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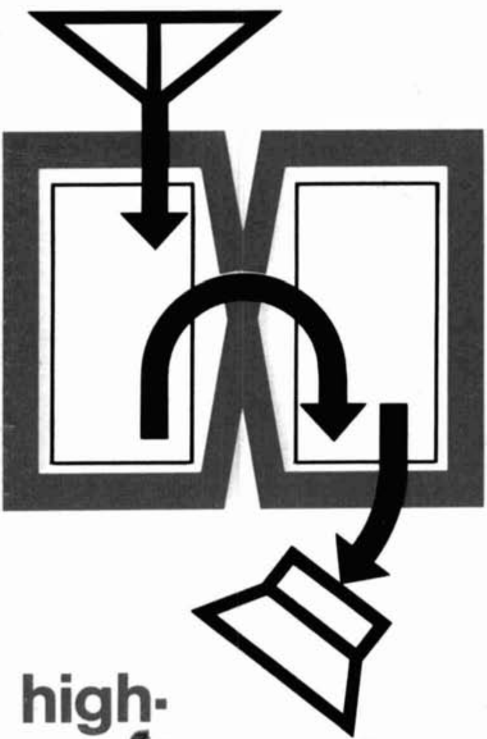
ham radio magazine

NOVEMBER 1975



high-performance vhf fm receiver

this month

More Details? CHECK—OFF Page 126

November, 1975
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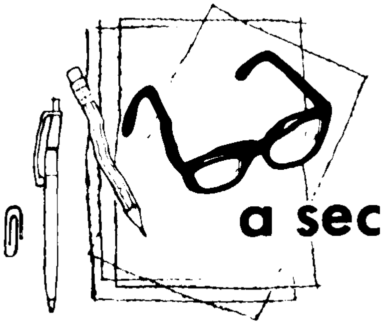
contents



a second look

by jim fisk

Although MOS integrated circuits are finding widespread use in microprocessors, memories and other LSI (large-scale integration) applications, it appears that a relatively new form of bipolar logic, called I^2L (for integrated injection logic), can do everything its MOS rivals do – and probably better and cheaper. Although MOS manufacturers continue to squeeze more and more performance out of n-channel MOS technology, some researchers believe that the high performance-low cost characteristic of I^2L will end the dominance of MOS circuits in new generations of equipment.

Another characteristic of I^2L which intrigues designers is its versatility: although it doesn't directly lend itself to analog functions, it is compatible with bipolar manufacturing techniques used for linear devices so linear and I^2L can be combined on the same chip. Some digital-linear chips are already being developed, as are completely digital chips. In fact, according to one report, I^2L is now being designed into more circuit types by IC makers than are all MOS and other bipolar techniques combined!

Originally formulated about four years ago at IBM's laboratories in Germany, and developed by Philips in the Netherlands, I^2L achieves MOS-level circuit densities by using planar npn transistors upside down (the basic logic element is an inverter). A direct result is the automatic isolation of all collectors, while the emitters are common. Lateral pnp transistors inject current directly into the base of a multi-emitter npn transistor operating in the inverse mode (see **fig. 1**). The result is a very simple gate structure which dissipates little power and has propagation delays on the order of 10 nanoseconds. This performance is comparable to that of standard TTL gates. By using integrated Schottky diode clamps speed can be pushed down to about 1 ns, making I^2L as fast as low-power Schottky TTL – Schottky-clamped I^2L, however, consumes 1/100th the power and is ten times smaller (circuit densities of 85 gates per square millimeter are routine).

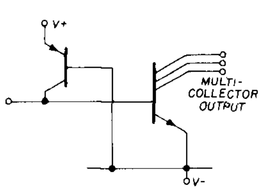


fig. 1. I^2L logic gate uses inverted transistor. Operation is completely independent of resistors and speed depends only on injected base current.

Since I^2L units are powered through lateral pnp transistors, the circuitry is totally independent of resistors and can be operated over a wide speed range by simply varying the total current into the injector. Thus, the same I^2L device can run at slow speed in a watch, for example, dissipating microwatts, or at high speed in a microprocessor, dissipating milliwatts.

Many of the large semiconductor firms, including Fairchild, Motorola and Texas Instruments, are working on large-scale integration of I^2L and some devices are already on the market including TI's SBP0400 4-bit I^2L microprocessor. A 4096-bit I^2L random access memory may be available by the end of the year, and a 16-bit microprocessor with cycle times of less than 50 ns is expected sometime next year. No doubt MOS and TTL will be with us for a long time to come, but I^2L promises complex logic systems that could not be built economically with the older technology.

Jim Fisk, W1DTY
editor-in-chief

presstop

NEW CHIEF OF FCC'S AMATEUR AND CITIZENS DIVISION is John Johnston, K3BNS. The announcement was made during the FCC Forum at the ARRL National Convention in Reston, Virginia by FCC Safety and Special Services Bureau Chief, Charles Higginbotham, W3CAH. Charlie said the choice had been made official by the Commissioners only a few days earlier.

Johnston's Selection was a natural and will be widely welcomed by the Amateur fraternity. John had already established a fine track record with the Amateur and Citizens when he served there as Chief of the Rules and Legal Branch. He left Amateur and Citizens just a year ago to become Deputy Chief of the Spectrum Management Task Force. He originally joined the FCC in 1972.

"DE-REGULATION" will be the key word when Johnston picks up the reins at Amateur and Citizens. John plans to take a very hard look at the present rules to see where they can be relaxed to the benefit of both Amateur Radio and the Commission.

WARC 79 Working Group on Amateur Radio had its second full group meeting at Reston, with Prose Walker still in the Chairman's seat. Much of the all-day session was devoted to reports of the various task force chairmen, and it was obvious to the more than 30 attendees that the considerable effort that had already been invested was only a small part of the total job.

With Respect To Frequencies, the Working Group position is to strive for more spectrum in the HF bands both by making the bands we presently share with other services (and/or do not have at all in other parts of the world) exclusive worldwide Amateur bands, and by adding new Amateur bands. Proposed new HF bands would be 10.1-10.6 MHz, 18.1-18.6 MHz, and 24-24.5 MHz. It was also proposed that 40 meters be extended to 7.5 MHz, 20 meters to 14.5 MHz, and 15 meters to 21.5 MHz. At the low end of the spectrum a totally new band in the 150-200 kHz region will also be proposed. There is reason for hope that all or at least a good part of this expansion could be achieved, since some heavy users of the HF bands are moving to satellites; however, other services will be going for more HF frequencies, too. In the VHF/UHF spectrum, competition is tougher and the picture less clear — we'll have problems there.

INVERTED SPLITS for additional two-meter repeaters in the northern California area were selected as standard at "Sacramento '75." Northern California thus follows the lead of southern California, while the eastern seaboard goes the opposite way.

RIGHT-SIDE UP SPLITS were the choice of the Mid-Atlantic Repeater council at their meeting. Reasons were a wish to remain compatible with other East Coast areas, and encourage increased use of narrow-band gear.

AMSAT'S EDUCATIONAL BULLETINS via OSCAR 6 resumed in September and will continue throughout the school year on mornings (U.S.) of even numbered days. Bulletin stations will transmit to be heard about 29.5 MHz on appropriate morning orbits as indicated by an "E" following the orbit number in the predictions.

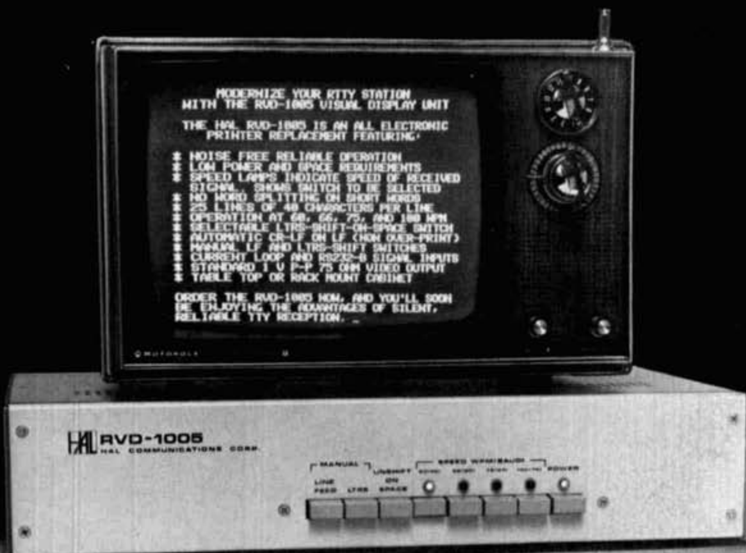
Orbital Predictions from both HR Report and W6PAJ's booklet are both more than adequately accurate despite on-the-air comments to the contrary. Current HR Report sheet is within a few seconds, while W6PAJ's (prepared much earlier in the year) is accurate to within about a minute.

MULTI-2000, the multi-mode vhf rig which has caused interference in the aircraft band, is an offender primarily in its original version as imported by ITC, reports Mike Staal of KLM. The prime problem was with a spur ±16.9 MHz from the signal frequency and Mike reports that this has been corrected in the later versions which bear the KLM nameplate. All KLM Multi-2000s are being checked out with a spectrum analyzer to confirm that they meet published spurious specs.

All Early Multi-2000s should be checked out with proper instrumentation. Mike has some helpful suggestions for owners of the earlier radios — call him at KLM, (408)779-7363.

WORKING ALL STATES DURING 1976 will be rewarded by a very special Bicentennial WAS certificate from the ARRL. Only one award, for QSOs on any mode, any band — will be offered.

With the HAL RVD-1005, what you see is what you get.



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The HAL DKB-2010 dual mode keyboard is another example. It allows you to transmit TTY or Morse—TTY at all standard data rates, and CW between 8 and 60 WPM. You also get complete alphanumeric and punctuation keys, plus 10 other function keys, a "DE—call letters" key and a "QUICK BROWN FOX..." diagnostic key. In both modes you have a three character buffer for bursting ahead (larger buffers optional); and in the CW mode you can adjust the dot-to-space ratio (weight) to your liking.

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RVD-1005 Video Unit: $575. RVD-2110 Monitor TV: $150. DKB-2010 TTY/CW Keyboard: $425.
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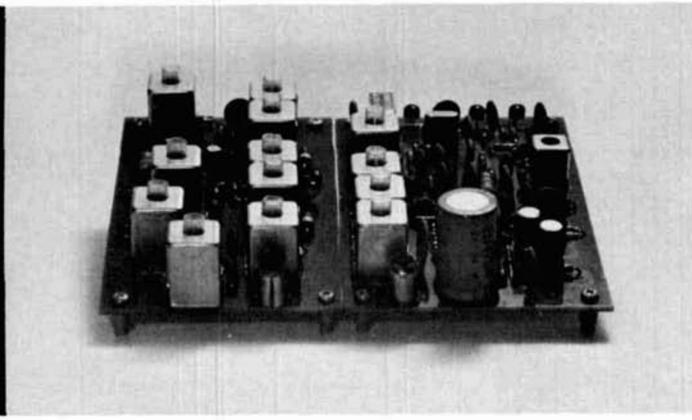
More Details? CHECK—OFF Page 126



high-performance vhf fm receiver

Design and construction of a versatile fm receiver for use on any of the amateur bands from 28 through 220 MHz

Jerry Vogt, WA2GCF, Hamtronics, Inc., Rochester, New York

Are you looking for a compact, low-cost receiver to use with your new home-brew fm transmitter? Are you interested in trying fm without investing a lot of money right away for a transceiver? Do you need an extra fm receiver around the shack to monitor your local repeater or calling channel while you're operating on another frequency? This article describes a second-generation, solid-state vhf fm receiver which might be the answer. It is an improved version of an earlier receiver designed a few years ago[1] and uses two circuit boards: a vhf converter board and an i-f/audio board. The basic fm communications receiver may be used for 28, 50, 144 or 220 MHz (or adjacent commercial bands).

This new design includes the best features of its predecessor as well as refinements which improve selectivity and sensitivity, make construction and testing easier, and provide more flexibility. Built-in test points facilitate alignment and allow external signal strength and carrier frequency meters to be used.

