 or MPS2924. Transformer T1 is an Allied 6K28HF. T2 is a Stancor P8180.

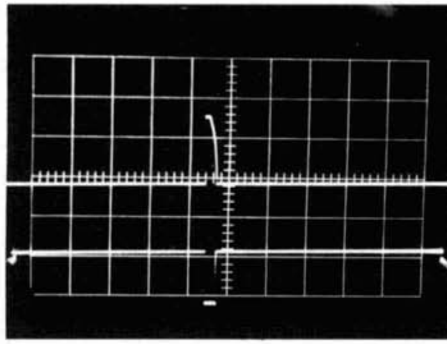
will be high, Q9 will turn on, and U5-10 will be positive. If the anti-space latch is off, U5-9 will be positive along with U5-10, so any polarity changes in the input signal appear inverted at U5-8. U11-6 inverts the signal again to drive Q7. Two unused inputs to U5 and U11 may be used to add an automatic line-feed generator.[6] The CW latch, U11, is instantly operated by any spacing condition during the stop pulse, turning on Q8, and inhibiting print by placing a low on U5-9.

The gated and controlled signal leaves the logic board at Q7 collector and enters

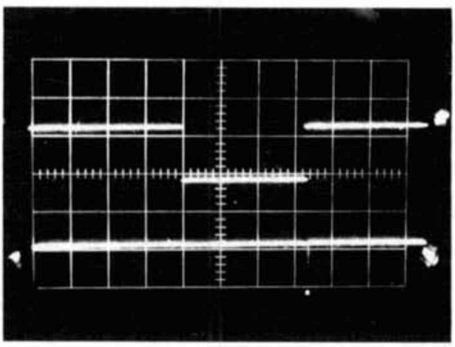
The complete unit is enclosed in a 4 x 7 x 12-inch Minibox with input and output connectors, printer jacks, and an LM309K regulator mounted on the rear apron. A sketch of the autostart board package layout is shown in **fig. 6.** The two circuit boards are stacked on long machine screws, which were obtained from toggle bolts. The power supply is mounted on top because of heat considerations. Extra wire should be provided as a service loop so this board can be removed and operated while probing voltages and waveforms in the logic. This will elimi-



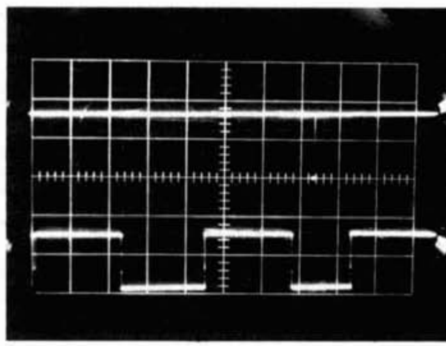
Incoming RTTY signal (bottom trace) is shifted into storage flip-flop and appears delayed and regenerated at U3-5 (top trace). 1.5 millisecond after being transferred into storage, top waveform is compared with bottom waveform (which may be static, CW, or noise and not necessarily the RTTY signal for the letter I as pictured). If a change in polarity occurs, an error pulse is generated.



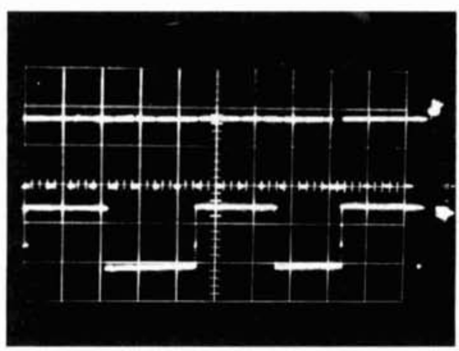
Top trace is a decode pulse; bottom is a pulse at character-gate output U10-6. Decode pulse sets timing. For this pulse to be present, denoting a valid character, a positive-going pulse must appear at U10-4 and a positive-going decode pulse must appear at U10-5 (top trace), and a positive (inverted) stop pulse must appear at U10-3. Scale: 5 milliseconds/centimeter horizontal, 2-volts/centimeter vertical.



Bottom trace is a pulse output from the character gate, U10-6, which triggers monostable U12. U12 output is shown in top trace. Normally U12-6 is low, as in center of top trace, but when triggered by the "good character" gate U10-6, the Q output of the character one-shot goes positive and remains positive, even into the next character (at machine speed). This action keeps the 100-μF memory capacitor charged. The expanded one-shot output is about 100 milliseconds long. This shows conditions during print. Pulse is only 40 milliseconds long during standby, so an occasional "good" pulse doesn't have much effect. Eight consecutive 40-millisecond pulses will turn on printer. Scale: 20 milliseconds/centimeter horizontal, 2-volts/centimeter vertical, unless otherwise noted.



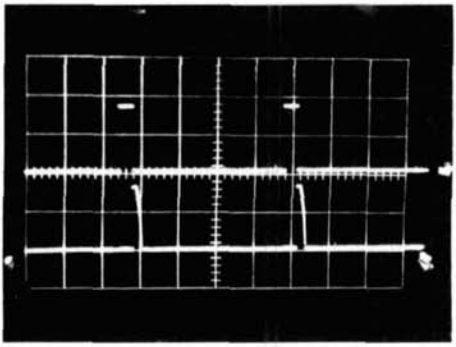
Top waveform shows output of character gate at U10-6 versus the incoming RTTY signal at U2-9. Location of this pulse in relation to the stop pulse is shown.



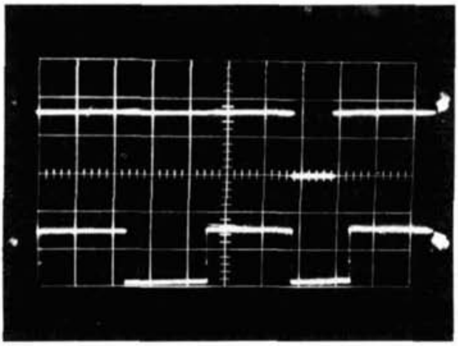
Top shows 4 clock pulses at pin 11 os 7474N divider. Bottom shows RTTY signal for letter I at input of digital TTL autostart (Q6 collector). Bottom os each trace is logic 0, or near zero Vdc.

nate the possibility of inadvertently shorting the high loop-supply voltage to the logic.

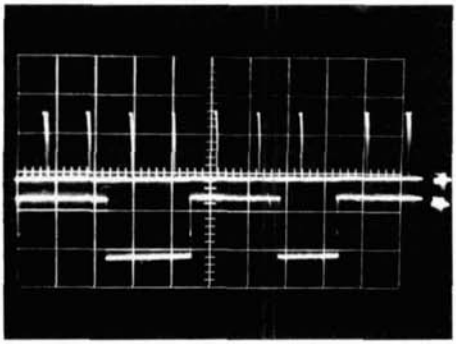
Construction is simplified and appearance enhanced if the available circuit



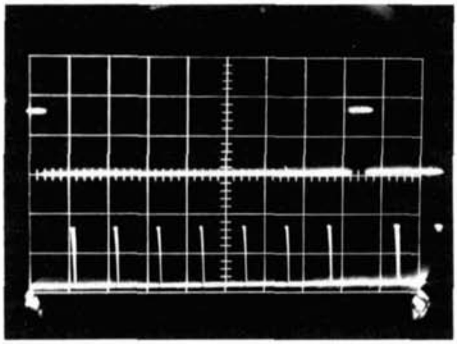
This shows shift pulse versus decode pulse (U9-8 and U13-6). Note relative timing. Positive-going edge of shift pulse (top) transfers RTTY character into storage, where it is checked 1.5 *millisecond later* by decode pulse action, which turns on the gates. Scale: 5 milliseconds/centimeter horizontal, 2-volts/-centimeter vertical.



Bottom trace is letter I sent at machine speed. Top trace is voltage at pin 9 of U8, the 7442N BCD decoder. This shows that the decoder goes low at pin 9 only during the stop pulse. This pulse is then inverted in U9 and enables both the anti-CW detector gate and the valid RTTY character gate, U10.



Top shows decode pulses (7 for each RTTY character). Bottom shows RTTY signal for letter I at input of autostart board (Q6 collector). Decode pulse checks each part of RTTY character at approximate center of the bit. Example: first positive-going part of square wave (bottom trace at left) is composed of start pulse (22 milliseconds) plus first bit (22 milliseconds), which *is* 44 *milliseconds*. Two decode pulses directly above this part of square wave show polarity of pulse and relative timing. The 7 decode pulses check start, plus 5 bits, plus stop pulse. Scale: 20 milliseconds/centimeter horizontal, 2-volts/centimeter vertical.



Bottom trace shows 7 decode pulses. Top trace is voltage on pin 12 of U2 start latch at machine speed. This voltage is used to externally sync scope during tests (negative slope triggering). Start latch goes off (high) during last portion of stop pulse until new start pulse triggers clock and generates new series of decode pulses at center of each 22-millisecond *interval*.

boards are used (see **fig. 7**). Each board is sent with a photograph that shows parts and jumper locations. Most of the component values are screened on the board.

critical components

The following suggestions are given to ensure proper operation. The small transistors should have moderately high h_{FE}. I selected mine from a large number of 2N706s with the aid of a scope curve tracer, but if you don't have a means of testing beta, use HEP-54 or MPS-2923, 24, or MPS3393 for Q1, Q2, Q3, Q6, Q7, Q8, Q9, Q10. Q11, and Q12. For Q4 and Q5, use pnp HEP-715, MPS-3702 or MPS-3703. These transistors are inexpensive and universally available. MJE340 transistors are recommended for Q13 and Q14.

The motor relay should have a coil resistance of not less than 120 ohms. Olsen no. SW-557 or Potter-Brumfield no. KA11DG dpdt, 12 Vdc, are satisfactory. (An almost identical relay constructed from the P & B relay kit is unsatisfactory due to too-low coil resistance.)

Pilot lights should be low current types, such as Chicago miniature

verify that it is close to 25 μF. More than 25 μF here will reduce the turn-on requirement and may cause false starts.

attachment to the demodulator

The ST-6 has a suggested sel-cal take-off point at pin 6 of the slicer op amp. If not already present, this additional connection may be made without affecting

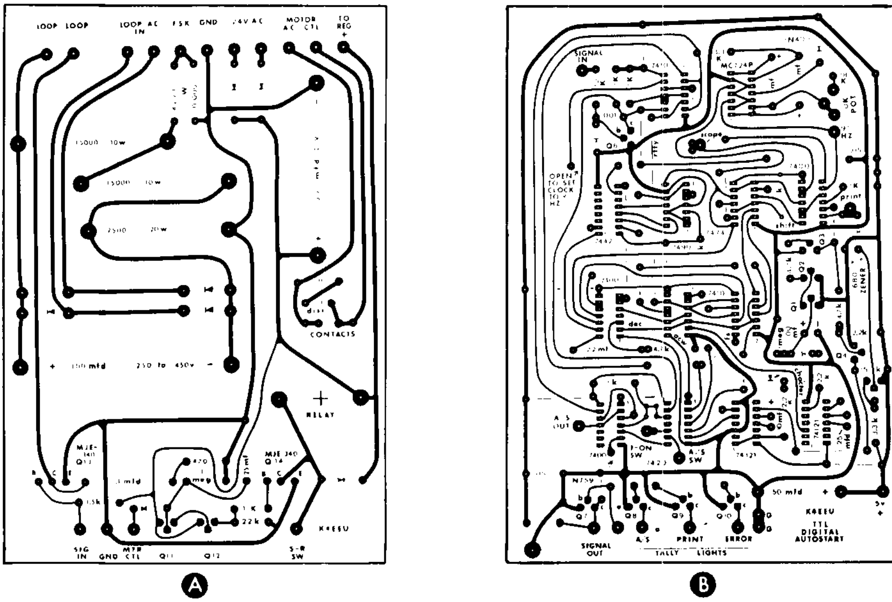


fig. 7. Etched circuit board layout for power-supply/motor control/loop, A, and autostart logic, B.

CM22-2-00-20, 6.3 V at 20 mA. HAL Devices also have suitable pilot lights if a different dc voltage is used.

The memory capacitor circuit is high impedance due to the long time constant. The 100-μF capacitor and the 1N914 diodes should have low leakage. Transistors Q1 and Q2 affect the loading, with the input resistance to Q1 approximately equal to the product of the betas of Q1 and Q2 and the resistance of the 4.7k base resistor to Q3.

The number of characters needed for turn-on is determined by the pulse lengths from the character one-shot, U12. The length of the pulse is set by an internal timing resistor at pin 9 of U12 plus the capacitor across U12-10, 11. In nonprint, the 3.3k resistor across Q5 emitter and collector is shorted out. Check the capacitor before installation to

the operation of the ST-6. A phone jack may be added for a convenient external connection. The ST-5 is adapted similarly. The connection point should be the op-amp side of the 2.2k resistor The ST-3/4 connection point is the collector of pnp transistor Q2, with Q10 disabled so that the autostart circuit does not mute Q2. For other demodulators, the take-off point should be the processed signal in its best possible condition — not, for example, across the mark discriminator coil. The signal polarity should be as follows: The mark signal should be a positive voltage between 5 and 10 V; the space signal should be either zero or negative.

adjustment

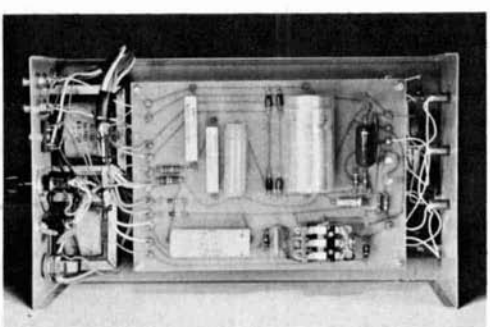
Only one adjustment is required. The clock oscillator should be set at 91 Hz with a digital counter connected to a test point indicated on the printed-circuit board. Remove the jumper between U8-10 and U2-13, set the frequency, and replace the jumper. If all is well, the autostart should be in operating condition. When the receiver is tuned to the space frequency, both space and error tallies should light, and go off promptly when the receiver is retuned to mark.

The idle line turn-off time should be checked to ensure it is approximately 1 minute ±15 seconds. The voltage across the memory capacitor should be measured with a vtvm when checking becomes necessary. It will read about 2.8 volts during steady typing, about 1 volt on noise, and 1.9 volts will be the dividing line between print and nonprint. The turn-on character requirement should be seven or eight characters.

trouble shooting

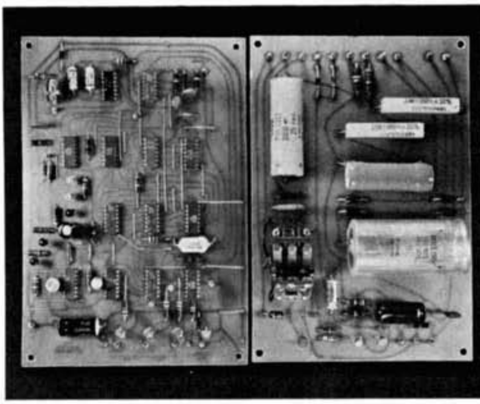
Trouble shooting is reasonably straightforward. A kit scope will usually suffice for signal checks through the unit. The scope should be synchronized on the test point provided to stabilize the trace and to make pulses appear in their relative positions on the trace. Typical waveforms of selected points in the circuit are shown.

With a ready-made circuit board, wiring errors are eliminated. Trouble spots to look for would be solder splashes, unsoldered connections, an IC installed backward, or a missing jumper.



Top view showing power-supply/motor-control/loop board installation.

If the autostart will not go into print unless the force-on switch is used, trouble in the logic is indicated. Isolate by disconnecting the three jumpers to the inputs of error adder U5, leaving only the trail connection to U5-1 and check to see if the error one-shot continues to fire. If so, the cause must be traced backward through U10-8. If the autostart begins to



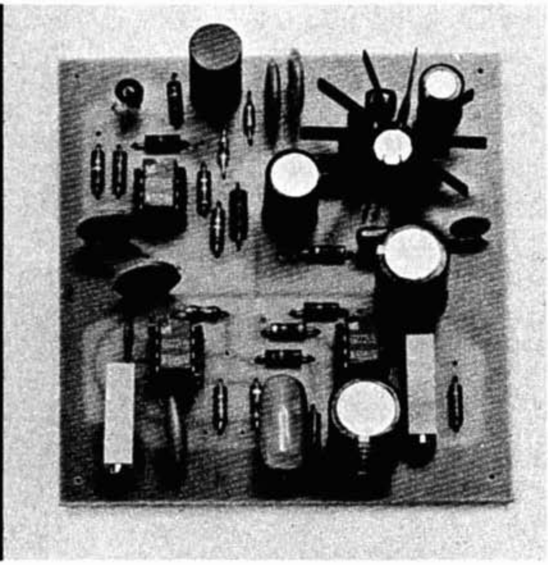
Logic and power supply/motor-control/loop boards.

operate, connect the gates, one at a time, until the offending source of error pulses is isolated. Be sure that the test signal source is clean and that the clock is correctly set at 91 Hz. If all else fails, write me, giving results of checks and measurements made. Be specific, clearly state the difficulty, and enclose a self-addressed, stamped envelope.

references

1. Irving Hoff, W6FFC, "Mainline ST-3 RTTY Demodulator," *QST*, April, 1970, page 11.
2. Irving Hoff, W6FFC, "Mainline ST-6 RTTY Demodulator," *ham radio*, January, 1971, page 6.
3. Frank Stewart, K5ANS, "Digital Autostart for RTTY," *RTTY Journal*, November, 1970, page 3.
4. Irving Hoff, W6FFC, "The Mainline ST-5 RTTY Demodulator," *ham radio*, September, 1970, page 14.
5. Durwood Tucker, W5VU, *RTTY from A to Z*, Cowan Publishing, pages 18 and 58.
6. A.A. Kelley, "Automatic Line Feed for RTTY," *ham radio*, January, 1973, page 20.

ham radio



a complete audio module

This audio module includes an active filter, preamplifier, audio compressor and power output stage

Ray Megirian, K4DHC, Box 580, Deerfield Beach, Florida 33441

When I recently decided to build a new receiver based on the modular concept, I spent several weeks delving into piles of magazines and clippings from trade journals to come up with the audio system described here. I don't know for certain why I started with the audio function block first, though on occasion my wife has accused me of doing things backwards. However, I am more inclined to believe I was influenced by the recent rapid advances in active-filter design and the abundant supply of circuits offered in the various publications. For whatever reason, the audio module came first, and since I felt some of the features might be of interest to others, I decided to write it up before going on to the next module.

features

Four distinct functions are provided in the audio package. These include a filter, a compressor, a preamp and a power amplifier. Both bandpass and band-reject functions are provided by the filter with bandwidth and frequency adjustable by means of front panel controls. When not in use, the filter is bypassed.

The compressor, or audio agc amplifier, was considered to be a worthwhile addition to the complete system. It provides flat output with low distortion from about 20 mV to 2.0 V rms input. An external switch allows the compressor to be cut in or out, as desired. When the compressor is switched out, a preamp is automatically switched into the circuit to make up for the gain normally supplied by the compressor at low signal levels.

The final section uses a Motorola MC1454G power amplifier IC which is capable of providing up to 1-watt output for driving a speaker. A headphone jack is available for high-impedance headphones along with a switch to shut off the power amplifier if the speaker is not needed.

the filter

During my search through the magazines and clippings, many active-filter circuits were pulled and tried before I decided to use the circuit shown here.[1] Both bandwidth and frequency are independently adjustable by means of front-panel controls. With the values shown in the schematic of **fig. 2** frequency is variable from about 300 Hz to 2.0 kHz.

The original circuit was strictly a bandpass filter; a simplified circuit of which is shown in **fig. 1A.** In **fig. 1B** the large, hard-to-tune inductor has been synthesized by an RC network and op-amp IC, U2, resulting in a far more practical circuit. Since an extra op-amp was available on the board, it was used to implement the band-reject filter. In this mode, equal and in-phase signals are applied to both the inverting and non-inverting inputs of the op-amp, resulting in cancellation or zero output at the notch frequency.

Although the primary purpose for including a filter in the audio module was to aid in CW reception, the notch function can be quite useful for nulling heterodynes during phone reception. With the bandwidth control set at the sharpest position the 3-dB bandwidth is about 11 Hz.

Incidentally, a peaking function could

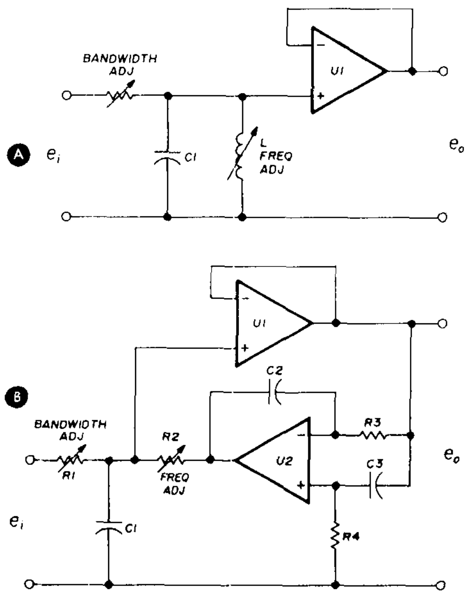


fig. 1. The basic active filter circuit used in the audio system. The simple bandpass configuration is shown in (A). Practical filter section is shown in (B).

be added to the filter if desired. Instead of using U2A as a subtracting amplifier, it could be used in the summing configuration with both signals fed to the inverting input. This would result in a 6-dB peak at the selected frequency. An additional position and one more pole would be required on the function switch to accommodate this extra function.

the compressor

Several audio agc circuits were tried, including one using the LM370 which provided squelch in addition to agc, but somehow I preferred this one over the others.[2] Referring to the schematic in **fig.**

2, you can see how simple the circuit is and how few components are required.

Use of the T-network in the feedback loop allows the circuit to handle signals considerably larger than in those cases where the fet appears directly across the

tion to be adjusted when the compressor is switched out of the circuit.

The power amplifier uses an MC1454G IC and requires no additional comment since the circuit is straight from the data sheet.

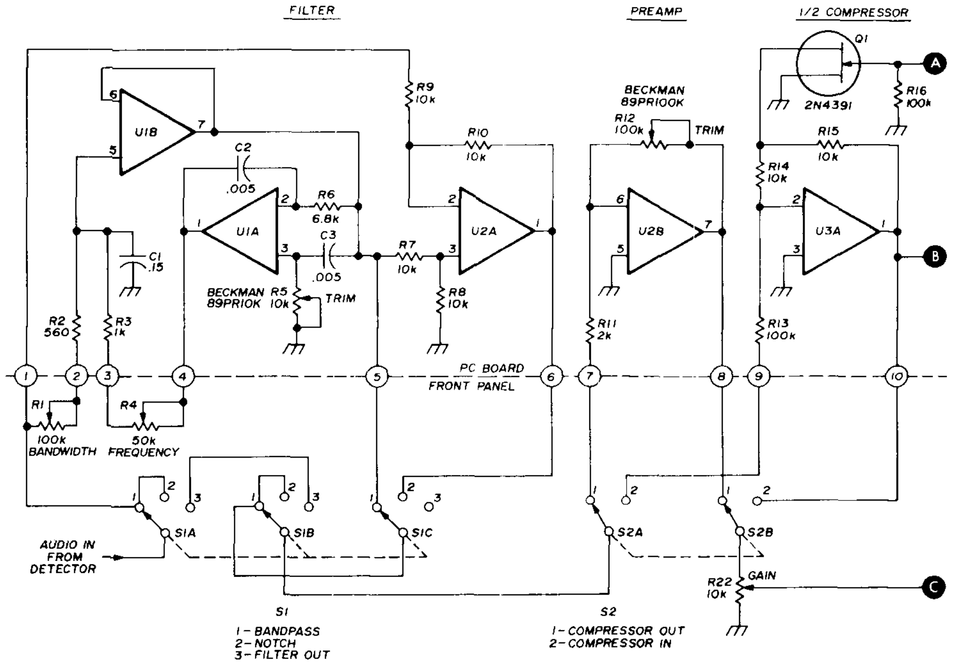


fig. 2. Circuit of the complete audio system module includes an active filter, preamplifier, compressor and power output stage.

signal path. Eventual gain of the circuit is limited by the maximum *on* resistance of the fet. The 2N4391 used here has a maximum of 30 ohms.

The voltage gain in my unit before compression begins is about 17. The agc has a fast attack characteristic with a slow decay. Electrolytic capacitor C5 controls the decay time and its value may be varied to suit your own requirements.

preamp and power amplifier

The remainder of the circuit is quite conventional, consisting of a standard preamplifier implemented with an op-amp whose gain may be adjusted by means of a trimmer resistor in the feedback loop. This permits gain compensa-

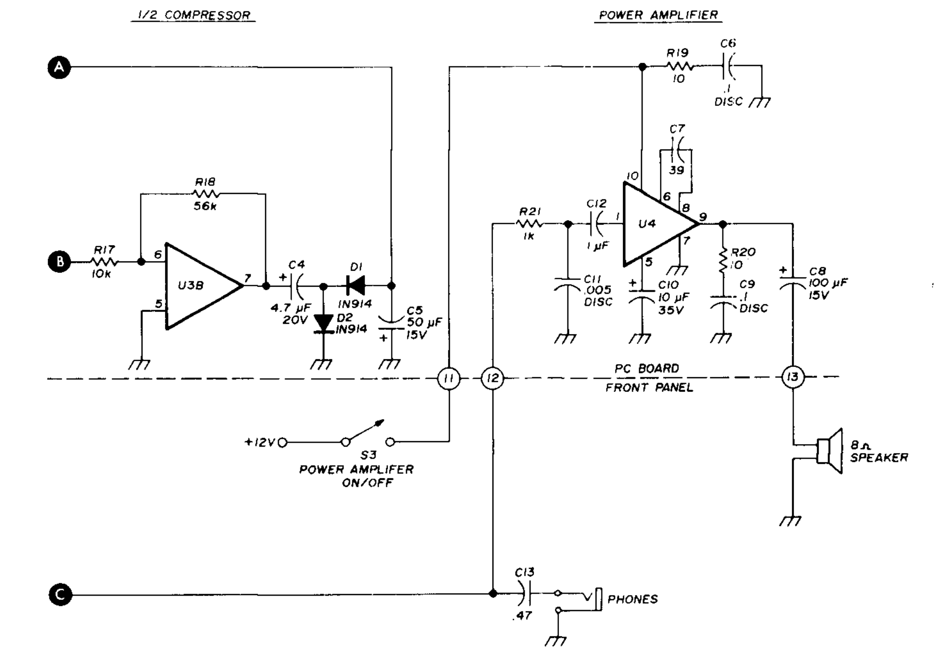
construction

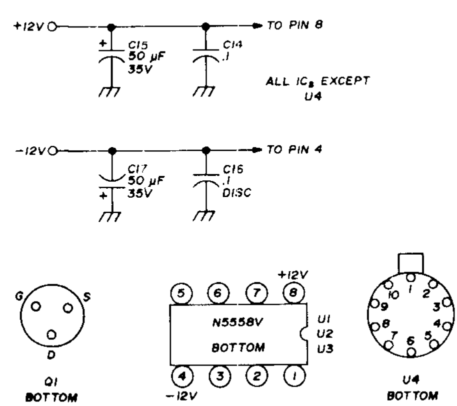
Signetics type N5558V ICs were used for all op-amps on the board. These 8-pin dual-in-line packages contain two 741 op-amps each, allowing a very compact assembly. The board measures 3.2 by 3.4 inches and a layout is shown for those interested in duplicating the module. All external controls are connected by wire leads to holes provided in the board. If desired, the layout could be modified to suit a plug-in arrangement.

The following information may be helpful in obtaining parts physically suited to the hole spacings used in the original layout. All resistors are ¼-watt, 5%, though 10% units would be adequate. All the electrolytics are printed-circuit types (single-ended) except C4, which is a small axial-lead tantalum.

The disc capacitors are 50-volt types and C7 is a dipped mica in the smallest size. This latter capacitor lies flat against the board so it will clear the heatsink mounted on U4. Capacitor C1 is a dipped mylar unit rated at 75 volts. C2 and C3 were Japanese mylars salvaged from my junk box and rated at 100 volts. They were very thin and had close-spaced leads for printed-circuit mounting. Domestic equivalents may require some lead bending to affect a fit.

A 50-volt monolythic capacitor was used for C12 because I happened to have one and it fit nicely under the heat sink. Since these capacitors in the 1-μF range are rather expensive, you may wish to substitute at the expense of a few mechanical problems. The 15-turn trimmer resistors are the small 3/4-inch units such as the Beckman 89P type used here. The 2N4391 in a metal can is around $3.00, depending on the manufacturer. The plastic version I used costs less than a dollar.





adjustments

A scope and an audio generator make filter adjustment a fast and simple procedure. Set trimmers R5 and R12 to mid-range before beginning. Switch out both the filter and the compressor and feed in enough signal at 1.5 kHz to obtain an output of 1 or 2 volts p-p as seen on the scope when connected to the high end of the gain control.

Set the bandwidth to maximum resistance (sharp) and turn the function switch to *bandpass.* Carefully adjust the frequency control for a peak. Trimmer R5 should then be adjusted for an output amplitude equal to that obtained without the filter. Make sure you're right on frequency, it's quite sharp! That's all there is to it.

