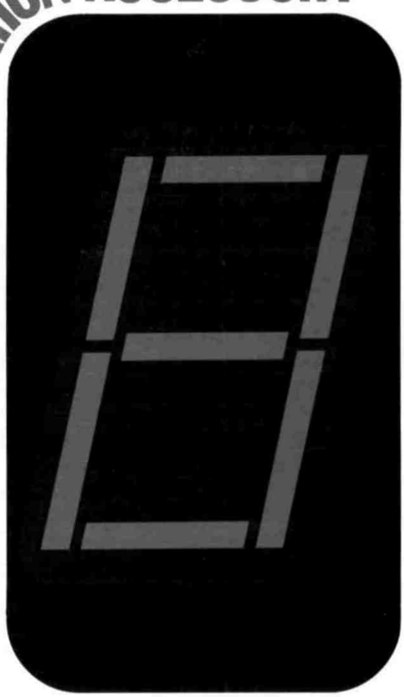
75 cents

focus on communications technology . . .

ham radio magazine

FEBRUARY 1972

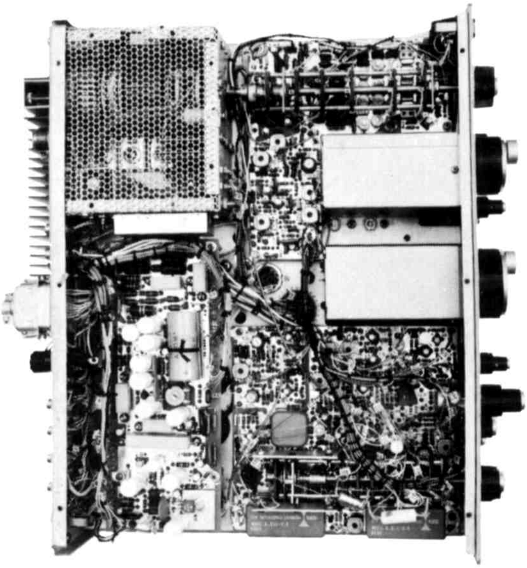
DIGITAL READOUT STATION ACCESSORY

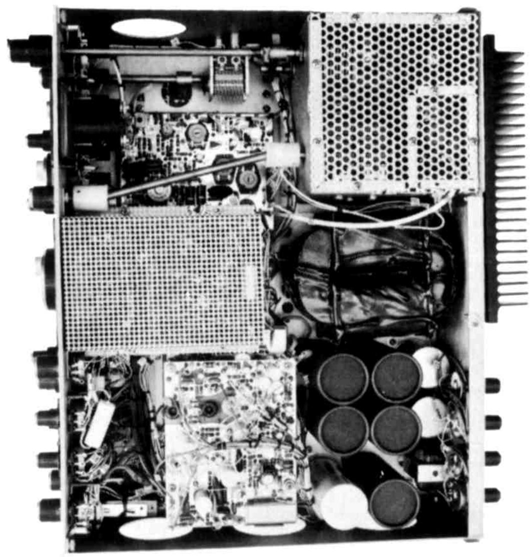


this month

- two-meter transverter 24
- ssb speech processing 38
- modular vhf fm receiver 42
- fm deviation measurements 52

We built every imaginable feature into the CX7A.





Including reliability.

The CX7A was designed as the amateur's ultimate rig and every conceivable feature you could want was incorporated.

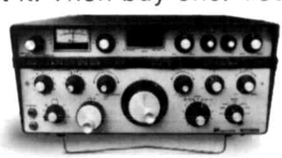
As you can imagine, this design resulted in some pretty complicated circuitry. And at first there were bugs. There always are when you're treading new paths.

Some of the first sets did their job so enthusiastically they went right up in smoke. So we went over the problems with a fine-toothed comb. We learned a lot, and we did something about it.

Now we buy only the finest components obtainable. And we check each component individually. Every resistor, every semiconductor, every whatever, is "burnt-in" before it's put in.

So now when you crank up a CX7A it'll smoke all right — with the heaviest talk power and most sensitive receiver of any rig you can buy. And you can rely on that. For it, you pay $2,195.

See the CX7A at your signal/one dealer. Or write us for a detailed brochure about it. Then buy one. You'll be the most reliable operator in town.



signal/one

a subsidiary of

Computer Measurements, Inc.

1645 West 135th Street

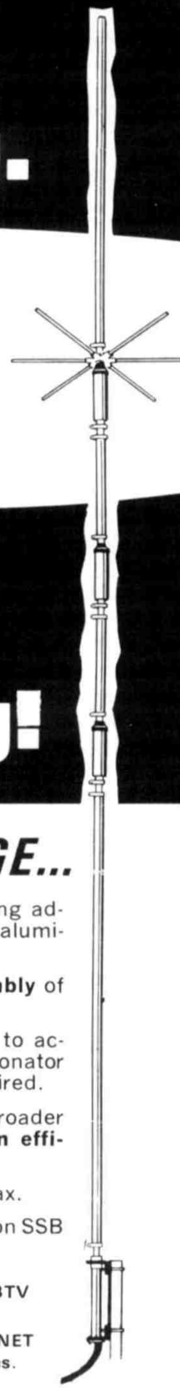
Gardena, California 90249

Phone: (213) 532-9752

Everyone has something.

FIXED STATION TRAP VERTICAL

40 THROUGH 10 METERS



HUSTLER® has everything!

One Setting for TOTAL BAND COVERAGE...

- **Lowest SWR**—PLUS!
- Bandwidth at its **broadest!** SWR 1.6 to 1 or better at band edges.
- Hustler exclusive trap covers **"Spritz" extruded** to otherwise unattainable close tolerances assuring accurate and permanent trap resonance.
- Solid one inch **fiberglass trap forms** for optimum electrical and mechanical stability.
- Extra heavy duty aluminum mounting bracket with **low loss—high strength** insulators.
- All sections **1¼" heavy wall,** high strength aluminum. Length 21′5″.
- **Stainless steel clamps** permitting adjustment without damage to the aluminum tubing.
- Guaranteed to be **easiest assembly** of any multi-band vertical.
- Antenna has ⅜"-24 stud at top to accept RM-75 or RM-75S Hustler resonator for **75 meter operation** when desired.
- Top loading on 75 meters for broader bandwidth and **higher radiation efficiency!**
- Feed with **any length** 50 ohm coax.
- Power capability—**full legal limit** on SSB and CW.

Buy **HUSTLER** *. . . buy the verified choice of thousands!*

MODEL 4-BTV
$42.95
AMATEUR NET
Wgt. 15 lbs.

Available from all distributors who recognize the best!

NEW-TRONICS CORP.
15800 COMMERCE PARK DRIVE
BROOK PARK, OHIO 44142

World Wide Export, Roburn Agencies, Inc., 349 W. 14th St., New York, N.Y. 10014, Cable Address: Roburnage - New York

More Details? CHECK—OFF Page 94

More Details? CHECK—OFF Page 94

February, 1972
volume 5, number 2

offices

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

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

Subscription rates, world wide one year, $6.00, three years, $12.00
Second class postage paid at Greenville, N. H. 03048 and at additional mailing offices

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

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

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

Printed by Wellesley Press, Inc
Wellesley, Massachusetts 02181, USA

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

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

hr

ham radio magazine

contents

6 digital station accessory
E. H. Conklin, K6KA

20 solid-state final amplifier
C. Edward Galbreath, W3QBO

24 two-meter transverter
Louis E. Savoie, K1RAK

32 high- frequency mosfet converter
Michael J. Goldstein, VE3GFN

38 pre-emphasis for ssb transmitters
Veikko Aumala, OH2CD

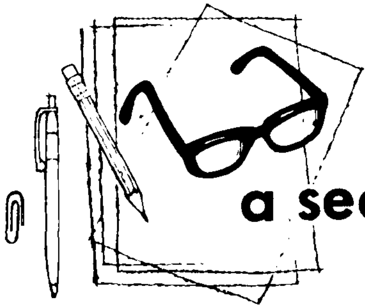
42 two-meter fm receiver
Harvey L. Wagner, WA2GBF

46 simple crystal checker
Henry D. Olson, W6GXN

50 calculating toroid inductance
Michael J. Gordon, Jr., WB9FHC

52 fm deviation measurements
Edward M. Noll, W3FQJ

4 a second look
94 advertisers index
52 circuits and techniques
83 flea market
58 ham notebook
62 new products
94 reader service



a second look

by jim fisk

As more and more amateurs switch to factory-made gear, and as industry uses more ICs and disposable plug-in modules, the life of the dyed-in-the-wool home-brewer gets tougher and tougher. If you've recently tried any of the construction articles in *ham radio*, you are already well acquainted with the hassle involved in obtaining a few needed components.

At one time you could drop in at your local corner radio store with a list of parts and the man behind the counter would fill your order. But that was when the vacuum tubes, resistors and capacitors in your ham gear were the same as those in the family radio. It's not the same anymore – now the transistors and ICs in radios and television sets are apt to be designed specifically for that purpose and have operating characteristics that are of little use elsewhere. There are exceptions, but they are few and far between.

Another problem that faces the serious home builder is the generous variety of transistors and ICs available from different manufacturers. Although some types of devices are made by more than one company, in most cases the semiconductor manufacturers crank out devices that are completely different from those of their competitors. And to add insult to injury, the same device may carry a dozen different part numbers: a 2N number, a replacement number plus special numbers for units sold in large quantities to equipment manufacturers.

There is only one way to combat this lunacy: arm yourself with a good semiconductor cross-reference guide and a wide selection of electronic parts catalogs. Tops on the list of replacement guides is Howard Sams "Transistor Substitution Handbook." This handy little paperback, which is updated every year, covers practically every transistor ever made, from 2N34 to 2N6000, with recommended substitutes. It also covers devices from Japan and Europe, as well as replacement types manufactured by Delco, General Electric, International Rectifier, Motorola, RCA, Semitronics, Sylvania and Workman. Most of these manufacturers also publish replacement guides, available for the asking from their authorized distributors.

If you live in a large metropolitan area, chances are that there is an industrial electronics supply house that can fill your parts need. Many of these firms don't advertise, because they are not particularly interested in small quantity sales, but if you show up at their office, they will sell you the parts. If you want to find them, pick up your telephone directory and check the Yellow Pages; look under "Electronic Equipment and Supplies." If you live out in the sticks, the problem is more difficult, unless you can get into the city. If you can't, you must purchase your components through the mail. Allied Radio is the best bet in this case and you can get a catalog from any Allied/Radio Shack store. Be sure you get the Industrial catalog though, the more common entertainment catalog is devoted primarily to hi-fi, CB and simple experimenter's stuff.

Jim Fisk, W1DTY
editor

More Details? CHECK—OFF Page 94

digital readout

station accessory

This versatile station accessory may be used as a digital vfo readout, digital clock, identification timer, electronic keyer or frequency meter

E. H. Conklin, K6KA, Box 1, La Canada, California 91011

The most attractive magazine articles may be those that provide instructive or interesting reading to a large percentage of readers, including those readers who do not plan to build or use the device described. It is hoped that this article will be of that type.

Possibly each of us should plan to build one electronic gadget every year, just to avoid becoming entirely an "applicance operator." This is not easy to do under present conditions other than for small items of accessory or test equipment. Of all the gadgets other than kits, digital nonlinear integrated circuits offer perhaps the most pleasant areas in which to experiment, design and build an accessory for your station. There is widespread interest in such devices, as will be seen from the many technical papers which have been published during recent years.

Instead of building a series of devices to accomplish different things, I have given consideration to the idea that one cabinet, chassis, power supply and readout can be used for an almost endless number of jobs. This saves construction, space and expense. By using some form of plugboard for the circuitry, new active devices can be added, or replaced even temporarily, such as when you are asked to time a swimming meet or auto race to a thousandth of a second.

I plan to cover the basic unit at this time, and the detailed accessory devices in coming months. Some of the accessories will not be the subject of an article because of the number of similar units already in print. These can be built on suitable plugboards and used in the accessory unit.

In the meantime, general planning and

background reading well may be in order to acquaint you with the subject. This will make the subsequent plug-in devices very easy to understand. In fact, they may not even require a circuit diagram, except for block diagrams and switching plans for the station maintenance files.

Some of the items that can be worked into the accessory are: high-stability crystal calibrator, harmonic generator, frequency counter, digital clock, identification timer, receiver digital dial, transmitter digital dial, general-purpose receiver dial, electronic keyer, event timer or stopwatch, auto speed trap, photo timer and *wife-reminder*. The *wife-reminder* refers to anniversaries, birthdays and the like. These, and license renewal date, can be added, with suitable alarms for the purpose!

In preparing such an article, it is desirable to simplify parts procurement in order to eliminate a month or two of planned purchasing, with the inevitable back-ordering and interdependence of one item on what is obtained for some other requirement. Also, chassis and cabinet dimensions given are for the very few that matter. And finally, difficult machining problems and other sources of frustration and discouragement should be avoided.

nixie read-out displays

Chassis construction depends to a considerable extent upon the type of read-out displays that you select. Tube-types such as Nixie (a Burroughs trade name) and Numatron (RCA) may require a specific chassis height, or shelf, or mounting on the forward edge of vertical epoxy-glass circuit boards. It is feasible to use a chassis only in the center to support the read-out tubes and the power supply with all other parts except panel switches mounted on plugboards (such as Vector *plugbords*).

The widely known Nixie gas-discharge display device requires a few milliamps at about 180 volts. It also requires a high-voltage BCD-to-decimal decoder/driver IC. As in other uses of decoders and drivers, care must be taken to obtain those with *active high* or *active low* operation as required by the particular type of read-out. A current-limiting resistor is used as with neon tubes. Sometimes a grounded wire-mesh screen is placed over the panel window to prevent inside radiation from leaking out, or the reverse.

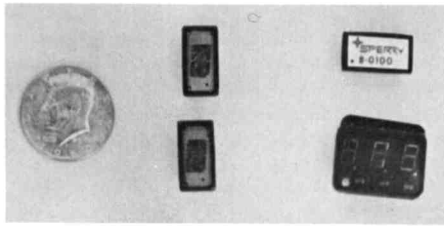


fig. 1. Two Minitron readouts are shown on the left. A three-digit Sperry cold-cathode display, resting on its special socket, and one of the decoder/driver ICs, are on the right.

These read-outs will be found in large mail-order industrial catalogs. However, note that this is a fast-moving field, and spare tubes should be on hand to prevent running short if the type you use is not available in the future.

Burroughs has extended the cold-cathode gas discharge design into *Panaplex,* a single tube with eight or more 7- or 9-segment digits, including driver circuitry. A strobed or multiplexed time-sharing method is used to minimize decoder/driver cost. The hoped-for cost of $1 per digit is a few years away.

In the meantime, Sperry Information Displays* is producing some very pretty replacements for Nixie tubes. These are 1½-, 2- or 3-digit flat glass plates, a socket and active-low 7-segment decoder-driver units, shown on the right in **fig. 1.** Sperry offers demonstration kits including read-out, socket and decoder/driver, and may furnish the 2- or 3-digit ones on request at $14.95 for the lot, thus being one of the low-cost devices. They do

*Sperry Information Displays Division, Box 3579, Scottsdale, Arizona.

require the low-current 180-volt supply, though.

General Electric offers the Y-1938 7-segment low-voltage tubes with filament. They have an unusual blue-green character color and require 1.6 volts on the filament and 25 volts dc on the anode, but can be driven by suitable IC decoder/drivers. General Instrument and Hughes make up/down counters, buffer storage, and decoder/drivers in a single large 24-pin dual in-line package (DIP) IC that will operate the GE tube. These combined counter ICs have merits but are not desirable for digital clock purposes.

incandescent displays

The RCA Numitron is a 7-segment incandescent tube, taking up to 5 volts, but at 24 milliamperes per segment. This requires one of the high-current decoder/drivers.

There are other simple incandescent lamp displays, some requiring higher current than is provided by a 7-segment decoder/driver IC. One made in Japan, however, built like a 16-pin DIP IC, is the Minitron, shown on the left in **fig. 1.** Its 5-volt and low-current requirements are well within normal 7-segment decoder/driver output, like the inexpensive active-low Monsanto MSD 047 and the Texas Instruments 7447, all available from Circuit Specialists.* These have provision for decimal, lamp test and read-out blanking input and output. Currently the Minitron and MSD 047 decoder/driver combination appears to be the lowest-priced read-out system available.

light-emitting diodes

The Monsanto MAN3A light-emitting diode read-outs are built somewhat like a ten-pin IC flat-pack, with pins spaced 0.034 inches. The 7-segment display is only 0.115 inches high, thus about the smallest in the business. At around $6.50 a digit this is the lowest cost of the bright red-colored light-emitting diode displays. The Heath 14-pin DIP LED display, used in their 80-MHz counter, sells for $8.50.

Light-emitting diodes are attractive and will be very popular when the small-quantity cost comes down a bit. They require a dropping resistor in each segment lead and each decimal-point lead. LEDs are compatible with systems that include the decoder/driver, latch, and possibly the decade counter, all in the same IC.

other displays

Sigmatron* has a light-emitting film multidigit display; in large quantities, this runs only $1.50 a digit, but unit prices are much higher. These units require an audio-frequency multivibrator driver which can be time-shared by all of the digits with a multiplexing device.

Optel† offers liquid crystal displays. These require a small 20-volt supply. With the decoder/driver and Hughes HCTR 0107 display driver the *small-quantity* cost is much higher than many other read-outs.

color filters

Usually a color filter is placed over a numeric display to increase the contrast between the read-out's light and the background. Most displays are red, but a few are blue-green. The incandescent ones are close to an orange-white color, depending upon the voltage at which they are operated.

Litronix mentions that the Rohm & Hass no. 2423 acrylic plastic has 71% light transmission, and that the Polaroid HRCP-7 has only 40% light transmission but offers a nonglare surface. In a test, Circuit Specialists did not find any advantage in the Polaroid material compared with sticking red Scotch tape on individual Minitrons and trimming the edges even.

Plain half-sheets of thin flexible plastic cost about $1.50 at art supply stores; similar colors are available at school supply stores as "report covers" at 19c

*Circuit Specialists, Box 3047, Scottsdale, Arizona 85257.

*Sigmatron, 849 Ward Drive, Santa Barbara, California 93105.

†Optel, Box 2215, Princeton, New Jersey.

each, which is quite a bargain. The red looks good. For incandescent displays, the rose (not quite amber or orange) probably passes more visible light, even when two thicknesses are used.

It is desirable to minimize light spread by having the plastic window close to the read-out. The chassis described in **fig. 6** has the plugboard holding the displays directly behind the panel window with the Minitrons actually touching the plastic. The plastic can be glued to the rear of the panel or it can be secured with flat-head 2-56 machine screws with a washer and nut on the rear side of the panel.

For trying different colors, a 3 x 5-inch card holder can be purchased at a builders' hardware store. This can be held in place on the rear of the panel with flat-head machine screws. It is practical to cut out a section on the 3-inch dimension, mounting the old top and the remaining side lengths from the upper machine screws. This has been done on the panel shown in **figs. 2** and **6.** Inasmuch as the Minitron read-outs are thicker than the other ICs there is no problem in clearances from the panel. If fewer than eight read-out digits are planned, such as by omitting the megahertz, smaller escutcheons can be used without modification.

number of read-outs

The unit pictured in **fig. 2** has eight Minitron read-outs in one row, shared for all purposes, so that 99 MHz can be displayed right down to the last cycle. In some applications it is feasible not to bother with counters, latches and decoder/drivers for the MHz digits; if these are available they can be activated by a bandswitch to connect 5-volts dc through steering diodes to the correct read-out segments.

Some read-outs can be omitted, such as the MHz ones, or the units or tens of Hertz. It is quite useful to have only three kilohertz digits and one for tenths-of-kHz, thus requiring only four read-out tubes.

Another option is to use two rows of read-outs, with frequency (counter) on one row, and time of day on the second row – if sufficient plugboard contacts are available. In this way, by not sharing these displays, there will be the added cost of the extra read-outs and their decoder/drivers for the extra four units or more used to display time.

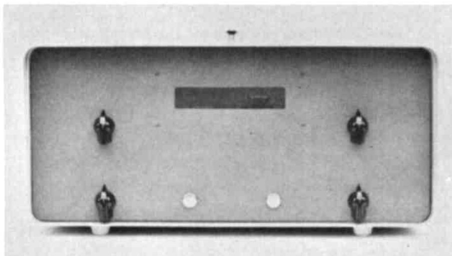


fig. 2. Front panel and cabinet of the digital accessory prior to the application of panel lettering.

There will be some saving on switching, and also about $5 for the four quadruple 2-input AND gates used as data selectors on the displays alternately used for time and for counting. Texas Instruments promises production of their SN74157N quadruple 2-line-to-1-line data selectors to do this same job of switching between two types of input data to the read-outs, but prices are not yet available.

cabinet and chassis

With IC-type read-out displays a miniature unit is possible, but it limits flexibility in usage and may complicate experimentation, test and maintenance. Readers with other Heath equipment can select from a number of cabinets used in many Heath units.

As a first attempt at packaging, I decided to use the gray CO-1 cabinet made by LMB shown in **fig. 2.** It measures 14½-inches wide, 6½-inches high and 13½-inches deep including the shadow front. It closely matches Collins S-Line cabinets and the original Henry 2K.

Through separate order, the alternate 1½-inch-high chassis – not the more popular 2-inch-high chassis – was ordered. These are obtainable through supply stores. Unlike the Collins cabinets, it does not come with a rectangular hole for access to the rear apron of the chassis. Such a large rectangular hole can be cut out, or small guide holes can be drilled from the rear of the cabinet into the rear of the chassis and later enlarged to pass phono plugs through the cabinet into phono jacks mounted on the chassis.

This operation is facilitated by shimming the rear of the chassis 1/16-inch with washers held in the corners with masking tape or by a 4-40 machine screw permanently threaded into each of the two rear chassis angle brackets. Scrap pieces of Vector T-strut can be used to hold the chassis by placing these pieces in the guide rail at the sides of the chassis. By blocking up the chassis from the front and holding it from popping out, guide holes for the entire set of phono jacks can be drilled.

Subsequently, sets of black and white letters* can be applied to both the gray cabinet and the aluminum chassis to identify the phono plugs. The Letraset is smaller than that offered by electronics mail-order houses; it and other alternatives are available from art supply stores. Crystal-clear Krylon spray coating over the transferred letters will make them permanent.

There is no provision for a chassis fuse nor for a complete on-off switch inasmuch as the oven and clock components will remain turned on except during trips abroad. The unit is fused in the power plug (Allied Radio Shack no. 270B1249).

The large hole required for a power-cord strain relief is beyond many home drilling facilities; a grommet with suitable tight-fitting hole will do a reasonable job. Stretch the grommet onto the power cord, then drill out the chassis hole that will accept the grommet but retain the power cord.

The cabinet's cover has no provision for a handle or finger hole. However, a 4-40 machine screw with fibre washers and spacer under the head, will pass through a ventilation hole, to be used as a cover handle.

If the unit will be near Collins equipment, obtain two or four tapered feet (Collins 543-8101-002). Four are used

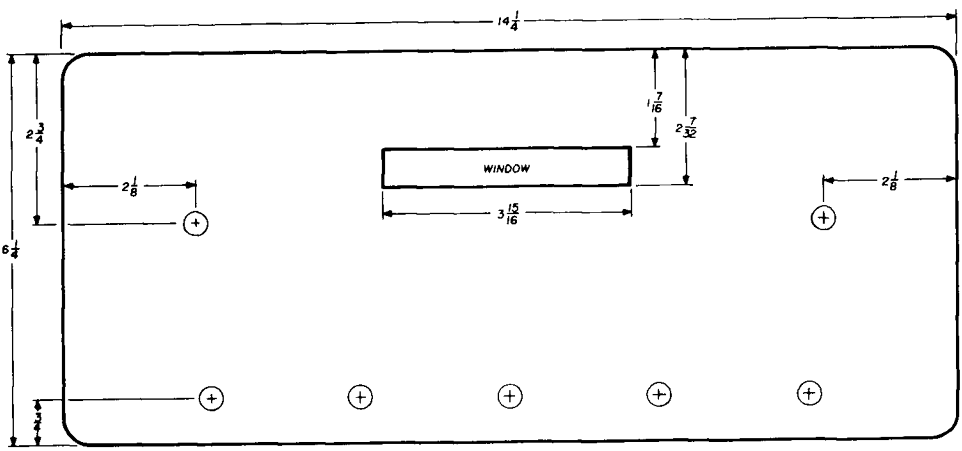


Fig. 3. Front panel drilling instructions.

*Letraset 10-point Helvetica light (1573), catalog number 48-10-CLN, upper and lower case, available at art supply stores.

when stacking above or below S-Line units, maintaining ventilation space. Rubber feet are Collins 200-5010-000.*

the panel is the right distance back at its bottom, then drill new screw holes up through the bottom. A sheet-metal screw

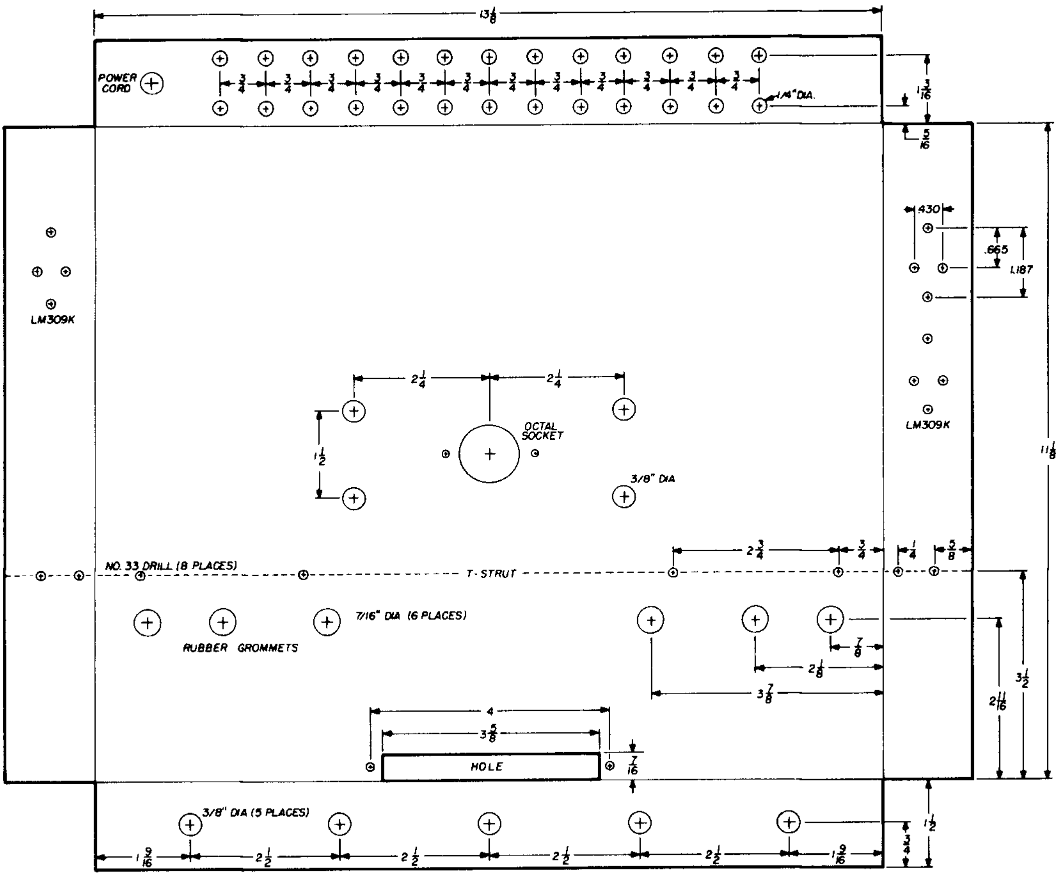


fig. 4. Chassis drilling instructions; the power-supply holes are omitted because they will not apply for different parts.

panel

The front panel angle comes secured under the cabinet cover by two sheet-metal screws which also hold down the hinged top. This is inconvenient for adjusting the crystal oscillator and setting the clock. The answer is to clamp a piece of wood to the lower cabinet lip so that

*Collins parts may be ordered from Customer Service Representative, Collins Radio Company, Cedar Rapids, Iowa 52406.

should be put into the first hole before the second is drilled. In this way, the chassis and the front panel are held firmly, even when the cabinet lid is opened.

The lower set of controls will require holes ¾-inch up from the panel bottom, through the chassis, as shown in **figs. 3** and **4.** Old controls or their bushings then can be inserted to hold the chassis and panel in place as additional holes are drilled.

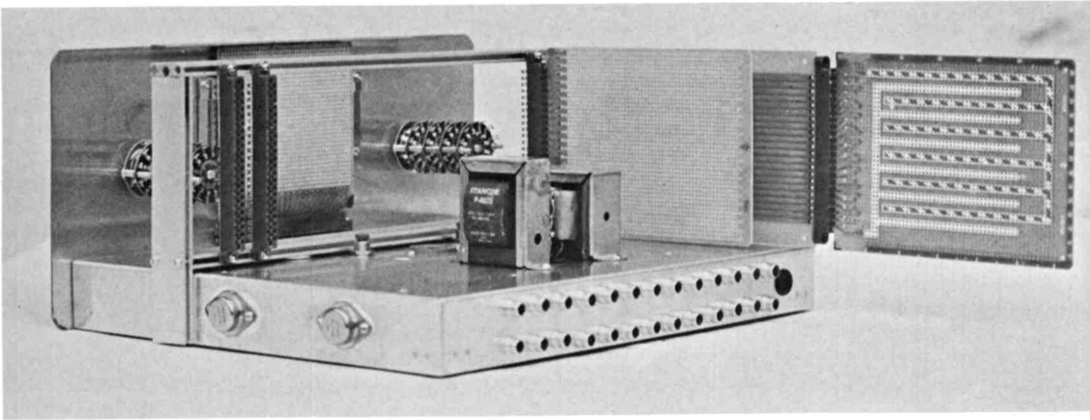


fig. 6. Rear view of digital accessory showing the mounting of Vectorboard to hold Minitron readouts and T-struts for other circuit boards prior to above-circuit chassis wiring.

It can be seen in **fig. 5** that the small space under the chassis permits a switch only as large as the Centralab PA-1000 and PA-2000 subminiature series. Even then the switch must be wired when dismounted, bending contacts in, and applying plastic tape to the chassis and cabinet to prevent the contacts from shorting.

These switches are attractive because spare parts and wafers are available for possible future expansion. Smaller switches may require smaller panel holes and 1/8-inch shafts. The small Daka-Ware knobs that were supplied with the switches are helpful when positioned so close to the bottom of the cabinet.

Some controls can interfere with the read-out plugboard receptacle contacts. In this case, two control nuts can be used to mount the central controls far enough behind the panel in order to clear the receptacle contacts.

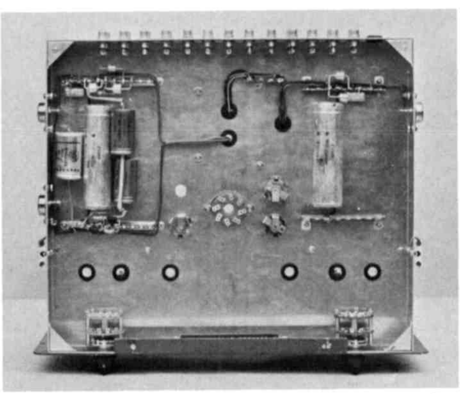


fig. 5. Bottom view of digital accessory showing power supply and unwired switches and other controls.

More holes for controls are shown in **fig. 3** than were planned for expected requirements. Unused holes can be filled with snap-in plugs until required by future expansion.

read-out window

A rectangular hole is required in the panel for the read-out display. This can be slightly smaller than IC-type read-outs. The old way of drilling a series of small holes, then connecting them by one of several means, is a lot of work. There are two easier ways.

First, lay out the desired rectangle on the back side of the panel, marking all four sides. Drill small holes in all four corners just inside the rectangle. Then back away from the corners and drill large holes inside of the rectangle. If a neighbor has home shop equipment with a milling device, a small milling tool can be used to rout out the metal within the rectangle.

Without this, borrow a sabre (scroll) saw with a fine-tooth nonferrous metal-cutting saw blade. These saws are priced from under $10 at Sears and about twice that in the Skil tool line. Cloth should be placed on each side of the panel, then wood blocks, before putting it in a vise for sawing. The rectangle can be cut by sawing in different directions from a starter hole, even by using the side of the saw blade as a file for thin cuts.

After the panel work is finished, hang the panel by a wire or cord through a screw hole in the bent-over angle lip (or through both holes), and spray with Krylon all-purpose gray (no. 1318) or a suitable alternate.

The same type of cutting operation can be used for the rectangular hole for the contacts of an R-644 Vector *plugbord* receptacle on the front of the chassis below the rectangular window in the panel.

Later, a Vector 3662 *plugbord* ($6.95), with P pattern 0.1-inch hole spacing, can have two inches sawed off the end of the board, 4-7/16 inches from the plug end, to retain 36 rows of holes including the two rows connected to the 44 contacts. This board will mount up to eight read-out units such as Minitron or light-emitting diodes, plus their decoder/drivers, and considerably more DIP ICs if desired.

The drivers should be mounted with the read-outs in order to have only four data leads per decade, not seven, to keep within the limit of 44 contacts. Boards with more contacts are available, but may not be necessary.