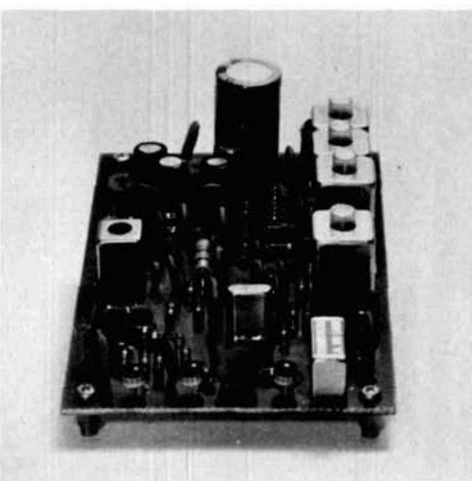
Stable, cascode circuits are easily tuned and require no neutralization. The sensitivity of the receiver is about 0.2 to 0.4 μV for 20 dB quieting. Adjacent channel selectivity is about 90 dB beyond the desired ±7.5 kHz passband. Image rejection is 40 dB. Operating power is 13.6 Vdc at 60 to 200 mA, *depending on audio level.*

Construction and alignment details are organized in three sections. The i-f/audio board is described first since it is straightforward and does not vary with the input frequency. Then the vhf converter board is described, along with variations for 10, 6, 2, and 1¼ meters. Finally, to demonstrate ideas for various receiver packages which can be based on the two basic boards, a short discussion of options is presented.

i-f and audio

The i-f/audio circuit (**fig. 1**) includes a sensitive and selective i-f amplifier, narrowband fm detector, audio amplifier and squelch circuitry. By including the proper external circuitry it may be used to build a single-channel vhf or uhf receiver, a multi-channel receiver, or a scanning receiver. The 10.7 MHz input to the board has a three-pole L-C filter operating into a low-noise grounded-base preamplifier, Q1. The high gain cascode mixer (Q2 and Q3) translates the input to a 455 kHz i-f with a selective ±7.5 kHz ceramic ladder filter providing 90 dB of adjacent channel selectivity and 40 dB image rejection. The 455 kHz i-f amplifier and limiter chain consists of five low-noise, high-gain transistor stages (Q5-Q9). The previous design used an IC – this discrete design provides improved operation, easier maintenance, and better metering.

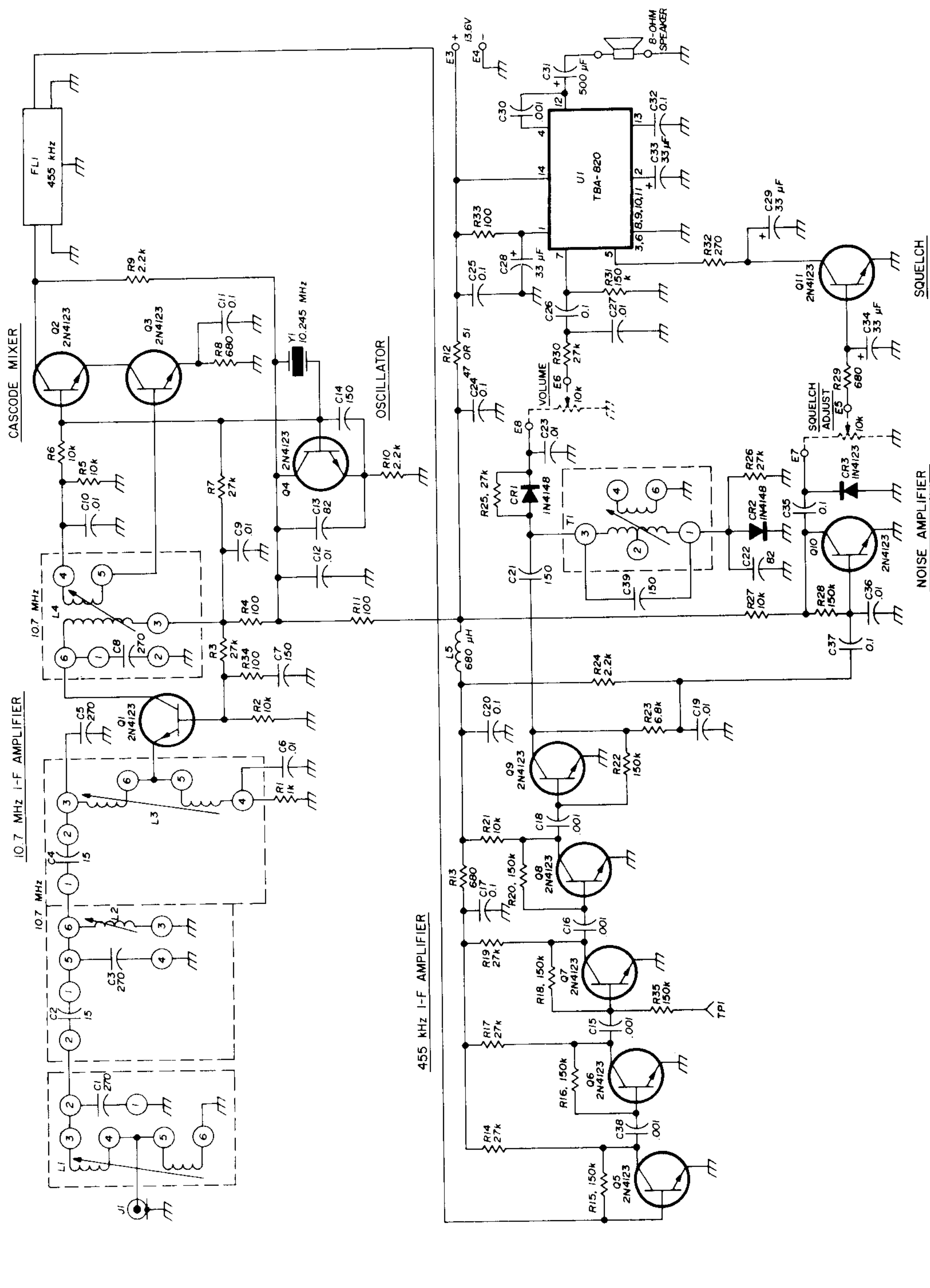
The i-f/audio board used in the vhf fm receiver. Murata 11-pole ceramic ladder filter is in lower left-hand corner.



The fm discriminator drives a special communications service 2-watt audio amplifier IC, an SGS ATE TBA-820, which incorporates lowpass filtering and de-emphasis to minimize hiss on weak signals. A sensitive squelch circuit (Q10-Q11) detects any a-m noise in the 7 kHz region to determine if a carrier is present in the limiter circuit. A flutter-proof circuit is used to prevent drop out of weak mobile stations. The audio circuit is set up so the user can change the volume control range or high-frequency response, if desired, to suit his own operating habits.

construction

Most pertinent construction details for the i-f/audio board are shown on the component location diagram (**fig. 2**). Following are details of coil assembly and other suggestions to facilitate proper assembly. The coils are wound on 10-32 (about 5mm diameter) plastic forms with carbonyl TH slugs. All are wound in a clockwise direction, as viewed from the top, using number 26 (0.4mm) solderable wire. All turns are close-spaced as shown in **fig. 3**. This drawing is exaggerated for clarity, but all leads should be pulled tight. No fancy bends are required, and no coil dope is necessary. Holes in the base of the form are numbered as indicated for


10.7 MHz I-F AMPLIFIER
CASCODE MIXER
OSCILLATOR
455 kHz I-F AMPLIFIER
VOLUME
SQUELCH ADJUST
SQUELCH
NOISE AMPLIFIER
FL1 455 kHz
Y1 10.245 MHz
U1 TBA-820
8-OHM SPEAKER
E3 + 13.6V
E4 -
J1
TP1
Q1 2N4123
Q2 2N4123
Q3 2N4123
Q4 2N4123
Q5 2N4123
Q6 2N4123
Q7 2N4123
Q8 2N4123
Q9 2N4123
Q10 2N4123
Q11 2N4123
CR1 1N4148
CR2 1N4148
CR3 1N4123
L5 680 µH
C31 500 µF
C29 33 µF
C33 33 µF
C34 33 µF
C28 33 µF
R12 47 OR 51

reference when winding the coils. The coils can be prewound and then installed on the board with the keyways as shown. Primaries should be wound first, followed by the secondaries; then the capacitors, if any, are inserted through remaining holes in the base of the form.

Do not be overly concerned with coil winding. Neatness is not a requirement; the turns can overlap, and the windings don't have to be uniform. Secondary windings can be wound in a second layer over the primary or by continuing the first layer next to the primary. The only critical requirement is that primary and secondary of L1 and L3 must be correctly phased. (When the primary is finished at the tap, the secondary should start at the tap and be wound in the same [clockwise] direction.)

When the coil leads are inserted through the board, they should be started into the holes in the board while the coil form is spaced slightly away from the board; the form is then seated into place. Do not attempt to insert capacitor leads with the form tight against the board. After the coils are installed, application of heat from a very hot soldering iron for 10 to 15 seconds will automatically strip the wire. If you prefer, the leads may be stripped in the conventional way before installation. Do not solder-strip the leads unless the coil is mounted on the board as the leads will migrate into the plastic form.

Be careful, when installing the ceramic filter and the discriminator transformer, to seat them slowly by rocking to avoid lead stress. Resistor R35 is installed vertically with the top lead extending about 1/4 inch (6.5mm). to form a test point. Connections to the outside world are made by soldering number-22 (0.6mm) leads to pads on the board. The output circuit is designed for an 8-ohm speaker. However,

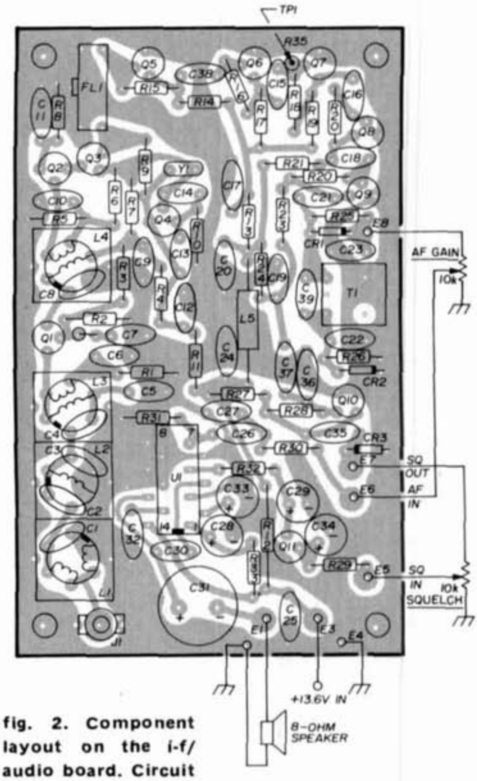


fig. 2. Component layout on the i-f/audio board. Circuit board is 2-3/4" wide (7cm) by 4½" (11.5cm) long.

fig. 1. I-f and audio system (left) for the vhf fm receiver has input at 10.7 MHz and includes five-stage 455-kHz i-f amplifier, squelch and two-watt IC audio amplifier. Filter FL1 is an 11-pole Murata CFS-455 ceramic ladder filter. Transformer T1 is a miniature 455-kHz i-f transformer with the internal resonating capacitor removed. The audio power IC is an SGS ATES TBA-820.

L1	Terminals 3 to 4: 10-5/6 turns no. 26 (0.4mm) on 10-32 (5mm) slug-tuned form; terminals 5 to 6: 2-5/6 turns no. 26 (0.4mm)
L2	12½ turns no. 26 (0.4mm) on 10-32 (5mm) slug-tuned form
L3	Terminals 3 to 6: 11½ turns no. 26 (0.4mm) on 10-32 (5mm) slug-tuned form; terminals 4 to 5: 3-1/6 turns no. 26 (0.4mm)
L4	Primary, 15½ turns no. 26 (0.4mm) on 10-32 (5mm) slug-tuned form; secondary, 9-1/6 turns no. 26 (0.4mm) on same form

other speakers may be used with some effect on frequency response and audio level.

alignment

With a 455-kHz signal generator connected through a dc blocking capacitor to the base of transistor Q5 and a vtvm connected to the top of the volume control (point E8), adjust transformer T1 for zero volt dc. Noise will be heard with no signal input, and the squelch should operate as expected. About 2 to 10 μV at 455 kHz should provide 20 dB quieting. Now set the signal generator to 10.7 MHz and couple it to the input, J1. Alternately peak L1 through L4 for maximum negative voltage at TP1 (top of R35). Image response at 9.79 MHz should be down about 40 dB, and the sensitivity at 10.7 MHz should be 2 to 10 μV.

If you wish to use meters to indicate signal strength or carrier frequency, this may be done. A zero-center 50 μA meter may be connected in series with the top of the 10k volume control (connect a small electrolytic capacitor across the meter). The dc current through the volume control will operate the meter, with positive swings indicating high-frequency error and vice versa. A sensitive voltmeter circuit can be built around a Darlington pair or an op amp to drive an S-meter from the limiter test

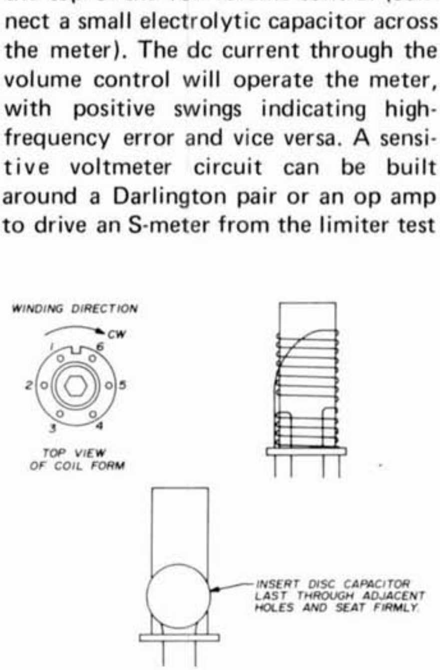
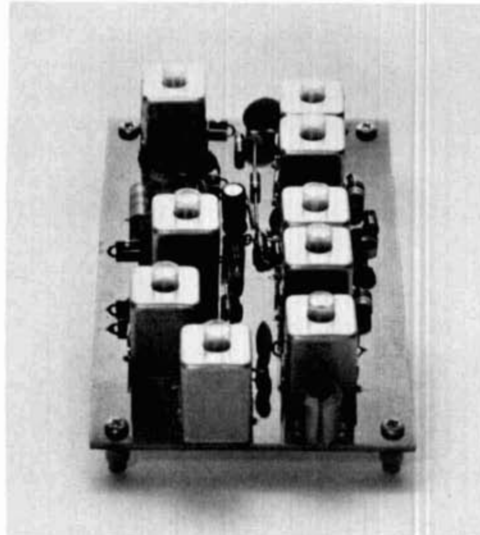


fig. 3. Coil winding and lead identification.



