focus on communications technology...

this month

- S-meter circuits 20
- az-el antenna mount 34
- programmable calculators 40
- electronic vox biasing 50

ultra low noise uhf preamplifier
Don’t be misled by our prices... they are based on experience, large quantity buying of materials, great engineering and efficient office personnel. We are happy hams trying to hold the line on prices for you. So... why pay more when you can get the best for less!

**FM 2 METER ANTENNAS**

**FM TWIST**
Ten elements horizontal polarization for low end coverage and ten elements vertical polarization for FM coverage. For OSCAR buffs we have 144 MHz and 432 MHz models.

**POWER PACK**
The big signal (22 element array) for 2 meter FM uses two A147-11 yagis with a horizontal mounting boom, coaxial harness and all hardware.

**4-6-11 ELEMENT YAGIS**
The standard of comparison in VHF-UHF communications, now cut for FM and vertical polarization. There are models covering the 450 MHz, 220 MHz and 147 MHz bands. All are rated at 1000 watts with direct 52 ohm feed and PL-259 connectors.
simply a great transceiver

The FT-101B transceiver features advanced, solid-state, plug-in modular circuitry—with a complete line of versatile accessories including the NEW YO-100 Monitor Scope. Add this ideal companion for complete signal monitoring.

**FT-101B FEATURES:**
- 240 watts PEP input (180 watts CW)
- AC & DC power supply
- Noise blanker
- VOX with break-in CW
- 25 & 100 KHz calibrators
- WWV reception
- Internal speaker

**YO-100 FEATURES:**
- 1500/1900Hz tone generator
- Wide range inputs for all mode monitoring—even RTTY

**ACCESSORIES AVAILABLE:**
- FL-2100B 1200 watt linear
- FV-101B External VFO
- YO-100 Monitor scope
- SP-101B External speaker
- SP-101PB Speaker/Phone Patch
- MMB-1 Mobile mount
- FA-9 Cooling fan
- XF-30C 600Hz CW filter
- YD-844 Desk microphone
- 160 meter crystal

Compare the features, versatility, and performance. Ask the amateur who owns one and your choice will be Yaesu—the world’s leader in amateur communications equipment.

*160 meter crystal optional

Specifications subject to change without notice.

Visit your dealer for details or write for our new catalog.

All Yaesu products warranted by the selling dealer. Complete after-warranty service available in Paramount, Calif.

7625 E. Rosecrans Avenue, Unit #29 Paramount, California 90723 (213) 633-4007
For Those Who Demand The Finest

MODEL CX-11... Deluxe Integrated Station

New solid state broadband linear power amplifier 10-160 meters. 150 Watts DC output — requires no tuning, operates into any VSWR — continuous duty at full rated output.

New concept front-end design — utilizing double active balanced mixers for unmatched sensitivity, blocking and cross-modulation rejection.

Solid-state modular construction utilizing gold-plated, pins and plug-in sockets for all transistors, IC's, and circuit board connectors.

Five Bandwidths of selectivity are standard — 2.4, 1.5, 1.0, .4, .1 kHz.

Peak notch filter with adjustable frequency notch depth and Bandwidth controls.

RTTY narrow and wide shift FSK-LSB.

Built-in electronic Keyer with independent speed and weight control and partial or full dot memory.

Built-in Power Supply completely self-protecting — both thermal and current overload, integrated circuit controlled.

New six-digit frequency counter utilizing new ½ inch amber or red LEDs optimized for a non-blinking, stable display.

ADDITIONAL FEATURES

Dual VFO's for transceive, split operation, or dual receive.

Adjustable IF shift.

Receive or transmit offset tuning.

Push Button spotting.

Adjustable R.F. clipping.

Instantaneous break-in CW.

Built-in Wattmeter.

Built-in noise blanker.

Adjustable R.F. power output.

Pre-IF, adjustable noise blanker.

Now in production at $2600

Distributed by PAYNE RADIO
BOX 525, SPRINGFIELD, TENNESSEE 37172
Phone seven days and evenings 615-384-2224

For a brochure, personal service and a top trade on your gear contact Payne Radio

Contact the factory for parts and service only

Built-in Power Supply completely self-protecting — both thermal and current overload, integrated circuit controlled.

New six-digit frequency counter utilizing new ½ inch amber or red LEDs optimized for a non-blinking, stable display.

march 1975
March, 1975
volume 8, number 3

staff
James R. Fisk, W1DTY
editor-in-chief
Patricia A. Hawes, WN1OJN
assistant editor
J. Jay O’Brien, W6GDO
fm editor
James A. Harvey, WA6IAK
James W. Hebert, WABOOG
Joseph J. Schroeder, W9JUV
Alfred Wilson, W6NIF
associate editors
Wayne T. Pierce, K3SUK
cover
T. H. Tenney, Jr., W1NLB
publisher
Fred O. Moller, Jr
advertising manager

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
U.S. and Canada: one year, $8.00
two years, $13.00; three years, $18.00
Worldwide: one year, $10.00
two years, $17.00; three years, $24.00

Foreign subscription agents
Canada
Ham Radio Canada
Box 114, Goderich
Ontario, Canada, N7A 3Y6

Europe
Ham Radio Europe
Box 444
194 04 Upplands Vasby, Sweden
France
Ham Radio France
20 bis, Avenue des Clarions
89000 Auxerre, France

United Kingdom
Radio Society of Great Britain
35 Doughty Street
London WC1N 2AE, England

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

Copyright 1975 by
Communications Technology, Inc
Title registered at U.S. Patent Office
Printed by Wellesley Press, Inc
Framingham, Massachusetts 01701, USA

Microfilm copies of current and
back issues are available from
University Microfilms
Ann Arbor, Michigan 48103

Second-class postage
paid at Greenville, N. H. 03046
and at additional mailing offices

contents

8 ultra low-noise uhf preamplifier
Joseph H. Reisert, Jr., W1JAA

20 solid-state s-meter circuits
M.A. Chapman, K6SDX

24 lowpass transmitting filter
Neil A. Johnson, W2OLU

28 Regency HR-212 frequency scanner
Raymond E. Johnson, WA8SJK

34 simple az-el antenna mount
Stuart D. Cowan, W2LX

40 programmable calculators
Raymond P. Aylor, Jr., W3DVO

50 electronic vox biasing
Marvin H. Gonsior, W6VFR

54 low-power dc-dc converter
Gail A. Graham, W5MLY

58 brass pounding on wheels
Charles W. Clemens, Jr., K6QD

4 a second look 62 ham notebook
94 advertisers index 64 new products
60 comments 94 reader service
83 flea market 6 stop press
Two of the major semiconductor manufacturers are working on new families of bipolar digital logic that may do as much to revolutionize the computer world as anything in the past. Texas Instruments, for example, has developed a new family of Schottky logic, called Schottky II, with 1-to-2-nanosecond delays (compared to 10 nanoseconds or so for TTL) which operates from a single 5-volt power supply, offers better performance than today's ECL 10k and is provided in standard, easy-to-use pinouts. Unfortunately, because of the dismal market conditions which are facing the semiconductor manufacturers just now, it may be months before Schottky II is available to designers.

Although not a great deal is known about Motorola's new bipolar logic family, it is known to feature 1-to-2-nanosecond delays and will be compatible with ECL 10k. However, they have been working with a system of complementary constant-current logic (C3L) with 1-nanosecond delays (and 1 mW per gate) that could provide the necessary performance. Motorola is also rumored to be working on a family of sub-nanosecond logic called ECL 100k that should provide some answers for digital designers who are looking for faster and faster computers.

The complementary constant-current logic is particularly interesting because it combines the best of several worlds not previously available on one chip: very high speed, high packaging density and low power consumption. The high packing density of C3L is due to its very simple transistor-gate structure, shown below, which consists only of a pnp current source transistor, an npn switching transistor and a few Schottky barrier diodes. By way of contrast, the Schottky TTL gate uses four transistors, plus diodes.

Because of the simple structure, a five-output gate requires only 12 square mils (0.008 square mm). By comparison, a low-power cmos circuit of the same complexity requires about 65 square mils (0.04 square mm) of chip space. This high packaging density means that a 1000-gate C3L array could be placed on a 150-by-150-mil (4x4mm) chip.

While you may be hard put to think up an application in your amateur station for a 1000-gate logic array, many traditional analog circuits (TV tuners, for one) have gone the digital route in recent years, and other devices, such as frequency synthesizers, small hand-held calculators and digital meters, would never have seen the light of day in an all-analog world. If the past is any indication, future digital applications will have an even far wider effect.

Jim Fisk, W1DTY
editor-in-chief
DV-21

The perfect companion for your IC-21A, the DV-21 is an all new unique digital VFO to complete your ICOM 2 meter station. The DV-21 will operate in 5 or 10 KHz steps over the entire 2 meter band. It can also scan either empty frequencies, or the frequencies being used, whichever you select. Complete, separate selection of the transmit and receive frequencies, is as simple as touching the keys. When you transmit, bright easy to read LEDs display your frequency. Release the mic switch, and the receive frequency is displayed. There are also two programmable memories for your favorite frequencies. You won't believe the features and versatility of the DV-21 until you've tried it. It's new, and it's from ICOM.
AMATEUR LICENSE FEES REDUCED with reductions to go into effect March 1. New fee schedule is $4 for a new license or renewal, $3 for a modification. Requests for special calls will still cost $25.

WWV/WWVH PROPOSE CUTBACK in services, solicit advice from users. Write Time and Frequency Services, National Bureau of Standards, Boulder, Colorado 80302 for detailed questionnaire.

BICENTENNIAL CALLSIGNS pretty well set, will use only AA-AL prefix block to cover both continental and offshore W and K prefixes during 1976 celebration. Though stateside bicentennial prefixes will use present numbers to indicate call areas, look for some real odd balls for such things as Alaskan Novices...

220-MHZ CLASS-E CB still very much a threat -- recent letter from OTP Acting Director Eger to FCC Chairman Wiley urges giving "every consideration" to "expeditious action" in granting Class-E 222-224 MHz! The letter cites the need for a "disciplined" citizen's communications service, half-billion dollar a year market, gives lip service to value of amateur service — and would let us continue to use the new CB band, with limitations! Class E could start up as early as May!

GOVERNMENT AGENCY SHAKES ANTENNA TOWERS -- OSHA, the occupational safety people, want all towers over 20 feet to have a built-in OSHA-approved ladder (16-18" wide, with side rails mounted 6" off the tower)! Since the OSHA ladder is heavier than most light-duty amateur and TV antenna towers, such a requirement would have a great effect on tower prices. Ruling would become effective this summer barring protests, but look for lots of those from users and makers alike.

ARRL DIRECTORS' MEETING in January confirmed Dick Baldwin, W1RU, as League General Manager and QST editor to replace John Huntoon. Dick took over February 1, while John continues as both ARRL and IARU Secretary. Docket 20282 Discussion occupied much of the Directors' time, resulted in authorization of a "membership opinion survey" to be conducted on the Division level. Survey will be made in time for individual directors to consider results before a special board meeting in May when League response will be determined.

NATIONAL ENVIRONMENTAL POLICY ACT OF 1969 appears likely to have little direct impact on amateur radio, but indirect effect on the unwary may cause lots of bother. Environmental impact report must be filed with amateur license applications on Form 610 or 610B only if the station will have a "major" impact on the environment. Installations having a "major" impact are: Antenna towers or antennas over 300 feet high (but not an antenna mounted on an existing structure 300 or more feet high); satellite earth stations with dishes of 30 feet or more in diameter; locations in a wilderness area, wildlife preserve or national scenic or recreation area; stations affecting sites significant in U.S. history; and any involving extensive changes in land-surface features.

Applications Other Than The Above are considered "minor" and no statement need be filed. However, to be on the safe side, until new forms are available, add a statement such as, "This application is a 'minor action' as defined by Section 1.1305 of the Commission's rules." somewhere on the form unless you will have a "major" environmental impact, in which case a call to the FCC is advisable.

NEWLY ANNOUNCED HAND-HELD CALCULATORS, as promised in January editorial, offer more performance for less cost. New HP-21 Scientific from Hewlett-Packard ($125) is more powerful than HP-35 and features 32 pre-programmed functions including rectangular/polar conversion, while new programmable HP-55 ($395) provides 49-step programming and 86 keyboard functions. Also new are Novus Mathematician ($80) and 10-digit Corvus 500 ($200).
GIANT KILLER

Atlas-210
5 BANDS 200 WATTS
SOLID STATE
SSB TRANSCEIVER

$599

Don't let the small size fool you. The spectacular Atlas transceiver is truly a Giant Killer. Just 7 pounds of sheer dynamite, it occupies only 0.18 cubic feet. But this is only a small part of the story. There are many other reasons why you will want to own an Atlas Transceiver:

MOST ADVANCED STATE-OF-THE ART CIRCUIT DESIGN, INTRODUCES A NEW ERA IN PERFORMANCE SPECs. We ask you to mark these words. They are not merely an advertising statement.

RELIABILITY. Total value engineering, craftsmanship and quality control give you unsurpassed reliability. With over 1000 Model 180's now on the air, we at Atlas are proud of their most exceptional reputation for performance, reliability, and owner satisfaction. It is safe to say that practically every owner has a love affair going with his Atlas radio. You too can have such an affair.

RECEIVER SENSITIVITY AND RESISTANCE TO OVERLOAD AND CROSS MODULATION, SECOND TO NONE. (Better than anything else we have seen or any other claims.)

SELECTIVITY: A breakthrough in filter design by Network Sciences. Designed especially for Atlas, this filter provides unprecedented selectivity. Only 9200 cycles wide at 120 db down when installed and measured in the Atlas transceiver! Ask any other brand for specs at this level! And to top this off, the front end design of the Atlas makes it possible to utilize this fantastic degree of selectivity!

TRANSMITTER TALK POWER: 200 watts of linear solid state power input, with clear, crisp audio.

NO TRANSMITTER TUNING: Simply connect to a 52 ohm load and you're on the air. Infinite SWR protected.

IDEAL MOBILE SIZE: One-third the size of any other 5 band HF transceiver. Only 3½ in. high, 9½ in. wide, 9½ in. deep.

PLUG-IN DESIGN provides quick removal from mobile mount. Plugs into AC console, as illustrated, giving you a handsome desktop station.


Model 210 covers 3700-4050; 7000-7350; 14,000-14,350; 21,100-21,450; 28,400-29,100 KHz.

Model 215 covers 1800-2000; 3700-4050; 7000-7350; 14,000-14,350; 21,000-21,450 KHz.

The new 210 and 215 are identical to the former Model 180 except for band coverage.

SPECIAL MARS MODELS, 210M/215M permit out of band operation when used with Model 10X external crystal oscillator accessory.

NOISE BLANKER, optional plug-in. Also VOX, and other accessories.

CUSTOMER SERVICE, second to none. Your satisfaction is guaranteed.

ALL THIS, and priced lower than any other 5 band solid state or hybrid transceiver.

Atlas 210/215 .................................. $599
AR 117 AC Console .................. $129
AR 200 Portable AC Supply ........ $89
Plug-in Mobile Mount .............. $44

Available NOW at your Atlas dealers. See him for complete details, or drop us a card and we'll mail you a brochure and dealer list.

73 Herb Johnson W6QKI
Design and construction of an ultra low-noise preamplifier with a 1.0 dB noise figure at 432 MHz that provides high performance on 144 and 220 MHz as well.

There is always a need for a better preamplifier with a lower noise figure and higher gain. Such a preamplifier was introduced in November, 1972. This preamplifier took up the slack after the TIXM05 disappeared and the low-noise fets bottomed out, and it introduced several new features to amateur radio including state-of-the-art noise figure, wide bandwidth, low-Q input, current-source biasing and built-in limiter. In addition, it required no tuning.

Since the original preamplifier was introduced, an improved version has been developed. This new preamplifier has higher gain, lower noise figure, and an improved biasing scheme while embodying all the other features mentioned above. It has been duplicated by over twenty-five individuals throughout the world and is the input preamplifier used at most of the 432-MHz EME stations. Two of the die-hard paramp users now have models of these preamplifiers in use. It meets or exceeds their paramp performance and is easily
mounted at the antenna, a feature not easily duplicated with paramps and their associated pumps.

requirements for low noise figure

A low-noise-figure transistor is required in the circuit but it is not the only requirement for a low-noise-figure preamplifier. Other requirements include proper operating current and voltage, optimum source impedance, low-loss matching circuits, low feedback, moderate gain and good stability, to mention a few. Let's discuss these requirements separately.

The need for a low-noise-figure transistor should be obvious. You cannot attain a noise figure which is lower than the device is capable of delivering due to other factors affecting the design. You will be lucky, at best, if you end up within 0.25 to 0.5 dB of the device's capability.

Joe Reisert, W1JAA, was first licensed in 1951 as WN2HQL, and in 1956 earned his Extra Class license. He moved from Long Island to San Jose, California, in 1961, where he was licensed as WA6TGY, later as W6FZJ. He attained the DXCC Honor Roll in 1968 and presently stands at 330 confirmed. In the late 1960s he became interested in uhf, had his first 432-MHz contact in 1970, and put his EME station on the air in 1972. Before moving to Massachusetts last spring he had worked nine states on 432 MHz from California plus Canada and Australia. He is joint holder of the 2304-MHz tropo DX record of 330 miles set in February, 1974, and is active from Massachusetts on 432-MHz EME. Primary amateur interests are DX, EME, and antenna and receiver design.

Joe was formerly the supervisor of Microwave Product Engineering at Fairchild Microwave after working at Sperry, IBM, Lockheed and Wescom Microwave, and is presently manager of Microwave Applications Engineering at Alpha Industries, Inc., in Woburn, Massachusetts—a leading manufacturer of microwave diodes.

The collector current ($I_C$) and collector-to-emitter voltage ($V_{CE}$) are also prime considerations. Generally, $V_{CE}$ is not too important if it is greater than 6 volts. Lower $V_{CE}$ generally lowers the collector cutoff frequency ($f_T$) and hence, the gain. The collector current, on the other hand, is very important. Older devices were usually optimum with 1.0 to 1.5 mA collector current. The newer devices, as a rule, work best at 2 to 3 mA collector current and their noise figures do not degrade as fast as their predecessors' at higher collector currents (more on this later).

The optimum source impedance is the impedance that the transistor wants to see in order to deliver the lowest possible noise figure. At frequencies below 1000 MHz this value is seldom 50 ohms. Therefore, a matching network is usually necessary between the antenna input and the transistor. This network must have very low loss since any losses will add directly to the overall noise figure of the preamplifier.

In addition, low feedback is essential to low-noise operation and feedback will usually raise the noise figure. This also applies to series feedback in the emitter lead. The emitter should be well bypassed to ground to prevent degeneration and higher noise figures. Current-source biasing is preferred since it allows the emitter to be grounded directly without bypassing. A suitable scheme was used in the original preamplifier. This design will include a simpler and less critical circuit.

High gain is essential for low noise performance. If the gain of the preamplifier is not high enough, the overall system noise figure will be degraded due to the noise figure contribution from the second stage. However, if the preamplifier gain is too high it may become unstable or may overdrive the second stage and cause desensitization or intermodulation distortion. A good rule of
thumb is to strive for 10 to 13 dB minimum preamplifier gain. Gain above 18 to 20 dB should be avoided since it generally indicates a potential instability. More on this later. A method for computing gain and overall noise figure is discussed further in appendix 1.

tradeoffs

Noise figures below 1.5 to 2 dB are usually wasted on meteor scatter and tropo communications. At 144 MHz this is still a low enough noise figure for EME since the sky temperature is usually not much lower than the terrestrial temperature. Therefore, a good fet is sufficient to deliver all the performance needed. However, on EME above 420 MHz the sky temperature may be below 70° K, so a lower noise figure is desirable. For example, a 1 dB noise figure preamplifier may yield up to 2 dB better signal-to-noise ratio than a 1.5 dB noise figure unit.

Cost is obviously the most important tradeoff. Low-noise-figure, high performance transistors are expensive. However, in view of the performance gained, it is penny wise and pound foolish to cut corners too closely. Generally speaking, a low-noise transis-

![Diagram](image)

**fig. 1. Typical FMT4575 noise figure and gain at 432 MHz vs collector current (VCE constant at 7 volts).**

usually wasted on meteor scatter and tropo communications. At 144 MHz this is still a low enough noise figure for EME since the sky temperature is usually not much lower than the terrestrial temperature. Therefore, a good fet is sufficient to deliver all the performance needed. However, on EME above 420 MHz the sky temperature may be below 70° K, so a lower noise figure is desirable. For example, a 1 dB noise figure preamplifier may yield up to 2 dB better signal-to-noise ratio than a 1.5 dB noise figure unit.

Cost is obviously the most important tradeoff. Low-noise-figure, high performance transistors are expensive. However, in view of the performance gained, it is penny wise and pound foolish to cut corners too closely. Generally speaking, a low-noise transis-

![Diagram](image)

**fig. 1. Typical FMT4575 noise figure and gain at 432 MHz vs collector current (VCE constant at 7 volts).**

usually wasted on meteor scatter and tropo communications. At 144 MHz this is still a low enough noise figure for EME since the sky temperature is usually not much lower than the terrestrial temperature. Therefore, a good fet is sufficient to deliver all the performance needed. However, on EME above 420 MHz the sky temperature may be below 70° K, so a lower noise figure is desirable. For example, a 1 dB noise figure preamplifier may yield up to 2 dB better signal-to-noise ratio than a 1.5 dB noise figure unit.

Cost is obviously the most important tradeoff. Low-noise-figure, high performance transistors are expensive. However, in view of the performance gained, it is penny wise and pound foolish to cut corners too closely. Generally speaking, a low-noise transis-
of dollars and hours building a suitable station. Why skimp when it comes to the preamplifier? A suitable performance increase in the antenna may be completely out of the question due to size or money.

Gain isn't everything, but it does help. This is especially true when the preamplifier is remotely mounted. An extra gain margin helps to overcome cable losses. Furthermore, on the more modern low-noise transistors the gain increases quite smoothly when the collector current is increased while at the same time the noise figure may not rise as rapidly as you would expect (see fig. 1). As an additional by-product, the intermodulation distortion decreases significantly with increasing Ic. Again, it pays to use a high performance transistor so you can "have your cake and eat it too."

A broadband preamplifier can present some problems since there is little or no discrimination to out-of-band signals. Therefore, an input filter is highly recommended. A suitable type will be discussed in the latter part of this article.

transistor selection

I have evaluated many npn transistors, all with an eye on minimum noise figure and maximum stable gain at 432 MHz. The circuit described in reference 1 used the NEC 2N5650 series (and its offshoots such as the NEC V766). However, a 1.4 dB noise figure was the lowest measured, and stable gain seldom exceeded 13 dB. Other high performance devices which were tried included the Fairchild FMT4225 and Hewlett-Packard HP-21 series. They delivered high gain but higher noise figures (1.5 to 2 dB typical). Likewise, the Amperex BFR90 and BFR91 seldom provided noise figures below 2 dB.

The Fairchild FMT4575/4578 and FMT4000/4005 were true eye-openers;
figure. After optimization the bias points are varied up or down (within manufacturer's ratings) and the tuners are readjusted. This procedure is continued until the lowest possible noise figure is obtained.

**circuit description**

While the preamp described here is quite similar to the original design, there are important differences. They are basically the transistor used, the input/output matching and the current source.

The transistor was chosen by the method described above. Then the transistor test fixture was split apart and a low-loss 50-ohm termination was substituted for the noise-figure generator. With the aid of a network analyzer, the desired source impedance was measured. This impedance is called the optimum source impedance as described earlier. In the case of the Fairchild FMT4575, this impedance can be approximated by a series circuit consisting of a 50-ohm resistance and an inductive reactance of 80 ohms (see fig. 3).

It so happens that at 432 MHz most of the low-noise transistors evaluated generally required a similar network except that the values varied from 25 to 75 ohms for the resistance and from 30 to 100 ohms for the inductive reactance. These values can be easily simulated by slight changes in the inductance value and by placing a small (0.3 to 3 pF) low-loss variable capacitor either between point X or Y to ground (fig. 3). However, this capacitance value is not critical and seldom yielded much improvement in noise figure on the devices I tested.

A low-loss input matching circuit is very important. Therefore, low-loss components should always be used with the least complicated, low-Q circuit.
This is in direct contrast with previous design philosophy which frequently used filters and/or resonant input circuits. Such circuits can contribute additional losses. The input of a low-noise preamplifier is a poor place to obtain selectivity. A better choice is to install a low-loss filter external to the preamplifier as discussed later.