The other trimmer, R12, controls the takes some getting used to. When using the notch function, turn the bandwidth control to minimum resistance (broad) or you may never find the null. In the bandpass mode, the broad bandwidth setting can be used for phone reception since rolloff is quite gradual.

As I have done in the past with several

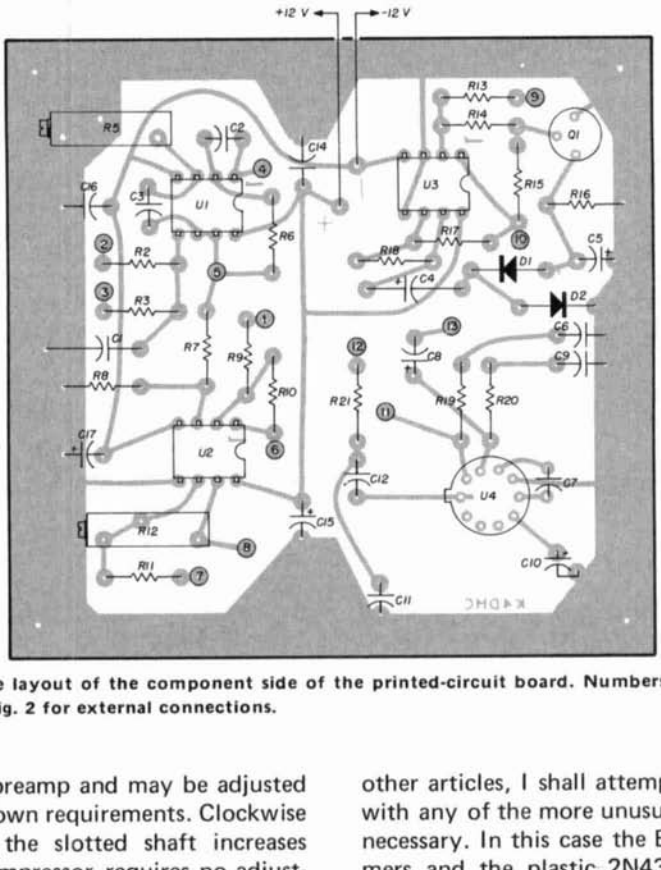


fig. 3. Full-size layout of the component side of the printed-circuit board. Numbers correspond to those used in fig. 2 for external connections.

gain of the preamp and may be adjusted to suit your own requirements. Clockwise rotation of the slotted shaft increases gain. The compressor requires no adjustment, but while the scope is connected you can check the circuit for proper operation. With the compressor switched in, output should be around 1.0 V p-p with input levels from 60 mV p-p to around 6.0 V p-p. Of course, there may be some differences due to variations in the characteristics and tolerances of the components.

operating hints

The active filter is quite sharp and

other articles, I shall attempt to help out with any of the more unusual parts if it is necessary. In this case the Beckman trimmers and the plastic 2N4391 are about the only items which may be troublesome. Drop me a line and a self-addressed, stamped envelope if you need help.

references

1. John Jenkins, "Active Filter Has Separate Band and Frequency Control," *Electronics,* September 11, 1972, page 110.
2. Leonard Accardi, "FET Gain-Control Stage Handles High-Level Signals," *Electronic Design,* March 2, 1972, page 64.

ham radio

SERIOUS RADIO OPERATORS RELY ON SWAN

No fooling around. If you want superior full-band performance combined with ease of operation, then it's time you invest in SWAN equipment. Reliable equipment that gives dependable service every time you're on the air.

Here are two single-sideband transceivers that seasoned radio amateur veterans put their trust in, both at home and on the move:

Install a SWAN 500CX and join an elite legion of hams whose experiences have made this the most desired 550 watt P.E.P. transceiver in its class. Enjoy unsurpassed tuning ease, extraordinary signal sensitivity, and transmissions that'll push through noise which would obscure readability in a lesser piece of gear.

500CX, less power supply . . . . $529.95; 117XC, matching AC power supply with speaker . . . . $109.95; 14-117, DC power supply (can be adapted to AC use with $8.00 optional line cord) . . . . $139.95.

Perhaps portability is your need. You can have confidence in the deluxe 270B Cygnet. Compact and lightweight, it has 260 watts P.E.P., a built-in power supply and loudspeaker, plus a solid-state VFO. 12 volt operation is easily adaptable with an optional plug-in DC converter . . . should fit well with vacation plans.

270B, with built-in power supply . . . . $469.95; 14-A, DC converter . . . . $44.95.

Both the 500CX and the 270B cover the five most popular frequency bands – 10, 15, 20, 40 and 80 meters with CW or selectable sideband operation. See SWAN's 1973 catalog for complete specifications.

If you're serious, send us a 10% down payment to your SWAN REVOLVING CREDIT SERVICE account and we'll deliver your choice before another month goes by . . . we don't fool around.

SWAN ELECTRONICS

A subsidiary of Cubic Corporation

305 Airport Road • Oceanside, CA 92054 • Phone (714) 757-7525

More Details? CHECK–OFF Page 94

fm repeater installation

Suggestions on dealing with setup and control problems

George R. Allen, W2FPP, 4059 Bay Park Drive, Liverpool, New York 13088

A recent article in *ham radio*[1] caused many questions on how to set up a repeater and how to solve the problems encountered. These notes are presented to help answer these questions and help solve some of the problems.

definition of a repeater

A repeater is an fm, TV, facsimile, or similar station that receives a signal on some input frequency and automatically transmits the received signal on some output frequency. The purpose of a repeater is to extend the communication range between a group of stations. The repeater generally consists of a receiver with its antenna, a control unit, and a transmitter with its antenna. This sim plest form of an amateur fm repeate station is shown in **fig. 1**.

setting up a repeater

From the block diagram of **fig. 1**, it i: seen that a basic repeater station consist: of five components: two antennas, ε receiver, transmitter, and control unit When setting up a repeater, care must be taken to select each component carefull\ so that the components will function as ε reliable repeater system rather than ε collection of pieces of equipment with ε high maintenance rate and low perform ance. For example, when selecting ε receiver, care must be given to its selectiv ity, sensitivity, and intermodulation char acteristics.

The receiver must be sensitive enough to receive low-power signals within the desired coverage area; on the other hanc it must not be so sensitive as to pick uг signals greatly removed from the desirec coverage area. The receiver must be selec tive enough to eliminate strong signals or adjacent channels, but not so selective that most signals are too wide for the receiver passband. The receiver must be relatively insensitive to intermodulatior products. For example, if two commer cial stations are on the air simultaneousl\ from a nearby site, the receiver must no1 mix the two signals, causing the receptior of unwanted signals.

The transmitter must have enough power when used with the transmitting antenna to produce an adequate signal within the desired coverage, but must not be so powerful that it causes interference in outlying areas. The transmitter, furthermore, must generate a signal free from spurious radiation and transmitter noise. The antennas should have sufficient gain for adequate receiving and transmitting coverage within the desired area. Each item in the repeater should be chosen to be as maintenance free as possible. This does not exclude tube equipment, but it does mean that the equipment must be capable of operating continuously at some remote location without frequent maintenance.

hooking it all together

Once the receiver, transmitter, and antennas have been assembled, the only remaining task is to connect the equipment together and see if it will work. To do this, it will be necessary to build some type of carrier-operated relay circuit, which will turn the transmitter on when a received signal is present. **Fig. 2** shows a simple Carrier-Operated Relay (COR) circuit for use with a tube receiver. This circuit is similar to the COR used in reference 2, which should be consulted for connection to various types of receivers. For a very simple repeater, the relay itself can be used to key the transmitter directly when a signal on the input frequency is received. While this method will work, direct transmitter keying has some very serious disadvantages. For one, if something goes wrong and the transmitter suddenly decides to generate a birdie on the input frequency, the repeater will latch up and remain in operation even though an input signal is not present. In addition, some long-winded fellows could keep the repeater keyed for days at a time without giving the other stations a chance to talk.

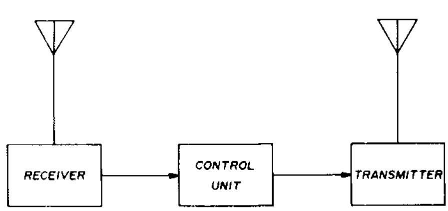


fig. 1. Basic repeater setup.

Another problem with this simple circuit is that the transmitter will undergo rapid on-off cycles during periods of short transmissions. This will produce excessive wear and tear on mechanical relays, and the resulting series of double squelch crashes is hard on the ears. These problems can be cured by inserting a reliable control unit between the receiver and the transmitter. This control unit will "time out" any received signal that is on longer than some predetermined interval (say, three minutes) and will provide a carrier dropout delay so that the transmitter carrier will not drop out between transmissions. The hookup of this control unit is shown in **fig. 3.** The control unit is described in reference 1. Note that **fig. 3** also shows a relay in series with the transmitter keying lead. This relay is used for turning the repeater on and off either locally or via remote means such as a leased telephone line (radio line).

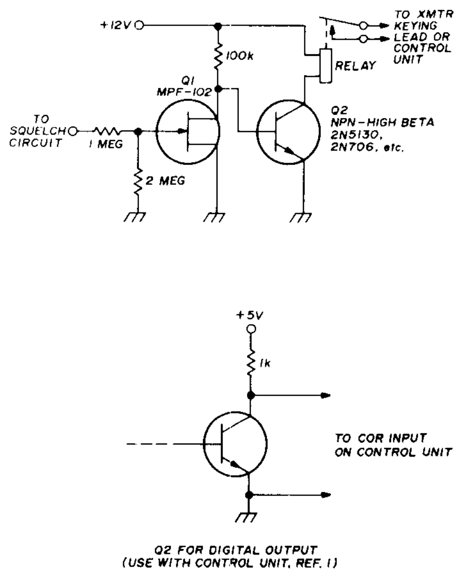


fig. 2. Simple carrier-operated relay circuit.

Note also that some additional items will be needed for a legal repeater. An identifier of some sort will be required to identify the repeater automatically at five-minute intervals, either by phone or CW. The referenced repeater control unit provides a timer that will trigger the identifier as long as the repeater is active. Another item required by law is a monitor to monitor the input and output frequencies.

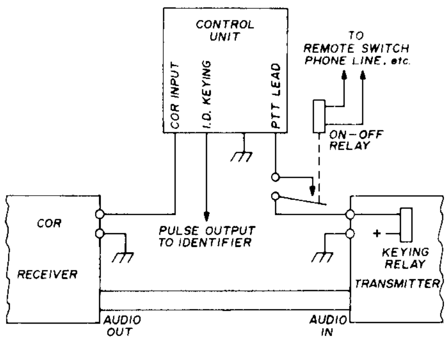


fig. 3. Typical control-unit hookup.

some problems involved

While it is possible to hook a repeater together as previously described and have it work the first time, few people are so lucky. Most repeater groups encounter problems of one type or another.

One of the most common problems is desensitization. This problem is caused by too much transmitter power getting into the receiver front end. This power will desensitize or block the receiver. The result is that the receiver will only respond to very strong signals, or to no signals at all, when the transmitter is operating. This problem can be identified very easily by listening to a weak received signal and monitoring the first limiter with a meter (transmitter off). If, when turning on the transmitter, the signal gets weaker or disappears, and the first limiter current goes *down,* you have a desensitization problem. If the signal gets weaker, and the first limiter current goes *up,* the problem is caused by transmitter-generated noise.

Desensitization can be cured in several ways. The transmitter and receiver should be well shielded, and power leads from inside the shielded units should be well bypassed. The antennas should have a large vertical separation to prevent transmitter power from getting back into the receiver. Most commercial two-way radio dealers have charts giving the separation required for frequency versus amount of isolation desired.

The problem of transmitter noise is another matter. If a commercial, type-accepted unit is used as the transmitter, it is unlikely that transmitter noise will be a problem. If home-brew equipment is used, transmitter noise is likely to be an annoying problem. Noise can be eliminated either by redesigning the transmitter output stages or by installing one or more cavity filters in the transmitter output. The cavity filter is very selective and can be successfully used to eliminate transmitter noise from the receiver input. The best way to use the cavity is shown in **fig. 4**. In this case, the cavity is inserted in the transmitter output lead and is used in a suck-out mode. In other words, it passes all rf energy but sucks-out the energy or noise at the receiver input frequency. Some of the references given explain the proper use of cavity filters.

Cavities can also be used to help reduce desensitization, but don't get the idea that cavities are a requirement in a repeater. They are not. As an example, the Liverpool repeater, in Liverpool, New York, operated for over a year without cavities and without desensitization or transmitter noise problems.

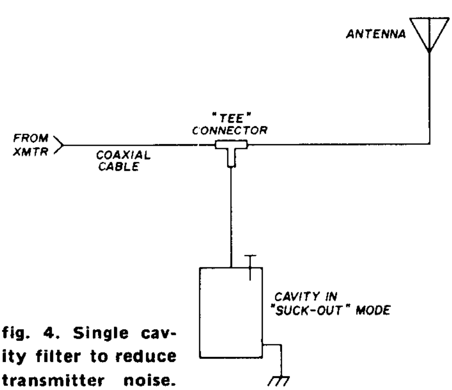


fig. 4. Single cavity filter to reduce transmitter noise.

choice of frequencies

While there is no rule giving a list of input and output frequencies and channel separation for repeaters, it is recommended that the current plan suggested by the ARRL be used. If this plan is supported nationally, it will be possible to travel coast-to-coast and work into a large number of repeaters using only a handful of crystals.

This article isn't intended as a short course on repeaters, but as a guide for dealing with some of the problems that may be encountered in repeater installation. The articles in the references provide essential details and should be read before attempting to set up your repeater.

references

1. G. Allen, W2FPP, R. Sobus, K2QLE, "Repeater Control with Simple Timers," *ham radio,* September, 1972, page 46.
2. G. Allen, W2FPP, "FM Channel Scanner," *ham radio,* August, 1971, page 33.
3. R.C. Heptig, KØPHF, Robert D. Shriner, WAØUZO, "Carrier-Operated Relay," *ham radio,* November, 1972, page 58.
4. R.B. Shreve, W8GRG, "Integrated Circuit Sequential Switching for Touch Tone Repeater Control." *ham radio,* June, 1972, page 22.
5. Murray Ronald, VE4RE, "Solid State Carrier-Operated Relay and Call Monitor," *ham radio,* June, 1971, page 22.
6. Vern Epp, VE7ABK, "Plain Talk About Repeater Problems," *ham radio*, March, 1971, page 38.
7. K.W. Sessions, Jr., K6MVH, "The Split Site Repeater," *73,* November, 1971, page 39.
8. Donald L. Milbury, W6YAN, "Technological Locusts that Plague the Age of Repeaters," *73,* April, 1971, page 20.
9. Paul Hoffman, W1ELU, Ray Pichulo, W11RH, "Repeater Audio Mixer," *73,* March, 1971, page 57.
10. Paul Hoffman, W1ELU, Ray Pichulo, W11RH, "Repeater Zero Beater," *73,* January, 1971, page 52.
11. K.W. Sessions, Jr., K6MVH, "Optimizing Antenna Separation in FM Repeaters," *73,* September, 1970, page 45.
12. W.B. Kincaid, WA4YND, "A Repeater Controller," *73,* April, 1970, page 34.
13. K.W. Sessions, K6MVH, "Understanding the Carrier-Operated Repeater," *73,* April, 1970, page 41.

ham radio

regulated ac power supply for mobile fm equipment

This low-cost regulated power supply provides a convenient way of powering your mobile vhf fm equipment at your home station

Paul J. Dobosz, WA8TMP, 855 East Commerce Road, Milford, Michigan 48042

If you have been looking for a good regulated 12 to 14-volt dc power supply to use your mobile vhf-fm solid-state gear at home, look no further. This simple low-cost regulated supply will power most solid-state rigs and a beefed up version will power most of the popular rf power amplifiers currently available for mobile use. Power supplies suitable for this purpose are available from electronic suppliers and transceiver manufacturers, but the prices are far from cheap. That fact makes construction of a supply the only economical alternative.

The design is about as simple, versatile and straightforward as a regulated power supply can get. It can be tailored to suit a wide variety of individual needs from milliwatt HT to high-power linear. The best news is the price. The basic 3-amp version costs slightly less than $25, using brand new parts. A 6-amp model can be built for an additional $5. Regulation is between 5 to 8 percent for full load with ripple of not more than 100 millivolts.

the circuit

Transformer selection is not critical as long as the transformer meets these simple requirements. It must provide the necessary secondary current at 15 to 20 volts rms.

The full-wave bridge rectifier can consist of four individual diodes with a PIV of 50 volts or greater, or an epoxy encapsulated bridge can be used. Current capacity of the individual diodes or bridge should be equal to (or preferably, greater than) the amount of current to be drawn from the supply. The use of a pre-packaged bridge is advantageous because of its low cost, compactness and convenience. Individual diodes might prove more economical though if they are readily available.

The capacitive filter consists of a single electrolytic capacitor connected across the output of the bridge rectifier. The only requirement for the capacitor is a capacitance of at least 2000 μF at 35 to 50 volts dc. A smaller amount of capacitance will work but the ripple will increase considerably as the value of capacitance is decreased. If the ripple reaches more than 500 millivolts it will begin to appear on the transmitted signal as hum.

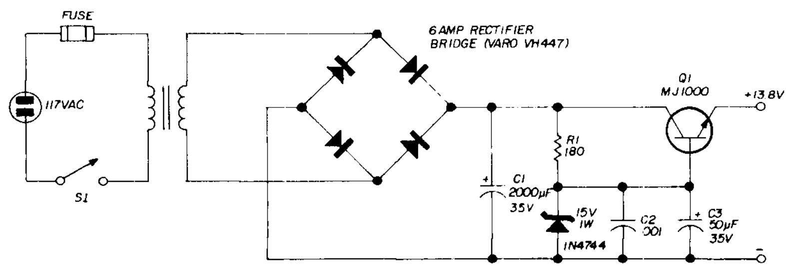


fig. 1. Circuit diagram for the regulated low-voltage power supply. Transformer T1 is a Triad F47U (3 amps) or Triad F48U (6 amps). For current capacity greater than 3 amps, transistor Q1 should be paralleled with another MJ1000 for each additional 3 amps of output current.

regulator

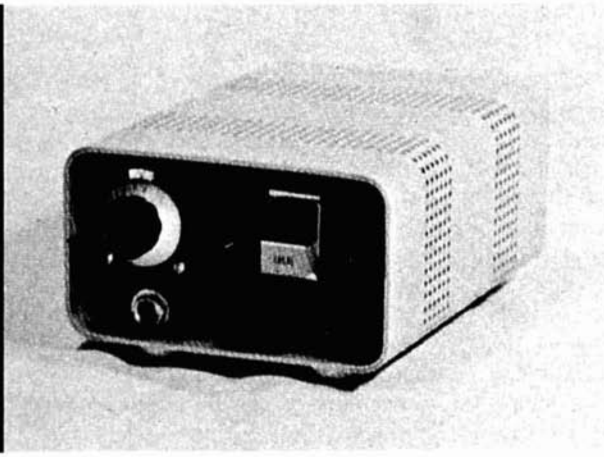
The regulator circuit is a simple series regulator using a zener diode as a voltage reference. The heart of the regulator is the series regulator transistor which is a pre-packaged Darlington amplifier with extremely high gain. This allows the use of inexpensive 1-watt instrument zeners as the voltage reference. The high beta of the MJ1000 transistor means that only one or two milliamps of base current are required to provide each amp of output current. The MJ1000 is rated at 5 amps but it is necessary to reduce the load of the MJ1000 to about 3 to 4 amps per unit because of the power dissipation rating of the device.

This conservative design will prevent thermal damage to the MJ1000. If more than 3-amp capacity is needed, the additional current can be obtained by paralleling MJ1000s along with increases in the capacity of the bridge rectifier and power transformer. Selection of the zener diode voltage should be approximately 1.2 volts higher than the desired output voltage to overcome the two base-to-emitter drops of 0.6 volt each in the Darlington.

construction

The power supply can be constructed on almost any chassis or cabinet. Although it is not absolutely necessary it would be a good idea to fuse both the ac input and dc output of the supply. The MJ1000 should be heat sinked and mounted in the clear so that air can circulate freely. If an epoxy encapsulated bridge rectifier is used it should also be heatsinked. All wiring should be at least no. 18. Layout is not critical so your imagination is the only limit for a custom installation.

ham radio



micropower communications receiver

This high-performance solid-state 20-meter receiver requires less than 80 milliwatts of power

Michael J. Gordon, Jr., WB9FHC, 1615 Elmwood, Wilmette, Illinois 60091

If you've ever tried to operate a typical transistorized receiver from dry-cell batteries you know how expensive it can be. The current drain of most receivers is on the order of hundreds of milliamperes and battery life is short. For example, a General Electric fm transceiver draws 500 mA in the receive mode, with the transmitter section off and the final tube filaments disconnected. At twelve volts this represents total power dissipation of 6 watts, making dry-cell operation impractical. Of course, this is a rather complex receiver and, in that light, this may not be considered an excessive amount of current drain.

However, consider a much more simple receiver such as the *beginners receiver* described in the 1970 ARRL Handbook. This is a direct-conversion receiver and uses only two transistors and a single IC; yet, current drain is 24 mA and power dissipation is about 350 milliwatts.

In the receiver presented in this article the total power dissipation is only 80 milliwatts. Unlike the simple direct-conversion receiver it features performance superior to the receivers in a great many commercial transceivers at least in regard to sensitivity, noise figure and stability.

Selectivity is determined by how much you are willing to pay for a crystal filter, and in this respect a transceiver may be slightly superior, although no significant differences may be noted in use. Also, this receiver covers only one band, twenty meters, and is designed primarily for CW operation.

A low-power receiver is especially advantageous in an emergency situation when the only source of power is a battery. With the low current required by this unit, many hours of operation can be obtained from a single set of batteries. For example, a few surplus sub-C size nicad batteries rated at 750 mA hours will provide more than 60 hours of continuous operation. And, even during non-emergency situations there are advantages to a low power, high performance receiver. When operating portable, for example, a few AA batteries will provide many hours of operation and weigh very little.

used here because of its lower cost compared with a fet. After the signal passes through the crystal filter, cross modulation is no longer a problem so other considerations were given more priority. The last i-f amplifier is coupled to the detector, an RCA CA3028A IC. This IC is well suited for this application and the circuit has extremely high conversion gain and good overall performance as a product detector.[1]

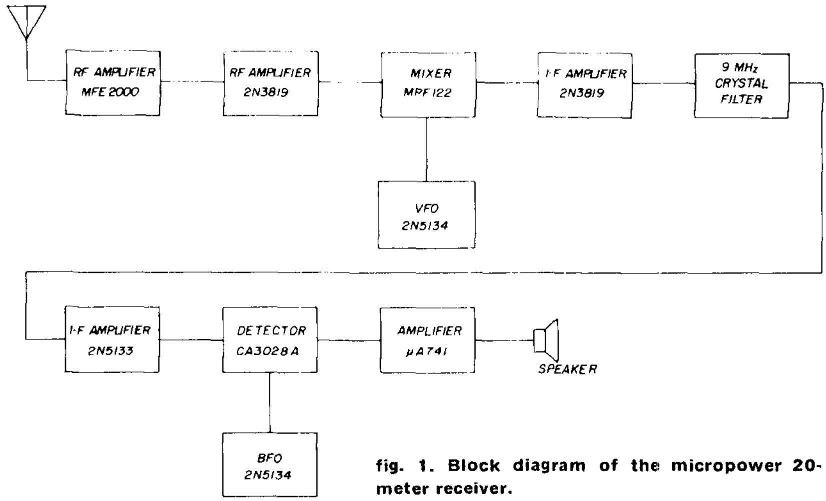


fig. 1. Block diagram of the micropower 20-meter receiver.

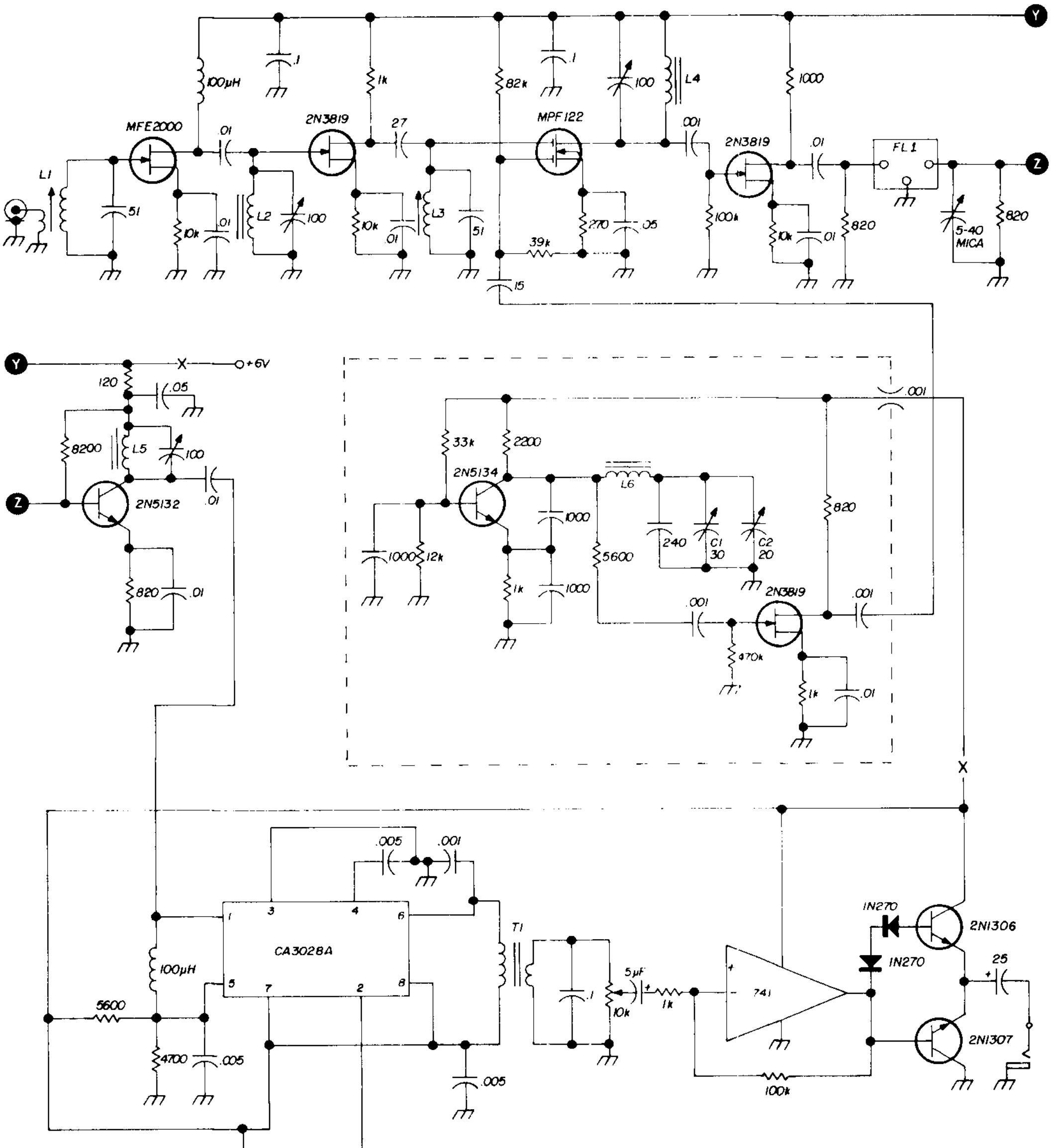
circuit

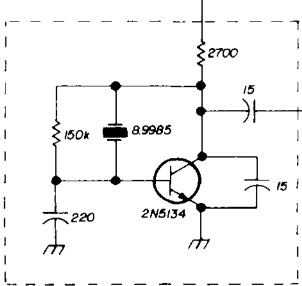
A block diagram of the complete low-power receiver is shown in **fig. 1**. A signal at the antenna is amplified by two fet rf stages and fed to a mosfet mixer. The MPF122 mosfet is a low-cost plastic device and features diode protected gates. The 9-MHz output of the mixer is amplified by another fet which also acts as an *impedance matcher*, transforming the high-impedance output of the mixer to the lower input impedance of the crystal filter.

After filtering, the signal is amplified by a high-gain bipolar transistor. The base-bias network of this transistor serves to properly terminate this side of the crystal filter. A bipolar transistor was

The output of the detector is fed to the audio gain control and from there to the audio amplifier, a simple circuit using an IC op amp and a pair of complementary transistors. The bfo is a single transistor in a simple crystal oscillator circuit; the vfo is a two-transistor circuit. One transistor is in a Vackaar oscillator circuit, the other, an fet, is used as a buffer.

The two rf amplifiers are almost identical, with the exception of the method in which the supply voltage is fed to the drain. In one case an rf choke is used for minimum voltage drop, and in the other a resistor is used. Two stages of rf amplification are used because the gain of a single stage operated at these voltage and current levels is not adequate for the





C1	30 pF maximum, glass piston or air dielectric trimmer
C2	20 pF maximum, main tuning capacitor
L1,L3	1.65-2.75 µH (J.W. Miller 23A226RPC) 4-turn link added to L1
L2	22 turns no. 28 on T-37-2 toroid core
L4,L5	30 turns no. 28 on T-37-2 toroid core
L6	27 turns no. 28 on T-50-2 toroid core
T1	10k:2k miniature audio transformer

fig. 2. Complete circuit diagram of the micro-power receiver. Total current drain with a 6-volt power supply is about 15 mA. The crystal filter is a Hermes X9MA or equivalent.

performance I wanted. Substitution of the MFE2000 is not recommended unless you replace it with a device of similar specifications. Even the 2N3819 produced noticeably poorer performance as far as noise figure and tendency to oscillate are concerned.