Normally, mounting the SN7475N quadruple bistable latches on this board is not desirable, because latches are to be omitted from the circuit when time is being displayed. Of course latches for the digits not required to display time can be mounted on this board to use up some of the available board space here, and relieve the other circuit boards which will be used for the time base, and for the counting functions.

If light-emitting diodes are used as read-out displays the voltage dropping resistors required between the decoder/drivers and the read-outs should be on this board. There must be sufficient contacts to handle decimal points. With eight digits displayed, there may not be sufficient contacts for future expansion.

hardware

Most of the circuitry is on Vector *plugbords* using the 3662 mentioned above for linear rf uses and the 3682-2 ($8.49) which has convenient ground and $+V_{CC}$ busses printed on it for nonlinear ICs and the input circuitry.

These boards mount in the R-644 receptacles as shown in **fig. 6.** A convenient means of mounting is available by obtaining two 24-inch Vector TS240 T-struts.* The company continues to use this address although the earthquake caused them to move to another area.

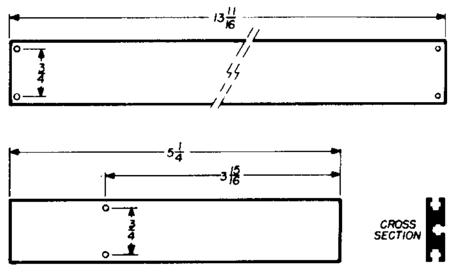


fig. 7. T-Strut lengths and locations of holes. Two pieces of Vector no. TS-240 24-inch stock are required.

Also, order a package of 24 NT6-3 plastic inserts, with no. 6 sheet-metal screws, SC6-11; and a package of 25 square 4-40 nuts, NT4-7. The screws and inserts make right-angle butt joints possible, and the square nuts are used to secure to chassis by the center T-slot nut cavity, and to fasten R-644 receptacles by one of the two edge T-slot nut cavities. (Small hex 4-40 nuts *will* work.)

Saw off, and file smooth, one top T-strut, one bottom T-strut, and two side T-struts as shown in **fig. 7. Fig. 6** shows the side T-struts 3/8-inch longer than the dimension in **fig. 7.** This is satisfactory if the bottom chassis guide rails are wide enough to take the chassis plus both side

*Vector Electronics, 12460 Gladstone Avenue, Sylmar, California 91342, $1.50 each.

T-struts without more than minor springing, but it is a close fit.

It is necessary for the bottom strut to be shimmed up 0.1-inch above the chassis with two large washers so that the lower edge of the plugboards will be above the chassis surface. Some chassis space could be saved for pushbutton location by using two short pieces of strut in lieu of the long bottom one, and shimming their ends with washers held in place with screws through the chassis and up into nuts in the central T-slot nut cavity. This would result in a small loss in strength.

chassis holes

The more critical chassis holes are marked on **fig. 4.** Adequate 7/16-inch holes for large-hole grommets may be drilled in front of the lower T-strut and located convenient to the below-chassis control wiring. The holes for the crystal oscillator oven and clock reset pushbuttons were originally planned to be in front of the bottom T-strut. However, that results in possible conflict should nearby panel holes be used for longer switches or controls in the future.

The hole for an octal socket for the crystal oscillator oven should be punched or drilled with a fly-cutter; due to the thin, soft aluminum the ¼-inch fly-cutter center guide drill should pass through a ¼-inch bushing taken from an old switch or potentiometer, temporarily mounted to keep the drill from wandering.

Suitable holes for the transformers and power-supply parts, and for adequate pushbuttons for reset and adjusting the clock, should be drilled. Switchcraft type 103 are suitable spdt pushbuttons. The holes for the grounded and the insulated LM309K 5-volt voltage regulators can be drilled in the side aprons of the chassis to save top chassis space and provide adequate heat-sinking.

t-strut assembly

Prepare the lower T-strut (it has no holes) by inserting a plastic screw insert, properly oriented in the slot, into each side T-slot at one end of the lower T-strut, then cutting off the flat plastic that continues to extend beyond the end of the T-strut. Next, put a sufficient number of square 4-40 nuts, or small hex nuts if you do not have the Vector square ones, into the rear T-slot to take care of any future expansion. Eight or ten should be sufficient.

Now put plastic screw inserts into the other end of the side T-slots, again cutting off the flat surplus material. Put a 4-40 x 3/8-inch machine screw up through each of the four holes in the top of the chassis with a lock washer. On top of the chassis put on a shimming washer (not retained by the nut), and then a square nut, on the two screws that are clear of the sides. Before tightening the nuts, slide the lower T-strut onto these nuts using the central T-slot. Adjust the position at the sides and tighten the machine screws.

Next, place plastic screw inserts into the side T-slots at the top of each side piece of T-strut (away from the mounting holes), again removing excess plastic. Put 4-40 x ¼-inch machine screws, lock washers and a square nut through the four holes provided, from inside the chassis, using the mounting holes. Slide the side T-struts down over the square nuts, using the central T-slots, so that the side T-struts stand up outside of the sides of the chassis. Secure the machine screws. Insert no.-6 round-head sheet metal screws through the T-strut mounting holes drilled through the side T-slots and into the plastic inserts in the ends of the lower T-strut.

Now, using no.-6 flat-head sheet-metal screws, secure the top T-strut to the top of one side T-strut. Then insert the same number of square nuts into the rear T-slot of the top T-strut as were put into the bottom T-strut, and secure the remaining end of the top T-strut to the vertical side T-strut. Later, the R-644 receptacles can be attached – probably after soldering wires to the contacts. The completed assembly appears in **fig. 6.**

After the R-644 receptacles are attached it may be necessary to bevel with a file the lower side edges of the Vector 3682-2 *plugbords* in order to ensure that there will not be a short circuit from the edge printed buss to the chassis (though both may be at ground potential). Later, it may prove to be advisable to place a strip of plastic tape

power supply

Inasmuch as the provisions for digital clock, latches, decoder/drivers, read-outs and digital dial mixers may consume considerable power, adequate amperage has been provided in the design. The most

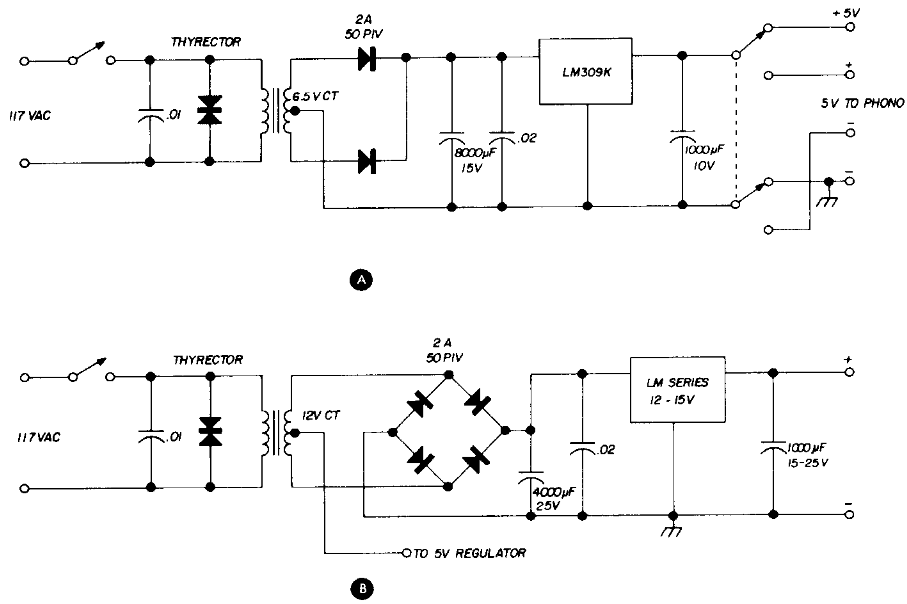


fig. 8. Power supply options. Center-tapped transformer, LM309K five-volt regulator and switched ungrounded output for experimental connection elsewhere is shown in (A). 12- or 15-volt supply using LM336 or LM337 regulator, with centertap to five-volt filter and regulator in (B).

along the top of the chassis where the plugboard will be, or to place tape around the bottom edge of the plugboard.

The rear view, **fig. 6,** shows the far plugboard with its printed $+V_{CC}$ and ground busses extending out from the receptacle by use of a Vector 3690 card extender. This permits operation of a board in the clear for maintenance or test purposes. In a few cases the extension may change the operating characteristics of the board somewhat. An alternate method is to make up a cable extender using the R-644 receptacle and a 3662 board connected by 44 wires. The wires can be flat ribbon cable, but it is difficult to obtain this in less than 100-foot lengths.

convenient 5-volt regulator with internal overload protection appears to be the National Semiconductor LM309K for currents around one ampere. These will be seen in **figs. 5** and **6** mounted on the chassis skirt to conserve chassis space.

The LM309K is in a diamond-shaped TO-3 case which requires heat-sinking if its full capability is to be used. This regulator has only an input, an output and a ground (negative) connection. It does not provide any other voltage, although there is a way to vary it by lifting the ground voltage with respect to the output. It is recommended that silicone heat-conducting heat-sink compound be used under the regulators, on both sides of the mica insulator.

Apparently the LM309K was designed to have an input voltage of 7 to 25 volts. Avoid loading the transformer, rectifier and input capacitor to a lower input voltage to the regulator. This is provided by a good 6.3-volt transformer; with a large filter capacitor of some 8000 μF for the 5-volt supply, and half that for 10 to 15 volts. A good 2-ampere transformer for under $4 is the Calectro DI-747 (GC Electronics), producing over 9 volts input to the regulator from a 12-volt center-tapped rectifier, before a load is applied. The use of a 12-volt center-tapped winding permits a bridge rectifier for the higher voltage, and half that voltage from the center tap, as shown in **fig. 8.**

higher voltages

National Semiconductor also produces the LM336 for 12 volts at about 500 mA, and the LM337 for 15 volts at about 400 mA, depending upon both the input voltage (which should not be excessive) and the adequacy of the heat sink. With one of these regulators a center-tapped transformer of sufficient voltage can be used simultaneously for the 12- or 15-volt regulator, and also for the 5-volt regulator.

For that matter, it is feasible to use two regulators or more for different voltages from the same higher-voltage rectifier, provided that the maximum regulator voltage and heat dissipation ratings are not exceeded. The higher-voltage regulators are priced around $6. All three of these ICs are protected by internal current-limiting.

With any of these power supplies rectifier diodes that handle 1.5 to 3 amperes may prove convenient. Glass-amp units can break unless all bends in the leads are made between two long-nosed pliers so that there is no strain on the glass.

For current less than about 45 mA the adjustable type 723 IC voltage regulator (made by Fairchild and others) may be used. It is rated up to 150 mA, which would require a 0.335-inch clip-on heat sink if the metal package is selected. The total internal power dissipation must be limited to 800 milliwatts. The input voltage must not exceed 40 volts. There must be at least a 3-volt drop between input and output voltages.

The current-limiting resistor, R_{sc}, can be selected by dividing 0.65 by the desired limiting current in amperes, and frequently is ten ohms (see **fig. 9**). Approximate values for the R1/R2 voltage divider are given in **table 1**. These figures are derived from a Fairchild application note with some adjustment to approach standard resistor values. R3 is needed only for minimum temperature drift; it can be calculated from R1 x R2/(R1 + R2), and frequently is around 3k ohms. **Fig. 9** shows a circuit used for an output above 7 volts.

Avoid blowing out the 723 IC by accidental application of reversed rectifier voltage. This can be done by using a series diode between the rectifier and the IC.

Circuits, including those for external-pass transistors, will be found in the Fairchild application note for cases where more than the rated current is to be regulated by the 723, or the output voltage is to be below 7 volts.

Keep in mind the much higher peak input voltage to the regulator. A 15-volt capacitor or larger is required for the first filter capacitor at the output of the 5-volt rectifier diodes, and a 25-volt or larger capacitor in the 12-volt supply. A lower break-down voltage capacitor is satisfactory for the output side of the voltage regulators, just exceeding this regulated voltage. Generally, a smaller capacitance is suitable on the output of the regulator, since additional capacitors generally are placed on the circuit boards because of the tendency of TTL flip-flops to create spikes and noise which can trigger other flip-flops.

If mica mounting kits are used to insulate the TO-3 regulator cans, be sure that there are no burrs around any holes, and test the unit for high-resistance isolation from chassis or heat-sink with an ohmmeter before connecting it to other parts.

In the unit pictured in **figs. 5** and **6** one 5-volt power supply is completely insulated from ground until it is switched into the circuitry, so a pair of phono jacks can bring the voltage out to other devices, such as the Palomar Engineers' electronic keyer which requires a grounded positive. Other phono jacks bring out the grounded 5- and 12-volt supplies for other uses.

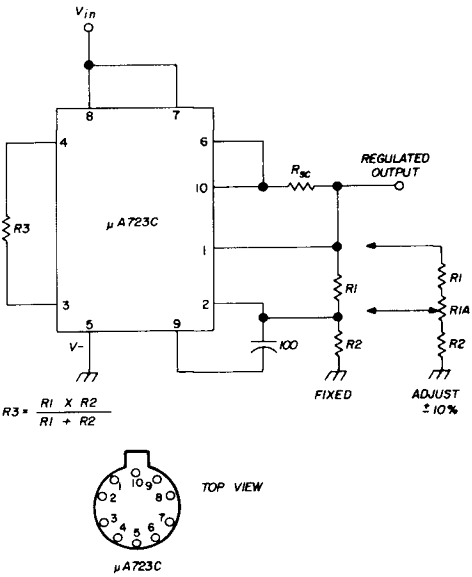


fig. 9. Fairchild μA723-type IC precision voltage regulator circuit for use above seven volts, without series-pass transistor. Input must exceed output by at least three volts.

frequency standard

Initially you can use the 60-Hz power (or 50-Hz elsewhere with three flip-flops in a divide-by-five circuit, or the BCD section of a 7490 decade[1]) for satisfactory operation of a digital clock and for equipment digital dials for tenth-kilohertz read-out. This was discussed in *ham radio*[2] in connection with measurements made from a line-frequency-controlled counter using Fairchild 9093 DTL dual JK flip-flops.

The 9093 flip-flops have toggled on ac at all frequencies from a few hertz up to their limit of 2.2 MHz without any input circuitry. Three FFs can divide by two and three, and four FFs (or a decade counter) can divide by ten, to give a one-second frequency. The remaining FF in the dual units can produce the one-second on and one-second off frequency desired for counter gates.

table 1. Approximate values for the R1/R2 voltage divider in fig. 9.

output voltage	fixed output R1	fixed output R2	adjustable output R1	adjustable output R1A	±10% R2
9	1800	6800	750	1k	2700
12	4700	6800	2000	1k	3000
15	8200	7500	3300	1k	3000
28	22000	7500	5600	1k	3000

The 9093 and some other FFs can be driven directly by a volt or so of ac. Some may require a diode across the input to pass the negative half of the cycle. Usually, several volts of ac are available between ground and a terminal in a power supply, even from a bridge rectifier without a transformer center-tap. A stopping capacitor can be added; then, if desired, a 2-volt zener or several series silicon diodes can be added with anode grounded to provide the FF connected across the zener or diodes with a volt or two of ac safely. This also eliminates the unnecessary negative excursion of the ac sine wave.

Another source of ac is the power line itself, through a nonpolarized capacitor, then the resistor and zener[3] mentioned above. With a power-line source the accuracy of a counter will be within about 0.02 percent on any count, and the average of a number of measurements will probably be correct.

Be sure to provide an octal socket hole in the chassis for future addition of an oven-controlled crystal oscillator. The common, inexpensive E-cut 100-kHz crystal is not nearly as good as a DT-cut crystal for 100 kHz or 1 MHz. The DT-cut has a broad flat temperature curve.[4] The cost is a few dollars more. For best results, the crystal and oscillator should be in an oven.

The counters I have use 100-kHz and 1-MHz oscillator ovens made by Monitor

Products.* One has a 400-kHz crystal, IC flip-flop oscillator and two frequency-dividers which use cross-connected gates. The 100-kHz output is suitable to drive DTL and TTL dividers with fair isolation. However, if the output is taken to other devices it would be well to connect these and the time-base dividers to the oven output through isolating gates.

The oven operates on 120 volts ac, though proportional control would require at least pulsating dc. The oscillator operates on 10 to 12 volts, being zener-regulated internally to 5 volts. A 20-percent change in voltage causes about a 3-Hz change in the 14-MHz harmonic, so it is well to feed the oscillator from a regulated power supply or, at least, from a stable power supply that does not feed a varying load.

The oven is left on except during foreign trips; no adjustment in crystal frequency appears to be needed except possibly once a month, or for an ARRL frequency-measuring test in which an error of one or two Hertz may be undesirable.

C. & H Sales* has sold a large number of James Knights (now CTS Knights), oven/oscillators, 1 MHz, model JKO-PIP-X96D, with proportional ovens. These ovens also plug into octal sockets but operate from 23 to 36 volts dc, both for the oscillator and the oven. Varying the voltage on the oscillator down to eight volts controls the frequency over a considerable range. A hole plug in the top can be unsoldered in order to reach the frequency-adjusting capacitor.

Probably there are other oscillator/oven sources, both surplus and new, such as Bliley and CTS Knights. Only mercury thermostats and proportional control will be free of occasional clicks in a receiver.

*Monitor Products Company, 815 Fremont, South Pasadena, California 91030.

*C & H Sales, 2176 East Colorado, Pasadena, California 91107.

*The SN74162N synchronous up/down decade counter is available from Polypaks, Box 942, South Lynnfield, Massachusetts 01940.

up/down counters

Before concluding it may be desirable to make preliminary mention of the SN74162N synchronous up/down decade counter, which is fully programable[5] – that is, it can start counting at any number, and even divide by odd figures like seven. This has become available under $5 and need be used only in decades that are displayed on the read-out.*

For a year or more these devices have provided a newer approach to decade frequency division; like the 7490 decade they divide the frequency, but they also provide a down-counted read-out. There is good reason to mention these because of a possible simplification of equipment by eliminating all circuitry used for synthesis of the original signal frequency before counting it.

reading material

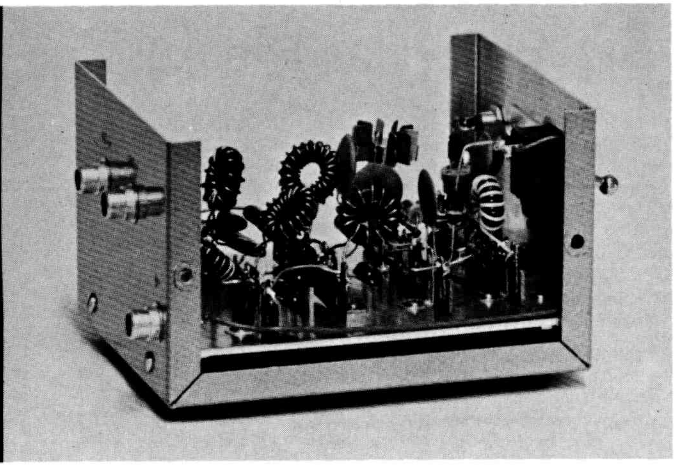
Preliminary reading material on non-linear ICs, counters and clocks will be found in the following reference material.

references

1. R. Wilson, G3TBS, "A 24-Hour Digital Clock," *Radio Communications*, April, 1971, page 254.
2. E. H. Conklin, K6KA, "Counter Gating Sources," *ham radio*, November, 1970, page 48.
3. D. Kochen, K3SVC, "Transformerless Power Supplies," *73*, September, 1971, page 14.
4. I. M. Hoff, W6FFC, "The Mainline FS-1 Secondary Frequency Standard," *QST*, November, 1968, page 34.
5. E. H. Conklin, K6KA, "Electronic Counter Dials," *ham radio*, September, 1970, page 44.
6. H. S. Knoll, WAØGOZ, "Simplified Digital-Counter Readout," *ham radio*, January, 1970, page 66.
7. O. C. Stafford, "Electronic Digital Clock," *ham radio*, April, 1970, page 51.
8. A. A. Kelley, K4EEU, "Digital Frequency Counter," *ham radio*, July, 1970, page 16.
9. A. A. Kelley, K4EEU, "10:1 Digital Frequency Scaler," *ham radio*, August, 1970, page 26.
10. R. M. Vaceluke, W9SEK, "Modular IC Counter Circuits," *ham radio*, August, 1970, page 63.

ham radio

More Details? CHECK—OFF Page 94



solid-state driver

and final for 40 and 80 meters

A project for one or two weekends — features include antiresonant traps, making band switching unnecessary

C. E. Galbreath, W3QBO, 8326 Still Spring Court, Bethesda, Maryland

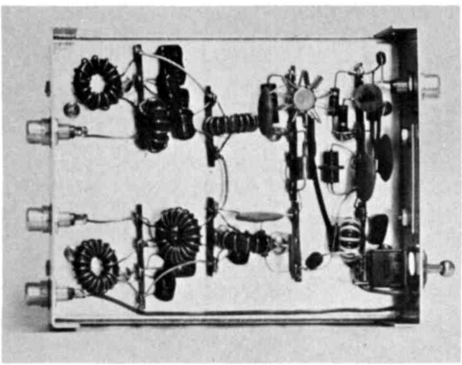
This two-band solid-state transmitter was designed for use with a vfo such as the one described in an earlier issue of *ham radio.*[1,2] It operates on 40 and 80 meters, consists of only two stages, and incorporates the best design practices for stabilization and unwanted signal suppression. The unit is easy and inexpensive to build and is an excellent performer. Output can be varied from a few milliwatts to over two watts.

the circuit

The driver stage (**fig. 1**) uses an inexpensive Motorola 2N4124, Q1, which operates as a class-B amplifier with its base biased through a voltage-divider to obtain approximately collector-current cutoff. With no signal applied collector current is near zero, which minimizes current drain during key-up conditions. As a class-B amplifier, the stage is easier to drive than if operated in class C. The signal input from the vfo is coupled to the base of Q1 at low impedance. A 100-ohm resistor in series with the input at the base of Q1 eliminates any tendency to self-oscillation, which sometimes may occur without it. The signal input at the base of Q1 is not appreciably reduced by this resistor.

Other transistors may be substituted for Q1; for example, I've used a Motorola 2N3904 with good results. No heat sink is required for Q1.

The driver tank circuit includes a broadband toroidal inductor, L1, which is



Wiring of the 40-80 meter transmitter.

fixed-tuned by C1. L1 resonates on both bands without changing the tank-circuit capacitance. The emitter-bias resistor of Q1 is unbypassed to provide a small amount of degenerative feedback, which increases driver stability. Interstage coupling through the B+ line is reduced by the 25 μH choke between driver and amplifier. Added protection is provided by the .05 μF bypass capacitor between B+ and the chassis.

The driver output is inductively coupled to the amplifier transistor through L2, which is wound over L1. L2 also provides the correct impedance match for the excitation voltage to the amplifier.

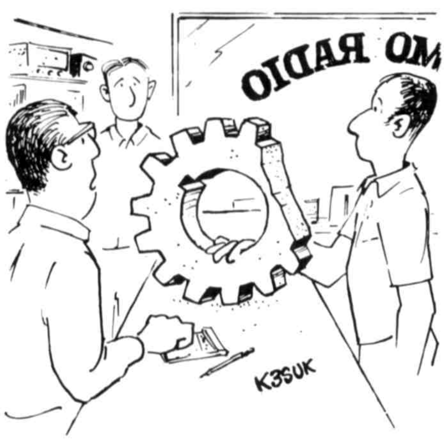
output stage

The final amplifier consists of a 2N2102 transistor, Q2, whose tank circuit is a double pi network for each band. Toroidal inductances are used in the pi networks as they are self-shielding and occupy little space. They are also easy to make and mount in the circuit. The output impedance of the final stage is approximately 50 ohms. A heat sink is required for Q2.

No switching is needed to change bands. An antiresonant trap is inserted ahead of each pi network. On 80 meters the trap ahead of the 40 meter pi network is resonant at 80 meters and isolates the 40-meter tank from the output circuit. On 40 meters the trap ahead of the 80-meter pi network is resonant at 40 meters and isolates the 80-meter tank from the output circuit. I've used traps for this purpose since early 1968.* When changing bands, it's necessary only to insert the transmission-line plug into the appropriate output jack at the rear of the Minibox.

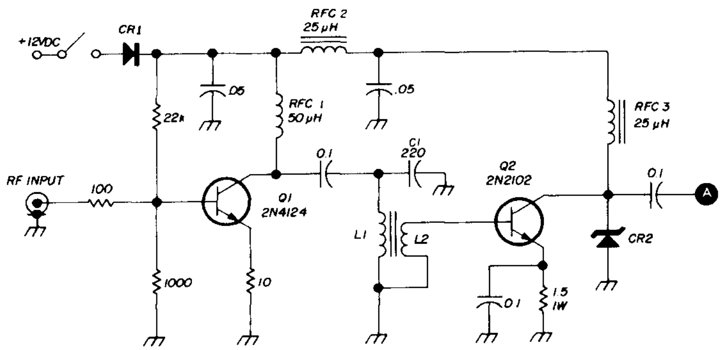
performance

The rig runs about 2 watts output using a 12 V supply. The two stages together draw about 320 mA. The voltage drop across polarity-guarding diode CR1 is over 1 volt. The transmitter will operate on as little as 3 volts, reducing the output to a few milliwatts. For regular duty, a 12-volt lantern battery makes a good power supply. A battery pack of 8 or 10



"Joe, we got any parts for those 160-meter beam rotators we were selling last year?"

*They were used in 1967 in a transmitter known as the ARP-1.



C1	220 pF dipped silver mica capacitor	L1	24 turns No. 24 enamelled on Amidon T-50-2
CR1	50 volts, 1.5 amps	L2	12 turns No. 24 insulated over L1
CR2	39-volt, 1 watt zener, American Semiconductor Corp. 1N3034 or equivalent		

fig. 1. Schematic of the 40-80 meter transmitter. Traps ahead of each output network eliminate bandswitching.

D cells in series will also do very well. For reduced power a 6-volt lantern battery or a 6-volt battery pack will work well. Although I have operated the transmitter on 15 volts, I have not established a safe maximum B+ voltage. †A 100 µF electrolytic capacitor across the battery terminals provides an ac path to ground.

A zener diode, CR1, between the collector of Q2 and ground protects the transmitter from spikes in excess of 36 volts. Too much voltage on the collector will destroy the transistor. Normally the peak rf swing on the collector will not exceed twice the supply voltage.

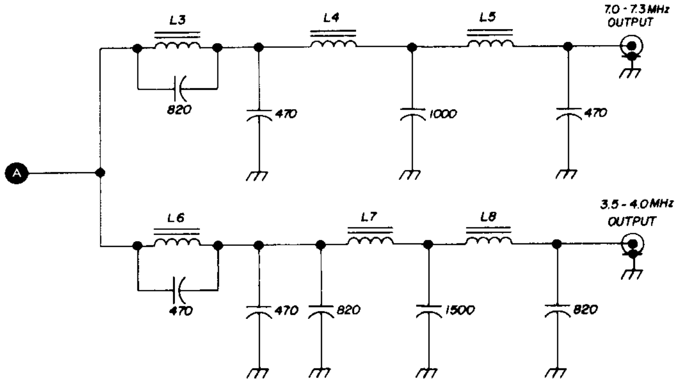
construction

The transmitter is housed in a 3 x 4 x 5-inch Minibox. Components are mounted on terminal strips for ease of construction. The terminal strips may be mounted either on the base of the Minibox or on an aluminum plate, which may be inserted into the box after component wiring is completed. I prefer the second method, as it simplifies component mounting and wiring, and the unit can be tested before inserting it into the box. The aluminum plate is bolted to ½-inch right-angle brackets at each end of the Minibox.

Start construction with the angle brackets. I used ½-inch right-angle aluminum purchased at the local hardware store. Cut two brackets about 3½ inches long and mount one at each end of the Minibox. Cut a piece of aluminum 3½ x 4-7/8 inches and bolt on the brackets in the box. Now remove this piece with the brackets attached and use it outside the box as the chassis on which to mount the terminal strips and assemble and wire all components.

The driver stage is located at the front end. All components for the driver stage except the tank circuit are mounted on a 5-lug terminal strip, center lug grounded. The driver-stage tank is mounted on a 3-lug terminal strip in line with the 5-lug strip. Similarly, all components for the final except the tanks are mounted on a 5-lug terminal strip. A 3-lug strip in line with this 5-lug strip holds the B+ line decoupling choke and bypass capacitors. Q1 and Q2 may be soldered directly into the circuit, or transistor sockets may be used with two of the socket terminals in

†Motorola's Semiconductor Data book lists maximum V_{cb} ratings of 30 V (2N4124) and 120 V (2N2102). *editor.*



L3,L7,L8	18 turns No. 20 enamelled on Amidon T-68-2
L4,L5,L6	13 turns No. 20 enamelled on Amidon T-68-2
Q1	Motorola 2N4124
Q2	Motorola 2N2102 (heat sink required)
RFC1	50 μH rf choke, Millen 34300-50
RFC2,RFC3	25 μH rf choke, Millen J-300-25

each case soldered firmly to two lugs on the terminal strips. Placement of resistors and capacitors on the terminal strips is not at all critical. The use of terminal strips assures ease of mounting and short direct connections.

Each trap is mounted on a 3-lug terminal strip, center lug grounded. Each double pi-network tank is mounted on a 4-lug terminal strip, one lug grounded.

table 1. Typical rms signal voltages.

	80 meters	40 meters
output of vfo	4.0	4.4
at base of Q1	3.0	3.4
output of Q1	9.2	8.0
at base of Q2	2.7	2.9
output of Q2	15.0	8.0
final output (tank)	10.0	9.0

The two tanks with their associated traps are positioned on either side of the centerline toward the rear of the chassis.

After all components have been mounted on the chassis and wiring completed, check the circuit, point to point, for possible wiring errors. Operation of the two stages can then be tested before mounting the chassis in the Minibox. Use a two-watt, 50-ohm composition resistor as a dummy load. A sensitive swr bridge and reflected-power meter connected between transmitter and dummy load is most useful for checking operation. The swr should be 1:1; there should be no reflected power indication on the meter. Meter deflection in the forward direction indicates transmitter output. Those with a vtvm and an rf probe can check rf voltages at various points in the circuit. **Table 1** gives typical rms rf voltage readings as measured by a Heath vtvm and a Heath rf probe when using a 12-volt power supply. Different transistors of the same type will often produce somewhat different results.

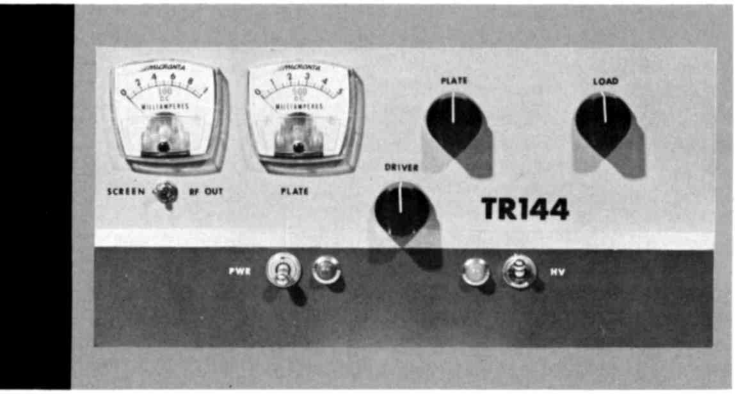
On the front of the Minibox is the on-off switch for the power supply and the phono jack for the vfo line. On the rear of the box are 3 phono jacks, one for the output on each band and the third for the power-supply connection. The holes should be drilled and the switch and jacks fitted before the completed chassis is put back into the box. The switch and jacks, of course, must be removed to permit installation of the chassis.

For good results on the air be sure to use an efficient antenna system.

reference

1. C. E. Galbreath, W3QBO, "A VFO for Solid-State Transmitters," *ham radio*, August, 1970, p. 36.
2. C. E. Galbreath, W3QBO, "VFO Buffer Amplifier," *ham radio*, July, 1971, p. 66.

ham radio



the TR-144

a transverter for two meters

Introducing another vhf transmitting converter and power amplifier compatible with Drake equipment — a companion to the TR-50

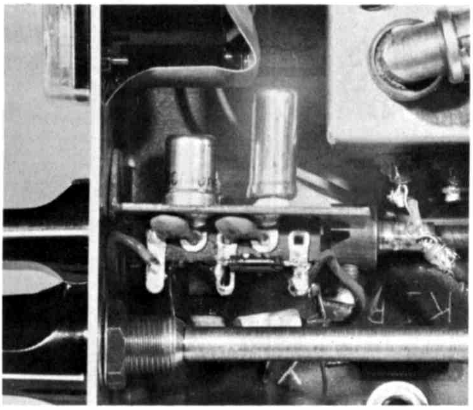
Louis E. Savoie, K1RAK, 29 Hillsdale Road, Holbrook, Massachusetts 02343

The TR-144 is a two-meter version of the TR-50 transverter described in an earlier issue of *ham radio.*[1] Like the TR-50, the TR-144 is compatible with Drake TR-3 equipment. Features include 350 watts PEP input (two-tone test signal), self-contained power supply, relay switching circuits, and a high-performance mosfet receiving converter. An Eimac 4X150 is used in the power amplifier. Full metering of critical circuits is provided. Additionally, the screen-current meter doubles as an rf-output indicator, which is desirable for initial tuning and on-the-air monitoring.

packaging

The cabinet is a TR-6 unit, purchased from Drake for $20. The chassis is made of .047 copper-plated steel (the plating isn't necessary; merely a preference). Chassis measurements are 10½ x 13 1/8 x 2 inches. The front panel, which is secured to the chassis by the switch and panel-light hardware, is .060 aluminum, 5½ x 10½ inches.* Captive hardware is pop-riveted to match mounting holes in the TR-6 cabinet.