The final input matching circuit chosen was a low-loss, low-Q, L-matching section consisting of L1 and CR1 (fig. 4). Capacitor C1 is a blocking capacitor (not a critical value). However, a low-loss, high-Q type is desired. RFC1 is essentially a low-Q parallel-resonant circuit at 432 MHz and therefore is effectively out of the circuit. It actually works quite well from 100 to 450 MHz. Some of the physically larger RFCs available are parallel resonant below 450 MHz and are not recommended. A grid-dip oscillator can be used for a quick test or, you can wind your own choke using a 0.1 to 0.2-inch (2.5 to 5.0 mm) diameter air core. A higher inductance RFC can be used if only lower frequency operation is desired.

Do not leave out the hot-carrier diode, CR1. It is the capacitance part of the L-matching section and adds about 0.75 pF to the circuit. Other hot-carrier diodes can be substituted provided the capacitance is 0.5 to 1.0 pF at zero volt. Do not use ordinary silicon or germanium diodes since they may increase the noise figure.

Diode CR1 also functions as a low-loss limiter and can save the transistor from being damaged if the preamplifier is subjected to excessive rf. Even rf from a high-frequency transmitter operating near a vhf antenna can do damage. This type of limiter is simple and effective. An added advantage is that it is placed after the selectivity. Hence, it will only activate when a strong input signal is present — it will not generate extraneous signals such as is common with back-to-back diodes connected across the input of a preamplifier ahead of the selectivity.

The bias scheme is a modification of the current source used in the previous design and is a variation of a method proposed by Fairchild Semiconductor. I refer to it as "zener-diode biasing." It is much simpler than the transistor current-source and is less prone to oscillate. This bias scheme allows the emitter to be grounded directly, is insensitive to transistor current gain, provides some dc protection to the transistor and requires no adjustments.

Fig. 5 is a simplified circuit of the zener-diode biasing scheme. The zener diode, CR2, sets the transistor collector-to-base voltage (V_{CB}), R3 sets the I_C with a fixed supply voltage and R1 provides a keep-alive current flow for CR2. CR2 also provides protection to Q1 and limits the collector voltage to a fixed value. Once the proper values are chosen the transistor can be changed without any re-adjustment. The operation of this circuit is described in detail in appendix 2. CR3 (fig. 4) is an idiot diode (if you leave it out you’re an idiot).

The output matching scheme is simplicity in action. This transistor (and many others like it) is so “hot” that all attempts at output matching caused instabilities. A computer program called SPEEDY was called into action and a
program was written to select an output network which was unconditionally stable (will not oscillate regardless of input or output load). The final network turned out to be a 37-ohm collector resistor without any other matching elements. However, this lowered the gain too much. It was determined empirically that the collector resistor R2 can be raised to 100 ohms and seldom causes any instabilities. Therefore, if the input to your preamplifier and converter is highly reactive (most are), then the 100-ohm resistor may have to be lowered accordingly. This type of loading is also applicable to other preamplifiers which are only conditionally-stable.

Finally, a simple "bias-tee" consisting of RFC2 in the preamplifier and RFC1 and C1 in the bias tee itself (see fig. 6) was added in case remote installation is desired. It not, this circuitry can be eliminated.

construction

Fig. 7 shows the preamp construction and the FMT4575 pin configuration. A small cast aluminum box such as the Pomona 2417 (2.25x1.375x1.125 inches or 57x35x29mm) is recommended. This box is available from most major electronic suppliers for $1.60. However, almost any shielded box is acceptable. The entire preamp is built on a small 1-1/8x2-inch (29x51mm) piece of double-clad glass-epoxy printed-circuit board which is attached to the box cover by the connector screws. If remote installation is not desired, FT3 can be mounted through the PC board and cover for power supply connections. This method of construction is versatile and simplifies soldering and testing. If you use the Pomona box, be sure to remove the paint where the lid contacts the box. Also file off the anodized coating on the edge of the cover which contacts the box. Failure to do so may result in erratic operation.

Be sure to check the data sheet for proper connection of any transistor other than the FMT4575. There is no industry standardization for lead identification on microwave transistors. The emitter lead length on this type of microwave package is not too critical and 1/8 inch (3mm) is recommended for operation up through 500 MHz. Both emitter leads should be the same length and both should be grounded. The leads of CR1 should be kept as short as possible so that it performs like a capacitor.

The rf connectors should be a good
UHF type such as SMA (OSM®). Discontinuities in BNC connectors can cause noticeable noise figure increases when operating with such a low-noise-figure device. Type-UHF connectors are definitely unacceptable at 432 MHz. Type N or TNC are also acceptable, but may be too large if a small box is used. An inexpensive version of the SMA connector is manufactured by the E.F. Johnson Company (JCM series, part number 142-0296-001) and is priced under $2.00. The type of output connector is not critical.

Operation and test

After the preamplifier is assembled, a careful check of the wiring is recommended. Next, the preamplifier should be connected to a +12 volt power supply through a milliammeter (0 to 10 mA recommended). Terminate the preamplifier with a 50-ohm input and output load if available. If not, connect an antenna and converter to the preamplifier.

For proper operation, the total current should be 3.5 to 5.0 mA. If the indicated current is greater than 5 mA, remove power and recheck circuit wiring. High current usually means either a short circuit and/or improperly connected zener diode. If the power supply is variable, bring the voltage up slowly. At +11 volts, the current will be about 1 mA less than at +12 volts; with a +13 volt supply the current will be about 1 mA higher than at +12 volts. This indicates proper operation of the zener diode biasing circuits.

It should not be necessary to make any adjustments. However, if you have sufficient test gear available, adjust the turns spacing on L1 for best noise figure by pulling apart or squeezing. This usually will only vary the noise figure by ±0.1 dB. For those purists who want to get all they can squeeze out of the circuit, an additional 0.3 to 3 pF low-loss piston capacitor can be placed between the input or transistor side of L1 to ground (see figs. 3 and 4).

Input filter

It is advisable to use a low-loss, quarter-wavelength cavity filter ahead of the preamplifier since the simple broadband input circuit may cause intermodulation products from out-of-band signals. A suitable filter is shown on fig. 8. It should be connected as close to the preamplifier as possible. This can usually be accomplished with a short coax adapter. Multiple-element filters such as comb-line and interdigital types are not recommended. The input VSWR to this, and most other, low-noise preamplifiers is typically 5:1. If a multiple-pole filter is used, it may suffer severe passband ripple due to the high VSWR. The net result may be additional loss...
and, hence, higher noise figure at the operating frequency. It may also cause out-of-band oscillations.

A word about the use of the proposed filter may be in order. After many hours of testing and re-testing various quarter-wavelength filters, I have concluded that a filter should not be tuned while connected to the preamplifier. Best results occur when the filter is adjusted by itself for minimum VSWR with a good 50-ohm termination. Then the filter adjustment is locked in place. No further adjustments should be attempted if best results are to be achieved. Just connect the tuned filter to the preamplifier and accept its performance.

If very sensitive test equipment is available, the overall stability of the preamplifier may be tested. The reverse loss (inverting the input and output connections) should be at least 8 to 10 dB greater than the forward gain. The collector current can be easily adjusted by varying the supply voltage \( f \) volt. The lowest noise figure usually occurs at 2 mA \( I_C \). With the circuit shown in fig. 4, this will measure 3 mA to the preamp (subtract 1 mA, the keep-alive current of the zener diode — see appendix 2).

A typical plot of noise figure and gain versus collector current is shown in

The rear view of the preamplifier showing locations of R1, R3, CR2 and CR3. Components can be identified from fig. 7 on next page.
However, at 2 mA $I_C$, the gain will be 1 to 1.5 dB lower and the intermodulation performance will drop by 6 to 8 dB. Therefore, 3 to 3.5 mA $I_C$ is recommended and is set by the values in fig. 4. It is interesting to note that the noise figure is optimum from 1.0 to 5.0 mA $I_C$ and therefore no re-tuning is really necessary as only slight improve-
ment is possible at higher collector currents.

If a variable power supply is available, the operating point can be smoothly and easily varied up to 10 mA $I_C$ for improved gain and intermodulation performance. The noise figure will typically only be degraded up to 1 dB under these conditions; if only a fixed supply is available, R3 (see fig. 4) can be changed to 390-ohms and an external 1000-ohm potentiometer (wired as a rheostat) can be used to vary $I_C$. In this case a milliammeter in series with the preamp power supply input is recommended. At extremely cold temperatures the noise figure decreases while the gain increases. Hence, instabilities can occur; they are easily rectified if $I_C$ is varied accordingly.

**Noise-figure measurements**

One last point may be in order concerning noise-figure measurements. Below 500 MHz there are considerable discrepancies when using automatic noise-figure measuring gear and units using the 5722 noise tube. Above 30 MHz these devices tend to generate additional excess noise which tends to make noise figures *look better than they really are*.

For instance, at 30 MHz the output of a typical automatic noise figure generator is 5.2 dB excess noise while at 432 MHz the excess noise can climb to 6.4 dB. If this is not accounted for the preamp may show a 1.2 dB better noise figure than the true value. This discrepancy is well known by the manufacturers and typical values are available. However, manufacturers are reluctant to compensate the older models since it would invalidate all test data and units in the field.

On the Hewlett-Packard 343A this effect can be easily compensated for by lowering the diode current from 3.31 to 2.5 mA at 432 MHz. Errors on the Hewlett-Packard 349A gas tube are less, typically only 0.4 dB. Newer units such as the AIL-75 should not have this problem. The so-called “hot-cold” method of testing is the most accurate system but is tedious and requires liquid nitrogen.

The noise figures quoted in this article have been tested by the hot-cold test method and with automatic test gear that was compensated. Therefore, the results are true noise figures, not ad-

---

**fig. 1.** The ultra low noise 432-MHz preamplifier is built on a small section of double-clad printed-circuit board which is attached to the cover of the cast aluminum box.
vertising propaganda. Results have been widely correlated at the National Bureau of Standards, Boulder, Colorado; CSIRO (Commonwealth Scientific and Industrial Research Organization), Sydney, Australia, and elsewhere. In most cases this preamplifier exhibited 1.0 to 2.0 dB lower noise figures than the once revered low-noise standards such as the TIXM05, AF239, etcetera.

**other variations**

As pointed out earlier, this preamplifier works well at other frequencies although performance deteriorates above 500 MHz. The circuit was not optimized for other frequencies. However, even as is, the noise figure will be less than 2 dB at 144 and 220 MHz. Some slight adjustments will easily optimize operation at any frequency from 50 to 1000 MHz.

Other transistors will probably work well in this circuit “as is.” However, gain may be lower, the stability poorer, and the noise figure higher. Therefore, some adjustments or changes may be necessary, but these changes have already been discussed and should not be a problem.

**summary**

This preamplifier should bring you right up to the state of the art in noise figure. It is simple to build and operate with no adjustments necessary. Don’t forget the input filter, especially if you operate in a strong rf environment. Remember that this problem may be worse when the preamp is antenna mounted since the input line losses are usually lower.

It is hoped that this article will inspire more vhf/uhf building and operating activity. Antennas and transmitters are presently approaching the optimum. Now it is time to update our receivers to go along with this trend.

My special thanks go to Fairchild Microwave for the use of the test equipment and devices necessary to design this preamplifier. Special thanks go to Will Alexander, WA6RDZ, for all his helpful suggestions. Last but not least, let me thank my wife for typing this manuscript. She says, “It’s the most boring thing I’ve ever typed.”

**references**


**ham radio**
Appendix 1

**noise figure**

The affect of gain on overall system noise figure can be calculated using the formula:

\[ NF_T = NF_1 + \frac{NF_2 - 1}{G_1} + \frac{NF_3 - 1}{G_1 G_2} \]  

(1)

where:

- \( NF_T \) = overall system noise factor
- \( NF_1 \) = noise factor of the first stage
- \( NF_2 \) = noise factor of the second stage
- \( NF_3 \) = noise factor of the third stage
- \( G_1 \) = power gain of first stage
- \( G_2 \) = power gain of second stage

Note that all numbers must be in power gain form since the use of dB will result in large errors, especially when low noise figures are used. Noise factor can be converted to noise figure by applying the formula:

\[ \text{noise figure} = 10 \log_{10} (\text{noise factor}) \]  

(2)

Conversely, noise figure (dB), can be converted to noise factor by

\[ \text{noise factor} = 10 \text{antilog}_{10} (\text{noise figure}) \]  

(3)

**Appendix 2**

**zener diode biasing**

Refer to fig. 5. CR2 is a Zener diode and determines the collector-to-base voltage, \( V_{CB} \), of the transistor Q1. The base-to-emitter voltage, \( V_{BE} \), of most low-noise transistors is 0.7 to 0.8 volt and relatively constant. Therefore, the collector-to-emitter voltage, \( V_{CE} \), of Q1 is a fixed voltage which is the sum of the \( V_{BE} \) and the voltage of CR2. The current through R3 is given by the equation

\[ I = \frac{V_S - V_{CE}}{R3} \]

The current through R3 divides between Q1 and CR2. Ignoring R1, the only current flowing through CR2 is the base current of Q1. Therefore, most of the current flows through the collector of Q1 as \( I_C \). If the dc current gain of Q1 is low, the current through CR2 will increase accordingly. However, if the dc current gain of Q1 is high (as it usually is), the current through CR2 is low and the regulation as a zener is poor. Therefore R1, a 1000-ohm resistor, has been added to the circuit to force at least 0.7 mA through CR2. Since there is usually some base current, a value of 1.0 mA can be assumed for calculations.

As an example, assume you want to operate from a 12-volt power supply with a \( V_{CE} \) of 7.0 volts and an \( I_C \) of 3.0 mA.

\[ R3 = \frac{V_S - V_{CE}}{I_C + I_{CR2}} = \frac{12 - 7}{0.003 + 0.001} = 1250 \text{ ohms} \]

A 6.2 volt zener would be an appropriate choice for CR2. The collector current can be readily varied by changing either R3 or the supply voltage as indicated in the text. In the circuit of fig. 4 an additional diode was added in series with the supply voltage for reverse voltage protection. This voltage drop must be subtracted from the power supply voltage when calculating the value of resistor R3.
solid-state

S-meters

These simple solid-state S-meter circuits feature printed circuits that attach directly to the meter terminals.

It's a pleasure to tune in a nice strong S9 +20 dB signal, but it's even nicer if you have an S-meter on your homebrew receiver with which to read signal strengths. The unfortunate thing is that very few S-meter circuits are available, and most of those that are available are carry-overs from the vacuum-tube days. Several popular circuits using either a single device or an IC have the further disadvantage that they are at full scale with no input signal and decrease with increasing signal strength, just opposite to what you would like to see on the meter face.

The most straightforward approach to signal-strength indication is by voltage amplification of the detected audio. Most detected audio signals are in the 10 to 50 mV range, and pushing this up to drive a 5-mA meter movement takes a voltage gain of about 100, plus the added current gain. Neither of these tasks are easy with a single active device.

Commercially available meters with S-unit calibration seem to be limited to two movements, 0 to 1 mA and 0 to 5 mA types. Many modestly priced and military surplus meters also have these same basic movements. In addition, there are a number of specialty meters with removable scales that use a basic 0 to 1 mA movement, and these can be readily adapted for amateur applications.

Fig. 1 and 2 illustrate two types of S-meter PC boards which mount directly to the rear of a meter using the

fig. 1. Construction of the 5-mA S-meter circuit shown in fig. 4. Printed-circuit layout is shown in fig. 7.
common-emitter voltage amplifier with a simple positive pulse rectifier for the meter. The 35-μF meter shunt capacitor, C1, filters the rectified audio signal.

Fig. 4 is an S-meter amplifier for a typical 0 to 5 mA meter movement. Similar to the 0 to 1 mA design, the second-stage voltage amplifier, Q2, is followed by an impedance-matching stage, Q3, a simple emitter follower. Performance specifications for both circuits are given in table 1.

meter's plus and minus terminals. This allows free access for panel mounting, separates the meter-amplifier circuits from the rest of the receiver, and provides for easy add-on or modification at a later date.

circuit operation

Fig. 3 shows a schematic for a meter amplifier designed for a 0 to 1 mA S-meter. The fet input provides a high impedance to the detected audio and minimizes loading and distortion problems. The second stage, Q2, is a

construction

Fig. 5 and 7 show the PC board layouts and component installation diagrams.* Resistors can be 1/8- or 1/4-watt units although 1/2-watt components can be bent slightly or installed

| Table 1. Performance specifications of the S-meter circuits shown in figs. 3 and 4. |
|---------------------------------|-----------------|
| Audio signal input (S-9)        | 25-30 mV p-p    |
| Audio signal input (full scale)| 50-60 mV p-p    |
| Frequency response              | 500 Hz to 10 kHz|
| Input Impedance                 | greater than 1 meg |
| Power supply                    | 12 to 15 Vdc    |

*Undrilled printed-circuit boards are available from the author for $1.00 postpaid.
An infinite number of transistor substitutions are possible in these two circuits. Almost any audio n-channel, depletion-type fet should work at Q1 by adjustment of the 560-ohm source resistor for maximum voltage gain at the base of Q2. A general-purpose audio npn transistor can be substituted for Q2 and Q3 by adjusting the 15k bias resistor of Q2, and the 7.5k bias resistor of Q3, respectively. In both cases the resistors should be selected for maximum voltage gain to the succeeding device.

Vertically on the board to fit. The values for the source and emitter bypass capacitors is arbitrary, and almost any tantalum or electrolytic above 5 or 10 μF will work satisfactorily. An inexpensive dipped tantalum is recommended. The same general capacitance discussion applies to the 5-mA board, but more room is available on this board for the installation of axial-lead components.

fig. 5. Printed-circuit layout for the 1-mA S-meter circuit. Full-size printed circuit is shown in fig. 6.

fig. 6. Printed circuit for the 1-mA S-meter. Component layout is shown in fig. 5.

fig. 7. Printed-circuit layout for the 5-mA S-meter circuit. Full-size printed circuit is shown in fig. 8.
fig. 8. Printed circuit for the 5-mA S-meter. Component layout is shown in fig. 7.

stage or in the case of Q3, selected for maximum meter movement. When selecting bias resistors, it is suggested that a 20- to 50-mV 1000-Hz audio signal be applied to the input of Q1, and that a high-impedance scope or vtm be used to monitor signal gain.

application notes

Fig. 9 shows a typical application for the S-meter assemblies in a receiver. Since the detected audio level will vary with each receiver, it is necessary to install a sensitivity adjustment. Although this schematic shows a potentiometer, a simple two-resistor voltage divider is adequate. The sensitivity adjustment should normally be set for a meter indication of S9 (approximately half scale) with a modulated 50 µV signal applied to the receiver's antenna terminal. The sensitivity control should be a 50k to 100k unit to minimize loading effects on previous stages.

Since many 0 to 1 mA and 0 to 5 mA meters have different screw terminal locations than those shown here, you may want to use Vector board construction, following the general parts and connection data shown in fig. 5 and 7. An alternative is to locate the PC board externally and use jumper wires to the meter.

If meter motion bothers you, the needle can be damped (or left to free swing) by increasing (or decreasing) the value of the 35-µF meter shunt capacitor.

ham radio

fig. 9. Installing the S-meter amplifier in a typical receiver. Sensitivity pot may be replaced by simple resistive voltage divider, if desired.

march 1975
One of the best ways to motivate a casual reader to build a project is to describe something comparatively simple to construct which has more-or-less universal appeal. When such a project is presented along with a solution to any parts procurement problems, the desired result is often achieved: the reader becomes a builder. The following is offered with such a philosophy in mind.

**A simple, easily duplicated, lowpass filter, with 60-dB attenuation on channel 2 that can be built for under five dollars**

Recently a supply of high-quality ceramic capacitors came to my attention at the extremely low price of six for a dollar — they usually sell for three dollars apiece. These are ideal for a TVI lowpass filter being rated at 67 pF at 7500 Vdc and they are small enough to be non-inductive since they’re only 3/4 x 3/4 inch (19mm x 19mm). My first thoughts were to use these in a relatively non-critical lowpass filter circuit of the type shown in fig. 1A. This is
merely a combination of three pi-section filters, as shown in fig. 1B. No tune-up adjustments would be needed, and the circuit is easily reproduced. That dream went down the drain when the resultant filter showed comparatively low attenuation at TV channels 2 and 3. Unfortunately this is where it is needed most. One could re-design, possibly by lowering the cutoff frequency and thus omitting 28-MHz coverage, but only at the cost of larger, more cumbersome, and more expensive components.

Back to the old reliable. If we elect to keep the good features of the simple filter mentioned above, and then add series-tuned circuits at each end of the filter, we find that most of our needs can be satisfied by the design shown in fig. 2. Engineers describe this type of lowpass filter as having M-derived terminating half sections at each end, with two constant-K midsections. Most of the construction is non-critical, and when the end sections are tuned to channel 2 (55 MHz) or channel 3 (61 MHz) the theoretical attenuation approaches 60 dB, a ratio of one million to one! Assuming that your transmitter is properly shielded and filtered, this should cure any TVI problems except the toughest ones. As an unintended bonus, this should prove to be a very rugged filter, difficult to burn out even when operated on lines with high standing-wave ratios.

chassis

I used an unpainted LMB type 780 "tight-fit" chassis as the basis for this filter. It is made with a great deal of attention, and the close mechanical tolerances employed by the manufacturer should endear this type of chassis to all filter builders. I also tried to simplify the internal shielding problem by using a smaller LMB type 770 "tight-fit" chassis to enclose the center section of the filter. While this is a good design, I felt that even better shielding and harmonic attenuation were called for, at least in the prototype circuit. The additional vertical shield is the result of these considerations.

Personally, I doubt whether such extreme "weatherproofing" is required in all installations. You might simplify your construction initially by omitting the vertical interstage shield, adding it later if needed. In a strong TV signal area I don't believe this shield will be necessary. The ¼-inch (6.5mm) square rods which I attached to the main chassis cover as a precautionary measure are similarly optional.

coil winding instructions

All five coils are wound with either number-16 or -14 enameled wire,* using a ¼-inch (12.5mm) diameter form as a mandrel. Wind the coils in closewound fashion and leave 1-inch (25mm) pigtails at each end. Bend these at approximately right angles, carefully remove

*Do not attempt to use bus-bar wire or hard drawn copper wire for the coils. These types are prone to spring open to a greater diameter when removed from the ½-inch (13mm) form.
the enamel, and tin the ends. Space the coils uniformly by using a 2-inch (51mm) length of number-14 wire as a gauge, passing it between the turns from one end of the coil to the other. After this is done, make certain that the shape and spacing of the coils is not altered by handling; if this happens, re-space the turns with a piece of number-14 wire as outlined above.

I used number-16 enameled wire for the end-section coils (L1 and L5), since the current carrying capacity of number-16 wire (22 amperes continuous in open air) is more than adequate. I chose number-14 wire for the inductors carrying the throughput (L2, L3 and L4) since I wished to keep losses down. The filter should be capable of handling the output of all but the highest powered amateur rigs, although it was designed to serve the 90% of amateurs who own high-frequency rigs in the 200 to 300 watt input class. All capacitors were checked at 1000 volts ac before installation, and the completed filter was tested at 700 volts ac. A 1-kW input transmitter will have an rf output of 800 watts at most; if this is fed into a well matched 50-ohm coaxial line, the maximum rf voltage will be 200 volts at a line current of 4 amperes.* The filter could probably handle this with no trouble.

It is not necessary that the mechanical layout be followed, but if you do, success will be easier to come by. One item of note: In the mechanical design of this filter I took a close look at the problem of interstage leakage. When you consider that the coils are only

---

The text continues with a diagram and more detailed specifications, including values for capacitances, inductances, and other components. The diagram shows the layout of the filter with various symbols indicating the connections and components.

**W2OLU's lowpass filter is housed in LMB-780 chassis which provides a compact, nearly rf-tight enclosure.**

*Standing waves on the line will cause the maximum rf voltage to increase. Editor*
Also, center inductor L3 was offset so that it was mounted as far as possible from the other two parallel mounted coils. Attention to these seemingly small details makes the difference between a first-class filter and one having only "so-so" characteristics. It is all too easy to nullify part of the potential attenuation of such a filter unless you remember that our goal is to cut down on TVI harmonics by a ratio of a million-to-one!

**tune up**

When the end sections are first installed, short them to ground with a short strap and dip them to 55 MHz (61 MHz for channel 3) with a grid-dip oscillator. If you lack this simple instrument, I found that if the filter is constructed closely following the original, the two end capacitors are each about 75% fully meshed and at an angle of 41°. This was measured both with a machinist’s protractor and the 25¢ plastic type that can be found in stationery stores. If the filter is built as described, the intermediate sections should come out close to the optimum figures (see fig. 3) since the mid-section capacitors are rated at 5% accuracy.