The mixer is a standard circuit, and the dual-gate mosfet features excellent conversion gain as well as diode-protected gates and low cost. Gate two is biased at one-third of the supply voltage to increase conversion gain. Oscillator injection is through a 15-pF mica capacitor to minimize pulling of the vfo, whose output is a very stable signal, nominally in the 5.0- to 5.150-MHz frequency range.

The mixer takes the difference between the incoming 14-MHz signal and the 5-MHz vfo to produce the 9-MHz i-f, which is further amplified. The coil in the vfo is a toroid which provides a high-Q inductance in a minimum amount of space. Vfo stability is excellent, partly due to this high-Q coil, and partly because the transistor parasitic capacitances are swamped by external capacitors on all elements. These capacitors must be high quality silver-mica units if any degree of stability is desired.

The first i-f amp is fairly straightforward and it is coupled to the crystal filter through a capacitor. The crystal filter determines the selectivity of the receiver, and if substitutions are made, there are a few things to keep in mind. First, the circuit shown was designed around a surplus four-crystal unit which had no dc path between the output pin and ground. In order for this circuit to work there must be no dc path through the filter between the base of the second i-f amplifier transistor and ground. If there is, the base bias will be upset and the circuit will not function properly.

If your filter has a dc short from the output to ground, as measured on an ohm-meter, simply insert a .01-μF capacitor between the base of the transistor and the filter. The base-bias network current is set to allow for proper impedance termination of the crystal filter specified.

The output of the second i-f stage goes to the product detector which is a circuit from the ARRL Handbook. Although it was not intended to be operated from a 6-volt supply, it seems to work fine at that voltage, having high gain and a good output level.

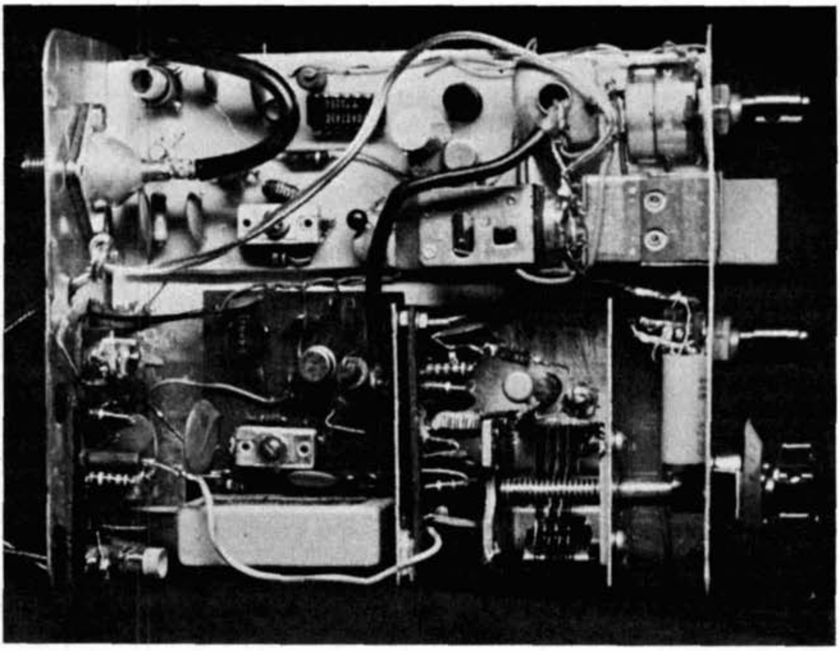
The output of the product detector is transformer coupled to the audio amplifier, which consists of an IC op amp driving a pair of transistors operating in Class B. The current drain of this circuit is extremely low and the amplifier is very efficient. Since there is no provision for avc, and since the receiver is designed primarily for CW reception, the audio amplifier is designed to clip at a certain input level above which the audio output cannot rise. Although this produces severe distortion on strong signals, the ease of copying the CW is in no way affected. This provides a very effective means of limiting the dynamic range of the output volume without impairing performance. In fact, it represents a marked improvement over the receiver with no avc at all.

The output of the audio amplifier is sufficient to drive a pair of sensitive high-fidelity type headphones to adequate volume, if the elements are wired in series. However, the recommended load is a good pair of sensitive 600-ohm headphones. It is important that the headphones shut out as much external noise as possible since the audio output is not great. The output coupling capacitor was selected with this headphone impedance in mind. With lower impedance phones you can expect a loss of low-frequency response.

construction

A modular type of construction was used, with one or two stages in the receiver on each of several printed-circuit boards. All of these boards were made by hand, using nail polish for resist. This method proved to be adequate for circuitry of this type where there are no really tight foil runs. This method is very good because it allows for change in the circuitry as deficiencies show up during construction, without necessarily having to go through a multi-step process of preparing a photographic pattern, exposing the board, and the rest of the work that goes with making a photographically etched circuit board. This is not to slight the photographic process, which is great once you have the breadboard version of your project working and are ready to make a *professional version.**

The vfo and bfo were put into individual compartments for shielding, the former in a small minibox, the latter in an old i-f transformer can. Mechanical stability of the vfo is an important consideration and no effort should be spared to achieve it. The minibox mounted on another chassis proved to be adequate in this case. Everything was mounted in a LMB CO-3 cabinet which presents a fine looking piece of equipment when complete. A low-cost vernier dial was used for tuning purposes, and it works well even though you are not able to read frequency directly from its calibrations.



Construction of the micropower receiver.

*A complete etched and drilled PC board is available from Psynexus Systems, 445 Oakdale, Glencoe, Illinois 60022 for $3.50. A complete parts package is $60.00.

alignment

Alignment is simple, requiring nothing other than a calibrated receiver or transmitter for reference. The vfo is set very simply by placing the main tuning capacitor at maximum capacitance and adjusting the trimmer until the received frequency is that frequency at which you wish the lower band edge to fall.

In view of the fact that the vernier dial will give you only an approximation of what frequency the receiver is tuned to, it is wise for advanced and general-class licensees to set the lower band edge a kilohertz or so above 14.025 MHz so you cannot hear, and therefore will not be tempted to transmit to, any stations outside of your frequency segment. By the same token, the Extra-class licensee should set the low end of the band at roughly 14.001 MHz.

It is not critical where the high end of the band falls so no further adjustments are necessary. You should find that the high end of the band is roughly 150 kHz above the low end. If you find it necessary to change the bandspread, the following information will be useful. First, decreasing the inductance of the vfo coil by removing turns and then adding compensating capacitance in parallel with the main tuning capacitor will increase bandspread. That is, the tuning range will be made smaller. Conversely, increasing inductance by compressing the wire on the coil or adding turns, and decreasing capacitance to compensate will decrease band-spread (a greater range of frequencies will be covered).

Rf and i-f alignment is simply a matter of peaking the various coils for maximum signal strength. A fairly weak signal should be used, and the audio amplifier should be kept below the limiting point by keeping the gain as low as possible. You may wish to temporarily hook up an external audio amplifier for these tests in order to provide more volume. When the unit is properly tuned you will notice a significant increase in the output noise level when your 20-meter dipole is connected up to the antenna terminals. When the band is open, a 3- or 4-foot piece of wire will bring in plenty of signals.

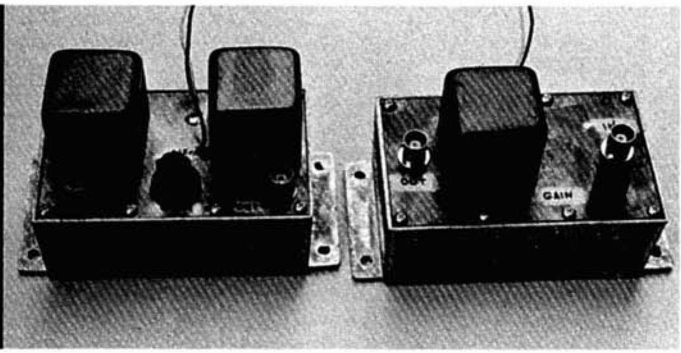
conclusion

All in all, this receiver makes an excellent construction project. The circuit is simple enough for the average ham with a little previous experience to build, yet performance is superior to many commercial transceivers on the market. Cost is reasonable, and the receiver is better insofar as current drain is concerned than anything else available. All you need is a simple QRP transmitter, such as the Ten-Tec TX-1 to make a complete high efficiency amateur station, ready for any portable or emergency situation that may come up.

reference

1. *The Radio Amateurs Handbook*, A.R.R.L., 1970, pages 137-142.

ham radio



high-performance broadband ic amplifiers

Construction details for two broadband IC amplifiers which provide up to 40-dB gain over the frequency range from 1 to 56 MHz

Hank Olson, W6GXN, Post Box 339, Menlo Park, California

Presented here are a pair of IC amplifiers which are useful in a variety of measurement and communication systems problems that lie between 1 MHz and 56 MHz. As such, they encompass the seven lowest amateur bands, providing useful gain at these frequencies.

Both amplifiers make use of the Motorola MC1590G integrated circuit which is characterized as an i-f/rf amplifier by the manufacturer. The more simple of the two amplifiers, **fig. 1,** uses only one broadband 400:50-ohm ferrite transformer, providing approximately 25-dB gain and a noise figure of about 13 dB at 30 MHz. The more complicated amplifier, **fig. 2,** uses two broadband transformers and provides approximately 40-dB gain and a noise figure of about 3 dB at 30 MHz. Both amplifiers have a gain control.

The quoted noise figures for both amplifiers were measured at maximum gain with an AIL Model 75 automatic noise-figure meter. Since the typical noise figure for the MC1590G integrated circuit is the only one specified (6dB at 60

MHz), it is possible that somewhat different values be obtained with individual ICs.

applications

Just what good is a broadband amplifier to the amateur world? Probably the same question was asked about the broadband double-balanced hot-carrier mixer when it first arrived on the scene. Since hams are usually concerned with bands that represent only a few percent bandwidth, broadband devices are not a requirement. However, the convenience of having a broadband device that can be used on *any* of the lowest frequency ham bands, without switching, tuning or adjustment is a real asset in rf measurements or when a system is being first checked for concept.

Consider, for example, that you have just heard on the news that the Russians have launched a satellite that transmits on 40 MHz – complete with dog heart beats. You quickly jury-rig a receiver to hear the satellite transmissions. A signal generator is used for a local oscillator, a double-balanced hot-carrier diode mixer is used to convert 40 MHz to a convenient i-f, say 7 MHz and an amateur-band receiver is used as an i-f amplifier, detector and audio amplifier. The broadband IC amplifier is used as an rf amplifier.

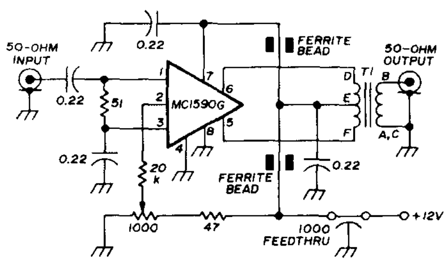


fig. 1. Broadband IC amplifier covers the frequency range from 1 to 56 MHz and provides approximately 25-dB gain with a noise figure of about 13 dB at 30 MHz. Transformer T1 *is a broadband 400-ohms balanced to* 50-ohms unbalanced type such as the North-Hills 556026 available from the author. All 0.22-µF capacitors are Erie Redcaps (see text).

With such a temporary setup you *may* be able to take a first cut at reception of the satellite. If you used 47 MHz as the LO frequency the image at 54 MHz (another ham operator) might provide some occasional unwanted interference,

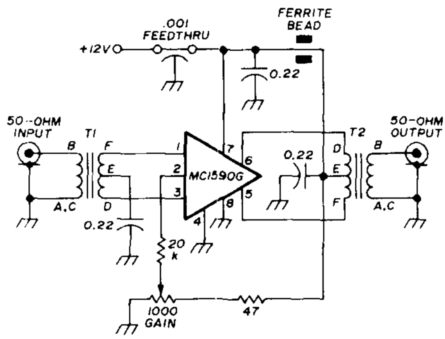


fig. 2. This broadband IC amplifier uses two broadband transformers to provide 40-dB gain with a noise figure of about 3 dB at 30 MHz. Transformers T1 and T2 are broadband 400-ohms balanced to 50-ohms unbalanced types such as the North-Hills 556026-336 available from the author. All 0.22-µF capacitors are Erie Redcaps (see text).

but at least you would have an operating receiver system.

A second illustration is one where a measurement problem exists. A transistorized heterodyne exciter is being built. In the exciter two oscillators are mixed together and they are *supposed* to provide an output at 29 MHz from the mixer. However, it is possible to have mixed a harmonic from one of the oscillators (or both), and it is also possible to get either the sum or the difference frequency out of the mixer. You want to use a frequency counter on the output of the mixer. However, the mixer output level is far too small to operate the counter. By putting the broadband IC amplifier after the mixer, the output can be brought up to 0 dBm (0.225 volt rms across 50 ohms). This will operate most counters.

The first illustration is a case where it would be desirable to use the more complicated broadband amplifier because of its lower noise figure. In the second example the more simple broadband amplifier probably would have been adequate. The single-transformer amplifier, having a 51-ohm resistor across its input terminals, represents an almost pure resistive impedance that is quite unlikely to upset the circuit being tested (if it is made to drive 50 ohms).

It was not intended in either example that the use of broadband amplifiers represent an optimum solution, but rather, a quick one — from which an assessment of system problems can be made.

Whether or not a broadband amplifier should be used as a preamplifier ahead of a communications receiver is open to question. It is often true that you get a better noise figure with a preamp ahead of the receiver and therefore, better sensitivity. However, the extra gain of the preamp will, in general, reduce the dynamic range of the receiver. This usually has the consequence of causing cross-modulation in some stage of the receiver.

construction

Both broadband amplifiers are built into cast-aluminum Pomona 2905 boxes which measure about 1½x2½x4¼ inches. These boxes are normally furnished with an aluminum top plate. In these amplifiers this plate is replaced by a piece of double-sided copper printed circuit board. The copper laminate makes an excellent ground plane and provides good grounding. Note that pins 4 and 8 of the IC socket are bent down and soldered to the copper ground sheet. This provides both a low inductance ground and mechanical support for the socket.

The sockets I used for the MC1590G ICs are Robinson-Nugent type LP-5178. The 400-ohm balanced to 50-ohm unbalanced transformer is similar to the North-Hills 0600AA. The 400:50-ohm transformer I used is a special unit (556026-336) that I obtained as a project overrun item.* The transformers are mounted above the copper-laminate plate with their pins protruding through to the circuitry side. Pins A and C are grounded and pin B connected to the adjacent BNC jack. Pin E is the center-tap of the balanced 400-ohm side with D and F the high ends.

The long spider-like legs of the IC socket (pins 5 and 6) are bent a bit and soldered directly to the D and F pins of the output transformer. This provides short, low-inductance connections and gives additional support to the IC socket.

Since the amplifiers must operate over wide bandwidths, it is important to use

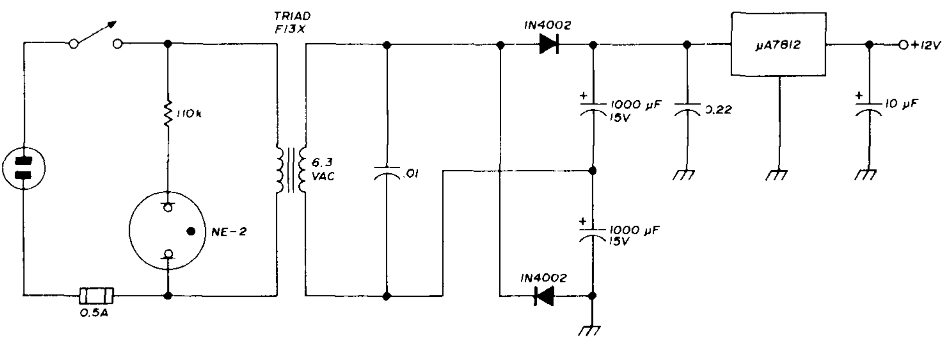
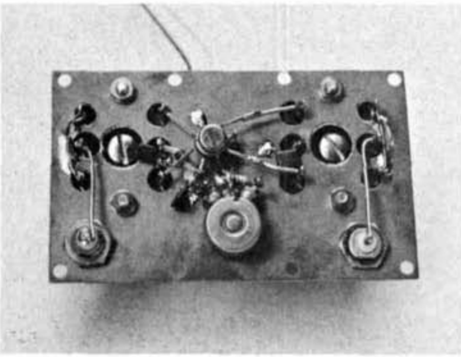


fig. 3. Simple regulated power supply for the broadband amplifiers uses a Fairchild μA7812 voltage-regulator IC (Fairchild part number UGH7812393).

*Available for $5.00 plus 50 cents postage, each, from Hank Olson, Box 339, Menlo Park, California 94025.

relatively large-value, low-inductance capacitors for rf bypassing and coupling. The particular types of 0.22-μF capacitors I used are Erie Redcaps which are small ceramic units. If these capacitors *cannot be readily obtained it would be* better to use 0.01-μF or 0.02-μF ceramic discs that to use a standard foil-type 0.22-μF capacitor such as a Mylar type. The smaller 0.01- or 0.02-μF disc ceramic capacitors may cause some loss of gain at the lower end of the passband, but that's preferable to having highly inductive capacitors at the high frequency end.



Construction of the broadband IC amplifier. Note the simple, direct-path wiring for minimum inductance.

The ferrite beads used to decouple the +12-volt supply line between different bypassed points in the circuit are made by a number of manufacturers, including Ferroxcube, Stackpole and Allen Bradley. They *are also available in smaller quantities* from Amidon Associates, 12033 Otsego Street, North Hollywood, California 91607.

A simple regulated power supply for the IC amplifiers is shown in **fig. 3.** Although the supply is capable of considerably more output current, the amplifiers require only about 40 mA. The use of *a 6.3-volt ac filament transformer, a* full-wave voltage doubler and an inexpensive three-terminal voltage-regulator IC make this supply not only a good performer, but also low in cost.

ham radio

using the Heath SB-650 frequency display with other receivers

Complete details on modifying the popular SB-650 for use with the Allied SX-190 and other receivers

Marvin R. Clinch, K2BYM, 4500 Skenandoah Drive, RD 2, Oneida, New York 13421

The **introduction** of the Heath SB-650 frequency display unit has provided a relatively easy means of adding a digital frequency display to the Heath SB and HW receivers and transceivers. The SB-650 provides a decimal readout of the frequency to which the receiver or transceiver is tuned to the nearest 100 Hz. This article describes a means of using the display with virtually any receiver without permanent modification of the SB-650. The entire modification effort takes less than an hour and can be removed in five minutes if you wish to return the frequency counter to its original configuration.

the counter

The SB-650 is designed to accept three input signals from each of the three oscillators present in Heath receivers and transceivers. These are the high frequency oscillator (hfo), a switched fixed frequency oscillator; the linear master oscillator (LMO), a variable frequency oscillator of limited range; and the beat frequency oscillator (bfo), an oscillator either fixed or variable, usually around 455 kHz.

The heart of the SB-650 frequency display unit is an integrated-circuit up/down counter which provides the capability to count and add or subtract frequencies. The Heath design counts the hfo frequency, then counts down to subtract the LMO frequency. The result of this set of operations is then displayed on a set of Nixie digital displays. The

Nixie tubes display the operating frequency to the nearest 100 Hz.

mixing combinations

A block diagram of a hypothetical receiver with only the oscillators and mixers is shown in **fig. 1.** There are a number of ways the oscillator frequencies may be set to receive a given frequency signal and still produce the same frequency output. First, let us assume that the last i-f is 455 kHz. The bfo frequency is also 455 kHz, plus or minus a few kHz. For the purposes of discussion assume that it is exactly 455 kHz, thus providing a zero beat with any incoming signal which is precisely tuned to the center of the i-f bandpass filters. More on this later.

Now, the mixing of two signals to generate a desired frequency can be shown in **eqs. 1** and **2.**

$$F_3 = F_2 - LMO \quad (1)$$

$$F_3 = LMO - F_2 \quad (2)$$

In these equations, only the difference frequency is considered. It is assumed that appropriate filtering is available to remove the sum and fundamental frequencies. Thus, F_3 (455 kHz) can be generated if the LMO frequency is 455 kHz below the input signal frequency (**eq. 1**) or if the LMO is 455 kHz above the signal frequency (**eq. 2**).

Similarly, F_2 can be generated if the hfo frequency is either above or below the incoming frequency (F_1) by F_2 (**eqs. 3** and **4**

$$F_2 = F_1 - HFO \quad (3)$$

$$F_2 = HFO - F_1 \quad (4)$$

By substituting and re-arranging terms, it

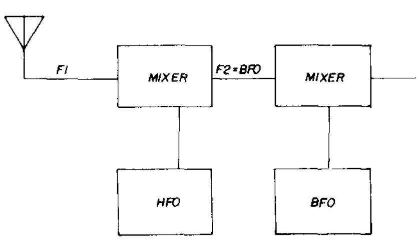


fig. 2. Simple single-conversion receiver uses only two local oscillators.

is possible to come up with four different methods of finding the input frequency F_1

$$F_1 = HFO + BFO + LMO \quad (5)$$

$$F_1 = HFO - BFO + LMO \quad (6)$$

$$F_1 = HFO - BFO - LMO \quad (7)$$

$$F_1 = HFO + BFO - LMO \quad (8)$$

$$F_1 = HFO - BFO \quad (9)$$

$$F_1 = HFO + BFO + LMO \quad (10)$$

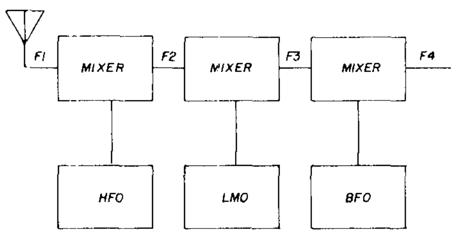


fig. 1. Simplified block diagram of a double-conversion communications receiver. Signal frequencies F1, F2, F3 and F4 are discussed in the text.

If you look at these equations for a minute you'll see that the frequency to which the receiver is tuned can be found by simply counting and adding or subtracting the various oscillator frequencies. This in no way requires an input signal from the first rf stage of the receiver. The Heath SB-650 is designed to operate with equipment meeting the parameters of **eq. 7.**

modifications

With only slight modification of the input and control circuits it is possible to use the SB-650 with receivers configured to meet **eqs. 6, 8** or **10.** A single-conversion receiver meeting **eq. 9** and configured as shown in **fig. 2.** may be accommodated without modifying the SB-650.

The counter portion of the SB-650 makes a complete count every 160 milliseconds. This time is divided up into four equal periods of 40 milliseconds each, t_1 through t_4. During the first three of these periods the counter counts the appropriate frequencies, and during the last, the final count is transferred to the display. A pair of control signals are generated by the digital timing circuits every 40 milliseconds to control these operations.

Each IC counter (SN74192N) has two input lines. With the proper manipulation of these input lines, the counter can be made to count up, count down (by

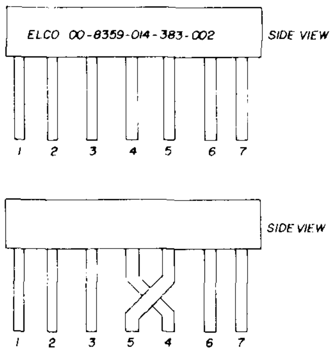


fig. 3. Modification of a 14-pin IC socket to change the counting arrangement of the SB-650. IC-12 is removed from the SB-650, this midified socket is plugged in, and IC-12 is plugged into it.

counting backwards), or not to count at all, as shown in **table 1.** Since the control signal is digital, the digital convention is used, a 1 being a high voltage (5 volts nominal for the SN7400 series of ICs) and a 0 being a low voltage (zero volts nominal). These logic signals are applied to the counter inputs to cause the counters to count up, down or to inhibit the count. The *signal* of **table 1** consists of the frequency being counted. This signal is previously shaped to consist of alternate ones and zeroes.

The SB-650 has one period of count up and two periods of count down. For the Allied SX-190 receiver you need *two* periods of count up and *one* period of count down. To make the change simply follow the instructions. Take one 14-pin IC socket (ELCO 8359, 014-383-002) and bend the socket pins 4 and 5 as shown in **fig. 3B.** Put a piece of insulated tubing over one of the two leads just bent (heat-shrink tubing is best). File each lead to a taper so that it may be inserted into IC socket in the SB-650. Now, remove IC-12 from the SB-650. Plug the modified socket into the IC-12 socket and plug IC-12 into the modified socket. The counter will now count up for two periods and down for one period. There is no change in the display cycle.

After the modification, the hfo input signal counts down while the bfo and LMO inputs are counted up. This does not yet meet the requirements for the SX-190. However, this is no real problem. You only have to shift the input circuits around. The hfo input has a selected fet for better high-frequency response, so you want to retain it as the hfo input (count up). To do this, you have to make two more jumpers for the appropriate logic inputs and outputs.

Take two more 14-pin IC sockets and bend the pins outward as follows: on one socket bend pins 2 and 6 as shown in **fig. 4.** On the other socket bend pins 3 and 13 as shown in **fig. 5.** File the remaining socket pins so they can be plugged into another IC socket. Now solder a 4- or 5-inch piece of insulated hookup wire to each of the bent pins on the first socket. Cover the soldering pins with insulating tubing. Tin the other end of each wire.

Slip another piece of spaghetti over the wires and solder the wire from pin 2 of the first socket to pin 3 of the other socket. Solder the wire from pin 6 of the first socket to pin 13 of the other socket. Slide the spaghetti over these connections. Remove IC-24 from the SB-650 and insert the first modified socket in its place. Insert IC-24 into the new socket. Now remove IC-10 and insert the second modified socket in its place. Re-insert the IC-10 in its new socket. Now connect the terminals on the back of the SB-650 as

table 1. Counting periods and inputs to the Heath SB-650 frequency display unit.

	time	input 1 (pin 4)	input 2 (pin 5)
T1	count up	1	signal
T2	count down	signal	1
T3	count down	signal	1
T4	display	1	1

shown in **table 2.** With the counter modified in this way and the input connections shown in **table 2** you can use the counter for receivers which are designed to meet **eqs. 6** or **8.** The Allied SX-190 follows **eq. 8.** Simply connect the receiver outputs to their respective counter input terminals and use it as described in the SB-650 manual.

receiver oscillators

The SB-650 input uses a high impedance fet. The Heath Company recommends you use 50-ohm coaxial cable to connect the receiver to the counter (RG-58A/U). It is possible that the loading effects of the coaxial cable may stop the oscillator from oscillating. Such appeared to be the case with the SX-190 bfo even though the counter was not connected to the cable. The buffer amplifier shown in **fig. 6** was connected to the bfo through a 7-pF capacitor to reduce any loading on the bfo. With this buffer in the circuit the oscillator worked without any problems. The same fet buffer circuit may be used for other oscillators which are sensitive to loading.

tuning

Since the SB-650 was designed primarily for ssb equipment with fixed beat-frequency oscillators, proper technique must be used when the receiver has only a variable bfo, and is used on CW or a-m signals. First, tune the receiver to the desired signal for maximum signal strength (that is, tune it to the center of the receiver i-f passband). Now, turn the bfo on and zero beat it with the signal. Now the incoming signal (after conversion) and the bfo are exactly the same frequency, and the SB-650 will be able to read the incoming frequency within the nearest 100 Hz. (The human ear can zero beat well below 100 Hz difference, so you don't have to worry about accuracy.)

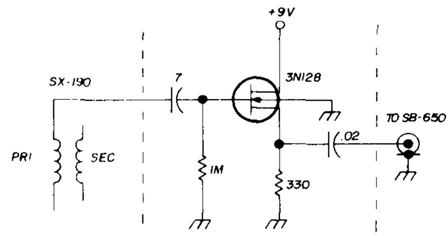


fig. 5. Buffer amplifier may be useful where coaxial cable loads down the oscillator circuit.

If you are receiving an a-m signal turn off the bfo and note that the frequency counter has changed frequency by the amount of bfo frequency. If you are receiving a CW signal, when you tune the bfo to provide a good CW tone the counter display will change by the bfo frequency change. Just remember that for a proper count the variable bfo must be turned on and zero beat with the incoming signal.

other receivers

The SB-650 frequency counter can also be used for single-conversion receivers which meet either **eq. 9** or **10.** It should be cautioned, however, that for a band-switching receiver all of the bands must meet the same set of mixing relationships.