*Full-scale drawings of the TR-144 front panel and chassis are available from *ham radio* for $.50 and a self-addressed stamped business envelope. *editor*



New oscillator circuit is built on a single-side PC board and mounted under the retaining hardware of the driver tune control.

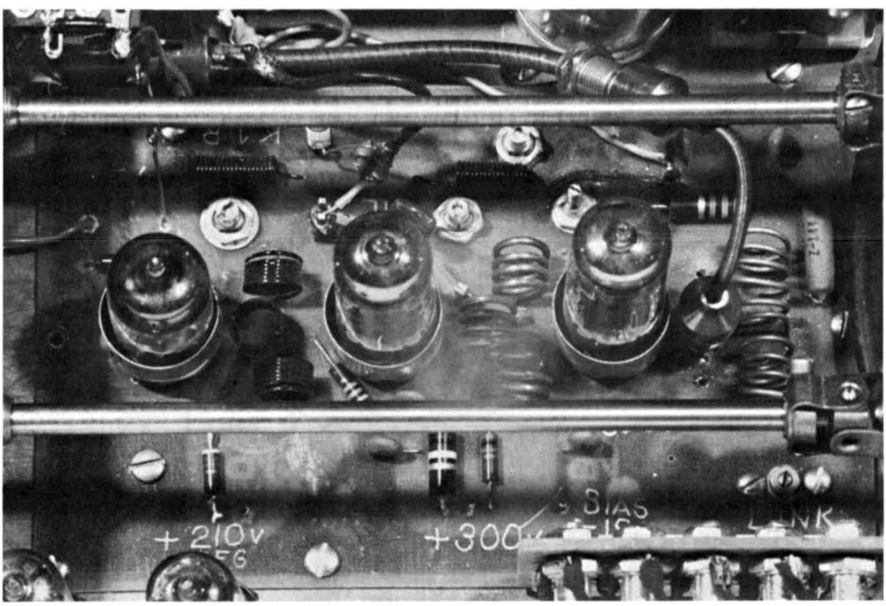
Much of the power and control circuitry had been designed for the TR-50 and is adaptable to the TR-144. The power transformer provides high and low B+ voltages, bias voltage, filament power, and relay-switching power. A series-phasing circuit provides the bias and relay voltages from the multiple secondary windings of the transformer.

The mixer (**fig. 1**) is the PC transmitting converter described previously.[2] It's the big brother of the six-meter mixer described in the same article, which used a 12AT7 oscillator feeding a 6360 doubler into a 6360 mixer-driver. (This circuit was changed for the TR-144, as shown later.) Initial bench tests of the mixer showed an output of 1½ watts with the voltages suggested. The mixer board requires no modification. However, some of the coils in the ocillator and buffer sections must be changed to accommodate the 28-MHz heterodyning system. Visual monitoring of the mixer output with a scope indicated a faithful reproduction of the Drake sideband generation.

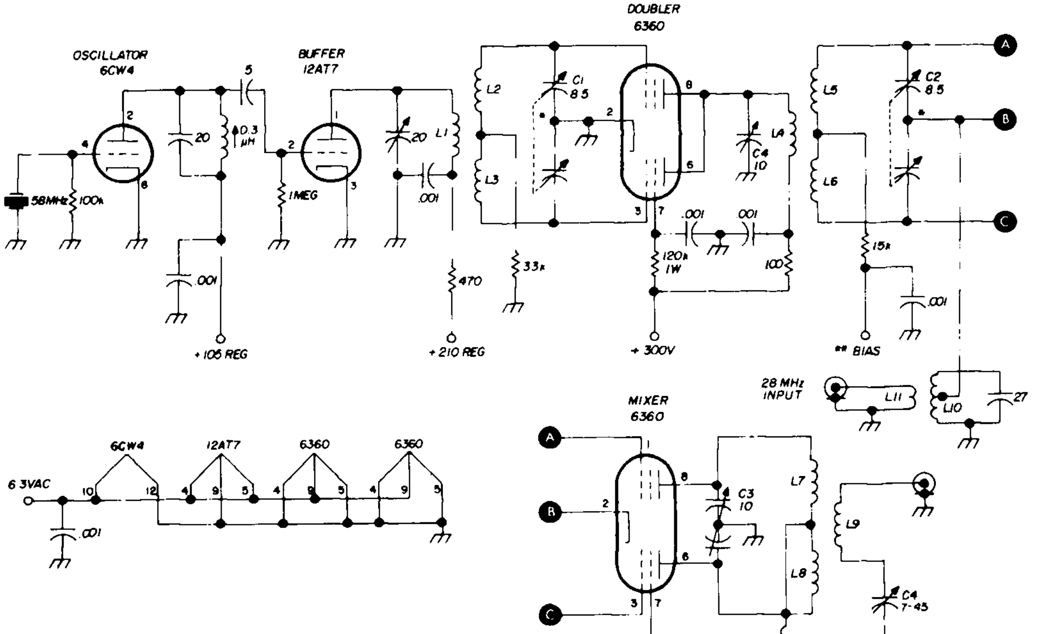
power amplifier

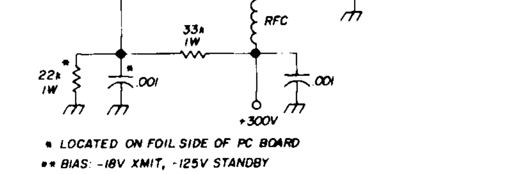
Based on previous experience and the success of the TR50, I decided to stay with the 4X150/4X250B power-tetrode family for the TR144 power amplifier. A push-pull circuit would yeild more output power, but limited cabinet space dictated a single-ended power stage.

The circuit (**fig. 2**) is straight-forward. Conventional vhf construction practices should be used. The power-amplifier plate circuit is enclosed in a 3 x 4 x 5-inch



Top view of transverter. A double flex shaft arrangement connects front-panel control to mixer output-tuning capacitor.





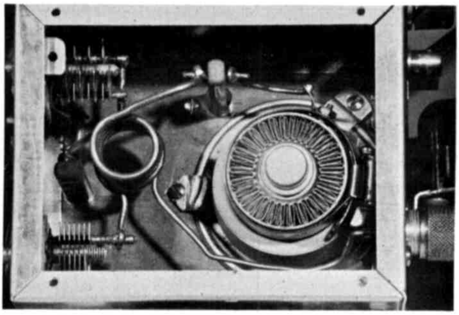
C1,C2	miniature 8.5 pF butterfly (E. F. Johnson 189-253-5)
C3	10 pF butterfly (E. F. Johnson 160-211
L1	7 turns no. 20 AWG Formvar, air wound, 3/8" dia., close spaced
L2,L3	9 turns no. 20 AWG Formvar, air wound, 3/8" dia., close spaced
L4,L5,L6	4 turns no. 16 AWG tinned copper wire, air wound, 3/8" dia.; turns spaced one-half wire diameter
L7,L8	4 turns no. 16 AWG tinned copper wire, air wound, 3/8" diameter; turns spaced 1 wire diameter
L9	2 turns no. 16 AWG tinned copper wire, air wound, 3/8" diameter; spaced 1 wire diameter
L10	12 turns no. 20 AWG Formvar, close wound on ¼"-diameter slug-tuned form, tapped 4 turns from cold end
L11	2 turns no. 20 AWG on cold end of L10
L12	8 turns no. 26 Formvar on ¼" dia. slug-tuned form
RFC	Ohmite Z-144
Xtal	58 MHz third-overtone

fig. 1. Modified two-meter transverter (from an original circuit by K1ISP in the April 1969 issue of ham radio).

aluminum utility box mounted on the chassis. Universal joints and ¼-inch steel shafts connect tuning controls to the front panel.

The grid-compartment box is made of 0.47 steel and mounted on the chassis underside flush with the rear-chassis panel. The 4X150 tube-socket hardware secures the box to the chassis undersurface.

The blower is a 15 cfm unit bracketed to the rear chassis wall and utility box. A



TR-144 plate-circuit compartment. Output link to antenna is mounted directly below plate coil. Plate-tuning capacitor is modified with alternate rotor and stator plates removed.

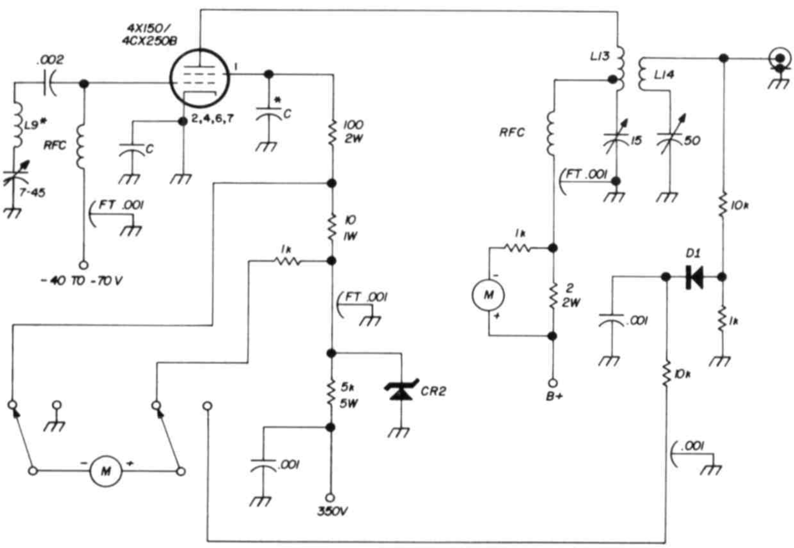
one-inch-diameter hole through chassis and grid box accepts the blower output. The mating edges of the blower outlet and chassis are sealed with a fillet of RTV silicone. The grid-box cover has a rubber gasket to inhibit air leakage.

Power- and filament-supply connections to the 4X150 are via .001-μF feedthrough capacitors. Rf coupling from the mixer link to the 4X150 grid is via an unbypassed ceramic feedthrough (photo). This arrangement provides excellent grid/plate circuit isolation, and the amplifier requires no neutralization. Should instability occur, conventional stub neutralization should stabilize the circuit.

power supply

Power for the TR-144 is supplied by a single transformer **(fig. 3)**.* A full-wave rectifier/filter provides 900 Vdc (key down) for the amplifier B+. Twelve Vdc for the receiving converter and relay-switching circuits are obtained from

fig. 2. Power amplifier circuit. Metering scheme features switching circuit to monitor rf output.



C*	.001 μF 600 V disc from each cathode pin to ground screen bypass (part of Eimac SK600 socket)
L9*	link on mixer board
L13	4 turns no. 10 5/8 in. dia., 1 in. long. Tap 1 turn from bottom end
L14	2 turns no. 12 5/8 in. dia. spaced 1 wire dia. Mount 1/4 inch from cold end of L13

RFC	Ohmite Z144
D1	1N34
CR2	1N2990B (ten 33V 10 W zeners in series)
M	Micronta 0-1 mA (Radio Shack, $2.98)

*The transformer is available from J. Reeves, WA9HKE, 2207 Columbus Ave., Anderson, Indiana 46014. Ask for P&H transformer.

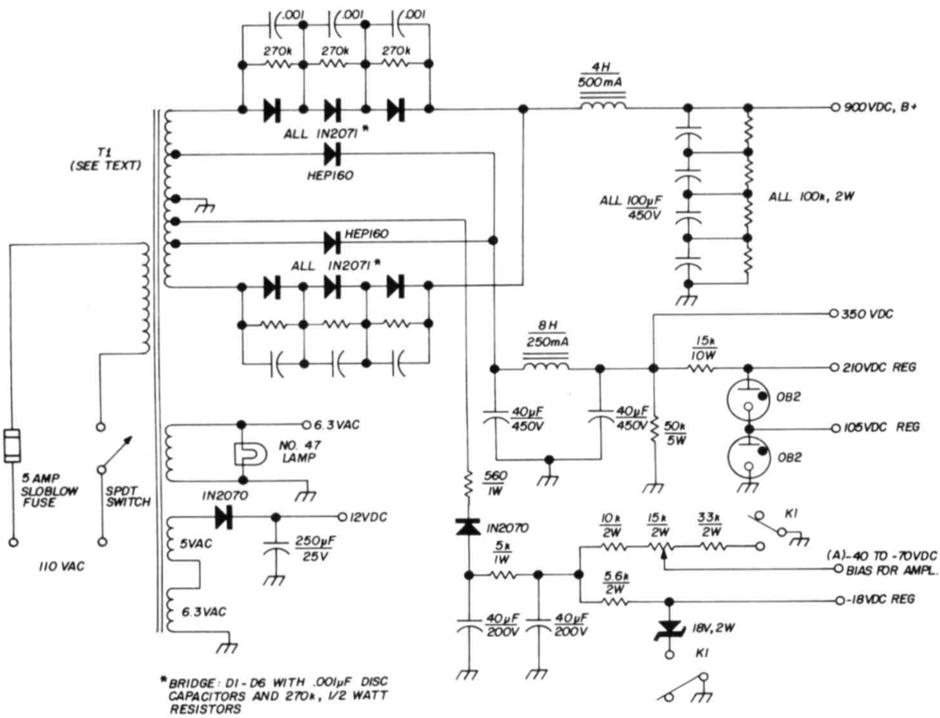
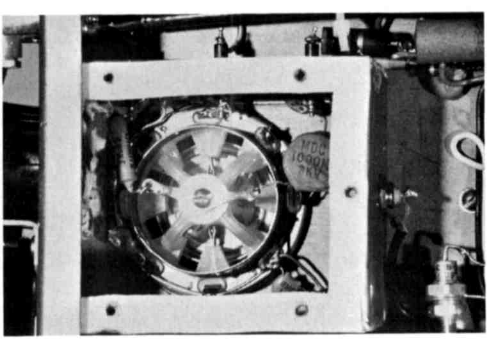


fig. 3. TR-144 power supply. High and low voltages for all circuits are provided by a single power transformer.

series-connected 6.3- and 5-Vac secondaries. Voltages for the transverter stages are obtained from taps on the HV secondary.

Ten series-connected zeners provide regulated screen voltage for the 4X150. Any combination of zeners that will deliver 350 Vdc and dissipate 20 watts is suitable.



Amplifier grid compartment. Filament screen, and bias voltages are supplied via feedthrough capacitors. Input from the mixer is via unbypassed ceramic feedthrough connectors mounted on front of box.

metering

The TR-144 metering scheme is the same as that used for the TR-50. Two 0-1 dc milliammeters in series with 1k-ohm ½-watt resistors monitor screen and plate current. Shunts for the screen- and plate-current meters (0-100 and 0-500 mA) are respectively 10 ohms 1 watt and 2 ohms 2 watts. The screen-current meter may be switched to indicate rf output.

Numbers on the meter scales were removed with a typewriter eraser and replaced with press-on transfers to indicate the desired ranges. Each meter face was sprayed with two light coats of clear acrylic lacquer to restore gloss and secure the transfer numbers.

switching and controls

The relay controls are identical to those in the TR-50 (**fig. 4**). The 10-dB pad, which must be used to reduce ssb exciter output, is switched into the system in the transmit mode.

All rf connections between the TR-3, TR-144, and 10-dB pad are via short lengths of RG-58/U cable and BNC connectors. The main control relay, K3, is a 110-Vac unit by Potter-Brumfield, type KA4314-1, which is actuated by the keying line from the TR-3. Relay K3, in turn, actuates the Dow-Key antenna changeover relay, K1, and the miniature coax relay, K2 (a surplus item). Relay K2 switches the TR-3 to the 10-dB pad on transmit. Relay timing causes no problem, and VOX action is good.

receiving converter

The receiving converter, available from Spectrum International,* is model DGTC 22 and features mosfet rf and mixer stages. It has a gain of 25 dB and is designed for 28-32 MHz output.

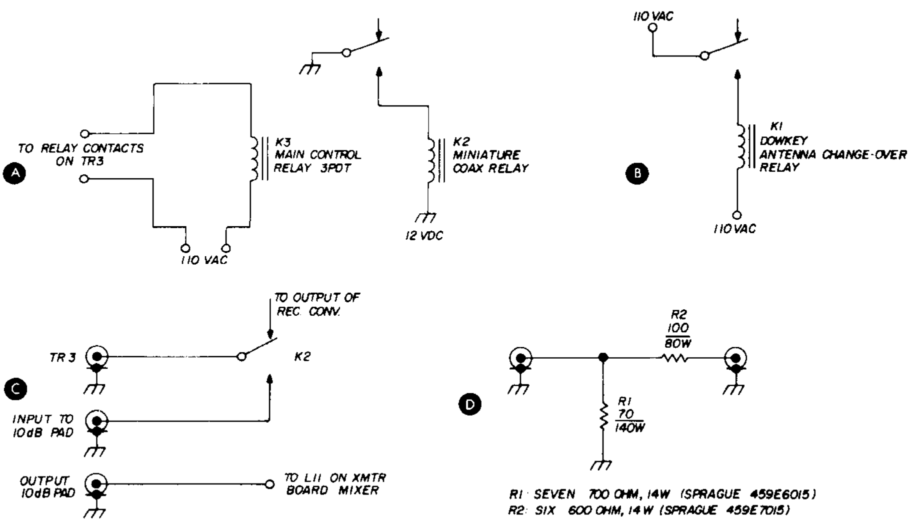
The converter is mounted in a 4 x 2 1/8 x 2¼-inch Minibox. The box cover has BNC fittings and feedthroughs for 12 Vdc and oscillator input. The feedthrough for oscillator injection is an unbypassed type.

The converter must be modifed slightly for transverter operation. The converter oscillator was disabled and the 0.5-pF coupling capacitor removed. It took some looking to find this capacitor in the converter. It turned out to be nothing more than a small loop of wire mounted next to the coil in gate 1 of the 3N140 mixer mosfet.

Remove the cover can of this coil by carefully unsoldering its tabs from the PC board. Unsolder and discard the wire loop, then resolder the shield can. Connect a 1-pF capacitor between gate 1 on the PC board and the junction of L4, C4 on the mixer board. Interconnections between boards are via RG-174/U coax. This change makes the 116-MHz oscillator common to transmit and receive

*Spectrum International, Box 87C, Topsfield, Mass. 01983.

fig. 4. Control circuits. A and B are primary control and antenna switching circuits. Circuit C switches the TR-3 exciter between receiving converter and the 10-dB pad during transmit mode. D is the attenuator necessary to reduce exciter output power.



functions. No further changes are required in the receiving converter.

A pair of 1N100 diodes connected back-to-back between receiving-antenna terminals and ground will provide front-end protection.

alignment and test

After completing the wiring shake the chassis vigorously to remove wiring debris.* Inspect all soldered connections on tube sockets, tie points, and terminals. A 5X magnifying glass is helpful here. Often an unsoldered wire will be revealed beneath top connections on tie points. A toothpick is a useful device to test the integrity of soldered connections while inspecting the work through the glass.

I follow a standard procedure after wiring circuits, which consists of cleaning all soldered connections with a 50/50 mixture of toluene and alcohol to remove solder flux and grime. Next I check all point-to-point wiring with an ohmmeter. With all tubes removed I then check voltages throughout the unit. (Voltages will be slightly on the high side with tubes removed.) These checks are worthwhile, and often a wiring error can be detected and corrected before damage occurs. A time-consuming and tedious procedure — but well worth the effort!

After completing the post-wiring checks, install the 12AT7, 6360s, and OB2s. Solder a 50-ohm noninductive 2W resistor between link output and ground. Apply power and tune the oscillator and doubler circuits for maximum output. Turn off the TR-144 and install the 4X150 in its socket.

Remove the 50-ohm resistor. Apply power and, after sufficient warmup, key the exciter. With no drive applied, adjust the bias pot for 50 mA of resting plate current on the 4X150. Apply drive and tune L10, C3 and C4 for maximum screen-current indication, then tune plate and load controls for maximum rf output. Plate current should be 200 mA. Power input with the transformer I used was 180 watts dc — power output was 108 watts as measured with a Bird Thru-line wattmeter into a Heath dummy load.

mixer output control

The TR3 tunes from 28 to 29.7 MHz. Tuning the TR144 from the low to the high end indicated a significant reduction in output power. This reduction was traced to the output circuit of the 6360 mixer. The 6360 mixer output circuit is not sufficiently broad to accommodate a 1.7-MHz bandwidth. To obtain maximum output over the entire range, I added a front-panel tuning control for C3 in the mixer output. A Rube Goldberg lashup of two flexible shafts from a panel bearing mount is shown in the photo. A machinist friend is making a miniature right-angle drive so the installation can be improved esthetically. This control allows the mixer output to be peaked over the full tuning range of the exciter.

oscillator pulling

The unit was tested on the air for about a week. A shift in frequency between transmit and receive modes was noted. Circuit analysis suggested only one possibility — the 12AT7 oscillator was pulling. Coupling between oscillator and doubler had to be reduced.

Several changes in coil positions were tried without success. An outboard oscillator using a 6CW4 was constructed, and the 12AT7 was changed to a buffer amplifier. The 6CW4 oscillator voltage is 105 Vdc regulated. Oscillator output is coupled to the 12AT7 with a 5-pF capacitor. The grid resistor in the 12AT7 was changed to 1 megohm.

The oscillator was built on a piece of scrap PC board and mounted by the retaining hardware of the driver tune-control panel bearing. When air tested again, no frequency shift was observed between transmit and receive modes. Sufficient room is available on one corner of the mixer board to mount the 6CW4 tube socket, coil, and other components. The board was bench tested and worked perfectly.

*A small bicycle air-pump is also helpful when cleaning a chassis. *editor.*

painting

Sanding with light horizontal strokes, using fine-grade emery cloth, yields a brushed aluminum finish on the panel. The shiny center strip was made by using a ¼-inch masking tape mask. The upper panel half is dove gray; the lower half equipment gray (both are Krylon colors).

Each panel half was painted with *light* coats of paint and baked for 30 minutes. Front panel lettering consists of press-on transfers – black on the light-gray and white on the dark-gray panel halves. Three coats of clear acrylic lacquer spray, baked for 30 minutes, protect the lettering.

conclusion

The TR144 completes my original project to design and build six- and two-meter transverters to match Drake TR-3 equipment. Switching the TR-3 rf connector through a Waters coax switch allows for easy selection of either six- or two-meter output.

An auxiliary rocker switch was installed on the panel to switch the TR-3 keying line to either transverter. The TR-144 faithfully transverts the TR-3 sideband quality, and on-the-air reports have been excellent.

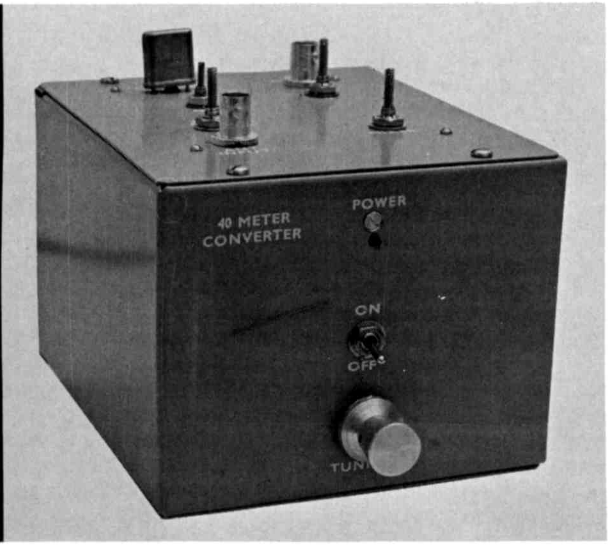
It's quite satisfying to look over one's operating position, see identical cabinets, and be able to say, "I built it!" This is the prime source of my enjoyment in ham radio.

Once again I must express my thanks for the photographic talent and equipment of Dick McGinn, WA1IMS. I'll be happy to answer any inquiries about the construction of this unit upon receipt of a stamped, self-addressed envelope.

references

1. Louis E. Savoie, K1RAK, "TR-50 Customized Six-Meter Transverter," *ham radio,* March, 1971, p. 12.
2. D. W. Bramer, K2ISP, "Heterodyne Transmitting Mixers for Six and Two Meters," *ham radio,* April, 1969, p. 8.

ham radio



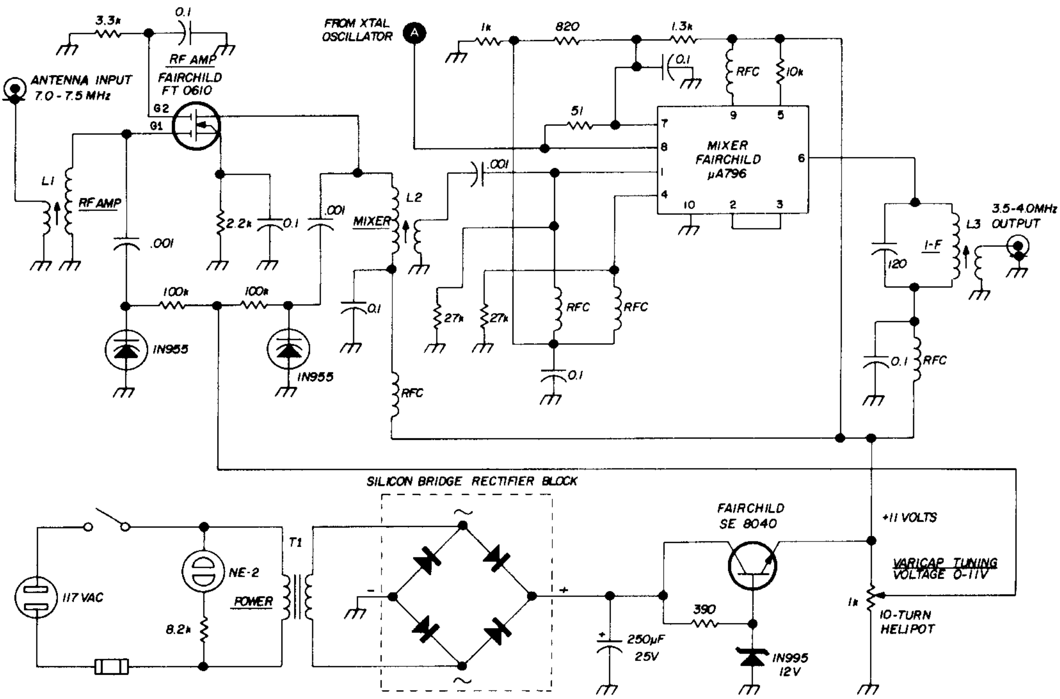
third-generation solid-state high-frequency converter

This converter combines ICs with transistors to provide optimum monoband performance

Mike Goldstein, VE3GFN

Anyone who spends a lazy afternoon thumbing through the past few years' ham publications is bound to notice the rapid advances in solid-state technology. This is true not only of commercial equipment but of the homegrown variety as well. For example, a few years ago the "in thing" was a receiver with a bipolar transistor frontend; even with the low-impedance problems and poor cross-modulation characteristics they presented. Today, to the knowing builder, they are passé; design has already run the gamut from jfet frontends through unprotected and then protected mosfet designs, and new ground is being broken using integrated circuits. How's a guy supposed to keep up to date when things move so fast?

A few years ago, I built a fet converter which seemed to work pretty well.[1] Shortly afterward, they introduced the dual-gate mosfet, which put my converter back into the Dark Ages. I went back to



40-meter circuit values

L1,L2	35 turns no. 29 closewound on Cambion 1534/2/1 form. L is 12 μH, Q is 50. The link is 6 turns of no. 27 wire on the cold end of L1.
L3	50 turns no. 29 wire closewound on Cambion 1534/2/1 form. L is 17 μH and Q is 40. The link is 6 turns of no. 27 wire on the cold end.
L4	75 turns no. 37 closewound on Cambion 1536/2/1 form. L is 30 μH and Q is 70.
RFC	1 mH at 35 mA.
T1	Hammond 166D20, primary: 120 V, secondary: 20 V centertapped at 0.1 A. Note: only one half of secondary is used.
Y1	3.5 MHz.

For 20-meter operation, parts values are:

L1,L2	15 turns no. 27 closewound on Cambion 1534/2/1 form. L is 2.5 μH and Q is 100. The link is 4 turns of no. 27 wire on the cold end.
L3	50 turns no. 29 closewound on Cambion 1534/2/1 form. L is 17 μH and Q is 40. L3 is shunted with a 5.6 k resistor. The link is 3 turns no. 27 wire on the cold end.
L4	20 turns no. 27 closewound on Cambion 1534/2/1 form. L4 has 50 pF connected across it instead of the 82 pF used in the 40-meter converter.
Y1	10.5 MHz.

fig. 1. Schematic diagram of the third-generation mobile converter for 40 meters. For 20-meter operation, parallel the primary of L3 with a 5.6k resistor and change the tuned circuits to appropriate values.

the drawing board and came up with a second generation converter.[2] Then Motorola came up with an IC double-balanced modulator (the MC1596G) which turned out to be a superb mixer, and I was done in again![3]

This third-generation converter, unlike previous efforts, is a single-band converter designed to deliver optimum performance on 40 meters for net operation during the poor summer conditions. Low noise, high gain and good dynamic range were all important design requirements, as well as the usual high-stability and image-rejection performance necessary for smooth operation. The circuit can be used to cover any band right up to ten meters merely by substituting the proper tuned circuits and crystals; a version of the same circuit has been used at 100 MHz with no noticeable instability. Making such a converter bandswitching would be quite easy.

circuit

Varactor diode tuning is used in the rf amplifier which uses a Fairchild FT0601 dual-gate protected mosfet. The RCA 40673 could be used as a direct substitute. The tuning is very smooth, with no instability of any sort, even though the amplifier is not neutralized. It is possible to peak the converter on a signal anywhere in the band, but the tuned circuits are broad enough that constant retuning with frequency change is unnecessary. This is a refreshing change from previous efforts in which all circuits were deliberately resistance-loaded to broadband them, which compromised the stage gain and increased the chance of images appearing.

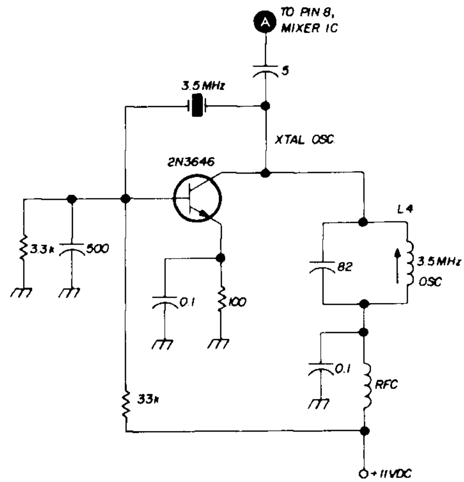


fig. 2. Schematic of the local oscillator for the hf converter. For 20-meter operation change the 5 pF oscillator-output coupling capacitor to 2 pF and change the crystal to 10.5 MHz along with re-resonating the tuned circuit.

"Each kit has a vital component or two missing."

A double-balanced modulator was used for the mixer. The Fairchild μa796, or the Motorola MC1596G or 1496G may all be used in the same circuit. These IC devices make excellent mixers, with *only* the sum and difference of the two input frequencies appearing at the output. A lot of the spurious rejection takes place in the mixer which seems to actually refuse to process anything other than the correct input coming from the rf amplifier. The chance of any spurious crossproducts appearing in the output is very low. In fact, the output waveform is such a clean sinusoid (at 3.5 to 4.0 MHz) that it can be used to drive a digital frequency counter – an instrument easily confused by input waveforms containing more than one frequency.

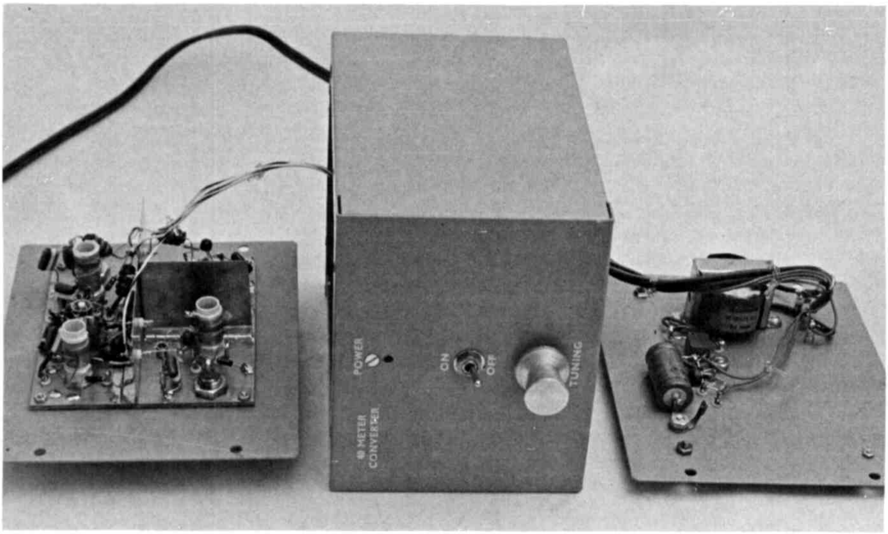
The oscillator is an old reliable circuit, and almost any npn high-frquency transistor can be used. I used the 2N3646 for this unit, but the 2N706, 2N4124 or

HEP50 would work as well, and the circuit should work right up to ten meters even with overtone crystals.