**conclusion**

Full instructions for dipping and tuning lowpass filters can be found in both the *ARRL Handbook*¹ and the *Radio Handbook*². Follow the drawings closely and the odds are that the TVI beasts will no longer flow out through your coaxial line. Total cost? A pleasant surprise in these days of high inflation. How does five dollars strike you . . . and with spare parts left over!

**references**


---

Center section of the filter consists of four 850S ceramic capacitors and one inductor, contained in a LMB 770 Minibox.

---

fig. 3. Tuneup data for the lowpass filter. The input and output sections in (A) are first shorted to ground and tuned to 55-MHz (Channel 2 video carrier) or to 61 MHz (Channel 3 video carrier). Center section in (B) should resonate at 31 MHz, and terminating half-sections (C) should resonate at 37.5 MHz. Filter cutoff frequency is 42.5 MHz.
channel scanner

for the
Regency HR-212

Construction data
for a 12-channel
frequency scanner
to update
this popular
two-meter transceiver

If you've been thinking about trading
your Regency HR-212 two-meter fm
transceiver for one of the scanning
models on the market, but find you
have more time than money, then this
modification may be the solution to
your problem. For about $20 you can
provide your HR-212 with scanning
capability.

Explicit details on parts layout are
not included because the circuit was
built on a board designed for experi-
mentation and isn't the best possible
layout. Although I used wire-wrap for
IC interconnections, there's no reason
why someone with more time and talent
couldn't use printed-circuit techniques.
As the photo shows, the mods made to
the transceiver front panel don't detract
from its appearance.

Since the HR-212 uses diode switch-
ing of receive crystals, half of the
scanning circuit is already contained in
the unit. The circuit described here is
essentially an electronic switch which
replaces the receive mode rotary switch,
S2, on the HR-212.
The scanning circuit operates as follows:

1. The circuit scans 2, 3, 4, 5, 6, 7, 8, 10 or 12 channels, depending on how programmed. These numbers can be changed easily when crystals are added or removed.

2. Scanning will stop and remain stopped on the channel being monitored if:
   A. There is an incoming signal on that channel.
   B. The LOCK switch is in the LOCK position.
   C. Transceiver is in the transmit mode.
   D. The SCAN-MANUAL switch is in the MANUAL position.

Scanning will resume three seconds after the locking stimulus has been removed.

3. If scanning has been locked manually, pushing the STEP switch causes a jump to the next channel. If the scanner is stopped on an incoming signal, pushing the STEP switch will cause the scanning operation to resume until another active channel is encountered.

4. The SCAN-MANUAL switch takes the place of the original mode switch, S3, on the HR-212. When placed in the MANUAL mode, the scanning circuit is disabled and receive frequency follows transmit frequency. (Transmit frequency is always determined by the transceive rotary switch.)

construction

Receive channel indication is by means of LEDs, one for each channel.

![Diagram of LED board and switching connections.](fig. 1)

Switch S1A is the transceive 12-position switch on the HR-212. The HR-212 switching diodes are common to this switch (CR501 through CR512).

(fig. 1). The LEDs are placed on a 3x2½-inch (76x64mm) copper-clad circuit board, which is then mounted to the front chassis panel (see installation instructions). These LEDs will then protrude through small holes which are drilled in the front panel of the cabinet. I chose to place the indicators on the right side of the channel identification positions. This method still left enough room for identification using standard ¼-inch (6mm) embossing tape.

The scanning circuit (fig. 2) is constructed on a 2x4½-inch (51x114mm) copper-clad circuit board. Discrete components are interconnected through the copper of the circuit board wherever possible. Wire-wrap sockets are used for the integrated circuits, and connections are made between them and to the
discrete components using wire-wrap terminals which are soldered to the board. Discrete component values can vary to some extent from values given with the exception of Resistor $R_T$ and capacitor $C_T$. Therefore, don't be afraid to use your junkbox. Almost any npn silicon transistor can be used for Q1, Q2 and Q3.

The 5-volt power supply necessary for the ICs and LEDs consists of an LM335 voltage-regulator IC and several capacitors (fig. 3). This IC comes packaged in a TO-3 transistor case and can be mounted directly to the chassis below the scanner board. Don't neglect to use the bypass capacitors as shown with the voltage regulator as it is import-

tant to keep rf and transients out of the 5-volt supply.

**testing**

When the scanner board has been completed, test it with an oscilloscope.
or voltmeter before mounting it in the HR-212. Before applying 5 volts, connect the squelch input to a 5-volt point in the circuit and ground pins 6 and 7 of the SN7492 IC (U3). When voltage is applied, a square wave of approximately 6 Hz should be detected on the collector of Q3 (point Y). If no square wave is present, then look for it on pin 3 of the NE555 timer IC (U1). If nothing is there, then check the voltage on pin 4 of U1 and U2; both should read more than 2 volts dc. If the oscillator is working properly, then check the squelch locking circuit by grounding the squelch input. Oscillation should cease abruptly. When 5 volts is reapplied to the squelch input, oscillation should resume in about three seconds.

The scanner board switching outputs are checked as follows: place a 10k resistor between 5 volts and pin 1 of U4 (SN74145N). If the oscillator is running, the voltage on this pin should drop to zero momentarily once every two seconds. Perform this same test for pins 2 through 6 of U4 and 1 through 6 of U5. Now ground pins 10 and 12 of U2 (SN7400N). All switching outputs should remain constantly at 5 volts. If the scanning circuit has passed all the preceding tests, then wash up and prepare for surgery (if you’re not shaking too badly).

installation

First remove the dial light from the receive dial (right) side of the HR-212. Then cut the wires off of the receive channel rotary switch (S2 of HR-212) close to the switch. Remove the 12-position rotary switch and replace it with a 3-pole, 2-position rotary switch. Mount the LM335 voltage-regulator IC on top of the chassis (centered in front of the transmitter circuit board). Mount a 12-terminal board or block on the underside of the chassis below the voltage regulator. Connect the wires remaining from the removal of S2 to this terminal board in a sequential manner.

LED board. Position the board in front of the chassis, making sure it clears the transceive dial on the left. Mark and drill holes for the manual-scan switch shaft and the momentary contact step switch (this switch is mounted on the LED board). The step switch will protrude through the hole vacated by the receive dial window on the front cabinet panel. Remove the front panel from the cabinet and drill twelve 3/32-inch (2.5mm) holes for the LEDs. Then line up the LED board and front panel using the hole drilled for the manual-scan switch shaft as a guide.

Clamp the panel and board together and drill the LED board using the front panel as a template. These holes should then be enlarged to 1/8 inch (3mm). Etch a suitable pattern on the board to which the LEDs can be soldered, and make a provision for the 68-ohm current-limiting resistor. When the LEDs are mounted, check to make sure they all work, then secure with epoxy. This is very important, because the MV-5080 LEDs have very delicate leads that will break off if the LEDs have any freedom of movement. Finally, attach thirteen 8-inch (20cm) leads to the board (one for each LED and one for the 5-volt common bus).

Mount the momentary contact switch on the LED board, then carefully position the board on the front chassis panel and mount it on 1/4-inch (6mm) spacers. The spacers should be secured to the chassis first, then the LED board should be positioned loosely over both the spacers and nuts. Dress the wires through the front chassis panel and connect them to the proper terminals on the terminal board beneath the chassis. Connect the 5-volt common lead directly to the 5-volt side of the voltage regulator.

Scanner board. Mount four 1-inch (25.5mm) spacers to the chassis and secure them with nuts. Position the scanner board far enough away from the
front chassis panel so that wires can be routed between, then mark and drill mounting holes on the circuit board. Mount the board loosely on the spacers.

Connect twelve wires to the switching outputs using the wire-wrap tool, then connect the other ends to the appropriate terminals below the chassis. The rocker switch on the HR-212 is now used for the locking switch, S2. It should be open in the UNLOCKED position. Two unused, normally open contacts on the HR-212 transmit-receive relay are used for K1. The 470-ohm resistor in series with this relay is optional. Its function is to shorten the delay time of the scanner. This may be desirable if most of your activity is via repeaters.

The squelch input is connected to the HR-212 receiver. Locate R5, a 33k resistor connected directly to the transmit-receive relay; replace this resistor with a 27k resistor. The squelch input line should be connected to the side of this resistor that is not common to the relay.

Follow the programming matrix for setting the number of channels you intend to scan. The dashed lines on the schematic show how the scanner would be programmed for four channels. You may wish to employ a switch or switches to facilitate easy programming. Connect the SCAN-MANUAL switch to the circuit board and note that the rotating contact of the TRANSCEIVE rotary switch should also be connected to the SCAN-MANUAL switch at point X. All that remains to be connected now is the power supply. Try the scanner out for awhile before you fasten the board down. The scanning rate can be increased by making CT or RT smaller (preferably CT only).

**Conclusion**

Parts layout for the scanner circuit is not critical. There was enough room on the board for the scanner as well as a tone-burst oscillator, which was designed around a Signetics NE566 function-generator IC. You may wish to lay out the entire project on a printed-circuit board rather than use the wire-wrap method.

The greatest problem encountered with this scanning unit initially was that it tended to go wild during transmit operation due to rf and transients getting into the TTL ICs. This should not be a problem if all bypassing capacitors shown are used. Additional 0.05-μF capacitors can be installed at the VCC input of each IC if this problem persists.

If you don’t like the idea of drilling holes in your HR-212 cabinet, you might consider building the scanner as a remote unit. This will require a 15-conductor cable and connectors. The output of the SN7492 counter could be used with a BCD-to-seven-segment decoder to drive a seven-segment display as a means of channel identification.

If you live in an area with a lot of two-meter activity you’ll probably find it necessary to improve the selectivity of your HR-212. If you don’t, you may find the scanner locked on 146.88 MHz while the received station is transmitting on 146.94 MHz.

**Reference**

Thousands...

of Drake TR-3 and TR-4 Sideband Transceivers are giving dependable service...

many of them since 1963!

And now the Drake TR-4C is already surpassing their record!

Now at your dealer's

R. L. DRAKE COMPANY
540 Richard St., Miamisburg, Ohio 45342
Phone: (513) 866-2421 Telex: 288-017
low-cost
az-el antenna mount
for satellite communications

This article describes a simple, easy-to-build az-el (azimuth and elevation) mount for medium-sized vhf beams, and suggests that experimenting with the angle of elevation of beam antennas and the type of polarization, using the various vhf propagation modes, may yield useful scientific information.

In my az-el antenna mount the azimuth rotor is a TR-44, although a smaller, less expensive unit would work as well with small beams. (Oscar 6 expert K2BZT uses two Alliance U-100 rotors in his az-el mount which handles a 10-element circularly polarized Yagi.) The TR-44 azimuth rotor is mated to the bottom plate of a plywood sandwich by an 11-inch (28cm) stub mast and the bottom mast support which comes with CDR rotors. The stub mast can be as long as five or six feet (1.5 to 2 meters) to get the beam antennas higher, but much more than that would
be pushing your luck in ice and wind storms.

**plywood sandwich**

The plywood sandwich consists of two pieces of half-inch (13mm) plywood 8x9½ inches (20x24cm) and four spacers of the same material which keep the top and bottom plates one-half inch (13mm) apart so that the mounting hardware does not touch. Construction details for the plywood sandwich are shown in fig. 2 and 3.

A unique feature of the sandwich is that the elevation rotor mounts directly over the azimuth rotor which results in balanced downward thrust. Unbalanced weight creates a bending moment which strains both mast and rotor.

Before assembly, the two plywood plates and four spacers should be sanded and given at least two coats of high quality, outside house paint. After the sandwich is bolted together, the two seams are sealed with vinyl tape to keep water out, and the unit is given a final coat of paint. If this sounds too fussy, it is only because I have seen water pour out of waterproof baluns, trickle down the inside of new coaxial cable, split and destroy plywood, and fill a sealed quarter-wave transformer made of hollow tubing. No one will ever know how many weak signals are due to watered-down power!

**elevation rotor**

The U-100 elevation rotor is attached to the top of the plywood sandwich using the mast hardware supplied with the unit. Use flat washers and lock washers throughout. Tape the seams of the U-100 to keep water out. The bolts holding together the two halves of the U-100 loosen with time; tighten them every six months.

The U-100 rotor permits the boom holding the vhf antennas to pass entirely through the rotor unit, as the photographs show. Blonder-Tongue Prism-Matic rotors offer the same advantage. This is a must to achieve proper weight balance. If a single crossed Yagi is mounted on one side of the elevation rotor, a counterweight should be mounted on the opposite side.

The cross boom is a 5-foot (1.5-meter) wooden pole from a beach umbrella in order not to detune the Yagis, which should be mounted as closely together as possible. A metal boom could be used, but I prefer a strong, well painted wood boom for proper decoupling.

The two 3-element Yagis are mounted at 90° to each other, and 45° to the boom. One beam could be mounted
vertically and the other horizontally, but that posed a problem in this case because of the beam hairpins and baluns. The stub mast must be long enough to permit the beams to clear the supporting structure when the beam is rotated at full 90° elevation.

**elevation control**

A word of caution: before installing your masterpiece on top of a tall tower or high roof, conduct a dry run on the ground where you can easily, "correct any malfunction," as they say in the electronics industry. (The first time I elevated my antennas they pointed down into the driveway.)

Calibrating the elevation control is simple. I use east for the horizontal position and north for 90° elevation (straight up). A paper elevation calibration chart is pasted to the control unit between E and N.

**use with satellites**

While you do not need a beam, or an az-el mount, to work successfully through a satellite, using a good beam on such a mount gives superior results with less power. And the tests you can make are very educational. The Oscar satellites give you an opportunity to do something which amateurs have never before been able to do — listen on the downlink to your own signal coming back to you from a distant point (outer space) so that you can instantly hear the results of changes in power, types of antennas, and beam headings and elevation angles. There’s no guesswork, no baloney, no inflated reports!

With a satellite, those adventurous souls with a high-gain beam on an az-el mount are the first stations to access the bird on its pass, have the best signals (if they keep the beam heading in the right direction, at the right elevation), and work through the satellite up to the last possible moment before it drops over the horizon. On the other hand, an az-el mount keeps you a lot busier on a satellite pass than a fixed antenna so if you are the nervous type, you probably

---

fig. 2. Details of sandwich made of ¥2-inch (13 mm) plywood, well painted against weather. Bottom plate bolts to mast support for TR-44 or Ham-M rotor. Top plate bolts to U-100 rotor. Bolts fasten plates together, separated by four plywood spacers. Dimensions are shown in fig. 3.

fig. 3. Construction details for the bottom plate of the plywood sandwich. Top plate is similar (see fig. 2).
would be better off to stick to a ground plane. Another possibility is the automatic az-el control system described in the January issue of *ham radio*.

**vhf propagation**

There are numerous types of vhf propagation to explore and much to learn about over-the-horizon vhf/uhf paths, most of which exhibit very unpredictable behavior. Here is ideal territory for the purposeful amateur seeking a chance to contribute to scientific knowledge.

*fig. 4. Assembly, supported by four braces, mounted on 2x4-foot (60x120cm) plywood frame for fastening to flat area. TR-44 rotor can be mounted on regular tower. Length of mast from TR-44 to U-100 should not exceed 5 to 6 feet (1.5-2 meters).*

For example, does the angle of elevation of an efficient multielement beam with a relatively narrow main lobe affect vhf/uhf propagation which results from ducting, sporadic-E, temperature inversion, obstacle gain, aurora reflection, tropospheric scatter, ionospheric scatter, etcetera? If it does affect propagation, then in what way?

It is already known that the angle of elevation is important in satellite and moon reflection communications. Moonbounce expert W6PO reports that once an antenna is high enough to be free of ground effect, elevation control is a key factor in meteor trail reflection, making possible short-range communications (under 500 miles), such as between California and Nevada. Antennas are tilted upward and aimed at a meteor shower over northern Oregon so that the angle of reflection equals the angle of incidence on the reflection path. *Presto* — meteor reflection contacts over short distances!

**polarization**

Besides experimenting with the angle of elevation, worthwhile tests can be conducted comparing horizontal, vertical and circular polarization (right- and left-hand). W6PO suggests that tilting an array *sideways* — halfway between horizontal and vertical polarization — to achieve “lopsided polarization” might lead to interesting results.

Circular polarization may be produced with a helical beam, or with two Yagis, one of which is fed 90° out of phase with the other. The Yagis may be on the same boom, or separate as shown here. With Yagis, the transmission line to one beam is an electrical quarter-wavelength longer than the line feeding the other beam, thus imparting a minute delay in the power fed to the second
beam. Data on circular polarization may be found in references 2 and 3.

The results of these tests can be recorded by a reliable observer at the other end of the path, preferably using a tape recorder, or better, by having that amateur patch your signal into the telephone line so that you can actually hear the effects of the changes you make.

summary

Vhf and uhf territory, 50 MHz and higher, is one of the few remaining frontiers where pioneering amateurs still have an opportunity to contribute scientific discoveries in the honored tradition of the amateur service (the discoveries have been a bit sparse of late).

Except for satellite and moonbounce communications, little is known about the effects of changes in angle of elevation of antennas, and their polarization, on the propagation and reception of vhf and uhf signals. Who can tell what awaits the determined amateur with a pioneering spirit?

Thanks are due K2BZT, W6PO and W6SA1 for data in this article, and to WA2ECC for the photographs.

references


*ham radio*
GIANT SAVINGS!

Look at These UNBEATABLE PRICES!

GTX-600 6-Meter FM
100 channels, 35 watts
WAS $309.95
NOW $219.95
(Incl. 52.525 MHz)

GTX-2 2-Meter FM
10 channels, 30 watts
WAS $299.95
NOW $189.95
(Incl. 146.94 MHz)

GTX-200 2-Meter FM
100 channels, 30 watts
WAS $299.95
NOW $199.95
(Incl. 146.94 MHz)

GTX-100 1¼-Meter FM
100 channels, 12 watts
WAS $309.95
NOW $219.95
(Incl. 223.5 MHz)

GTX-10 2-Meter FM
10 channels, 10 watts
WAS $239.95
NOW $169.95
(Incl. 146.94 MHz)

CLIP OUT AND ORDER NOW!

GENAVE, 4141 Kingman Dr., Indianapolis, IN 46226

HEY, GENAVE! Thanks for the nice prices! Please send me:

- GTX-600 @ $219.95 $
- GTX-200 @ $199.95 $
- GTX-100 @ $219.95 $
- GTX-2 @ $189.95 $ (Incl. 146.94 MHz)
- GTX-10 @ $169.95 $
- PSG-1 AC Power Supply @ $49.95 $
- Lamda/30 2-M Base Antenna @ $39.95 $
- Lamda/4 2-M Trunk Antenna @ $29.95 $
- TE-1 Tone Encoder Pad @ $59.95 $
- PSI-9 Port. Power Package @ $29.95 (less batteries)

and the following standard crystals @ $4.25 each:

- Non-standard crystals $5.75 each; allow 8 weeks delivery.

For factory crystal installation add $8.50 per transceiver.

Sub-Total $  
Ind. residents add 4% sales tax:  
Cal. residents add 6% sales tax:  
TOTAL: $  

All orders shipped post-paid within continental U.S.  
For C.O.D., include 20% Down.

NAME
ADDRESS  
CITY  
STATE & ZIP

Payment by:  
- Certified Check/Money Order  
- Personal Check  
- C.O.D.

Note: Orders accompanied by personal checks will require about two weeks to process.

- 20% Down Payment Enclosed, Charge Balance To:
  - BankAmericard #  
  - Master Charge #  

Expires  
Expires  
Interbank #  

Prices and specifications subject to change without notice.

More Details? CHECK-OFF Page 94
programmable calculators

for solving engineering problems

An example of the versatility of these machines plus some expert advice on their use

During the last few years the use of small electronic calculators has become increasingly popular in broadcast and communications engineering. The small units available, even the $19.95 housewives' grocery-store special, offer a speed of operation and portability far above that of the slide rule. Almost overnight the field of mechanical calculators has been wiped out by progress.

In keeping with progress, a new breed of calculators of the mini-computer type has appeared on the market and several machines of reliable manufacture are now available. They are within reach of the average budget and will prove themselves in the first engineering problem calling for a repetition of calculations to be made in some orderly sequence. These machines are known as programmable calculators: they can accept one or more programs and can process them from a series of memory registers. Numbers may be recalled, changed, or restored at will in these registers.

programmable computers

The word "programmable" is apt to conjure up some scary ideas in the mind of the casual reader. Let's see what the word means. We may start out and store in the memory registers those quantities that are known or which we'll want to process, doing all this before we load the program into the machine. If desired, a sample calculation may be made at this point to acquaint ourselves with the routine, but this is not really necessary. Better that we go into LOAD, then proceed as if we were making an ordinary calculation, manipulating the keys to work toward an answer. Then we go back into the RUN mode. The program is now stored and we may insert new values into the memory registers and give the machine the go-ahead to process the new data.

The beauty of such an operation is that it doesn't have to be entered in a precise machine language such as BASIC, FORTRAN IV, or COBOL. In these languages, the big sophisticated machines must be commanded in an exact routine, using precise statements, and using exact names for what is to be
done. In the operation described here, the user simply goes through a series of key manipulations as if he were operating an ordinary electronic calculator.

A relatively new machine, the Compucorp 324G,* will perform such routines and run a very high program-step-to-memory ratio, presently 8:1, and will present 10-digit results! The sophistication of the programming is left to the imagination of the user. The machine actually processes to the 13th digit although only presenting 10 — with no apologies being offered to users of the IBM-360 or to equally serious programming with ordinary single-precision results.

**elementary programming**

Without attempting to go into an elaborate computer course, one or two no-no functions apply equally to the Compucorp 324G and the big IBM jobs; and the first of these is multiplication or division by zero. This is another way of saying that the memory registers should be loaded *before* inputing a program,

Several years ago *ham radio* published a rather whimsical article about how computers might someday influence amateur radio.* The author made a prediction that has now become a reality: low-cost calculators for home use. In a later issue we presented an article by another author, who described a method of circuit analysis using a canned program, ECAP, but which required large machines such as the IBM 1620.† Here’s yet another offering on solving electronic design problems using the computer. Only this time the machine is one of the relatively low-cost minicomputers known as a programmable calculator. Author Aylor leads you through the action in a step-by-step fashion (with advice on avoiding pitfalls) from initial programming to the final result — all on the new Compucorp 324G. Time has indeed marched on. Editor


*Marketed in the United States and Canada by Monroe Business Machines.

**some examples**

The above was a simple exercise in repetition, which may be included in a program as a stepping function. A typical example would be in the design of a directional antenna where you want to obtain a value of field intensity for every five degrees of azimuth. The above routine would be placed either at the beginning or the end of the program, storing the azimuth value in one of the registers and including the quantity for each successive step either in the program itself, or in one of the other registers. Each time the START button is pressed, the value in the register containing the azimuth would step forward, and the calculator would compute
the new value of field intensity at the new azimuth. Don't forget that you can recall the stored number from your controlling (azimuth) register as many times as you wish with the RECALL button, and the value will not be destroyed until you use the STORE key.

The stepping function, which is incorporated in a loop, is by no means confined to additive quantities. In the directional antenna example you could have as easily started at 360 degrees (or 180 degrees for that matter) and used the subtractive form of stepping; i.e., taking away 5 degrees each time the function was repeated.

Stepping to form a loop is by no means confined to any specific part of an equation. For convenience, the Compucorp 324G micro-computer has a set of parenthesis or brackets and you can form a stepping loop within these boundaries if desired. There is one additional no-no associated with the use of these: you must always use the same number of closing parentheses as used for entrance. Failure to do this will get you that great big error E---- signal, and only use of the reset button will clear the machine. Once that signal comes up, the reset button is the only key on the board that will work. Moral: get it in right next time.

using parenthesis

Here's a specific example of a short program with an internal loop. In this instance, the stepping function will be

![Diagram of a program for use with Compucorp 320-series programmable calculators to solve a typical problem: finding component values for a T-network.](image)

fig. 1. Part A of a program for use with Compucorp 320-series programmable calculators to solve a typical problem: finding component values for a T-network. Page 1, left, presents the problem, shows data to be entered into the machine, and shows the network reactances obtained from the program steps on page 2, right*.
enclosed within parenthesis, which stipulate the power to which a number will be raised. This is the old "double-each-day" routine. You've heard the one of going to work for only a penny a day and having your wages doubled every day and so on until you make it rich. The equation for this exercise is day's pay = \(2^{(N+1)} \times 0.01\). Let's see how to form a loop with the Compucorp 324G.