For a receiver meeting **eq. 9,** simply connect the hfo and bfo from the receiver to the counter. It would also be best to terminate the LMO input with a 50- or 52-ohm resistor to prevent noise spikes from causing faulty readout. If you have a single-conversion receiver meeting **eq. 10** modify the counter as described above and connect as shown in **table 2** for **eq. 10.**

What if you don't know which way

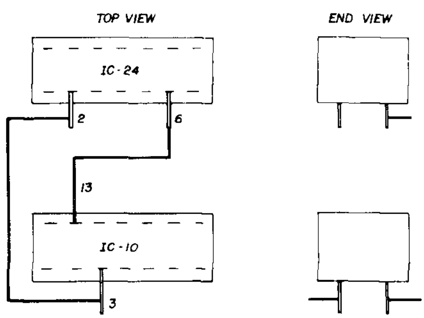


fig. 4. Simple technique for rearranging the input circuitry of the SB-650 (see text).

your receiver is designed? Just use the counter to measure your local-oscillator frequencies. Terminate the LMO and bfo inputs with 50-ohm resistors. Now, tune the receiver to some appropriate frequency and connect the counter hfo input to each of the receiver oscillators. Calculations will show the frequency arrangement of the receiver and which equation the receiver meets.

other uses

The Heath SB-650 frequency display is

table 2. Input connections to the modified SB-650 frequency display unit.

SB-650 input	eq.6	eq. 8	eq. 10
HFO	HFO	HFO	none
BFO	LMO	BFO	BFO
LMO	BFO	LMO	HFO

Input connections to unmodified SB-650

SB-650 input	eq. 7	eq. 9
HFO	HFO	HFO
BFO	BFO	BFO
LMO	LMO	none

a most versatile piece of equipment and can be used with many receivers. It can also be used as a standard frequency counter up to 30 MHz with resolution of 100 Hz. One unit tested by WA2DJU ran up to nearly 50 MHz with only a slight degradation of sensitivity. Transmitter frequencies may also be counted if the signal is kept to a point where the counter is not damaged. However, take precautions to make sure that the ratings quoted by Heath are not exceeded. The input mosfet is tough but it cannot be abused.

I would like to express my appreciation to Edward A. Murphy, a serious SWL, who brought up the original question about the SB-650's added capabilities and who was willing to gamble on my suggestions. Thanks are also due to Mr. E.J. Cupples, WA2DJU, who tested the frequency response of the SB-650 and provided the fet buffer amplifier circuit.

ham radio

SBE

SB-50

50.050-50.280 MHz

SSB and AM . . . push button selection.

six shooter

SBE scores again, encourages occupancy of the higher frequency amateur bands with moderately priced, full-feature equipment.

Now—**hit** those challenging 6 meter targets—**be there**—be ready instantly for those thrilling DX breakthroughs and skip happenings. In the interim, join a select group who have discovered that mobile SSB on the low end of 6 approaches the ideal for solid, uncluttered local contacts. Here **now**—from SBE, SB-50, a very tidy package that provides all the ammo you need for 6 meter bullseyes! **Synthesized frequency selection** is an example in point: No crystals to buy, no concern about VFO stability. The band between 50.050 and 50.280 MHz is divided into 23 channels, spaced at 10kHz intervals. A clarifier control allows the master crystal frequency to be moved anywhere between two 10kHz points. SBE, SB-50, is a transceiver but switching to RIT enables a drifting signal to be zeroed without affecting transmitter frequency. A fine receiver with high sensitivity insures that the weak ones will be heard during band openings. Exclusive SBE "Super Shape" BP filters provide excellent SSB/AM response, both transmit and receive. A lighted panel meter monitors what's coming in—and going out. Squelch, noise limiter contribute to performance. Power input is 20 watts p.e.p. on SSB, 8 watts on AM. Equipment is all solid state, easy on car battery. Dynamic microphone is provided.

SEE IT AT YOUR SBE DEALER

SYNTHE-SIZED! No crystals to buy.

Tunable ±6kHz, any 10kHz point.

Receiver frequency separately adjustable with RIT

Lighted meter shows "S" units receive—power output SSB/AM

SBE exclusive "Super Shape" Bandpass SSB filter

All solid state. Low drain on 12V car battery.

SBE

LINEAR SYSTEMS, INC.
220 Airport Blvd.
Watsonville, CA
95076.

More Details? CHECK—OFF Page 94

logic oscillator

for multi-channel crystal control on vhf fm

Using digital TTL ICs in a logic oscillator to provide a bank of selectable crystal frequencies

Stirling Olberg, W1SNN, 19 Loretta Road, Waltham, Massachusetts 02154

The acquisition of several Motorola fm mobile rigs, which are single-channel vacuum-tube rigs, required modification to include at least six additional receiving and transmitting frequency controls. Since the space to include the additional tubes and components is at a premium within these chassis, TTL ICs seemed to be appropriate for the additional circuitry.

These components are mounted on a small board which has a modified FT-243 crystal holder, epoxied to one end, allowing it to plug into the Motorola crystal socket. The wiring to the 12-volt power supply and a frequency selector switch have separate connections which will be described later.

the circuit

The circuit consists of six individual crystal oscillators which may be adjusted exactly to the required frequency by a trimmer capacitor, C1. The input to each oscillator is turned on when the selector switch is set to the desired crystal frequency. Only one of the oscillators is in operation at one time, as will be explained using channel 1 as an example. In this discussion a logic 1 is a plus voltage and a logical zero is ground.

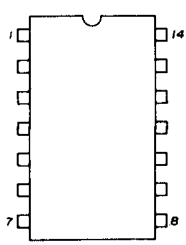
The frequency selector switch is set to channel 1, grounding the logical 1, provided by R13 at the input of inverter U5, to a logical zero. The conversion at the output of U5 presents a logical 1 to an input of U1, turning on the oscillator. The oscillator output is fed to another inverter, U4, which presents a buffered output to the receiver or transmitter it is used with. All channel outputs are in parallel.

A TTL logic level of 3 volts average is the rf level at the combined oscillator outputs; this provides sufficient drive to the original oscillator grid. This output is a square wave but offers no problem, because the original vacuum-tube oscillator now acts as a buffer and since it has a tuned output circuit, it provides a sinusoidal output.

Five-volts dc is required for the logic circuitry. This is controlled by the simple voltage regulator built around transistor Q1. This regulator insures that the 5 volts for the logic circuits will be held stable when operating from an auto-battery charging system.

installation

The control wiring in my car consisted of a section of seven-conductor shielded intercom cable. The frequency selector switch is located at the control head, near the front seat of the car. In this installation the receiver and transmitter have independent frequency controls allowing cross channel listening and operating. If this feature is not desirable,



TOP VIEW

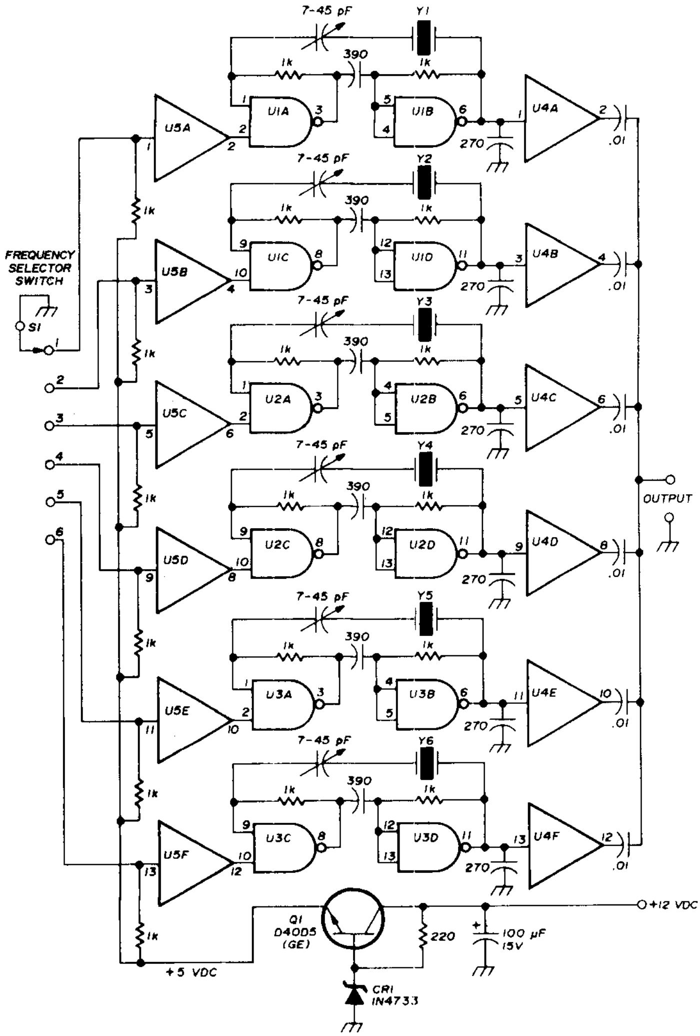


fig. 1. Schematic diagram of the 6-channel crystal-controlled oscillator. Simple control is possible because of the logic of the TTL ICs which are used in the circuit. ICs U1, U2 and U3 are SN7400N quad NAND gates; U4 and U5 are SN7404 inverters. Crystals are Jan Crystals type 4C-6/U, frequency as required. Switch S1 is a Mallory 8511496. Although not shown on the drawing, pin 14 of all ICs is connected to the regulated 5-volt line; pin 7 of all ICs is connected to ground.

the two switches may be ganged together. The 12-volt dc power was supplied from the filament string.

summary

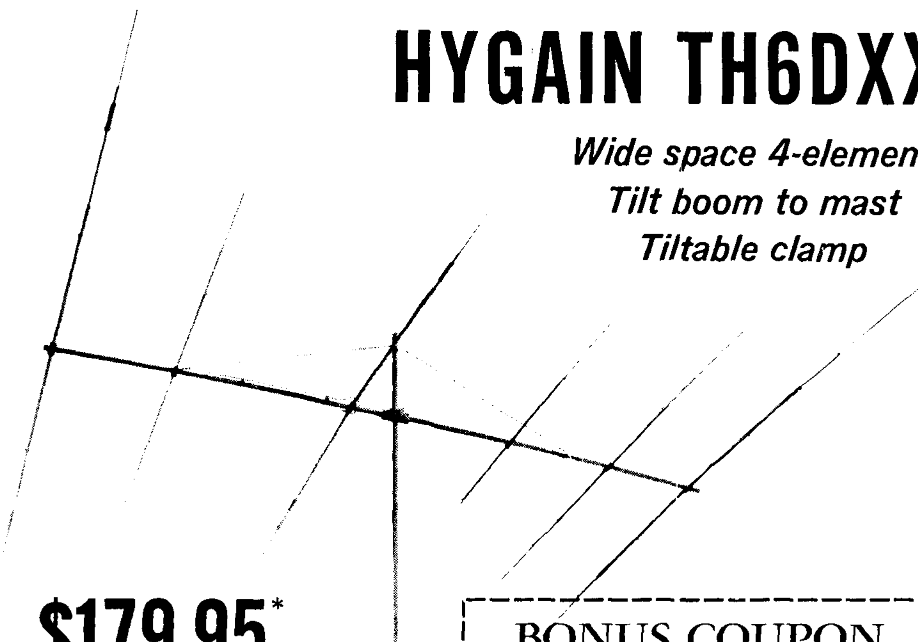
It might seem, at first glance, that this offering does not add much to improve a piece of equipment simply because it uses ICs and some well known logic facts. The fact is, however, that it adds an indefinite number of channels, in a very limited space, with a modest amount of effort. It can be built and installed in one evening's work into almost any receiver or transmitter which requires additional channels.

ham radio

Antenna KING

HYGAIN TH6DXX

Wide space 4-element
Tilt boom to mast
Tiltable clamp



$179.95*

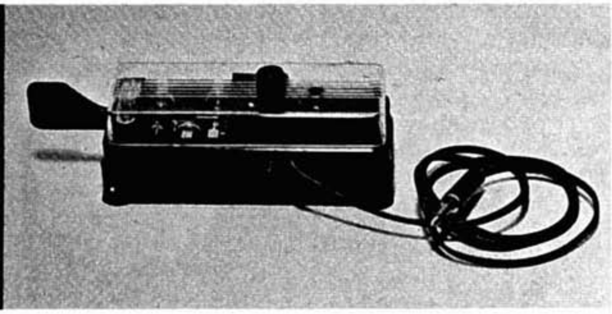
BONUS COUPON
FREE
1 BN-86 balun
100 ft. RG8 low loss foam
WITH EVERY TH6DXX
AND THIS COUPON

*FREIGHT PREPAID in Continental USA

ANTENNA KING
Box A
Lomita, Calif. 90717
Phone (213) 534-"KING"

More Details? CHECK–OFF Page 94

More Details? CHECK—OFF Page 94



solid-state bug

An improved version of the semi-automatic key using the principles of the solid-state switch

Arthur J. Glazar, K2FV, 31 Amapola Lane, Kings Park, New York 11754

Automatic CW generators are not for me. I enjoy hand sending and suspect there are many other operators who are turned off by anything more automated than a bug. But the bug can stand improvement, and this article describes one operator's approach to modernizing the semi-automatic key. I wanted to maintain the bug's basic operating characteristics and features (automatic dots, manual dashes, and portability) while eliminating its shortcomings (mechanical dot system, unreliable contacts, and awkward speed control). The design goals were: conveniently adjustable speed during operation, all solid-state design, low-drain battery operation, single unit construction and a "feel" identical to a conventional bug. The result is the solid-state bug shown in the photograph. The circuit is built into a modified Lafayette bug.* The dot spring and damper were removed to make room for the five-transistor circuit shown in **fig. 1.**

features

Dot speed is knob-controlled and adjustable from 4 to 22 dots per second. The dot weight control is a screwdriver adjustment to avoid confusion during operation and is variable from about 25 to 100 percent weight. Once set, the

*Lafayette Radio Electronics Catalog number 99P25520, $14.75.

weight remains constant over the speed range. At maximum weight the dots merge, and the key becomes a sideswiper rather than a bug. This mode of operation, may hold some appeal to mobile marine operators.

The circuit operates from a 9-volt transistor radio battery and draws no current during key-up conditions, thus assuring long battery life and eliminating the need for an on/off switch. The output capability the resistor values should be halved; to halve the current the resistor values should be doubled, and so forth. Because battery drain increases in direct proportion to current requirements, the largest resistor values should be used. With the values shown, key-down battery drain is less than 6 mA. At that rate, battery life should approach shelf life.

Note that bilateral operation of the key depends on the ability of the battery

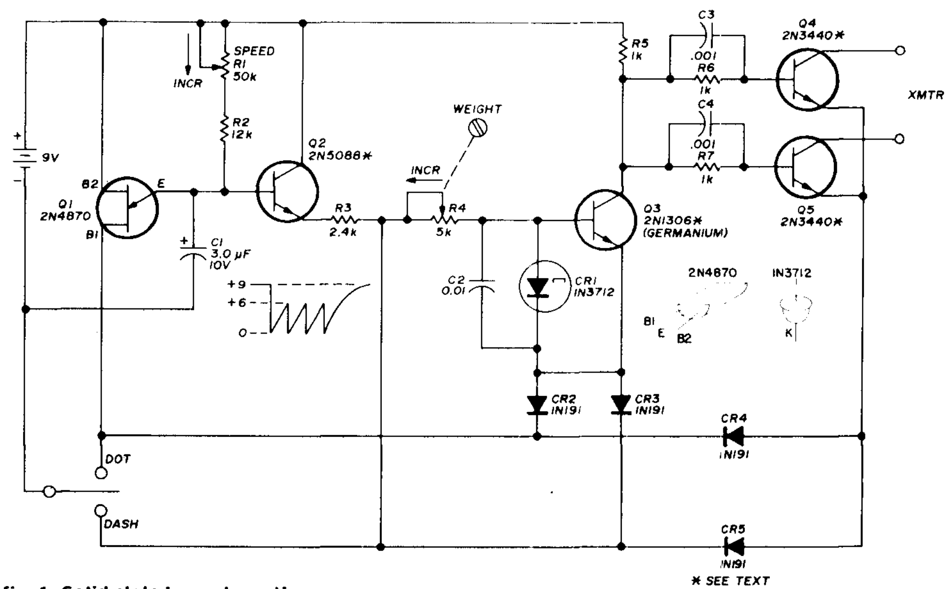


fig. 1. Solid-state bug schematic.

of the bug is, in effect, that of a solid-state relay. It is a bilateral transistor switch capable of keying circuits up to 250 volts at 15 or more mA. Polarity need not be observed when connecting the bug to the keyed circuit. Transistors less expensive than the 2N3440 may be substituted for Q4 and Q5 if only low-voltage circuits are to be keyed. The 2N3440 has a V_{CBO} of 300 volts.

The amount of current that can be keyed is determined by resistors R5, R6, and R7. With the values indicated (1k) the circuit should handle at least 15 mA and perhaps double that amount; the maximum being a function of transistor gain.* To double the current-carrying

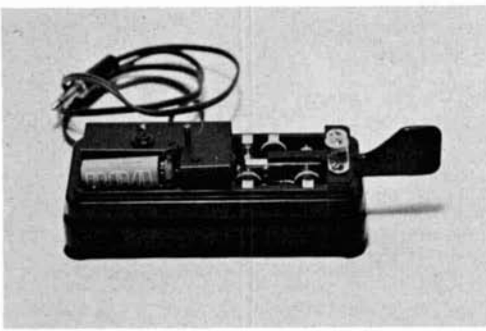
to float with respect to the keyed circuit. Therefore there must be no direct connection between the battery and any transmitter voltage bus, including ground.

circuit

The bilateral output swtich[1] is closed when Q3 is off, and base current is therefore supplied to Q4 and Q5 via R5, R6, and R7. When a dash is made, Q3 is turned off by returning the junction of R3 and R4 to battery negative, thus removing its base drive. Closing the dot contact starts the dot generator, Q1,

*Actually, the *inverted* gain of Q4 and Q5. See reference 1.

which applies negative-going dot pulses (via emitter-follower Q2) to the base of Q3, thus turning it off. The dot generator is a unijunction transistor relaxation oscillator.[2] It is idle until the dot contact is closed, which connects the base 1 (B1) terminal to battery negative and permits it to oscillate. As long as the dot contact is closed, the voltage on C1 approximates a linear saw-tooth waveform, oscillating between about 0.6 volt (with respect to



The bug with plastic cover removed, showing the battery at left front, the speed-pot shaft protruding vertically from the chassis, and the weight control to the left of the speed pot.

battery negative) and 6.2 volts, the exact amplitude being a function of Q1 parameters.

The oscillation frequency is determined by R2, C1, and the speed-control pot, R1. The sawtooth on C1 is applied through emitter follower Q2 to a variable threshold level detector comprising R3, R4, tunnel diode CR1, and transistor Q3.[3] The high input impedance of the emitter follower (roughly 700k) prevents capacitor loading.* The voltage at which the level detector trips is determined by the setting of the weight control, R4. Q3 is turned off when the sawtooth is below the preset level. The higher the threshold level (i.e., the higher the value of R4), the longer the dot duration becomes.

*The 2N5088 is an inexpensive plastic transistor with an h_{FE} of about 300. Any other npn with a gain approaching 100 can be used for Q2. Q3, however, must be a *germanium* npn.

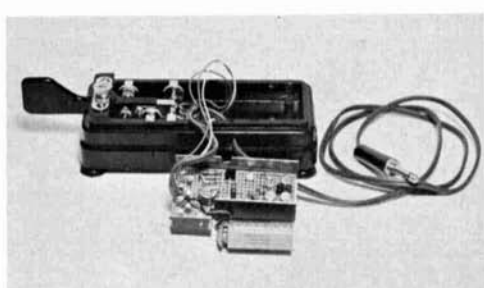
Note that Q3 emitter is permitted to return to battery negative only during keydown: through CR2 for dots, and through CR3 for dashes. Thus, Q3 cannot draw current during keyup. A similar situation exists for the emitters of Q4 and Q5, which return to battery negative through CR4 for dots and through CR5 for dashes. The purpose of this latter arrangement is to *prevent* the dots from self-completing, thereby preserving the feel of a standard bug.

Capacitor C2 is essential to prevent stray rf from tripping the tunnel diode. Capacitors C3 and C4 were found, by trial and error, to be most effective in further desensitizing the circuit to stray rf.

construction

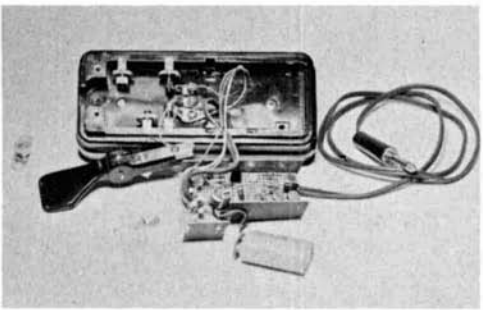
The circuit is built on a small L-shaped piece of 0.1-inch perforated board. To keep component height to a minimum no sockets are used. The board is mounted upside-down on 5/16-inch spacers inside a U-shaped chassis. The inverted U rests inside the bug's base and conceals all the circuitry. An extra fold in the U permits easy access to the battery. The chassis simply rests in the base with no fastening; the plastic cover affords adequate hold-down, since it fits snugly on the base. For traveling, a rubber band around the entire unit works nicely to keep everything secure.

The speed-pot shaft extends through the plastic cover, and the weight adjustment simply requires a hole for screwdriver access.



Circuit components shown when the chassis is lifted from the base and inverted.

The photos should give sufficient information to duplicate the solid-state bug. One suggestion may save time for someone attempting to disassemble a Lafayette bug; the base is weighted with three pieces of sheet iron, which fit snugly in the underside of the base. They are held by two screws and considerable friction. (The screw heads are visible in the top view photo of the disassembled bug.) Once the four rubber feet and the



A top view of the disassembled bug. Two Phillips-head screws can be seen, which hold the sheet-iron weights in the base. Toward the right can be seen slots where original binding posts were removed to make room for the chassis.

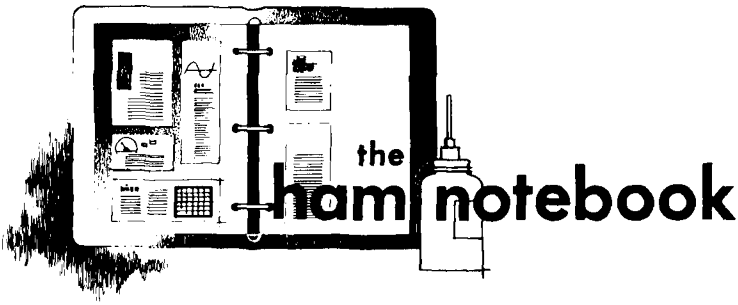
two screws are removed, the sheet iron must be forcibly dislodged by poking through the screw holes and by slamming down the base.

With the sheet iron out of the way, the contact wiring is accessible and must be modified to spdt operation. I found it necessary to carve away some of the plastic base material to accommodate the re-routed wiring, but this was easily accomplished with a sharp wood chisel. The dot, dash, and common connections are brought to the top surface of the base by means of three countersunk flathead 6-32 screws. On top, solder lugs are used to make connection to the circuit.

references

1. "GE Transistor Manual," (Seventh Edition) General Electric Company, Syracuse, New York, 1964, Chapter 3.
2. Ibid., Chapter 13.
3. Ibid., Chapter 14.

ham radio



crystal control and narrow shift RTTY with the Heath SB-series

The RTTY enthusiast interested in narrow shift auto-start faces two problems with the Heath SB-Series of receivers and transceivers. The first problem is modifying the receiver to receive narrow shift with the optional 400-Hz filter. This filter, unlike the ssb filter, is centered at 3395.4 kHz and will not pass the standard tones of 2125 and 2295 Hz. It is therefore necessary to move the bfo injection frequency to 3393.190 kHz. This frequency is somewhat critical and dependent on the actual filter bandpass. It is possible to use a bfo crystal provided with the receiver to provide the proper injection frequency.[1]

Although the Heath LMO is known for its extremely good stability, it will not hold the frequency well enough to provide unattended auto-start operation over a period of weeks or months. There are two solutions to this problem. One is to crystal lock the receiver. This is not quite the same thing as crystal control. In the crystal lock mode, a crystal is tied from the grid to ground of the variable oscillator tube. The oscillator tuning then allows varying the frequency about 50 Hz either side of the frequency determined by the crystal. The fine tuning effect and the simplicity of this method make it quite desirable.

On the negative side, the crystal lock method does not allow for quick change from one auto-start frequency to another, and in many cases it is not possible to pull the crystal far enough to hit the desired frequency. It is usually possible to pull the frequency about 50 Hz. It may be difficult to purchase a crystal this close to the desired frequency. Also, crystals and oscillators have been known to change enough that the crystal lock method fails after a time. However, this is unusual.

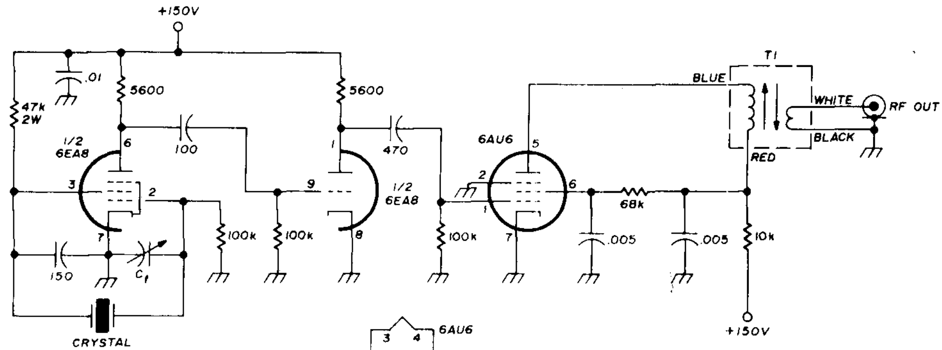
I had the problem that the high-quality (high-price) crystal I ordered would not hit the frequency in the crystal locked mode. I decided that the XT-4 oscillator[2] with its low-capacitance circuit would allow more variation in output from a given crystal than any other oscillator that I was familiar with.

The XT-4 was built, and the output frequency was adjusted to center the receiver on the auto-start frequency. I had the receiver crystal controlled on frequency now, but receiver sensitivity was degraded by insufficient mixer injection from the XT-4. Several cures were tried, such as tuned output on the XT-4, but injection was insufficient in all cases until a buffer stage was added.

Fig. 1 shows the modified XT-4 circuit with the frequency-shift keyer removed. It would be advisable to review Hoff's article on the XT-4 concerning parts and calculation of crystal frequency. He also gives ordering information for the crystals which should be followed carefully. For general information, I ordered a 5425.0 crystal for the 14075 kHz auto-start frequency. When placed in the XT-4, and properly centered on frequency, the crystal oscillator output measured 5424.229 kHz. It was not possible to pull the crystal this far (almost 800 Hz) in the crystal lock mode, but was no problem at all with the XT-4. In fact, I could have moved it considerably farther.

The bandpass transformer, T1 is available from Heath (No. 52-103) for $4.30. The rf output from the modified XT-4 is routed to a ceramic switch which selects either the original LMO or one of several XT-4 oscillators. The oscillator, buffer, power supply and regulator were built in a 4 x 6 x 3-inch Minibox. It is a bit crowded, but everything was made to fit. It is important that the crystal be shielded from rf. If the oscillator is used in a room where wide temperature variations occur, it may be necessary to temperature compensate the oscillator to realize the high degree of stability necessary for unattended auto-start.

Robert Clark, WA4VYL



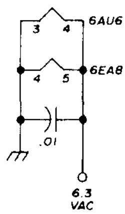


fig. 1. XT-4 crystal oscillator circuit with buffer stage for crystal control of Heath SB-series equipment. Bandpass transformer T1 is Heath part number 52-103. Capacitor Cf is a piston trimmer in parallel with fixed capacitors to adjust oscillator to desired frequency.

references

1. Robert Clark, K9HVW, "Narrow-Shift RTTY Reception with Heath SB Receivers," *ham radio,* October, 1971, page 64.
2. Irvin M. Hoff, W6FFC, "Crystal Controlled RTTY," *RTTY Journal,* December, 1967, page 4.

simple DXCC check list

The following ideas may be helpful to fellow DXers. The plan uses the standard ARRL Countries List (Operating Aid No. 7). By simply marking it appropriately, immediately to the *left* of the call-letter prefix which is followed by the country identity, you have a progressive and updated record of your DXCC status. You know at a glance if the country is: needed, worked, confirmed (QSL received), or credited (officially counted).

The legend of symbols I use for this is as follows:

- = worked
+ = confirmed
⊕ = credited to DXCC count

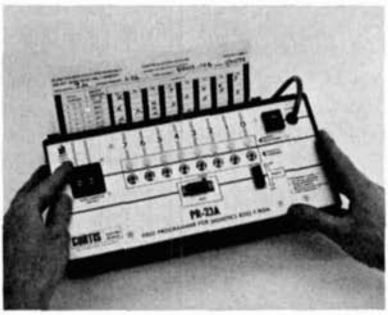
To re-cap, a short horizontal mark for *worked,* add a short vertical mark through the horizontal mark for *confirmed* when the QSL card is received, and circle the ⊕ when official credit is received.

As you near Honor Roll status, you will want to identify those countries which have been deleted as current countries. Simply draw a slightly larger circle to form a double-circle symbol to easily spot those deleted countries.

Lowell White, W2CNQ

new products

ROM programmer



An inexpensive portable field programmer for the Signetics 8223 256-bit field-programmable ROM has been introduced by Curtis Electro Devices. Called the PR-23A, this instrument allows manual programming of the 8223 in the laboratory, in the factory or in the field by unskilled personnel.

To program a device, the operator places a blank F-ROM in the test socket, selects the appropriate octal word address and presses one of eight output pushbuttons to open the selected fusible link. Program sequence is automatic and independent of operator timing to ensure uniform program conditions. A typical pattern can be programmed in about five minutes.