You can use any low-power npn transistor in the series-pass regulator in the power supply. The design is simple, and you can use any bridge block rectifier or discrete diodes. The converter draws only 7.8 mA from a 12-volt supply, so the unit could be powered by a 9-volt transistor-radio battery for quite a while without battery deterioration. If battery operation is likely, use a 100k tuning potentiometer.

construction

The converter is built directly on a piece of glass-epoxy printed-circuit board using press-fit terminals where needed and with shields and ground connections directly soldered to the copper. This type of construction is excellent for rf work, eliminating the usual mess of nuts, screws and lugs needed for grounding to an aluminum chassis, and the time and materials needed for printed circuitry. An alternative would be to use the new *Circuit-Stik* instant printed-circuit decals. None were available at the time of building. The type of construction used added to circuit stability, allowing very short leads and solid ground connections. Nothing less than a good hot soldering iron should be used to make all ground connections, as a cold joint anywhere could be fatal to circuit stability.



Overall view of the 40-meter converter board, cabinet, power supply and connecting wiring.

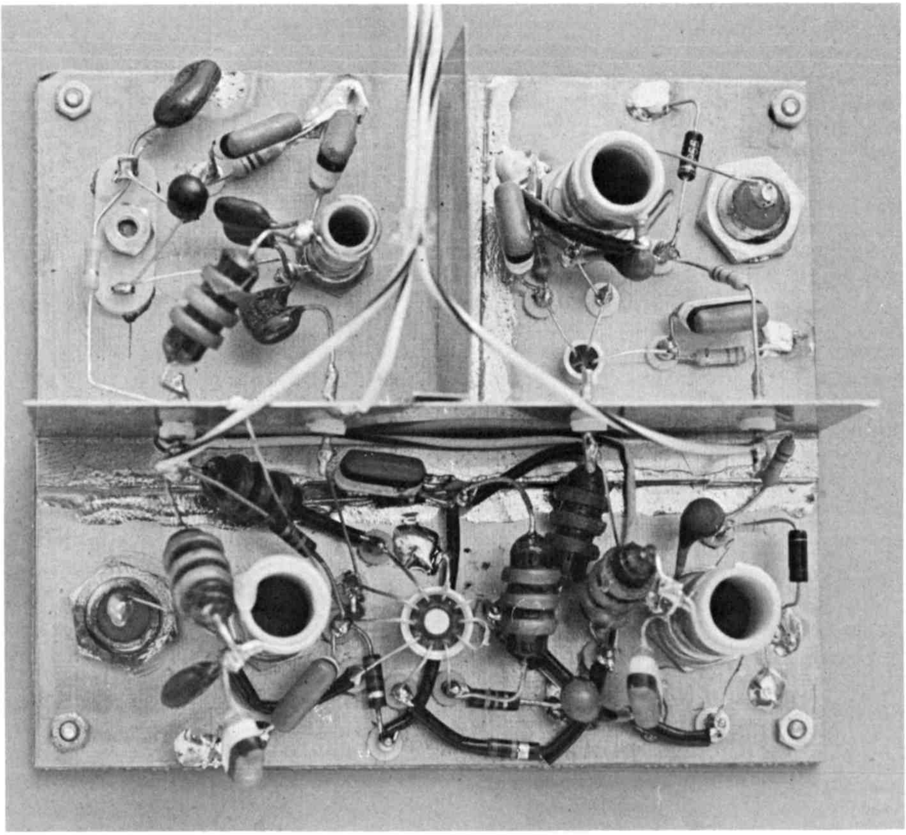
All semiconductors are soldered directly into the circuit, using a heat sink when soldering each lead. Keeping leads short and eliminating the possibility of lead-to-socket capacitance assures stability without neutralizing – even on ten meters.

The general layout of the circuit board can be easily seen in the photograph. The layout minimizes stray capacitance and isolates inputs from outputs; it should be followed quite closely.

To make sure the holes in the circuit board line up with the utility-box cover upon which the board is mounted, the board was mounted on the cover and all centering holes for coils and connectors were drilled through both; the circuit board was then removed from the cover while the circuitry was installed. In this way the holes for the terminals are concealed when the final assembly is completed.

When construction is completed, set the varicap tuning voltage at the potentiometer wiper at 7 volts, tune in a signal at 7.15 MHz, and adjust the rf amplifier, mixer, and i-f coils for maximum signal. You're in business.

The converter input and output impedance, with the coils constructed as shown, is 50 ohms. When driven and terminated in this impedance the system gain is about 30 dB, so keep the receiver gain low to avoid overload. If the converter has too much gain for the receiver used, insert a resistance (1000 ohms or more) between pins 2 and 3 of the mixer IC. Note that the 3.5-MHz crystal oscillator will be heard when the receiver is tuned to 7 MHz.

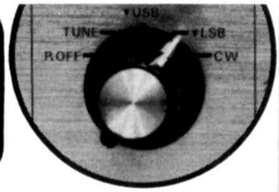


The 40 meter converter circuit board. Upper right section: rf amplifier. **The Varicap can be easily seen just to the right of the antenna coil. The FT0601 is in the lower left area of the section, upside down, with the drain connected directly to the feedthrough terminal.** Upper left section: oscillator. Lower section: mixer. **The IC is turned upside down and mounted directly by its terminals. Pins 2 and 3 are clipped short and soldered directly together. Note how all ground connections are soldered directly to the copper board.**

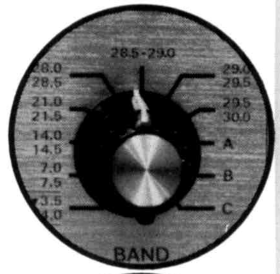
references

1. Mike Goldstein, VE3GFN, "Bandswitching FET Converter," *ham radio,* July, 1968.
2. Mike Goldstein, VE3GFN, "Second Generation FET Converter," *ham radio,* January, 1970.
3. Roy Hejhall, K7QWR, "An Integrated-Circuit Balanced Modulator," *ham radio,* September, 1970.

ham radio



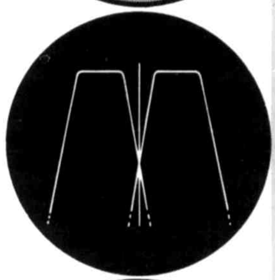
feature
after
feature
after
feature



In addition to those pictured---there's 500 watts P.E.P. power input---digital readout to 100 Hertz---husky matching 115VAC power supply/speaker unit and external VFO as an available accessory.

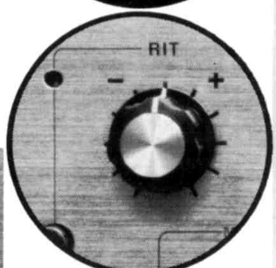
Add all of these and you have the brilliant SB-36---a beautiful experience in operating convenience and enjoyment.

See it at your dealer---write for data sheet.



Separate bandpass filters for USB and LSB. Absolutely no carrier shift when changing sidebands!

SB-36
SSB/CW TRANSCEIVER



SBE

LINEAR SYSTEMS, INC.

**220 Airport Blvd.
Watsonville, CA
95076**

pre-emphasis for ssb transmitters

Reducing peak-to-average power ratio results in increased talk power — here's an af processor that gives 6-9 dB improvement in ssb rigs

V. Aumala, OH2CD, Vanhaistentie 4B7, Helsinki 42, Finland

Single-sideband transmitters are usually rated in terms of peak envelope power (PEP). According to one authority,[1] the average output power of an ssb transmitter is one-half the peak envelope power if no distortion is present. This statement is made on the basis that measurements are taken when the ssb transmitter is modulated with a standard test signal of two equal-amplitude signals.

It can be shown that the ordinary voice contains high-amplitude peaks that are about 14 dB greater than the average level.[2] Furthermore, it is well known that ssb transmitters are peak-power limited. This means that an ssb linear amplifier may be able to handle 1000 watts average power but will begin to flat top when peak power approaches 2 kW.

From the considerations above, it may be inferred that many amateur ssb transmitters are not being used to their full capability. If the peak-to-average ratio of the ssb transmitter output power can be reduced, then the talk power, or articulation index, can be increased. Speech processing circuits have been introduced to reduce the ratio of peak-to-average power; however if the processing scheme introduces distortion, then the articulation index is reduced. The best method of speech processing, for ssb transmitters, is one that provides maximum increase in talk power without distortion and subsequent flat topping.

Let's look at two popular methods of speech processing in amateur ssb equipment: the speech compressor and speech clipper.

compressor

The speech compressor, which is used in the audio circuits of the ssb transmitter, has a typical attack/release time constant of 5×10^{-3} and 5×10^{-1} second. As the ratio of these time constants is made shorter, the compressor action approaches that of a clipper. However, audio compressors do not affect the peak-to-average power ratio of the ssb transmitter; therefore we'll not discuss them further.

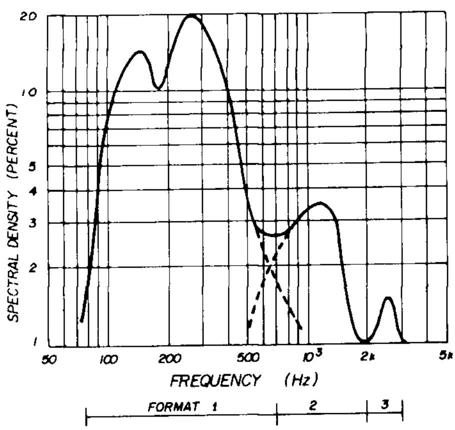


fig. 1. Profile of speech spectral density.

clipper

A speech clipper affects the ratio of peak-to-average power in an ssb transmitter, which is of interest here. First, let's see what is clipped. Speech spectral density is distributed according to **fig. 1.** This curve isn't quite accurate, because speech characteristics vary with differences in languages and with male and

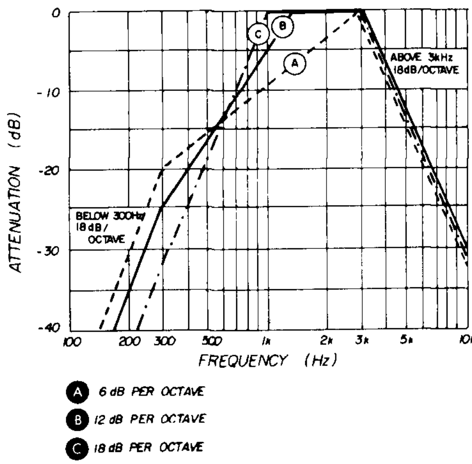


fig. 2. Results of different pre-emphasis networks analyzed in reference 3. Optimum performance was obtained with curve B.

female voices; however it is sufficiently accurate for our purposes.

Note that spectral density is distributed into three formants. The first formant is dominant and lowest in frequency. This formant includes most of the sounds in personal voice characteristics. Such voice power has little to do with readability in an ssb radio circuit; it merely adds fidelity to the transmission. Audio-frequency compressors emphasize this speech-energy formant, which is why they don't do much good in ssb communications systems. When clipped, the energy envelope in formant 1 creates strong harmonics, which create harmonic distortion.

Formant 2 contains most of the communications intelligence, but it is of much lower power level. Reference 3 examines different types of pre-emphasis circuits and gives optimum slopes of audio-response curves. From **fig. 2** it is seen that the lower in frequency at which tioning by a low-pass filter, noise was added until the signal-to-noise ratio was unity. The criterion for evaluating test results was the percentage of words

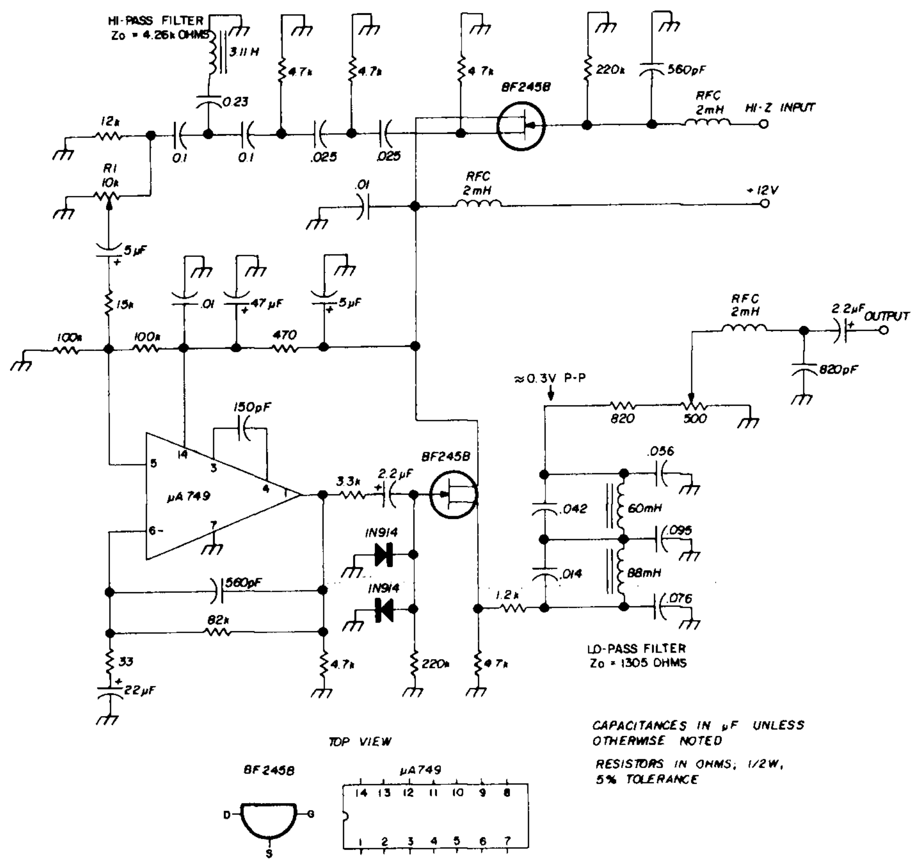


fig. 3. Pre-emphasis circuit used by the author. High-and low-pass filters are those shown in reference 4. Diodes should be matched for symmetrical clipping action. Inductors in the low-pass filter are toroids, available from many surplus sources. Capacitor values are important for proper operation; correct capacitances may be obtained by combining standard units. Pot R1 adjusts clipping level.

the knee of the response curve occurs, the steeper will be the slope. Best results have been obtained with curve B of **fig. 2**, where the kneepoint is at 1.1 kHz. The slope of this curve is 12-dB/octave.

test results

Tests were made as follows. Pre-emphasis was first applied to the signal, then the signal was clipped with a Schmitt trigger. After clipping and conditioning by a low-pass filter, noise was added until the signal-to-noise ratio was unity. The criterion for evaluating test results was the percentage of words understood in the transmission. Test results were:

1. Linear nonclipped speech – 10 percent.

2. Linear response with "infinite" clipping – 60 percent.

3. Pre-emphasis and clipping – 90 percent.

The most interesting observation was

that no equalizer was needed after the processor (e. g., in the receiver).

The benefits of pre-emphasis circuits are most noticeable in af clipping. Pre-emphasis circuits reduce the harmonic content in the microphone channel, whereas rf clippers must use elaborate filters to accomplish the same objective at radio frequencies.

pre-emphasis circuit

The schematic is shown in **fig. 3.** The input circuit uses a source follower for high-impedance microphones. If you have a low-impedance microphone, this stage may be omitted. Two RC networks in the input circuit shape the slope for a response of 12 dB/octave below 1.4 kHz (see **fig. 4**).

A high-pass filter[4] attenuates frequencies below 300 Hz. A low-noise, high-gain amplifier (Fairchild μA749) increases the microphone signal for the clipping diodes, a pair of 1N914s. The degree of clipping can be controlled with a pot at the amplifier input (R1, **fig. 3**).

The diodes must be matched pairs to obtain symmetrical clipping action.

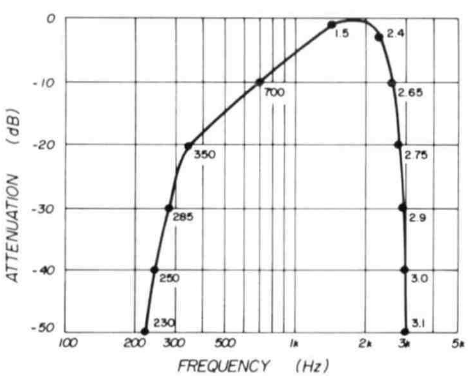
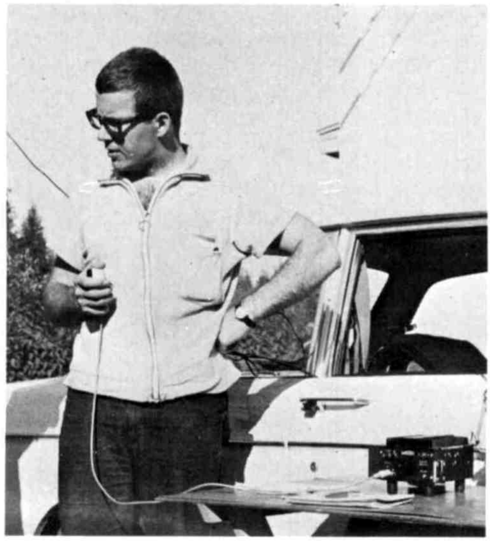


fig. 4. Speech-processor response without clipping. An optimum slope of 12 dB/octave below 1.4 kHz is obtained with two RC networks in the imput circuit.

A source follower is used after the clipper to obtain the proper impedance for a low-pass filter. This filter, also shown in reference 4, reduces frequency response above 2.4 kHz and attenuates harmonics. The processor output is sufficient for most solid-state balanced modulators.

conclusion

I have used this processor in a solid-state 10-watt mobile transceiver with encouraging results. Approximately 20 dB of clipping resulted in 6-9 dB output improvement in speech intelligibility.



The speech processing unit described in this article is included in the 10 watt transceiver shown in this photograph of the author, OH2CD.

Thanks are due OH10Y, who inspired me to build this unit while a larger unit, using rf clipping, was being developed. But that's another story, as Kipling used to say.

references

1. Keith Henney, *Radio Engineering Handbook,* Fifth Edition, McGraw-Hill, N. Y., p. 18-64.
2. Bill Sabin, WØIYH, "RF Clippers for SSB," *QST,* July, 1967, p. 13.
3. Thomas and Niederjohn, "The Intelligibility of Filtered-Clipped Speech in Noise," *Journal of the Audio Engineering Society,* Vol. 18, No. 3, 1970.
4. Ed Wetherhold, W3NQN, "An Amateur Application of Modern Filter Design," *QST,* July, 1966, p. 14.

ham radio

modular receiver for two-meter fm

Modular construction with inexpensive kits produces an easy-to-build two-meter fm receiver or converter

Harvey L. Wagner, WA2GBF, 83-19 141 Street, Jamaica, New York 11435

Over the past few years vhf fm has moved from the private domain of a few hardy experimenters to an increasingly popular mode of communications. One drawback still exists for amateurs who wish to get on fm: good equipment is either expensive, or as in the case of surplus gear, takes modifications which are enough to discourage the average appliance operator from digging in and learning what radio is all about. Because of these factors – expensive equipment on one hand and apparent complexity on the other – I set out to find a reception method that would give the average amateur a chance to hear what fm is really like before making the commitment in time and money that current equipment demands.

receiver design

Keeping in mind that the receiver must be simple enough for an appliance operator to build and inexpensive enough so that even an out-of-work college student (like myself) could afford it, modular construction was chosen as the simplest and cheapest system on which to base a workable receiver. The heart of this receiver (or hearts, I should say) are transistor module kits from International Crystal which tremendously simplify construction and subsequent modifications of the unit. The design uses an fm broadcast receiver for i-f, detector and audio output stages; leaving only the

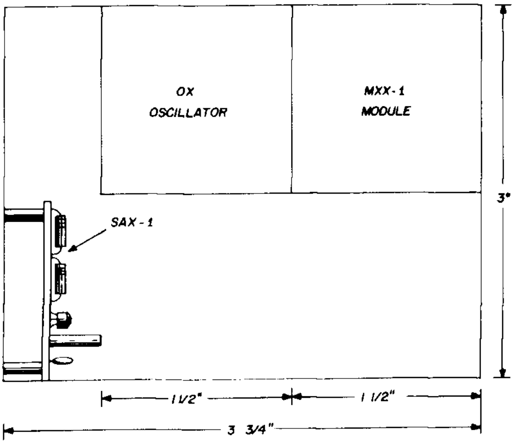


fig. 2. Converter is built into an ordinary minibox.

front end, mixer and local oscillator stages for the builder. If you wish, this system can be built as a converter to be connected to an existing broadcast receiver or it can be built as a complete receiver utilizing the circuit board from the now ubiquitous Japanese a-m/f-m radio.

Fig. 1 shows the block diagram of the basic modular receiver. The SAX-1 module which is used as the front end, is a small-signal amplifier with a sensitivity of 1 microvolt and about 10 dB gain at two meters. The MXX-1 module, designed specifically as a mixer, has a conversion gain of about 6 dB and a sensitivity of one microvolt. The local oscillator in this circuit is the OX oscillator module with a type EX crystal.

When wiring the circuit boards, the builder will have to select the proper coil and capacitor combination for the tuned circuits from several supplied. When making this selection, bear in mind the input and output frequencies of the converter and the crystal frequency needed to produce this conversion.

Assembly of the converter section is simple and straightforward. The circuit is housed in a 2 x 3 x 3¾ inch minibox, and suggested placement of the modules within the box is illustrated in **fig. 2.** The SAX-1 module is mounted vertically at one end of the box next to the input jack. The OX and MXX-1 modules are mounted horizontally with the MXX-1 closest to the output jack.

Connections carrying rf between modules should be made with small shielded cable such as RG 174/U, and all power leads should be choked to prevent the circuit from oscillating. The value of resistor R1 in the B+ lead to the OX module is determined by the voltage used to power the converter and can be found in **table 1.**

The selection of a crystal frequency for the converter will depend on the output frequency used. For the 88- to 108-MHz band, the frequency of the crystal may be found by using the formula $f_{crystal} = f_{in} - f_{out}$. For output frequencies below 88 MHz the crystal frequency is found by using the formula $f_{crystal} = (f_{in} - f_{out})/2$. If outputs below 88 MHz are used, it will be necessary to use the series tuned circuit L1 – C1

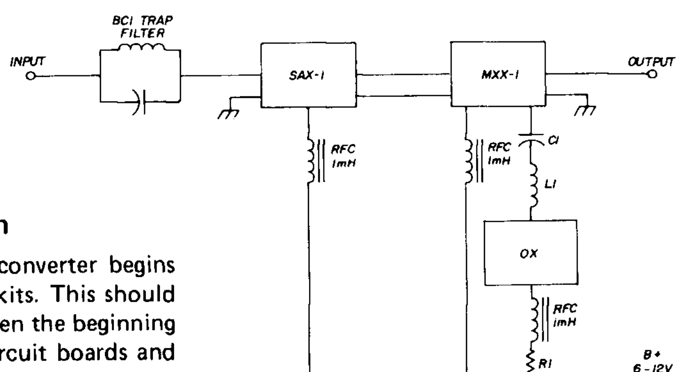


fig. 1. Block diagram of the complete converter.

converter construction

Construction of the converter begins with wiring the module kits. This should present no problem to even the beginning builder as they are all circuit boards and have parts placement clearly marked.

table 1. Supply voltage vs R1.

voltage	R1 (ohms)
6	0
9	150
12	300

which is tuned to the local-oscillator injection frequency, which is the second harmonic of the crystal frequency. The values of L1 and C1 will depend on the injection frequency, and can be determined by the use of a nomograph such as the one which appears in all recent issues of the *ARRL Handbook*. For injection of the fundamental crystal frequency, L1 and C1 may be omitted, using shielded cable between the OX and MXX-1 modules.

In some areas, it may be necessary to install a parallel-tuned trap filter at the antenna input of the converter to eliminate feedthrough of local fm broadcast stations. The filter should be tuned to the frequency of the offending station.

Before power is applied, all tuned circuits should be adjusted to their proper frequencies with a grid-dip meter. Although this procedure is not absolutely necessary, it is a good idea as it makes alignment much simpler, and if an error has been made in component values in a tuned circuit, this procedure will allow you to detect and correct it before things reach the hair-pulling stage. If you do not own a grid-dip meter it may be a good idea to buy or build one as it is one of the most useful pieces of test equipment you can have around the shack.

If the converter is to be used as part of a receiver rather than as an outboard converter it is worth pointing out that most, if not all, of the imported transistor radios use a positive ground system; this converter uses a negative ground. If the receiver board has a positive ground, care should be taken to isolate the board from the chassis ground used for the converter. It may be simpler to power the receiver board with a separate battery and to leave it in its plastic case.

operation

When power is applied to the converter there will be a slight increase in receiver background noise. If there is an extremely high noise level and all manner of whistles, blurps and birdies appear, or if the converter draws more than about 35 mA, the circuit is probably oscillating. If oscillation occurs and the power leads have all been choked, it will be necessary to shield the MXX-1 module with grounded partitions made of flashing copper or copper-clad circuit board.

When the converter is operating properly it is aligned as follows:

1. Using a signal generator, grid-dip oscillator or received signal, peak the coils on the SAX-1 and MXX-1 modules for maximum audio output at the receiver.

2. If a tuned circuit is used between the OX and MXX-1 modules adjust it for maximum audio output at the receiver.

3. If you used a trap filter tune it for maximum attenuation of the interfering signal.

4. All of these adjustments are slightly interlocking, and it may be necessary to repeat this procedure several times until maximum performance is obtained from the converter.

The prototype receiver, which consisted of the converter feeding a hastily repaired GE portable receiver, performed better than expected. Although the receiver has a wide i-f and uses a wideband detector, the only difficulty encountered in copying narrow-band signals was that of adjacent-channel interference from strong signals during crowded-band conditions.

This design is an adequate receiver for monitoring the local repeater. For higher performance several modifications can be made to the original design. The addition of an fet preamp will provide more sensitivity and greater overall gain. It may also be desirable to include a second SAX-1 module between the MXX-1

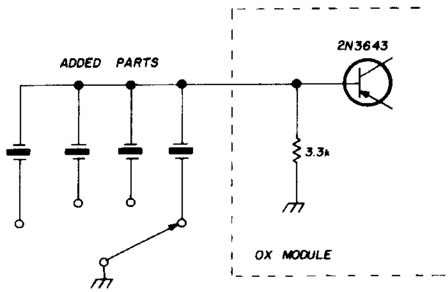


fig. 3. Fixed-frequency modification.

module and the receiver if the converter does not provide sufficient gain.

You could add a noise-operated squelch and an improved tuning mechanism. Although the receiver can be tuned with its main tuning capacitor, the designed bandspread of 20 MHz does not lend itself to tuning easily between channels spaced 60 kHz apart. You can add a small variable capacitor in parallel with the main tuning capacitor to provide a slower tuning rate over a limited range of frequencies. Another method which may be used is shown in **fig. 3**. This method uses switch selected crystals to determine frequency and guarantees that the receiver will always be right on frequency and will allow the receiver to find and monitor an inactive channel. Although I did not try either of the above methods, there is no reason why they should not work as long as you use good construction techniques and keep lead lengths short.

Transistor modules provide an easy way to get on fm. The flexibility provided by this method of construction encourages experimentation and optimization of designs. The receiver design presented in this article is only one of many possible ways for the amateur to get decent performance at two meters for reasonable cost. It is hoped that the design presented here will not be considered a cut and dried cookbook recipe, but rather a starting point for experimentation with various receiving techniques.

ham radio

a simple
crystal checker

An old circuit with new components makes a handy one-evening project for testing surplus crystals

Hank Olson, W6GXN, Box 339 Menlo Park, California 94025

Often I have wanted to check a crystal for activity and frequency before using it in an electronic project. Many surplus crystals have two or three numbers on them, any one of which could be the crystal frequency; and it is sometimes unknown *which* mark to believe. By plugging the unknown crystal into the checker described here, it will oscillate at its first mode, allowing me to tune it in on a nearby hf receiver. Also, a high impedance voltmeter connected to the test point of the checker gives a dc indication of oscillation.

The circuit of the crystal checker is presented in **fig. 1.** It is the old familiar Pierce Oscillator, with an insulated-gate fet substituted for the original vacuum tube. Unlike a vacuum tube, however, an insulated-gate fet cannot draw dc grid current, and so D1 has to be added if we intend for the grid-leak bias system to work. (Perhaps "gate-leak" bias system is more correct in this case.) The diode should be fast enough to rectify up to 20 MHz, I suggest three devices in order of their preference. The Hewlett-Packard HP 5082-2800 and the Motorola MBD 501 are both Schottky Barrier (or hot carrier) types, and the Fairchild FD 700 is an extremely fast silicon switching diode.

The MFE 3004 insulated-gate fet is best *soldered* into the circuit so that it cannot be destroyed by static voltages between the gate and either source or drain. The MFE 3004 comes with a small metal sleeve that shorts all four of its leads together. Before removing this sleeve, the circuit should be finished and ready to receive the fet. Then wrap several turns of fine tinned wire (one strand pulled from a short piece of stranded hookup wire) around the MFE 3004 leads, so as to short them all together. Remove the metal sleeve and solder the fet into the circuit, leaving the shorting wire in place until finished soldering.

The Pierce circuit is fundamentally a form of the Colpitts oscillator, where the crystal looks inductive, and parasitic capacitances of the fet form the capacitive tap. This is shown in **fig. 2;** note that

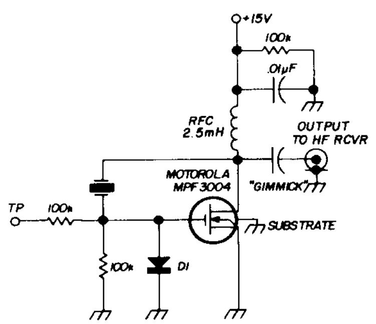


fig. 1. Schematic of the crystal checker. D1 is explained in the text. The checker is made for fundamental mode operation only.

C_{gd} is in parallel with the crystal, and the net reactance of the crystal and C_{gd} is inductive.

The crystal checker will only work with fundamental mode crystals in the 1- to 20-MHz range. Below 2 MHz, the impedance of the rf choke becomes too low to allow the drain to appear to be floating. AT-cut crystals are not generally made for the fundamental mode above about 20 MHz. Many surplus crystals in

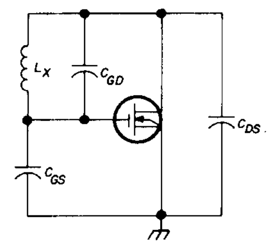


fig. 2. Equivalent circuit of a Pierce crystal oscillator, showing that it is, in fact, a form of Colpitts oscillator.

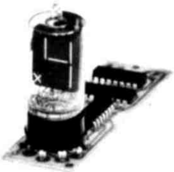
the 20-MHz range (particularly CR9/U and CR24/U) are third-overtone types. If such a crystal is used with the checker (with appropriate pinning adapter) it *will not* oscillate as marked, but at approximately one-third that frequency. For instance, a CR9/U crystal marked 19.825 MHz oscillated at 6.615 MHz.

As shown, the crystal checker was built to accommodate either the FT 243 or HC6/U styles of crystals, because these are by far the most common. Other crystal sockets could, of course, be added. The checker is constructed in an LMB-00 box chassis with the battery terminals out one side. Since I only use the unit occasionally, no power switch was included; I simply connect the 15 volts for use. A Burgess U10 or Eveready 411 battery is adequate as a 15 volt source.

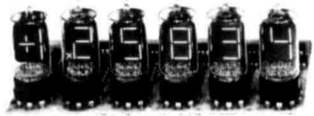
With the 15-volt battery connected, the fet will draw I_{dss}, which is rated 2 to 10 mA for the MFE 3004. A high-impedance voltmeter (such as a vtvm) measuring the voltage between ground and test point should read about zero before a crystal is plugged in. When the crystal is plugged in, the voltage at the test point should jump to some negative voltage (−10 volts for a good, active crystal) indicating oscillation.

ham radio

ENVIRONMENTAL PRODUCTS



UNIVERSAL
DCU/DRIVER



These universal counting modules have heavy duty outputs to drive all 7 segment displays requiring up to 15V and 40mA per segment. TTL used throughout. Requires 5 volt @ 120mA per module and any number of modules may be cascaded. Typ. count rate is 20MHz except the NR-3H which is 70 MHz. Will drive any display in this ad (not included).

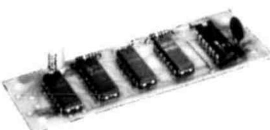
NR-3	Modulo 10 Counter 20 MHz	$8.75
NR-3A	Modulo 6 Counter 20 MHz	8.75
NR-3H	Modulo 10 Counter 70 MHz	10.50
NR-3B	Modulo 12 Counter clock	12.95

The most versatile multi-digit counting kit ever offered!! Comes with 5½ digits of counting and 7 segment decoding with the same heavy duty outputs as the NR-3. Typ. maximum count rate is 70 MHz. Each counting stage is completely independent allowing a custom approach to your application. The "+" and "−" sign are great for DVM or over-under circuitry. The overrange stage also has an overflow latch and reset buffer. Displays not included. PC board is 3½″ x 6″.