First go to RESET, which clears the display, then switch to LOAD and the machine is ready to receive the program. Then proceed as follows:

<table>
<thead>
<tr>
<th>action</th>
<th>explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Punch 2</td>
<td>Installs the integer to be raised to ((N + 1)) (program starts).</td>
</tr>
<tr>
<td>(A^X)</td>
<td>Instructs the machine that the next expression will be raised to a power.</td>
</tr>
<tr>
<td>(</td>
<td>Entrance parenthesis.</td>
</tr>
<tr>
<td>1</td>
<td>Incrementing step, once per day.</td>
</tr>
<tr>
<td>+</td>
<td>Addition command.</td>
</tr>
<tr>
<td>RCL(_n)</td>
<td>Prepares machine to go into memory register on next stroke.</td>
</tr>
<tr>
<td>0</td>
<td>Memory register stored under key 0, reads, and presents sum.</td>
</tr>
<tr>
<td>=</td>
<td>Prepares for storage.</td>
</tr>
<tr>
<td>ST(_n)</td>
<td>Alerts for next stroke, which will put selected number under next key punched.</td>
</tr>
<tr>
<td>0</td>
<td>Destroys that which was previously in register 0 and puts in a new quantity, (N + 1), which is the stepping function.</td>
</tr>
<tr>
<td>)</td>
<td>Closing parenthesis. The quantity ((N + 1)) is now poised and ready for action because you conditioned the machine with (A^X) earlier.</td>
</tr>
<tr>
<td>(=)</td>
<td>This is the go-ahead for the machine to raise 2 to the ((N + 1)) power. Remember, the original was raised to an increasing power each day.</td>
</tr>
<tr>
<td>(\times)</td>
<td>Multiply command. You must convert whole numbers to pennies and dollars.</td>
</tr>
<tr>
<td>.01</td>
<td>One hundred cents per dollar.</td>
</tr>
<tr>
<td>=</td>
<td>Presents final result.</td>
</tr>
<tr>
<td>START/STOP</td>
<td>Halts program.</td>
</tr>
<tr>
<td>RESET</td>
<td>Clears display to all zeros.</td>
</tr>
<tr>
<td>RUN</td>
<td>Terminates and conditions computer for RUN mode.</td>
</tr>
</tbody>
</table>

Now let's see what we've done. The calculator is capable of storing up to 80 steps or operations, and the display presents a running account of each time you press the key. Although there are only 17 apparent actions before the switch to RUN, the above storage actually consumed 20 of the 80 available steps. Why? Because, near the end of the program, entering .01 to convert cents to dollars required three key operations — the decimal, the zero and the one. The last step is actually a switch operation and does not count as a step.

We are now ready for a step test. For exactness we store a zero to obliterate anything remaining from the program entry operation, then press START/STOP and the machine momentarily displays a 1, meaning the first day has passed. The machine pauses and presents .02. Press START/STOP again and the machine displays a 2, pauses, then presents .04, and so on. After pressing START/STOP twenty-four times, the answer will be 167,772.16, or in hard Uncle-Sam-type greenbacks, $167,772.16 — not bad for a day's pay after only twenty-four days on the job!

additional looping forms

The example above was a rather simple one in a relatively common exercise. Earlier we used an example of destructive replacement in the \(2 + 3 = 5\) procedure, and that is exactly what we are doing here. In this example we installed the stepping increment (the fourth action), and on the sixth and seventh action we retrieved the quantity stored in register 0. The moment we punched the EQUAL button, the program added 1 to the quantity retrieved. Thus added, we are no longer interested in the quantity stored in register 0 so we use the storage key (ST\(_n\)) and store the new, added value in register 0.

To review, you went into register 0, retrieved what was there, added 1 to it, used it in the calculation, then destroy-
ed it by placing a new number as a replacement into that register, which previously contained the old number. All you did was replace the old value of N with a new value, defined as N + 1.

The rest is simple: put in a closing bracket and you have the portion of the equation shown as a power all set to go.

The calculator has been patiently waiting, poised since you told it that you were going to raise 2 to a power in the first and second steps of the program. Obviously, all that is necessary now is to punch the equal button — calculation gets under way immediately. The rest of the procedure places the decimal point, presents the result, and stops the calculation. Omission of START/STOP, a common mistake, will allow the machine to run wild until it hangs up on some value with more than 99 values or figures presented as an exponent in scientific notation.

There are other variations that are somewhat more sophisticated but easily worked on the machine. Suppose you want to construct a map and keep the longitude constant while walking up the curvature of the earth with a stepping value and reach a distance and bearing for each intercept — or suppose you want to construct a tower guy anchor (actually a large block of concrete) and given the weight requirement, you must know the most economical dimensions for placement. Or suppose you must design a transmission line-to-antenna network while solving for all phase shift values. The rule is the same: store it, recall it, and sum it in presentation. Store the presentation in the same register that kills the old value by destructive replacement and let the remainder of the program do the spade work, then go on from there.

There are a few other routines that will become apparent as the user gets more familiar with the use of the machine. For example, the Wayne-Kerr balanced impedance bridge, which is manufactured in Great Britain, gives a reading of the equivalent parallel circuit in terms of millimhos conductance shunted by equivalent picofarads susceptance, and the instruction book gives the equations for conversion. The equations are basic, requiring the conversion of the susceptance to reactance at a specified frequency.

Now, the condition where the susceptance dial reads zero picofarads is very real and means that the load is purely resistive, a function of the conductance. If, during the course of the factoring, the calculator encounters a zero in the denominator, it will latch up on the error signal. The way to avoid this is to input a small additive constant, such as 0.1 x 10^{-30}, into the capacitance value within the program. The machine adds the zero capacitance to the 0.1 x 10^{-30} picofarads residual, and the sin committed never shows on 10-place results. Of course, it would
have been easier to have inverted the conductance with the 1/X button and ignored the capacitance reading. But the objective is to achieve a program that will work with any list of data you use, with an answer (meaning no error latch-up) on anything you insert, and this means no exceptions.

Although taking the square root of a negative number was introduced as a no-no at the beginning of this article, there may be an exception in certain problems where you are stepping one or more variables in a multiplication form and wish to compare the product with a constant that is the criteria beyond which you cannot go. This constant is stored in another register. You then arrange to subtract the product from the constant and take the difference, then promptly take the square root. When the calculator attempts to go past the boundary condition — you guessed it: error! It's easy to reset and then recall the values that caused the latch-up. Note that earlier mention was made of dimensioning a large block of concrete to use as a guy anchor for a tower. With concrete costing $150 to $200 a cubic yard in place, overdesign can be costly and underdesign can be disastrous!

a typical program

The discussion that follows is specifically arranged for the Compucorp 324G minicomputer and consists of two programs that can be stored under a single bank of memory registers. The programs are typical of problems encountered in electronics; in this case it's desired to find the inductance and capacitance of a T-network between a generator (usually 50 ohms but subject to the user's choice) and a load such as an antenna, where any impedance may be encountered.

Both programs (fig. 1 and 2) are based on standard handbook equations. Program 1 yields the impedance of the three arms of the network. Program 2, into which the desired frequency is entered, gives the network values in μH and pF. In running the programs it's easy to plug in variables, store a value associated with program 1, then give the machine the go-ahead by pressing the START/STOP key. Then you switch to program 2, the machine retrieves the impedance values stored in program 1 and, using the frequency value entered in program 2, converts and displays the network numbers in microhenries and picofarads. Stepping is not included, but plenty of room exists in program 1 at step 60 to recall any values from the first three registers and add the steps in place of S/S (START/STOP) using the same old rule: recall, add (or subtract), store, punch S/S, and be prepared to process again.

analysis

Now let's see what went on in part 1 of the program. The expression under the radical was recalled and multiplied, the square root extracted and put to rest in register 6 at step 10 (fig. 1B). Then you recalled the phase shift from register 3, took the sine and promptly stored it into register 4 at step 15 for later use. Next you obtained the cosine with the second function (F2) button and stored it into register 5; but while it was available, you multiplied by the input impedance from register 1 and hit the equal (=) button for the product, then subtracted from the square-root quantity you had stored into register 6 at step 10.

At step 28 you came back for the sine you put into register 4 and divided, switched the sign in step 31, and put the input leg of the network into register 7 on step 33. The same process, with the stored quantities (sine 0 and cosine 0) and the value under the radical, is repeated, which takes you up to step 50, yielding the output leg impedance. The shunt, or mesh, leg value is obtained by dividing the number under the
radical by the sine, which is entered into register 9. Registers 7, 8 and 9 now have input, output, and shunt leg values respectively; program 1 is concluded with START/STOP; and you switch back to RUN.

Program 2 is for those allergic to reactance tables and only requires 40 steps. The microcomputer is switched to meters in impedances and phase shift. With further recalling, registers 7, 8 and 9 have the reactance values, and recalling 4, 5, and 6 gives you the design value of each component. Don’t forget register 0 down in the left-hand corner, which contains the frequency.

At this point, if you want to make changes in any parameter in registers 0, 1, 2, or 3 we can enter or store the new value in the register, switch to program 1, hit START/STOP, then switch to program 2, hit S/S again, and you will have an entirely new and different set of network values. The program described applies not only to matching antenna impedances but may be used for intermediate or output stages of transmitters, delay lines, or any problem of a similar nature in impedance matching. The designer always has control of the parameters he enters, and he may wish to make a number of trials before
deciding on the most economically feasible set of final components.

You might ask, “What does all this buy me?” On the presumption that you’ve followed the previous paragraphs and understand the manipulation or game plan, it’s only a jump upward into BASIC or FORTRAN IV. You’ve already learned an elementary form of assembly language.

final remarks

The average reader will find it’s easy to generate programs within a very short time. There’s really nothing complicated if a few simple ground rules are observed; i.e., start as deeply within the equation as possible, attacking the constants, and store for recall after the variables have been processed. As stated earlier, use the various registers for short storage, enter, kill, or substitute as you manipulate your way out. If you want to pause to read intermediate data, it’s as easy as pressing the START/STOP button, but be wary of using this mode too often since you and the machine may become out of phase. When you want to bracket something, a set of parenthesis is available, which can be doubled if you want.

A little green man is inside the machine to count the number of entrance parentheses and make sure you use the same number of closed parentheses before you terminate the program. He’s the same fellow who places the machine in lock-up if you violate any of the rules; but forgiveness is instant with the reset button, and you are permitted to start over again.

Programming and debugging come only with practice. There are all kinds of tricks that an operator will develop on any computer, whether using the simple program presented here or one on the big IBM-360 or IBM-370. The union of man and machine occurs only when one plus one functions as one!

ham radio
Put together the top-value Heathkit 2-meter package!

Start with the Heathkit HW-202 2-Meter FM Transceiver.

It's an all solid-state design that you can build and completely align without special instruments. And this compact little beauty gives you independent pushbutton selection of 6 transmit and 6 receive crystals. 10 watts minimum output. Will operate into an infinite VSWR without failure. And for the ultimate in convenience there's the optional tone burst encoder for front panel selection of four presettable tones. The HW-202 kit includes two crystals for set-up and alignment and simplex operation on 146.94; push-to-talk mike; 12-volt hook-up cable; heavy duty clips for use with temporary battery; antenna coax jack; gimbal bracket, and mobile mounting plate.

See specifications below.

Crystal certificates available at 5.95 each.

**Kit** HW-202, 11 lbs., mailable ... **179.95**

**Kit** HWA-202-2, Tone Burst Encoder, 1 lb. ... **24.95**

**Kit** HWA-202-1, AC Power Supply, 7 lbs. ... **29.95**

Add 40 watts of output

with the Heathkit HA-202 2-Meter Amplifier. It's designed for the HW-202, 4 lbs. ... **69.95**

Tune-up your 2-meter rig

with maximum precision. The Heathkit HM-2102 V/C SWR Bridge makes it happen, 4 lbs. ... **34.95**

New Heathkit

10-Watt Amplifier, HA-201, is perfect for hand holds or any 1 to 1 1/2 watt 2-meter rig.

3 lbs. ... **25.95**

---

**HW-202 SPECIFICATIONS — RECEIVER — Sensitivity: 12 dB SINAD* (or 15 dB of quieting) at 0.5 μV or less. Squelch threshold: 3 μV or less. Audio output: 2 W at less than 10% total harmonic distortion (THD). Operating frequency stability: 0.005% ± 0.005%. Image rejection: Greater than 55 dB. Spurious rejection: Greater than 60 dB. IF rejection: Greater than 75 dB. First IF frequency: 10.7 MHz ± 2 kHz. Second IF frequency: 455 kHz (adjustable). Receiver bandwidth: 22 kHz nominal. De-emphasis: —6 dB per octave from 300 to 3000 Hz nominal. Modulation acceptance: 7.5 kHz minimum. TRANSMITTER — Power output: 10 watts minimum. Spurious output: Below — 45 dB from carrier. Stability: Better than ±0.005%. Oscillator frequency: 6 MHz, approximately. Multiplier factor: X 24. Modulation: Phase, adjustable 0.75%. Duty cycle: 100% with ∞ VSWR. High VSWR shutdown: None. GENERAL — Speaker impedance: 4 ohms. Operating frequency range: 143.9 to 148.3 MHz. Current consumption: Receiver (squelched): Less than 200 mA. Transmitter: Less than 2.2 amperes. Operating temperature range: —10° to +125° F (—20° to +50° C). Operating voltage range: 12.6 to 15.0 VDC (13.8 VDC nominal). Dimensions: 9 1/2" H x 8 1/4" W x 9 1/4" D.

* SINAD = Signal + noise + distortion
  Noise + distortion

**HEATHKIT ELECTRONIC CENTERS — Units of Schlumberger Products Corporation**

Retail prices slightly higher.

**HEATH** Schlumberger

**Heath Company**

Dept. 122-03

**Benston Harbor, Michigan 49022**

Please send free 1975 Heathkit Catalog.

Enclosed is $ , plus shipping.

Please send model(s).

Name ___________________________

Address ________________________

City __________________ State __ Zip __________

Prices & specifications subject to change without notice.

*Mail order prices; F.O.B. factory AM-307
Your best buys in scopes come from the hams at Heath

Single or dual trace, there's a low-cost Heath scope to fit your need.

The 10-4530
... a professional scope with a practical price

A versatile easy-to-use single-trace scope for ham or hobbyist. Features DC-10 MHz bandwidth, 10 mV sensitivity... calibrated X-channel input for X-Y operation... TV coupling for service work... time bases from 200 ms/cm to 200 ns/cm... digitally-controlled trigger circuits... kit-form 10-4530 only $299.95*... assembled & calibrated SO-4530, $420.00*.

Our best scope... the dual-trace 10-4510

A precise lab-grade scope with DC-15 MHz bandwidth... post-deflection accelerated CRT for high brightness... 1 mV/cm input sensitivity... 45 MHz typical triggering bandwidth... Time base sweep to 100 ns/cm... vertical delay lines for complete waveform display... X-Y capability... operates on any line voltage from 100 to 280 VAC. Kit-form 10-4510 only $549.95*... assembled & calibrated SO-4510, $750.00*.

INSTRUMENTS ROUNDTABLE

Bob Ashton
Instruments Design Engineer
K9EGB/8

The INSTRUMENTS ROUNDTABLE presents tips from the Heath technical staff to simplify your measurements. Many different Heath instruments will be covered in future issues, often by the engineers who designed them. Your comments and suggestions are welcome. The following questions reflect some measurement problems with oscilloscopes.

Q. How can I make accurate measurements in applications where the oscilloscope input impedance loads the circuits under test?
A. Use a low-capacitance scope probe such as the Heath PKW-101. Be sure to consider the attenuation factor of the probe when making voltage measurements. Also, remember to compensate the probe for your scope's input capacitance to insure accuracy over the frequency range.

Q. How can I tell if a waveform or a segment of a waveform is an exact multiple of the power line frequency (60 Hz)?
A. The easiest way to check is to switch your scope's trigger select control to the "line" position. If the waveform or a segment of the waveform stops its horizontal movement across the screen, it is an exact multiple of the power line frequency.

Q. How can I tell if my transmitter is putting out harmonics?
A. You can use your scope if the transmitter frequency does not exceed the useful bandwidth of your scope. Connect a loop of wire at the end of a probe and place it near the tank or antenna connection. If the sine wave pattern displayed has "wrinkles" in it, there may be harmonics present. At slower sweep speeds these wrinkles look like light and dark horizontal lines through the raster.

For information on all the Heath scopes
... send for your free copies of our latest catalogs. Our '75 Heathkit Catalog describes the world's largest selection of electronic kits - including a full line of lab & service instruments. The latest Heath/Schlumberger Assembled Instruments Catalog features a complete line of high performance, low cost instruments for service and design applications.

Heath Company
Dept. 122-031
Benton Harbor, Michigan 49022

□ Please send the new 1975 Heathkit Catalog.

□ Please send the latest Assembled Instruments Catalog.

Name__________________________
Address_________________________
City_________________ State_____ Zip____

(Prices and specifications subject to change without notice)

More Details? CHECK-OFF Page 94
electronic bias switching for linear amplifiers

A simple electronic vox biasing circuit that lowers quiescent plate dissipation of linear power amplifiers

The use and value of an electronic bias switch has been known for some time, having been introduced in the popular ETO Alpha 70/77 linears. Bryant subsequently published an excellent version of that circuit in QST.\(^1\) It has significant application in two-kilowatt PEP input class-B and class-AB1 linear amplifiers where, especially in the latter, nominally two-thirds of the total plate dissipation is required in the quiescent state for best linearity.\(^2\) This immediately gives rise to the impact of such a device as a means of reducing tube dissipation, the accompanying heat, the ambient noise, as well as lengthening tube life and saving some of your power bill. One further consideration is the possibility of reducing the fan speed, its resultant noise and power consumption. Also, the high class-AB1 idling current is no longer a problem, permitting greater linearity.

circuit

Basically, the bias switch data and background were well covered by Bryant, and served as an excellent basis for a modified design to fulfill my particular requirements, which I prefer to call Electronic Vox Biasing, or as a friend dubbed it, a Vox Box. That more accurately describes the action of my circuit shown in fig. 1. This was, I felt, necessary because the original circuits were much too fast, resulting in a very harsh vox-like action, especially on the make of the switch, and other operating time constants, which were far too short, giving rise to what might be described as a paper-crunching sound, especially at the end of a sentence during ssb operation. For CW break-in operation, however, it would be very effective.

The problem centered on how to slow down an inherently fast circuit due to the saturation characteristics of the transistors resulting from the high current gain of the Darlington configuration. After considerable work an integrator circuit, consisting of C3 and R3, was finally developed which allowed for a softer make that provided an almost indiscernable operation of the switch. The speed on the make, or ris
time of the switch, was changed by a factor of 20, from 2 to 40 milliseconds. The decay time of 140 milliseconds is no problem at all since \( C_2 \) and \( R_2 \) may be easily altered to any required time constant.

It should be recognized that the quiescent bias voltage itself at point A in fig. 1 supplies \( V_{cc} \) to the Darlington pair. This is the self-bias developed by

![fig. 1. Electronic vox biasing circuit. The transistors used for Q1 and Q2 depend upon the cathode voltage of the power amplifier tube (see table 1). Adjust C1, R1 for drive level. Switch S1 permits establishing operating point for class-AB1 amplifiers and is used as operating switch in case of bias circuit failure.](image)

circuit, for independent test it is necessary to temporarily supply the \( V_{cc} \) separately through a 100k limiting resistor, R6, to point A.

**Table 1.** Transistors for the electronic vox biasing circuit.

<table>
<thead>
<tr>
<th>Transistor</th>
<th>Output Voltage</th>
<th>Output Voltage</th>
<th>Output Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1</td>
<td>2N5681 (TO-5)</td>
<td>2N3439 (TO-5)</td>
<td>2N3439 (TO-5)</td>
</tr>
<tr>
<td>Q2</td>
<td>2N5681 (TO-5)</td>
<td>2N3439 (TO-5)</td>
<td>2N6262 (TO-3)</td>
</tr>
<tr>
<td></td>
<td>2N3440 (TO-5)</td>
<td>2N3440 (TO-5)</td>
<td>2N6354 (TO-3)</td>
</tr>
<tr>
<td></td>
<td>2N3441 (TO-3)</td>
<td>2N3440 (TO-5)</td>
<td>RCA411 (TO-3)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>DTS423 (TO-3)</td>
</tr>
</tbody>
</table>

*Use heatsink with TO-5 devices

The serious designer could consider a total redesign of the circuit starting with an op-amp shaper driving a transistor as a voltage follower, rather than the Darlington configuration. This would provide complete control of the rise and
decay times. This will be something for a future project.

construction

I built my electronic vox biasing circuit on one-sided, copper-clad Vector board as shown in fig. 2. It only took a couple of hours to build, and could be done in less time if an unclad board

were used since a good ground plane is apparently not required. Parts location is very noncritical and no problems were encountered with any instability, etcetera. Switch S1 may be a miniature relay, as I used, or a simple spdt toggle switch to short the bias switch to set the proper operating quiescent current, \( I_p \), or to eliminate the switch in case of an open-type failure.

In the case of a shorting-type failure, the electronic vox biasing circuit will hold \( I_p \) to its normal switched value of 0.7 volt, i.e., essentially zero biasing. In the event resistor R5 were to open up, resistor R4 will prevent the full plate voltage from appearing on the cathode. These fail-safe precautions are in order for obvious reasons and will provide the user with a reasonable amount of volt-

age and dissipation security, since the total \( I_p \) flows through transistor Q2 along with the aforementioned high voltage risk.

Fig. 4 depicts the switch operation at a half-second sweep speed, with a male voice saying, “one, two, three, four.” Fig. 5, at the same sweep speed, depicts the word, “four.” As may be seen, the switching speed looks much like conventional CW keying time constants.
fig. 3. Typical application for the electronic bias-switching circuit. In rf power amplifiers using directly-heated tubes (such as the 3-S002), the cathode output of the bias-switching circuit is connected to the center-tap of the filament transformer.

A few words are in order regarding the time constants. Resistor R2, in combination with C2, basically establishes the decay time of the switch with some interaction with the make time. Capacitor C3 in combination with R3 affects the make and the break, while the combination of R1 and C1 establishes the keying sensitivity and the hold time. These should be set for the reliable operation of the switch at the highest frequency of operation and at the lowest anticipated power level.

A dc-coupled scope is highly recommended for adjustment for all time constants, bearing in mind that the current gains of the semiconductors and variations in component values will alter the result to some degree. All of my timing measurements were made on a H-P 1220A oscilloscope. At 14 MHz, the keyer will reliably turn on completely at 0.5 volt rms as indicated on the output meter of a Measurements Corporation model 65B signal generator and verified with the oscilloscope.

The results of numerous on-the-air tests, both under local and skip conditions, indicate little or no perceptible switching action, and a 32°F temperature reduction in the outlet air temperature of my linear amplifier. This, at 55 cfm air flow, calculates to a 520 watt average power reduction, a well worthwhile improvement by any criteria.

references
When designing electronic systems around ac power, an additional supply voltage seldom represents any problem. For low power an additional rectifier and/or regulator will often suffice, and worst case means the addition of a small transformer. When mobile operation is considered the problem becomes more difficult. If the requirement is for a voltage of the same polarity and lower than that of the automobile battery, then a simple voltage regulator will do the job. However, if you need a voltage that is higher or of opposite polarity than the vehicle battery, then something more elaborate is indicated. Occasionally it is possible to obtain power from an existing converter and suitably regulate it, but with more and more equipment being designed for direct 12-volt operation this option is fast disappearing.

The transformerless dc-dc converter described here may be adapted to a variety of low-power applications requiring voltages either higher or of opposite polarity than the vehicle battery. This power supply may also find some application as an on-card supply in fixed installations. As a negative voltage supply it may be used to power linear ICs such as operational amplifiers. By
fig. 1. Low-power dc-dc converter may be used to supply negative voltages (A) or positive voltages of greater value than the input (B). For positive-ground systems, allow the ground shown in these circuits to float. Voltage-current capabilities of these circuits are listed in table 1. All diodes are 1N914, 1N4148 or equivalent.

Using the vehicle battery as the positive supply and the dc-dc converter for the negative supply, signals may be referenced to the vehicle ground. This is very convenient, especially in control applications. As a voltage booster supplying voltage of the same polarity but of a higher potential it provides a convenient source for such things as trickle charging 12-volt nickel-cadmium batteries.

The basic negative converter is shown in fig. 1A and the positive booster shown in fig. 1B. Fig. 2 shows how additional diode-capacitor voltage-doubler sections may be added to increase the voltage output of the positive voltage booster (at the expense of available current). The same principle may also be applied to the circuit of fig. 1A to produce negative voltages of higher potential. Although all the schematics indicate a negative-ground input power source, positive-ground input may be used by grounding the positive input to U1 and floating the ground shown in fig. 1 and 2.