Eight indicator lamps provide a continuous display of output states. A slot at the rear of the instrument holds the truth table in proper alignment with panel markings.

The PR-23A is priced at $199.50. A 240 Vac model also is available. For more information contact Curtis Electro Devices, Inc., Box 4090, Mountain View, California 94040, or use *check-off* on page 94.

rackmounted directional rf wattmeter

The new Bird model 4372 Thruline® Directional High Power Wattmeter covers 25 to 500 MHz from 1-watt full scale to 500-watts full scale without changing plug-in elements. This universal flexibility is accomplished by eight easily switched ranges: Four forward power levels (10-500 watts) and four reflected power values (1-50 watts). The lower reflected power ranges are also available for forward readings by reversing rf connections.

In operation, a precision machined 50-ohm reference line-section is inserted between the signal source and the antenna, load or other component under power test. Directional power sensors incorporated in this line-section produce dc signals proportional to both incident and reflected rf main-line power, for readout on scales calibrated in watts as well as dB. All variable measurement parameters – frequency range, forward/reflected power and full scale values – are switched right on the front panel. The read-out unit and the line-section may be separated by as much as 3 feet for operational convenience.

The new multi-range model 4372 Thruline Wattmeter is ideal for CW, a-m, fm, ssb and tv signals, for design and maintenance of oscillators, transmitters and transceivers, for antenna matching, and design and development of rf components such as filters, sensors, loads and

More Details? CHECK–OFF Page 94

power transistors. It requires neither ac nor battery power.

Measurement accuracy is ±5% on all ranges from 0-1 watt to 0-500 watts at 25-500 MHz. Model 4372 fits standard 19-inch racks and takes 5¼-inches of panel width. For more information, write to Bird Electronic Corporation, 30303 Aurora Road, Cleveland (Solon), Ohio 44139, or use *check-off* on page 94.

automatic six-channel scanner

Hamtronics has announced a new scanner kit to help vhf amateurs and monitor buffs complete the project presented on page 22 of the February, 1973, issue of *ham radio* magazine. The scanner is compatible with any crystal-controlled receiver with a squelch circuit as described in K2ZLG's article. Although designed primarily to operate with the Hamtronics Mark II FM Receiver and Six-channel Adapter, it is relatively easy to convert the oscillator circuit of any receiver or the receiver oscillator section of any transceiver to diode switching to allow the scanner to automatically crystal-switch. Channel indication may be provided, if desired, by a digital readout or discrete lamps. Full conversion instructions for various sets are given in the magazine article.

The kit comes complete with a 3-3/4 x 3-3/4-inch etched pc board (undrilled), all integrated circuits, transistors, resistors, isolation diodes, zener diodes and capacitors required to complete the unit. Also included are a schematic diagram and a pc board layout diagram. Price is $14.95 postpaid anywhere in the U.S. or Canada.

Available accessories include a seven-segment digital readout, priced at $5.00, and a number-66 twist drill (use in drill press to avoid breaking), $0.65. Send orders with remittance to Hamtronics, Inc., 182 Belmont Road, Rochester, New York 14612. Orders shipped promptly on receipt. For faster delivery, add 50 cents for air mail postage differential. For more information, use *check-off* on page 94.

instant-weld evaluation kit

Oneida Electronics has recently made available a new five-pack selection of its permanent bond *Instant-Weld* alpha cyancacrylate adhesive. The powerful, single component adhesive is said to have a tensile strength up to 5,000 pounds per square inch in each drop.

Four different formulas are available to provide users with the one best suited for the types of materials they want to bond. The five-pack Evaluation Kit contains all of the types, conveniently packed in 2-gram tubes totalling up to 760 one-drop applications. Red Label 101, for use when bonding any combination of plastic, rubber, ceramic or glass; sets in 10 to 20 seconds. Blue Label 102, for use when bonding any combination of plastic, rubber, ceramic or glass; sets in 45 to 60 seconds. Yellow Label 747, for use when metal is one or both of the bonded components, such as metal to plastic or metal to rubber, glass, etc; sets in 30 to 45 seconds.

Green Label 240, holds porous and nonporous materials. (Other grades of *Instant-Weld* bond non-porous materials — metals, plastics, glass, porcelain, hard woods, rubber, etc.) *Instant-Weld* 240 holds all of these materials plus leather, paper, soft woods and many fibrous substances; sets in 60 to 120 seconds.

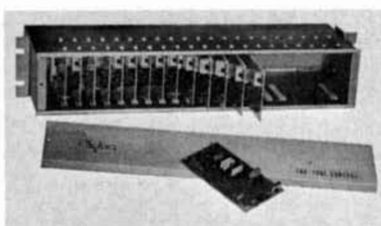
The kit has been made up to help users find the most effective type for their specific bonding application. It's available from Oneida Mfg., Inc., Meadville, Pennsylvania 16335 for $7.95 postpaid. For more information, use *check-off* on page 94.

scanner-monitor servicing data

The new Howard W. Sams publication, *Scanner-Monitor Servicing Data,* provides up-to-date servicing data on vhf fm scanners and monitors. This new book features the most comprehensive gathering of service data for 30 of the most popular vhf and uhf receivers in the field, including such well-known trade names as B&K, Browning, Johnson, Midland, Pace, Pearce-Simpson, Penneys, Realistic, Sonar and Teaberry.

Scanner-Monitor Servicing Data provides valuable up-to-the-minute servicing information in the form of schematics, voltages, alignment, parts lists, crystal formula data, pictorial presentations, general troubleshooting information, etc. This handy new manual is priced at $4.95 postpaid, from Comtec Books, Greenville, New Hampshire 03048.

repeater tone panel



Alpha Electronics has announced its new multi-frequency repeater tone panel for use on repeater systems where tone control of numerous functions is required. Replacing the popular RCP-760 and RCP-770 tone panels, the new Alpha RCP-780 is considered the most modern, universal and compact tone control panel available. The unit is capable of handling up to 18 separate tone-controlled functions, using a modular plug-in card for each function.

A variety of tone system configurations are possible with the RCP-780. System A will respond to a received tone, either sub-audible or pulse tone, by keying and modulating the transmitter with the same tone, filtered and regenerated. System B removes the received tone from

More Details? CHECK—OFF Page 94

the audio and keys and modulates the transmitter with the received signal minus the tone. A new tone is generated for the transmit carrier which can be the same tone frequency as the received tone or may be a different frequency if desired. System C utilizes any number of pulse tone combinations to accomplish the same action as system B.

All tone encoding and decoding circuits use thick-film hybrid chip modules that plug into the individual carrier cards. Each tone card plugs into a gold-plated connector and all adjustments and indicator lights are at the front edge of the card for easy access.

Optional accessories include an adjustable time-out timer, carrier operated switch, wire line termination panel to allow hard wire interconnect, and low standby current drain option, expansion to accomodate 56 tone frequencies and provision for input-output relay drive circuits to control various functions.

For additional information write to Alpha Electronic Services Inc., 8431 Monroe Avenue, Stanton, California 90680, or use *check-off* on page 94.

audio frequency meter

The new 1200A audio frequency meter from Linear Digital Systems incorporates the latest LSI integrated-circuit chips and a solid-state LED display that account for its small size and excellent reliability. It was designed to withstand the abuse found in university laboratories and in the field. A crystal-controlled period generator assures long-term accuracy.

Frequency can be read directly up to 1.999 MHz and indirectly to, typically, 3.5 MHz. The lowest range extends the sample period to ten seconds and provides the 0.1 Hz resolution necessary for calibration of electronic musical instruments, such as organs. Five- or six-digit resolution can be obtained by alternating between two adjacent ranges.

The high input impedance and sensitivity minimizes loading and allows measurements in low-level circuitry. Despite the 20 mV sensitivity, the Model 1200A can withstand a 200 Vac and 400 Vdc overload, indefinitely. The monolithic input circuitry in conjunction with the threshold control eliminate false triggering from noise and high harmonic levels. The built-in hysteresis is always proportional to the input signal level.

The model 1200A audio frequency meter is priced at $245. For more information, write to Linear Digital Systems, Box 954, Glenwood Springs, Colorado 81601, or use *check-off* on page 94.

etco electronics catalog

In this day and age of electronics catalogs showing only lifeless mixes of fast-moving merchandise, the *ETCO Idea Book* comes as a refreshing surprise. This 1973 catalog is the outgrowth of ETCO founder Marvin Birnbom's (VE2ANN) desire to provide a little entertainment, some mailorder browsing, a little education, hundreds of surplus bargains, along with pages and pages of hard-to-find parts, gadgets and unusual items.

This fascinating 126-page catalog is bound to excite the imagination of everyone from the 9-year-old budding electronic genius to the 90-year-old, young-at-heart, engineer and inventor. The $1.00 (redeemable) requested to cover costs is well spent. Mail name and address and $1.00 to ETCO Electronics, Box 741, Montreal, Canada.

More Details? CHECK—OFF Page 94

bleeptone

The Bleeptone compact audible signal source can be used as a code practice oscillator, circuit continuity tester, null detector or audible alerting device. The Bleeptone emits an audible signal of 70 dB to 86 dB sound pressure level at one meter when 8 to 16 Vdc is applied to its terminals. The very low current drain is 5 to 9 mA. No rfi is produced. The Bleeptone is available with standard nominal frequencies of either 2.5 kHz or 1.0 kHz.

Both a nylon ring and a horn adapter are available for mounting the Bleeptone. For additional information, please contact Cybersonic Division, C.A. Briggs Company, Box 151, Glenside, Pennsylvania 19038 or use *check-off* on page 94.

mobile antenna mount

A new mobile antenna mount that features fewer parts, simplified and quicker installation, lower silhouette and positive weather protection has just been introduced by Larsen Electronics. Designed to go into the usual 3-inch hole, the mount is adaptable to any location on roof, fender or trunk. Only three parts are involved and no special tools are required for the installation.

The new Larsen mount will accommodate either soldered or solderless coax fastening. A case hardened steel flange assures a positive grip and ground connection to the vehicle. It will fit any antenna that requires a 5/16 by 24 thread, and when used with the Larsen LM Antenna provides a low, low silhouette and thread to thread connection for greatest electrical efficiency. It also provides an installation that permits quick and easy removal of the antenna when the car goes through mechanical car washing facilities or into low garages.

To install the Larsen mount you only have to attach the coax according to the step-by-step-full-scale illustrated instructions which are included. The under part of the mount goes easily through the ¾ inch hole and a tough plastic fitting and weather-proofing O-ring spins into place. With those three steps the mount is ready to receive the antenna.

For more details write to Larsen Electronics, Inc., Box 1686, Vancouver, Washington 98663 or use *check-off* on page 94.

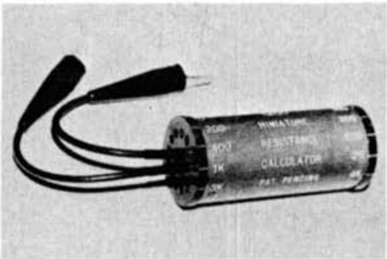
frequency counter

Miida Electronics announces the introduction of its new Digipet-60 Frequency Counter. This frequency counter has a range of 1 kHz to 60 MHz, extendable to 160 MHz with the Digipet 160 converter. It features a resolution of 1 kHz to 1 Hz (at 1 ms or 1 second gate times). It can be operated on either ac or dc, with complete overload protection, plus a stability aging rate of one part in a million per week. The entire unit is a compact 7-inches deep by 2½ inches high. It sells for $299.

For further information contact Andy Babiak at Miida Electronics, Division of Marubeni America Corporation, 2 Hammarskjold Plaza, New York, New York 10017 or use *check-off* on page 94.

More Details? CHECK–OFF Page 94

multifunction resistor decade



Called the R-1 Miniature Resistance Calculator by the manufacturer, Lee Electronic Labs, this handy new unit serves as a 10% resistance decade, a voltage divider or a resistor substitution box. Values between 100 ohms and 11 megohms are possible. Short leads plug into different jacks on the unit allowing 825 different values without the need for sequential switches and the inevitable wear which comes with their use.

The new unit is small, self-contained and lightweight. It comes with short leads to facilitate use in rack-mounted gear and in equipment where long leads to a decade box might introduce hum and undesirable rf pickup.

The unit sells for $17.45, postpaid. Complete specifications are available from Lee Electronic Laboratories, Inc., 88 Evans Street, Watertown, Massachusetts 02172 or by using *check-off* on page 94.

confidential frequency list

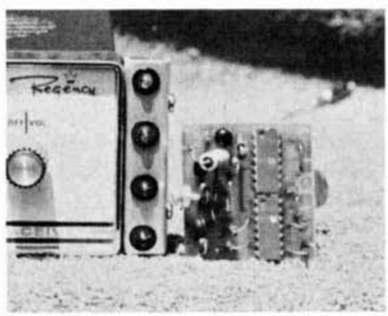
A *Who's Who* of unusual radio stations has just been published by Gilfer Associates. Called the "Confidential Frequency List," this book is the first major compilation of a-m, CW, ssb, RTTY and FAX nonbroadcast stations made available to the general public. Frequencies, callsigns, locations, schedules and radiated power are shown for thousands of radio stations operating between the broadcasting and ham bands from 12 to 27,240 kHz.

Prepared by Robert B. Grove, WA4PYQ, the "Confidential Frequency List" reveals radio frequency and callsign

information heretofore kept under wraps. There are 34 separate listings in the list including: Interpol, CIA, RTTY Press, USAF Global Aero, spy and number stations, radio-beacons, weather broadcasters, Flying Doctor Service, foreign embassy networks and hurricane hunters.

The "Confidential Frequency List" is one of a series of new publications from GILFER Associates, specialists in disseminating information on radio frequency usage around the world. 64 pages. Soft-bound. $3.95 from Gilfer Associates, Inc., Box 239, Park Ridge, New Jersey 07656.

regency scanner modification

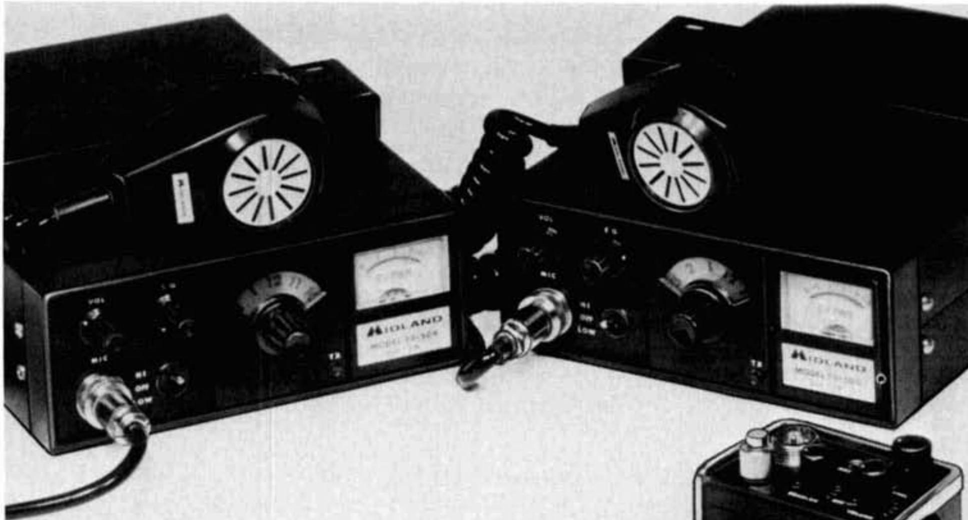


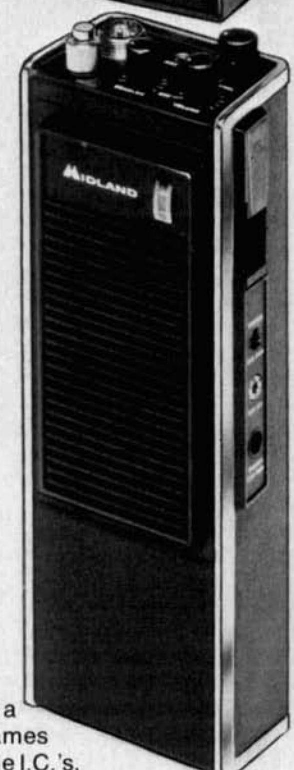
The popular Regency HR2, HR2A and HR212 two-meter fm transceivers can be made to scan four channels with Diamond Enterprise's model 4CS scanner. The 4CS comes as a kit for $29.95 or ready-built for $49.95. Both units use a fiberglass circuit board and come with all mounting hardware and an external light-emitting diode display. The display is small – only ½-inch wide and just as high as the Regency transceivers. The scanner board itself is also small – 1 5/8 by 1½ inches – and fits inside the transceiver cabinet.

The units allow the transceiver to scan four different channels – with the LED display indicating which channel is being monitored. The unit is activated by the transceiver channel position switch.

For more information contact Triangle Enterprises, 404 North Centennial Street, Indianapolis, Indiana 46222 or use *check-off* on page 94.

More Details? CHECK–OFF Page 94

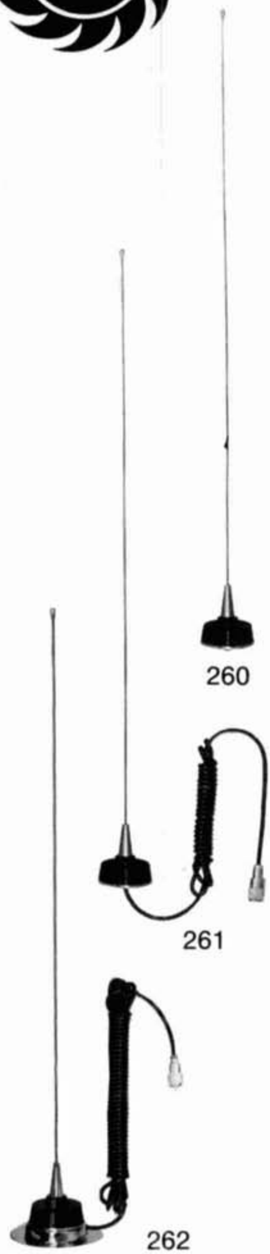




More Details? CHECK—OFF Page 94

For the most powerful antennas under the sun

Go all the way into the REPEATER



There's nothing half-way about the new Hy-Gain REPEATER LINE.

Designed for the man who demands professional standards in 2 meter mobile equipment, the REPEATER LINE is the 2 meter HAM's dream come true. It's got everything you need for top performance...toughness, efficiency and the muscle to gain access to distant repeaters with ease. Reaches more stations, fixed or mobile, direct, without a repeater.

The right antennas for the new FM transceivers ...or any 2 meter mobile rig.

Rugged, high riding mobiles. Ready to go where you go, take what you dish out...and deliver every bit of performance your rig is capable of.

260 Commercial duty 1/4 wave, claw mounted roof top whip. Precision tunable to any discrete frequency 108 thru 470 MHz. 17-7 ph stainless steel whip.

261 Same as above. Furnished complete with 18′ of coax and connector.

262 Rugged, magnetic mount whip. 108 thru 470 MHz. Great for temporary or semi-permanent no-hold installation. Holds secure to 100 mph. Complete with coax and connector. Base matching coil for 52 ohm match. 17-7 ph stainless steel whip.

More Details? CHECK—OFF Page 94

2 meter mobile! with

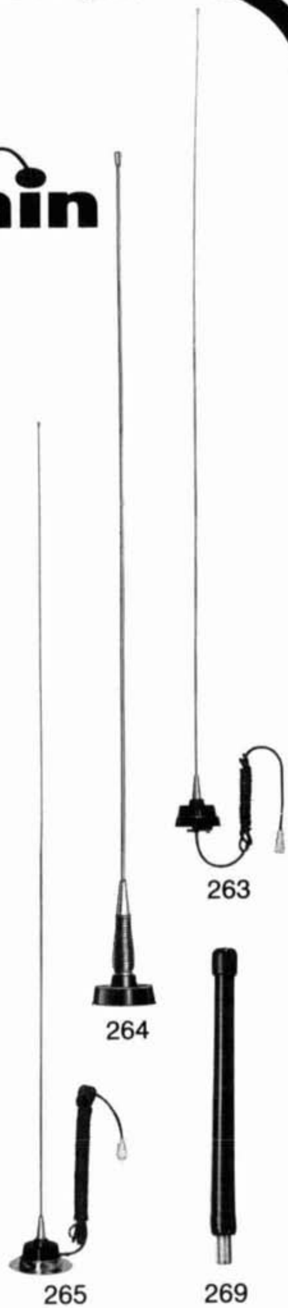
LINE from hy-gain

263 Special no-hole trunk lip mount. 3 db gain. 130 thru 174 MHz. 5/8 wave. Complete with 16′ coax. Operates at DC ground. Base matching coil for 52 ohm match. 17-7 ph stainless steel whip.

264 High efficiency, vertically polarized omnidirectional roof top whip. 3 db gain. Perfect 52 ohm match provided by base matching coil with DC ground. Coax and connector furnished.

265 Special magnetic mount. 3 db gain. Performance equal to permanent mounts. Holds at 90 mph plus. 12′ of coax and connector. Base matching coil for 52 ohm match. 17-7 ph stainless steel whip. DC ground.

269 Rugged, durable, continuously loaded flexible VHF antenna for portables and walkie talkies. Completely insulated with special vinyl coating. Bends at all angles without breaking or cracking finish. Cannot be accidentally shorted out. Furnished with 5/16-32 base. Fits Motorola HT; Johnson; RCA Personalfone; Federal Sign & Signal; and certain KAAR, Aerotron, Comco and Repco units.



Top performance for 2 meter mobiles
THE REPEATER LINE
from

HY-GAIN ELECTRONICS CORPORATION

BOX 5407 · WF LINCOLN, NEBRASKA 68505

WRITE FOR DETAILS

A COMPLETELY PORTABLE FREQUENCY COUNTER WITH . . .

* 10 HZ to 65 MHZ range
* Full six digit readout (L.E.D.)
* Sensitive front end (LESS THAN 10 MV.)
* Only $199

FEATURES

- High capacity rechargeable Ni Cd batteries
- Crystal controlled time base (can be field calibrated)
- Convenient 3-position range select switch allows:
  1. Readout always in MHZ.
  2. Eight digit resolution by range selection
  3. Direct reading pre-scalar operation to 999.999 MHZ.
- "Battery save" switch for spot checks
- Less than 5 watts power consumption (5 volts @ 0.9 AMPS)
- Dimension 6" x 3.5" x 2.3"
- TTL input for use with pre scalar
- Can be operated on internal or external power, with trickle charge and full charge positions
- Sample control lets operator determine how often the readout is updated. Can "hold" present count without being updated

Mail orders directly to:
Great American Miniatures, Inc.
P. O. Box 10990
Midwest City, Okla. 73110

Model C-65 Freq. counter	$199.00
Battery charger	8.00
Battery charger & eliminator	18.00

— PCB KITS —

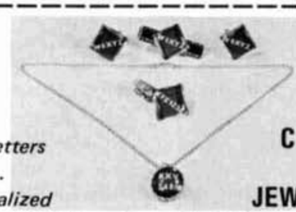
RTTY SPEED CONVERTER Drilled PCB	5 & 11 VDC	$40.00
DRILLED PCB ONLY		$ 6.00
RTTY AFSK Gen. All Shifts & CW I.C.	9 VDC @ 2ma	$6 60
100 KHz XTAL CALIBRATOR Less Xtal	9 VDC @ 2ma	$4.75
100 KHz XTAL (Limited Supply)		$2.50
PREAMP MICROPHONE, 26 DB Gain	9 VDC @ 1ma	$3.50
LIMITER PREAMP For High Z Mike	9 VDC @ 1ma	$4.80
PRODUCT DETECTOR For Your Receiver	9 VDC @ 1ma	$3.60
"S" METER KIT Less 1ma Meter	6.3VAC	$4.75
SWR METER, Stripline, Less 200μa Meter		$2.95
WWV CONVERTER 3.5-4.0 MHz Output, Requires 6-6.5MHz Crystal	9 VDC @ 5ma	$5.25
6 METER CONVERTER FET Front End, 7-11 MHz Output. Less 43 MHz Xtal	9 VDC @ 5ma	$5.95
CW KEYING MONITOR, RF Keyed, Less Spkr.	9 VDC @ 9ma	$4.70
POWER SUPPLY - 9 VDC @ 50ma Output	115VAC	$4.85
6 OR 2 METER CASCODE PREAMP, Wired & Tested Less 2 ea 6CW4 Nuvistors. Specify 6 or 2 Meter Model	80 VDC @ 4.5ma	$4.95
DRILLS, #54, 56, 58 or 60	(each)	$.40
Finest Quality for PCB'S, Made in USA	Three For	$1.00

EXCEPT AS NOTED ABOVE, ALL KITS ARE NEW, 100% SOLID STATE. AND COME COMPLETE WITH AN UNDRILLED G-10 PCB (PRINTED CIRCUIT BOARD) AND ALL PCB MOUNTED COMPONENTS. KITS ARE LESS POWER SUPPLIES, CHASSIS, AND ENCLOSURE HARDWARE. SEND SELF-ADDRESSED, STAMPED ENVELOPE FOR COMPLETE DATA SHEET AND SCHEMATIC.

SATISFACTION GUARANTEED. RETURN IN 30 DAYS FOR REFUND. ALL KITS POSTPAID. INCLUDE 25¢ HANDLING CHARGE. WASHINGTON RESIDENTS ADD 5.3% SALES TAX.

P. M. ELECTRONICS INC.

519 SOUTH AUSTIN, SEATTLE, WASH. 98108



Your Call Letters On . . . Personalized

CUSTOM MADE JEWELRY*

Insignias and Initials on Request. All finishes unconditionally guaranteed for one year. 24K gold or silver finish.

SETS	$6.50	NECKLACE	$4.25
SMALL TIE CLASP	$3.50	EARRINGS	$4.50
LARGE TIE CLASP	$4.50	BRACELET	$4.75

*Sizes and Shapes May Vary.

Add tax to above prices. Calif. Sales, 5%. M.O. or Check

HOBBY JEWELRY 13407 SHOUP AVENUE HAWTHORNE, CALIF. 90250

NEW COAXIAL ANTENNA CHANGEOVER RELAY

Barker & Williamson Model 377 Coaxial Antenna Changeover Relay is a compact unit providing an efficient and economical method for switching antenna to receive. Receiver connector automatically grounded when in the transmit position.

VSWR	1.15:1
Frequency Range	D.C. to 150 MHz
Power Rating	1 KW-2 KW PEP
PRICE	**$11.95**

See your dealer or write:

Barker & Williamson, Inc.
Canal Street, Bristol, Pa. 19007

More Details? CHECK—OFF Page 94

GTX-2

2 meter FM Transceiver

(1) GTX-2 (with built-in DC PS) and 94/94 ..... 249.95
(2) AC POWER SUPPLY $49.95
(3) 2 Extra crystals of your choice $12.00

REGULAR $311.90
OUR SPECIAL PACKAGE PRICE! $249.95

GTX-200

100 channel combinations; features independent selection of transmit and receive frequencies, and switch for pre-selected pairing.

(1) GTX-200 (with built-in DC PS) & 94/94 $259.95
(2) AC POWER SUPPLY $49.95
(3) 2 Extra xtals your choice (stock list) $12.00

REGULAR $321.90
OUR SPECIAL PACKAGE PRICE! $259.95

10 watts output **GTX-10**

- Simple Conversion to 30 Watt Output

(1) GTX-10 (with built-in DC PS) & 94/94 $199.95
(2) AC POWER SUPPLY $34.95
(3) 2 Extra xtals your choice (stock list) $12.00

REGULAR $246.90
OUR SPECIAL PACKAGE PRICE! $199.95

Please add $10.00 Substituting HAMPAK for AC on GTX-10 Package. With HAMPAK & AC $232.00

HAMPAK

Battery pack for GTX-10 portable operation. Uses 10 D cells (not included). (Includes portable antenna, carrying handle & mike clip) $39.95

*** FLASH * FLASH * FLASH ***

Look at what you get for NO REPEAT-NO EXTRA CHARGE. The GTX-2 and GTX-200 now have a supersensitive Dual-Gate Mos Fet pre-amplifier BUILT IN the receiver front end for superb, less than .25 microvolt sensitivity. THE BEST receiver now even better!

30 WATTS OUTPUT. ALL SOLID STATE (no tubes). TRUE FM (not Phase modulation) for superb audio quality. 10 channels in GTX-2 & GTX-10 with 146.94/146.94 included. Three pole low pass filter on both transmit and receive. 1 watt low power position. Provision for tone encoder. Simple internal strapping provision allows multi-channel use of any crystal in GTX-2 and GTX-10. Microphone and mobile mounting bracket supplied. G-10 GLASS BOARDS. Professional level construction by distinguished Avionics Mfg. — General Aviation Electronics, Inc. The finest amateur FM transceiver available at any price. Size: 9 x 6½ x 2½. Weight 5 lbs. Current Drain: Receive: .09 amps, Transmit: High 5.0 amps, Low: 1.7 amps. Made in U.S.A.