NR-3FM Multi-Stage Counting Unit $39.95

CRYSTAL
FREQUENCY
STANDARD

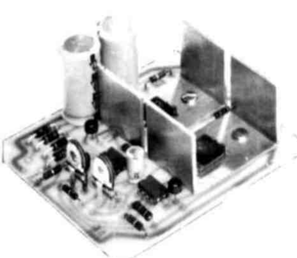
Contains a .002% crystal oscillator with TTL decade dividers to give output frequencies of 10, 1 MHz, 100, 10, 1 kHz, 100, 10, 1, & 0.1 Hz. Kit requires 5 volt supply @ 175mA. Uses low TC components and has zero-beat trimmer. Great for freq meter, digital clock, etc. W/ complete instructions. CRO-1P $21.95



LINE
CLOCK
SOURCE

The DCC-2 derives precision gating and clock signals from the 60 Hz line. The input is a combination schmidt trigger and integrator which eliminates false triggering from line noise. The input is over-voltage protected and requires no adjustment. TTL compatible output frequencies are 10, 1, 0.1, & 0.01667 (1 pulse/min.) Hz. PC board measures 1.2″ x 3.5″.

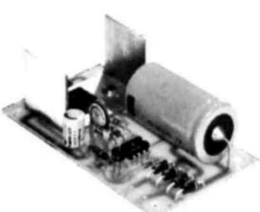
DCC-2A Line Frequency Standard $12.95



ANALOG
POWER
SUPPLY

Power your OP-AMPS with this versatile, low cost, dual-polarity regulator. One control varies both outputs simultaneously over the range of 0-15V. Electronic current limiting may be set separately for each output over the range of 25-200mA. Regulation is 0.1% and the ripple is below 3mV RMS. All parts conservatively rated for long life.

APS-5A Op-amp Power Regulator	$12.95
TR-200 Transformer for APS-5A	2.95

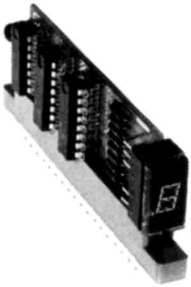


LOGIC
SUPPLY
REGULATOR

Both kits have an output range of 3.3V to 5V with current limiting and short circuit shut down. Regulation is 1% and ripple & noise is 10mV RMS. Heavy duty components insure long life and allow rugged use.

DPS-1A Output current 0.6A	$6.95
DPS-2A Output current 2.2A	9.95
TR100 Transformer for DPS-1A	2.29
TR500 Transformer for DPS-2A	5.95

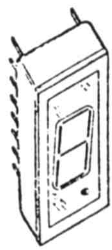
More Details? CHECK—OFF Page 94



LED READOUT MODULE · COUNTER · LATCH · DRIVER

This new module has all the most desirable features required in counting and display. Fits 18 pin connector. 5V supply. All TTL logic. 20 MHz count rate.

$16.95



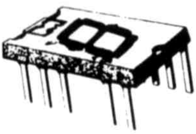
Miniature 7 segment display mounts in 16 pin dual in-line socket. 5V operation at 8 mA. per segment. 100,000 hr. life. W/decimal pt.

3015 Miniature Display .... $3.45 3/$10.00

LARGER 7 segment display as pictured with the NR-3 series kits. Bright numerals can be seen even in direct sunlight. Mounts in 9 pin miniature socket supplied with the kits.

2010 7 Segment Display 0-9 DP $4.45

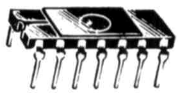
2020 As above except "1" "+" "–" 3.95



LED

Electrically and physically identical to the popular MAN-1. Has higher light output than MAN-1. Includes LH decimal point. W/spec sheet & app information.

LED700 7 Segment LED Display $7.95
(QUANTITY DISCOUNTS AVAILABLE)



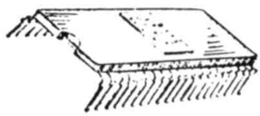
RAM

The 1101 Random Access Memory (RAM) will store and readout 256 bits. The chip is TTL compatible and comes with a complete spec sheet w/applications.

1101 256 Bit RAM $8.95

Build several instruments with this chip and little else. First really useful LSI chip for the experimenter. Contains:

- Four decade counters + overrange
- Four 4 bit latches w/BCD outputs
- Seven segment decoder
- Display multiplexing circuitry
- Two programmable oscillators
- Single 5 volt supply at 5mA ! ! !
- Inputs TTL compatible
- Housed in 28 pin dual in-line pak

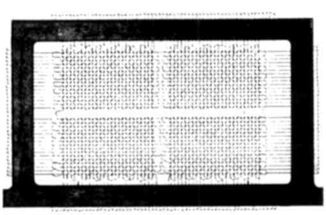


LSI

Comes with 9 p. booklet of specs & app notes. Booklet contains interfacing info on all seven segment displays made.

5002 LSI Chip $26.95

5005 Booklet on 5002 only 1.50



At last! Noncritical memory planes for the experimenter. Made by Ampex for IBM spares. They were removed from NEW core stacks. The large 50 mil cores allow the use of the most inexpensive sense amps. The cores are in an 80x50 array. All the necessary core specs are included with each plane. Available is an 80 page booklet describing an 8 bit x 1000 word memory using the MP-2A. Parts lists, schematics, and app notes are included in the booklet.

MP-1A 4000 Bit Core Plane $12.95

MP-2A 16K Bit Core Stack 47.50

MPB-1 80 Page Core Memory Booklet 10.00

WE STOCK THESE ITEMS & MORE

INTEGRATED CIRCUITS
TRANSISTORS & DIODES
POWER TRANSFORMERS
RESISTORS & CAPACITORS
PC BOARD DRILLS

ENVIRONMENTAL PRODUCTS

BOX 406

LAFAYETTE, INDIANA 47902

WE PAY POSTAGE

317-743-1893

calculating the inductance of toroids

Two handy formulas and a table give quick approximations of the inductance of homemade toroids

Michael J. Gordon Jr., WB9FHC, 203 Woodbine Avenue, Wilmette, Illinois 60091

Toroid inductors, with their high Q, small size and self-shielding properties, are excellent for use in modern solid-state gear — especially where space is a valuable commodity. In the past, however, there has been one drawback: It was very difficult to calculate how many turns it would take to give you a desired inductance. In a back issue of *QST,* there were instructions for doing this, provided you owned an *ARRL Lightning Calculator Type A,* or a *Coil Winding and L/C/F Calculator Type A.*[1] I did not have one of those devices, so, rather than waiting until I could get one, I sought a formula which could be used without any special apparatus.

I found the equation:

$$N = K\sqrt{L} \qquad (1)$$

Where N is the number of turns, L is the desired inductance in microhenries and K is a constant dependent on the toroid being used. **Table 1** lists this constant for a number of Amidon cores in common use. In this table, K is printed to eight decimal places. It is not necessary to use all of these places, and your results will be close even if you truncate the last 6 or 7 digits. For example, suppose you need a 10-μH coil and have a T-68-2 core. Substituting the known values into the equation, you obtain

$$N = 13.71\sqrt{10} = 13.71(3.162) = 43.35102$$

Since there is no such thing as a fraction of a turn on a toroid, you should round the answer off and use 43 turns.

If you desire to use a core other than one of those in **table 1,** you can calculate K for yourself. The formula is

$$K = \frac{N1}{\sqrt{L1}} \qquad (2)$$

Where N1 is the number of turns on the particular form you are using which gives the inductance L1. To illustrate, suppose table 2. Maximum number of turns of various gauge wires on standard Amidon toroid cores.

T-94	T-80	T-68	T-50	T-37	T-25	T-12	T-05	wire size
15	14	10	8	5	3	—	—	10
20	18	13	10	7	3	—	—	12
25	22	16	13	9	4	—	—	14
32	28	20	17	11	6	—	—	16
41	36	26	21	14	8	3	—	18
51	45	33	26	18	10	4	—	20
64	57	42	33	23	13	6	—	22
80	72	53	42	29	16	8	3	24
101	90	66	53	37	20	10	4	26
127	113	83	67	47	26	13	5	28
158	141	104	84	59	33	16	7	30
198	176	130	105	73	41	20	8	32
250	223	165	133	93	53	26	11	34
307	273	202	163	114	65	32	13	36
393	350	259	210	147	83	41	18	38
495	441	326	264	185	105	52	23	40

you have a toroid form of unknown properties and you need a specific inductance. The first thing to do is put on a test winding and measure it's inductance.

The easiest way to do this is by making a tuned circuit with the test coil and a capacitor and finding the resonant frequency with a grid-dip meter. I have experimented with this and have found that the best way to couple to a toroid is by using rather long leads on the capacitor and draping the tuned circuit over the gdo pickup coil. An alternate method is to make the tuned circuit with the shortest leads possible and putting a length of wire through the core and shorting the ends. Coupling to the tuned circuit is made through this pickup loop.

In any case, once the resonant frequency is known, the inductance of the trial winding can be calculated. Now you are ready to use **eq. 2.** Simply substitute in the now known values of N1 and L1. In case you need it, the formula for inductance is

$$L = \frac{25330}{F^2 C}$$

Where F is in MHz, C is in pF and L is in μH.

One other thing you might need to know is how many turns of a given size wire you can fit on a given toroid. **Table 2** gives this information for most of the toroids in **table 1.** In general, use the largest size wire you can, since this will help to insure maximum Q. At first glance, it might seem that many of the cores on **table 1** are not listed in **table 2.** Keep in mind that the first two numbers in the type designation specify the size of the core (a T-94-2 has the same physical dimensions as a T-94-6 and will hold the same amount of wire).

These formulas should provide the correct answers to the nearest turn or two — accurate enough for most amateur work.

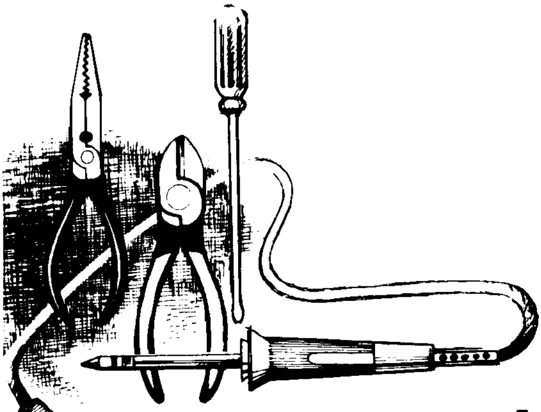
table 1. Toroid-core constants for use in equation 2.

type	K
T-94-2	10.87375857
T-80-2	13.09481019
T-68-2	13.71166566
T-50-2	13.49065790
T-37-2	15.09667411
T-25-2	16.76244696
T-12-2	21.17423645
T-94-6	11.64825226
T-80-6	14.54857791
T-68-6	14.61045410
T-50-6	15.31238723
T-37-6	17.48997890
T-5-6	18.97143316
T-12-6	23.75741463
T-50-10	16.71056534
T-37-10	19.07988330
T-25-10	20.87788877
T-12-10	27.84454642

reference

1. "Technical Correspondence," *QST,* April, 1971, page 48.

ham radio



circuits and techniques

ed noll, W3FQJ

fm deviation measurements

In the enjoyable task of learning technical techniques, the knowledge gained from making tests and measurements is especially rewarding. This is particularly true when learning the makeup of the fm wave. In spite of this, very few amateurs make deviation measurements, and the carrier-zero technique of deviation measurement has been almost ignored by most radio amateurs. It should be better known.

A complete fm wave has a constant amplitude and a varying frequency. It is composed of a carrier component and a number of sideband pairs that depend upon the modulation index. The carrier and sideband spectra for an fm wave of ±10-kHz deviation and 2000-Hz modulation is shown in **fig. 1.**

If the magnitude of the fm wave is to be kept constant and at the same time contain a number of changing sideband pairs, it is obvious that the carrier amplitude itself must vary up and down with modulation. In fact, at certain index values the carrier level reduces to zero. The first five such null points are: 2.405, 5.52, 8.654, 11.792 and 14.931.

Spectra distribution for the first two index values are given in **fig. 2.** A 1000-Hz modulating tone is assumed. You can gain a practical understanding of the technique by considering what happens when a 1000-Hz tone is applied to the input of the fm transmitter and its amplitude is increased gradually from zero to produce higher and higher deviation levels. Obviously there is an increase in deviation and an increase in the modulation index. If this is done gradually and the level of the carrier only is measured, it is found that its magnitude moves up and down. When the amplitude of the 1000-Hz notes rises to a point at which the modulation index is 2.045, the carrier magnitude falls to zero. At this point the deviation would be:

deviation = modulation index x audio frequency

deviation = 2.405 x 1000 - ±2.4 kHz

If you now continue to increase the audio, the carrier once again rises and falls in magnitude. When the index of 5.52 is reached, the carrier again falls to zero. The deviation at this carrier frequency is:

deviation = modulation index x modulating frequency

deviation = 5.52 x 1000 = ±5.52 kHz

As the magnitude of the audio frequency

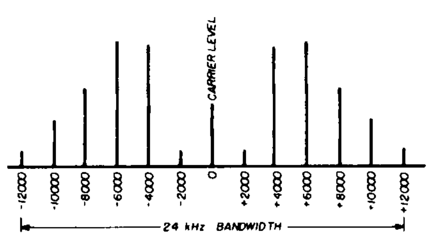


fig. 1. Carrier and sideband distribution for modulation index of 5. Modulating frequency = 2 kHz.

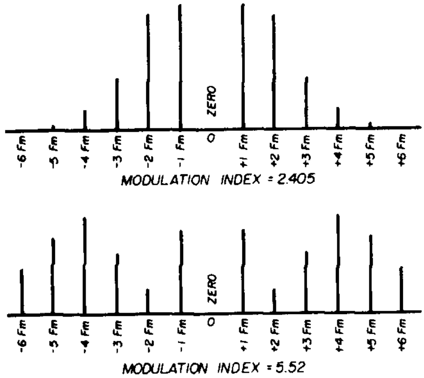


fig. 2. Spectrum distribution for first two carrier-zero positions.

is increased the carrier will pass through a succession of zero positions. For the fifth carrier-zero point (using 1000-Hz modulation), transmitter deviation would be approximately ±15 kHz.

You can use these carrier-zero points to advantage in making carrier-deviation checks. To use them the emission spectra must be displayed on the screen of a spectrum analyzer. Alternately, a frequency meter or receiver could be used if they contain sharply tuned resonant circuits able to delineate the carrier from the first pair of sidebands. The functional block diagrams of **fig. 3** show typical test setups. A spectrum analyzer permits the display of carrier and sidebands in accordance with **figs. 1** and **2.** Such an oscilloscopic analyzer can be connected directly to the i-f system of an fm receiver. More expensive analyzers that operate in the vhf band can be connected directly to the transmitter output using an appropriate dummy load.

You can make carrier-zero measurements with relatively inexpensive setups. A vhf converter can be used to supply signal to a high-frequency a-m receiver. The S-meter circuit of the receiver must be such that it responds to carrier level only. One of the older a-m receivers with a sharp crystal filter is ideal; I have used the old National NC-109 successfully. Use a high-enough modulating frequency that the first pair of sidebands (1000 Hz and up) does not influence the deflection of the S-meter measuring the carrier amplitude. The S-meter reading should fall off to zero as you tune between the carrier and the first sideband. *Remember that you need a highly selective a-m receiver with an S-meter that responds faithfully to carrier level but not to modulation.* The modern single-sideband receiver cannot be used for this type of measurement because of its S-meter system.

An accurate and highly selective frequency meter can also be used to identify a center-frequency null. Such a frequency meter must have sharply-tuned and high-Q resonant circuits to be able to delineate between carrier and sidebands.

practical audio frequencies

In amateur and commercial fm two-way radio systems, narrow-band (±5 kHz) and wide-band (±15 kHz) deviation are common. Many radio amateurs settle on an in-between value of approximately ±10 kHz so their signals might be demodulated by receivers designed for either narrow-band or wide-band demodulation. Practical tone frequencies of 1000, 1200 and 1800 Hz are attractive for making deviation measurements. An oscillator can be set precisely on frequency by choosing the standard tone transmitted by WWV and a Lissajous pattern display.

The second carrier-zero checkpoint of 5.52 in conjunction with a 1000 Hz note

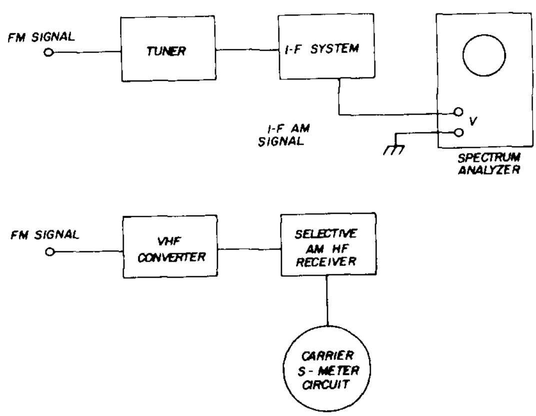


fig. 3. Carrier-zero test setups.

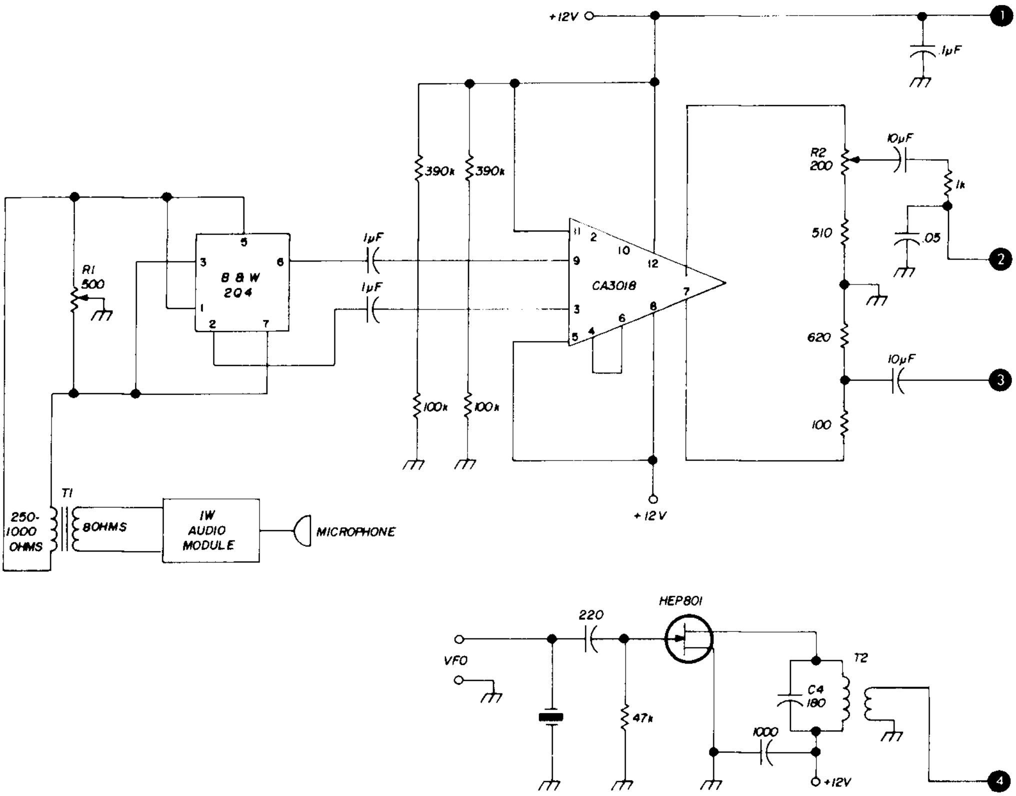


fig. 4. IC phasing-type sideband generator for 160 meters.

can be used to determine the setting of the deviation control needed for ±5.52-kHz deviation. If you now measure the audio-input amplitude to the fm transmitter you will know just how much voice signal is needed for this amount of deviation.

A 1200-Hz tone and the third carrier-zero point is an excellent checkpoint for determining deviation of ±10 kHz.

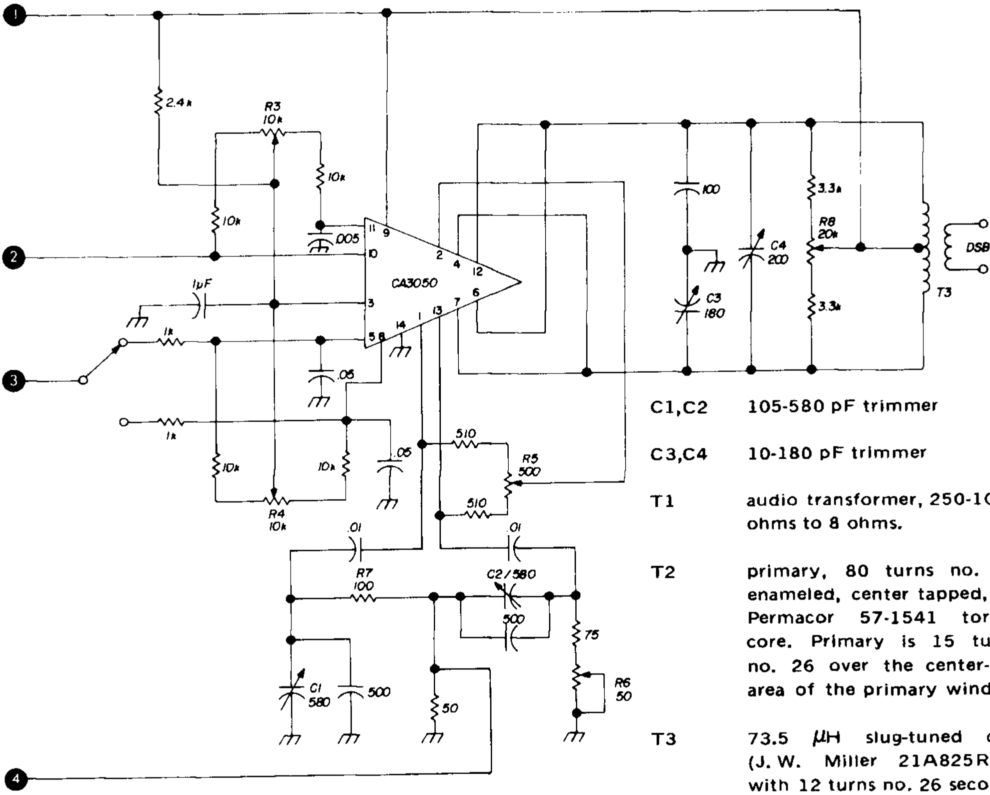
The third carrier-zero point and 1800-Hz tone or the fourth carrier-zero point and 1200-Hz tone can be used as check points for indicating maximum wide-band deviation. Corresponding calculations are:

deviation = 5.52 x 1000 = ± 5.52 kHz
deviation = 8.654 x 1200 = ±10.30 kHz
deviation = 8.654 x 1800 = ±15.58 kHz
deviation = 11.792 x 1200 = ±14.15 kHz

The carrier-zero method of measurement is especially useful in checking out home-built fm transmitters. You can use inexpensive equipment and make use of one of the good old a-m receivers that have been sitting idly around the shack. Most importantly it gives you a better insight into just what takes place in using frequency modulation.

top-band sideband generator

In the August issue[1] I presented a general schematic diagram for a phasing-type single-sideband generator using two RCA integrated circuits. I build a 160-meter version of this generator using the B&W 2Q4 audio phase-shift network shown in **fig. 4.** The balanced center-tapped primary and low-impedance output winding were wound on a toroid core.



C1,C2	105-580 pF trimmer
C3,C4	10-180 pF trimmer
T1	audio transformer, 250-1000 ohms to 8 ohms.
T2	primary, 80 turns no. 26 enameled, center tapped, on Permacor 57-1541 toroid core. Primary is 15 turns no. 26 over the center-tap area of the primary winding
T3	73.5 μH slug-tuned coil (J. W. Miller 21A825RBI) with 12 turns no. 26 secondary wound below original winding

The generator was chassis-mounted, **fig. 5**, for ease of adjustment, measurement and self-education. Test instruments were a 1000-Hz tone oscillator, audio voltmeter (fet vom), 160-meter sideband receiver and service-type oscilloscope. The latter is an optional piece of test equipment, but it is very useful and instructive because it can display the various sideband waveforms. I used the 1-watt audio module shown in **fig. 4** for voice testing. A transistor output transformer connected in reverse stepped up the low impedance of the audio-module output to the higher input impedance of the phase-shift network.

The rf output transformer T3 was wound on a Permacor 57-1541 toroid core. The primary consists of 80 turns no. 26 enameled wire center-tapped while the secondary is 15 turns of no. 26 overlapping the center-tap area of the primary. The rf oscillator-amplifier transformer T2 is a J. W. Miller (21AB25RBI) coil; the secondary winding consists of 12 turns no. 26 wire on the same coil form below the original winding. The audio transformer T1 is an output transformer with the secondary (8 ohms) connected to the output of the module and the primary (250- to 1000-ohm range) to the audio input of the sideband generator.

A fet oscillator-amplifier stage was also added. It operates as a crystal oscillator, or it will function with the crystal removed as an amplifier and isolation stage for use with an external 160-meter vfo. The carrier signal is applied to the two 45° rf phase-shift networks which supply 90°-related carrier components to terminals 1 and 13 of the CA3050 IC. The combination fixed- and trimmer-capacitor values permit proper 90° relations on the 160-meter band.

tuning

A good first step is to adjust the audio and rf phase-shift networks. The audio-input attenuator R1 is set to midposition. Set potentiometers R3 and R4 to midposition. An oscilloscope or audio voltmeter can be used to observe the 1000-Hz tone at terminals 10, 5 and 8 of the CA3050. Place a 50-ohm carbon resistor across the sideband-generator output. Potentiometer R2 can then be adjusted so the audio level at pin 10 is the same as at pins 5 or 8, depending upon the position of the sideband switch.

The objectives of the rf phase-shift adjustments are to supply equal-level and 90°-related rf components to pins 1 and 13 of CA3050. How do you determine when a 90° phase shift occurs? Forty-five degree networks are involved, and in any series resistor-capacitor combination voltages of equal value appear across the resistor and capacitor when a 45° relationship is established. Your indicating instrument can be an oscilloscope or rf voltmeter that can measure up to 2 MHz.

Initially, the 50-ohm potentiometer R6 is set to midposition. Potentiometer R5 is also set to midposition. Capacitor C1 is adjusted for equal-magnitude levels across R7 and C1. Likewise the trimmer capacitor of the C2 combination is adjusted for equal levels across the C2 and R6 series combination.

Keep the 50-ohm terminating resistor across the output and connect the output of the sideband generator to the antenna input of the sideband receiver. Apply the rf-carrier component only. Turn back the rf gain-control setting or detune the pre-selector so you do not overload the receiver. Adjust the level for an S9 meter reading. Open up capacitor C3 several turns away from its maximum setting. Now adjust the tuning-capacitor C4 for maximum S-meter reading.

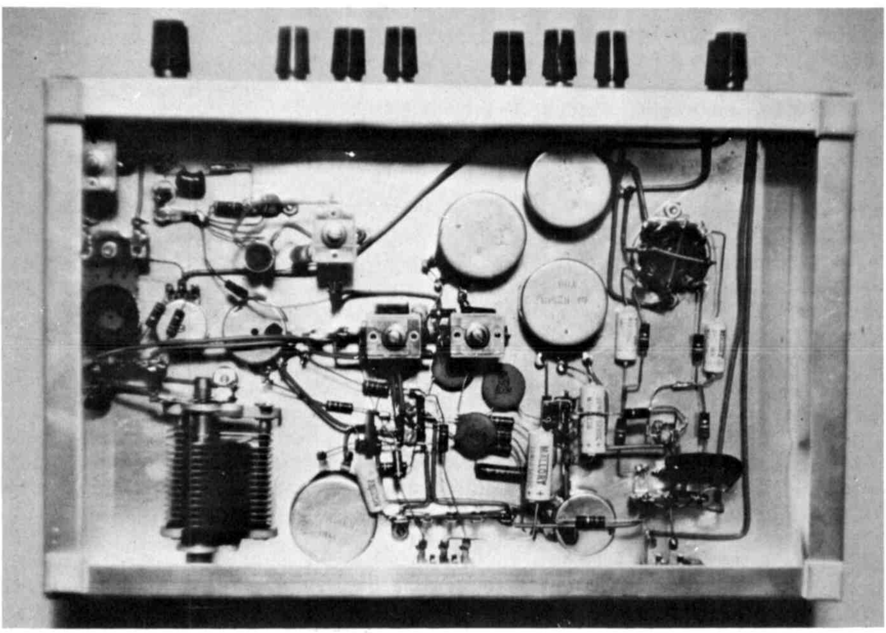


Photo of the ssb generator. The phase-shift network is the socket in the right hand corner.

Adjust capacitor C3 and potentiometer R8 alternately for minimum S-meter reading. A slight readjustment of potentiometers R5 and R6 may help a bit in further reducing the carrier level. Make these readjustments carefully and be certain that you can return them to their initial positions if necessary.

You can also make oscilloscopic observations with a high-impedance probe.

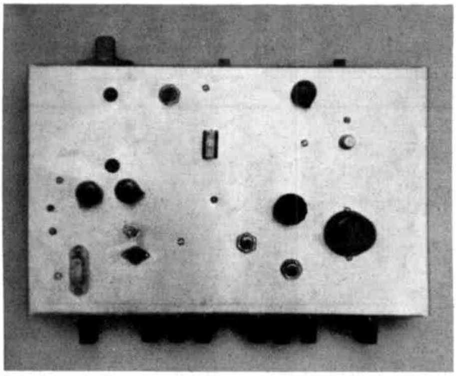


fig. 5. Chassis layout for the 160-meter ssb generator.

Since the probe attenuates the desired signal a problem that often arises is direct carrier pick-up by the scope lead which can result in a false pattern display.

Apply a 1000-Hz audio tone, tune in the modulation on the receiver and check the upper and lower sidebands to determine which position provides the highest ratio between the desired sideband and the undesired sideband. This procedure permits you to determine the position to set your phasing sideband switch.

Throw the phasing sideband switch to the opposite position. Also change your receiver sideband switch to the other position. Your dominant sideband should now have moved from one side of the carrier frequency to the other.

Set up the combination for operation on lower sideband. Now tune to the opposite sideband and adjust potentiometer R1 for minimum undesired sideband. Very slight readjustments of potentiometers R3 and R4 as well as R2 may aid in the reduction of the undesired-sideband level.

reference

1. Ed Noll, W3FQJ, "Circuits and Techniques," *ham radio,* August, 1971, page 50.

ham radio

the ham notebook

color coding parts

Fearing that I would drop a parts bin full of unlabeled surplus diodes and transistors – as Poly-Paks and other bargain assortments often come – I developed a scheme for color coding them. For 15 cents per bottle, I bought a ¼-ounce jar of quick drying enamel for each color of the standard color code. After experimenting with expensive artist's brushes, I

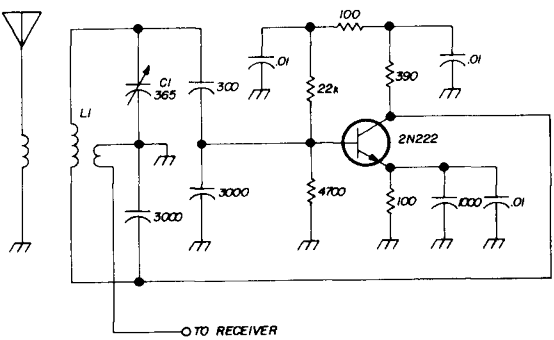


fig. 1. Selective rf amplifier for 80 meters. L1 resonates to 3.5 MHz with 365-pF broadcast variable. Coupling coils (3 turns each) are spaced 1" from L1, not wound around it.

found that the lowly round toothpick worked best for marking the components. You can use a different toothpick for each color so you don't have to clean the brush at the end.

To mark transistors I do not put any mark for the 2N- prefix; I just paint on the last digits. For a 2N706, for example, I put three dots of color on the side of the case – purple, black and blue (706). For an epoxy diode with an 800 volt PIV rating, I paint on a grey, black and brown dot – with the grey dot at the narrow (cathode) end. For power diodes I mark the PIV rating the same way but I put a colored dot on the stud for the current rating – brown for one amp, red for two amps, and so forth.

Paul M. Rich, WA7BPO

selective rf amplifiers

All rf amplifiers and preamplifiers are characterized by broad bandwidth. Because of this they are easily overloaded by static and strong signals several MHz away from the operating frequency. The resultant distortion products from the rf amplifier are fed on to an inherently broadband mixer. The i-f is supposed to clean up the mess, but it can only eliminate those signals that are outside of its passband; the distorted signals within the intermediate frequency are passed on to the detector and audio amplifier.

The answer to this problem is more selectivity in front of the rf stage. This can easily be done by increasing the Q of the input circuit and decreasing the coupling. On 144-MHz this can be accomplished with a high-Q cavity. The cavity is fairly selective, but has some insertion loss, and can be built *after* taking a course

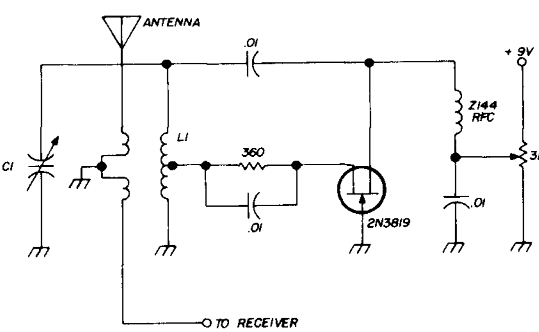


fig. 2. Selective rf amplifier for vhf use. C1 is 35-pF per section split stator variable with insulated shaft (see fig. 3).