Vhf converter board for the fm receiver. Although designed for use with the 10.7 MHz i-f/audio board, it can be used with other i-f systems as discussed in the text.

point at R35. Do not load the base of Q7 by changing the value of R35 or by making connections directly to the base of the transistor. The voltage swings from +0.6 volt to about −3 volts, so some bias is required in the meter amplifier to avoid swinging through zero on the meter.

Since some operators may prefer different frequency response or volume control range, the following information is provided as a guide. The value of R32 may be reduced as low as 47 or 51 ohms to increase audio gain. A corresponding increase in the high frequency response also results. The value of C27 may be changed to vary the audio frequency response. A 0.1 or 0.05 μF capacitor here will provide bass response or more de-emphasis; a 0.001 μF capacitor at C27 will increase high-frequency response.

vhf converter

The vhf converter consists of a sensitive cascode rf amplifier, low-noise fet mixer, an oscillator, and an injection multiplier/buffer chain. Two schematic

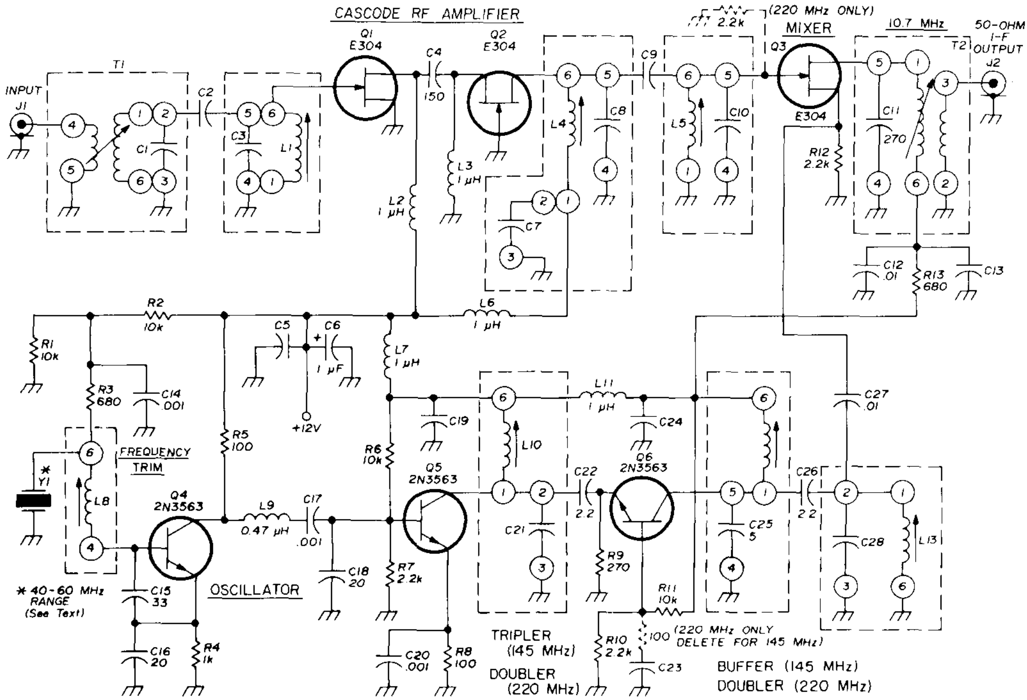


fig. 4. Schematic of vhf converter designed for use on two meters (values shown are for 145 to 155 MHz) and 220 MHz. Inductors and transformers are wound with no. 26 (0.4mm) wire. Tuned-circuit values may be changed as required for operation in adjacent commercial bands.

	145 MHz	220 MHz
C1	10 pF	3.9 pF
C2	1.0 pF	0.68 pF
C3	15 pF	5 pF
C5	1000 pF	82 pF
C7	150 pF	82 pF
C8	5 pF	3.9 pF
C9	1.0 pF	0.68 pF
C10	15 pF	5 pF
C13	270 pF	82 pF
C19	150 pF	600 pF
C21	15 pF	20 pF
C23	270 pF	150 pF
C24	150 pF	270 pF
C28	10 pF	20 pF
L1	2-1/6 turns	2-1/6 turns
L4	4-5/6 turns	3-1/6 turns
L5	2-1/6 turns	2-1/6 turns
L8	14-1/3 turns	14-1/3 turns
L10	2-5/6 turns	3-5/6 turns
L12	4-1/6 turns	2-1/6 turns
L13	2-1/6 turns	2-1/6 turns
T1	Primary, 1-1/6 turns; secondary, 3-1/6 turns	Primary, 1-1/6 turns; secondary, 3-1/6 turns
T2	Primary, 14-1/6 turns; secondary, 2-5/6 turns	Primary, 14-1/6 turns; secondary, 2-5/6 turns

diagrams (**fig. 4** and **5**) give details for various bands, including tuned circuit variations, bypass values, and local-oscillator chain.

The i-f output normally is 10.7 MHz for use with the i-f/audio board. However, the output transformer can be modified to cover other *intermediate* frequencies, such as 14, 28, or 50 MHz, if you wish to use the converter with a tunable receiver as an i-f.

The converter board includes one oscillator. Multichannel operation may be accomplished by using a multichannel adapter[2] in place of the built-in oscillator. The converter may be used for scanner operation by switching oscillator frequencies in the multichannel adapter.

The crystal in the converter is a third *overtone*, 0.002% unit cut for series resonance less 1000 Hz (many two-meter transceiver crystals may be used).

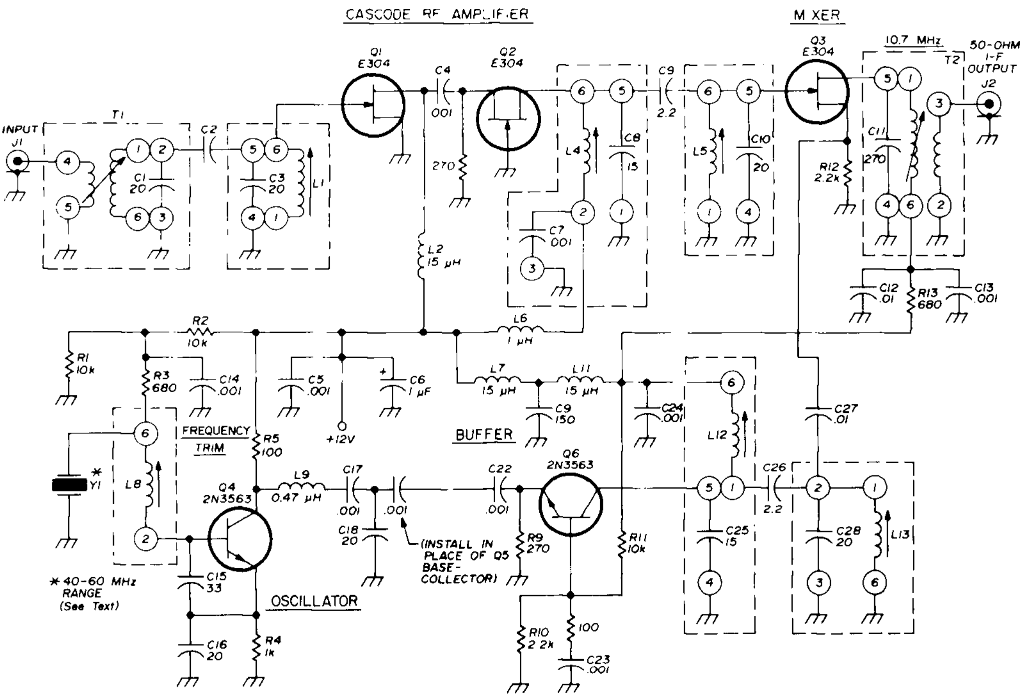
The required crystal frequency is given by

$$\frac{\text{channel frequency} - \text{i-f}}{X}$$

where X is the frequency multiplier. For channel frequencies of 30 to 60 MHz, X = 1; 90 to 130 MHz, X = 2; 130 to 180 MHz, X = 3; and 180 to 230 MHz; X = 4. The crystal should be cut about 1000 Hz less than the calculated frequency. This fudge factor allows the crystal to be trimmed to the desired operating frequency.

construction

Most pertinent construction details are shown on the component location diagram, **fig. 6**. Coil forms are the same as used in the i-f/audio board, except that carbonyl J slugs are used in the coil forms. Winding information for the i-f coil is for 10.7 MHz. For an i-f near 14



	28 MHz	50 MHz
L1	16-1/6 turns	9-1/6 turns
L4	17-1/6 turns	10-1/6 turns
L5	16-1/6 turns	9-1/6 turns
L8	14-1/3 turns	14-1/3 turns
L12	13-1/6 turns	13-1/6 turns
L13	8-1/6 turns	8-1/6 turns
T1	Primary, 5-1/6 turns; secondary, 20-1/6 turns	Primary, 5-1/6 turns; secondary, 11-1/6 turns
T2	Primary, 14-1/6 turns; secondary, 2-5/6 turns	Primary, 14-1/6 turns; secondary, 2-5/6 turns

fig. 5. Vhf converter for use on the six- and ten-meter amateur bands. All inductors and transformers wound with no. 26 (0.4mm) wire.

MHz, the primary winding should be reduced to about 10-1/6 turns. For 28 MHz, the primary should be 7-1/6 turns, and the secondary should be 1-5/6 turns. For 50 MHz, capacitor C11 should be changed to 15 pF, and the turns should be as shown on the schematic.

As a matter of interest, the unconventional long leads on a few of the components and the +13 volt connection to the center of the board permit maximum ground area in the board layout. In effect, you get the ground plane performance of a double-sided circuit board without the problems encountered in working with two foils.

When building the converter be sure to observe polarity on the electrolytic capacitor, and be sure to solder the shield can lugs to the board. If coil pruning becomes necessary, the shield cans may be unsoldered. All components should be seated close to the board to provide short leads. If a multichannel adapter is to be used, the oscillator on the converter board can be included for test purposes and later disabled when the adapter is connected.

Phono connectors are used to allow easy connection to the board with coaxial cable. This may be done at a tuned circuit because the coax is terminated at such a point. However, any connectors used in mid-line should be constant-impedance types for low loss, and phono and type-uhf connectors may put a bump in the line in such applications. Likewise, the cable should be chosen carefully for low signal levels. RG-8/U cable (or better) should be used unless you can accept the higher loss of the smaller cable types. If a separate transmitter is used with the converter, a good coax relay should be used to minimize signal loss and to prevent coupling of large amounts of rf into the front end of the converter.

converter alignment

The most difficult part of the alignment procedure is obtaining a stable test signal. Even my HP-608 signal generator takes several hours to settle down enough to stay within a 5 kHz passband at vhf. An alternative is a crystal-controlled weak-signal source such as

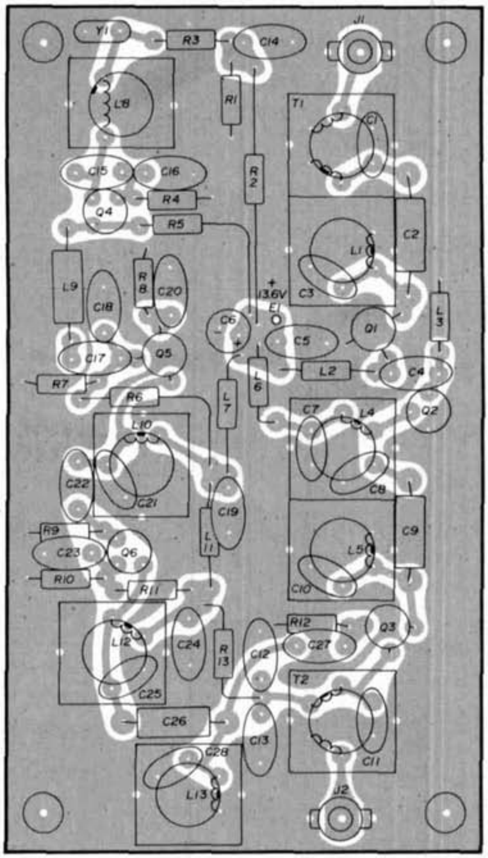


fig. 6. Component layout for the vhf converters. Same circuit board is used for each of the converters shown in figs. 4, 5 and 6. Circuit board is 2½" (6.5cm) wide and 4½" (11.5cm) long.

those which have been described in the past. An on-the-air test, if it can be arranged, is another possibility.