Genave

100% AMERICAN MADE

Marine/Master-25w

2-Way VHF-FM Marine Radio Telephone

$259.95

(Includes Weather Monitor and Channels 6 & 16)

OPTIONAL ACCESSORIES

(1) 3 dB Gain Lay-Down Gleaming White Fiberglass Antenna
(2) 6 dB Gain Lay-Down Gleaming White Fiberglass Antenna
(3) 9 dB Gain Lay-Down Gleaming White Fiberglass Antenna
(4) 3 dB Sailboat Antenna, Mounting Hardware and 60′ of Marine White Cable
(5) Channels 68, 26, 28, 12

PLEASE WRITE FOR OUR SPECIAL PACKAGE PRICES!

Full 25 watts power. ALL SOLID STATE (no tubes) reliability. 10 channels with 6 ½ pairs of crystals installed for calling and distress, weather, ship-to-ship, ship to coast and public and port operations. Self contained, compact. Pre-tuned. Vinyl covered unit is splash proof — impact, humidity and fungus resistant. Can be mounted in panel, on bulkhead, on or below table top with universal mounting bracket included.

JUST CONNECT TWO WIRES and YOU'RE ready to OPERATE.

signal/one

Service Manual CX7-CX7A
$29.00 ppd. anywhere

COMING SOON!!

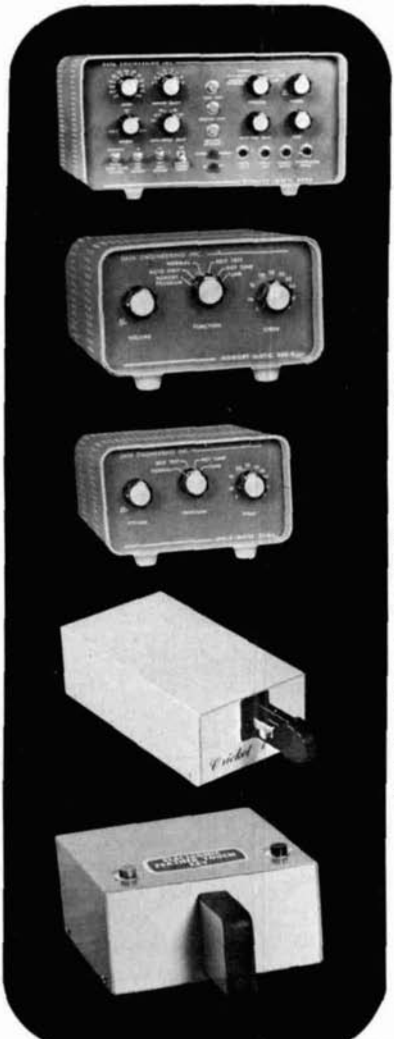
GENAVE TOUCH-TONE PAD
GENAVE REPEATER
and MUCH MORE

master charge THE INTERBANK CARD

AMATEUR-WHOLESALE ELECTRONICS
8817 S.W. 129 Terrace – Miami, FL 33156
Telephone — days (305) 233-3631 — night and weekends — (305) 666-1347

NO ONE ANYWHERE BEATS OUR DEAL!

Your BANKAMERICARD welcome here



The BEST CW *in the world!*

comes from Keyers by DE

MEMORY-MATIC KEYERS

A whole new concept in the idea of an electronic keyer. Not only the most advanced keyer ever offered with every feature you might ever imagine, but complete with easy in - easy out memories (up to 19,200 bits in the MM-8000). Just key in your message. They play it out at any speed at any time.

For the first time you can automate your station to permit virtually automatic operation for DX, Contesting and traffic handling. Far too much to describe in a magazine ad. Send for our new catalog with the complete Memory-Matic Story.

Memory-Matic 8000 with up to 19,200 bit memory capacity
Memory-Matic 500B with up to 800 bit memory capacity

SPACE-MATIC 21-B

The Switchable Keyer. It's up to eight-keyers-in-one. Use the switches to make this your very own personal keyer, both today and tomorrow. Add such features as dot dash memory or adjust spacing with the turn of a switch. Completely versatile, completely perfect with everything you will ever want. Full details in our catalog.

Sh. wt. 4 lbs. $89.50

CRICKET 1

At last — a popularly priced IC keyer with more features for your dollar than all others in its price range. Fatigue-free sending with clean, crisp CW at all speeds.

Sh. wt. 3 lbs. $49.95

FEATHER TOUCH KEY

Replace that mechanical key with our new electronic key. Go modern with Feather Touch the electronic key that detects the mere touch of your finger. Develop a truly professional fist.

Assembled, Sh. wt. 2 lbs. $19.95
Kit, Sh. wt. 2 lbs. $15.95

AC Power Supply $2.95
Remote Switches for use with Memory-Matic Keyers $3.95

All assembled **Data Engineering** products are sold with a five year guarantee on both workmanship and materials.

DATA ENGINEERING INC.

FREE!

The most exciting

NEW CATALOG

in amateur radio

SEND TODAY FOR YOUR FREE COPY

More Details? CHECK—OFF Page 94

Exciting NEW FM Products

by DE

TOUCH TONE PADS

More features than any other pad including built-in monitor speaker and latest Phase-Lock loop circuitry.

TTP-1 Standard pad for portable transceiver mounting.
TTP-2 Standard pad in attractive case for home or mobile use.
TTP-3 Mini-pad in attractive case for home or mobile use.
TTP-4 Mini-pad for portable transceiver mounting.

TTP-1, 2, 3 & 4, Sh. wt. 1 lb. $44.50
TTP-1K, 2K, 3K & 4K, Sh. wt. 1 lb. $34.50

TOUCH-TONE DIALER

The electronic Touch-Tone dialer for home and car. It's safer and more accurate to use than a pad. Memory includes Access Code plus five phone numbers. Numbers easily updated. Built-in monitor. Complete PPT operation with transmitter hold. **Sh. wt. 2 lbs**

TTD-4K Complete Kit $49.00 TTD-4 Assembled $59.00

REPEATER ID

Highly stable oscillator for automatic timing. AC or DC operation. ROS provides for more than 25 characters, more than necessary for DE "any call" RPT. AUX is automatically added to ID if desired when main power is lost. Tone Burst operation available.

ID-101K P.C. Board Kit, Sh. wt. 2 lbs. $49.95
ID-101 P.C. Board, Wired & Tested, Sh. wt. 2 lbs. $69.95
ID-101R Assembled in 1½" rack cab. Sh. wt. 5 lbs. $109.00

TONE ENCODER

Eight pre-adjusted tones. Duration and Output adjustable. PLL circuitry for extreme stability. Choice of continuous or Tone burst operation. Tone burst operation requires no batteries. Easy to install. Includes three special single or dual tones.

TE8-K Complete Kit, Sh. wt. 2 lbs. $31.95
TE-8 Tone Burst Encoder (1800, 1950, 2100, 2250, 2400, plus any 3 single or dual tones above 1200 Hz.) $39.95

AUTO-PATCH CONSOLE

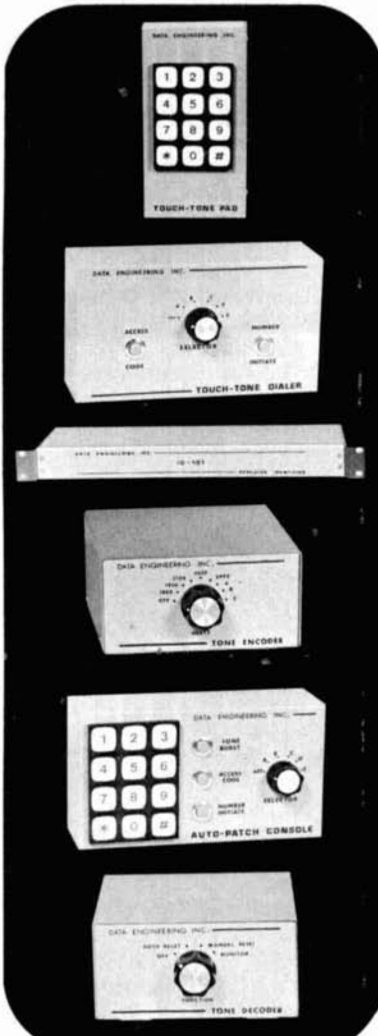
This mobile or home console includes all the features you need for complete auto-patch operation. A Touch-Tone Pad; an automatic dialer for sending one access code plus five Touch-Tone phone numbers; a single/dual tone burst encoder adjusted to your choice of frequency above 1200 Hz, and a built-in monitor. Complete PTT operation with one second transmitter hold. **Sh. wt. 2 lbs.**

APC-4K Complete Kit $84.50 APC-4 Assembled $98.50

TONE DECODER

Versatile single/dual tone decoder. PLL circuitry for extreme stability. 1 amp output relay can be reset automatically or manually. Monitor position. Adjustable sensitivity. Internal strap selects single or dual tone operation.

TD-2K Complete Kit, Sh. wt. 2 lbs. $31.95
TD-2 Single/Dual Tone Decoder $39.95
(Specify any freq. above 1200 Hz)



Please include sufficient postage for shipping

BANKAMERICARD master charge

Ravensworth Industrial Park, Springfield, Va. 22151

5554 Port Royal Road • 703-321-7171

2-METER PREAMP

Specially made for both OLD and NEW receivers. The smallest and most powerful preamp available. Provides 20dB gain to bring in the weakest signals.

Sh. wt. 4 oz. $9.50 kit
$12.50 wired

PAD-PULSER

Now you can also obtain pulsed operation from your Touch-Tone Pad. Convert Touch-Tone frequencies to decimal pulses at 2805 Hertz with just a flip of a switch. Option can be added to TTP-2/K, TTD-4/K and APC-4/K. **Sh. wt. 1 lb.**

PP-12K P.C. Board Kit $22.95
PP-12 Assembled $29.95

TOUCH-TONE DECODER

A highly reliable twelve digit decoder with input protection, and PLL circuitry for extremely stable operation. Heavy duty output relays, small size, plug-in circuit board. All these major features at an UNBEATABLE price. **Sh. wt. 1 lb.**

TTD-12K P.C. Board Kit $89.50
TTD-12 Touch-Tone Decoder $129.50

More Details? CHECK—OFF Page 94

More Details? CHECK—OFF Page 94

Problem-solving handbooks

Highly popular Editors and Engineers books from Sams give amateurs everything they need to know about radio operation and technology. They're authoritative, clear, and easy to follow. You'll want them for your library.

Famous E&E RADIO HANDBOOK—19th Edition
By William I. Orr, W6SAI
The completely updated electronics industry standard for engineers, technicians, and advanced amateurs. Shows how to design and build all types of radio-communications equipment. Includes ssb design and equipment, RTTY circuits, latest semiconductor circuits, IC's, and special circuitry. **No. 24030—$14.95**

SINGLE SIDEBAND: THEORY & PRACTICE
By Harry D. Hooton, W6TYH
A basic text covering the origin of ssb, derivation of signals, sideband selection, ssb generators, carrier-suppression techniques, carrier generators, speech amplifiers and filters, balanced mixers and converters, low-power ssb transmitters, linear r-f power amplifiers, and much more. **No. 24014—$6.95**

SEMICONDUCTOR AMATEUR PROJECTS
By Louis M. Dezettel, W5REZ
For the ham who still takes pride in using his hands and head, here are projects for 16 useful, money-saving accessories, using easy-to-build semiconductor circuitry. Units are for measuring equipment, increasing power and adding convenience, etc. **No. 24025—$4.95**

MARINE SINGLE SIDEBAND
By Donald M. Stoner and Pierre B. Goral
Covers the why and how of single sideband; interpreting specifications, alignment tests and measurements, installations, securing a limited coastal license, high-seas telephone service, and marine radio terminology. **No. 24029—$5.95**

RADIO AMATEUR OPERATING HANDBOOK
By Marshall Lincoln, W7DQS
This single-source working guide is a practical aid for improving the operating methods and techniques of hams. **No. 24028—$4.95**

SOLID-STATE QRP PROJECTS
By Edward M. Noll, W3FQJ
By building QRP equipment you learn solid-state technology, since these rigs include transistors and/or integrated circuits. The low-cost units described have power ratings from less than 100 milliwatts up to about 20 watts. Both cw and phone rigs are included. **No. 24024—$4.25**

73 DIPOLE AND LONG-WIRE ANTENNAS
By Edward M. Noll, W3FQJ
Detailed construction data for 73 different types of wire antennas. Appendices describe construction of noise bridges and line tuners, plus data on measuring resonant frequency, velocity factor, and SWR. **No. 24006—$4.50**

73 VERTICAL, BEAM, AND TRIANGLE ANTENNAS
By Edward M. Noll, W3FQJ
Design and construction of 73 different antennas used by amateurs, each built and air-tested by the author. Also construction of noise bridges, transmission-line tuners, and measurement methods. **No. 24021—$4.95**

ELECTRONICS FOR THE AMATEUR
By Louis M. Dezettel, W5REZ
Covers radio-wave propagation as it applies to amateur band frequencies, reception and transmission pertaining to ham equipment, and the special field of antennas and how to feed them. Provides you with everything needed to pass the theory sections of the FCC exams. **No. 24022—$7.95**

RADIO AMATEUR'S F-M REPEATER HANDBOOK
By Ken W. Sessions, Jr., K6MVH
The definitive work on amateur f-m repeaters. Includes: Preparing and obtaining sites for repeaters; How to build a repeater; Repeater applications; and an f-m repeater directory. **No. 24008—$6.95**

AMATEUR TESTS AND MEASUREMENTS
By Louis M. Dezettel, W5REZ
Shows how to accomplish virtually all performance tests on amateur transmitters, receivers, and antennas, and how to make required adjustments. **No. 24007—$5.50**

HAM AND CB ANTENNA DIMENSION CHARTS
By Edward M. Noll, W3FQJ
Tabulates dimension data in feet and inches for all popular antenna configurations. With this data, an antenna can be dimensioned for a specific frequency range according to license class and mode of operation. **No. 24023—$1.95**

Order today from

comtec

BOOKS

Greenville, NH 03048

ALSO ASK FOR

FREE

HOWARD SAMS CATALOG

More Details? CHECK—OFF Page 94

CW or RTTY, whichever way you go,

HAL HAS TOP QUALITY YOU CAN AFFORD!

TOP QUALITY RTTY...WITH THE HAL MAINLINE ST-6 TU. Only 7 HAL circuit boards (drilled G10 glass) for all features, plug-in IC sockets, and custom Thordarson transformer for both supplies, 115/230 V, 50-60 Hz. Kit without cabinet, only $135.00; screened, punched cabinet with pre-drilled connector rails, $35.00; boards and complete manual, $19.50; wired and tested units, only $280.00 (with AK-1, $320.00).*

TOP QUALITY...WITH THE HAL 1550 ELECTRONIC KEYER. Designed for easy operation; perfectly timed CW with optional automatic ID for sending call letters, great for DX and RTTY; TTL circuitry, transistor switching for grid block, cathode keying. Handsome rugged crackle cabinet with brushed aluminum panel. With ID, only $90.00; without ID, $65.00.*

OTHER HAL PRODUCTS INCLUDE:

ID-1 Repeater Identifier (wired circuit board)	$ 75.00*
ID-1 (completely assembled in 1½" rack cabinet)	$115.00*
HAL ARRL FM Transmitter Kit	$ 50.00*
W3FFG SSTV Converter Kit	$ 55.00*
Mainline ST-5 TU Kit	$ 50.00*
Mainline AK-1 AFSK Kit	$ 27.50*

TOP QUALITY... WITH THE HAL MKB-1 MORSE KEYBOARD. As easy as typing a letter—you get automatic CW with variable speed and weight, internal audio oscillator with volume and tone controls, internal speaker, and audio output jack. Smooth operation; completely solid-state, TTL circuitry using G10 glass boards, regulated power supplies, and high voltage transistor switch. Optional automatic ID available. Assembled MKB-1, $275.00. In kit form, $175.00. *

NEW FROM HAL—TOP QUALITY RVD-1002 RTTY VIDEO DISPLAY UNIT. Revolutionary approach to amateur RTTY... provides visual display of received RTTY signal from any TU, at four speeds (60, 66, 75, and 100 WPM), using a TV receiver modified for video monitoring. Panasonic solid-state TV receiver/monitor, or monitor only, available. RVD-1002, $525.00; Panasonic TV receiver/monitor, $160.00; monitor only, $140.00.*

TOP QUALITY...WITH THE HAL RKB-1 TTY KEYBOARD. Gives you typewriter-easy operation with automatic letter/number shift at four speeds (60, 66, 75, and 100 WPM). Use with RVD-1002 video display system, or insert in loop of any teleprinter, for fast and easy RTTY. Completely solid state, TTL circuitry using G10 glass boards, regulated power supplies, and transistor loop switch. RKB-1 assembled, only $275.00.*

HAL provides a complete line of components, semi-conductors, and IC's to fill practically any construction need. Send 24¢ to cover postage for catalog with info and photos on all HAL products available.

*Above prices do not include shipping costs. Please add 75¢ on parts orders, $2.00 on larger kits. Shipping via UPS whenever possible; therefore, street address required.

HAL COMMUNICATIONS CORP., Box 365 H, Urbana, Illinois 61801

More Details? CHECK—OFF Page 94

NEW RX-144C RECEIVER KIT

For Repeaters or Those Who Need The Best

$69.95

WITH 10.7 CRYSTAL FILTER

- Low cross modulation front end
- 10.7 MHz crystal filter
- Sensitive noise squelch
- COR output for control
- 2 watts audio output
- Less than .2 μV sensitivity
- Measures 4 x 6 x 1 inches

ALSO AVAILABLE

TX-144 Transmitter Kit $29.95 — RX-144 Receiver Kit $59.95 — PA-144 Amplifier Kit $29.95

Add $1.00 shipping per kit ordered. New York Residents add sales tax.

We are now in our new location, please note the new address.

BANKAMERICARD

VHF ENGINEERING

320 WATER ST. POB 1921 BINGHAMTON, N.Y. 13902 607-723-9574

GROTH-Type

COUNTS & DISPLAYS YOUR TURNS

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

PRICES POST PAID

TC 2	—	$7.00
TC 3	—	$7.50
Spinner (-S)	—	$1.00

Add $0.75 for Air or UPS

Case: 2x4"; shaft ¼"x3"
Model TC2: Skirt 2⅛"; Knob 1⅝"
Model TC3: Skirt 3"; Knob 2⅜"

R. H. BAUMAN SALES

P.O. Box 122, Itasca, Ill. 60143

NEW!!

2 METER CONVERTER

144CC

$49.95

postpaid

HIGH SENSITIVITY • VERY RESISTANT TO OVERLOAD • FREE FROM BIRDIES • 12VDC POWER • DELUXE DIE CAST CABINET. This new addition to our VHF/UHF converter line is well suited to DX, FM and general purpose applications. Write for full details on this and all our other converters and preamps.

JANEL LABORATORIES
Box 112, Succasunna, N. J. 07876
Telephone 201-584-6521

MOR-GAIN

NOW EXCLUSIVE 66 FOOT 75 THRU 10 METER DIPOLE **IS BACK**

NO TRAPS — NO COILS — NO STUBS — NO CAPACITORS

Fully Air Tested — Thousands Already in Use

#16 40% Copper Weld wire annealed so it handles like soft Copper wire—Rated for better than full legal power AM/CW or SSB-Coaxial or Balanced 50 to 75 ohm feed line—VSWR under 1.5 to 1 at most heights—Stainless Steel hardware—Drop Proof Insulators—Terrific Performance—No coils or traps to break down or change under weather conditions—Completely Assembled ready to put up—Guaranteed 1 year—ONE DESIGN DOES IT ALL; 75-10HD—ONLY $12.00 A BAND!

Model 75-10HD .... $60.00 .... 66 Ft .... 75 Thru 10 Meters
Model 75-20HD .... $50.00 .... 66 Ft .... 75 Thru 20 Meters
Model 75-40HD .... $40.00 .... 66 Ft .... 75 Thru 40 Meters
Model 40-20HD .... $33.00 .... 35 Ft .... 40 Thru 20 Meters
Model 80-40HD .... $42.00 .... 69 Ft. 80-40-15 Meter (CW)

ORDER DIRECT OR WRITE FOR FULL INFORMATION

MOR-GAIN

300H Shawnee
Leavenworth, Kansas 66048

OR THRU YOUR FAVORITE DISTRIBUTOR

More Details? CHECK—OFF Page 94

"INTRODUCTORY PRICES"

ST-5 BOARDS ONLY	$ 5.25
ST-5 KIT OF ELECTRONIC PARTS	$ 47.50
ST-5A BOARDS ONLY	$ 5.25
ST-5A KIT OF ELECTRONIC PARTS	$ 54.00
ST-6 BOARDS ONLY (These are the 8 original by W6FFC)	$ 18.00
ST-6 KIT OF ELECTRONIC PARTS	$128.50
MOD. KIT FOR UPDATING THE ST-5 TO THE ST5A	$ 9.00
PEMCO MODEL 50A FREQUENCY COUNTER SEMI-KIT	$125.00

This is a fully assembled and tested board, you add only your own power supply and cabinet, etc. Write for details.

You must supply the cabinet, A.C. cord, meter, switches, etc. on all kits except where noted otherwise. (All prices are postage paid (we pay shipping).

We will do most any printed circuit board for individuals or prototypes. If required we will also do the layout of the boards. All our boards are G-10 glass-epoxy solder plated and come drilled only. At present time we can do only single sided. All component parts used in our kits are new manufacturers stock. We Do Not Use Any Used or Surplus Parts. All inquiries are answered promptly.

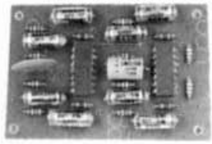
PEMCO ELECTRONICS MANUFACTURING

422 18th St., N.E., Salem, Ore. 97301, (503) 585-1641

ACTIVE AUDIO FILTERS

IC's FOR SUPER HIGH PERFORMANCE

CW FILTER (CWF-2)
Get razor sharp selectivity; No impedance matching! BW (selectable) 80 Hz, 110 Hz, 180 Hz; Center frequency F=750 Hz; Skirts 60 dB down at ½F and 2F; 4 op amps; 2" x 3" PC board; $14.95 wired, tested, guaranteed; $12.95 kit.



CWF-2: $12.95 KIT
$14.95 WIRED

CW MINI FILTER (CWF-3)
1½" x 2" PC board; Center frequency F=750 Hz; 30 dB down at ½F and 2F; BW 110 Hz, 180 Hz; 2 op amps; $8.95 wired, tested, guaranteed; $7.95 kit.

LOW PASS FILTER (LPF-1)
Resistors set cutoff 500 Hz to 20 kHz; Factory set to 2.5 kHz; Rolloff 48 dB per octave; Input imp 1 M; Gain=1; 5 op amps; 2" x 3" PC board; $16.95 wired, tested, guar.; $14.95 kit. Please include 55¢ postage on all orders.

MFJ ENTERPRISES
P. O. BOX 494-A
MISS. STATE, MS. 39762

WORLD TIME-TELLER

GREAT for DX OP

A **turn of knob** and **2-color drum** dial shows time your QTH and corresponding local time in all zones-also GMT. Fast-visual-great for sked making.

Map 2-color enamel on aluminum. Cabinet assembly of polished acrylic.

List: $18.50 complete-plus postage. Kit: Complete $14.75, or less cabinet and knobs (cab. dwgs. inc.) $11.75

U-J Industries
6605 Shoal Creek Blvd.
Austin, Texas 78757

BOUND VOLUMES
HAM RADIO MAGAZINE

available for
1970 — 1971 — 1972
14.95 per year postpaid
Have a deluxe Ham Radio collection
HAM RADIO
GREENVILLE, NH 03048

RADIO COMMUNICATION MAGAZINE

Many thousands of you have become very familiar with the various Radio Society of Great Britain books and handbooks, but very few of you are familiar with their excellent magazine, Radio Communication.

It includes numerous technical and construction articles in addition to a complete rundown on the month's events in amateur radio. Surely a most interesting addition to your amateur radio activities.

We can now offer this fine magazine to you along with the other advantages of membership in the RSGB (such as use of their outgoing QSL Bureau) for $9.95 a year.

order today from

comtec BOOKS

Greenville, New Hampshire 03048

DUAL BAND ANTENNAS

These ready to mount antennas consist of full ½ wavelength elements of No. 12 copperweld wire and can be used as either dipoles or inverted vees. No traps, coils, gimmicks, etc. are used to shorten the elements. 2KW rating. Single coax feedline required. Individually mounted dipoles with common center insulator: 80/40, $21.95; 40/20, $16.25; 20/15, $14.10. Other combinations available. Send for free catalog listing dual band, monoband, and folded dipole antennas. Baluns available. Postpaid conterminal U. S. A.

HOUSE OF DIPOLES
P. O. BOX 8484
ORLANDO, FLORIDA 32806

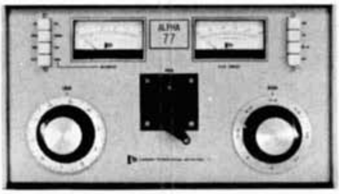
More Details? CHECK—OFF Page 94

More Details? CHECK—OFF Page 94

BARRY
presents

The incomparable

***ALPHA 77* by ETO**



The finest amplifier ever offered for Amateur, Commercial & Military service. 3000 watts PEP continuous-duty. Perfect companion to the CX7A.

$1,495 net

Unprecedented 2 year warranty on major power components, the transformer and filter capacitor. Full year warranty on the entire amplifier.

ALPHA

PA-70-V LINEAR AMPLIFIER

Write or Call

DYCOMM

2 Meter Repeater — Deluxe model $600.00
10-0 10w in 100w out $195.00
2 Meter Amplifiers (Power ratings approx.)
BRICK BOOSTER, 2w in 35w out .... $ 79.95
BLOCK BOOSTER, 10 in 50w out, new, $ 99.95
demos, $ 79.95

DRAKE

TR-72 2 meter FM transceiver, 23 channel, 1 & 10 watts, 13.8 VDC $299.95
AC-10 AC Supply for TR-72 .... $ 39.95
TR4/C new, $599.95 W4 .... new, $ 61.95
R4C Rec. $499.95 TR22 new, $219.95
T-4XC Trans. $529.95
AC-4 Drake A.C. Power Supply .... $ 99.95
MN-2000 — 2 KW PEP antenna tuner $195.00
AA-10 2 meter 10 watt linear amp. for use with TR-22, etc. .... $ 49.00
AA-22 2 meter 25 watt linear amp. for TR-22 or similar plus preselector, for improved sensitivity and rejection $149.95

CLEGG FM-27B NO XTALS
25w out Synthesized
$479.95
Latest Model
Completely checked out if you wish.
Clegg FM27B Regulated AC Power Supply $79.95

COLLINS

51J-4 Receiver .5-30.5 mcs continuous with 1, 3 & 6 kc mechanical filters in cabinet with book $475.00
F455F15 1.5 kc mechanical filter, unused $ 25.00
F455F60 6.0 kc mechanical filter, unused $ 19.95
30L1 spare parts kit less chassis/cab. etc., Write

TEN TEC

All below is new merchandise
ARGONAUT MODEL 505 .... $288.00
ARGONAUT 405 LINEAR AMP. 50w. out $149.00
210 POWER SUPPLY for Argonaut 505 only $ 24.95
250 POWER SUPPLY, powers 505 & 405 $ 49.00
315 RECEIVER 10-80 meters SSB, AM, CW $229.00
CW FILTER FOR 315 .... $ 14.95
All above in stock
AC4 SWR Bridge $ 14.95
KR2 .... $ 12.95
KR20 .... $ 59.95
KR40 .... $ 89.95
PM2A .... $ 64.95
AC5 Tuner $ 8.95

INSTRUMENTS

Pan Adapter BC-1031A ± 100 kc unused with spare parts & book .... $ 75.00
SIMPSON 2701 Digital Multimeter reg. approx. $895 Special, $595.00
Hewlett Packard 236A Audio osc., 50 Hz-560 kHz .... excellent/like new, $175.00

12 VOLT DC POWER SUPPLIES: 110 AC OUTPUT

MODEL 102, is a 4 amp overload protected power supply that automatically resets itself when the overload is removed .... new, $24.95
MODEL 104R, is a regulated power supply with the same electronic overload protection as the model 102. MODEL 104R .... new, $34.95
MODEL 107M is a heavier duty supply with the same features as the Model 102 but puts out 6 amps, useful for Clegg 27 series, etc. new, $27.95

HALLICRAFTERS

SR-150 Transceiver 10-80 meters AC or DC power supplies .... write
SR-160 Transceiver 80, 40, 20 meters .... write
PS-150-R DC power supply for SR-150 or SR-160 .... new, $109.50
FPM-300 .... new, $595.00

LITTLE LULU

Your chance to build a high quality deluxe AM, CW 6 meter transmitter. Can be converted to FM. See Aug. '63 QST, page 45 for complete details. 115 VAC and 12 VDC power. Parts and information available. Call or write for further details.