$20 a month

That's how easy it is to own a Swan 270B with your Swan Revolving Credit Card.

Just fill out and mail the coupon below (or use your Swan Catalog order form) with a check for 10% down, and your Swan 270B will be shipped to you the day we receive your order. You'll have the finest 5 band 260 watt transceiver made, in just a few days.

The lightweight compact design of this transceiver with its built-in AC power supply and loudspeaker make it the best transceiver value on the market today. Perfect for a mobile rig or as a low-cost fixed station. Just connect to an AC source, plug in your antenna and microphone, and you're on the air.

All for $20 a month. Don't delay, order your Swan 270B today. **$429**

MONEY BACK GUARANTEE.
If you are not completely satisfied with the Swan 270B, return it to us and we will credit your account with the full purchase price (and refund your down payment), or refund the entire purchase price if you paid cash.

ACCESSORIES:

Model 14-A DC Converter for mobile operation... **$39***
Model 404 Hand Microphone.................. **$18***
Model 444 Desk Microphone.................. **$25***
Model VX-2 VOX Accessory................... **$35***

*Any or all of the above accessories, when purchased with the Swan 270B, can be included for the same $20 a month. In other words, own the 270B **and** any or all of the above accessories for a total of $20 a month. Annual percentage rate of finance charges is 18%.

Gentlemen:
Please send me the Swan 270B for $429, and the following accessories:

______________ @ $______
______________ @ $______
______________ @ $______
______________ @ $______

Total Price $______

☐ Send my FREE 1972 Swan Catalog
☐ Charge to my Swan Revolving Credit Card
______. I am enclosing 10% down.
☐ Charge to my BankAmericard # ______
☐ Charge to my Master Charge # ______
Master Charge Interbank # ______
☐ Ship C.O.D. ☐ Check enclosed.

Name ______ Call ______
Address ______
City ______ State ______ Zip ______

Delivery will be made by fastest surface shipment. Shipping charges collect. Prices do not include local area sales tax.

SWAN
ELECTRONICS
A Subsidiary of Cubic Corporation

SWAN FACTORY / 305 Airport Road, Oceanside, CA 92054, (714) 757-7525
EASTERN OFFICE / P.O. Box 2288, Ocean, N.J. 07712, (201) 531-4114

More Details? CHECK—OFF Page 94

in plumbing and silver soldering. The required cavity size for six meters makes it a nice monument to your ingenuity.

High selectivity can also be added to the rf stage by introducing some regeneration, much in the same fashion as is used in Q-multipliers. This approach will provide insertion gain instead of loss, and you don't have to be a plumber.

An oscillator circuit that is sufficiently stable for use as a vfo can be used as a selective rf amplifier by simply loosely coupling the antenna and receiver input to the oscillator tank coil and adding a potentiometer to drop the supply voltage to the point where oscillation just ceases. Gain and selectivity of this system can be adjusted (one at the expense of the other) by moving the two coupling coils closer or further away from the vfo tank coil. On 80 meters I use the modified Vackar oscillator circuit shown in **fig. 1**. For 144 MHz the fet circuit in **fig. 2** is doing wonders.

Gus Gercke, K6BIJ

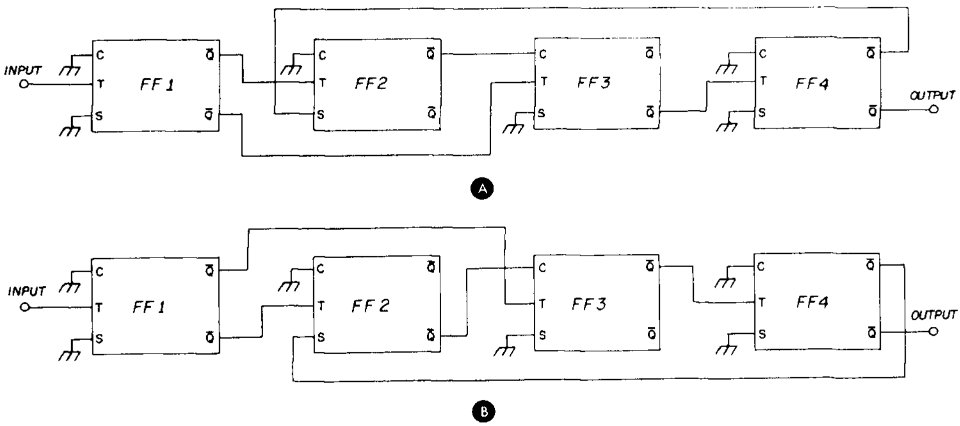


fig. 4. Standard divide-by-10 circuit is shown in (A). In (B) flip-flops 1 and 3 are reversed internally and must be wired as shown to divide by 10.

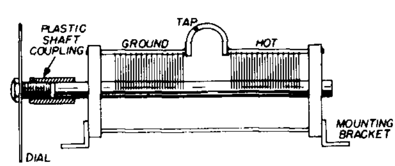


fig. 3. Tank circuit for selective two-meter rf amplifier. Split-stator capacitor is 35 pF per section insulated shaft. For two meters, coil is ½ turn, 1" diameter; six-meter coil is 2 turns, 1" diameter.

using the flop-flip

A recent bargain hunt turned up some RTL flip-flops in TO-5 cans; I bought some to make up a logic demonstration board for my sons to work with. Unfortunately, they could not get the modulo-ten minimum hardware circuit to count by ten as it should. After checking the patch connections I put a meter on the flip-flops and found that some of them were actually *flop-flips*.

With the normal RTL flip-flop connected as a binary divider (all inputs but toggle grounded), when you initially apply power Q should be low and $\overline{Q}$ should be high. If some of your bargains are *flop-flips* the reverse is true. I got the modulo-ten circuit to count by ten by treating the normal Q and $\overline{Q}$ outputs of the *flop-flips* as though they were reversed at the pins of the IC. **Fig. 4A** shows the normal circuit if all flip-flops were actually flip-flops. **Fig. 4B** shows a circuit where flip-flops 1 and 3 are *flop-flips*. These inverted ICs are usable in this fashion once you understand their peculiarities.

Allan Joffe, W3KBM

Owning the FT-101 is a very personal thing

If there ever was a personalized amateur rig, this is it . . . the jewel-like FT-101 portable transceiver.

Hardly larger than a portable typewriter, the FT-101 packs 260 watts PEP SSB, 180 watts CW, 80 watts AM input power.

It even includes built-in 117 VAC and 12 VDC power supplies. A noise blanker, so essential for mobile operation. VOX. A built-in speaker. 25 and 100 KHz calibrators. A ±5 KHz clarifier. Break-in CW. And much, much more, even a mike.

The compactness of the FT-101 chassis is a marvel of electronic engineering. One look inside and you'll know what we mean. For instance, all critical circuitry is on customer-replaceable PC cards. And, except for the finals and driver, it's all solid state. A complete transceiving package, reduced to a compact, thirty-pound wonder.

There's nothing else like it on the market. Anywhere.

Isn't this the rig you have to have? Whether you're a seasoned amateur, or whether you're just starting out, the FT-101 is the rig you've been waiting for. And it's here right now. For only $559.95, you can have it.

Owning and using the FT-101 is a very gratifying, very personal thing. You know the feeling.

SPECTRONICS WEST

Dept. Q, 1491 E. 28th, Signal Hill, Ca. 90806 / (213) 426-2593

SPECTRONICS EAST

Dept. Q, Box 1457, Stow, Ohio 44224 / (216) 923-4567

☐ Please send detailed information on all Yaesu products.

☐ Enclosed find $ ____________

Please send model(s) ____________

Name ____________

Address ____________

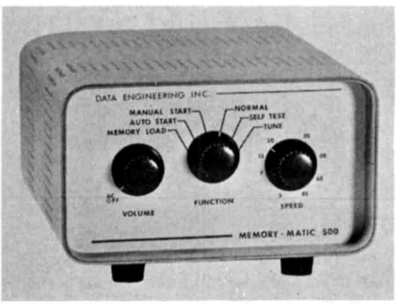
City ____________ State ________ Zip ________

All prices F.O.B. Signal Hill, Ca.

Master Charge and BankAmericard accepted. "H6"

new products

ic keyers



The Memory-Matic 500 and the Space-Matic 21 are two new electronic keyers from Data Engineering. They were developed especially to meet the demands of professional and amateur code operators. These keyers were designed to send *all* code elements: dot, dash, dot space, dash space, character space and word space in an instant-start, self-completing mode with a guarantee of no missed or extra dots or dashes and provides jam-proof dot, dash, character and word spacing. Each code element is automatically generated with little or no effort on the part of the operator.

The memory system included with each Memory-Matic 500 provides the serious DX, contest or traffic operator with provision for instant storage of code characters or messages, for an immediate reply to on-the-air contacts.

Messages of approximately 40 code characters are easily keyed into the memory for calling stations, giving a contest exchange, calling CQ or testing. Loading code characters into memory or transmitting messages from memory is accomplished at the same speed and weighting ratio in use by the operator. The memory allows continuous transmission on a repetitious basis of any message in storage.

Iambic squeeze keying is provided through the use of twin paddles. Iambic operation provides alternate dots and dashes when both paddles are squeezed. Advanced dot-dash memories automatically insert a dot in a series of dashes or a dash in a series of dots and insures against missed or extra dots or dashes.

Jam-proof spacing is provided for dots, dashes, characters and words. Dot and dash spacing is automatically added following each dot or dash. Character spacing is automatically added following the last dot/dash element which make up each character. Word spacing is automatically added following the last character which makes up each word.

A 500-bit instant-load memory is provided in the Memory-Matic 500 which can be programmed or updated by moving the function switch to *memory-load* and keying any message into memory. When 50 storage positions remain in memory the monitors's sidetone pitch automatically increases, indicating to the operator that the memory is *near-full.* The monitor will emit a steady sidetone if the memory overflows; this condition necessitates reprogramming of the memory-load sequence. Once a message is entered into memory it can be transmitted manually or automatically at intervals ranging from a fraction of a second to several minutes. Adjustment of the automatic transmission interval is accomplished by a rear panel control.

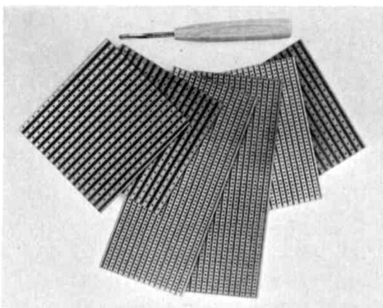
Both the Memory-Matic 500 with the 500-bit memory and the Space-Matic 21 without the memory feature have a speed range of 5 to 85 words per minute with adjustable weighting, independent of speed. They have provision for keying

More Details? CHECK—OFF Page 94

with a regular straight key and keyer activation by either a single or dual paddle key. Tune switch, variable pitch sidetone oscillator, 117-Vac power supply, and off-the-air self-testing circuitry are built into both keyers.

The units come with instructions, all cables and connectors and are guaranteed for a year. The Memory-Matic 500 costs $198.50 and the Space-Matic 21 is $89.50. Use *check-off* on page 94 for more information or write directly to Data Engineering, Inc., Box 1245, Springfield, Virginia 22151.

veroboards



The Vero method of construction does away with the etching, drilling, and tools usually associated with breadboarding. A perforated board has a series of parallel conductor paths connecting all the holes in one column. After inserting component leads in appropriate holes, a scriber is used to break the conductor paths where they are not needed. Where paths are needed but are not provided by the foil, the component leads may be used, jumpers inserted or special pins inserted in the holes for tie points.

Vero offers an introductory BK-6 Vero-board kit designed for experimenting with discreet components.

The BK-6 Kit consists of six Veroboards, two with a 0.2 x 0.2-inch matrix and four with a 0.156 x 0.1-inch matrix, both having a 0.052 diameter hole. The Vero BK-6 Kit sells for $5.95.

Vero also offers the new MC-10 kit for dual in-line integrated circuits. ICs can be plugged in anywhere on the 0.1 x 0.1-in. drilled matrix.

The kit contains a single sided 18-inch long Veroboard with 34 copper strips on 0.1 centers, a plug-in single-sided board with 32 plated contacts, a double-sided plug-in board with strips at right angles and an epoxy glass plain board pierced at 0.1 centers with 0.052 holes. There are also 500 terminal pins to fit the 0.052 diameter holes in a 0.1 plain Veroboard, a pin insertion tool, a spot face cutter to break the copper strip where required, a 0.1 reproducible design sheet and a 32 contact 0.1 edge connector. The Vero MC-10 Kit sells for $29.95.

For more information write to Vero Electronics, Inc., 171 Bridge Road, Hauppague, New York 11787 or use *check-off* on page 94.

new callbook

Marking it's fiftieth anniversary, the Radio Amateur Callbook Magazine is changing to a new format of one major edition per year. This first of the new Callbooks will be the Winter 1971-72 issue, published on December first.

A "new information service," in Callbook form, consisting of new licenses, silent keys, call letter and address changes for the preceeding three months, will be initiated on a quarterly basis — every March 1, June 1 and September 1 — to those who have purchased the previous December issue. This information service will be available by subscription only, through the order form printed in the December edition. The price for this service will be $6.00 per year for the United States series, and $4.50 per year for the foreign series. The subscription is on a consecutive, annual basis only.

The Winter U. S. Callbook and three supplements will cost $15.20 per year, and the Foreign Callbook and supplements will cost $11.70. The U. S. Callbook alone will remain at $8.95; the Foreign Callbook is $6.95.

For more information use *check-off* on page 94 or write to the Radio Amateur Callbook Magazine, 925 Sherwood Drive, Lake Bluff, Illinois 60044.

More Details? CHECK—OFF Page 94

Now...professional-quality Heathkit instrumentation at amateur prices

Keep your rig operating at peak performance with these new Heathkit budget-minders.

New Heathkit Digital Multimeter... 229^95*

- 3½ digits for 100 uV resolution on 200 mV range, 1 uV on 1000V
- Furnished DC calibrator gives 0.2% accuracy VDC (can be lab calibrated to 0.1%)

Here's a true digital multimeter (circuitry and readout) at far less than you'd pay for comparable wired units... and accuracy that's better than many wired DMMs. The IM-102 accurately measures AC & DC voltages, currents, and resistance with no need to change probes or switch meter for changes in DC polarity. Five overlapping ranges measure voltage from 100 uV to 1000V on DC (either polarity); 5 ranges cover 100 uV to 500 V on AC; 10 ranges measure 100 nA to 2A on AC or DC; and 6 ranges measure resistance from 0.1 ohm to 20 megohms. Input impedance is approx. 1000 megohms on 2V range, 10 megs on higher ranges, with overload protection built-in. Decimal point automatically placed with range selection. Front panel light indicates overrange. DC calibrator furnished. An internal circuit and unique transfer method allow accurate ACV calibration. Solid-state design with cold cathode readout tubes and memory circuit assure stable, non-blinking operation. Kit includes standard banana jack connectors complete with test leads. Put it together in about 15 hours for a lifetime of precision performance.

Kit IM-102, 9 lbs. **229.95***

New Heathkit 5″ Triggered Sweep Scope... 229^95*

- DC-10 MHz response — Triggered Sweep
- 50 ns sweep rate with magnification
- AC-DC coupling

Maximum flexibility in a general purpose scope, at a price to fit any budget... the new Heathkit IO-103 is a radio amateur's dream come true! Big 6x10 cm screen with lighted graticule for easy, accurate measurements. DC-10 MHz ±3 dB response with less than 50 ns rise time on vertical channel. Horizontal expansion gives x2 magnification ±5% for a 50 ns/cm sweep rate. Triggered sweep, too, with selection of either normal or automatic modes. Other features are switch controlled AC-DC coupling; provision for external triggering signals and horizontal deflection signal; front-mounted connectors for vertical inputs and 1V peak-to-peak signal for checking calibration; 120/240 VAC operation. Put this budget-minder to work in your ham shack...now.

Kit IO-103, 37 lbs. **229.95***

HEATHKIT
Schlumberger

HEATH COMPANY, Dept. 122-2
Benton Harbor, Michigan 49022

☐ Enclosed is $________________, plus shipping.
Please send model(s)________________
☐ Please send FREE Heathkit Catalog.

Name________________
Address________________
City__________State__________Zip__________

Prices & specifications subject to change without notice.
*Mail order prices; F.O.B. factory. AM-262

More Details? CHECK—OFF Page 94

More Details? CHECK—OFF Page 94

E&E guides hams through radio's mysteries.

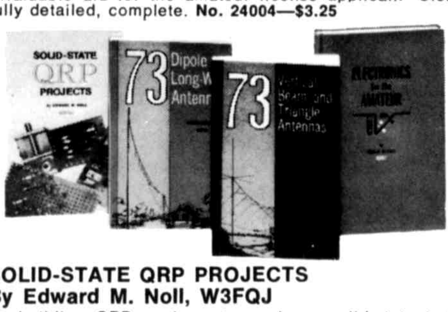
Highly popular Editors and Engineers books from Sams give amateurs everything they need to know about radio operation and technology. They're authoritative, clear and easy to follow. You'll want them for your library.

Famous E&E RADIO HANDBOOK—18th Edition
By William I. Orr, W6SAI
The completely updated electronics industry standard for engineers, technicians and advanced amateurs. Shows how to design and build all types of radiocommunications equipment. Includes ssb design and equipment, RTTY circuits, latest semiconductor circuits, IC's, special circuitry **No. 24020—$13.50**

SINGLE SIDEBAND: THEORY & PRACTICE
By Harry D. Hooton, W6TYH
A basic text, covering origin of ssb, derivation of signals, sideband selection, ssb generators, carrier-suppression techniques, carrier generators, speech amplifiers and filters, balanced mixers and converters, low-power ssb transmitters, linear r-f power amplifiers, much more. 388 pgs., hard cover. **No. 24014—$6.95**

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

AMATEUR RADIO INCENTIVE LICENSING STUDY GUIDE
By Robert M. Brown, K2ZSQ and Tom Kneitel, K2AES
Invaluable aid for the amateur license applicant. Clear, fully detailed, complete. **No. 24004—$3.25**



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

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

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

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

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

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

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

order today from

comtec

BOOKS

Greenville, New Hampshire 03048

More Details? CHECK—OFF Page 94

More Details? CHECK—OFF Page 94

More Details? CHECK—OFF Page 94

2-M CLASS "C" AMPLIFIER

NEW

SIZE
ONLY
7″ x 5″ x 3″

13.5 V.D.C.
MOBILE OPERATION

MODEL FM-3-30

1 TO 3.5 WATTS INPUT GIVES
17 TO 30 WATTS OUTPUT
TYPICALLY 20 WATTS OUT FOR 1 IN
AUTOMATIC T/R SWITCHING

Model FM-3-30 $89.95

ONLY HIGH QUALITY AMERICAN PARTS USED IN ALL MODELS

MODEL FM-7	MODEL FM-25	MODEL FM-10-50	*FLASH!* Now Available MODEL FM-1-40
13.5 V.D.C.	13.5 V.D.C.	13.5 V.D.C.	35 WATTS OUT FOR TR22 OR EQUIVALENT.
1 TO 3.5 WATTS INPUT	4 TO 12 WATTS INPUT	4 TO 12 WATTS INPUT	
4 TO 12 WATTS OUTPUT	12 TO 30 WATTS OUTPUT	20 TO 50 WATTS OUTPUT	
AUTOMATIC T/R SWITCHING	TYPICALLY 25 OUT FOR 10 IN	AUTOMATIC T/R SWITCHING	
SIZE: 5¼″x3″x2⅛″	AUTOMATIC T/R SWITCHING	SIZE: 7″x5″x3″	
	SIZE: 5¼″x3″x2⅛″		
Only $49.95	**Only $69.95**	**Only $119.95**	**Only $119.95**

Also available — 2M Preamps — 12 V.D.C. Operation — 13 dB Gain — 3.5 db Noise — 2″ x 2½″
No Case — Mosfet with Diode Protection — G-10 Glass Solder Dipped Circuit Board — with Instructions **$12.95**

90 DAY PARTS AND LABOR WARRANTY ON ALL PRODUCTS

SEND CHECK OR MONEY ORDER TO: (Dealer inquiries invited)
Limited time only — a 2 meter pre-amp free with purchase of any of our amplifiers.

vhf SPECIALISTS

PO BOX 167 VIENNA VA 22180

WE WILL SHIP UPS POSTPAID ON CASH ORDERS — C.O.D. ORDERS ACCEPTED WITH 25% DEPOSIT

STUD NUT — THE NEW

unitized fastener for rapid and convenient mounting of threaded-stud, solid-state devices.

Replaces 5 separate items of hardware now required for mounting SCR's, Zeners, Diodes and Power Transistors.

PROVIDES
- Exact stud centering for maximum voltage insulation
- Stud isolation from mounting surface
- Locking action
- Electrical connection to device stud

Rated to 30 Amperes, continuous. Mounted with std. 7/16″ hex-nut driver.

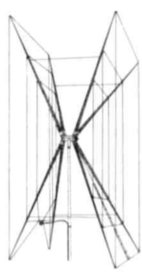
Supplied with Mica washer for COMPLETE mounting kit for #10-32 threaded stud devices.

Package of 4 STUD-NUTS & WASHERS - $1.00
Package of 24 STUD-NUTS & WASHERS - $5.00

SCF Corp. P. O. Box 999, Hightstown, N. J. 08520

GEM-QUAD FIBRE – GLASS

ANTENNA FOR 10, 15, and 20 METERS.



Two Elements	$107.00
Extra Elements	$60.00 ea.

Submit Payment with Order
Shipped Freight collect.
Price includes
Canadian Federal Sales Tax
or U.S. Customs Duty.

KIT COMPLETE WITH
- **SPIDER**
- **ARMS**
- **WIRE**
- **BALUN KIT**
- **BOOM WHERE NEEDED**

SEE OUR FULL PAGE IN MAY ISSUE

Buy two elements now — a third and fourth may be added later with little effort.

Enjoy optimum forward gain on DX, with a maximum back to front ratio and excellent side discrimination.

Get a maximum structural strength with low weight, using our "Tridetic" arms.

MANITOBA DESIGN INSTITUTE AWARD WINNER

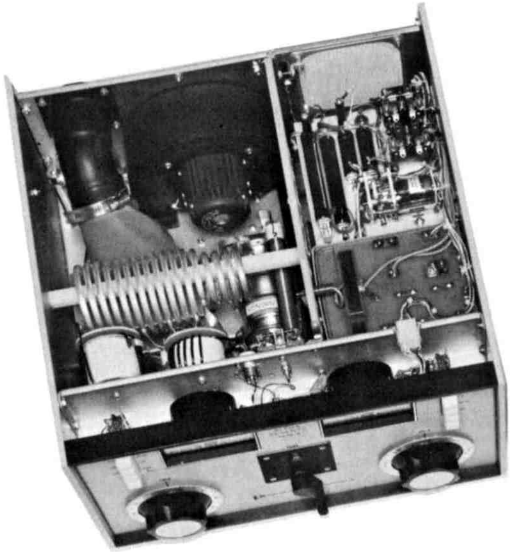
Structural Glass LIMITED

Canadian Patent No. 794506
U.S. Patent No. 3532315

20 Burnett Avenue, Winnepeg 16, Manitoba, Canada

More Details? CHECK—OFF Page 94

THE STRONG, SILENT ONE. . .



IS NOW EVEN GREATER!

8877 / 3CX1500A7 air-cooled ceramic triode. **Eimac's new tube is the finest available at any price; delivers** *even more* **power output with less drive!**

Ultra-rugged vacuum relays **previously optional at extra cost for commercial applications are now standard on every** *ALPHA SEVENTY* **.**

A really "cool" kilowatt! **You can run it** *key-down continuously for a month* **at a full kilowatt d-c input—or at 2.5 kilowatts PEP with a two-tone or voice SSB signal—and the** *ALPHA SEVENTY* **will stay** *literally* **cool. But you'd better have a mighty husky dummy load!**

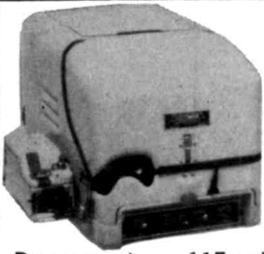
Every performance, convenience, and ruggedness feature **that put the** *ALPHA SEVENTY* **in a class by itself among high powered linear amplifiers!**

You must see the *ALPHA SEVENTY* **in operation to believe it!**

Air cooled model PA77-A, $1695

ETO EHRHORN TECHNOLOGICAL OPERATIONS, INC.
Brooksville, Florida 33512

ELECTRONIC SURPLUS BARGAINS



REPERFORATOR-TRANSMITTER

MODEL TT-179/FG Mfg. by Kleinschmidt. This unit is used for printing on and punching tape. Also for transmitting a prepared tape when used with Model TT-117/FG page printer.

Power rqmt. — 115 volts 60 cy. —Shpg wt. 90 lbs. Used **$59.50**

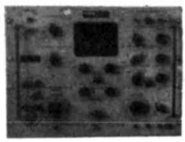
RT11A/APN-12 RECEIVER-TRANSMITTER

The transmitter interrogates a remote radar beacon by Pulse Type R.F. Signal. The pulse reply is received and displayed on an indicator. Contains a 24 v.d.c. gearhead motor, a blower and many tubes.

Freq. range - 160-240 MHz - Excellent Cond. **$18.95**
ID-169 indicator used with above - Excellent Cond. **$14.95**

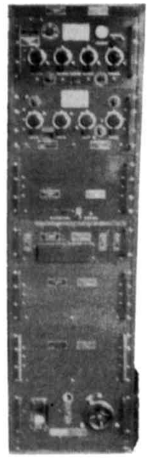
AUDIO OSCILLATOR

TS-382-C
20cps - 200kc
Var. 0-10 volts
Shpg. wt. 40 lb.
17" x 10" x 11"-115 volt, 60 cy.
Used, good cond., $65.00



A wide-range, high gain, portable test unit for observation of pulses, short-period electrical disturbances, sine waves, Band width 3 cyc.-15 mc. 105/125 VAC, 50-1000 cyc.

AN/USM-50 OSCILLOSCOPE $79.00

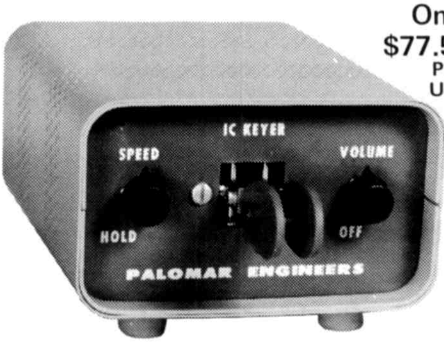


2-METER-VHF
BC-640 X'MITTER
50 watt - CW and AM. Freq. range 100-156 MC crystal controlled Pwr. rqmt. 100/125 60 cyc. Crated wt. 600 lbs. 6' x 22" wide.
$49.50

R. JAROSS & COMPANY **ELECTRONIC SALES DIV.**
6427 Springer Houston, Texas 77017 713-645-7057

NEW! IC KEYER

Only
$77.50
PPD
USA



- Self completing dots and dashes.
- Dot memory for easy keying.
- Precision feather-touch key built-in.
- Sidetone oscillator and speaker built-in.
- Relay output keys 300-V @ 100-ma.
- Keyed time base. Instant start.
- 5-50 wpm. Perfect dot-dash ratio.
- Send QSL or postcard for free brochure.

PALOMAR ENGINEERS
BOX 455, ESCONDIDO, CAL. 92025

GATEWAY ELECTRONICS

WE HAVE MOVED TO LARGER QUARTERS
NEW LOCATION
8123 PAGE BLVD., ST. LOUIS, MO. 63130
NEW PHONE NO. 427-6116

6.5 DB GAIN VERTICAL BASE station antenna 140-160 mhz. Manf. by Antenna Eng. Co. 4 lb. $23.95

base for above 3 lb. $5.95

4.5 DB GAIN VERTICAL MOBILE antenna 140-160 mhz. 3 lb. $15.95

7200 VOLT C.T. PLATE TRANSFORMER 1 AMP - 115 or 220 volt Pri. 11" x 11" x 13". 100 lb. $30.00

811A TUBES — NEW. 1 lb. $4.95

6146A TUBES — NEW. 1 lb. $3.75

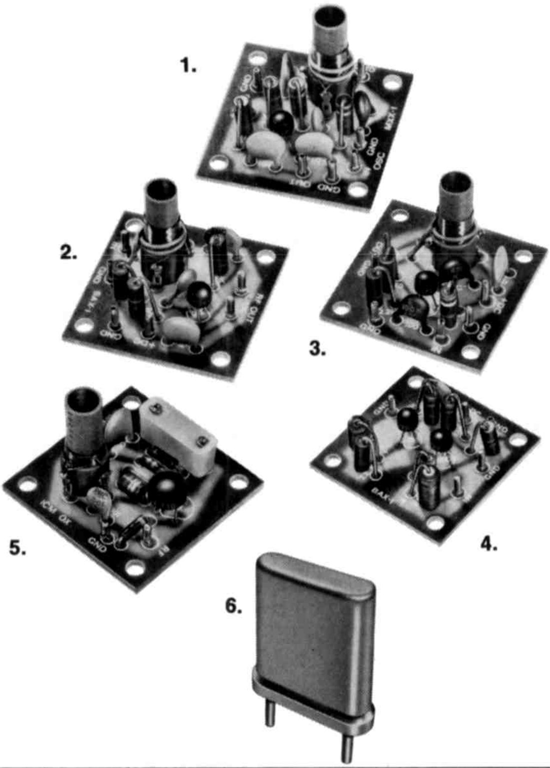
Write us for your IC needs.
Stop in and see us when you're in St. Louis.

More Details? CHECK—OFF Page 94

for the experimenter!

INTERNATIONAL EX CRYSTAL & EX KITS

OSCILLATOR • RF MIXER • RF AMPLIFIER • POWER AMPLIFIER



1. MXX-1 TRANSISTOR RF MIXER

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

2. SAX-1 TRANSISTOR RF AMP

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

3. PAX-1 TRANSISTOR RF POWER AMP

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

4. BAX-1 BROADBAND AMP

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

5. OX OSCILLATOR

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

6. TYPE EX CRYSTAL

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

for the commercial user

INTERNATIONAL PRECISION RADIO CRYSTALS

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

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

WRITE FOR CATALOG.

INTERNATIONAL

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

More Details? CHECK—OFF Page 94

More Details? CHECK—OFF Page 94

G&G CATALOG
MILITARY ELECTRONICS

24 PAGES, crammed with Gov't Surplus Electronic Gear – the Biggest Bargain Buys in America! It will pay you to **SEND 25¢** for your copy – Refunded with your first order.

TG-34A CODE KEYER, self-contained, automatic, reproduces code practice signals from paper tape. 5 to 12 WPM Built-in speaker. Brand new with tech manual, takeup reel and AC line cord.... **$24.50**
Code practice tapes for above P.U.R.

HEADSET Low impedance. With large chamois ear cushions. 4-ft cord and plug. Reg. $12.50. Our Special Price **$2.95**
Less ear cushions.................. $1.95
High impedance adaptor for above... $ .69

SCR-274-N, ARC-5 COMMAND SET HQ!

Freq. Range	Type	Exc. Used	Like New	BRAND NEW
RECEIVERS.	Complete with Tubes			
190 – 550 Kc	BC-453	$16.95	$23.50	$27.50
6 – 9.1 Mc	BC-455	—	—	$22.50
1.5 – 3 Mc	R-25	—	$19.50	$21.50
TRANSMITTERS.	Complete with Tubes			
4 – 5.3 Mc	BC-457	$8.95	—	$11.95
5.3 – 7 Mc	BC-458	$8.95	—	$11.95

AN/APR - 4Y FM & AM RECEIVER "FB" for Satellite Tracking!
High precision lab instrument, for monitoring and measuring frequency and relative signal strength, 38 to 4000 Mc. in 5 tuning ranges. For 110 v 60 cycle AC. Built-in power supply. Original circuit diagram included. Checked out, Perfect. LIKE NEW.................. **$88.50**
All tuning units available for above. P.U.R.