Start with all adjustments at about half range. Tune in a signal, and peak all adjustments. If the coils do not peak within the range of the slug, an adjust-

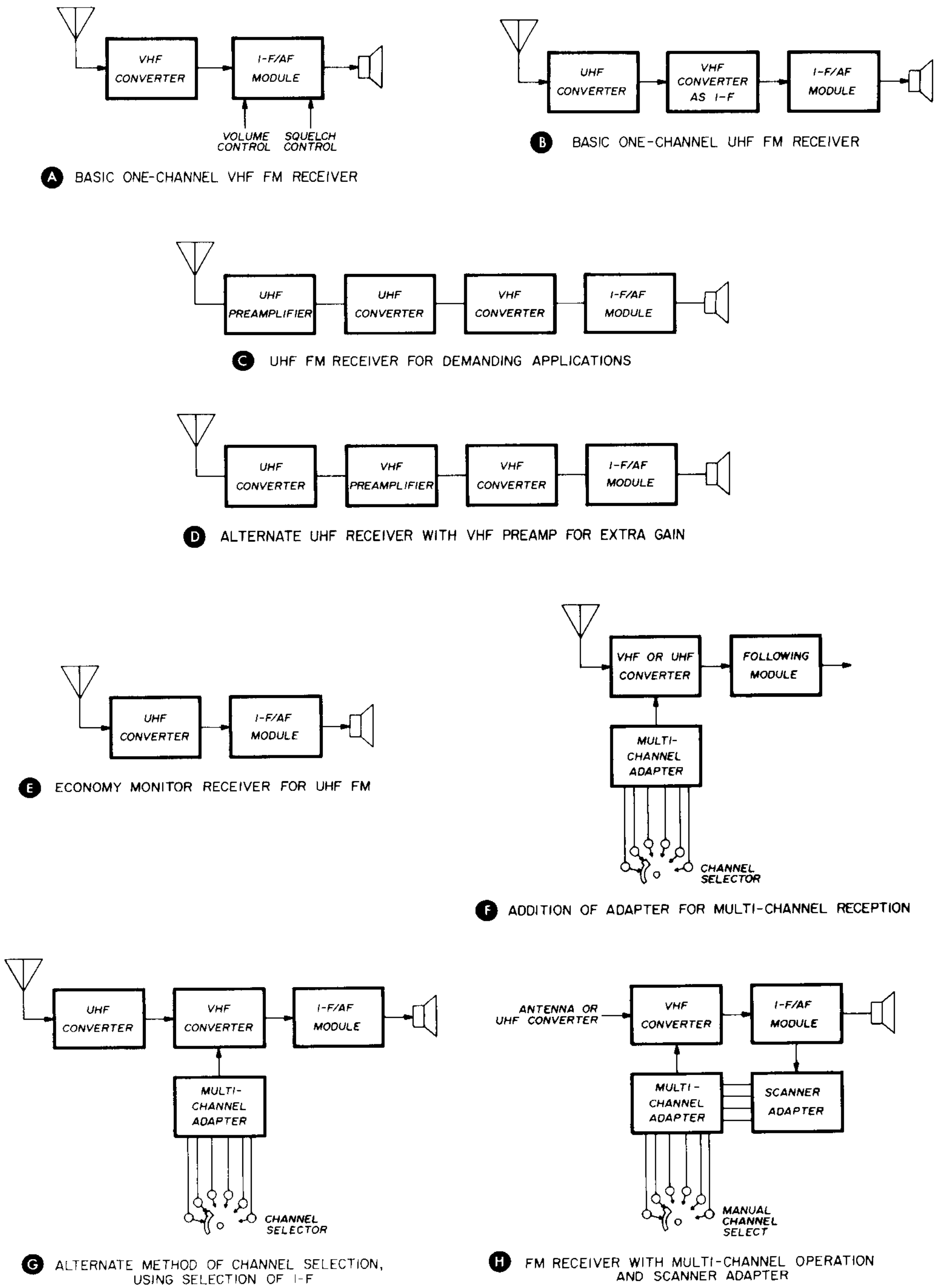


fig. 7. Some ideas for complete vhf receiver systems using the vhf converter and i-f/audio board described in this article. Kits for each of the circuits shown here are available from Hamtronics.*

ment in the number of primary turns may be necessary. Be careful, however, that you don't tune a multiplier coil to the wrong harmonic. Then, adjust the oscillator trimmer coil (L8) to net the converter to the channel frequency by monitoring the receiver discriminator or S-meter. Note that the crystal may be pulled enough for adjustment over a range of about 4 kHz at vhf. A vtvm connected to test point TP1 may be used for peaking adjustments when aligning a converter which will be used with the previously described i-f/audio board.

The final alignment should be done by peaking all rf, i-f and multiplier or injection coils with a weak received signal. Antenna reactance may require that the input coil be repeaked when the antenna is connected. Because of interactions between pairs of coils, such coils should be peaked alternately until you find the combination which provides the test sensitivity. This is especially true of L12 and L13, which are somewhat overcoupled. There should not be any tendency to oscillate when the coils are peaked.

When used with the i-f/audio board, the converter should provide sensitivity of about 0.2 to 0.4 μV for 20 dB quieting. Meter action at TP1 on the i-f/audio board should start with as little as 20 μV of signal into the converter.

If a multichannel oscillator is used in place of the converter's local oscillator, R5 and Q4 should be removed from the converter. The following parts also may be removed if desired: R1, R2, R3, R4, C14, C15, C16, Y1, L8 and shield.

receiver system ideas

After building the basic receiver you may wish to add accessories to extend its usefulness. **Fig. 7** illustrates a variety of receiver configurations using the two boards described in this article as well as circuit boards featured in earlier articles.

The arrangement in **fig. 7A** is the basic setup described in this article. The layout in **fig. 7B** uses the uhf converter described in a previous article[2] for coverage of the 450-MHz amateur band. For weak signal uhf reception or long-distance communications, a uhf preamplifier may be included as shown in **fig. 7C**. An alternate layout that provices good uhf performance is shown in **fig. 7D**.[3,4] For uhf monitor service, the simple circuit of **fig. 7E** is recommended.

Fig. 7F shows how a multi-channel adapter may be added to the circuit for multi-channel operation. A multichannel fm receiver with a scanner adapter[5] is shown in **fig. 7H**.

*The following kits are being made available in conjunction with this article. Be sure to specify exactly what you want, including frequency band.

I-f/Audio Board kit	R40	$40.00
Vhf Converter kit	C25	25.00
Receiver kit (both of above)	R60	64.95
Vhf Preamplifier kit	P6	6.00
Six-Channel Adapter kit	A13-45	12.95
Scanner Adapter kit	AS-10	10.00
Uhf Converter kit	U20-450	20.00
Uhf Preamplifier kit	P15-450	15.00

When ordering please add shipping; New York residents please add sales tax. Quantity prices are available to clubs and to individuals who are interested in distribution at hamfests, etc. A complete catalog is available in exchange for a self-addressed, stamped envelope. Hamtronics, Inc., 182 Belmont Road, Rochester, New York 14612.

references

1. Gerald Vogt, WA2GCF, "VHF FM Receiver," *ham radio*, November, 1972, page 6.
2. Gerald Vogt, WA2GCF, "Uhf Converter and Preamplifier," *ham radio*, July, 1975, page 40.
3. Gerald Vogt, WA2GCF, "Improved 6-Meter Preamplifier," *ham radio*, January, 1973, page 46.
4. Gerald Vogt, WA2GCF, "Improved 2-Meter Preamplifier," *ham radio*, March, 1972, page 25.
5. Gerald Vogt, WA2GCF, "Channel Scanner for VHF FM," *ham radio*, November, 1974, page 26.

ham radio

using TTL ICs in single-sideband equipment

Simple TTL IC ssb circuits include a complete transceiver using only three SN7400 NAND gates

Peter J. Hampton, G4ADJ

A while ago I was toying with TTL crystal oscillators for use as clocks in digital equipment. The performance of standard multivibrator configurations (see **fig. 1**) was quite surprising. Just about every crystal I had performed equally well in the circuit. Fundamentals from 100 kHz to over 20 MHz all gave outputs of at least 2 volts peak-to-peak. Perhaps, I thought, these circuits could be used successfully as local oscillators in high-frequency ssb equipment.

Since the output of the circuit of **fig. 1** is a square wave, lower second harmonic content can be expected as compared to most conventional oscillators.[1] This can be a very good thing when trying to filter out the spurious responses so often troublesome in homebrew ssb gear.

mixer

Having found a cheap, sure-fire local oscillator, A TTL-compatible mixer was required to provide the appropriate double-sideband signal. For this purpose nothing more complicated than a single NAND gate was found to be necessary. Two square waves, $f1$ and $f2$, when applied to the separate inputs of a NAND gate, yield outputs of $f1 + f2$ and $f1 - f2$. Hence the gate is performing the function of a *product modulator*. If, however, one input to the gate is biased at the point (A) on the transfer characteristic shown in **fig. 2**, then a small signal applied to that input will be amplified linearly (see reference 2), and also switched by the square-wave signal at the other input. Thus, if the switching signal is an rf carrier and the other a speech waveform, then the gate becomes a low level amplitude modulator. A carbon or crystal microphone used as the audio source will usually provide enough output to give a 100 per cent modulated signal.

Reference 2 states that a TTL gate can give large amounts of gain at frequencies as high as 10 MHz when operating as a linear amplifier. Thus it was decided to see if the device could be used as a simple and inexpensive rf

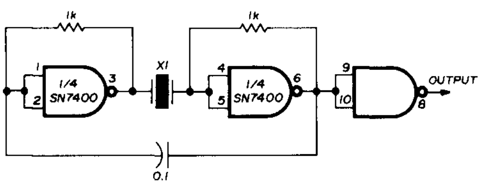


fig. 1. TTL oscillator for fundamental crystals operating in the range from 100 kHz to 20 MHz.

amplifier for small signals. The circuit of **fig. 4** was lashed up, and, to my surprise, it performed very well indeed when correctly biased. A gain of around 15 dB was obtained at 8 MHz and there seemed to be no major instability problems. However, it is recommended that double-sided PC board be used with one side acting as a ground plane. Also 0.1 μF and 100 μF capacitors should be wired across the supply pins of each IC to provide adequate decoupling of the +5 volt bus.

ssb exciter using TTL gates

In the junkbox at home I found a large number of 10XJ crystals of surplus origin with fundamentals of 3.446 and 3.449 MHz. Not being able to think of anything else to do with them, I attempted to make up something of an ssb filter for use in an exciter built around circuits similar to those outlined

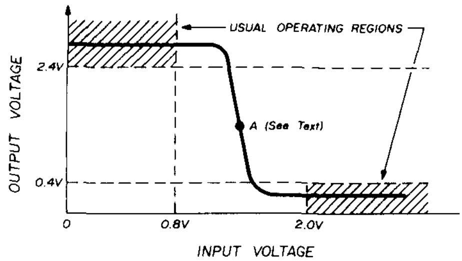


fig. 2. Transfer characteristics of the TTL NAND gate.

above. The unit was designed to generate and detect upper-sideband signals at 3.447 MHz. **Fig. 5** shows the circuit of the complete prime-mover.

The oscillator section is straight forward enough and uses a 3.446 MHz crystal for upper sideband and 3.449 MHz for CW. Gates U1C and U1D are buffers for transmit and receive, respectively. These are followed by controlled gates U3B and U2A which route the carrier to the appropriate mixer while shutting the unused one off. PTT (or full break-in CW) is provided by U3A and U2B.

Gates U2C and U3C are the modulator and detector, each giving an output of 2 volts p-p for inputs of 100 mV or so. Following the modulator is a filter/amplifier arrangement comprised of crystals X2, X3, X4 and U2D which is used to supply a certain amount of rf clipping before the main filter. U3D, the remaining gate, is used as an rf amplifier preceding the product detector U3C.

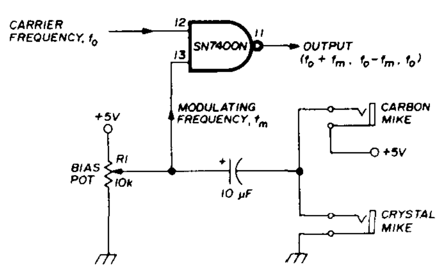


fig. 3. Using the SN7400 gate as a product modulator (mixer).

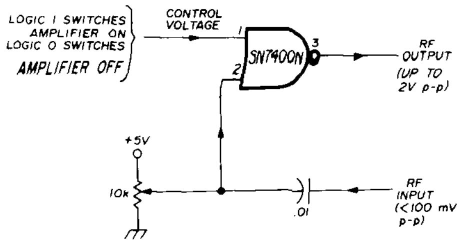


fig. 4. Simple rf amplifier using a TTL NAND gate. Rf output is about 2 volts p-p for 100 mV p-p input.