**operation**

Operation of the dc-dc converter is straight forward. U1 is a 555 timer IC operated as a free-running square-wave oscillator. The 555 makes an ideal oscillator for this application as it requires only three external components for oscillation and the output has the ability to source and sink up to 200 mA without additional buffering. The frequency of operation is determined by R1, R2 and C2 (with the values shown it is approximately 6 kHz). Capacitor C1 is used to reduce the amount of

fig. 2. Voltage output from the positive voltage booster (fig. 1B) may be increased by the use of voltage multipliers as shown here. Diodes are 1N914, 1N4148 or equivalent.
6-kHz signal radiated through the input power lines.

Since the switching times of the 555 IC are quite fast, this 6-kHz signal generates harmonics up into the higher high-frequency bands and may be heard on a communications receiver if the switching transients are not filtered. If the dc-dc converter is operated as part of a high-frequency receiver, it may be necessary to insert small (100-μH) rf chokes in the power leads to further reduce these harmonics.

The 6-kHz output at pin 3 of U1 is capacitive coupled by capacitor C3 to a rectifier circuit and filtered. The output filter capacitor, C4, may be increased above the 10 μF value shown if a low ripple content is essential. However, for operating an op-amp or two the amount of ripple with the circuit as shown is not objectional for most simple applications. Voltage-current capabilities for various voltage inputs are listed in table 1.

**construction**

Construction of the dc-dc converter is not critical although capacitor C1 should be as close as possible to U1 to reduce radiation of the 6-kHz harmonics. As it is anticipated that the converter will probably be incorporated as part of another circuit board, no PC layout is shown. For prototype applications, however, it may be convenient to build up a few on small PC boards (the supply shown in fig. 1A will fit with room to spare on a PC board 3/4-inch wide by 1 1/2-inch long (19x38mm).

---

**table 1. Voltage-current capabilities of the dc-dc converter shown in fig. 1.** For circuit of fig. 1B, add input voltage to output voltage (i.e., 5-volt input with no load, E output = 5 + 3.8 = 8.8 volts).

<table>
<thead>
<tr>
<th>Input = 5 Vdc output</th>
<th>Input = 6 Vdc output</th>
<th>Input = 9 Vdc output</th>
<th>Input = 12 Vdc output</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.8 V, 0 mA</td>
<td>4.8 V, 0 mA</td>
<td>7.7 V, 0 mA</td>
<td>8.9 V, 2 mA</td>
</tr>
<tr>
<td>2.2 V, 1 mA</td>
<td>3.2 V, 2 mA</td>
<td>6.2 V, 1 mA</td>
<td>8.4 V, 10 mA</td>
</tr>
<tr>
<td>2.1 V, 2 mA</td>
<td>3.0 V, 4 mA</td>
<td>6.1 V, 2 mA</td>
<td>8.1 V, 15 mA</td>
</tr>
<tr>
<td>2.0 V, 3 mA</td>
<td>2.9 V, 6 mA</td>
<td>6.0 V, 4 mA</td>
<td>7.9 V, 20 mA</td>
</tr>
<tr>
<td>1.9 V, 4 mA</td>
<td>2.7 V, 8 mA</td>
<td>5.9 V, 6 mA</td>
<td>6.7 V, 30 mA</td>
</tr>
<tr>
<td>1.9 V, 5 mA</td>
<td>1.5 V, 10 mA</td>
<td>5.7 V, 8 mA</td>
<td>6.1 V, 40 mA</td>
</tr>
<tr>
<td>1.8 V, 6 mA</td>
<td></td>
<td>5.6 V, 10 mA</td>
<td>5.7 V, 50 mA</td>
</tr>
<tr>
<td>0.6 V, 7 mA</td>
<td></td>
<td>5.3 V, 15 mA</td>
<td>5.5 V, 60 mA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5.0 V, 18 mA</td>
<td>5.0 V, 70 mA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.2 V, 20 mA</td>
<td>4.6 V, 80 mA*</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4.0 V, 90 mA*</td>
</tr>
</tbody>
</table>

*Current exceeds rating of recommended diodes.

---

"I wish I could establish a single transmission for almost three minutes with you."
Why make do with a converted Mark II Gizwachi when you can get a complete repeater designed for Hams by Hams, AT A PRICE YOU CAN AFFORD. The RPT 144 and RPT 220 are self-contained—all solid state machines. Conservatively rated, high quality, components deliver EXCELLENT RELIABILITY. Careful consideration has been given to both interfacing and control flexibility.

Factory wired and tested $595.95

Kits available Write for details

320 WATER ST. P.O. BOX 1921 BINGHAMTON, NY 13902 607-723-9574
Many of the operating stories we read in the amateur publications are about sea-going brasspounders. This one is about a brass pounder who rode the rails. Back in the summer of 1942, I was working my shift at WAR in Washington when an officer walked up behind me and tapped me on the shoulder. He told me to go pack my clothes for a trip to a warm climate. That was how I started as the first CW operator at the White House.

I learned that the White House had a Signal Corps detachment that now had the task of providing communications on a continuous basis between the Presidential Train and the White House. I believe this was the first time such a thing had been attempted in the United States. The Washington end was to be handled by the big War Department communications center, WAR; the remote end by the train plus relays, when necessary, from local stations along the way.

My first trip on the communications car, Old 1401, was the second trial run for the car. On this trip I went with the detachment commander, Col. Beasley; a radio operator recently made a Lieutenant, Lt. Greer; a civilian engineer from the War Department named Jack Kelleher; a radio maintenance man named John J. Moran; and a Secret Service man named George J. McNally. It is interesting to note that all of us were amateur radio operators. We went from Washington, D.C. to New Orleans and returned with our car in a regular passenger train, coupled between two baggage cars.

Old 1401 was a combine car. That is, she was half baggage and half passenger. She had been built for the Baltimore and Ohio Railroad in 1914. At the time I first met her, all identification on her sides had been painted out. Her number was her only identification, and it was painted in beautiful gilt over the entrance at the passenger end.

Inside, a couple of front seats had been removed and an operating table installed in their place. One operating position was located on each side of the aisle between the seats. Each position had a Super Pro receiver and a BC-342. The BC-342 was a new model at that time, designed for use in tanks and other rough riding vehicles. This receiver was installed on shock mounts, but my first trip proved that the best way to mount equipment on the train was to bolt it down solidly. Installed in this manner, the whole car moved as one unit and the
receivers worked beautifully. There was, however, a modulation on the received signals imparted by the train’s vibration. But this was better than having the tubes jump out of their sockets—which they frequently did when the equipment was on shock mounts (the tube clamp was not yet in common use).

Telegraph lines alongside the tracks provided a lot of clicks that made it difficult to copy poor signals. However, we didn’t have too much trouble with this problem except in the Southwest. The transmitter was a BC-447, running about 300 watts.

The clearance requirements for railroad cars prohibited using a real antenna. Ours was a wire inside an insulating tube mounted on standoffs about six inches above the metal roof of the car. This was later changed to a copper tube, the same size as the insulating tube, with much better results. Our frequency complement ran from 3 MHz to 17 MHz.

I was supposed to contact a number of Army stations along the way, none of them more than a couple of hundred miles from our route. As might be expected, results were poor and it was decided to contact WAR in Washington direct. Successful contacts were made from New Orleans and on the way home. The only real difficulty came when we were close to Washington. At that time, it was difficult to receive WAR on any frequency. Overall, however, our results were encouraging and we were assigned the task of accompanying President Roosevelt on his swing around the country visiting military bases and aircraft plants.

To my knowledge, this big trip was the first time continuous communications had ever been attempted between the presidential train and Washington. We contacted WAR in the eastern half of the country and WYV (San Francisco) or WVD (Seattle) in the western half. Results were excellent. In fact, our volume of traffic was so high that it was necessary to pick up an additional message clerk in Seattle, our first major stop, to handle the paper work.

To make a long story quite short, I worked six years on the Presidential Train, traveling with Presidents Roosevelt and Truman in the United States, Canada and Mexico. We logged well over a hundred thousand miles.

Equipment and facilities were improved over those years, and when I left Old 1401 in 1948, the car had a small operating room, a code center, a small bunk room with four bunks, a lounge room, and the baggage half of the car packed with equipment. We had two BC-339 transmitters for our message traffic. These were fixed station Federal jobs that loafed along at 1500 watts in radioteletype service and could easily run 3 kW on CW.

A single BC-610, a 500 watt a-m transmitter, was available for occasional broadcast services. We also had a 250-watt Motorola fm transmitter for guard radio service. On the receive side, we had the two BC342s I mentioned earlier, two Super Pros, a big Navy receiver whose type number I can’t recall, two Western Electric CV-31 teletype converters and a single teleprinter.

We also had a telephone switchboard that provided service throughout the train. The telephone cable permitted us to provide music throughout the train and intercom service, too, if it were desired.

Power was provided by two 25-kW diesel generators. Only one of these was required, and we switched them every 24 hours. We also had two 100-amp battery chargers to charge the train’s batteries when we were parked away from railroad terminal facilities, and two converters to provide ac power from the batteries to run our receivers in standby.

Today, the train is no more. Old 1401 has been retired and the President’s car—Ferdinand Magellan—is gone, too. The small detachment I knew has grown to the White House Communications Agency. Their responsibilities have grown a great many times over. But I’ll bet they aren’t having any more fun working assignments today than I did when Old 1401 was my home on wheels.
impedance bridges

Dear HR:

I noted the two items on noise bridges in the May, 1974, issue and perhaps my experiences with the two bridges might be useful. First, regarding WB2EGZ's bridge (December, 1970) I had the same problem, i.e. insufficient gain. I solved this by the use of two stages of amplification using the high beta RCA transistor 40245 before going into the balun transformer. This yields a very simple circuit and only a 5 mA drain on the battery, an important point because when making measurements the unit is often run for long periods. Since this bridge measures only the parallel equivalent resistance of the load, the presence of a significant amount of reactance greatly reduces the depth of the null.

The bridge design presented in the January, 1973, issue does measure reactance and consequently the depth of nulls within its range of reactance tuning can be as deep as those obtained with pure resistances. However, I found that the plus/minus 70-pF range for reactance to be inadequate. An examination of the possible capacitive or inductive components encountered around a 2:1 vswr circle on a 50-ohm Smith chart indicates, for example, that if $R_{\text{series}} = 58.8$ ohms and $X_{\text{series}} = \pm 38$ ohms, the parallel equivalents are $R_P = 83.3$ ohms and $X_P = 129$ ohms. This translates into a $C_P$ of $\pm 324$ pF at 3.8 MHz or $\pm 88.2$ pF at 14 MHz. The consequence is that a bridge capable of reading $\pm 70$ pF can only yield information about an antenna on these bands whose vswr is already pretty good. I changed this bridge to use a 365-pF variable (Radio Shack has a small one for $\$1.95$). The 68-pF fixed capacitor then has to be changed to 180 pF. Furthermore, I brought out terminals from these capacitors so that I can add further fixed capacitors as needed.

One point needs emphasis when working with these bridges and Smith charts: these particular bridges read out the parallel equivalents of resistance and reactance, while the Smith chart is designed for the series equivalents. The following series-parallel transformation equations should be kept handy:

\[
R_s = \frac{R_P X_P^2}{R_P^2 + X_P^2} \quad X_s = \frac{R_P^2 X_P}{R_P^2 + X_P^2}
\]

\[
R_P = R_s + \frac{X_s^2}{R_s} \quad X_P = X_s + \frac{R_s^2}{X_s}
\]
It can also be shown that:

\[
\frac{R_p}{X_p} = \frac{X_S}{R_S} = Q
\]

One further comment: While the \( R_p \) calibration holds pretty well from 3.5 to 30 MHz (paying careful attention to strays), the \( C_p \) calibration rotates towards the inductive direction by about 20 pF at 30 MHz for \( R_p \) values between 35 and 200 ohms, more so for values under 35 ohms. If the experimenter is using this bridge at 30 MHz or higher it is important that he calibrate the bridge for these frequencies. I found that a calibration made at 3.5 MHz holds pretty well through the 21-MHz band.

Provided one knows the characteristics of the coax line (characteristic impedance, velocity factor, attenuation and electrical length) with this bridge and a Smith chart one can measure the characteristics of an antenna at the shack coax terminal. It is not necessary that the line be an exact half-wave multiple. The assumption that the load characteristics are faithfully represented at the end of a multiple of a half-wavelength transmission line is true only at the exact frequency for which the line is a half-wave multiple (see April, 1974, QST article by W2DU). Usually we are interested in what an antenna is doing over part or all of an amateur band and it is important to realize that for frequencies other than the exact half-wave multiple the load is no longer faithfully represented. The error becomes increasingly significant with increasing VSWR.

Forrest Gehrke, K2BT
Mt. Lakes, New Jersey

**ac current monitor**

Dear HR:

The *Ham Notebook* section of the January, 1974, issue described a line voltage monitor that is very similar to one I have been using for about four years. The differences are slight, but my circuit has fewer components than WA8VFK's version. I didn't feel that the bridge rectifier and filter capacitor were required. If you are willing to accept only a little more non-linearity, a half-wave rectifier with bypass capacitors connected across the diodes and the input are all that is required. Rather than one expensive zener diode, I used three zeners from my junk box which added up to the voltage I needed.

A variable transformer in the ac power to my bench is used to check the performance of various types of equipment for over and under-voltage, and to compensate for line-voltage variations.

![fig. 1. Ac current monitor uses high-current 2.5-volt filament transformer. One amp through 2.5-volt winding yields 11-Vac between TP1 and TP2.](image)

A 2.5-volt, 10-amp transformer in the circuit (see fig. 1) is used to provide a readout of ac current on a voltmeter connected across TP1 and TP2. Each ampere of ac current passing through the 2.5-volt winding develops 0.25 volt across the winding — this is transformed to 11 Vac at TP1 and TP2 (1 amp = 11 Vac, 2 amps = 22 Vac, etc.). Any low-voltage, high-current transformer can be used in this application, but the 2.5-volt, 10-amp unit is ideal because the transformed voltage is easily interpolated into current (1 volt ≈ 100 mA ac current).

E.G. Sullivant, Jr., WB5MAP
Shreveport, Louisiana
increased flexibility for the memory keyer

In a recent article WB9FHC described the construction of a two memory electronic keyer.* After using this unit on the air for several weeks, I decided to expand the keyer's capability, permitting greater operating flexibility during contests.

As a first step, I wanted a self-contained keying monitor, particularly for initial off-the-air programming. A simple but effective circuit is shown in fig. 1. The circuit uses half of a 7413 dual NAND Schmitt trigger. A miniature 500-ohm pot is used for the tone control, while the inexpensive 8-ohm speaker was salvaged from an old transistor radio. The monitor can be switched out of the circuit when not in use.

Many times during a contest, especially during low activity periods, a message, such as a CQ, is to be repeated a number of times without having to manually recycle the memory each time. A simple solution is to install a spst toggle switch in parallel with S1 of the original circuit. In my particular case, a CQ without the AR K ending was desired to nearly fill the 256-bit memory capacity. During programming a stop-watch was used to note the elapsed time of the memory cycle. By careful spacing of the message CQ CQ DX TEST DE K3NEZ K3NEZ, the entire memory can then be filled without any appreciable pause at the end. If the message is to be sent three times, the toggle switch is closed and then opened just after the desired message starts to repeat for the third time. The AR K ending is then sent manually with the paddle after the callsign has been sent by the memory.

Since it was desired to add a third, and possibly fourth, 256-bit memory to the keyer, it became apparent that the use of a single rotary switch for selecting the memory was not efficient. The circuit of fig. 2, when added to the original circuit, permits the operator to simultaneously select the desired memory and cycle the four-bit counters.

Although three memory units are shown, additional units are easily paralleled, as the circuit is straightforward. A LED indicator is provided for each message. Note that the part of the original circuit from Q of 7473C is omitted. For example, to read or write from memory A, simply depress the corresponding switch; otherwise, operation is the same as described in the original article.

Howard M. Berlin, K3NEZ

hi-fi interference

An excellent article on audio-frequency interference in a recent issue of *Radio Communications* discussed problems which are not mentioned in our usual Handbooks.

A simple LC filter was first tried on the bench to keep rf out of the coaxial lead to the audio amplifier, particularly from a record player. The coil turned out to be resonant, so it was not reliable at widely varying frequencies. The capacitor alone, to ground, was usually better. When tried in a Garrard record player, however, which has unshielded pick-up leads connected to phono jacks, no improvement was noted.

The rash of hi-fi complaints here results from unidentified CB as well as my own transmissions. The greatest problems were from Garrard players, but to a lesser extent from a Wollensak-3M cartridge player. When all input and output coaxial lines were removed the fm broadcast receiver played without interference, but one a-m tuner had many signal peaks in its tuning range.

In addition to bypassing audio-amplifier base-emitter junctions with rather large capacitors (1000 pF up), I hope to try the recommended ferrite beads, and to develop lowpass filters to plug into the coaxial input and output lines without creating unacceptable loss of high-frequency audio.

Radio Shack tells me that several manufacturers have produced filters which can be inserted in the audio leads from record-players and tape-players to prevent rf pick-up from reaching the audio transistors in the amplifier. These filters are seldom known even to the hi-fi departments of stores, but are available upon request, much as high-pass TVI filters have been available to those who know about them and are familiar with this method of complying with the FCC regulations.

Bill Conklin, K6KA
Hamtronics, Inc., well known for its vhf preamps, receivers and scanners, is moving into the uhf field with two new products. The first is a uhf converter kit, shown above, which operates on the 432- to 450-MHz amateur band or on the rapidly growing 450-470 MHz public safety band. The converter is constructed on a 3x4-inch G-10 board and features a low-noise jfet, high-quality, milled variable capacitors, integral coax connectors, and low current 12-volt operation.

The converter has one built-in oscillator, and an adapter is available for six additional frequencies for channelized fm operation. It can be built to output on the popular two-meter fm band or 6 meters, 10 meters, commercial bands, etc. Price for the kit is $20, which includes domestic shipping. Add 80¢ for air mail if desired. Crystals are available for any frequency scheme at $5.50.

The second new uhf product is a low-noise preamp kit for 432-450-470 MHz. This unit has features similar to those of the converter. Price is $15 for the kit or $25 wired, including domestic shipping. Add 60¢ for air mail if desired. For more information or to order, write to Hamtronics, Inc., 182 Belmont Road, Rochester, New York 14612.

how to troubleshoot and repair test equipment

"Cure your own equipment" is the watchword of this brand-new volume, written by Mannie Horowitz, one of the top designers of electronic test equipment. Any competent amateur should be able to repair his own equipment, and it's easier than ever before with this new one-of-kind book! It's jam-packed with practical, ready-to-use data on the repair of power supplies, multimeters, oscilloscopes, audio and rf signal generators, sweep generators and tube and semiconductor testers. No complex math or circuit theory is included — this is not a book that requires study, but one that can be used from the very minute it's opened. With the complete, simplified theory that is presented, read-
ers with even modest electronic backgrounds will understand equipment as never before, and get more out of using it as well.

For each piece of equipment there is a clear, illustrated explanation of the basic circuits it contains. There's also a complete trouble analysis of each circuit, telling what can go wrong and what the probability of it is. Next comes an explanation of how the basic circuits are integrated into a complete circuit by the switching circuitry. Then, test procedures for an actual example are presented. Published by Tab Books, 252 pages, soft bound, $6.95 from Ham Radio Books, Greenville, New Hampshire 03048.

high-precision trimmer capacitor

A new type of miniature trimmer capacitor claimed to give outstandingly linear response (better than 2%, with no local reversals of capacitance) has been announced by Jackson Brothers of England. The Trimline capacitor is a tubular design 5-mm in diameter and 18-mm long. Its constant length simplifies layout planning. Minimum capacitance is below 0.5 pF and maximum is above 5 pF. Adjustment is by screwdriver slot, with ten turns between minimum and maximum to permit very fine setting.

Unlike most tubular trimmers, the Trimline employs air as the dielectric, and the moving element does not rotate. This avoids eccentricity and deviations

### FREE DATA SHEETS WITH EVERY ITEM 739/749 IC WITH EVERY $10 ORDER*

- **REDUCE YOUR PROJECT COSTS**
- **MONEY-BACK GUARANTEE**
- **24-HOUR SHIPMENT**
- **ALL TESTED AND GUARANTEED**

### TRANSISTORS (NPN)

- ZN3653 TYPE RF Amp & Switch (TO-18/106) $6.90
- ZN3655 TYPE Gen. Purpose High Gain (TO-12/106) $6.90
- ZN3657 TYPE High Current Amplifier Sw 500 mA $4.90
- ZN3658 TYPE RF Pwr Amp 1.2 W @ 100-600 MHz $1.50
- ZN3693 TYPE GP Amp & Sw to 100 mA and 30 MHz $1.50
- ZN3904 TYPE GP Amp & Sw to 100 mA (TO-12/106) $3.90
- ZN3919 TYPE RF Pwr Amp 3.5 W @ 3.3 MHz $3.90
- ZN4274 TYPE Ultra High Speed Switch 12 ns $4.90
- MPM5655 TYPE High Gain Amplifier & CE 250 $3.90
- Assort: NPN GP TYPES, ZN3655, ZN3641, etc. (15) $2.00
- ZN3638 TYPE (PNP) GP Amp & Sw to 300 mA $4.90
- ZN4249 TYPE (PNP) Low Noise Amp 1 µA to 50 µA $4.90

### FET's:

- n CHANNEL (LOW NOISE): ZN4089 TYPE RF Amp & Switch (TO-18/106) 3/51.00
- n CHANNEL (HIGH GAIN): ZN4416 TYPE RF Amplifier to 450 MHz (TO-72) $2.90
- n CHANNEL (HIGH SATURATION): ZN5163 TYPE Gen. Purpose Amp & Sw (TO-106) $3.90
- n CHANNEL (HIGH SPEED): ZN4586 TYPE RF Amp to 450 MHz (plastic ZN4416) $5.90
- n CHANNEL (LOW GAIN): E100 TYPE Low Cost Audio Amplifier $1.50
- n CHANNEL (STAGE outfield): ITE4688 TYPE Ultra Low Noise Audio Amplifier $2.60
- n CHANNEL (SLOW SWING): TIS74 TYPE High Speed Switch 40 ns $3.90
- Assort: RF & G FET's, ZN5163, ZN6466, etc. (8) $2.90

### P-CHANNEL:

- ZN4360 TYPE Gen. Purpose Amp & Sw (TO-106) $3.90
- E175 TYPE High Speed Switch 125/1 TO-106) $3.90

### MARCH SPECIALS:

- ZN2222 or ZN222A NPN TRANSISTOR GP Amp & Switch $5.50
- ZN5900 TYPE NPN TRANSISTOR GP Amp & Switch $5.90
- 741 Op Amp, Compensated (DIP/TO-5 MINI DIP) $1.10
- ZN3067 TYPE PNP TRANSISTOR GP Amp & Switch $5.90
- MM516 Digital Alarm Clock Switch/Alarm Timer $5.90
- MM516 Digital Switch/Op Amp (MINI DIP) $5.90
- MM5236 6 Digit 4 Function Calculator 18 PIN DIP $3.95

### LINEAR IC's:

- 308 Micro Power Op Amp (TO-5 MINI DIP) $1.00
- 309K Voltage Regulator 5 V @ 1 A (TO-3) $1.00
- 324 Quad 741 Op Amp, Compensated (DIP) $1.00
- 380 2.5 Watt Audio Amplifier 34 48 (DIP) $1.29
- 555X Timer 1.8 to 10 µs, pinout from 555 (DIP) $0.85
- 790P 2.5 Volt Op Amp (DIP/TO-5) $0.29
- 723 Voltage Regulator 5.2 V @ 350mA (DIP/TO-5) $0.58
- 739 Dual Low Noise Audio Preamp Op Amp (DIP) $1.00
- 1458 Dual 741 Op Amp (MINI DIP) $0.95
- 2556 Dual 555 Timer 1.9 ms to 1 hour (DIP) $1.50

### DIODES:

- 1N3600 TYPE H Power Switch 75 V/200 mA $6.10
- 1N3939 TYPE RECTIFIER Stud Mount 5 Volt 5 Volt $2.10
- 1N914 or 1N914H TYPE Gen. Pwr. 100V/100mA 10.50
- 1N479 ZENER 4.3 Volt (±10%) 400 mA $4.90
- 1N533 ZENER 6.2 Volt (±10%) 400 mA $4.90
- 1N555 ZENER 7.5 Volt (±10%) 400 mA $4.90
- 1N575 ZENER 9.1 Volt (±10%) 400 mA $4.90
- 1N58 ZENER 10 Volt (±10%) 400 mA $4.90
- 1N655 ZENER 15 Volt 400 mA $4.90
- 1N650 ZENER 20 Volt 400 mA $4.90
- 0.5 VARACTOR 5.80 W Output 30 TO 250 MHz, 7.70 pf $5.90
- 0.7 VARACTOR 12W Output @ 100 500 MHz, 3.30 pf $1.50

*MAIL NOW! FREE DATA SHEETS supplied with every item from this ad. FREE 739 or 749 Low Noise Dual Op Amp included ($1.00 value) with every order of $10 or more, postmarked prior to 4:30 P.M. ORDER TODAY. All items subject to prior sale and prices subject to change without notice.