More Details? CHECK—OFF Page 94

CUSH-CRAFT 2M ANTENNAS!
IN STOCK . . . SHIPPING PREPAID

AR-2 – **FM RINGO** 3.75 DB Gain! 135-175 MHZ 100W Omnidirectional $12.50
AFM-4D **4 POLE** – Up to 9 DB Gain! All Hardware 360° 6 DB 180° 9 DB $42.50
AM-147 – **FM MOBILE** – 3 DB Gain! Fiberglass Roof or Trunk $26.95
A147-11 – **11 ELEMENT YAGIS** 13.2 DB Gain! Can be Vertically Polarized $17.95
A147-22 – **POWER PACKS** – 16 DB Gain! Two A147-11's and Complete Stacking Kit . . . $49.50
A147-4 – **4 ELEMENT YAGIS** – 9 DB Gain! 1KW Mast or Tower Side Mount . . . . $ 9.95
DX-120 – **20 ELEMENT DX ARRAYS** – 14.2 DB Gain! Combine the Best Yagi and Colinear Features Can Be Stacked Up To 80 Elements Dynamite for DX ing and Moonbounce . . . $29.50

ASK FOR COMPLETE CUSH CRAFT CATALOG . . . AMATEUR, COMMERCIAL, CB

Catalog Number	*Any Quantity Per Item (Mix)* 1-99	100-999	1000 up	*Multiples of 10 Per Item (Mix)* 100-990
7400	.34	.32	.30	.28
7401	.34	.32	.30	.28
7402	.34	.32	.30	.28
7403	.34	.32	.30	.28
7404	.36	.34	.32	.30
7405	.36	.34	.32	.30
7406	.56	.53	.50	.47
7407	.56	.53	.50	.47
7408	.38	.36	.34	.32
7409	.38	.36	.34	.32
7410	.34	.32	.30	.28
7411	.34	.32	.30	.28
7413	.60	.57	.54	.51
7416	.54	.51	.48	.45
7417	.54	.51	.48	.45
7418	.38	.36	.34	.32
7420	.34	.32	.30	.28
7421	.34	.32	.30	.28
7423	.84	.80	.76	.72
7425	.54	.51	.48	.45
7426	.40	.37	.34	.31
7430	.34	.32	.30	.28
7437	.56	.53	.50	.47
7438	.56	.53	.50	.47
7440	.34	.32	.30	.28
7441	1.73	1.64	1.55	1.46
7442	1.34	1.27	1.20	1.13
7443	1.34	1.27	1.20	1.13
7444	1.34	1.27	1.20	1.13
7445	1.74	1.62	1.53	1.44
7446	1.34	1.27	1.20	1.13
7447	1.30	1.23	1.16	1.09
7448	1.44	1.37	1.29	1.22
7450	.34	.32	.30	.28
7451	.34	.32	.30	.28
7453	.34	.32	.30	.28
7454	.34	.32	.30	.28
7459	.34	.32	.30	.28
7460	.34	.32	.30	.28
7470	.46	.43	.40	.37
7472	.40	.38	.36	.34
7473	.52	.49	.46	.43
7474	.52	.49	.46	.43
7475	.80	.76	.72	.68
7476	.58	.55	.52	.49
7480	.80	.76	.72	.68
7482	1.10	1.05	1.00	.95
7483	1.72	1.64	1.56	1.48
7485	1.58	1.51	1.44	1.37
7486	.60	.57	.54	.51
7490	.85	.80	.75	.70
7491	1.48	1.41	1.34	1.27
7492	.85	.80	.75	.70
7493	.85	.80	.75	.70
7494	1.32	1.26	1.20	1.14
7495	1.32	1.26	1.20	1.14
7496	1.32	1.26	1.20	1.14
74100	1.80	1.70	1.60	1.50
74104	.70	.67	.64	.61
74105	.70	.67	.64	.61
74107	.54	.51	.48	.45
74121	.60	.57	.54	.51
74122	.74	.71	.68	.65
74123	1.30	1.20	1.10	1.00
74141	1.75	1.66	1.57	1.48
74145	1.50	1.43	1.36	1.29
74150	2.00	1.85	1.70	1.55
74151	1.30	1.24	1.18	1.12
74153	1.70	1.60	1.50	1.40
74154	2.75	2.55	2.35	2.05
74155	1.56	1.49	1.42	1.35
74156	1.46	1.39	1.31	1.23
74157	1.56	1.48	1.39	1.31
74158	1.56	1.48	1.39	1.31
74160	2.20	2.10	2.00	1.90
74161	2.20	2.10	2.00	1.90
74162	2.20	2.10	2.00	1.90
74163	2.20	2.10	2.00	1.90
74164	2.20	2.10	2.00	1.90
74166	2.30	2.20	2.10	2.00

Catalog Number	*Any Quantity Per Item (Mix)* 1-99	100-999	1000 up	*Multiples of 10 Per Item (Mix)* 100-990
74175	2.00	1.90	1.80	1.70
74180	1.30	1.23	1.16	1.09
74181	5.20	4.90	4.60	4.30
74182	1.26	1.19	1.12	1.05
74192	2.10	2.00	1.90	1.80
74193	2.10	2.00	1.90	1.80
74198	3.10	2.95	2.80	2.65
74199	3.10	2.95	2.80	2.65
SCHOTTKY TTL				
74S00	.88	.84	.79	.75
74S01	.88	.84	.79	.75
74S03	.88	.84	.79	.75
74S04	1.00	.95	.90	.85
74S05	1.00	.95	.90	.85
74S08	.88	.84	.79	.75
74S09	.88	.84	.79	.75
74S10	.88	.84	.79	.75
74S15	.88	.84	.79	.75
74S20	.88	.84	.79	.75
74S21	.88	.84	.79	.75
74S22	.88	.84	.79	.75
74S40	1.00	.95	.90	.85
74S50	.88	.84	.79	.75
74S51	.88	.84	.79	.75
74S60	.88	.84	.79	.75
74S64	.88	.84	.79	.75
74S65	.88	.84	.79	.75
74S73	1.82	1.73	1.63	1.54
74S74	1.82	1.73	1.63	1.54
74S107	1.82	1.73	1.63	1.54
74S112	1.82	1.73	1.63	1.54
74S114	1.82	1.73	1.63	1.54
74S140	1.00	.95	.90	.85
LINEAR IC'S				
NE501A	2.99	2.82	2.66	2.49
NE526A	3.59	3.38	3.17	2.95
NE531V	3.81	3.58	3.36	3.14
NE536T	7.31	6.88	6.45	6.02
NE540T	2.40	2.25	2.10	1.95
SE540T	4.48	4.20	3.92	3.64
NE550A	1.30	1.23	1.16	1.09
NE555V	1.10	1.05	1.00	.95
N5556V	2.10	1.95	1.80	1.65
N5558V	1.00	.95	.90	.85
NE560B	3.57	3.36	3.15	2.94
NE561B	3.57	3.36	3.15	2.94
NE562B	3.57	3.36	3.15	2.94
NE565A	3.57	3.36	3.15	2.94
NE566V	3.57	3.36	3.15	2.94
NE567V	3.57	3.36	3.15	2.94
N5111A	.90	.86	.82	.78
N5595A	3.40	3.20	3.00	2.80
N5596A	1.87	1.77	1.66	1.56
709V	.50	.47	.44	.41
710A	.50	.47	.44	.41
711A	.55	.52	.49	.46
723A	1.00	.95	.90	.85
733A	1.90	1.80	1.70	1.60
741V	.55	.52	.49	.46
747A	1.10	1.04	.98	.92
748V	.60	.57	.54	.51
LM335	2.85	2.72	2.64	2.55
LM336	3.85	3.66	3.46	3.27
LM337	4.05	3.70	3.51	3.31
TRANSISTORS AND DIODES				
1N270	.15	.14	.13	.12
1N914	.10	.09	.08	.07
1N4001	.10	.09	.08	.07
1N4002	.11	.10	.09	.08
1N4003	.13	.12	.11	.10
1N4006	.15	.14	.13	.12
1N747A - thru				
1N758A	.25	.22	.19	.16
2N3860	.25	.23	.21	.19

All IC's are supplied in 8–, 14–, or 24–pin DIP (Dual-in-line) plastic or ceramic package except for NE536, NE540, and SE540 which come in TO–5 package. Voltage Regulators LM335, LM336 and LM337 are supplied in TO–3 (Diamond) package.

We give FREE data sheets upon request, so ask for those data sheets that you NEED, even for those listed IC's that you are not buying.

LED 7-SEGMENT DISPLAY:

Solid State Systems has now expanded it's line of LED Displays and also reduced their cost. The following are now available from us at these prices.

	1–49	50–99	100–499	500–999	1,000 up
SSS-1	4.50	4.25	3.75	3.40	3.00
SSS-1C	4.75	4.50	4.00	3.65	3.25
SSS-2	4.50	4.25	3.75	3.40	3.00
SSS-3	7.75	7.50	7.00	6.75	6.50
SSS-4	7.75	7.50	7.00	6.75	6.50
SSS-7	3.50	3.25	3.00	2.75	2.50
SSS-9	3.50	3.25	3.00	2.75	2.50
Minitrons*	3.00	2.75	2.50	2.25	1.90

The SSS-7 and SSS-9 are the common .33 in character height 7-Segment and overflow display respectively, with decimal point on the left and wide angle viewing. The SSS-1 and SSS-2 have the same physical dimensions as the SSS-7 and SSS-9 with increased life and slightly lower current requirement. The SSS-1C is the same as the SSS-1 except it has a colon instead of a decimal point, making it ideal for use in a digital clock. The SSS-3 and SSS-4 are the new giant .77 in character height 7-Segment and overflow display respectively, with decimal point on the right and readability up to 40 feet. *Also included above is a new reduced price on our Incandescent 7-Segment Display.

Package of 8, 1/4 watt current limiting resistors . . . . $0.30.

MOLEX IC SOCKET PINS: Use these economical pins instead of soldering your IC's to PC boards. Sold in continuous strips in multiples of 100 pins only.

100 for $1.00	200 for $1.80	300 for $2.60	400 for $3.40
500 for $4.20	600 for $5.00	700 for $5.80	800 for $6.60
900 for $7.40	1000 for $8.20		each additional 1,000 $7.50

Dual-in-line SOCKETS. Brand new with gold plated pins.

		1–49	50–99	100–499	500–999	1,000 up
14 Pin	Solder	.50	.45	.40	.35	.25
16 Pin	Solder	.55	.50	.45	.40	.30
14 Pin	Wire Wrap	.55	.50	.45	.40	.30
16 Pin	Wire Wrap	.60	.55	.50	.45	.35
14 Pin	Closed-Entry Cap	.05	.05	.04	.04	.03
16 Pin	Closed-Entry Cap	.05	.05	.04	.04	.03

STANCOR TRANSFORMERS: Ideal for use with LM series.

P-8180, 25.2VCT, 1 amp $3.00
P-6134, 6.3VCT, 1.2 amp $2.75

HEAT SINKS: *Wakefield series 680 circuit board coolers, 1¼" high with a dissipation up to 20 watts.* Designed for use with TO–3 package.

	1–49	50–99	100–499	500–999	1000 up
Type 680 - 1.25A	1.20	1.10	1.00	.90	.80

ALLEN-BRADLEY MIL-GRADE (5-band) RESISTORS. Any of the 84 STANDARD 10% values from 2.7Ω to 22MΩ ¼ or ½ WATT. EACH . . . . $0.05.

CERAMIC DISC CAPACITORS. Type 5GA-1000WVDC:
5, 7.5, 10, 12, 15, 20, 22, 25, 27, 30, 33, 39, 50, 56, 68, 75, 82, 100, 120, 150, 180, 200, 220, 250, 270, 300, 330, 360, 390, 470, 500, 560, 680, 750, 820, 1000, 1200, 1500, 1800, 2000, 2200, 2500, 2700, 3000, 3300, 3900, 4700, 5000μμF.
EACH . . . . $.10
0.01μF, EACH . . . . $.11 0.02μF, EACH . . . . $.12

LOW VOLTAGE DISCS, Type UK.

1.0μF, 3V . . . . $.25	0.47μF, 3V . . . . $.25	0.2μF, 10V . . . . $.20
.1μF, 10V . . . . $.12	2.2μF, 3V . . . . $.30	0.01μF, 16V . . . . $.10

ELECTROLYTIC CAPACITORS: All values are available in both, axial or upright (PC Board) mount. Please indicate your choice.

10μF, 15V . . . . $.10	30μF, 35V . . . . $.20	5μF, 50V . . . . $.10
30μF, 15V . . . . $.10	50μF, 35V . . . . $.20	10μF, 50V . . . . $.15
50μF, 15V . . . . $.10	100μF, 35V . . . . $.20	20μF, 50V . . . . $.20
100μF, 15V . . . . $.10	500μF, 35V . . . . $.40	50μF, 50V . . . . $.20
220μF, 15V . . . . $.15	1000μF, 35V . . . . . . $.50	100μF, 50V . . . . $.20
500μF, 15V . . . . $.20	1μF, 50V . . . . $.10	200μF, 50V . . . . $.30
1000μF, 15V . . . . . . $.30	2μF, 50V . . . . $.10	500μF, 50V . . . . $.55
20μF, 25V . . . . $.15	3μF, 50V . . . . $.10	

TERMS: Rated firms NET 30 days. Otherwise check or money order with order. BankAmericard and Mastercharge are welcome. All invoicing is now done by computer therefore, the following standard charges will automatically be added to your order.

If your merchandise total is between:

$ 0.00 - $ 4.99	add	$1.00
$ 5.00 - $24.99	add	$0.75
$ 25.00 - $49.99	add	$0.50
$ 50.00 - $99.99	add	$0.25
$100.00 and up	add	$0.00

SPECIAL CHARGES

COD	$1.00	additional
Air Mail	$0.50	additional
Postal Insurance	$0.25	additional
Special Delivery	$0.75	additional

With this new system all shipments will be F.O.B. destination, via First Class or UPS (your choice). These charges include shipping, handling and insurance.

MISSOURI RESIDENTS: Please add 4% sales tax.

SOLID STATE SYSTEMS, INC.

P. O. BOX 773 • COLUMBIA, MISSOURI 65201

TWX 910-760-1453 • PHONE 314 - 443-3673

Your BANKAMERICARD *welcome here*

ORDER DESK
1-800-325-2981
1-800-325-2595

master charge
THE INTERBANK CARD

More Details? CHECK—OFF Page 94

flea market

■ **RATES** Commercial Ads 25¢ per word; non-commercial ads 10¢ per word payable in advance. No cash discounts or agency commissions allowed.

■ **COPY** No special layout or arrangements available. Material should be typewritten or clearly printed and must include full name and address. We reserve the right to reject unsuitable copy. **Ham Radio** can not check out each advertiser and thus cannot be held responsible for claims made. Liability for correctness of material limited to corrected ad in next available issue. Deadline is 15th of second preceding month.

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

EXCLUSIVELY HAM TELETYPE — 20th year. RTTY Journal, articles, news, DX, VHF, classified ads. Sample 30¢. $3.00 per year. Box 837, Royal Oak, Michigan. 48068.

2ND OP — W9IOP's amazing DX calculator quickly gives you the information you are looking for. Just $2.00. Comtec, Greenville, N. H. 03048.

WORLD QSL — See ad page 88.

VERY in-ter-est-ing! Next 6 big issues $1. "The Ham Trader," Sycamore IL 60178

HELP W2KUV. Here is a deserving old timer, who needs some gear to get back on the air at his nursing home. Will anyone give or loan him enough gear to get going again? Write John Sanford, Amchare Heritage Hall, 524 Hamilton Road W., Neptune, N. J. 07753.

16TH ANNUAL PICNIC AND HAMFEST, on Sunday August 5th at the Frankfort Picnic Grove, 1 mile north of U. S. 30 on U. S. 45, Frankfort, Ill. Food and Drinks, Swap and Shop. Advance registration $1.50. Admission at gate $2.00. For further information and advance tickets contact Val Hellwig, K9ZWV, 3420 South 60th Court, Cicero, Ill. 60650.

SIGNAL ONE OWNERS, expert and prompt service by ex-Signal/One employee. Write or call for details. Larry Pace, K2IXP/7, 1071 W. Roller Coaster, Tucson, AZ. 85704 (602-888-5234).

FOR YOUR FUTURE ROBYN RADIOS send your order to, Two Way Radio Sales, 1501 Monroe Street, Bogalusa, La. 70427 or 202 Farrell Street, Picayune, Miss. 39466.

DISCOUNT SPECIALS! Clegg FM-27A @ $378! Standard SR-C146 @ $219.50, SR-C826M @ $258! Genave, Miida, Mosley, Tri-Ex, Gladding, Sonar, Shakespeare, many others. Also Marine and C.B. Arena Communications, Dept. C., 1169 N. Military Highway, Norfolk, Virginia 23502.

MOBILE IGNITION SHIELDING provides more range with no noise. Available most engines in assembled or kit forms, plus many other suppression accessories. Free literature. Estes Engineering, 543-H West 184th, Gardena, California 90248.

TOROIDS, iron "E" powder 80-10 meters. .500" — 8/$1.00, .680" — 5/$1.00, .940" — 4/$1.00, 1.437" — 75¢ each or 3/$2.00, 2.310" — $1.50 or 3/$4.00. Please include 50¢ postage, slightly more on large orders. Fred Barken, WA2BLE, 274 E. Mt. Pleasant Ave., Livingston, N. J. 07039.

BARGAIN HUNTERS! Don't miss out. Closeout of 18th Edition of W6SAI's Radio Handbook, list $13.50, only $7.95 ppd. while they last. Comtec, Greenville, N. H. 03048.

FIGHT TVI with the RSO Low Pass Filter. For brochure write: Taylor Communications Manufacturing Company, Box 126, Agincourt, Ontario, Canada. MIS 3B4

6939's, 6360's GUARANTEED good, $2.50 each. Jack Elliano W6TNR, 15718 Mayall, Sepulveda, Calif. 91340.

CANADIANS: COLLINS 75A2 $200. Technical Material Corp. exciter SBE2, $250. FR4/U Frequency Meter, $100. All with manuals and in excellent condition. John Dobroshinsky, Ve3 DDD, Newcastle, P. O. LOA 1HO.

CAPE COD'S fabulous Hyannis! N. E. ARRL Convention, September 29 & 30. Flea market, seminars, FM, SSTV, AMSAT, YL trips, 2 pools, golf, beaches, sailing. Early bird registration $3. W1KCO, 572 Berkley Street, Taunton, MA. 02780.

QSL'S. Second to none. Same day service. Samples 25¢. Ray, K7HLR, Box 331, Clearfield, Utah 84015.

WANT OLD RADIO SHOW TRANSCRIPTION discs. Any size or speed. Send details to, Larry Kiner, W7FIZ, 7554 132nd Ave. N.E., Kirkland, Wa. 98033.

ANTIQUE RECEIVERS: 1923 Freed-Eiseman NR-5 Neutrodyne, 2 - Atwater Kent with Philco Model 4 short wave converter. Sell or trade for tower, beam, etc. Make offer. Ben Doe, W1GQU, 210 Central, Gardiner, Maine 04345.

HALF KW LINEAR for 432 MHz (w. 4CX250B) new $350. Low noise 2 mtr converter and tuner (8 transistors, output 9 MHz for xtal filter IF) new $45. 50 W 2 mtr linear (solid state) new $50. UHF reflectometer, new $15. 4CX250B new $10. Henry Ingwersen, 33 Jewett Street, Georgetown, Massachusetts 01833, 617-352-2858.

REPEATER IDENTIFIER AC supply, timer, oscillator — all on one glass epoxy PC board pre-programmed with your call $69.95 complete, wired and tested. Write for brochure and specs. Tobel Electronics, 7920 Alida St., La Mesa, Calif. 92041.

WARREN HAMFEST, Largest family style Hamfest in East. Sunday, August 19th, at famous Yankee Lake Park. Giant Fleamarket, swimming, picnicing — All free. QSL W8VTD, Box 809, Warren, Ohio 44482.

WANTED — Hammarlund SP-600JX21 receivers — Need 20 or more. P. O. Box 4039, Foster City, California 94404.

MANUALS for most ham gear made 45/65, some earlier. Send SASE for copy quote. Hobby Industry, W0JJK, Box 864, Council Bluffs, Iowa 51501.

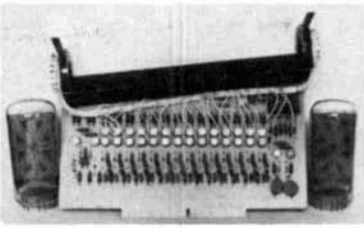
NEW SCANNER BOOK from Sams, includes comprehensive servicing data for 30 popular UHF and VHF Scanner-Monitor receivers including models by B & K, Browning, Johnson, Midland, Pace, Pearce-Simpson, Penney's, Realistic, Sonar and Teubury. Just $4.95 postpaid from Comtec, Greenville, N. H. 03048.

RTTY SPEED CONVERTER. A drilled 4" x 6½" PCB and all components except input output jacks, power supply and chassis. See Dec. '71 and Oct. '72 issue of Ham Radio. $40.00 postpaid. PCB only $6.00. P & M Electronics, Inc., 519 South Austin, Seattle, Washington 98108.

TELL YOUR FRIENDS about Ham Radio Magazine.

GIANT B-7971 NIXIES (2) with 2 sockets and driver board containing hi voltage transistors. Complete plug-in board as removed from operational equipment. Schematics included. Unbelievable but true . . . just $2.50 for the complete package. **#72S-10 $2.50**

NIXIE TUBE — B-7971 ALONE $1



Mod. 28-LPR Typing Reperf, 5 level 100 wpm w/motor **$35.00**

Mod. 28-LARP non-typing reperf, 5 level less motor **$10.00**

Mod. 28-LBX-D1 Trans/Dist, with motor, 5 level **$25.00**

COMBO DEAL — 1 ea. of above 3 units; $60.00

15¢ IC BONANZA

Brand new DTL dual inline (DIP) package, factory marked ceramic type. The price is too good to be true. Fully guaranteed and with specs.

930	**Dual 4 input NAND gate**	similar to **7420**
931	**Clocked flip flop**	similar to **74110**
932	**Dual 4 input Expand Buff**	similar to **7440**
933	**Dual 4 input expander**	similar to **7460**
936	**Hex Inverter**	similar to **7405**
945	**JK Flip Flop**	similar to **74110**
946	**Quad 2 input gate**	similar to **7400**
962	**Triple 3 input gate**	similar to **7410**

15¢ each

IC's — Buy $100 worth and deduct 10%

MEMORY CORE STACK $50.00
64 x 64 x 9 (38,865 cores)

MEMORY CORE STACK $100.00
32 x 32 x 16 x 9 (147,456 cores)

4096 CORE, single frame **$9.00**

16,384 CORE, single frame **$15.00**

Please add postage for above.

JOHN MESHNA JR. ELECTRONICS P. O. Box 62 E. Lynn, Mass. 01904

KM-420 CW MESSAGE MEMORY 100 OR 200 CHARACTERS . . . $299.95
Write for Brochures
EK-420 C-MOS DELUXE KEYER FOR QRP OR KW . . . $139.95

CURTIS ELECTRO DEVICES INC., BOX 4090, MOUNTAIN VIEW, CA. 94040
TEL: (415) 964-3136
NEW FOR 1973

THE RECIPROCATING DETECTOR

As a Kit $36 .... Wired $45

State your IF Frequency

PETER MEACHAM ASSOCIATES
19 Loretta Road, Waltham, Mass. 02154

WE PAY HIGHEST PRICES FOR ELECTRON TUBES AND SEMICONDUCTORS

H & L ASSOCIATES

ELIZABETHPORT INDUSTRIAL PARK
ELIZABETH, NEW JERSEY 07206
(201) 351-4200

2 METER FM

GLADDING 25™

. Full 25 watts output . Six channel capability — Crystals supplied for 146.34/.94 and 146.94/.94 . Complete with mounting cradle and microphone

Special Package Price

INCLUDING AC POWER SUPPLY

Only $275

Write for Price and information on the new Gladding Model 660 2 Meter FM Porta-Pack

BOB'S DISCOUNT ELECTRONICS
720 N. HUDSON, OKLAHOMA CITY, OK 73102
405-232-1384

FM Schematic Digest

A COLLECTION OF MOTOROLA SCHEMATICS

Alignment, Crystal, and Technical Notes covering 1947-1960

136 pages 11½" x 17" ppd $6.50

S. Wolf
P. O. Box 535
Lexington, Massachusetts 02173

More Details? CHECK—OFF Page 94

NAME YOUR DEAL! Following items offered either "Fully reconditioned with 90-day guarantee" or "Working condition — AS-IS" (price in parenthesis): Viking II's $35 ($25), Viking II with 122 VFO $79 (59), Valiants $99 ($89), Rangers $85 ($75), excellent Ranger II $129 ($119), Globe LA-1 Linear $55 ($45), Johnson Courier Linear $85 ($75), National NC-173 $59 ($49), Heath TX-1 $59 ($49), Gonset IV $99 ($85), Johnson 6-N2 Converter $25 ($20), Heath SB-10 $50 ($40). Write: Burghardt Amateur Center, Box 73H, Watertown, S. D. 57201.

DUMMY LOAD up to 500 W PEP. New (with oil) $7.95. 2M turnstile antenna new $7.95, SB610 monitorscope, mint $85. Wanted 8122 tubes, VFO matchbox SWR. W2FNT, 18 Hillcrest Ter., Linden, N. J. 07036.

STOLEN: The following pieces were taken from the Muskegon Area Amateur Radio Council Club station sometime during the week of March 12th. Any information may be sent to the MAARC, P. O. Box 691, Muskegon, Mich. 49443 or WA8GVK. AC 616-722-3910 or 744-1400. Equipment: Electro-Voice 641 MIC on astatic GN series stand, Drake R4B receiver SN 11578G, Drake T4XB transmitter SN 17801G, Drake W4 wattmeter SN 8390, Swan 250 transceiver SN F154806, Swan AC supply SN 0653556.

BOUND VOLUMES. The deluxe answer to a perfect Ham Radio Magazine collection. 1970, 1971 & 1972 now available. $14.95 postpaid. Ham Radio, Greenville, NH 03048.

MODERNIZE FOR PEANUTS! Frame & Display QSL's with 20 pocket plastic holders. Two for $1.00, seven for $3.00. Prepaid, guaranteed. Universally used and approved. Order now. TEPABCO, Box 198H, Gallatin, Tennessee 37066.

PRINTED CIRCUIT DRILL BITS. Trumbull, 833 Balra Drive, El Cerrito, California 94530.

EQUIPMENT FOR SALE: One Tempo FMP with all accessories and four sets of crystals for $200. Drake FET converter with power supply for $80. Thomas S. Jacobsen, 3371 Decatur Ave., Bronx, N. Y. 10467.

STOLEN: G-76 Transceiver #25682 with calibrator #20560. Please call 203-644-1110.

THE M.R.A. is holding their 2nd annual (Father's Day) Hamfest, June 17, 1973 at 8103 Austin Rd., Schererville, Ind. 46375, starting at 8:00 a.m. to 4:00 p.m. Free coffee, plenty of parking, call-in 146.94 FM. All sellers, buyers, swappers & browsers are invited

WE BUY ELECTRON TUBES, diodes, transistors, integrated circuits, Semiconductors. Astral Electronics, 150 Miller Street, Elizabeth, New Jersey 07207, (201) 354-2420.

REPAIR TV TUNERS — High earnings, complete course details, 12 repair tricks, many plans, two lessons, all for $1. Refundable. Frank Bocek, Box 3236 (Enterprise Branch), Redding, Ca. 96001.

90-DAY GUARANTEE on all these Fully Reconditioned receivers: Drake 2-C/2-CQS $219, Hallicrafters SX-99 $79, SX-101 $129, SX-101 Mark-3A $139, Hammarlund HQ-100 $99, HQ-100AC $129, HQ-110C $119, HQ-110AC $139, HQ-170AC $189. More arriving daily. Write: Burghardt Amateur Center, Box 73H, Watertown, S. D. 57201.

QSL'S — BROWNIE W3CJI — 3111B Lehigh, Allentown, Pa. 18103. Samples 10¢. Cut catalogue 25¢.

GIVE ME FIVE MINUTES OF YOUR TIME: And I'll show you how to crack the computer code on those utility and charge card bills. Rush name, address and $1.95 to Data Guide, P. O. Box 1205, Garland, Texas. 75040.

SELL: Panoramic Adapter AN/APA 10, three inputs, 455 kHz, 5.25 MHz, and 30 MHz. Power supply converted to 60 Hz, spare parts and manual included, $40. Coaxial Oscillator 1000 to 3000 MHz, part of APR-5A receiver, with 2C 40 tube $65, without tube $45. W8LRN, 4425 Streetsboro Rd., Richfield, Ohio 44286.

More Details? CHECK—OFF Page 94

More Details? CHECK-OFF Page 94

TAKE YOUR PICK from this wide selection of SSB Transceivers, all fully reconditioned with 90-day Guarantee: Drake TR-3 $359, TR-4 $419, Eico 753 with both AC/DC $159, Galaxy GT-550A/AC-400/SC-550A $499, Kenwood TS-511S/PS-511S $429, SBE SB-34 $269, Swan 175 with both AC/DC $129, 240/117AC $219, 250/117XC $249, 350C $279, 500/117XC $419, WRL Duo-Bander 84 with AC or DC $129. More arriving daily. Write: Burghardt Amateur Center, Box 73H, Watertown, S. D. 57201.

USED MYLAR TAPES — 1800 foot. Ten for $8.50 postpaid. Fremerman, 4041 Central, Kansas City, Mo. 64111.

TONE AND LOGIC circuit board layouts for WWV, RTTY, SSTV projects, systems. Two PCB samples, schematics, $3.00. Hornung, Box 24614, San Jose, California 95154.

NEWS: Free sample copy of "Worldradio", Amateur Radio's Newspaper. 2509-C Donner Way, Sacramento, Calif. 95818.