Both U3D and U2D are controlled by the PTT voltage applied to their unused inputs.

the filter

The *pièce de résistance* of most ssb rigs is their filter. Well, this one has quite a job to do since it must remove all the carrier from an a-m signal (the modulator is unbalanced) and also have a reasonable passband characteristic for good audio reproduction. The simple ladder arrangement shown in **fig. 6** seemed to work pretty well, but with an insertion loss of around 10 to 12 dB.

All the series elements of the filter use 3.449 MHz crystals with additional capacitance shunted across them to give series resonant frequencies spread throughout the range from 3.4465 to 3.4485 MHz. The remaining shunt crystals are all resonant at 3.4460 MHz, the carrier frequency, and effectively shunt it to ground.

In the original a total of twelve 10XJ crystals were used, giving about 45 dB of carrier and 35 dB of lower-sideband suppression. There is plenty of room for improvements in the filter design, however!

summary

In conclusion, we have here the basis of a very inexpensive unit which can generate and detect ssb signals at good quality with a minimum of external components. Transmit output power is

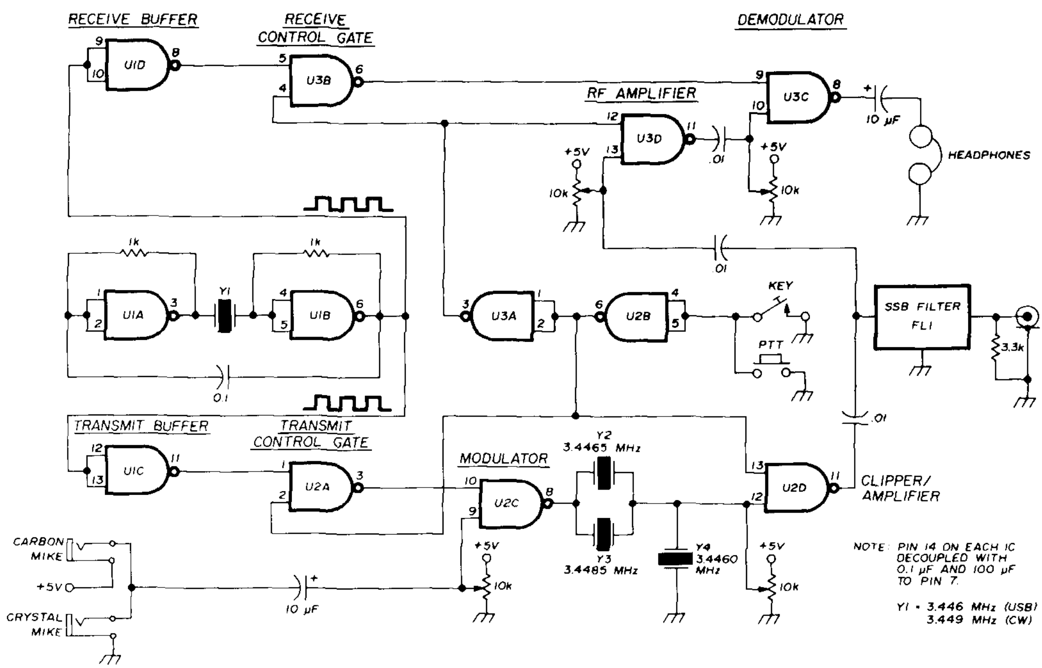


fig. 5. Schematic diagram of a complete ssb transceiver using 7400 series ICs. Circuit for ssb filter, FL1, is shown in fig. 6.

on the order of 10 mW PEP and receiver sensitivity is about 50 mV for noise-free audio (i.e., an S9 input signal). It is intended that the rest of the receiver gain be supplied by the preselector stages in the frequency translator.

is a good idea to use an oscilloscope for setting the bias points as there is a considerable variation in gate characteristics between samples. This is why potentiometers are shown in all the previous circuits instead of fixed resistors.

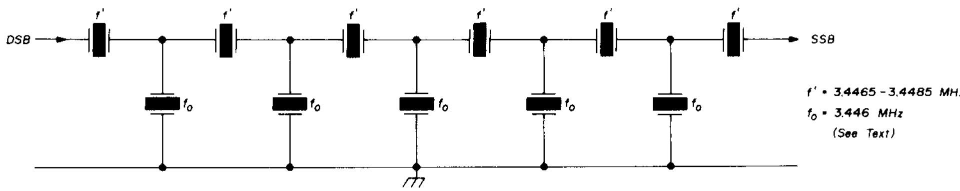


fig. 6. Simple ladder filter for 3.447 MHz upper sideband using surplus 10XJ crystals.

As far as I can see, the standard TTL gate is probably the most useful active device available to the home constructer on a cost/performance basis. It seems that it can be used in almost any application up to 20 MHz or so with a minimum of external components and little difficulty in setting up. Nevertheless, it

references

1. Max Robinson, K4ODS, and John Smith, "Local Oscillator Waveform Effects on Spurious Mixer Responses," *ham radio*, June, 1974, page 44.
2. *Texas Instruments System 74 Designer's Manual*, Texas Instruments, Inc., Dallas, Texas, page 20, note iii.

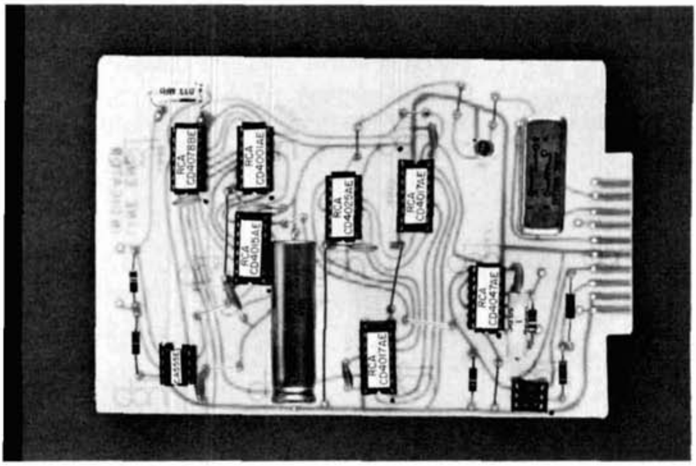
ham radio

Kenwood TS-520 CW filter option modification

Owners of the Kenwood TS-520 transceiver who have the CW filter installed are confronted with the problem that all CW reception must be with the narrow filter when transmitting in this mode. Often it's desirable and more pleasant to receive CW with a wider bandpass as on the upper and lower sideband modes. A very simple modification consisting of the installation of an auxiliary switch permits the option of the wideband or CW narrowband filter. Fortunately the TS-520 mode control employs diode switching when inserting the CW filter. Thus lead length and capacitance are no problem, and the CW filter control leads can be extended and switched remotely or externally.

The TS-520 has a flat plate on the chassis underside, which is part of the dial assembly and which is an ideal location for such a switch. Adequate clearance is available to install a miniature spdt switch by carefully drilling a hole in this plate for mounting the switch and a clearance hole in the bottom of the outer cover case to permit the switch handle to protrude without being obvious or defacing any panel space. A small three-wire cable connects the switch to the filter control circuit by attaching the center pole of the switch to the original brown common wire and connnecting one switch pole to the CW terminal on the TS-520 i-f circuit board and the other switch pole to the ssb terminal. Thus you now have the option of a wideband CW position (ssb filter) or the 500-Hz CW filter by the simple flick of this switch.

Bill Vandermay, W7ZZ



RTTY line-end indicator

Solid-state RTTY line-end indicator uses CMOS logic ICs for high reliability and low current drain

Robert Mendelson, W2OKO, RCA Solid-State Division, Somerville, N.J. 08876

Can you type a smooth 60 words per minute? Would you like to have your RTTY transmissions sound like commercial press sent from a tape? It really is quite easy to do provided you are equipped with a tape perforator and transmitter-distributor.

Unfortunately, many amateurs have the equipment but don't like to punch tape while receiving the other fellow's message. This is especially true when there is only one keyboard and printer in the station. You often hear, "How can I punch tape without seeing what I'm typing; how will I know when I am near the end of the line?" Or, "I have two machines, but if I run them both at once my wife would throw me out of the house!" Relax! It can all be done with one machine with the printer copying the incoming traffic while the keyboard types the answers. Typing blind is really not difficult, and an occasional error will not really matter during a ragchew. It's the end of line that is annoying.

Articles have been written about RTTY line-end indicators,[1] but they have all been based on mechanical switches, or counting word spaces instead of letters, or other similar circuits. With today's digital and linear ICs it can all be done electronically with the line-end light or bell actuated at 66 characters every time.

The circuit shown in **fig. 1**, which uses RCA CMOS digital ICs and a bipolar timer, does this. The CMOS ICs have many advantages over the more familiar TTL logic family. Power consumption is minimal. The whole circuit draws 5 mA *quiescent or operating,* except when the light goes on. The power supply voltage can be anything from 4.5 to 15 volts and does not really have to be regulated.* Further, the circuit needs only a few common resistors and capacitors.

circuit operation

In the circuit of **fig. 1** an optical isolator, U1, in the 60 mA loop will turn its transistor output on and off in response to the mark-space code. The output is separated completely from the input and allows the 120-volt loop supply to be applied without any danger to the CMOS circuits. The zener diode across the input protects the optical isolator against incorrect polarity or too high a source voltage.

The isolator collector is tied to the input of U2, an RCA CD4047 monostable oscillator. The appearance of a start pulse will trigger the oscillator whose holding time is set by R1 and C1 to 150 milliseconds, the time it takes for the start pulse, 5 code pulses, and part of the stop pulse to occur. The isolator output is also fed to U5, an RCA CD4015 shift register. This function will be explained later. Each time a character fires U2, its output will trigger U3, an RCA CD4017 divide-by-10 counter which, after 10 pulses, will trigger U4, another RCA CD4017.

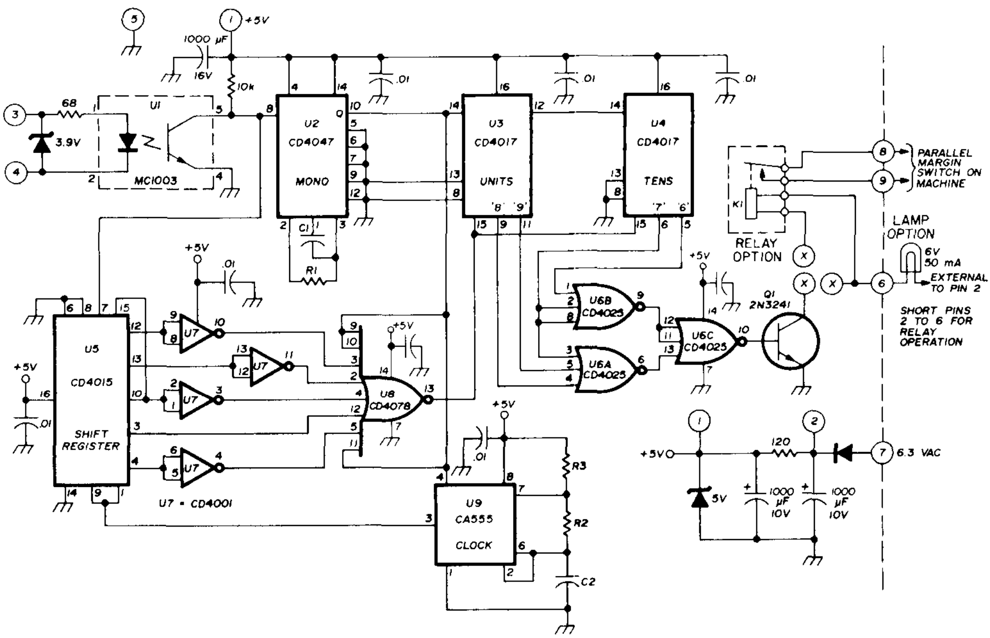


fig. 1. Schematic diagram of the RTTY line-end indicator. Correct values for C1, C2, R1, R2, and R3 are shown for speeds of 60 and 100 wpm. Power supply option for 6.3 Vac input is shown at lower right. Circled numbers refer to PC connector pins shown in fig. 2.

speed	C1	C2	R1	R2	R3
60 wpm	0.1 μF	0.033 μF	560k	470k	56k
100 wpm	0.1 μF	0.033 μF	330k	270k	56k

The CD4017 has a serial input and output, but it also has ten outputs, one for each digit. Only one of these outputs will be at logic 1, or high, at any time. Each input pulse will move the

*A zener regulator will help hold the clock frequency if the lamp load should cause a large change in supply voltage.

logical 1 state from pin to pin until, on the tenth pulse, it will be back where it started.

This rotating logic 1 can be used to form a sort of combination lock when used in conjunction with some simple NOR gates. The output of a NOR gate will go high only when all of the gate inputs are low. Using this information, let's work back from the lamp which will signal that the end of the RTTY line is near.