WRITE FOR FREE CATALOG offering hundreds of semiconductors not listed here. Satisfy your requirements.

TERMS: All orders must be prepaid. We pay postage $1.00 handling charge on orders under $10. Calif. residents add 6% sales tax.

ADVA ELECTRONICS
BOX 4181 A. WOODSIDE, CA 94062
Tel. (415) 851-0455

More Details? CHECK—OFF Page 94

march 1975 65
from linear response associated with designs based on a rotating piston. Here the stationary element is a small piston and the moving element is a coaxial cylindrical sleeve. Both are made of silver-plated brass. The sleeve is moved axially by a lead-screw engaging a threaded collet inside it; it is precisely located and guided by a fixed outer glass sleeve, and by two lugs in its tail which run in fixed longitudinal slots.

At both ends of the travel a slipping-clutch mechanism—a patented feature—prevents accidental damage being caused by over-adjustment. At maximum capacitance a Teflon stop prevents electrical shorting. Electrical losses are low (Q factor greater than 1000 at 20 MHz), and the capacitor has an expected life of over 10,000 adjustment cycles. For more information, write to Jackson Brothers’ agent, M. Swedgal, 258 Broadway, New York, New York 10007, or use check-off on page 94.

tool catalog

A free tool catalog describing over 2500 individual items is offered by Jensen Tools and Alloys. “Tools for Electronic Assembly and Precision Mechanics” is a 112-page handbook of particular interest to electronic technicians, radio amateurs and engineers.

Section headings include screwdrivers, wrenches, pliers, tweezers, files, shears, knives, microtools, relay tools, power tools, metalworking tools, wire strippers, soldering equipment, test equipment, engineering and drafting supplies and electronic chemicals. New sections include metric tools, books and wire-wrapping tools.

Another important feature of the catalog is the inclusion of four pages of technical data on tool selection. Known as “Jensen Tool Tips,” these pages include sections on screwdriver selection, machine screw data, tool materials,
plier facts, metal conductivity, color coding, wire and insulation data, solderability of metals, temperature conversion, drill sizes, metal gauges, metric conversion and safety. Five pages of "tool terms" are also included.

A free copy of the Jensen catalog may be obtained by writing to Jensen Tools and Alloys, 4117 North 44th Street, Phoenix, Arizona 85018, or by using check-off on page 94.

diode applications

Diodes are the simplest yet most versatile devices found in electronic circuits. Typical applications range from power supplies to waveform converters, logic elements, temperature-compensating devices, regulators and signal detectors. This new book by Courtney Hall, WA5SNZ, surveys these and many other important uses for diodes.

In a clear, readable presentation, the book begins with basic information about diode properties and how diodes work. Vacuum-tube diodes and rectifiers, semiconductor diodes and diode reverse recovery time are other topics covered in Chapter 1. Chapter 2 discusses rectifier power-supply circuits. Half-wave power supplies, full-wave rectifier circuits, voltage-doubler circuits, transformer ratings and more are explained in depth.

The next chapter covers circuits for ordinary diodes. Beginning with logical OR and AND circuits, it covers the ideal diode, diode gate circuits, flip-flop preset circuits and diodes for meter protection. Another chapter is devoted to zener diodes. Two chapters are set aside for the newer diode types such as LEDs, tunnel diodes, varactors and semiconductor lasers.

Soft cover, 96 pages, $3.50 from HR Books, Greenville, New Hampshire 03048.
Now is the time for all good hams to come to the aid of their code.

With the HAL MKB-1, you can send perfect CW as easily as using a typewriter. The all solid-state MKB-1 is a complete Morse keyboard code typewriter, with code speed variable from 10–60 WPM. Dot-to-space (weight) ratio is also variable.

The MKB-1 is full of features, like a variable volume/tone oscillator with internal speaker. Plus its own power supply. Computer-grade key switches. And it drives cathode or grid-block keyed transmitters.

An available option is the HAL KB-ID automatic identifier. Touch a button and "DE," followed by your call is automatically transmitted. And you can add two 2-letter characters of your own, e.g., "73 OM."

Assembled, the MKB-1 costs $250; with the KB-ID option, add $40. (We'll program your call into the KB-ID for you.) The MKB-1 kit is $170; with the KB-ID kit, add $29. Come to the aid of your code today — and enjoy CW like never before.

The ID-1A isn't much to look at.

The heart of any repeater identifier is its Read-Only-Memory. And inside the HAL ID-1A is a unique ROM — one you can easily reprogram yourself, should you need to change the call sign. The ID-1A's ROM capacity holds 39 dots, dashes and spaces — enough for "DE" plus the call sign. But there's a lot more inside the ID-1A than that. TTL IC's are used for high noise and temperature immunity. Accurate timing is assured from the 60 Hz VAC line source, or an internal oscillator — when the unit is operating on 12 VDC. And there's a wide selection of ID time intervals available to you (the factory-assembled set is programmed for 3, 6, 12 or 24-minute ID intervals). Code speed is adjustable. The keyed audio oscillator includes volume and tone controls, with a low-impedance output for driving the transmitter microphone line and a 2" monitor speaker. And there's a rugged transistor switch to actuate the transmitter keying relay or other controller.

The ID-1A is available factory assembled for $115 or as an assembled board/kit, including all parts external to the board except the cabinet for $75.
For the best RTTY, you need all the help you can get.

The HAL ST-6 terminal unit has been hailed by experienced RTTY amateurs. Its immunity to interference and noise is the talk of the RTTY world as the best in the business. In fact, we built it to highest standards — but kept the price in a range that you can afford.

The features of this unit tell the story of why it’s so popular: Autostart operation, separate input filters for each shift, an antispace feature, and switch selection of 850 and 170 Hz shifts are standard. An extra discriminator for a 425 Hz shift is available as an option. A space-saving special power transformer is part of the package; it includes windings for low voltage and loop supplies, and a 115/230 VAC primary. Dual-in-line IC’s are mounted in sockets for ease of testing and replacement. Seven G10 epoxy glass boards with reliable wiping contacts hold all circuitry. Tuning is read from a 1 ma. panel meter which, at the flick of a switch, serves as a loop current readout. Other visual indicators display AC power on, Mark, and Space conditions. Two other lamps indicate whether the ST-6 is in the receive or standby mode. For maximum safety, a three-wire grounding cord and grounding outlet for the printer are included. The power supply card contains easy-to-replace clip-in fuses. The ST-6 is available factory assembled and aligned, or in kit form. The PC boards and cabinet only are also available.

A popular option designed to plug right into the ST-6 is HAL’s AK-1 AFSK oscillator. Available assembled or in kit form, the AK-1 is an AFSK oscillator that demonstrates stability and reliability. It provides switch selection of 170 Hz and 850 Hz shift using standard AFSK tones. The AK-1 may also be mounted in its own cabinet for use as an independent unit. Frequencies are set by 15-turn trimmers for ease of accurate tone adjustment. The AK-1 operates on 12 VDC, or directly from the ST-6 power supply.

If you’re ready for the very best RTTY at an attractive price, look into the HAL ST-6 TU, the 425 Hz discriminator, and the AK-1 AFSK oscillator. They’ll give you all the help you need. Order yours today!

Kit Form:
$147.50 — ST-6 Terminal Unit
$35.00 — ST-6 Table or Rack Cabinet
$29.00 — 425 Hz Discriminator
$29.00 — AK-1 AFSK Unit

All prices postpaid, USA. For air shipment add $4 for the ST-6 kit or cabinet, $1 each for the 425 Hz kit or the AK-1 kit, $10 for the assembled ST-6 with any options.

HAL Communications Corp.
Box 365, Urbana, Ill. 61801
Telephone: (217) 359-7373

Enclosed is $____ for the following items: 
□ ST-6 Assembled, 
□ With all options; 
□ ST-6/425 Hz Disc; 
□ ST-6/AK-1; 
□ ST-6 kit; 
□ ST-6 Cabinet; 
□ 425 Hz Disc kit; 
□ AK-1 kit; 
□ Charge to my Master Charge
□ BankAmericard □ 
□ Master Charge/Interbank # and Exp. date

Please send me the HAL catalog.

Name
Address
City/State/Zip

Illinois residents add 5% sales tax.
KLM ELECTRONICS Introduces...

((ECHO II))

With 2 MONEY SAVING INTRODUCTORY OFFERS

((ECHO II))

A NEW 2-METER TRANSCEIVER

FOR FIXED AND MOBILE OPERATION.

Pkg #1
1 KLM ECHO II $389.00
1 PA 10-708L Linear Amp. 139.95
*1 KLM 144-148-9 Element Ant. 33.95

562.90
Now $499.95

Pkg #2
1 KLM ECHO II $389.00
1 PA 10-140BL Linear Amp. 199.95
*1 KLM 144-148-14 Element Ant. 49.95

639.90
Now $579.95

OUTSTANDING FEATURES
• 10 watt PEP output
• Synthesized 10 kHz steps with VXO & RIT.
• Noise blanker & squelch
• Compatible with KLMs new linear amps

Coming soon — the long awaited 450 MHz amplifiers and horizontally polarized omni mobile/OSCAR antennas.

See your participating dealer or write

KLM ELECTRONICS Dept. H
1600 DECKER AVE. SAN MARTIN, CA. 408-683-4240

TOUCH—TONE DECODER

• Dual tone decoder decodes one Touch-Tone digit.
• Available for 1, 2, 3, 4, 5, 6, 7, 8, 9, 0, #, * and other dual tones 700-3000 Hz.
• Latch and reset capability built-in.
• COR control built-in.
• Relay output SPST ½-amp.
• Octal plug-in case.
• Compact 1-½” square, 3” high.
• Free descriptive brochure on request.

T-2 Touch-Tone Decoder ... $39.95 PPD.
Specify digit or tone frequencies.
(Include sales tax in Calif.)

PALOMAR ENGINEERS
BOX 455, ESCONDIDO, CA 92205

the BIG ONE!

NEW IMPROVED
INSTANT-WELD
Adhesive

Now a choice of 4 formulas . . . and in Big 1900 drop application container.

SAVE BIG only $9.95
(less than ½¢ an application)

ORDER FROM
ONEIDA ELECTRONIC MFG. INC.
P.O. Box 678 — Dept. 761-D
Medfield, Pa. 19335

70 march 1975

More Details? CHECK—OFF Page 94
Space age communication equipment demands a crystal that meets all standards of technical advancement. Crystals that were acceptable some years ago do not meet present day specifications. As a general rule, your crystal must be selected from the best quartz . . . (no throw off cuts). Tight tolerances demand selected angles of cut. The x-ray is important in making this selection. The crystal should be preaged with stress cycling. It should be checked for frequency change vs temperature change. It must be checked for optimum spurious response. It should be calibrated to frequency with the correct oscillator. International Crystals are manufactured to meet today's high accuracy requirements. That's why we guarantee all International crystals against defective materials and workmanship for an unlimited time when used in equipment for which they were specifically made.

WRITE FOR CATALOG

INTERNATIONAL CRYSTAL MFG. CO., INC.
10 NORTH LEE
OKLAHOMA CITY, OKLA. 73102
HERE'S A REAL PLUS

You will add a real plus to your SSB station when you give it complete 160-meter receive and transmit capability with the exciting new Dentron 160 XV Transverter. Just two simple connections with no modifications and you're on the air.

- 5 watts drive gives 100 watts DC input
- 3.8 to 4.0 MHz input
- Matches 50 ohm antenna
- Built in 110/220 V 50/60 Hz supply
- Units are available for the 2 MHz MARS frequency

**Dentron 160 XV Transverter $199.95 ppd. USA**

plus even more!

Let the Dentron 160 AT antenna tuner solve your 160-meter antenna problems the easy uncomplicated way. This transmatch will load any random length antenna from a short whip to an extra-long wire. Use it with virtually any existing HF antenna you already have. Handles maximum legal power. Use with the 160-XV or any other 160 meter equipment requiring a 52 ohm antenna.

**Dentron 160 AT Antenna Tuner $59.95 ppd. USA**

More Details? CHECK-OFF Page 94
Put together a wide variety of exciting new products and a dynamic young company on the move and you have DENTRON . . . dedicated to Making Amateur Radio More Fun.

160-10 AT Super Tuner

Here is another Dentron first, a six band antenna tuner designed to solve virtually any matching problem you may have.
- Covers all bands 160 through 10 meters
- Handles maximum legal power
- Matches coax feed, random wire and balanced line
- Includes heavy duty balun for balanced line

160-10 Super Tuner $119.50 ppd. USA

Be ready for restructuring — Special Supertuner handles 3 KW PEP amplifiers — $229.50 ppd. USA

80-10 AT Antenna Tuner

This is the low cost way to match almost any random length wire on the five most used HF bands.
- Covers 80 through 10 meters
- Handles maximum legal power
- Matches random length long wire antennas
- Features Dentron quality and value

Model 80-10 Antenna Tuner $49.50 ppd. USA

The Brand New 160-V Vertical Antenna

Another eye opener from Dentron, this new vertical antenna will solve your 160, 80 and 40 meter problems.
- Efficient Vertical Design
- Self Supporting
- Weatherproof
- Quick & easy one man installation
- Cover complete 40 or 80 meter band or \(\frac{1}{2}\) of 160-meter band with one adjustment

160-40V Antenna .................. $79.50 ppd. USA

More Details? CHECK-OFF Page 94

March 1975
SUPER CW FILTER
The IMPROVED CWF-2BX offers RAZOR SHARP SELECTIVITY with its 80 Hz bandwidth and extremely steep sided skirts. Even the weakest signal stands out.

Plugs into any receiver or transceiver. Drives phones or connect between receiver audio stage for full speaker operation.
- Drastically reduces all background noise
- No audible ringing
- No impedance matching
- No insertion loss
- 8 pole active filter design uses IC's
- Bandwidth: 80 Hz, 110 Hz, 180 Hz (selectable)
- Skirt rejection: at least 60 db down
- Center frequency: 750 Hz
- 9 volt transistor CMOS-440RS
- Each IC is self completing dots and dashes
- Jam proof spacing
- Instant start with keyed time base
- Perfect 3 to 1 dash to dot ratio
- One octave from center frequency to 60 WPM
- Relay rated 250 VDC
- Center frequency: 750 Hz

DEALER INQUIRIES INVITED

MFJ Enterprises, P. O. Box 494, Miss. State, MS 39762, (601) 323-5869

WE'RE FIGHTING INFLATION
NO PRICE RISE IN '75

FOR FREQUENCY STABILITY

Depend on JAN Crystals. Our large stock of quartz crystal materials and components assures Fast Delivery from us!

CRYSTAL SPECIALS
Frequency Standards
- 100 KHz (HC 13/U) ...................... $4.50
- 1000 KHz (HC 8/U) ..................... $4.50
Almost all CB sets, TR or Rec
(CB Synthesizer Crystal on request)
Amateur Band in FT-243 .............. ea. $1.50
80-Meter .................. $3.00 (160-meter not avail.)
Crystals for 2-Meter, Marine, Scanners, etc. Send for Catalog.
For 1st class mail, add 20¢ per crystal. For Airmail, add 25¢. Send check or money order. No dealers, please.

DIV. OF BOB WHAN & SON ELECTRONICS, INC.
2400 Crystal Dr., Ft. Myers, Fla. 33901
All Phones (813) 936-2037
Send 10¢ for new catalog with 12 oscillator circuits and lists of frequencies in stock.

500 MHZ PRESCALER
EXTEND YOUR COUNTER TO 500 MHZ!!!
Can be used with any counter capable of 500 MHz.

*F_{MAX} greater than 500 MHz.
*HIGH INPUT SENSITIVITY less than 150 mV needed at 500 MHz - overload protected
*HIGH INPUT IMPEDANCE: 500 ohms
*OUTPUTS = +10 and -100 TTL compatible
*Includes Power Supply

ORDER NOW!
PS-K kit .................. $89.00
PS-A wired and tested . $109.00
plus $8.50 postage
Calif residents add 8 1/2% sales tax

LEVY ASSOCIATES
PO Box 961 R
Temple City, Calif. 91780

CMOS ELECTRONIC KEYER

Feature for feature the CMOS-440RS gives the most for your money. State of the art design uses digital CMOS ICs and NE455 sidetone. Built-in key with adjustable contact travel. Sidetone and speaker. Adjustable tone and volume. Jack for external key. 4 position switch for TUNE, OFF, ON, SIDETONE OFF. Two output jacks: direct relay, grid block keying. Uses 4 penlight (not included). Self completing dots and dashes. Jam proof spacing. Instant start with keyed time base. Perfect 3 to 1 dash to dot ratio 6 to 60 WPM. Relay rated 250 VDC, 1 1/2 amp, 30 VA.

CMOS-440RS, Deluxe . . . . $37.95

Write for FREE catalog and CMOS filter test reports. Please include $1.50 per unit for shipping and handling. Money back if not satisfied. One year UNCONDITIONAL guarantee.

More Details? CHECK-OFF Page 94
THE ULTIMATE RIG!!
GOLD PLATED CRYSTALS!!
AMERICAN MADE!!
ROCK BOTTOM DEAL!!
WE'LL BEAT ANY PRICE!!

SOUND TOO GOOD TO BE TRUE? . . . You see all kinds of claims these days to either have the radio that is best for every one or to offer you the lowest price on earth.

LET'S FACE THE FACTS . . . You are unique and so are your operating conditions. When you call "The FM People" we won't just try and sell you a radio. We will do our best to help fill your exact FM requirements with the best radio possible in the price range you want.

WHAT IS THE BEST DEAL? . . . In the long run the lowest price doesn't necessarily mean getting the best deal. Smart buyers look for selection assistance, realistic delivery information, and post sale help along with competitive pricing. This is what you get from "The FM People".

Shop around if you like, but whether you're looking for Motorola or other used equipment; or transceivers by Clegg, ICOM, Genave, Regency and SBE; or accessories to improve your present station . . . give us a call and find out for yourself just why we're called "The FM People".

HAVE YOU RECEIVED OUR 1975 BUYERS GUIDE??

Our new 1975 Buyers Guide is now being mailed. Here's your chance to get the most complete listing of goodies available from The FM Supermarket of Values. If you haven't requested your free copy yet, do so now as there will be no general mailing of Guides this year.

ATTENTION REPEATER/CLUB PERSONNEL

Group buying does pay off. For example your group can buy nationally advertised, 10 watt 220 MHz transceivers for as little as $179.95 ea. in quantity. INTERESTED?? . . . Contact us for full details. If you wish we will also put your group on our special club mailing list so that you can get first crack at some goodies.

TERMS OF SALE: Sales to licensed Radio Amateurs for use on Amateur freqs only. All prices FOB Oak Park, IL. Check with order, COD or you can charge to your BankAmericard or Master Charge.

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

INQUIRIES WITHOUT ZIP CODE OR CALL . . . NO ANSWER

WANTED: Good used FM & test equipment. No quantity too large or small. Finders fees too.

SPECTRONICS INC.
1009 GARFIELD STREET
OAK PARK, ILL. 60304
(312) 848-6778

More Details? CHECK-OFF Page 94
The DELA-BRIDGE I

Analyzes antenna characteristics, simplifies adjustment.

The DELA-BRIDGE I, when tied into your grid dip meter or low power exciter, quickly and easily analyzes: (1) Existing antenna & feed line characteristics, (2) Tuning & loading coils, (3) Filter & interstage coupling networks. Direct readout then lets you adjust for optimum performance.

DELA-BRIDGE I Specifications:

- **Frequency Range**: 50 Khz to 250 Mhz
- **Resistance Range**: 0 to 500 Ohms, balanced or unbalanced, log scale
- **Signal Requirements**: 1 MW to 2 Watts maximum from any grid dipper or signal generator
- **Power Requirements**: Internal 9V battery
- **Accuracy**: ±3% at 50 Ohms

To read & interpret: Complete null and reactance behind its products. Delavan guarantees the DELA BRIDGE I determination—unconditionally for 1 full year.

Order your DELA BRIDGE I today!

---

DELA-BRIDGE I guaranteed for 1 year by Delavan Electronics, Inc.

Delavan Electronics’ new Amateur Products Group might be a new name to you, but we’re no stranger to amateur radio operations and equipment. Delavan is well funded and deeply involved in aerospace and industrial controls. Delavan stands behind its products 100% and guarantees the DELA-BRIDGE I unconditionally for 1 full year.

Order your DELA BRIDGE I today!
NOW available for the first time in North America

the all NEW synthesized VHF FM TRANSCEIVER
the KDK-144

Compare the features:
SYNTHESIZED — no more crystals
L.E.D. READOUT — for quick, easy readability
10 KHZ FREQUENCY DIAL UP CAPABILITY 146-148 MHZ — Perfect for the 2nd generation of repeaters and simplex channels
600 KHZ UP AND DOWN REPEATER CAPABILITY
POWERFUL 2W AUDIO OUTPUT
10W.R.F. OUTPUT

Compare the sizes:
KDK-144 2" x 6 3/8" x 7 3/4" Deep
ICOM AC-230 2 9/32" x 6 1/8" x 8 1/2" Deep
CLEGG FM 27B 3/8" x 7 3/8" x 9 3/4" Deep

ONLY

$399
F.O.B. Blaine Wash.

HAM IMPORT SALES
P.O. Box 1009 Blaine Wash. 98230
(Washington State Residents add 5% Sales Tax)

Please Rush me a KDK-144. Enclosed is a □ cheque
□ money order for $399. (plus sales tax if applicable)

NAME: ..............................................
ADDRESS: ........................................
ZIP: ..............................................

More Details? CHECK—OFF Page 94

march 1975
Model PD 301 is a 300 MHz prescaler designed to extend the range of your counter 10 times. This prescaler has a built-in preamp with a sensitivity of better than 50 mv at 150 MHz, 100 mv at 260 MHz, and 175 mv at 300 MHz. The 95H90 scaler is rated at typical 320 MHz. To insure enough drive for all counters, a post amp. was built-in.

The prescaler has a self contained regulated power supply. The PD 301 is supplied without power supply if desired (input 50 Ohms) (output Hi Z). The PD 301 has been tested on the following counters: Heath Kit 1B101 - Heath Scientific 105 - Monsanto 105A - Miida - Regency - Beckman - Hewlett - Packard 5248 - and many home built. In short to this date we do not know of any counter that the PD 301 has failed to work well with. All prescalers are shipped in a 4" x 4" x 1½" cabinet all wired and tested.

ONLY RP GIVES YOU BOTH PLUS

- SUPER ACCURACY (.0005%)
- FULL 2M FM COVERAGE 144-148 MHz

WORKS WITH YOUR FINE AMATEUR OR COMMERCIAL GRADE RADIO

MFA-22 SYNTHESIZER

SEND FOR FULL DETAILS

R Electronics
810 DENNISON DRIVE
BOX 1201
CHAMPAIGN, IL 61820
Phone: 217-352-7343

FM YOUR GONSET

(for your Clegg 22 Jr, Poly Comm 2, PC 62, Johnson 6N2, Aerotron 500, HA-400, TX 62 or VHF 1)

- New! Plug-in modulator puts the Communicator transmitter on FM.
- No modification or rewiring on your Communicator. Just plug into mike jack and crystal socket.
- Compact self-contained modulator measures 4" x 3" x 1½".
- Works with Communicator I, II, III, IV and GC-105, and other rigs listed.
- FM at a tenth the cost of a new rig.
- Frequency adjust for netting built in.
- $34.50 postpaid U.S.A. $36.50 for PC-2, PC-62, HA-460. Specify transmitter model. California residents add 5% sales tax. (HC-6/U crystal and 9 volt transistor battery not supplied.)

Send for free descriptive brochure.

PAIOMAR ENGINEERS
BOX 455, ESCONDIDO, CA 92025
Announcing another first from the company and the designer of the world famous HCV-1B SSTV Camera and the HCV-2A SSTV Monitor, now the HCV-3KB Slow Scan TV Keyboard. This is the first commercially made SSTV Keyboard and it is built with the same quality as all SEEC/THOMAS equipment. We will not attempt to list all the features of the HCV-3KB here and we suggest that you write for full specifications. For those that are not familiar with SSTV Keyboards, the HCV-3KB eliminates the need for a menu board or other number/letter set-up arrangements which is very time consuming to set-up a meaningful text by arranging letters one at a time, by hand on a board or other surface. It also "frees up" the SSTV camera for other uses, such as live shots of the operator or other subject matter. Simply type out the message you wish to send.