BC-1206-C RECEIVER Aircraft Beacon Receiver 200 to 400 Kc. Operates from 24V DC 1.5A. Continuous tuning, vol control, on-off switch and phone jack. Very sensitive. Compact. Complete with tubes, NEW............. **$12.50**

BC-604 FM TRANSMITTER 20 to 27.9 Mc. Output approx 30 watts. 10 crystal controlled channels. Complete with tubes. NEW........................... **$12.50**

ARC-R11A	Modern Q-5 Receiver 190 – 550 Khz	$10.95
ARC-R22	540 – 1600 Khz Receiver with tuning graph	$15.95
R-4/ARR-2	Receiver 234-258 Mhz, 11 tubes, NEW	$8.95

BC-605 INTERPHONE AMPLIFIER, NEW $3.45 EXC. USED.... $1.95
TELEPHONE HANDSET, W.E. type............LIKE NEW $2.95
SCR-522 TRANSMITTER-RECEIVER, with 18 tubes. LIKE NEW $32.50

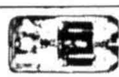
TV-10A UHF TRANSVERTER 28V DC
Made by Aircraft Radio Corp. Couples UHF Antenna to VHF transmitter and VHF receiver. Uses 6 tubes: 4/5763 and 2/6201. Includes 8 crystals ranging from 233.8 Mc to 257.8 Mc. Size: 11x 4-1/2x4-5/8". Wt 5-1/2 lbs.
LIKE NEW, with tubes and crystals..... **$9.95**

BC-733 RECEIVER Receives radio signals being transmitted by US satellite on approx. 108 Mc. AM, crystal-controlled on 6 preset freqs. in 108.3 to 110.3 Mc range. Operates on 12/24 V DC & 220 VDC 80 Ma. Complete with 10 tubes. Can be converted to FM Receiver 80 to 108 Mc. Exc. Used............. **$5.95**
BC-732A Control Box for above, NEW... 1.75

HANDMIKE
Rugged, heavy-duty carbon handmike with press-to-talk switch. Equipped with 4-ft cord & phone plug.
NEW, boxed....... Each **$1.88** SPECIAL 2 for $3.25

2" DC VOLTMETER
Mounts in 2-1/8" hole. Flange diameter 2-5/8" Two scales: 0-15 and 0-600. Calibrated for use on steel panel. Standard brand.
NEW, boxed....... Each $1.75 SPECIAL 2 for $3.00

TELEPHONE TYPE RELAY
Made by J.H. Bunnell, has adjustable sensitivity. 150 ohm coil. NEW...... **$3.45**



BRAND NEW BC-645 TRANSCEIVER
EASILY CONVERTED FOR 420 MC. OPERATION

FOR FIXED OR MOBILE USE — BRAND NEW, complete with 15 tubes, less dynamotor and accessories, in original factory carton **$16.95** — DEPENDABLE TWO WAY COMMUNICATION MORE THAN 15 MILES!

FREQUENCY RANGE: About 435 to 500 Mc.
TRANSMITTER has 4 tubes: WE-316A, 2-6F6, 7F7
RECEIVER has 11 tubes: 2-955, 4-7H7, 2-7E6, 3-7F7
RECEIVER I.F.: 40 Mc.
SIZE: 10 1/2" x 13 1/2" x 4 1/2". Shpg Wt 25 lbs.

Superb quality components and circuitry, ideal for the technician experimenter. Many fabulous experiments, for example: you can construct a Yagi antenna for the 420 Mc band that will produce a gain of 10 db and yet fit on your operating desk!

ACCESSORIES FOR BC-645

MOUNTING for BC-645 Transceiver $1.50
PE-101C DYNAMOTOR, 12-24 Volts, (easily converted to 6 volts) 7.95
MOUNTING for PE-101C Dynamotor 1.00
UHF ANTENNA ASSEMBLIES(set of 2), per set ... 2.95
COMPLETE SET OF 11 CONNECTORS 5.95
CONTROL BOX BC-646 .... 2.95
MOUNTING for BC-646 Control Box 1.00

SPECIAL "PACKAGE" OFFER:

SPECIAL PACKAGE OFFER: BC-645 Transceiver, Dynamotor and all accessories above, COMPLETE, BRAND NEW, While Stocks Last.... **$26.95**

BC-223AX TRANSMITTER 25 Watt, CW, MCW, Voice, Crystal control on 4 pre-selected channels, range 2000 to 5200 Kc by use of 3 plugin units, included. Complete.
BRAND NEW..................... **$27.50**

APN-1 FM TRANSCEIVER 400-450 Mc. Freq. modulated by moving coil transducer. Easily converted for radio control or 70 cms. Complete with 14 tubes, dyn.
BRAND NEW....................... **$9.95**

TG-5B TELEGRAPH SET for code communications or code practice. Portable, with hinged lid. Two or more units operate up to 25 miles apart. Bell call system, 1000 cycle howler, key, headpiece, canvas case, book.
Size 5-1/2x5-1/2x10". NEW.......... **$8.95**

DUAL AMPLIFIER has two input circuits each feeding a single 6SN7GT twin triode amplifier. Complete with 115V 60 cy. power supply using 6X5GT rectifier. NEW.......... **$5.95**

WILLARD 2-VOLT STORAGE BATTERY
Rated at 20 Amp.-Hours. Model 20-2. Rechargeable. Compact nonspill construction. Lightweight polystyrene container, 3x4x5 1/2". Shipped dry, uses standard electrolyte. Shipping Weight 3 lbs. NEW, each............ **$2.79**

TERMS: 25% Deposit with order, balance C.O.D. –or– Remittance in full. Minimum order $5.00 F.O.B. NYC. Subject to prior sale and price change

G&G RADIO ELECTRONICS COMPANY
45-47 Warren St. (2nd Fl.) New York, N.Y. 10007 Ph. 212-267-4605

More Details? CHECK—OFF Page 94

R. L. Drake Company makes radio communications equipment to satisfy the needs of the most discriminating user. There's at least one item of Drake gear just right for you . . .

TRY IT...

We're sure

YOU'LL LIKE IT!

R. L. DRAKE COMPANY

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

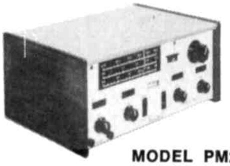
DRAKE®

More Details? CHECK—OFF Page 94

More Details? CHECK—OFF Page 94

Everything you always wanted in keyers and QRP equipment.

■ POWER-MITES



MODEL PM2B

MODEL PM2B. Popular two watt CW transceiver. Operates on 80-40-20 meters. Side-tone. Lantern battery or 12 VDC power source. Size 10⅜" W × 4½" H × 6⅝" D. Weight 2¾ lbs. **Price $64.95.**

MODEL PM3A. Advanced 5 watt CW transceiver. Operates on 40-20 meters. Side-tone. Push pull final. Pi Network. Break-in keying. Size 10⅜" W × 4½" H × 6⅝" D. Weight 3 lbs. **Price $79.95.**

■ ANTENNA TUNER

MODEL AC5. Matches 52 ohm output of Power-Mites to open wire on random length antennas. Maximum power 10 watts. Size 4" W × 2" H × 4" D. Weight 1 lb. 4 oz. **Price $8.95.**

■ SWR BRIDGE

AC4

MODEL AC4. Favorite for QRP. Measures from ¼ watt to 200 watts. Size 4" W × 2" H × 4" D. Weight 1 lb. 4 oz. **Price $14.95.**

Argonaut

The Argonaut is for every ham. A transceiver that operates on an AC pack or lantern battery. Covers Amateur bands 80-10, SSB and CW.

Completely solid state. Permeability tuning. Less than 100 Hz drift. ½ uv sensitivity. 9 MHz crystal filter. 2.5 kHz bandwidth, 1.7 shape factor. Amateur bands 3-30 MHz. AGC. Speaker, SWR bridge, S-meter built-in. Instant CW break-in. Side-tone. Plug-in circuit boards. Selects normal side band, reversible. One control tune-up. 50-75 ohm push-pull output. Direct frequency read out.

Argonaut price	**$288.00**
Power supply	**$24.95**
Microphone	**$17.00**

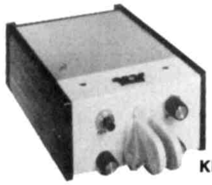
■ SIGNALIZER

S20

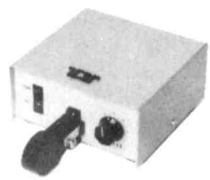
MODEL S20. Complete audio and speaker system for receivers/tranceivers. Plugs into headphone jack. Provides maximum AGC to keep all signals constant level. Front panel headphone jack. Size 8¼" W × 4½" H × 6½" D. Weight 3½ lbs. **Price $39.95.**

MODEL S30. Similar to S20 but has built in FR4 CW filter; switchable. Size 8¼" W × 4½" H × 6½" D. Weight 4 lbs. **Price $49.95.**

■ KEYERS AND KEYER PADDLES



KR40



KR5

MODEL KR40. Squeeze keyer. Iambic sequence. Full memories. Variable weighting. With dual paddles. Speeds from 6-60 wpm. 115 volt AC operation. Side tone. Size 4¾" W × 2½" H × 8" D. Weight 4 lbs. **Price $89.95.**

MODEL KR20. Keyer. Self-completing. On/off weighting. With dual paddles. Speed 6-60 wpm. Monitor side tone. 115 V AC operation. Size 4¾" W × 2½" H × 8" D. Weight 4 lbs. **Price $59.95.**

MODEL KR5. Keyer. Self-completing. Optimum weighting. Single paddle. Speed 6-60 wpm. Operates from 6 or 12 volts DC. Size 4" W × 2" H × 6" D. Weight 1 lb. 6 oz. **Price $34.95.**

MODEL KR1. Paddles as used in KR40 and KR20. Mounted in formed aluminum case. Size 4¼" W × 2" H × 6" D. Weight 1 lb. **Price $18.95.**

MODEL KR2. Paddle as used in KR5. Mounted in formed aluminum case. Size 4¼" W × 2" H × 6" D. Weight 1½ lbs. **Price $12.95.**

Ask your TEN-TEC dealer to show you our complete line. If there is no dealer in your area, send your order direct. Include $2.00 shipping for each Argonaut, all other items shipped postpaid.

Dept. J-2

TEN-TEC, INC.
Highway 411 East □ Sevierville, Tennessee 37862

More Details? CHECK—OFF Page 94

The most powerful signals under the sun!

When You Really Know...

hy-gain/galaxy

GT-550A Transceiver

- Unmatched dependability, flexibility and low cost
- Top performance either fixed station or mobile
- Higher power output than other popular transceivers available today
- Standard of the industry in frequency stability
- Outstanding receiver stability and selectivity
- Full line of accessories for integrated station capability

Order No. 855 Ham Net $495.00

RV-550A Remote VFO

- Solid-state construction
- Complete with plug-in cables
- Function switch controls Receive-Transceive-Transmit frequency independently

Order No. 856 Ham Net $95.00

RF-550A R.F. Console

- Contains precision wattmeter with top accuracy in range of 3.5/30.0 MHz
- Switch select forward or reflected power—calibrated scales are 400 and 4,000 watts full scale
- Switch select 5 antennas plus a dummy load

Order No. 857 Ham Net $75.00

RB-550A Rotator Control

- All new control head for Hy-Gain model 400 Rotor Brake Rotator
- Contains solid-state logic circuit to furnish electrical information for rotation and control of tower mounted rotator

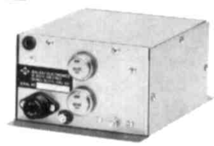
Order No. 859 Ham Net $59.95

SC-550A Speaker Console

- Matching speaker with headphone jack for the transceiver, complete with cable
- AC-400 power supply mounts inside console

Order No. 858 Ham Net $29.95

More Details? CHECK—OFF Page 94



HAL DEVICES

HAL DEVICES MODEL 1550 ELECTRONIC KEYER

All the features of previous **HAL** keyers and more. TTL circuitry. Optional identifier for sending call letters. DX and RTTY ops, take notice. Transistor switching for grid block **AND** cathode keying. Rugged crackle cabinet with brushed aluminum panel. Designed for ease of operation. Model 1550 only $64.95. With ID $89.95.

HAL MAINLINE ST-6 RTTY TU

Complete parts kit for the W6FFC ST-6 now includes all parts except cabinet. Only 7 **HAL** circuit boards (drilled G10 glass) for all features. Plug-in IC sockets. Custom transformer by Thordarson for both supplies, 115/230V, 50-60Hz. $135.00 kit. Screened table or rack cabinet $26.00. Boards and manual $16.50. Shipping extra. Wired units available.

HAL TOUCHCODER II KIT $55.00

Complete parts kit, excluding keyboard, for the W4UX CW code-typer. All circuitry on one 3 x 6" G10 glass PC board. Plug-in IC sockets. Optional contest ID available, $35.00. Watch for announcement of the new **HAL** code-typers, both Morse and RTTY.

HAL ARRL FM TRANSMITTER KIT

Drilled, plated, glass epoxy **HAL** PC boards. 2N5913 final transistor. RF detector with 0-1 ma. meter added. All parts, and the RF detector and meter only $50.00 + shipping. Cabinet and crystals excluded. Board only $7.50.

OTHER HAL PRODUCTS

ID-1 REPEATER IDENTIFIER. . . . . $75.00 wired
W3EFG SSTV CONVERTER. . . . . 55.00 kit
DOUBLE BALANCED MODULATOR. . . . 6.50 kit
DIP IC BREADBOARD CARD. 5.50
MAINLINE ST-5 TU KIT. $50.00
MAINLINE AK-1 AFSK KIT. 27.50
HAL RT-1 TU/AFSK KIT. 51.50

HOT CARRIER DIODES: HP2800 90¢ 12/$10.00 — Matched by **HAL** 4/$4.25
ZENERS: 1N4729(3.6v), 1N4733(5.1v), 1N4735(6.2v), 1N4738(8.2v), 1N4739(9.1v), 1N4742(12v) — 1 watt 75¢
LINEAR ICS: 709N 75¢ — 709L, 710N $1.25
741N $1.50 — MC1429G $3.75
MC1496G $3.25 — MC1590G $5.60
DIGITAL ICS: FML923 90¢ — MC723P 95¢
MRTL: MC788P $1.30 — MC880P $3.50 — MC890P $2.00
MC724P, MC725P, MC789P, MC792P $1.05
MC767P $3.30 — MC771P $1.75 — MC970P $3.30 — MC9760P $5.45
DIP TTL: 7400, 7401, 7402, 7410, 7420, 7430, 7440 48¢
7404, 7405 60¢ — 7441, 7495, 7496 $3.00 — 7442 $2.25
7472 75¢ — 7473, 7474 $1.05 — 7475 $2.40
7486 $1.15 — 7490, 7492, 7493 $2.10 — 74121 $1.40
FETS: 40673 MOSFET $1.60 — MPF102 60¢ — 2N3819 55¢
Indiana General CF102-06, CF102-Q1, CF101-Q2 50¢
TOROIDS: CF102-Q3 $1.25 — FERROXCUBE FERRITE BEADS 10/$1.25
CINCH IC SOCKETS: 8-ICS, 14-DIP 60¢ — 10-ICS, 16-DIP 70¢

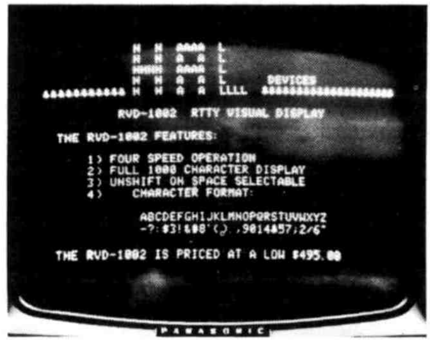
ORDERING INFORMATION

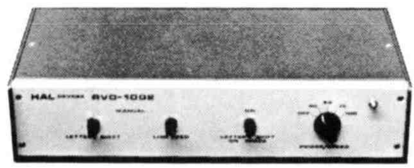
Catalog, including photos, of all items 24¢ postage. Please add 75¢ on parts orders, $2.00 on larger kits. Shipping via UPS when possible. Give a street address.

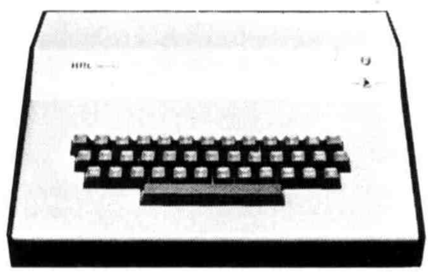
HAL DEVICES, Box 365H, Urbana, Il 61801
Phone 217-359-7373

HAL DEVICES

ANNOUNCING







The HAL DEVICES RVD-1002

A revolutionary approach to amateur radio teletype. The RVD-1002 provides:

- Display of 60, 66, 75, and 100 WPM 5 level TTY
- 1000 character display in 20 lines of 50 characters per line
- Selectable letters shift on space
- Manual control of line feed and letters shift.
- Standard CCIR video output for use with modified TV receiver
- Noiseless operation with solid state reliability

RVD-1002 (assembled). $495
RVD-1002 R (rack mount). $495
ST-6 (assembled). $280
ST-6/AK-1 (assembled). $320
TTY KEYBOARD. . . . . available soon

Modified solid state TV receivers will be available. Write for details.

HAL DEVICES, Box 365H, Urbana, Il 61801
Phone 217-359-7373

More Details? CHECK—OFF Page 94

flea market

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

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

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

TOLEDO MOBILE RADIO ASSOCIATION'S 17th Annual Hamfest and Auction will be held February 20, 1972. $1.00 registration, open table sales, map and info write: TMRA, W8HHF, Box 273, Toledo, Ohio 43601.

MOONBOUNCE: World record 1296 MHz equipment. 16 foot polar mount and 10 foot El-AZ dish. Power amplifiers (2) 600W and 350W output. Parametric amplifier and converter. Power supplies and all exitation equipment. Feedline, feeds and all peripheral equipment to operate SSB, CW, AM and FM. Equipment described in Aug. 68 and Aug. 69 **Ham Radio.** Also test equipment and components for general microwave work. Contact Peter Laakmann, WB6IOM, 8001 Airlane Avenue, L.A. 45, Calif. 90045. Phone 213-391-0711 Ext. 4629 during working hours.

SURPLUS MILITARY RADIOS, Electronics, Radar Parts, tons of material for the ham, free catalogue available. Sabre Industries, 1370 Sargent Avenue, Winnnipeg 21, Manitoba, Canada.

TOROIDS 44 and 88 mhy. Unpotted, 5 for $1.50 ppd. W. Weinschenker, Box 353, Irwin, Pa. 15642.

KIT BUILDERS — All American Sports Amplifier (featured Sept. 1971 Popular Mechanics) now available with step by step instructions. Fantastic new (patent pending) amplified filter concept doubles normal TV viewing range. Free data sheet. CADCO SYSTEMS, Box 18904, Oklahoma City, Oklahoma 73118.

YAESU FTDX-400 TRANSCEIVER: 500 watts SSB, 440 watts CW, 125 watts AM, Like New, $350.00: Robert Cook, W6PJA, 4303 Snowden, Lakewood, California 90713 . . . 213-429-4442.

ATTENTION DEALERS — stock All American Sports Amplifier long range TV receiving kits, featured September 1971 Popular Electronics. Write Dealer Division, CADCO SYSTEMS, Box 18904, Oklahoma City, Oklahoma 73118.

TELETYPE MACHINES — Kleinschmidt Mod 125 (FGC-20) $125 each, complete tape set (FGC-25) $175 each, reperf (TT-109) $40 each. Teletype Corp. Mod 14 typing reperf w/KBD $50 each, reperf only rebuilt $30 each, Mod 14 TD $15 each. Stelma TT-63A repeater $30 each. FOB Long Beach. John Fageol, WA6TAO/6, 3563 Conquista, Long Beach, Cal. 90808 — 213-429-5821.

TOROIDS! LOWEST PRICE ANYWHERE. 40/$10.00 POSTPAID (5/$2.00). Center tapped, 44 or 88mhy. 32KSR page printer, reconditioned, perfect $225. MITE UGC41KSR page printer, reconditioned, $250. Model 28 sprocket to friction kit, $25. Model 15KSR, $65. Matching RA87 P.S. unused, $5. Sync motors, $7. 14TD 60 speed, $25. 14DPE tape punch, $15. HP 200CD audio oscillator, $75. 11/16″ reperforator tape, 40/$1.00. Model 33ASR complete $650. Stamp for listing. Van W2DLT, 302H Passaic, Stirling, N. J. 07980.

HALLAMORE TELEVISION SYSTEM: Receiver MR17A, Camera CC400A, used on VHF amateur television . . . $125.00. Robert Cook, W6PJA, 4303 Snowden, Lakewood, California 90713. 213-429-4442.

"DON AND BOB" GUARANTEED GOODIES. Monarch KW SWR-FS meter 8.88 plus 1.50 postage/handling; Ham-M 99.00; TR44 59.95; Mosley CL33 114.00; Hy-Gain TH6DXX 139.00; Write quote list. Capacitors: Sangamo DCM600MFD/450V 4.95; Vacuum 50PF/7.5KV 1.95; Superior Powerstat 136B 59.95; Ray 6LQ6 3.50; #14 Antenna Wire 1.95/C; MOT MC1709CG Opamp (709) 50¢; MOT HEP170 Epoxy Diode 2.5A/1000PIV 39¢; Hallicrafters SX115 250.00; Clairex 604 Photocell 1.00; ¼″ Copper Ribbon 10¢/Ft; KY65 Code Identifier 5.95; 4Cond/5Ft Coilcord 50¢; Tempo Kenwood Dealer. Prices collect. Mastercharge, BAC. Warranty guaranteed. Madison Electronics, 1508 McKinney, Houston, Texas 77002 (713) 224-2668.

EXCLUSIVELY HAM TELETYPE — 19th year, RTTY Journal, articles, news, DX, VHF, classified ads. Sample 30¢. $3.00 per year. Box 837, Royal Oak, Michigan 48068.

COLLINS Mechanical Filters. 455 kHz, 2.4 kHz bandwidth. $11.00 Postpaid. V. Mozarowski, VE3AIA, 1 Belgrove Drive, Islington, Ontario, Canada.

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

2MFM, 50W, MOTOROLA 53GJV, two with accessories, tuned on 146 MHz, one with no xtals $100. Other with .34-.94, .85-.85, .94-.94, .82-.70, $150 W6DZO, 1021 W. Cedar Avenue, Redlands, CA. 92373.

TV & RADIO TUBES 36¢. FREE catalog. Cornell, 4219 N. University, San Diego, California 92105.

NEW ELECTRONIC PARTS. Buy-Sell. Free Flyer. Large catalog $1.00 deposit. Bigelow Electronics, Dept. HR, Bluffton, Ohio 45817.

HEATH SB-100 with AC supply, absolutely mint condition $300. Hallicrafters HT-32 transmitter FB $180. Both shipped prepaid. Cline, WB6LXI/7, Box 6127, Salt Lake City, Utah 84106.

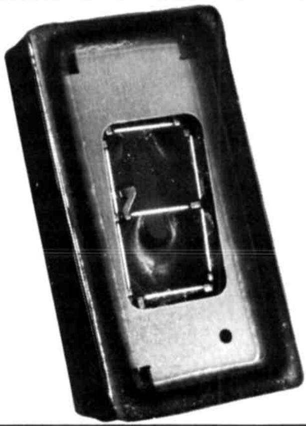
2ND WORLD SSTV CONTEST: 1st Period 15.00-22.00 GMT, February 5, 1972; 2nd Period 07.00-14.00 GMT, February 13, 1972. All autohirzed frequencies. Exchange consists of pictures and number of the message. A two way contact with a station receives one point (total points will be the number of individual stations contacted). No extra points for the same station contacted on different bands. A multiplier of 10 points for each Continent and of 5 points for each Country (ARRL list) worked is given. Total exchange points times the total of the multipliers. Log will contain: date, time, GMT, band, call sign, message number sent and received, points. All logs must be received by March 20, 1972. Send them to: Prof. Franco Fanti, via A. Dallolio 19, 40139 Bologna, Italy.

BUYING? SELLING? TRADING? Don't make a move until you've seen our new publication! Free sample copy! Six issues $1. Ham Ads, P. O. Box 46-653G, L.A., Cal. 90046.

TELL YOUR FRIENDS about Ham Radio Magazine.

Semiconductor Supermart

• MOTOROLA • RCA • FAIRCHILD • NATIONAL • HEP • PLESSEY •



DIGITAL READOUT

At a price everyone can afford **$3.70**

- Operates from 5 VDC
- Same as TTL and DTL
- Will last 250,000 hours.

SPECIAL OFFER

- Digital readout
- BCD to 7 — Segment Decoder/driver
- 7490 Decade Counter

Only **$8.50**

3.5 W AUDIO AMP IC HI-FI QUALITY

$3.95

with 12 pages of construction data

POPULAR IC's

MC1550	Motorola RF amp	**$1.80**
CA3020	RCA ½ W audio	**$3.07**
CA3020A	RCA 1 audio	**$3.92**
CA3028A	RCA RF amp	**$1.77**
CA3001	RCA	**$6.66**
MC1306P	Motorola ½ W audio	**$1.10**
MC1350P	High gain RF amp/IF amp	**$1.15**
MC1357P	FM IF amp Quadrature det	**$2.25**
MC1496	Hard to find Bal. Mod.	**$3.25**
MFC9020	Motorola 2-Watt audio	**$2.50**
MFC4010	Multi-purpose wide-band amp	**$1.25**
MFC8040	Low noise preamp	**$1.50**
MC1303P	Dual Stereo preamp	**$2.75**
MC1304P	FM multiplexer stereo demod	**$4.95**

FETs

MPF102	JFET	**$.60**
MPF105/2N5459	JFET	**.96**
MPF107/2N5486	JFET VHF/UHF	**$1.26**
MPF121	Low-cost dual gate VHF RF	**.85**
MFE3007	Dual-gate	**$1.98**
40673		**$1.75**
3N140	Dual-gate	**$1.95**
3N141	Dual-gate	**$1.86**

PLESSEY INTEGRATED CIRCUITS GREAT FOR SSB RCVRS AND XMTRS

SL610	low noise 150 MHz RF good AGC	**$5.65**
SL612	low distortion IF good AGC	**$5.65**
SL621	AGC generator for SSB rcvrs	**$8.30**
SL620	AGC gen. SL630 Audio	**$8.30**
SL630	multipurpose audio amp	**$5.35**
SL640	top performing balanced mixer	**$10.88**
SL641	low-noise rcvr mixer	**$10.88**

SIGNETICS PHASE LOCK LOOP

NE561B $9.50

NATIONAL LM309K 5V, 1A regulator. If you are using TTL you need this one.

NATIONAL DEVICES

LM370	AGC/Squelch amp	**$4.85**
LM373	AM/FM/SSB strip	**$4.85**

DIGITAL BARGAINS FACTORY FRESH TTL IC's

MSD047	decoder/driver for the digital readout	**$3.50**
7400	gates	**.35**
7441	NIXIE driver	**$1.95**
7490	decade counter	**$1.40**
7475	quad latch	**$1.40**
7495	shift Reg.	**$2.00**
7493	divide by 16	**$1.90**
74121	monostable	**$1.80**
7473	dual flip-flop	**.85**

MOTOROLA DIGITAL

MC724	Quad 2-input RTL Gate	**$1.00**
MC788P	Dual Buffer RTL	**$1.00**
MC789P	Hex Inverter RTL	**$1.00**
MC790P	Dual J-K Flip-flop	**$2.00**
MC799P	Dual Buffer RTL	**$1.00**
MC1013P	85 MHz Flip-flop MECL	**$3.25**
MC1027P	120 MHz Flip-flop MECL	**$4.50**
MC1023	MECL Clock driver	**$2.50**
MC4024	Dual VCO	**$3.00**
MC4044	Freq. Phase Det	**$3.00**

TRANSISTORS & DIODES

MPS6571		**.60**
2N5188		**.79**
2N706	packet of 4	**$1.00**
2N2218	packet of 2	**$1.00**
1N4001	packet of 6	**$1.00**
1N4002	packet of 6	**$1.00**
1N4004	packet of 6	**$1.00**

Please add 35¢ for shipping

CIRCUIT SPECIALISTS CO.

Box 3047, Scottsdale, AZ 85257

FACTORY AUTHORIZED
HEP-CIRCUIT-STIK
DISTRIBUTOR

More Details? CHECK—OFF Page 94

FOR SALE: National NCX-3 200W xceiver, NCX-A 110 Power Supply, G.E. Mike Model EM28B same as 444. CB xceiver Lafayette Micro-12. Best offer on any or all. Gerry Surprenant, Betty-Jean Drive, Monson, Mass. 01057.

ASK HARRY FIRST Ameco, Clegg, Cushcraft, Galaxy, Hallicrafters, Hy-Gain, Mosley, Regency, Sonar, Simpson, Ten Tec, others. Good trades accepted. S.A.S.E. Name literature wanted. Harry's Amateur Radio Supply, 3528 Gaskin Rd. (Belgium) Baldwinsville, N. Y. 13027. 10AM-9PM. Closed Sunday. 315-635-7452.

QSLS. SECOND TO NONE. Same day service. Samples 25¢. Ray, K7HLR, Box 331, Clearfield, Utah 84015.

2 METER FM GEAR for sale: Motorola L43 base on 146.58 $160. T43 trunk mtg 2 freq on 146.58 and 146.76 $150. GE MA36W trunk mtg 4 freq on 2M $250. FDFM-2 10w on 2 transistorized 6 channel transceiver 12VDC w/AC power supply, $185. W7YHS, 319 N 26th Street, Billings, MT 59101.

40′ TOWER WITH GUYS. Pick-up only. $50.00. Ham-M rotor $50.00. Box 87, Topsfield, MA 01983.

VHF NOISE BLANKER — See Westcom ad in Dec. '70 and Mar .'71 Ham Radio.

TONE ENCODERS AND DECODERS — New line of solid state encoders and decoders compatible with any sub-audible continuous tone system. Small in size, usable from 67-250 Hz, $8.95 to $14.95. Send for literature. Communications Specialists, Box 153, Brea, Calif. 92621.

WANTED for unique collection. Original rigs per QST, CQ, HAM RADIO articles. Close copies also desired. *Rigs will remain unmodified and* **will** be kept on the air. K1ETU, Charles J. King, 100 Laura Lane, Rocky Hill, Ct. 06067.

SAVE MONEY on parts and transmitting-receiving tubes. Foreign-Domestic. Send 25¢ for giant catalog. Refunded first order. United Radio Company, 56-HR Ferry Street, Newark, N.J. 07105.

AMATEUR SALES AND SERVICE before you buy it anywhere give us a chance to quote you a price. Alpha 70, Clegg, Regency, Robyn and Mosley are just a few of the leading names we sell. Write or call today. Amateur Sales and Service, 1115 Norris St., Raleigh, N. C. 27604. Tel. 1-919-833-2412.

NU SIGMA ALPHA — International Amateur Radio Fraternity. Membership now available. Includes wall certificate, I.D. card, newsletter, and more. Send for free brochure. Box 310, Dept. H, Boston, MA. 02101.

COLLINS SALE: 30S-1 Ampl. $980.00; 75S-3C Rcvr. $560.00; 32S-3 Xmtr $495.00; 516F-2 Pwr Supply $95.00. Call: J. Kelley, 1150 17th St., N.W., Washington, D. C. 20036. Tel. 202/466-4793.

FOR SALE: Best reasonable offer. 1 Clegg 22'er — Never used. 1 NCX-3, NCX-A, factory realigned. 1 Hammarlund 170-C, realigned. L. L. Baumgartner, Croton Falls, N. Y. 10519.

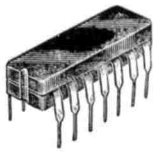
THE LAKE COUNTY AMATEUR RADIO CLUB, INC. announces its Annual Banquet to be held at 6:30 p.m., February 12, at the Scherwood Club, 600 E. Joliet St., Schererville, Indiana. Join us with wife or girl friend and enjoy good food (all you can eat), entertainment, speeches, awards, and fellowship. The Scherwood Club is less than a mile from the junction of U.S. Routes 30 and 41. And to help people unfamiliar with the area to get to the club, we have printed a map on the back of each ticket. Tickets are $5.00, each from Herbert S. Brier, W9EGQ, 385 Johnson St., Gary, Indiana 46402, and from other club members. No tickets will be sold at the door.

WANTED — TMC ATS-MCU-2 Monitor Control (C-2995/URA-27 Control-Indicator) and ATS-50CU-2 (CU-773/URA-27) Directional Coupler. Also AN/FRR-26 Manual (Navships 92557). P. F. Wilson, W7UNR, 14572 Newport Way, Bellevue, Washington 98006.

More Details? CHECK—OFF Page 94

IMPOSSIBLE? BARGAINS IN SURPLUS ELECTRONICS AND OPTICS

SURPLUS TTL INTEGRATED CIRCUITS, BRAND NEW IN ORIGINAL MANUFACTURERS CARTONS



B & F has one of the worlds largest inventories of surplus integrated circuits. All are new, meeting all manufacturers original specifications, and in factory packaging. The low prices should speak for themselves. Manufactured by Texas Instruments, National, Signetics or Philco, no choice. All packages are 14/16 lead silicone Dual In-Line Pak.

NEW LOWER PRICES!

ITEMS AT

40¢			95¢		$1.75		
7400	7409	7450	7406	7470	7413	7480	74141
7401	7410	7451	7407	7472	7442	7483	74151
7402	7411	7453	7416	7473	7443	7490	
7403	7420	7454	7417	7474	7444	7494	
7404	7421	7460	7426	7486	7475	7495	
7405	7430		7437	74121	7476	7496	
7408	7440		7438	74122	7477	74107	

$2.00	$2.50	$2.75	$3.75		$5.75	$9.75
7448	7445	7441	74150	7485	74166	7489
7491	7447	7491	74152	74182	74198	74170
7492	7448	74123	74153		74199	74181
7493	7483		74154			2501
74180	74145		74192			
	74194		74193			

HOT NEW INTEGRATED CIRCUIT ITEMS!