The lamp will be on when Q1 conducts; that is, its base is greater than 0.7 volt. The base voltage is supplied by the output of U6C, a NOR gate. For this gate to have a high output, its inputs from sections U6A and U6B must be low. For a count below 60 the leads from 6 and 7 of the tens counter will both be low, causing the output of U6B to be high. Under these conditions the output from U6C cannot go high to turn the lamp on.

At count 60 the output of section U6B will go low, but from count 60 to 67, the outputs from U3 units counts 8 and 9 will be low, as will the connection from the U4 7 count. Therefore, the output from U6A will be high and the output from U6C will stay low – the lamp stays off.

However, at count 68, the units 8 will go high, driving the output of U6A low. Since the U6B output is also low, output from U6C will go high and the lamp will turn on. This same condition will exist at count 69. At count 70 both U6A and U6B will have a high input (from the 7 count on U4) and the lamp will stay on until count 80, which is way past the line end of 72 characters.

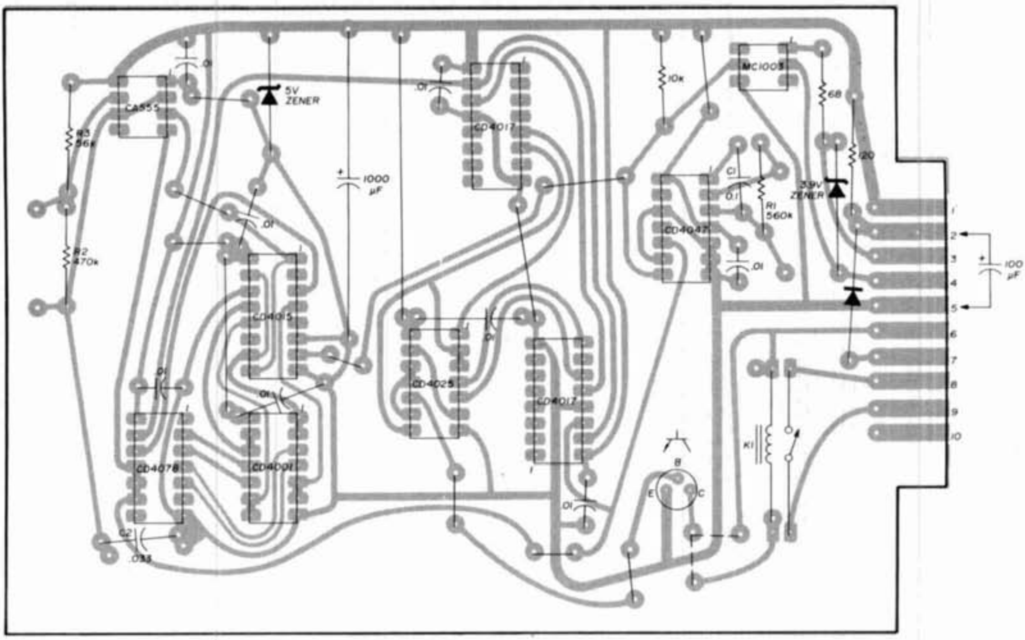


fig. 2. Printed-circuit layout for the RTTY line-end indicator. The unused contacts at R1, R2 and C2 are used, as required, for frequency adjustment. The connection from the collector of the transistor Q1 is chosen for relay or lamp option (see fig. 1). Connect the lamp to pins 2 and 6 of the board. For external power supply, omit the external 100 µF capacitor, 120 ohm resistor and 5 volt zener and short pin 1 of the board to pin 2.

Now that the lamp has gone on, a few more letters may be typed and then *carriage return-line feed-letters*. The *carriage return* code group is used to reset gate only when the *carriage return* character (SSSMS) is struck. The RCA CD4015 is a serial input, parallel output, static shift register. Each time a

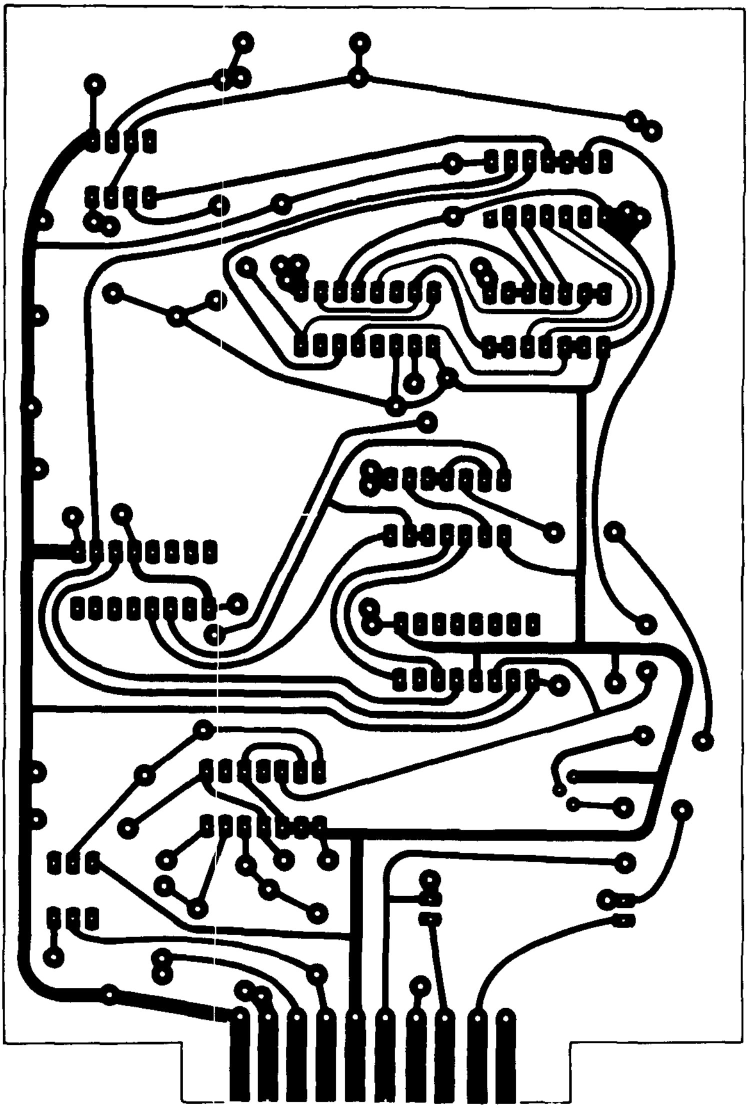


fig. 3. Full-sized printed-circuit board for the RTTY line-end indicator. Component layout is shown in fig. 2.

the counters to zero for the next line. Here's how it works: A shift register, U5, used to read the five-unit Baudot code, is preset to trigger another NOR pulse appears at its clock input, the information already in the register is shifted over one stage. The parallel output allows data monitoring at each stage.

The clock pulses are provided by an RCA CA555 astable timer, U9, set for approximately the same pulse width as the 22 millisecond Baudot code. The start pulse at the output of the optical isolator will turn on the monostable oscillator, U2, and will also appear at the data input of the shift register, U5. The oscillator output, in turn, will trigger the astable timer, U9, but will allow it to stay on only for seven pulses. These seven pulses will clock the register for each of the seven mark, or space, pulses of a Baudot character. After seven pulses the register will contain the code for the character sent.

Ignoring the start and stop pulses, the five-character code pulses available at the parallel outputs can now be checked to see if they form the code group for *carriage return* (SSSMS). By placing inverters in each of the space outputs, all outputs applied to U8 (RCA CD4078) become low. This condition will occur only for *carriage return* (for any other character, one or more of the outputs will be high). With all inputs low, the output of U8 will go high and reset U3 and U4. While the seven pulses are being fed into the shift register, the output of U8 is kept low by the input lines (pins 9, 10, 11) which are tied to the high output of U2.

If you were concerned about the lamp going on too close to the line-end after character 68 was struck, relax. All amateurs send the *carriage return-line feed-letters* combination at the end of line. The last two functions do not move the type box, so the lamp will go on at 66 printed characters, the same as the mechanical switch on the printer. Use of the *figures* or *letters* key on any line of type provides a safety factor. They will be counted even though there is no print.

Construction is simple whether you use hand wiring or a printed-circuit board. The layout of the circuit board is shown in **fig. 2**. The board can be mounted inside the machine. The printer remains in the TU loop while the keyboard and line-end indicator input are put in series in a separate loop to the perforator (watch the polarity).

If the board is too big, as shown, you can build a smaller one as there really is nothing critical. The only adjustments are to the two oscillators. The values shown in **fig. 1** should work with no problem. For exact adjustment use a digital counter and vary R1 and/or R2 for the monostable oscillator, U2, and astable oscillator, U9, respectively. Set the monostable for 150 milliseconds (7 Hz) and the astable for 22 milliseconds (45 Hz). If in doubt, set the astable slightly on the low frequency side. The rise time of its pulses can occur anytime during each 22 millisecond Baudot pulse.

A relay to turn on an existing margin light may be substituted for the lamp shown in **fig. 1**. The PC board provides contacts for a relay such as the General Reed GR410-P5 or Clare MRB 1A05. Just wire the relay contacts in parallel with the machine margin switch.

The circuit board also provides for a rectifier diode to allow use of 6.3 volt ac power. A dropping resistor and 5.1 volt zener diode are added to prevent wide voltage swings as the lamp turns on and off.

conclusion

And what do you have after you built this CMOS line-end indicator? You can receive a message and while reading what is being printed, you can type answers to questions, ask questions, or make comments. When the other station signs, you can turn on the transmitter and TD and continue to punch tape while you are transmitting commercial quality, 60 wpm copy.

reference

1. H. Dressel, W2UVF, "RTTY Line Length Indicator," *ham radio*, November, 1973, page 62.

ham radio

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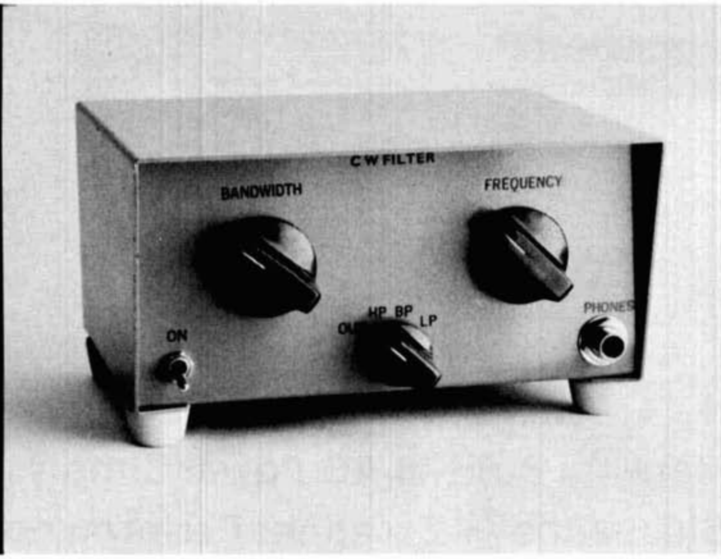


tunable audio filter

for weak-signal communications

A discussion of weak-signal CW detection techniques, including a versatile, high-performance audio filter

Ken Holladay, K6HCP, Gilroy, California 95020

Although there has recently been a great deal of controversy over the value of CW communications, CW continues to be the most efficient mode of radio transmission. This was true in the first successful transatlantic tests of the 1920s and it is still true today as amateurs work to improve the reliability of EME, meteor scatter and long-range tropospheric communications. Once a communications path has been proven to exist with CW, amateurs usually find a way to use ssb (or other mode) over the same path. CW is also valuable for working DX on the high-frequency bands when propagation conditions are poor, particularly during periods of low solar activity.

Amateur communications equipment has come a long way since 1921 when Paul Godley set up a receiving station on the Scottish coast to listen for signals from the United States. Now our transmitters run higher power, are more efficient and are stable; high-gain, directional antennas are commonplace and our stable and sensitive communications receivers are equipped with highly selective mechanical or crystal filters.

The communications receiver conditions the incoming CW signal so that the greatest receiver of all – our ear-brain – can capture that first detectable signal. The ear is capable of receiving signals from less than 20 Hz to more than 20 kHz and, when coupled with the brain, forms an extremely efficient and versatile CW detector. Furthermore, the ear-brain combination is capable of acting like a variable-frequency, variable-bandwidth audio filter which allows us to detect and copy signals which are buried in the noise or nearly obliterated by interference.

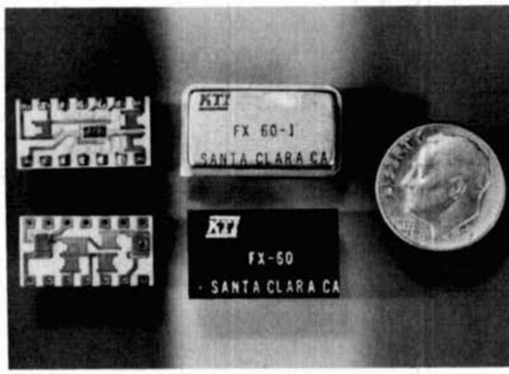


fig. 2. Universal Active Filters manufactured by KTI.