** BASIC SPECIFICATIONS **

- 30 Characters Per SSTV Frame. 6 Characters Horizontally and 5 Characters (lines) Vertically. Special 35 Characters per frame available.
- Meets all standard accepted SSTV specifications.
- Positive-Negative Color (Video) Reversal.
- 1/4 & 1/2 Frame Rates.
- 4 Shade Gray Scale Generator.
- Dual Fast & Slow Scan RF & Video Outputs (Special-Optional). Later mod kit to be available for Fast-Scan & RTTY.
- Plug-In Printed Circuit Board-Gold Flashed Edge Connector.
- ICs, Op Amps, Transistors in Plug-In Sockets.
- Built-In 115/230 V 60 Hz Power Supply.
- Special 16½" x 8½" x 3½" Aluminum Cabinet-Black & White or Optional 2 tone Gray — Specify.
- Special Introductory Cash With Order Price: $455.00. Regular Price $495.00. Five Ways to Purchase: Cash, C.O.D. (20% Deposit), Mastercharge, BankAmericard, SEEC Financing Plan (up to 36 months). Note: All Credit Cards Pay Regular Price of $495.00. All prices F.O.B. Hendersonville, Tn. Standard 1 year warranty.

** ALSO AVAILABLE FROM SEEC **

- HCV-1B SSTV Camera
  - (Reg. $475.00) $452.00
- HCV-2A SSTV Monitor with 2 CRT Filters
  - (Reg. $425.00) $398.00
- HCV-70FSVFK Fast Scan Viewfinder Modification Kit for 70 & 70A Monitors
  - Factory installation $37.50 additional. $69.95
- Sony TC110A Cassette Recorder
  - Heavy Duty Camera Tripod
  - $34.95

A complete line of Camera and Monitor accessories are available — please write for current prices and delivery. Five Ways to Purchase: Cash With Order, C.O.D. (20% Deposit), Mastercharge, BankAmericard, SEEC Financing Plan (up to 36 months). Note: All Credit Cards Pay Regular Price shown. All prices are F.O.B. Hendersonville, Tn. Call or write us for complete specifications on any of our equipment or to be put on our mailing list. We have a 24 hour telephone answering service to better serve you, plus on the air technical assistance from the designer, WB4HCV (Jim). Two locations to better serve you. Our main Plant at 138-B Nauta-Line Dr., and our lab at 218 Tyne Bay Dr., Hendersonville. Complete 80-2 meter operation from either location. Drop in to see us if you are ever near Nashville, TN.
CRYSTAL FILTERS and DISCRIMINATORS
1 27/64" x 1 3/64" x 3/4"

10.7 MHz FILTERS
XF107-A 14kHz NBFM $40.60
XF107-B 16kHz NBFM $40.60
XF107-C 32kHz WBFM $40.60
XF107-D 38kHz WBFM $40.60
XF107-E 42kHz WBFM $40.60
CRYSTAL SOCKET (for XM107-S04) type DG1 $1.50
Shipping 50¢ each

10.7 MHz FILTERS CONT'D.
XM107-S04 14kHz NBFM $18.95
XF102 14kHz NBFM $7.95
10.7 MHz DISCRIMINATORS
XD107-01 30kHz NBFM $22.10
XD107-02 50kHz WBFM $22.10

(Export inquiries invited)

J-BEAM ANTENNAS

MULTIBEAM 70/MBM46 $51.75 ea.
Gain, Ref Dipole 17.3 dB
Feed impedance 50 Ω

STACKING HARNESS:
2 Way PMH2/70 $12.80
4 Way PMH4/70 $28.25
SVMK/2M Vertical Polarization Mounting Kit $8.75
Write for detailed specifications.
F.O.B. Concord, Mass.
Shipping: Via U.P.S.

Great Lakes Hamvention &
ARRL Michigan State Convention
MUSKEGON COMMUNITY COLLEGE
MUSKEGON, MICHIGAN
MARCH 21-22, 1975

WOUF HONG INITIATION FRIDAY EVENING
AND HOSPITALITY ROOM AT THE RAMADA
INN

TECHNICAL FORUMS; NET MEETINGS; ARRL
FORUM SWAP & SHOP AND SPECIAL AT-
TRACTIONS AT MUSKEGON COMMUNITY
COLLEGE SATURDAY

REGISTRATION BEGINS 8 AM SATURDAY
DINNER PROGRAM RAMADA INN SATURDAY
EVENING. ADVANCE RESERVATIONS

Muskegon Area Amateur Radio Council
BOX 691, MUSKEGON, MICH. 49443
OR
WA8GVK Convention Co-ordinator
616 722-1378
Our revolutionary CT-1024 makes it possible to build a completely electronic RTTY system. The CT-1024 plus a video monitor, or TV set with a video input jack, is all you need to compose, transmit and receive. Interfaces with your transmitter at a standard RS-232 interface level.

It works like this—You type the message to be transmitted, plus any comments if you wish, onto the screen. You can use our KBD-2 keyboard, or any other ASCII encoded keyboard that you might have available. The characters are stored in a 1,024 bit static semiconductor memory. The format is two pages, or frames, of 16 lines having up to 32 characters per line. When you are finished, you push the "READ" button on the CT-1024. This causes the cursor to advance through the material on the screen one character at a time and place its ASCII code in the UART portion of the terminal. The UART converts the parallel code to a serial format and passes it on to the interface for transmission. The standard rate is 110 Baud, but 220, 300, 600 and 1200 are available as options.

When you receive, the process is reversed. The UART takes the incoming serial data, converts it to a parallel ASCII code and places the information in memory. The message is displayed on the screen at the same time.

You can also use the CT-1024 with a modem as a time share computer terminal or directly with a CPU as an input device.

Please note that this is a kit. It does not include a cabinet, or chassis. This system is not for the—"plug it in and transmit" crowd. This system is designed for the serious RTTY operator who builds his equipment and wants to use the latest techniques. You will need the first three items below for a system. You may, or may not need the keyboard and power supply, depending on what other equipment you already have on hand.

**#CT-2024 Terminal System Kit—less cabinet or power supply** ........................................... $175.00 PPd
**#CT-E Screen Read Plug-in Card Kit** ................................................................. $17.50 PPd
**#CT-S Serial Interface Kit (UART)** ........................................................................ $44.95 PPd
**#CT-M Manual Cursor Control Plug-in Card Kit** .................................................. $11.50 PPd
**#CT-P Power Supply for CT-1024—115-230 Volt Primaries** ................................ $15.50 PPd
**#KBD-2 Keyboard Kit—53 Keys** ............................................................................ $39.95 PPd

**FREE—1975 Catalog—Circle our number on the "Bingo" card.**

**SOUTHWEST TECHNICAL PRODUCTS CORPORATION**
219 W. RHAPSODY
SAN ANTONIO, TEXAS 78216
(512) 344-3140

**FREE—1975 Catalog—Circle our number on the "Bingo" card.**

**SOUTHWEST TECHNICAL PRODUCTS CORPORATION**
219 W. RHAPSODY
SAN ANTONIO, TEXAS 78216
(512) 344-3140
RATES Commercial Ads 35¢ 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.

NEED SCHEMATIC for Sencore fields effect meter model 149 or operating service center. Can you help? Neal Perry, P. O. Box 255, Zion, Ill. 60099.

QLSL'S — BROWNIE W3CJ — 3035B Lehigh, Allen-town, Pa. 18103. Samples with cut catalog 35¢.

432 MHz TRANSMIT CONVERTER, VHF-UHF receive converters. Write for more information. Car-michael Communications, P. O. Box 256, Car-michael, CA. 95608.

TELETYPE EQUIPMENT FOR SALE for beginners and experienced operators. RTTY machines, parts, gears. Send us a list of your teletype needs. Atlantic Surplus Sales Co., 1902 Mermaid Ave., Brooklyn, New York 11224. Call us first (212) 266-2629.

WANTED: Someone with a 1919 or 1920 Canadian license list or some other means of proving that John R. Nesbit was licensed as SBM at that time. Please contact VE7AS.

POLICE CALL. A complete listing including frequency and location of VHF-UHF public service stations. Nine volumes cover the whole USA. Order the volume for your state. Only $4.95 plus 25¢ shipping. HAM RADIO, Greenville, N.H. 03048.

WANTED: Diagram or manual for Supreme 5048 stations.

WANTED: Someone with a 1919 or 1920 Canadian model 149 or operating service center. Can you help? Neal Perry, P. O. Box 255, Zion, Ill. 60099.

FLEA MARKET

AUCTION — Canton Amateur Radio Club, Friday, March 14, 1975 at 6:00 p.m. Check in on 52 or 193. Imperial House at I-77 and Easton St., Canton, Ohio.

WANTED: AR-51, 618TL, ARC-102, etc. Have Sony TC-177SD Cassette Decks for trade. A R S Electronics, P. O. Box 34804, L. A., Ca. 90034. (213) 279-1275.

SELL: Heath SB-401, SB-301, SB-610, Mint $450. Q.S.T. prog. large, MT-13N and various straps. M. H. Klaip, 26 Gladwish Road, Delmar, N. Y. 12054.

MOTOROLA PORTABLES — Expert repairs, reasonable prices, fast turn-around time. More details and flat rate catalog FREE. Ideal Technical Services, 6663 Industrial Loop, Greendale, WI 53129.

CLEGG, SWAN, CUSHCRAFT at prices I dare not publish. Call or write WCNOS, Bob Smith Electronics, 1226 9th Ave. North, Fort Dodge, Iowa 50501. (515) 576-3866.

QLSLS. SECOND TO NONE. Same day service. Samples airmailed 25¢. Include your call for free decal. Ray, K7HRL, Box 331, Clearfield, Utah 84015.

POWER SUPPLIES FOR THE HOME BUILDER — 1.2kVA power transformer - input 115V 60Hz output 1000V 900mA, 600V 250mA and 6.3V 10A - $69.50. Miniature transformer with built-in wave rectifier - input 115V 60Hz, output 10V(DC) 100mA ideal for 12V lead chargers. 6.3V power supply kit - supplies plate and filament power from 12.6V DC or 115V 60Hz AC by changing leads - output 750V 200mA and 12V 6A from 115V AC or 200V 120mA from 12.6V DC input. All parts except chassis, terminals and wire - $39.50. Michigan residents include sales tax. All items postpaid. No C.O.D.'s. For fast service use M.O. or cashier's check. S.A.S.E. for specs. M.E.C. Sales Div., P. O. Box 611, Madison Heights, Mich. 48071.

TRAVEL-PAK QSL KIT — Send call and 25¢; receive your call sample kit in return. Samco, Box 205, Wynantskill, N. Y. 12198.

FREE BARGAIN CATALOG. LED'S, transistors, IC's, Xits, headsets, microphones, relays, micro components, misc. Chaney's, Box 15431, Lakewood, Colorado 80215.


MINICOMPUTER for sale. DEC PDP-8L minicomputer with 12 bit word by 12 bit memory, manuals, schematics, and some programs. $1500.00 or best reasonable offer. David Kohl, 3002 Bedford Ave., Brooklyn, N. Y. 11210.

TWO-METER FM ANTENNAS, 1/4; 5/8 W. "CAR-" and "PAC" and other all stainless designs. Send for literature. MARSH DEVICES, P. O. Box 154, Old Greenwich, Connecticut 06870 (h)

COLORADO HAM DIRECTORY. Over 4,000 listings by call, name and zip. Also repeaters and nets. $2.50. Colorado Council of Amateur Radio Clubs, Box 242-B, Longmont, CO 80501.

DO-IT-URSELF EXPEDITION — Stay at ZF1SB — Cayman Is. Vertical antenna and Caribbean at your doorstep. Diving/fishing if band folds. Write Spanish Bay Reef Resort, Box 800K, Grand Cayman, B. W. I.

LIONEL TRAINS WANTED. Looking for several different sets, some old, some newer. If you have any trains packed away and not in use I would like to have them so I could have them to buy or trade them from you. Will trade test equipment, KEK, H.P., etc. into ads, groups, names, or have some new 2 meter gear. Send description, like numbers, colors, condition to: Dick Robinson, 516 Mill St. N.E., Vienna, Va. 22180. Phone 703-936-3350.

ROCHESTER, N. Y. — Hamfest date of 1975 — May 31st. Marriott Inn is new headquarters. In-formation? Write WNY Hamfest, Box 1388, Ro-chester, N. Y. 14603.

TELL YOUR FRIENDS about Ham Radio Magazine.
AMSAT
The team that brought us OSCAR 7.

The Radio Amateur Satellite Corporation (AMSAT) is a non-profit, tax-exempt organization founded in the greater Washington, D.C. area five years ago. It is a membership organization open to all radio amateurs and interested non-amateurs. AMSAT's satellite programs are supported entirely from donations, membership dues, and grants.

Join AMSAT. Learn more about how you can participate with the exciting AMSAT-OSCAR 6 communications satellite, and with OSCAR 7 which promises to be even better! Receive the quarterly AMSAT Newsletter with the latest information on this new ham radio frontier. For membership information, write the Membership Committee, AMSAT, P.O. Box 27, Washington, D.C. 20044.

LEARN RADIO CODE

THE EASY WAY!

- No Books To Read
- No Visual Gimmicks To Distract You
- Just Listen And Learn

Based on modern psychological techniques—This course will take you beyond 13 w.p.m. in LESS THAN HALF THE TIME!

Album contains three 12" LP's 2 1/2 hr. Instruction $9.95

508 East Washington St., Arcola, Illinois 61910

SPACE SAVER TOWERS & MASTS

CZ series towers, cranks up, installs without guy wires. New lacing design creates greater strength. Mini and Magna rotating masts . . . high strength galvanized tubing, self-supporting crank-up.

For complete details and prices please check your local dealer or write Certified Welders L.A. City License #634

TRISTAO TOWER CO.
P.O. Box 115, Hanford, California 93230

The 24th Annual Dayton HAMVENTION®
April 25-26-27, 1975

Technical Sessions • Exhibits • Flea Market • Awards
Hidden Transmitter Hunt • Ladies Programs • Special Group Meetings

Write Dayton HAMVENTION
P.O. Box 44, Dayton, Ohio 45401

See You at the World's Largest Ham Convention
TELETYPEWRITERS - TRANSLATOR sorted $1.00. 44, Dayton, Ohio 45401.

OSCAR SLIDES set of September 6 & able.'

WANTED: Old toy trains and old radios from 1920's. fixed sets, punches, parts. reconditioned, reason-

26. 27. 1975. Program brochures mailed March 10th. Write for information if you have not attend-

Wauwatosa, WI.

TERRE HAUTE, Indiana 47802.

RECAPITULATING DETECTOR, write Peter Meacham Associates, 19 Loretta Road, Waltham, Mass. 02154.

OSCAR SLIDES, set of 5, $1.25. Launch and space-
craft. Proceeds AMSAT. K6PGX, P. O. Box 463, Pasadena, Calif. 91102.

TELETYPEWRITERS — Kleinschmidt — portable, fixed, sets, punches, parts, reconditioned, reason-
able. Mark/Space Systems, 3563 Conquistal, Long

Beach, Calif. 90808. 213-429-5821.

RADIO EXPO '75: The one you've heard about. September 6 & 7, 1975, Grounds, III. Information: Write EXPO, Box 1014, Arlington

Hills, Ill. 60006.

DAYTON HAMVENTION at HARA Arena, April 25, 26, 27, 1975. Program brochures mailed March 10th. Write for information if you have not attended

the last two years to HAMVENTION, P. O. Box 44, Dayton, Ohio 45401.

WANTED: Old toy trains and old radios from 1920's. Also train and radio magazines and catalogs. W2GHI, 45 Allen Dr., Woodstock, N. Y. 12498.

FIGHT TVI with the RSO Low Pass Filter. For brochure write: Taylor Communications Manufacturing Company, Box 126, Agincourt, Ontario, Canada. M1S 3B4.

SELL: Staco 1520 Transformer. $40. 2N3055. $40.

Pughyex, $40.

QRP TRANSMATCH for HW7, Ten-Tec and others. Send stamp for details to Peter Meacham Asso-

ciates, 19 Loretta Road, Waltham, Mass. 02154.

PADRE SEZ: We have a lot of goodies left over from our tremendous Rummage Sale! (Like

Collins. 19 Loretta Road.

TELETYPEWRITER PARTS, gears, manuals, supplies. Send $1.00 (refundable first order) for listing. A service of Tucker Electronics, Box 1050, Garland, Texas 75040.
Divides any frequency between 25 MHz and 525 MHz by ten to allow a 50 MHz counter to measure frequency in the UHF bands. Sensitivity is better than 50 millivolts at 500 MHz. Also includes a built-in 20dB preamp for frequencies between 1 MHz and 50 MHz to give extra gain for measuring oscillators. A thru-line sampler allows direct connection of transmitters up to 100 watts. Operates on 8 to 15 volts DC or AC line. Add $2.00 for shipping in cont. U.S.

UHF PRESCALER . . . $159.00

ARR-52 VHF RECEIVER
Easily converted to 2-meter FM. Now set for 163-173 MHz, 16 channels. $19.95 postpaid continental US. Includes schematic diagram and conversion details. As described in the Surplus Sidelights Column, (Pg. 58 Oct. CQ.

$19.95

OVER 100 SOLD POSTPAID
BankAmericard & COD Welcome

Electronic Equipment Bank, Inc.
516 Mill Street, N.E. Vienna, Virginia 22180
(703) 938-3350

525 MHz UHF PRESCALER
Divides any frequency between 25 MHz and 525 MHz by ten to allow a 50 MHz counter to measure frequency in the

UHF bands. Sensitivity is better than 50 millivolts at 500 MHz. Also includes a built-in 20dB preamp for frequencies between 1 MHz and 50 MHz to give extra gain for measuring oscillators. A thru-line sampler allows direct connection of transmitters up to 100 watts. Operates on 8 to 15 volts DC or AC line. Add $2.00 for shipping in cont. U.S.

UHF PRESCALER . . . $159.00

DELUXE PORTA-PAK $59.95
REGULAR PORTA-PAK $39.95

PORTA-PAK
P. O. BOX 67
SOMERS, WISCONSIN 53171

CATALOG
GOVERNMENT SURPLUS
ELECTRONIC EQUIPMENT
For 1975
FREE UPON REQUEST! Write for Copy of Catalog WS-75 Now!
Address: Attention Dept. HR

FAIR RADIO SALES
1016 E. EUREKA • Box 1105 • LIMA, OHIO 45802

"THE ELECTRONICS STORE"
RMS CORPORATION
675A GREAT ROAD (ROUTE 119)
LITTLETON, MASS. 01460
7400 SERIES I.C.'s
HUSTLER ANT.
GOTHAM ANTENNAS
VHF ENG. KITS — VHF-HT-144 — VENUS SSTV
LARGE INVENTORY OF COMPONENTS
1-495 to Rte. 119, Groton Exit 19
2 Miles On The Right

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 $6 each.
5200 Panama Ave., Richmond, CA USA 94804

HILDEBRTH ENGS.
Experiment with Op-Amps the easy way. Contains
741C Op Amp, Solderless-connectors, Switch, ...
$11.95 POSTPAID ADD $1.00 TO INCLUDE BATTERIES PO BOX Sunnyvale 3 Cal 94086

CASH
AN/MRC-94 SPACE ELECTRONICS CO.
78 Brookside Drive, Upper Saddle River, N.J. 07458
(201) 337-7640

Cash for any Collins military or commercial equipment or parts, especially 612T Transceiver, 4801 antenna couplers, AN/MRC-102, AN/MRC-64.

WORLD'S ONLY WEEKLY DX MAGAZINE
CURRENT DX NEWS - COMING EVENTS DATES - FREQUENCIES - TIMES - ALL THE NEWS IN DEPTH - 160 METERS THROUGH 3 METERS - DX CONTEST INFO & CLAIMED SCORES - MONTHLY PROPAGATION PREDICTIONS - DX HONOR ROLLS - and a very SPECIAL "FLASH CARD" SERVICE TO both SUBSCRIBERS and NON-SUBSCRIBERS - 10c PER CARD FOR SUBSCRIBERS & 25c PER card from NON-SUBSCRIBERS. YOU FURNISH STAMPED AND SELF ADDRESSED CARD (CAN BE EITHER AIR MAIL OR REGULAR FIRST CLASS POST CARD. JUST PUT PREFIX ON LOWER LEFT, BOTTOM ON FRONT OF YOUR CARD (WE ONLY FILE BY PREFIXES) ANY GOOD DX NEWS FROM THE PREFIXES ON YOUR CARDS SENT TO YOU IMMEDIATELY! DXING EASY!!

DX NEWS IS OUR BUSINESS
THE DX'ERS MAGAZINE
(Gus M. Browning, W4BPD)
Drawer "DX"
CORDOVA, S. C. 29039
WE ALSO PRINT QSL CARDS - FREE SAMPLES & PRICE LIST UPON REQUEST - WE PRINT ALMOST ANYTHING ELSE YOU NEED TOO - PRICES RIGHT

86 march 1975 More Details? CHECK—OFF Page 94
More Details? CHECK-OFF Page 94
NEW ARRIVALS — Good Quantities, except*
UG-273/U, co-ax adapter, VHF male, to BNC female. Teflon insert. BRAND NEW. AMPHENOL.
5.475; each $1.00

PCBs on Epoxy Glass
#1) 7" x 4" + 1/8" for 18, gold plated slide in
connections, 3" long. Loaded with 9 ICs; 1 25K
trimpot; 17 transistors; resistors, capacitors, PCBs, etc.
6/$7.00; each $1.25
#2) as above, but with 9 ICs; looks like 3 more, not installed; 6 transistors; capacitors; resistors,
rotors, etc.
6 for $5.50; each $1.00
AM/FM P.C.B. Unused rejects, some with broken
connections, broken resistors, etc. AS IS. With
AM/FM loop stick; 2 gang. AM/FM tuning capa-
citor, 8 transformer, miniature, RF, IF, etc.;
(IFs 455 KC & 10.7 MC); transistors, diodes,
resistors, capacitors, etc. On brown, bakelite
board, 3 1/2 x 3 x 1/2" high, with all parts.
1 lb.
10/$7.00; 5/$3.75; ea. $2.50
6 to 30 pf. JFD
6 to 52 pf. 2
6 to 30 pf. JFD
6 to 52 pf. 2

Cheaper VALARIC SPECIALS

Take-outs — clean, tested, operable, excellent —
GUARANTEED.
0-1 MA DC, 31/2 sq. SIMPSON meter. Scale 0-15
A. RF (NO thermocouple).
4/$8.50; each $2.25
7-90 pf. 2KV BUD #366. Variable capacitor.
5 rotor, 4 stator plates, 1 1/2" dia., .045" spaced; triangle front ceramic plate, 2" x 1 1/2"L;
2 lbs. —
4/$10.25; each $2.75
150 CFM blower; Dayton #9M-436. Motor 115V.
50/60 CYC.; 1/70 HP; 1500 RPM; 0.7 A; 3" dia. x
2 1/4". Impeller 8" dia. x 3"; air input 5 1/4" dia.;
output 3 1/16" sq. Electrically noiseless, some
air whirl. BRAND NEW. 5 lbs. 4/$29.50; ea. $7.75

CHEAP SKATE SPECIALS

Store — 5696 N. Ridge Ave., Chicago, Ill. 60660:
hours — Wed. 11:00 to 2:00; Sat. 10:00 to 2:00.
MAIL c/o Ben Cohn, 1249 W. Rosedale Ave., Chi-
ago, Ill. 60660. Phones (312) 784-4426 & 334-4463.

BC ELECTRONICS

25% to 50% discount

NEW 450 MHZ CONVERTER
Kitt FOR HAM OR COM'L.
BANDS, $20 LESS XTAL(s).

— SEND SASE FOR LITERATURE —

■ TOPS IN PERFORMANCE
■ LOW SILHOUETTE GOOD LOOKS
■ V.S.W.R. LESS THAN 1.3 TO 1
■ HANDLES FULL 200 WATTS

Larsen Külrod VHF Antennas are the result of over 25 years of practical experience in the
two-way radio field. They are rugged, reli-
able and built with infinite care to assure
top performance. Models available to fit all
standard mounts and for all popular ama-
teur VHF frequencies. Each is equipped with
the exclusive Larsen Külrod, your assurance
of maximum efficiency and no loss of RF
through heat. Comes complete with all in-
structions. Models for 2 meters deliver a full 3
db gain and full 100 watts capability.
Sold with a full money back guarantee . . .
the most liberal in the mobile antenna field.
Whether you work via repeater or simplex
you deserve to have a Larsen Külrod. Get
full fact sheet and prices, today.