AMATEUR RADIO APPRECIATION DAY will be held July 29 in Junction, Texas. This is a FREE Bar-B-Q for anyone holding an amateur license and their family. The day is sponsored by the Kimble County Chamber of Commerce to show its appreciation of the many public services and disaster assistance amateur radio operators provide. For information contact WB5BBT, or the Kimble County Chamber of Commerce, 603 Main, Junction.

SELL: Heath SB-610, R-390 receiver CV-157 SSB adapter, best offer or trade for ? Can pack and ship. K9HJU, 312-349-S002.

HOOSIER ELECTRONICS — Your ham headquarters in the heart of the Midwest where only the finest amateur equipment is sold. Individual, personal service by experienced and active hams. Factory-authorized dealers for Drake, Regency, Standard, Clegg, Ten-Tec, Galaxy, Hy-Gain, CushCraft, Ham-M, Mosley, Hustler, electronic pocket calculators, plus many more. Orders for in-stock merchandise shipped same day. Write or call today for our quote and try our personal friendly Hoosier service. Hoosier Electronics, R. R. 25, Box 403, Terre Haute, Indiana 47802. (812) 894-2397.

RESISTORS: Carbon composition brand new. All standard values stocked. 1/2W 10% 50/$1.00; 1/4W 10% 40/$1.00 — 10 resistors per value please. Minimum order $5.00. 15W RMS IC Audio Amplifier — Panasonic. Frequency response 20Hz-100kHz. 1/2% distortion. Price $6.50. Postpaid. Pace Electronic Products, Box 161-H, Ontario Center, New York 14520.

STELMAN #TA-1 TELEPHONE ADAPTER, $125. Heavy duty equipment slides $15 ea. Components, equipment, etc. Inquiries invited, catalog available. B. F. Williams Co., P. O. #7057, Norfolk, Va. 23509.

CHEAP SSB — Audio/Balanced Modulator board, with VOX, speech clipping, BFO board, w/Xtals for USB, LSB, 455 kc carrier. $6/Board, both $10. Collins 455F21 mechanical filter, $25. Boards are assembled, with schematics, postpaid, no C.O.D.'s. WA1AYS, Steve Gilbert, 55 Hinckley Rd., Newton, Mass. 02168.

DYCOM AMPLIFIERS — E, $55.00, ES, $75.00, D, $75.00, 10-0, $160.00. Foster, Box 198, Star Route, Tijeras, N. M. 87059.

WANTED, GONSET 220 communicator. State model, cond., price. Ron Veelik, WA6LTH, P. O. Box 210, Crestline, Ca. 92325.

WANT — COLLINS MM-2 BOOM mike/earphone. State price and condition. John Deal, 1235 Milano Drive, Naples, Florida 33940.

CANADA'S MOST UNUSUAL Surplus and Parts Catalog. Jam packed with bargains and unusual items. Send $1. ETCO-HR, Box 741, Montreal, Canada.

SSB CONVERTER CV-591A: Get upper or lower sidebands from any recvr. OK gatd. w/book $137.50

SP-600(*) RECEIVER 0-54-54 MHz continuous, overhauled, aligned, grtd, w/book 250.00

BRAND NEW FREQ-SHIFT TTY MONITOR

NAVY OCT 3: FM Receiver type, freq. range 1 to 26 MHz in 4 bands, cont. tuning. Crystal calib. Reads up to 1500 Hz deviation on built-in VTVM. Cost $1100.00 each! In original box, with instruct. book & cord. fob Mariposa, Cal. Min. signal needed: 15 mv. Shpg wt 110 lbs 49.50

HIGH-SENSITIVITY WIDE-BAND RECEIVER

COMMUNICATIONS • BUG DETECTION
• SPECTRUM STUDIES

38-1000 MHZ AN/ALR-5; Consists of brand new tuner/converter CV-253/ALR in original factory pack and an exc. used, checked OK & grtd main receiver R-444 modified for 120 v. 50/60 hz. The tuner covers the range in 4 bands: each band has its own Type N Ant. input. Packed with each tuner is the factory inspector's checkout sheet. The one we opened showed SENSITIVITY: 1.1 uv at 38.4 mhz. 0.9 at 133 mhz, 5 at 538 mhz, 4½ at 778 mhz, 7 at 1 ghz. The receiver is actually a 30 mhz IF ampl. with all that follows, including a diode meter for relative signal strengths: an atten. calibrated in 6 db steps to −74 db, followed by an AVC position; Pan., Video & AF outputs; switch select pass of ±200khz or ±2 mhz; and SELECT AM or FM! With Handbook & pwr. input plug, all only 375.00

30 MHz PANADAPTER OK grtd $137.50

NEMS-CLARKE #1670 FM Rcvr 55-260 MHz like new 275.00

Attention!
Buyers, Engineers, advanced Technicians:

We have the best test-equipment & oscilloscope inventory in the country so ask for your needs . . . don't ask for an overall catalog . . . we also buy, so tell us what you have. Price it.

R. E. GOODHEART CO. INC.
Box 1220-HR, Beverly Hills, Calif. 90213
Phone: Area Code 213, Office 272-5707

SAROC
9th annual fun convention
Best of Las Vegas — Best of Amateur Radio
January 3-6, 1974
SAROC Box 73 Boulder City, Nev. 89005

FOR YOUR GARDEN APARTMENT

Stay on the air with the **New B&W Model 370-10 Portable Whip Antenna.** Simple, quick installation for windowsills, poles, boats, trailers, hotels, etc.

Frequency Coverage	20, 15, 10, 6, 2 and CB Bands
VSWR	1.1:1
Power Rating	SSB—360 watts PEP CW—360 watts input
PRICE	$24.95

See your dealer or write:
Barker & Williamson, Inc. B&W
Canal Street, Bristol, Pa. 19007

More Details? CHECK—OFF Page 94

ENJOY CW!

USE A MATRIC KEYER & PADDLE

- SELF COMPLETING
- BATTERY OPERATED
- RELAY OUTPUT

MODEL 10

CIRCUIT BOARD KIT (LESS CASE) $12.95
KIT (LESS BATT)..............$21.90
WIRED (LESS BATT) $26.50
SIDETONE KIT $4.95 • WIRED $6.95

PADDLE

MODEL 11

★ ADJUSTABLE TRAVEL
★ NON-SKID WEIGHTED BASE
★ FULLY ASSEMBLED

ONLY $9.95

SEE YOUR DEALER

OR ORDER DIRECT. PRICES F.O.B. FRANKLIN, PA.

MATRIC
RD 1, PONE LANE
BOX 185A
FRANKLIN, PA. 16323
PHONE: AREA CODE (814) 432-3647

DIGITAL:THEORY,DESIGN, CONSTRUCTION

LOGIC NEWSLETTER ©

SAMPLE COPY $ 1.00
LOGIC NEWSLETTER
POB 252
WALDWICK,N.J. 07463

F.C.C. EXAM MANUAL

PASS FCC EXAMS! Memorize, study — "1973 Tests-Answers" for FCC First and Second class Radio-telephone licenses. Newly revised multiple-choice questions and diagrams cover all areas tested in FCC exams. — plus "Self-Study Ability Test." $9.95 Postpaid.

COMMAND PRODUCTIONS
RADIO ENGINEERING DIVISION
P.O. BOX 26348-K
SAN FRANCISCO, CALIF. 94126

WANTS TO BUY

All types of military electronics equipment and parts. Call collect for cash offer.

SPACE ELECTRONICS division of MILITARY ELECTRONICS CORP.

76 Brookside Drive, Upper Saddle River
New Jersey 07458 • (201) 327-7640

Andy Electronics Co., Inc.
Department "S" 6431 Springer Houston, Texas 77017
All prices FOB Houston, Texas

AN/USM-50-OS 62 PRECISION OSCILLOSCOPE
AC scope with a frequency response of 3Hz. - 20MHz. and a risetime of .022us. Sensitivity is 24-25Mv./inch over the entire frequency range. This unit has a built in 1,000Hz. calibrator and superimposed marker dots at intervals of .2, 1, 5, 20, 100, 500, and 2,000us. for determining frequency. The CRT is 3". Also has a illuminated scale. 115V/60Hz. Ship. Wt. is 65 lbs.
Excellent Condition (Checked).............. $79.95
Good Condition (Repairable) $65.95

TS-382 AUDIO OSCILLATOR Tunes from 20Hz. - 20KHz. Has a built in 60Hz. and 400Hz. calibrator meter. The output freq. has been calibrated to 2% of the freq. indicated on the main dial. 115V/60Hz. Ship Wt. 65 lbs.
Excellent Condition (Checked).....................$79.95
Good Condition (Repairable).......................$65.95

AN/URM-79 FR-4 PRECISION FREQUENCY METER
Covers the frequency range of 100KHz. - 20MHz. In seven bands. Accuracy is .001% over the entire range. Frequency measurements and calibration checking are made by means of a blinker light and earphones. This Frequency meter has a 3" CRT for visual interpolation of the frequency being measured. Units are complete with interpolation book and operation manual. 115V/60Hz. Ship Wt. 120 lbs.
Excellent Condition (Checked).............. $79.95

ICOM 2 MTR FM
SPECIAL CLEARANCE SALE

24 chan. IC-21 built-in AC supply, RIT, DISC, mtr, SWR ind. with 10 crystals supplied while they last $329.50

Crystals for IC-20 and IC-21 .... $2.80 each

All Prices are FOB Renton, Wash. You pay shipping costs.

Write to Woody W7RC, Racom Electronics, Inc., 15051 SE 128 Street, Renton, Wash. 98005 Tel. 206 AL5-6656

WORLD QSL BUREAU

THE ONLY QSL BUREAU to handle all of your QSLs to anywhere; next door, the next state, the next country, the whole world. Just bundle them up (please arrange alphabetically) and send them to us with payment of 5¢ each.

5200 Panama Ave., Richmond, CA USA 94804

• QRM QRM QRM QRM QRM QRM QRM •

QRM QRM QRM

WHY FIGHT QRM?

Win the battle against CW QRM with the new DE-101 using advanced integrated circuit design. Connect it between your receiver and high impedance earphones for a guaranteed superior CW reception. Operate your receiver the same way as before except now you discriminate against QRM. No adjustments, the DE-101 is factory tuned and complete with built in ac supply. One year warranty. 4" x 2½" x 6" $29.95 plus $2.00 shipping. Ala. residents add 5% sales tax.

DYNAMIC ELECTRONICS INC.
BOX 1131 DECATUR, AL. 35601

QRM QRM QRM

• QRM QRM QRM QRM QRM QRM QRM •

More Details? CHECK—OFF Page 94

TELETYPEWRITERS — Kleinschmidt — portable, fixed, sets, punches, parts, reconditioned, reasonable. Mark/Space Systems, 3563 Conquista, Long Beach, Calif. 90808. 213-429-5821.

"P.C.'S" I can supply boards for any construction article that includes the full size artwork. Many in stock. Write: D. L. McClaren, W8URX, 19721 Maplewood Avenue, Cleveland, Ohio 44135.

WANTED: Lafayette HA46, Bob, K6GEV, 11 Wool, San Francisco 94110.

TECH MANUALS for Govt. surplus gear only $6.50 each: R-390/URR, R-220/URR, R-389/URR, R-274/FRR,, URM-25D, TS-382D/U, CV-591A/URR, ALR-5, SP-600JX-17, TS-497B/URR, OS-8C/U. Hundreds of others available. Send 50¢ (coin) for list. W3IHD, 7218 Roanne Drive, Washington, D. C. 20021.

SELL: Model 28 KSR floor cabinet, mint condition $250.00. W2NQW, 66 Franklin Street, Port Jervis, N. Y. 12771.

FOR SALE: Data Engineering Memory-Matic 500B with 800 bit reprogrammable memory $175. Tom Gallagher, W6NUT, Box 31365, San Francisco, California 94131.

"HAM OF THE YEAR" award for 1973. Only amateurs in the 1st call district are eligible. Anyone may nominate an amateur. Winner of the award will be chosen for the amateur activity which brings the greatest benefit to an individual or group and for the amount of ingenuity and sacrifice displayed. Nominating letters should include the candidate's name, address, call letters and a complete description of the service performed. Letters must be sent before Sept. 1 to the Chairman of the FEMARA Awards Committee, 28 Forest Ave., Swampscott, Mass. 01907. The winner will be presented with a plaque and a cash award at the ARRL New England Convention, Dunfey's, Hyannis, Cape Cod on September 29, 1973.

YOUR KWM2 CAN WORK BETTER — You can do it, too. Write W0BNF, Box 105, Kearney, Nebr. 68847.

BEAM, TOWER SPRING SPECIAL: Triex W51 368.00; MW50 250.75; MW65 331.50; Ham-M 99.00; TR44 59.95; AR22R 31.95; Hygain TH6DXX 139.00; 204BA 129.00;TH3MK3 114.00; Mosley CL36 149.00; CL33 124.00; TA33 114.00; MCQ3B 91.00; S402 143.00; 8214 RG8 foam belden 17¢/ft.; 8448 8-wire rotor cable 10¢/ft.; 3/16" cable clamps 18¢; Mallory 2.5A/1000PIV epoxy diode 29¢; Polygon fiberglas spreader arms 7.50; 6V/600MA transformer 1.95; KY65 Ider 5.95; Write quote Clegg FM27B; Hallicrafters FPM300A; Drake TR72; B & W; SBE; Standard; Eimac; Collins; CDE replacement parts; prices FOB Houston, Warranty guaranteed. Mastercharge, BAC. Write List. Madison Electronics, 1508 McKinney, Houston, Texas 77002. (713) 224-2668.

DELMARVA HAMFEST, August 19, 1973, Harrington Fairgrounds. Registration fee $2 advance, $3 at the gate. For information write Delmarva Hamfest, Inc., Route 2, Box 90, Laurel, Delaware 19956.

WANTED: tubes, transistors, equipment, what have you? Bernard Goldstein, W2MNP, Box 257, Canal Station, New York, N. Y. 10013.

SELL: HALLICRAFTERS HA2, HA6, power supply, six and two meter transverters. Best offer over $150. Hallicrafters SX101A ham band receiver, best offer over $100. Johnson Viking Ranger I, best offer over $50.00. Floyd Chowning, K5CWS, 5637 Prince Edward Ave., El Paso, Texas 79924.

ROANOKE DIVISION CONVENTION — Sept. 14-16, 1973, Reston, Va. (near Dulles Airport). Unusual wide interest programs and sessions. Write K4MD, Box 7388, Warrenton, Va. 22186.

STANDARD 146-A still in factory carton with warranty card. $238.70. W4OAQ, Box 17222, Nashville, Tenn. 37217, (615-834-8999).

YOUR AD belongs here too. Commercial ads 25¢ per word. Non-commercial ads 10¢ per word. Commercial advertisers write for special discounts for standing ads not changed each month.

For the most powerful antennas under the sun

the REPEATER

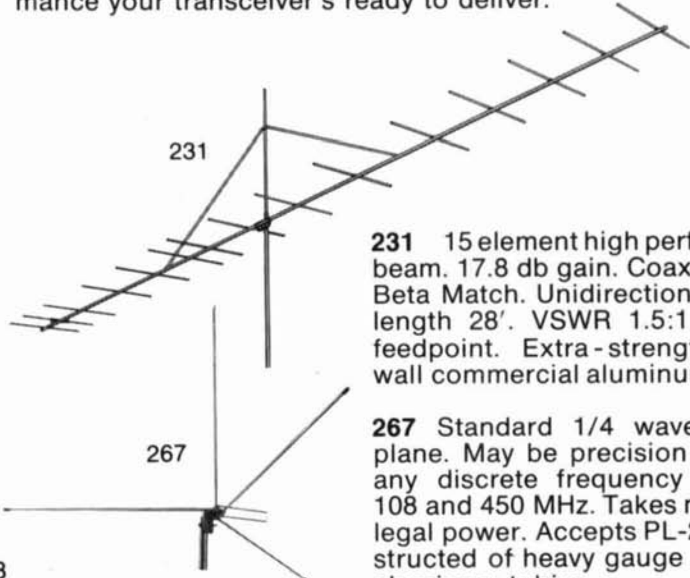
2 Meter Fixed Station

Designed for the man who demands professional standards in 2 meter equipment. *REPEATER LINE* fixed station antennas are the 2 meter HAM's dream come true. With everything you need for top fixed station performance...toughness, efficiency and the gain to gain access to distant repeaters with ease. Work many stations, fixed or mobile, without access to a repeater.

The right antennas for the new FM transceivers...or any 2 meter fixed station.

REPEATER LINE Fixed Station Antennas

Tough, high efficiency antennas with a long, low radiation. For the top signal and reception you want...and the top performance your transceiver's ready to deliver.



231

267

268

231 15 element high performance beam. 17.8 db gain. Coaxial balun. Beta Match. Unidirectional. Boom length 28′. VSWR 1.5:1 52 ohm feedpoint. Extra-strength heavy wall commercial aluminum tubing.

267 Standard 1/4 wave ground plane. May be precision tuned to any discrete frequency between 108 and 450 MHz. Takes maximum legal power. Accepts PL-259. Constructed of heavy gauge seamless aluminum tubing.

268 For repeater use. Special stacked 4 dipole configuration. 9.5 db offset gain. 6.1 db omnidirectional gain. Heavy wall commercial type construction. 144 thru 174 MHz. 1.5:1 VSWR over 15 MHz bandwidth eliminates field tuning. Extreme bandwidth great for repeater use. Center fed for best low angle radiation. DC ground. Complete with plated steel mounting clamps.

More Details? CHECK—OFF Page 94

More Details? CHECK—OFF Page 94

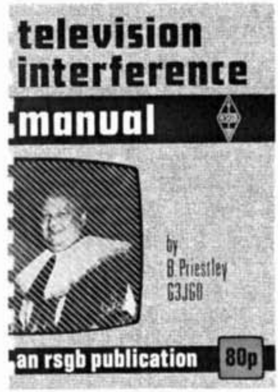
More Details? CHECK—OFF Page 94

NEW

Television Interference Manual

by B. Priestly G3JGO

The first new book on this vital subject in many, many years. Covers transmitter design, audio breakthrough, testing and much more. Written to cover British standards, but easily converted to American use.



$3.50 Postpaid

HANDBOOKS

We have all three

The Radio Amateur's Handbook

ARRL Staff

The standard reference for the radio amateur. Latest 1973 edition covers everything from the basics to such new areas as FM and slow-scan TV. The largest selling technical book ever published.

702 pages, softbound **Only $4.50**

RSGB: Radio Communication Handbook

Amateur Radio's most complete technical reference. This book covers virtually every phase of radio theory and practise in very complete and useful detail. Whether you use HF or VHF, SSB or RTTY you need this handbook.

832 pages, hardbound **Just $12.95**

Radio Handbook, 19th Edition

by William I. Orr, W6SAI

Latest updated edition of this famous handbook which is the standard for engineers, technicians and advanced amateurs. Explains in detail how to design and build all types of radio equipment, RTTY circuits, latest semiconductor and computer circuitry. 896 pages; hardbound.

Only $14.95

SPECIAL HANDBOOK PACKAGE

All 3 for just $27.50

Save nearly $5.00

CLOSEOUT SALE!

A SPECIAL PURCHASE ALLOWS US TO OFFER THE 18TH EDITION (JUST NOW SUPERSEDED) OF W6SAI's RADIO HANDBOOK (SEE ABOVE) FOR ONLY $7.95 WHILE THEY LAST.

comtec **BOOKS** Greenville, New Hampshire 03048

Advertisers check-off

. . . for literature, in a hurry — we'll rush your name to the companies whose names you "**check-off**"

INDEX

—Alpha
—Amateur-Wholesale
—Amtech
—Andy
—Antenna King
—Arizona Semi
—Babylon
—B. & H.
—Barry
—*Bauman*
—Bird
—Bob's
—CFP
—Bitcil
—Command
—Communications Specialists
—Comtec
—Curtis
—Cybersonic
—Data
—Display
—Dycomm
—Dynamic Electronics
—Ehrhorn
—Eimac
—Epsilon
—Erickson
—Etco
—Expo '73
—Frank
—Gateway
—Gilfer
—Gray
—Great American
—H & L
—HAL
—Hamtronics
—Ham Radio
—Henry
—Hobby Jewelry
—House of Dipoles
—Hy-Gain
—Icom
—IN-X
—International Crystal
—Jan
—Janel
—K. E.
—KRP
—KW
—Larsen
—Lee
—Linear Digital
—Linear Systems
—Logic
—MFJ
—Matric
—Meshna
—Micro-Z
—Midland
—*Miida*
—Mor-Gain
—Nurmi
—Oneida
—PM Electronics
—Palomar
—Pemco
—Peter Meacham
—Poly Paks
—RP
—Racom
—Callbook
—Raytheon
—Saroc
—Savoy
—Solid State
—Space-Military
—Spectrum
—Standard
—Swan
—Tri-Tek
—Triangle
—U-J Industries
—VHF Engineering
—Weinschenker
—Wilson
—Wolf
—World QSL
—Y & C
—Yaesu

Limit 15 inquiries per request.

June 1973

Please use before July 31, 1973

Tear off and mail to
HAM RADIO MAGAZINE — "check off"
Greenville, N. H. 03048

NAME..

CALL....................................

STREET..

CITY..

STATE.............................. ZIP..............................

Advertisers index

CONSIDERABLY SPECIAL CONSIDERING THE SPECS

2 METER FM TRANSCEIVER **Model SRC-146A**

Frequency	143-149 MHz (2MHz spread)
Number of channels	5 Supplied with 146.94 simplex, 146.34 / .94 (same plug in crystals as SR-C826M)
R.F. output	2 watt minimum
Sensitivity	better than 0.4 uv / 20 DB Q.S.
Audio output	500 mw
Meter	monitors battery voltage on Tx, S Meter on Rx
Current drain	620 ma Tx, 15 ma Rx standby
Size	8⅜" high x 3" wide x 1⅝" deep
Weight	24 oz., less batteries

Options: *Private channel (CTCSS), external mic, or mic-speaker, stubby flexible antenna, desk top charger, leather case.*

$289.00

Suggested Amateur Net Price

NEW 2 METER REPEATER

SCA-RPT-1

All solid state, 2M, 10W, FM REPEATER. Built-in C.O.R., adjustable carrier delay and time out timer.

Write for complete specifications and cost.

Standard
COMMUNICATIONS CORP.

213 / 775-6284 · 639 North Marine Avenue, Wilmington, California 90744

for the EXPERIMENTER!

INTERNATIONAL EX CRYSTAL & EX KITS

OSCILLATOR • RF MIXER • RF AMPLIFIER • POWER AMPLIFIER

1. MXX-1 TRANSISTOR RF MIXER
A single tuned circuit intended for signal conversion in the 3 to 170 MHz range. Harmonics of the OX oscillator are used for injection in the 60 to 170 MHz range. Lo Kit 3 to 20 MHz, Hi Kit 20 to 170 MHz (Specify when ordering) **$3.50**

2. SAX-1 TRANSISTOR RF AMP
A small signal amplifier to drive MXX-1 mixer. Single tuned input and link output. Lo Kit 3 to 20 MHz, Hi Kit 20 to 170 MHz (Specify when ordering) **$3.50**

3. PAX-1 TRANSISTOR RF POWER AMP
A single tuned output amplifier designed to follow the OX oscillator. Outputs up to 200 mw, depending on the frequency and voltage. Amplifier can be amplitude modulated. Frequency 3,000 to 30,000 KHz **$3.75**

4. BAX-1 BROADBAND AMP
General purpose unit which may be used as a tuned or untuned amplifier in RF and audio applications 20 Hz to 150 MHz. Provides 6 to 30 db gain. Ideal for SWL, Experimenter or Amateur **$3.75**

5. OX OSCILLATOR
Crystal controlled transistor type. Lo Kit 3,000 to 19,999 KHz, Hi Kit 20,000 to 60,000 KHz. (Specify when ordering) **$2.95**

6. TYPE EX CRYSTAL
Available from 3,000 to 60,000 KHz. Supplied only in HC 6/U holder. Calibration is ± .02% when operated in International OX circuit or its equivalent. (Specify frequency) **$3.95**

for the COMMERCIAL user...

**INTERNATIONAL
PRECISION RADIO CRYSTALS**

International Crystals are available from 70 KHz to 160 MHz in a wide variety of holders. Crystals for use in military equipment can be supplied to meet specifications MIL-C-3098E.

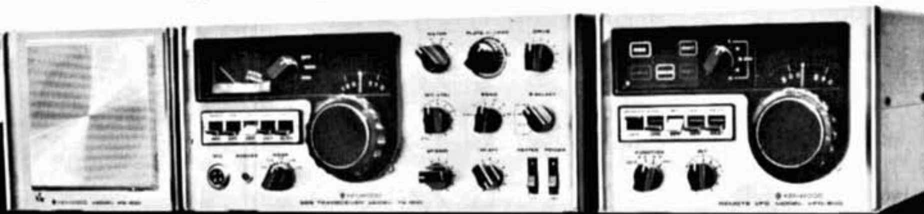
CRYSTAL TYPES:
- (GP) for "General Purpose" applications
- (CS) for "Commercial Standard"
- (HA) for "High Accuracy" close temperature tolerance requirements.

write for CATALOG

INTERNATIONAL
CRYSTAL MFG. CO., INC.
10 NO. LEE • OKLA. CITY, OKLA. 73102

More Details? CHECK—OFF Page 94

amateur radio's new standard of excellence



KENWOOD'S SUPERB NEW SOLID STATE SSB TRANSCEIVER

TS-900

FEATURES: • Break - in CW with sidetone • Built - in 100 KHz and 25 KHz crystal oscillator • Built - in RIT and RIT indicator light • Built - in RTTY frequency shift for FSK • Built - in noise blanker • Built - in VOX • Modular construction — repair in or out of equipment • RF AGC to prevent front end overload to strong signals • Completely solid state except final section • 1 KHz readout

GENERAL SPECIFICATIONS: Frequency Range: 3.5 - 30 MHz Amateur Bands and WWV • Mode: SSB, CW, or FSK • Power Output: 150 watts PEP nominal into 50 ohms for SSB, 100 watts nominal into 50 ohms for CW, 50 watts nominal into 50 ohms for FSK • Frequency Stability: Within 100 Hz during any 15 minute period after warmup. Within ± 2 KHz during the first hour after 1 minute of warmup • Receiver Sensitivity: 0.5 microvolts for a 10 db (signal + noise)/noise ratio • Receiver Selectivity: SSB and FSK — 2.2 KHz bandwidth (6 db down), 4.4 KHz bandwidth (60 db down), CW — 0.5 KHz bandwidth (6db down), 1.5 KHz bandwidth (60 db down), (with optional CW filter installed) • Dimensions: 12.6" wide × 5.5" high × 12.6" deep • Weight: 26.5 pounds (32.5 pounds shipping weight) • Price: TS - 900 $795.00, PS - 900 (AC Supply) $120.00, DS - 900 (DC Supply) $140.00, VFO - 900 (Remote VFO) $195.00.

THE KENWOOD R-599 RECEIVER . . . 1.8 to 29.7 MHz (Amateur Bands) • Dial readout to ½ KHz • Special detectors for SSB, AM, and FM • Transceive operation with T-599 • Built-in 100 KHz and 25 KHz calibrators • Built-in 500 cycle CW filter • Provision for 2 meter and 6 meter coverage with accessory self-contained converters • 120/240 VAC or 12 VDC operation • All solid state • R-599 — $389.00 Converters — $31.00 S-599 Speaker — $16.00.

THE KENWOOD T-599 TRANSMITTER . . . Clear, stable, selectable sideband, AM and CW • 4-way VFO flexibility plus RIT when used with the R-599 • Amplified ALC • Built-in VOX • Full metering • Built-in CW sidetone monitor and semi-automatic break-in CW • Built-in power supply for 120/240 VAC operation • Only 3 vacuum tubes • 200 watts PEP input nominal • Full amateur band coverage (3.5 to 30 MHz). T-599 — **$429.00**

✓ *NOTE: The TS-511S still sells for the same low price... still the same high quality*

THE KENWOOD TS-511S TRANSCEIVER . . . a powerful five band transceiver (3.5 to 30 MHz, amateur bands) for operation on SSB and CW • Built-in VOX • Built-in crystal calibrator • Built-in noise blanker • Receiver Incremental Tuning (RIT) • 1 KHz frequency readout • Eight pole filter • Exceptional stability • Provisions for installation of an accessory high selectivity CW filter • 500 watts PEP input for SSB • .5 μv sensitivity nominal • Full metering — Cathode current (IP), plate voltage (HV), ALC, and relative power output (RF) as well as an S-meter • Amplified ALC • Heavy duty 120 VAC external power supply. TS-511S — $415.00 PS-511S — $105.00 VFO-5SS — $105.00 CW-1 — $39.00

Prices subject to change without notice

EASY FINANCING • 10% DOWN OR TRADE-IN DOWN • NO FINANCE CHARGE IF PAID IN 90 DAYS • Good RECONDITIONED EQUIPMENT • Nearly all makes and models. Our reconditioned equipment carries a 15 day trial, 90 day warranty and may be traded back within 90 days for full credit toward the purchase of NEW equipment. Write for bulletin. Export inquiries invited.

TED HENRY (W6UOU) **BOB HENRY** (WØARA) **WALT HENRY** (W6ZN)

Henry Radio

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