The human ear is actually able to hear signals which are *below* the noise level.[1] Tests conducted by W2IMU, using a 3 kHz bandwidth receiver and a signal generator, showed that when a CW signal is adjusted to the same audio level as the noise (zero dB signal-to-noise ratio), the signal was 100 per cent

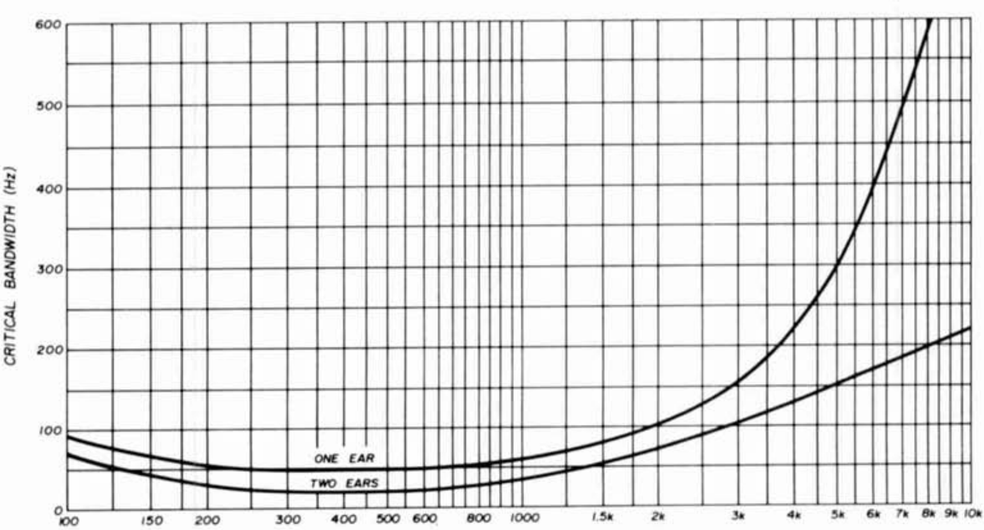


fig. 1. Critical bandwidth of the human ear as a function of frequency.

readable. The input signal was then reduced in 3 dB steps. Copy became more difficult but callsigns could still be accurately identified at 9 to 12 dB *below* the noise level. Although the *presence* of signals 20 dB below the noise could still be detected, the signals could not be copied.

The reason that these weak signals can be copied reliably is that the ear-brain filter has narrowed its bandwidth to approximately 50 Hz! The graph of **fig. 1** *shows the frequency response* of the human ear vs its bandwidth.[2] This curve also shows that 1000 Hz is *not* the optimum tone with which to copy weak CW signals. Most amateurs who have worked with weak CW signals have found that they prefer a lower pitch as signals get weaker. **Fig. 1** shows why.

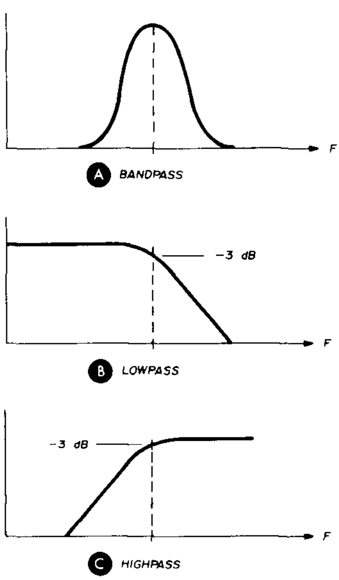


fig. 3. Comparison of active filter outputs as a function of frequency.

Another reason to lower the frequency of the signal you want to copy is that, if there is interference, the lower-frequency signal is easier to detect. For example, if the frequency difference between the desired and undesired signals is 100 Hz, and the desired signal is tuned for a 1000 Hz pitch, the frequency difference is only 10 per

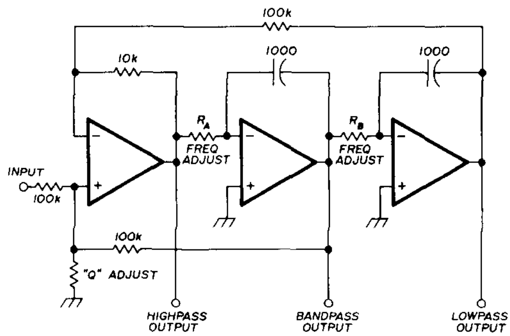


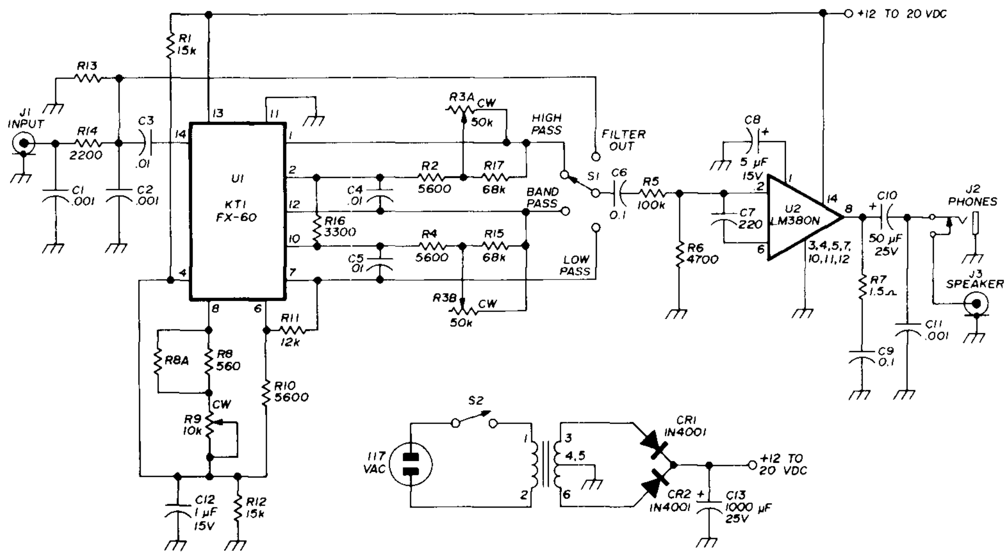
fig. 4. Basic schematic of the KTI Universal Active Filter.

cent. If you tune the desired signal for a 500 Hz pitch, the frequency difference is increased to 20 per cent, a 2:1 improvement.

The human ear-brain also copies signals by comparing signal against signal or signal against noise. If a narrow bandpass filter, say 200 Hz, is used in the receiver it excludes other signals as well as some of the noise. This is fine for strong signals but causes problems with weak ones because too much bandwidth restriction limits the amount of noise the ear has to compare with.

Very sharp filters also have a tendency to "ring" – this ringing sounds much like the signal and makes signal-to-noise comparison difficult, if not impossible, with very weak CW signals. In addition, narrow bandwidth filters are usually tuned to some fixed frequency so the individual operator cannot optimize the frequency and bandwidth of the filter to complement his own ear.

Since the human ear is already capable of 50 Hz bandwidth, very narrow filters are not the best for weak CW detection except for eliminating interference. What is needed is a variable frequency and variable bandwidth filter that can be adjusted for various operating conditions. Variable audio filters are sponse to less than 10 Hz. They can also provide simultaneous highpass, bandpass and lowpass outputs as shown in **fig. 3** so they are ideal for such applications as



R3	Frequency adjust. Dual 50k potentiometer, CCW log taper (Allen-Bradley 70C1N048-503B or equivalent)
R9	Bandwidth adjust. 10k potentiometer, linear taper
R8A	Selected for highest Q (narrowest bandwidth)
R13	Sets input level (10V p-p maximum), not normally required
S1	4 position, non-shorting rotary switch
T1	24 volt, 180 mA power transformer (Signal PC 24-180)

fig. 5. Tunable audio filter uses KTI FX-60 Universal Active Filter and provides highpass, bandpass and lowpass outputs. Circuit has unity voltage gain so it may be switched in and out of the receiving system as required without adjusting the audio gain control. Printed-circuit layout for the filter is shown in fig. 6.

difficult to build with lumped values of inductance and capacitance, but modern integrated-circuit technology provides the basis for excellent audio CW filters. Kinetic Technology* has developed a line of Universal Active Filters which can be used from less than 1 Hz to greater than 100 kHz, depending on the model. The bandwidth of these active filters can be adjusted for a flat re-

*KTI/Division Baldwin Electronics, Inc., 3393 De La Cruz Boulevard, Santa Clara, California 95050, telephone (408) 296-9305.

speech filters, notch filters, tone encoders, RTTY and, best of all, CW filters.

tunable cw filter

The KTI active filters use three operational amplifiers in a stable, negative-feedback circuit (**fig. 4**) which is commonly called a bi-quad. Although a complete description of device operation and its various connections is beyond the scope of this article, complete data is available from KTI.

A tunable CW filter which uses the KTI FX-60 and an LM380 audio amplifier is shown in **fig. 5**. This filter tunes the audio range from 300 to 1800 Hz and its bandwidth can be adjusted from 50 to 1200 Hz. The filter, which has unity gain and is built on a printed-circuit board, is designed to be plugged into the headphone jack of a communi-

(C1, R14, C2) passes the audio frequencies but blocks rf energy. Resistor R13 is used to lower the input signal level, if required, to the FX-60 active filter. The dual 50k potentiometer, R3A and R3B, sets the frequency of the filter while the bandwidth is adjusted with

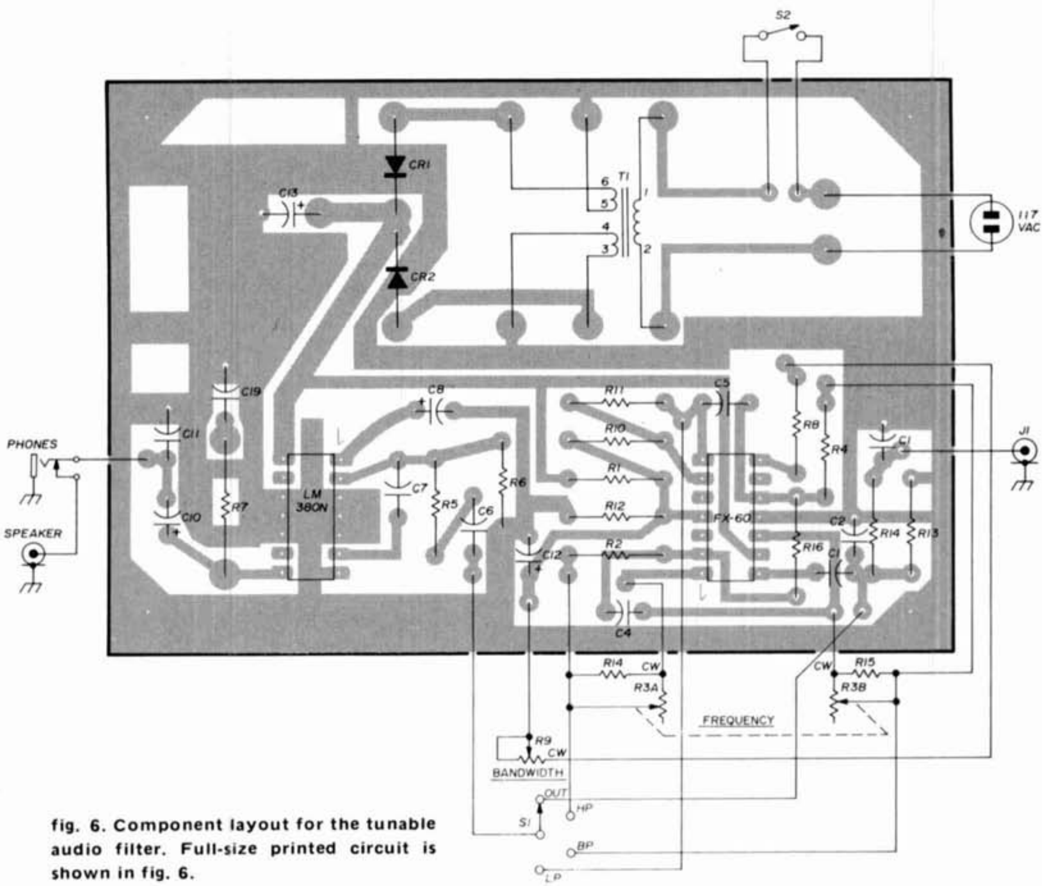


fig. 6. Component layout for the tunable audio filter. Full-size printed circuit is shown in fig. 6.

cations receiver. The output is then connected to the speaker or headphones and the filter can be switched into the circuit as required. The LM38ON provides two watts of audio output, more than enough for most applications.