©Külrod . . .

a trademark of Larsen Electronics

11611 N.E. 50th Ave. P.O. Box 1686
Vancouver, WA 98663
Phone 206/333-7672

You're Ahead when mobile with a
Larsen Külrod
Gain Antenna
HOME BREWERS: Stamp brings list of high quality components. CPO Surplus, Box 189, Braintree, Mass. 02184.

STOLEN: Drake TR4 #29782 from an Army MARS station. If you have any information, please contact Det. Lt. W. Jacobs, Englewood, New Jersey Police Department 201-568-2700 or Federal Bureau of Investigation, Newark, New Jersey 201-622-5613.

SOCIETY OF WIRELESS PIONEERS offers Life Membership to active and former C.W. operators on comm., military, govt., etc. wireless/radio circuits. Contact: Society of Wireless Pioneers, Dept. H, P. O. Box 530, Santa Rosa, California 95402.


BUY—SELL—TRADE. Write for monthly mailer. give name, address, call letters. Complex stock of tickets also need these control boxes - ARC-94/618T. ARC-5IBX. C-6287/ARC-5IBX. We also need R-1051 transceivers. We buy all major brands, new and reconditioned equipment. Call us for best deals. We buy Collins, Drake, Swan, etc.

KENTUCKY HAM-O-RAMA — Sunday, June 1st at Boone County Fairgrounds, Burlington, Kentucky. 10 miles south of Cincinnati near I-75. Features prizes, indoor exhibits, flea market, refreshments. Tickets: $1.50 advance, $2.00 at door. Contact: WABOGS, P.O. Box 67, Sandusky, Ohio 44870.

NOW PAYING $2000.00 and up for ARC-94/618T Automatic, $1800.00 and up for ARC-5IBX, $1500.00 and up for 490T-1 antenna couplers. We also need these control boxes - C-6287/ARC-5IBX, C-6476/ARC-5IBX, C-714E-2. We also need R-1051 receivers. RT-662/GRC-106 transceivers. We buy all late aircraft and ground radio equipment. Also pack radios. We are buyers not talkers. Bring your equipment in, you are paid on the spot. Ship it in, you are paid within 24 hours. We pay all shipping charges. If you want the best price for your equipment, call us. Call collect if you have, and want to sell or trade. We also sell. What do you need? D & R Electronics, R.D. #1, Box 56, Milton, Pa. 17847. Phone — 717-746-4604. 9:00 a.m.—9:00 p.m.

POWER SUPPLY, brand new solid state fully regulated Computer Test Corp. Model 3218 with manual, 110VAC input, outputs of 12VDC @4A, 6VDC @4A, 18VDC @7A. B. Rowan, 55 Runnymead Road, Berkeley Heights, N. J. 07922.

HAMFEST! Indiana's friendliest and largest Spring hamfest. Wabash County Amateur Radio Club's 7th Annual Hamfest will be held Sunday, May 18, 1975, rain or shine at the 4-H Fairgrounds in Wabash, Indiana. Large flea market (no table or set up charge), technical sessions, bingo for XYL's, free overnight camping, plenty of parking. Lots of good food at reasonable prices. Admission is still only $1 for advance tickets, $1.50 at the gate. For more information or advanced tickets write: Bob Mitting, 663 Spring St., Wabash, Indiana 46992.

STOLEN EQUIPMENT: Motorola Mocom 70 base station, L53BB-3100AM, SN KZ2090. Contact Richard M. Hambly, WTB2TNL, 16 Gaslight Dr, Peabody, Mass. 01960.

VACATION LAND HAMFEST Sunday, May 18, 1975; Erie County Fairgrounds near Cedar Point. Huge flea market area. First prize - Regency HR-2B. Tickets - $1.00 advance, $1.50 at gate. Information: Hamfest, P. O. Box 2037, Sandusky, Ohio 44870.

YOUR AD belongs here too. Commercial ads 35¢ per word. Non-commercial ads 10¢ per word. Commercial advertisers write for special discounts for standing ads not changed each month.

ATT. ALL FT-101 OWNERS
5-10 dB extra talk power. Better RX gain and selectivity. "Unit works so well we have given up plans to buy a Linear — WAZAQUL/" Price $110, post paid. Details to: Holdings Ltd., 39/41 Mincing Lane, Blackburn, BB2 2AF. England.

NEW ENGLAND CONVENTION CENTER
Durham, New Hampshire

Program directed by Joe Reisert, W6FZJ/W1JAA
- Expanded-range vhf/uhf communications
- Low-noise receivers and converters
- Power amplifier design and construction
- High-performance antennas
- OSCAR communications

Dinner speaker - Edward P. Tilton, W1HDQ
Technical Seminars • Discussion Groups
Noise-figure Measurements
Technical Exhibits • Awards and Prizes

Registration Information Available From
Chuck Benavides, WA1KIR
103 Peabody Drive, Stow, Massachusetts 01775

amateur radio's only weekly newsletter
a new standard of excellence in news reporting for today's involved amateur

HR Report
Greenville, N.H. 03048
TWICE THE SERVICE
AT NO INCREASE IN PRICE!

Yes, HR Report, amateur radio's first national newsletter, is going weekly. Now you can receive the latest news about your favorite hobby every Monday by first class mail.

Follow Restructuring, 1979 Allocation Proposals, ARRL Activities, AMSAT News, Propagation, DX News . . . Virtually all phases of amateur radio will be updated . . . every week.

News is flowing too fast these days to be followed only monthly or bi-weekly. HR Report is your answer.

HR Report has already set an enviable record for fast, concise reporting, and now weekly service will raise that standard even further. Don't miss out . . . sign up today.

HR REPORT — goes weekly

HR Report, Greenville, NH 03048
52 exciting issues
by first class mail only $12.00

Name________________________________________

Call________________________________________

Address________________________________________

City________________________________________

State________________________________________ Zip________

90 march 1975
SAROC HAWAIIAN HOLIDAY
including
SAROC's First Hawaiian Convention

Spend 8 fabulous days in exciting Hawaii on SAROC's Hawaiian Holiday

Your holiday includes:

- Attendance at the SAROC Hawaiian Convention
- 7 nights at the Sheraton Waikiki on famous Waikiki Beach
- Optional visit to the other islands
- Round trip air transportation from Los Angeles or San Francisco on Western Airlines
- Connecting flights from selected Eastern and Mid-Western cities via United Airlines
- Leave July 17, 1975 — Return July 24, 1975

Combine your favorite hobby with beautiful Hawaii and you have a vacation you'll never forget.

All travel arrangements by Del Webb World Travel Co.

for further details write

SAROC
Box 945
Boulder City, Nev. 89005
Here is an interesting general electronics hobby magazine. It's loaded with lots of interesting simple circuits and ideas, not only about radio, but in all phases of electronics including test gear, audio, remote control and security electronics.

We are sure that you will find a number of worthwhile projects in this British magazine.

1 Year (12 issues) $9.50

Radio Constructor
Greenville, NH 03048

If you want an excellent technical magazine then this is the one for you. Want to know what British amateurs are up to? This is the only publication which gives complete coverage of amateur radio in Great Britain. Well written and very interesting.

Your subscription also covers a one year membership in the Radio Society of Great Britain.

1 Year (12 issues) $12.00

Radio Communication
Greenville, NH 03048
<table>
<thead>
<tr>
<th>Month</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>March 1968</td>
<td>5-band SSB exciter, IC-regulated power supply, Transistor curve tracer</td>
</tr>
<tr>
<td>May 1969</td>
<td>Potpourri of integrated-circuit applications</td>
</tr>
<tr>
<td>August 1969</td>
<td>Homebrew Parabolic Reflector, Solid-state Q-5er, Frequency calibrator</td>
</tr>
<tr>
<td>September 1969</td>
<td>FM techniques and practices, IC power supplies, varactor tripler</td>
</tr>
<tr>
<td>October 1969</td>
<td>Hot Carrier Diodes, Low-cost linear IC'S</td>
</tr>
<tr>
<td>November 1969</td>
<td>Op Amps... theory, selection &amp; application, WWV receiver, Multiband antenna</td>
</tr>
<tr>
<td>June 1971</td>
<td>A practical approach to 432-MHz SSB, FM carrier-operated relay</td>
</tr>
<tr>
<td>June 1972</td>
<td>5 Band solid-state communications receiver, FM repeater control</td>
</tr>
<tr>
<td>August 1972</td>
<td>Frequency synthesizer for Drake R-4, 2304 MHz preamp, audio filters</td>
</tr>
<tr>
<td>October 1972</td>
<td>4 channel spectrum analyzer, HF frequency synthesizer, all-band dipole</td>
</tr>
</tbody>
</table>

**HAM RADIO BINDERS**

Collector's items deserve the best protection you can give them, and we know of no better than our handsome Ham Radio Binders. Bound in washable buckram and supplied with year labels to identify each volume. Each binder holds 12 issues.

- $4.50 each
- 3 for $12.00

There's no place like a good collection of Ham Radio back issues to find answers you're looking for. Go over the list above and find the ones you need.

Enclosed is ...................... for the items I have checked.

**HAM RADIO BOUND VOLUMES**

Here is a handsome addition to your library. Twelve issues (a full year) of Ham Radio bound into a rugged, good looking, hard cover book. Certainly the most deluxe way to collect Ham Radio and perhaps the only way to acquire some out of print back issues. Years 1971, 1972, 1973 and 1974 available.

- $14.95 each

<table>
<thead>
<tr>
<th>Month</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>March 1968</td>
<td>(first issue)</td>
</tr>
<tr>
<td>May 1969</td>
<td></td>
</tr>
<tr>
<td>August 1969</td>
<td></td>
</tr>
<tr>
<td>September 1969</td>
<td>January 1973</td>
</tr>
<tr>
<td>October 1969</td>
<td></td>
</tr>
<tr>
<td>November 1969</td>
<td>March 1973</td>
</tr>
<tr>
<td>June 1971</td>
<td></td>
</tr>
<tr>
<td>June 1972</td>
<td></td>
</tr>
<tr>
<td>August 1972</td>
<td></td>
</tr>
<tr>
<td>December 1972</td>
<td>Satellite communications, UHF SWR bridge, RTTY monitor, receiver, FM channel elements, helical mobile antenna.</td>
</tr>
<tr>
<td>February 1973</td>
<td>Communications receiver design, rf speech clipper, fm receiver scanner, Plessey SLC00 integrated circuits, solid-state noise blanker.</td>
</tr>
<tr>
<td>June 1973</td>
<td>Digital RTTY auto-start, fm repeater installation, micropower receiver, broadband amplifiers, logic oscillators.</td>
</tr>
<tr>
<td>July 1973</td>
<td>SSTV test generator, carrier operated relay, VHF receiver, two-meter frequency synthesizer, antenna matching.</td>
</tr>
</tbody>
</table>

Just $1.00 each ppd.

- Binders $4.50 each
- 3 for $12.00
- Bound Volumes $14.95 Specify year(s)
Adverxsers check-off

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

Place your check mark in the space between name and number. Ex: Ham Radio V 234

INDEX

Adva __ 265
Amsat __ 220
Atlas __ 198
BC __ 013
Barry __ 96
Budwig __ 233
CFP __ 022
Cal-Com __ 282
Craig __ 177
Cush Craft __ 035
DX'er __ 028
Data Signal __ 270
Dayton __ 223
Delavan __ 235
Dentron __ 259
Drake __ 039
Digicomm __ 278
Dycomm __ 040
VHF Conference __
Eimac __ 043
Electronic Equip Bank __ 288
Epsilon __ 046
Erickson __ 047
Fair __ 048
Geneve __ 168
Glade Valley __ 213
Great Lakes Hamvention *
HR Report __ 150
Hal __ 057
Ham Import __ 290
Ham Radio __ 150
Hamtronics __ 246
Heath __ 060
Henry __ 052
Hildreth __ 283
Holdings __ 252
Hy-Gain __ 064
Icom __ 065

*Please contact this advertiser directly

Limit 15 inquiries per request.

March 1975
Please use before April 30, 1975

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

NAME ..........................................
CALL ..........................................

STREET ..........................................
CITY ..........................................
STATE ..........................................
ZIP ..........................................

Advertisers Index

Adva Electronics ............................................. 65
Amsat ..................................................... 7
Atlas Radio Co. ............................................ 7
BC Electronics ............................................. 88
Barry ...................................................... 96
Budwig Manufacturing Co. .................................. 92
CFP Enterprises ........................................... 87
Cal-Com Systems, Inc. ...................................... 92
Craig Radio ................................................ 92
Cush Craft .................................................. Cover II
DX'er's Magazine .......................................... 86
Data Signal, Inc. .......................................... 47
Dayton Hamvention ........................................ 74
Delavan Electronics, Inc. .................................. 76
Dentron Radio Co. .......................................... 72, 73
Drake, Co. R. L ............................................. 33
Digicomm .................................................... 92
Dycomm ..................................................... 90
Eastern VHF Conference .................................. 89
Eimac, Div. of Varian Assoc. ................................ Cover IV
Electronic Equipment Bank, Inc. ......................... 86
Epsilon Records ............................................ 84
Erickson Communications .................................. 76
Fair Radio Sales ............................................ 86
General Aviation ........................................... 39
Glade Valley School Radio Session ....................... 76
Great Lakes Hamvention ................................... 80
HR Report ................................................... 89
Hal Communications Corp. ................................ 68, 69
Ham Import Sales ........................................... 87
Ham Radio .................................................... 85, 90, 93
Hamtronics, Inc. ............................................ 88
Heath Company .............................................. 48, 49
Henry Radio Stores ........................................ Cover III
Hildreth Engineering Co. ................................... 86
Holdings Photo Audio Centre ................................ 89
Hy-Gain Electronics Corp. ................................ 95
Icom ......................................................... 5
International Crystal Mfg. Co., Inc. ...................... 71
Jan Crystals ................................................ 74
Janel Labs .................................................. 92
K. E. Electronics ......................................... 84
K.Enterprises .............................................. 78
KLM Electronics ......................................... 70
Leland Associates .......................................... 88
Leyv Associates .......................................... 74
Logic Newsletters ......................................... 92
McClaren ................................................... 92
MFJ Enterprises ............................................ 74
Oneida Elect. Mfg. Co. ..................................... 70
Pagel Electronics .......................................... 86
Palomar Engineers ......................................... 70, 78
Poly Paks ................................................... 82
Porta-Pak .................................................... 86
RMS Corporation ........................................... 86
RP Electronics ............................................. 78
Radio Amateur Callbook, Inc. 66, 87
Radio Constructor .......................................... 92
Regency Electronics Inc. ................................... 88
SAROC ....................................................... 91
Signal/One .................................................. 2
Southwest Technical Products 81
Space-Military Electronics ................................ 86
Spectronics FM ............................................. 75
Spectrum International ...................................... 80
Sumner Electronics & Engineering ......................... 79
Tristao Tower Co. ......................................... 84
Tri-Tek, Inc. ............................................... 92
VHF Engineering, Div. of Brownian Elect. Corp. .... 57
Valu-Pak ..................................................... 85
Weinschenker ............................................. 67
World QSL Bureau ......................................... 86
Yaesu QSL Bureau .......................................... 86
Yaesu Musen USA .......................................... 1

94 March 1975
The New Hy-Gain 270 brings state-of-the-art design to 2 meter mobile.

The Hy-Gain 270 is specifically designed to solve the problems of gain 2 meter mobile antennas...hard tuning, high VSWR, poor pattern due to irregular ground plane, and fade from whip flex. The all white fiberglass and chrome design develops 6 db gain through the use of 2 stacked 5/8 wave radiators with a self-contained 1/4 wave decoupling system. Because the Hy-Gain 270 operates independent of the car body ground, you get minimum pattern distortion for maximum range in all directions. Independence from the car body also means the end to tune-up problems. The fiberglass design solves the fading problem due to upper whip flex. Since the antenna and feedpoint are sealed in fiberglass, the Hy-Gain 270 will deliver top performance year after year without loss due to corrosion. The Hy-Gain 270 can be mounted anywhere...bumper, cowl, deck or mast...for fixed, land mobile or marine service using Hy-Gain mounts listed below.

- 6.0 db gain.
- 250 watt rated.
- 144-148 MHz.
- VSWR less than 1.5:1 at resonance, 6 MHz Bandwidth.
- 96" whip height.
- No pruning required, completely factory tuned!
- 50 ohm input.
- 3/8 x 24 standard mobile thread.
- Comes with 18" coax and PL-259 connector.

Order No. 270

Mounts—Universal No. 271
Flush Body No. 499
Bumper No. 415

Get maximum range...get a Hy-Gain 270!

For prices and information, contact your local Hy-Gain distributor or write Hy-Gain.

Specials from Barry
Collins Model 1805-1 Kilowatt Antenna Tuner. Matches various impedances to 500, 3-30 MHz w/vac. variable. reg. price $750.00 Sale $295.00
Sierra Average Reading Termination Wattmeter. Model 185-A-100 FM, 100 watts, 500 new $125.00
Astatic D-104 Stand for CD.44 New $26.10
Astatic UG-8 Stand for CD.44 New $19.95
Astatic 531 Ceramic hi-impedance communications mike with switch New $10.50
Signal one CX-7A with 400 Hz & 1200 Hz filters Write B & W 334A Dummy Load-Wattmeter 0-3000 MHz 500, 1-10, 10, 300, 1000 watts $149.55
B & W 374 Dummy Wattmeter 0-3000 MHz 500, 1-10, 10, 1500 watts $175.00
Leader — LDM 815 Grid Dip Meter, portable, transistorized, banded 1.5-250 MHz $99.95

Drake — Official factory distributor
Drake T-4XC Receiver $580.00
Drake R-4C Receiver $549.00
FL-1500, 1500 Hz filter for R-4C $50.00
4-NB Noise blanker for R-4C $65.95
TR-22C Transceiver $229.95
Drake AA-10 TR-22C Amp. $49.95
Drake TR-4C Transceiver $99.95
Drake AC-4 Power Supply $120.00
Drake W-4 Wattmeter $62.00
Drake WV-4 Wattmeter $74.00
Drake MN-2000 Matching Network $200.00

Finest SSTV VENUS Latest Models
Ready to Operate SS-2, SLOW SCAN MONITOR $349.00
SS-2K MONITOR KIT $269.00
C1, FAST SCAN/SLOW SCAN CAMERA & CONVERTER $469.00

Antennas
TA-33, TA-36, TH6-6XX, etc.
Savoy DGA-4075, 40-75 meter dipole $99.50
Savoy DGA-4074, 40-75 meter collinear $29.95
Trunk tip bracket for DGA-2M $14.95
HyGain 1/2 wave 2M grnd plane for fixed station $13.00
B & W 376 5 position grounding Protax coax switch $17.95
Hustler 4 BTY Vertical Antenna $79.95
HyGain 18V 10-80 m. vertical $13.00
HyGain BN86 Deluxe Balun $15.00
HyGain 18 AVT/WB 10-80 meters vertical $97.00
Newtronics CG1-144 5.2 dB gain. Trunk mount $39.95
Gold Line Single Pole, 5 position coaxial switch, wall bracket or panel mount 1 KW AM $17.95
Times Wire & Cable, T-450, RG-8 foam 28¢/ft.

C.D. Ham II Rotator
New Improved $139.95 net $139.95
CD-44 All rotators with control box $99.95
8 conductor cable for HAM II or CD-44 16¢/ft.

Bird
We are official distributors for all Bird products.
Bird Model 43 Wattmeters with either N or SO239 connectors $100.00
Bird Model 104 Mike $39.95
Most VHF Slugs, Specify Power & Freq. $32.00
Slugs subject to factory availability
HT Kit from VHF Engineering, 2 watts out, 4 channel 2 meter transceiver kit HT-144B w/1 set stals $129.95

Viking Ranger 10 thru 160 meters w/book and lab O.K. $110.00
Nepcon insulated wire 12, 14 & 16 stranded & tinned Write B & W Mindufactors — Air-Dux coil stock $629.00
Millen 2200 Voltage Transmatch Write Famous Triton-II by Ten-Tec. Fully solid-state, 200 watt transceiver. 5 bands — full break in on CW $650.00
Ten-Tec 262 AC Power Supply with VOX $129.00
R-389/URR 15 to 1500 kc. Manual or motor tuned with digital readout. W/ book $139.00
Millen, Solid State Dipper 1.7-300 MHz Model 90052 $138.00
Kenwood R-599a $199.00
2M Converter for 599A $25.00
Speaker $15.00
Nye (Johnson) 52 ohm low pass filter $9.95
Nye Heavy Duty transmitting key $9.95
Nye 275 Watts Matchbox with relay $212.00

See Barry for Meters and Capacitors

IC-230
162+ channels, simplex or offset (600 kHz) $489.00
All modular construction $138.95
Super hot MOSFET/helical coil 4.4V cvr
AVAILABLE NOW! only $91.95
IC-230 Regulated Pwr. Supply $89.95

Deluxe Headsets. Telex and others for ham radio or audio visual: 600 ohms, vinyl cushioned: $9.99
With volume control $11.99
Clegg FG-27B, trade-ins, checked out $29.95
Call or write Standard 826M, Trade-ins $59.95
Regulated Power Supply for FM-27B $89.95
DYMCOM Block Booster D" Kit, 10-15 watts in $45.55 watts out continuous Sale $59.95
DYMCOM Brick Booster "E" Kit, 1-3.5 watts $39.95
Mallory UHF Inductunor, covers 50-250Mc $95.95 ea.
WE HAVE VIBROPLEX
Regulated Power Supply @5-50 vdc, steps of 5v 50ma, 150ma, 500ma, 1.5 amp with meter $95.95
tgood $59.95

10 Volt Fil. Transformer, herm. sealed, 115 V 50/60 cps, 11.2 vat, 31 amp, 6H x 5 x 5 $14.95
FR-14U Freq. — Interval Counter, 20 cys. to 1 Mc, exclnt working cond. $195.00
Hammarlund Dual Section 320/320 per section $89.95
Xmit'g Capacitor $24.95
Bird & W 333 PinNet Band switching inductor for 4-1000A, etc. $66.75
852 for 3-1000Z, 4CX-1000A $66.75
CONSTANTRIDGE TRANSFORMER. Input 115 VAC @ 60 Hz output, 24 Volts @ 15 amps regulated (plus or minus 1%) requires 6 mfd. 660 VAC capacitor add $4.95 +$1.59 ea.
See Barry for thousands of unadvertised specials

NCP POWER SUPPLIES
115 VAC Input - 12 VDC 4 amps out $4.95
Same as above but regulated $7.95
Model 105-115 VAC/13.6 VDC 4 amps continuous 12 amp surge. Regulated $69.95

BARRY BUYS UNUSED TUBES Send Your List. Tube Headquarters. Discontinued Stock. Heavy Inventory of Elmac tubes, chinnies, sockets, etc. 350002 or 340002 Specify $50.00
572-B $22.50
Tubes for worldwide and domestic, commercial service.

BARRY 512 Broadway NY, NY 10012
DEPT. H-3
212-WA-5-7000
TELEX 12-7670
now...
Your Kenwood line does more

the new
TV-502
2 meter transverter

Kenwood engineering scores again. . . the TV-502 transverter now adapts any TS-520 transceiver or T-599/R-599 combination to transmit and receive SSB or CW on the two meter band.
- All solid-state
- 144 to 146 MHz
- SSB, CW
- Output impedance 50 ohms
- 8 watts power output (W/AC)
- Frequency stability ± 200 Hz after warm-up
- Styled to match the TS-520
- Price $249.00

The brand new K-2000 linear amplifier is the perfect companion for your TS-520 or T-599A. It is compact, reliable and priced right. Uses two Eimac 8873 grounded grid triodes cooled thru a large heat sink. The K-2000 offers a full 2 KW PEP input for SSB operation and provides amateur band coverage from 80-10 meters. Provides a built-in solid state power supply, built-in antenna relay, a relative RF power indicator, and built-in quality to match much more expensive amplifiers. The K-2000 comes completely wired and ready for operation.

Amateur Radio's New First Family
The TS-900, TS-520, R-599A, and T-599A in a few short years have established new levels of achievement in communications for amateur radio. Inspired engineering, careful attention to quality, beautiful styling. . . these have become the hallmark of the Kenwood family. Now your Kenwood line does more. The TS-520 or T-599A operated with the new K-2000 amplifier provides the full power capability you need. Combined with the TV-502 they provide the 2 meter performance on SSB or CW which gives you “Oscar” capability and introduces you to the exciting new experience of 2 meter DX.

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