7413	Dual NAND Schmidt Trigger	$ 1.75
7485	Magnitude Comparator	3.75
74123	Dual One Shot W/clear	2.75
74153	Dual 4 Line to 1 Data Selector/multiplexer	3.75
7489	64 Bit Random Access Memory	9.75
74170	4 x 4 Register File	9.75
74181	Arithmetic Logic Unit	9.75
74182	Look Ahead Carry Generator	3.75
2501	256 Bit MOS Random Access Memory	9.75
74166	Parallel In Series Out Synch Shift Reg.	5.75
74198	8 Bit Shift Reg., Shift Right/left	5.75
74199	Same as 74198	5.75
2513	MOS 64 x 7 x 5 ASCI Character Generator – generates 64 alpha-numeric characters on a 5 x 7 matrix of lamps (or on a CRT)	$25.00

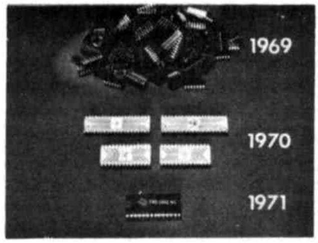
20% discount on all orders for 100 or more integrated circuits. All I.C.'s postpaid, with FREE air mail on orders over $50.00. We strive to ship I.C.'s by return mail. Free data sheets on all items.

SANKO AUDIO AMPLIFIERS

We have made a fortunate purchase of Sanko Audio Amplifier Hybrid Modules. With these you can build your own audio amplifiers at less than the price of discrete components. Just add a power supply, and a chassis to act as a heat sink. Brand new units, in original boxes, guaranteed by B and F, Sanko and the Sanko U.S. distributor. Available in three sizes: 10 watts RMS (20 watts music power), 25 watts RMS (50 watts M.P.) and 50 watts RMS (100 watts M.P.) per channel. 20 page manufacturers instruction book included. Sanko amplifiers have proved so simple and reliable, that they are being used for industrial applications, such as servo amplifiers and wide band laboratory amplifiers.

- ☐ 10 Watt RMS Amplifier . . . . $ 4.75
- ☐ 25 Watt RMS Amplifier $14.75
- ☐ 50 Watt RMS Amplifier $22.50

FEATURE ITEM!



This succession of devices portrays the evolution of active components necessary for implementation of an 8-digit calculator. In 1969 the effort required dozens of bipolar devices. By 1970 the same calculator could be produced using only four MOS/LSI devices, and now it has been implemented on a single MOS/LSI chip.

Texas Instruments TMS-1802 "Calculator on a Chip". This is tomorrows technology today, and at a fraction of list price. This calculator logic unit consists of a 3,520 bit read-only program memory, a 182 bit random memory, a decimal arithmetic logic unit, plus timing, control, and output decoders. The features are: eight digits • four operations • three registers • floating or fixed point decimal • constant or chain operations • automatic roundoff • leading zero suppression • internal keyboard encoding and debouncing • decoded display outputs • single phase clock operations • 28 pin DIP package • internal power on clear.

Every TM-1802 is a brand new Texas Instruments factory packaged, fully guaranteed unit. The only devices required to build a calculator are a battery, clock generator, keyboard, display drivers, and eight digits of display, all available from B & F. Full schematics, specifications and instructions from T.I. are included.

- ☐ Texas Instruement TMS 1802 Calculator Chip $29.00
- ☐ Texas Instruments keyboard $19.00
- ☐ T.I. SN25391, SN26392 Drivers, 4 required . . . 1 for $ 3.00
- ☐ All parts for clock generator . . . . $ 4.75
- ☐ Readouts, eight required . . . . 1 for $ 3.50
- ☐ Complete package, except battery $88.00

SPECIAL! SHARP MODEL EL8A CALCULATOR

The response to last months offer of the Sharp QT-8 calculator was overwhelming, and within a short period of time we exhausted their entire stock so that this model is no longer available. Because of this unprecedented response, Sharp has offered B & F a special quantity purchase on the model EL8A, which is the new pocket size version of the QT8. We can offer this model at only a few dollars more than the QT8, a remarkable buy at only $192.50.

Don't forget, you can charge this, as well as other items to Mastercharge or BankAmericard. Fully guaranteed by Sharp and B & F.

- ☐ Sharp electronic calculator, model EL8A $192.50

☐ **80 PAGE CATALOG** - Free with any order or send $0.25

ALL ITEMS POSTAGE PAID IN THE U.S.A.

Charges Welcome: BankAmericard – Mastercharge – $10.00 min.

B. & F. ENTERPRISES

Phone (617) 532-2323

P.O. Box 44, Hathorne, Massachusetts 01937

More Details? CHECK–OFF Page 94

NOVICE CRYSTALS — free flyer. Nat Stinnette Electronics, Umatilla, Florida 32784.

AUDIO FILTERS: Knock down that background noise. KOJO SSB, AM and CW filters do the job. Write for free brochure and see how serious DX boys hear them. KOJO, Box 7774, 741 E. Highland Ave., Phoenix, Arizona 85011.

SERVICE AND USERS MANUAL for the Solar Capacitor Analyzer. Not a reprint. $3.00 postpaid. James Fred, Cutler, Ind. 46920.

JENNINGS VVC UCS-375, complete with turning head, spin knob, counter, limit stop, coupling tested at 14 kv DC/AC, postpaid $25.00. W6YO, 1416 7th Avenue, Delano, Calif. 93215.

WWV, CW, RTTY tone to logic decoder. Educational includes eight epoxy PC boards, plans, hardware. $4. Hornung, K6BHF, 1630 Bowling Lane, San Jose, California 95118.

ROCHESTER, N. Y. is again Hamfest, VHF meet and flea market headquarters for the largest event in the northeast, May 13th. Write WNY Hamfest, Box 1388, Rochester, N. Y. 14603.

HELP: Will pay any reasonable price for information or manual for Racal Models RA6217A and RA6366A. Barry J. Buelow, WA0RJT/KH6, PSC 3, Box 4613, APO SFC 96553.

CASH FOR PC BOARD. All types of copper laminate wanted. 20 pounds or more. Bob Miller, WA8KGE, 2264 Welch, Stevensville, Michigan 49127.

TELETYPE #28 LRXB4 reperforator-transmitter "as is" $100; checked out $175. Includes two 3 speed gearshifts. Alltronics-Howard Co., Box 19, Boston, Mass. 02101. 617-742-0048.

WANTED: R389, R390, R390A, R391, R220, Racal and 51S1 receivers. SWRC. P. O. Box 10048, Kansas City, Missouri 64111.

WORLD QSL BUREAU — See ad page 92.

WANTED #195154 GEARSHIFT for Model 28 ASR. Larry Kleber, K9LKA/W9CPD, Belvidere, Illinois 61008.

RUBBER STAMPS: Your call in ½-inch letters, $2.00. Call plus name and address, $4.00. Postpaid. Ellis Enterprises, Dept. W, Box 3007, Anchorage. AK 99501.

TECH MANUALS — $6.50 each: URM-25D, TS-34A/AP, TS-497B/URR, R-274/FRR, SP-600JX, LM-21, OS-8C/U, CV-591A/URR, BC-639A. Hundreds more in stock. S. Consalvo, 4905 Roanne Drive, Washington, DC 20021.

WANTED JOHNSON 6 and 2M Thunderbolt in mint condition also Henry 4K. State cond. and price in first letter. Bill Smitherman, Rt. 2, East Bend, N.C. 27018 — 919-699-8699.

SWAN SW240, mint, $149 or trade for DX60B plus $100. WA6LML, 26760 Shadowwood, Palos Verdes Pen, CA 90274.

COLLINS 75S-1 Serial 3328 and 32S-1 Serial 2748. Very good. Both for $600. Cash and Carry. H. K. Monroe, 725 Caldwell, Piqua, Ohio 45356.

FOR SALE: R-390, cabinet, manual, $450, Gonset 3-6M., 3065 Linear, $100. Paul Haczela (K2BQO) 8 Yale Place, Armonk, N. Y. 10504. 914-273-9067.

SB200 Heathkit Kilowatt Linear $150. 415-593-7369. W6KJG, 1120 Furlong, Belmont, Calif. 94002.

SELL OR TRADE for 2 meter equipment: Mobile 6 meter FM GE Progress Line Transistor supply, 100 watt output. Very clean on 52.525. With manual, two frequency head, all accessories. Daniel Vernier, 19741 Broadacres, Mt. Clemens, Michigan 48043. 313-791-8364.

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

More Details? CHECK—OFF Page 94

More Details? CHECK—OFF Page 94

More Details? CHECK—OFF Page 94

OPEN HOUSE!

Washington's Birthday Weekend

FEBRUARY 18, 19 and 21

FREE Coffee and Doughnuts

FREE Frequency, Deviation & Sensitivity Checks of your FM Gear

FREE PRIZES

NEW GEAR

CLEGG	SONAR	STANDARD
DRAKE	REGENCY	MOSLEY
HENRY	JOHNSON	CUSHCRAFT
HEIGHTS	DYCOMM	ANTENNA SPECIALISTS

USED GEAR · AUCTION

DISPLAYS · DEMONSTRATIONS

FM TALK IN 146.94

BRISTOL RADIO

420 HOPE STREET
BRISTOL, R. I. 02809
401-253-7105

EARLE — W1RGG MIKE — K1OHE GLEN — W2CXX/1

More Details? CHECK—OFF Page 94

BRAND NEW FREQ-SHIFT TTY MONITOR:
NAVY OCT-3: FM Receiver type, freq. range 1 to 26 MHz in 4 bands, cont. tuning. Crystal calib. Reads up to 1500 Hz deviation on built-in VTVM. Cost $1100.00 each! In original box, with instruct. book & cord, fob Mariposa, California. $49.50

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

30 mHz Panadapter for the above .. 129.50

REGUL. PWR SPLY FOR COMMAND, LM, ETC.
PP-106/U: Metered. Knob-adjustable 90-270 v up to 80 ma dc; also select an AC of 6.3 v 5A, or 12.6 v 2½ A or 28 v 2½ A. With mating output plug & all tech. data. Shpg. wt. 50 lbs. 19.50

BARGAINS WHICH THE ABOVE WILL POWER:
LM-(*) Freq. Meter: 125-20 MHz, .01%, CW or AM, with serial-matched calib. book, tech. data, mating plug. Shipping wt. 16 lbs. 57.50
TS-323 Freq. Meter: 20-480 mhz. 001% 169.50
R23A/ARC5 Command Q-5'er 190-550 KHz, exc. cond. 16.95
A.R.C. R22 Command rcvr 540-1600 KHz, exc. cond 17.95
A.R.C. R15 (MIL R-509) command, 108-135 MHz, new 27.50

NEMS-CLARKE #1670 FM Rcvr 55-260 MHz like new. 475.00
WWV Rcvr/Comparator 2½ - 20 MHz, solid state 250.00
SSB Converter CV-591A/URR (455 KHz) w/book 137.50
Ferris #32(*) Field Strength Meter is a red-hot receiver from 150 KHz to 20 MHz, only. 95.00
Empire Devices NF-114 RFI meter is a red-hot receiver from 150 KHz to 80 MHz. 295.00
Spectrum Analyzer Give-Away: Polarad TSA with STU-1 head: 10-1000 MHz. Looks good, sold as-is. 350.00

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

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

THE MILLIWATT
NATIONAL JOURNAL OF QRPP
All about under-five watt ham radio
- Construction Projects • Operating News
- WAS & DXCC QRPP Listings • Log Reports

RATES: $3.00 (six issues/year) $3.40 1st Class Mail. Reprints: Vol. I—$4.00, Vol. II—$3.50 (both $7.00 plus subscription—$10.00)
SASE for info to:
ADE WEISS K8EEG/I
117 Central F-10, Acton, MA 01720

CONNECTICUT HAMS
Visit Roger Miner's Surplus Electronics, 246 Naugatuck Ave., Milford, Conn. Ph. 877-0555. Nights 7 pm to 10 pm and all day Saturday.
DRAKE TR-3 W/PS-$350. Collins 75S1 W/NBR-$300. HEATHKIT SB-200-$165. SB-620-$65. OP-1 Scope-$90. H.P. 460b Wideband amp.-$25, 210a Sq. W. Gen.-$15, 522b-$120. AMPEX FR-1100 Stereo tape rec.-$350. 4-1000A Filament Trans 7.5 vac @ 42 amps, will run a pair-$30. Amp filament chokes 3-30mcs 30 amps $9.50. Johnson 15 amp rotary ind. 27uh-$25. HIGH POWER HEADQUARTERS IN THE NORTHEAST. COME IN AND SEE US — K1DQV.

The Roger S. Miner
SURPLUS ELECTRONICS COMPANY
246 NAUGATUCK AVENUE • MILFORD, CONNECTICUT 06460

FACTORY FRESH IC'S AT BARGAIN PRICES
7400, 7401, 7402, 7403, 7404, 7410, 7420, 7430, 7440, 7451 and 7454 gates all 30¢ each. 7441A nixi driver $1.60. 7442 BCD-to-decimal decoder $1.50. 7447 seven segment driver $1.79. 7472 flip flop 50¢. 7473 dual flip flop 60¢. 7474 dual type D flip flop 60¢. 7475 quad latch $1.25. 7476 dual flip flop 65¢. 7490 decade counter $1.25. 7492 divide by 12 counter $1.25. 7493 4 bit binary counter $1.25. 7495 4 bit L-R shift reg. $1.50. 74121 monostable multivibrator 75¢.
LINEAR IC'S: 709C OP amp dip 60¢ TO-5 70¢
741C OP amp dip 75¢ TO-5 85¢.
TRANSISTORS:
2N5134 silicon NPN 7 for $1.00.
2N5138 silicon PNP 7 for $1.00.
Power Supply 110 volt AC to 5 volt DC $10.00
Discounts offered on large orders. Many other parts available. Send post card for free catalog. Orders less than $10.00 add 25¢ post. & handling. Above $10.00 ppd.
DIGI-KEY
P.O. BOX 126, THIEF RIVER FALLS, MN 56701

NEW 2M PREAMPLIFIER
12 vdc powered
27 db gain (approximately)
noise figure 2.5
will bring most receivers
to .1 μv sensitivity
without appreciable noise.
Metal case. **ONLY $17.95 ppd.**

CRAWFORD ELECTRONICS
302 West Main, Genoa, IL 60135

TOROIDS — TELETYPE
Lowest Prices Anywhere!

44 or 88 mhy TOROIDS
$10 FOR 40
ALL PPD. U.S.

MODEL 15-19
60 W.P.M. GEAR SET
(74912-74913)
$3.50

FRESH RIBBONS
FIT ALL MODELS 14-15
19-28-32-33
$3.50 BOX OF 12

MANY OTHER BARGAINS—SEND FOR CATALOG

Van's W2DLT Electronics
302H Passaic Avenue
Stirling, N. J. 07980
CALL 201-647-3639

WORLD QSL BUREAU
THE ONLY QSL BUREAU to handle all of your QSLs to anywhere; next door, the next state, the next country, the whole world. Just bundle them up (please arrange alphabetically) and send them to us with payment of 5¢ each.
5200 Panama Ave., Richmond, CA USA 94804

ANNOUNCING
TWO NEW FREQUENCY STANDARDS
Markers of 100, 50, 25, 10 and 5 KHz, selected by front panel switch. Zero adjust for WWV calibration, handsome cabinet, 100KHz crystal included and a six month warranty. Model 100-5PC, portable (battery operated) less batteries. Model 100-5PS for fixed station use (power line operated). $28.95 each PPD. Write for brochure.
BAKER & WINNAY
420 Maplewood Ave., Springfield, Pa. 19064

More Details? CHECK—OFF Page 94

CIRCUIT BOARDS in 10 Minutes ?

with just a pair of scissors

Pressure Sensitive Copper Foil Tape and Sheet

- No Chemicals — No Mess
- No Layout Restrictions
- Full Instructions
- Simple Circuit Changes
- Flexible — Conforms to any surface shape
- Use for Crossovers — Either insulate with Teflon or Mylar or use other side of board.

5 feet 1/16" or 1/8" wide .... $.60
100 feet 1/16" or 1/8" wide $9.95

Sheets 6" x 12" — $2.50 each or 5 for $9.95

Order Now

Cir-kit

Division of PHASE CORPORATION
315A Boston Avenue
Medford, Mass. 02155

TYMETER® *"Time At A Glance"*

CALL-IDENT

10-MINUTE STATION CALL REMINDER

24 HOUR CLOCK

#124

23.50

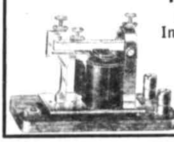
10-minute repeating timer buzzes warning to sign in your call letters. Walnut or ebony plastic case. 4"H, 7¾"W, 4"D. 110V, 60 cy. One Year Guarantee. Made in U.S.A.

At Your Dealer, or DIRECT FROM

PENNWOOD NUMECHRON CO.
TYMETER ELECTRONICS
7249 FRANKSTOWN AVE. PITTSBURGH, PA. 15208

TELEGRAPHERS WANTED - For membership in

Morse Telegraph Club, Inc.



Non-profit - Historical - Fraternal
Includes subscription to dots & Dashes
Dues $2 per annum

Write: James E. Smith, GS&T
P.O. Box 70
LaMirada, Ca 90638

FEBRUARY BIRTHDAY VALUES!

IT'S BIRTHDAY WEEK AT BARRY'S

George on the 22nd — Barry on the 23rd

JUMBO BIRTHDAY SALE — FEBRUARY 19, 21-26

TUBE HEADQUARTERS OF THE WORLD . . . TREMENDOUS STOCKS OF TUBES. Advise us of your tube needs for immediate quotations. We also purchase **UNUSED** tubes and new and used equipment. **THOUSANDS OF UNADVERTISED "GOODIES" - VISIT OR CALL!**

ROBOT SLO SCAN TV Camera Mod. 80 $465.00
ROBOT SLOW SCAN TV Monitor Mod. $495.00
FI.4 MACRO LENS $60.00

2 METER FM EQUIPMENT:

DYCOMM BRICK BOOSTER/For TR-22 1 W.in/ 20 W.out. $69.95
DYCOMM SUPER BRICK BOOSTER 1 W.in/ 35 W. out. $99.95
DYCOMM BLOCK BOOSTER 10 W.in/ 50 W.out. $89.95
DYCOMM "10-0" Mobile Amp. 10 W.in/ 100 W. out. $185.00
DYCOMM DIVIDE BY TEN PRESCALER, 10-240 MHz. $89.95
DRAKE ML-2 2 METER FM TRANSCEIVER AC/ DC 12 Ch., 3 supplied. $329.95
DRAKE TR-22 WALKIE TALKIE 2 Meter FM 6 Ch., 3 supplied, with Mike, Case, Cords and Nicad Batteries.
BARRY CAN SUPPLY any of the complete line of Drake or Dycomm Products.
SONA LABS 10 CHANNEL SCAN-O-MATIC 2 Meter FM or High Band Receiver. High Band Model 22-65A $149.95. 2 Meter FM Model 22-65B $149.95 (Crystals $5.00 each).
PEARCE SIMPSON 25 WATT 2 METER FM TRANSCEIVER, 6 Channel, two supplied. DC only at .... $249.95 AC/DC at $299.95
COLLINS 32V-1 Transmitter, Write.

TEN-TEC: RX-10 RCVR @ $59.95; S-30 Signalizer @ $49.95; PM-3A XCVR @ $79.95; PM-2B XCVR @ $65.95.
VHF HAMMARLUND HQ-170A 160 to 2 meters, new cond. $375.00; HQ-170 160 to 6 meters clean, $275.00.
RCA AN/SRR-11 V.L.F. Receiver 14 to 600 khz. Good cond. $175.00
TECHNICAL MATERIAL CORP. GPR-90-RXD General and Hamband coverage, a high quality RCVR that covers .54 to 31.5 mhz. With sideband adapter. $595.00
JOHNSON VIKING 500 XMTR., 500 watts 80 thru 10 meters, with pwr. sply, clean. $250.00
HALLICRAFTERS HT-37 80 thru 10 meter cw/ ssb Xmtr, clean. $125.00
YAESU FLDX 400 (80 thru 10 meters, AM, CW and SSB new cond. $295.00
EDDYSTONE 840C Deluxe General Coverage Rcvr, 480khz to 30mhz. Clean. $125.00
NATIONAL NC-183D General Coverage Rcvr, clean. $60.00
HP 130C OSCILLOSCOPE, rack mount. Exc. cond. $250.00

BARRY ELECTRONICS
Electronic Tubes & Equipment
512 BROADWAY NEW YORK, N. Y. 10012
212 WAlker 5-7000

More Details? CHECK—OFF Page 94

Advertisers check-off

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

INDEX

—Alarm
—American Crystal
—Arizona
—B & F
—BC
—Baker & Winnay
—Barry
—Bristol
—CFP
—Cir-Kit
—Circuit Specialists
—Comcraft
—Comtec
—Crawford
—Crystek
—Curtis
—Data
—Digi-Key
—Drake
—E-S
—Eastron
—Ehrhorn
—Eimac
—Environmental
—Frank
—Gateway
—Gray
—H & L
—HAL
—Heath
—Henry
—Hy-Gain
—International Crystal
—Jan
—Janel
—Jaross
—Jensen
—Juge
—Justin
—KW
—LA
—Linear
—Meshna
—Micro-Z
—Milliwatt
—Morse
—Newtronics
—Palomar
—Payne
—Pennwood
—Pickering
—Poly Paks
—RP
—Radiation
—Callbook
—Radio Constructor
—Robot
—SCF
—Savoy
—Signal/One
—Space-Military
—Spectronics
—Standard
—Structural Glass
—Surplus
—Swan
—Ten-Tec
—Tri Rio
—VHF Specialists
—Van
—Vanguard
—Vero
—Weinschenker
—Wheatlands
—Wolf
—World QSL

February 1972

Please use before March 31, 1972

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

NAME..

CALL..

STREET..

CITY..

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

Advertisers index

ATV Research 90
Alarm Component Distributors 87
American Crystal Co. 78
Arizona Semiconductor 90

B & F Electronics 86
BC Electronics 78
Baker & Winnay 90, 92
Barry Electronics 93
Bristol Radio 91

CFP Enterprises 90
Cir-Kit 93
Circuit Specialists 84
Comcraft Company 31
Comtec Books 67, 74, 85, 88
Crawford Electronics 92
Crystek 76
Curtis Electro Devices 90

Data Engineering 66
Digi-Key 92
Drake Co., R. L. 77

E-S Electronic Labs 76
Eastron Corp. 88
Ehrhorn Technological Operations, Inc. 71
Eimac Division of Varian .... Cover IV
Environmental Products 48, 49

Frank Electronics 90

G & G Radio Electronics 75
Gateway Electronics Corporation 72
Goodheart Co., Inc., R. E. 92
Gray Electronics 87

H & L Associates 90
HAL Devices 82
Heath Co. 65
Henry Radio .... Cover III
Hy-Gain Electronics Corp. 5, 19, 80, 81

International Crystal Manufacturing Co. 73

Jan Crystals 74
Janel Labs 88
Jaross R. & Co. 72
Jensen Tools & Alloys 90
Juge Electronics, Inc. 89
Justin, Inc. 76

KW Electronics 87

LA Electronix Sales 95
Linear Systems, Inc. 37

Meshna, John, Jr. 78
Micro-Z Co. 76
Milliwatt, The 92
Morse Telegraphers 93

Newtronics 1

Palomar Engineers 72
Payne Radio 90
Pennwood Numechron Co. 93
Pickering Radio Co., Inc. 68
Poly Paks 64

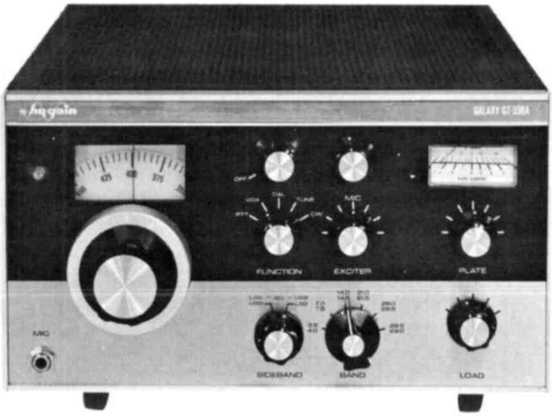
RP Electronics 74
Radiation Devices 90
Radio Amateur Callbook, Inc. 63, 68
Radio Constructor 78
Robot Research 96

SCF Corp. 70
Savoy Electronics, Inc. 69
Signal/One .... Cover II
Space-Military Electronics 88
Spectronics 61
Standard Communications Corp. 2
Structural Glass Ltd. 70
Surplus Electronics 92
Swan Electronics 59

Ten-Tec, Inc. 79
Tri Rio Electronics 45

VHF Specialists 70
Van 92
Vanguard Labs 68

Weinschenker, M. 57
Wheatlands 88
Wolf 88
World QSL 92



The NEW GALAXY 550A

Now available for immediate delivery at our new low price ONLY $495

SEE LA
FOR
THE TOP TRADE-INS IN THE WEST

LA Electronix Sales

23044 S. CRENSHAW BLVD., TORRANCE, CALIF. 90505
Phone: (213) 534-4456 or (213) 534-4402
HOME of LA AMATEUR RADIO SALES

BONUS COUPON

A VX35C VOX *and* A CAL-250-25 CALIBRATOR

Included FREE with every Galaxy 550A from LA Electronix

A $55.00 VALUE!

For $495 you can operate a two-way Robot SSTV station.

Now with the purchase of a Robot SSTV monitor only, Robot will make you a free personalized SSTV tape that will enable you to transmit a video SSTV signal without having to own an SSTV camera. After you have purchased your Robot monitor, just mail us the call sign card, photos, drawings, etc., that you want on your tape, and we will make up a five-minute tape for you (reel or cartridge) and send it to you by return mail. You then simply play the tape on an audio tape recorder that is plugged into the mic jack of your transmitter or transceiver, and you are transmitting an SSTV video signal.

Now, for just $495 (the cost of the Robot SSTV Monitor alone) you can join the many amateurs who have already made great progress towards their WAC, and WAS certificates and working their first 100 countries on two-way SSTV.

If you are already operating SSTV, you will be interested to know that we are preparing a directory of SSTV operators. Send us a post card and we will include your call in our directory and send you a copy.

For complete information on Slow Scan TV and our SSTV equipment, write:

ROBOT

ROBOT RESEARCH INC.
7591 Convoy Court
San Diego, California 92111
Phone 714-279-9430

See the complete line of Robot SSTV equipment at your nearest dealer.

Birmingham, Ala. 35233, James W. Clary Company, 1713 Second Avenue South, (205) 322-2486 • **Anaheim, Calif. 92804,** Henry Radio Company, 931 North Euclid, (714) 772-9200 • **Los Angeles, Calif. 90064,** Henry Radio Company, 11240 West Olympic Boulevard, (213) 272-0861 • **Oakland, Calif. 94607,** Amrad Supply, 1025 Harrison Street, (415) 451-7755 • **Denver, Colo. 80202,** CW Electronic Systems, 1401 Blake Street, (303) 244-5523 • **Miami, Fla. 33137,** Amateur Radio Center, Inc., 2805 NE Second Avenue, (305) 374-4101 • **Honolulu, Hawaii 96803,** Honolulu Electronics, 819 Keeaumoku Street, (808) 949-5564 • **Reading, Mass. 01867,** Graham Radio Company, 505 Main Street, (617) 944-4000 • **Muskegon, Mich. 49441,** Electronic Distributors, Inc., 1960 Peck Street, (616) 766-3196 • **St. Louis, Mo. 63132,** Ham Radio Center, 8342 Olive Boulevard, (314) 993-6060 • **Amsterdam, N.Y. 12010,** Adirondack Radio Supply, 185-191 W. Main Street, (518) 842-8350 • **New York, N.Y. 10012,** Barry Electronics, 512 Broadway, (212) 925-7000 • **Asheville, North Carolina 28801,** Freck Radio Supply, 38 Biltmore Avenue, (704) 254-9551 • **Cincinatti, Ohio 45231,** Queen City Electronics, 1583 McMakin Ave., (513) 931-1577 • **Cleveland, Ohio 44112,** Amateur Electronic Supply, 17929 Euclid Avenue, (216) 486-7330 • **Dayton, Ohio 45404,** SREPCO, 314 Leo Street, (513) 224-0871 • **Trevose, Pa. 19047,** Hamtronics, 4033 Brownsville Road, (215) 357-1400 • **Fort Worth, Texas 76110,** Ed Juge Electronics, 3850 South Freeway, (817) 926-5221 • **Spokane, Wash. 99206,** HCJ Electronics, E. 8214 Sprague, (509) 924-2343 • **Milwaukee, Wisc. 53216,** Amateur Electronic Supply, 4828 W. Fond du Lac Avenue, (414) 442-4200 • **CANADA: Fredericton, N.B.,** Audio Lectronics Ltd., 79 Prospect Street, (506) 454-3380 • **Toronto, Ontario,** VE Amateur Radio, 3768 Bathurst Street, Downsview, (416) 636-3636 • **Montreal, Quebec,** Payette Radio Company, 730 St. Jacques, (514) 866-6681.
Butler, Mo., Henry Radio (816) 679-3127

More Details CHECK—OFF Page 94

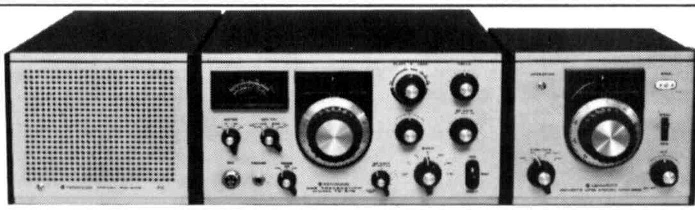
a winning pair...the "Kenwood twins"

THE MOST EXCITING RECEIVER AND TRANSCEIVER TO ENTER THE AMATEUR SCENE IN RECENT YEARS. THE KENWOOD R-599 SOLID STATE RECEIVER AND T-599 HYBRID TRANSMITTER HAVE ESTABLISHED NEW STANDARDS OF PERFORMANCE, RELIABILITY, FLEXIBILITY, STYLING AND VALUE.

THE R-599 RECEIVER: .5 microvolt sensitivity (amateur bands 1.8-21.0 MHz) • Dial readout to ½ kilocycle • Special detectors for SSB, AM, and FM • Transceive operation with T-599 • Built-in 100 kc and 25 kc crystal calibrator • Built-in 500 cycle CW filter • Provision for two meter and six meter coverage with optional accessory self-contained converters • Advanced "Space-Age" styling • Adjustable threshold squelch • Only $349.00 • S599 Speaker $16.00

THE T-599 TRANSMITTER: Clear, stable, selectable side-band, AM and CW • 4-way VFO Flexibility plus Receiver Incremental Tuning (RIT) when used with the R-599 • Amplified ALC • Built-in VOX • Full metering, including cathode current, plate voltage, ALC and relative Power Output • Built-in CW Sidetone monitor and semi-automatic break-in CW • Built-in power supply • Maximum TVI protection • Employs only 3 vacuum tubes • Only $395.00

THE KENWOOD **TS-511S** TRANSCEIVER



The Kenwood TS-511S is a five band SSB and CW transceiver packed with power and performance . . . offering features never before available in its price range. For example: built-in VOX, crystal calibrator, noise blanker, receiver incremental tuning, 1 kHz frequency readout, 8 pole filter, stable FET VFO, dual conversion and accessory CW filter.

FREQUENCY RANGE: 10, 15, 20, 40 & 80 meters (Amateur Bands) □ MODES: LSB, USB, CW □ INPUT POWER: 500 watts PEP, 300 watts CW nominal. □ SENSITIVITY: 3.5-21.6 mHz band; 0.5 uv S/N 10 db 28.0-29.7 mHz band; 1.5 uv S/N 10 db and less than 100 cps frequency drift per 30 minutes after warm-up □ SELECTIVITY: SSB more than 2.4 KC (at 6 db) with 2 to 1 slope ratio CW more than 0.5 KC (at 6 db) □ A.F. OUTPUT: more than 1 watt (10% distortion) □ TUBE & SOLID STATE COMPONENTS: 10 Tubes, 1 IC, 37 Transistors, 4 FET, 52 Diodes □ PRICE: $415.00

PS 5115 • Power Supply with built-in speaker $105.00
CW-1 Filter $39.00
VFO 5SS $105.00

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

Henry Radio

EIMAC conduction cooled 8873s keep Henry Radio's new Ultra Linear amplifier ultra quiet.

Henry Radio beat the blower noise problem by eliminating it. In their quiet, compact, rugged and reliable 2K Ultra Linear Amplifier, anode heat is silently conducted to an efficient heat sink. No more blower. No more blower noise. No more annoying problem.

Two EIMAC conduction cooled, high-mu 8873 power triodes are used in this very linear, state-of-the-art amplifier to provide 2 kW PEP input over the 3.5 to 30.0 MHz range.

Operating in cathode driven service, these tubes typically provide high power gain (greater than 13 decibels) in combination with low, low intermodulation distortion (3d order products better than −35 decibels below one tone of a two-tone test signal). These excellent characteristics of the 8873 may be utilized up to 500 MHz.

With Henry Radio, you know quality counts. And they know you can't do better than EIMAC. For full specifications on the 8873 and its sturdy companions, the 8874 and 8875, write to EIMAC Division of Varian, 301 Industrial Way, San Carlos, California 94070.

Eimac®
division
varian