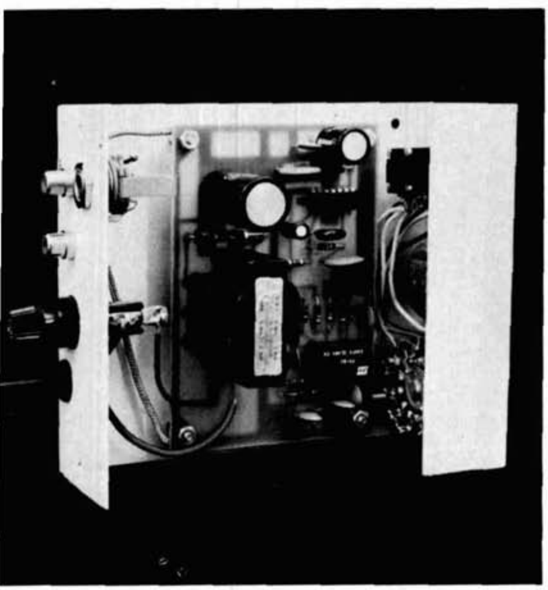
In the circuit of **fig. 5** the audio signal from the receiver is introduced to the CW filter at J1. The input pi network

potentiometer R9. The function switch, S1, selects the highpass, bandpass or lowpass output from the FX-60 or switches the filter out of the circuit.

In the active filter circuit resistors R1 and R12 provide the necessary biasing so the FX-60 can be operated from a single, positive power supply, Resistor R11 allows the three outputs to be at

Tunable audio filter built by W1DTY is housed in Ten-Tec JW-5 enclosure. Input and output jacks are on rear panel.

Construction of the tunable audio filter built by W1DTY using printed-circuit board available from Holladay Communications. Input and output jacks are on rear panel, left. Board is installed on chassis with 0.25" (7mm) spacers.



the same level. R10 limits the widest bandwidth while R9 sets the narrowest limit.

During setup resistor R8A is adjusted until the circuit goes into oscillation; the correct value is that just before the circuit oscillates. The narrowest bandwidth will vary from unit to unit, and some may not require R8A. Resistor R16 maintains filter stability at the narrow bandwidth setting and capacitors C4 and C5 set the frequency range.

The National LM38ON audio power IC is connected to the function switch through the dc blocking capacitor, C6. Resistors R5 and R6 set the input level and capacitor C7 provides high-frequency rolloff at 4 kHz. The series RC circuit (R7, C9) from the output pin to ground prevents high-frequency oscillations.

The tunable audio filter is built on a 3 by 4.4 inch (7.6 by 11.2cm) printed-circuit board. The component layout is shown in **fig. 6**. Printed-circuit boards and special components are being made available in conjunction with this article.*

The tunable audio filter may be used to improve various types of receiver signals. In the lowpass mode it can be helpful with ssb reception. For use on CW it should be set to the *bandpass* position, is quite simple and there is no preset adjustment to follow. Some amateurs like to use the unit in the narrow bandwidth, lowpass mode (**fig. 8**) as this provides some low-frequency noise to which the ear can compare weak CW signals.

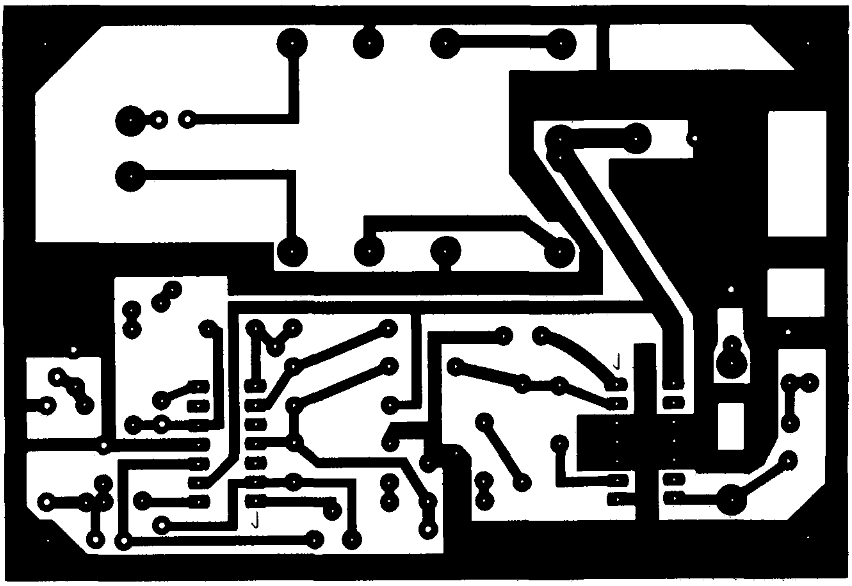


fig. 7. Full-size printed-circuit layout for the tunable audio filter. Drilled PC boards are available (see footnote below).

adjusted to narrow bandwidth and peaked on the desired CW signal. The optimum frequency and bandwidth will vary from operator to operator, as discussed previously. Operation of the unit

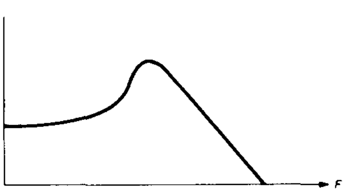


fig. 8. Frequency response of the tunable audio filter set for narrow bandwidth in the lowpass position. This response is sometimes preferred for weak-signal CW work.

*The following components can be supplied: drilled and plated printed-circuit board, $5.75; KIT FX-60 Universal Active Filter, $6.95; National LM38ON audio power IC, $1.75; Allen-Bradley dual 50k potentiometer, CCW log taper, $7.30; power transformer, Signal PC 24-180, $4.80. Wired and tested filters, model AF-100, complete with enclosure are also available for $60.00. Order from Holladay Communications, 2140 Jeanie Lane, Gilroy, California 95020.

references

1. R. Turrin, W2IMU, "Simple Super Selectivity," *QST*, January, 1967, page 48.
2. P. Laakmann, WB6ION, "Signal Detection and Communication in the Presence of White Noise," *ham radio*, February, 1969, page 16.

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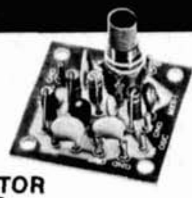

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More Details? CHECK—OFF Page 126

frequency selective and sensitivity controlled sstv preamplifier

Discussion of a specially designed op-amp circuit for reception of sstv pictures under adverse operating conditions

Dr. Werner Berthold, DK1BF, 6711 Dirmstein/Pfalz, Bleichstrasse 2A

Generally the input circuit of a sstv receiver uses a limiting amplifier so the frequency-modulated sstv signal is independent of amplitude variations. If this amplifier is not frequency selective and not sensitivity controlled, all signals within the range of the sstv signal frequency with amplitudes high enough to be limited will pass through the circuit and influence the picture.

Some sstv receivers use a filter in the input stage, but its efficiency depends on the signal strength, and undesired weaker signals, including unwanted sstv signals at the same frequency, will not be suppressed. A frequency-selective and sensitivity-controlled limiting amplifier avoids these disadvantages. It can be used as a preamplifier with any sstv receiver and permits the reception of sstv pictures under extremely adverse conditions.

In the block diagram of the system shown in **fig. 1**, the linearly amplified input signal passes through a high-pass filter and appears as a square-wave signal at the output of the comparator *only* if its amplitude exceeds that of the reference voltage, which is proportional to the peak voltage of the 1200-Hz synchronizing signal.

With this circuit the cutoff frequency of the high-pass filter is independent of the input amplitude. Furthermore, the sensitivity of the comparator is adapted to the amplitude of the sstv signal. Weaker signals, including sstv signals which are weaker than the desired signal, are totally suppressed.

Fig. 2 shows the circuit in detail. The back-to-back diodes (CR1 and CR2) at the input protect the linear amplifier, U1, from excessive drive. The high-pass filter (U2 and U3) is an active Tschebyscheff filter of the order $n = 4$ with a cutoff frequency of about 1000 Hz (-60 dB/decade).

The frequency of the selective amplifier, U4, can be tuned to 1200 Hz by means of potentiometer R1. The peak voltage detector (U5 and U6) has a charging time constant of about 1 millisecond; the discharging time constant was chosen to be about 1 second.

The comparator, U7, is clamped by two back-to-back diodes to limit the output amplitude to 0.7 volt. In most cases this amplitude is still too high and

*A printed-circuit board and parts kit are available from the author.

must be further reduced, typically to 100 millivolts or so. The output can be adjusted to the required level with potentiometer R4.*

To adjust the system first short the input of U1 and set the output of U6 to zero voltage with potentiometer R2. Feed an sstv signal into the input and adjust R1 for maximum reference voltage. Now reduce the reference voltage with R3 as much as is required to synchronize the picture. Otherwise the reference voltage is too high and the synchronizing frequency cannot pass through the comparator. Complete specifications for this circuit are given in **table 1.**

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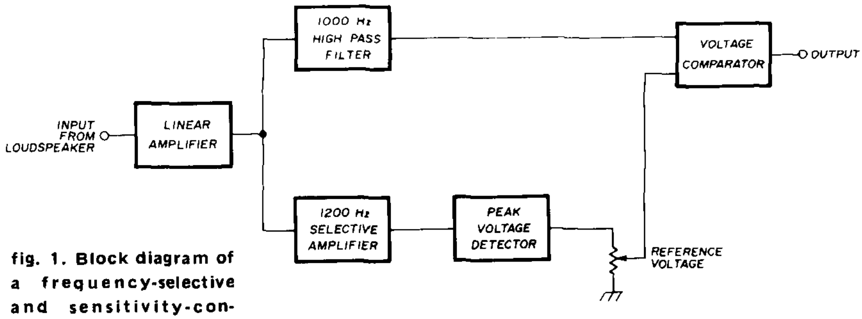


fig. 1. Block diagram of a frequency-selective and sensitivity-controlled sstv preamplifier which permits reception of sstv signals under adverse conditions.

table 1. *Operating specifications for the frequency-selective and sensitivity-controlled sstv preamplifier.*

Input sensitivity	1 mV rms
Regulating range	1 mV to 500 mV rms
Frequency range	1000 to 2800 Hz
Power requirements	±15 volts, 16 mA

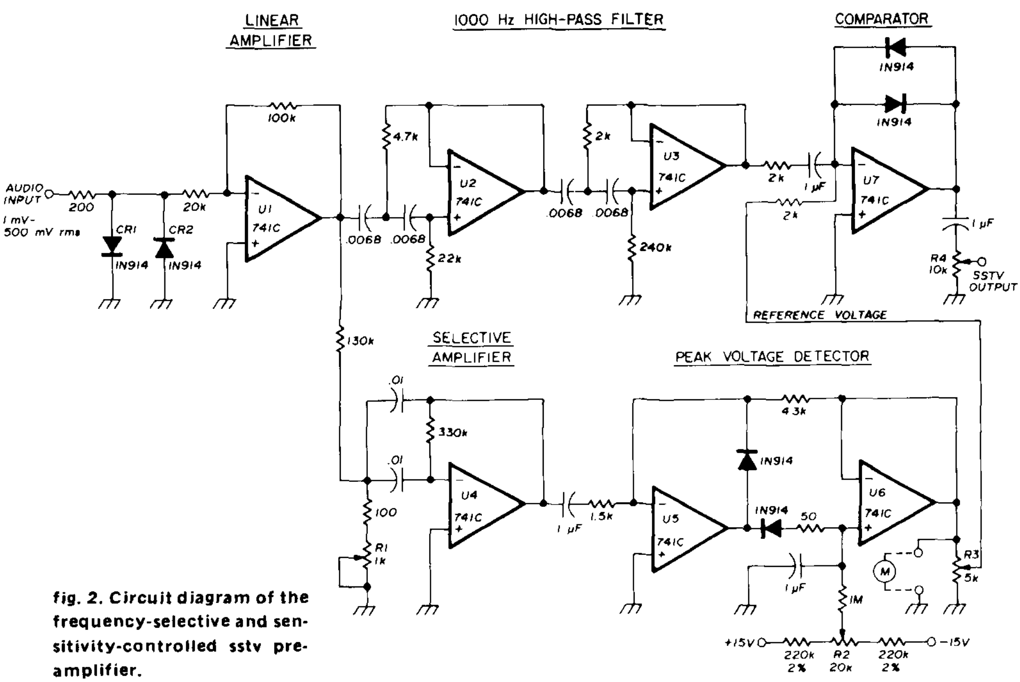


fig. 2. Circuit diagram of the frequency-selective and sensitivity-controlled sstv preamplifier.

the crystal mixer:

recipe for curing receiver drift

A novel method for taming receiver local oscillators, featuring a VXO and a divide-by-*n* network

Bill King, W2LTJ, 5 Midwood Drive, Florham Park, New Jersey 07932

RTTY operation made me aware of the need for frequency stability in my receiver. When copying nets receiver drift, although small, became a big problem. For example, autostart nets demand receiver stability on the order of several Hz. I tried the usual remedies to improve receiver frequency stability: voltage regulation, ventilation, and reduced heat sources but more stability was needed. Crystal control was the obvious answer.

the rock-mixer

My approach to the problem was simple and inexpensive. The device described here, which I call the rock-mixer, uses only a handfull of ICs and very few crystals. In fact, one odd-ball crystal and the rock-mixer will allow you to tune the entire 20-meter band with crystal control all the way. The rock-mixer is easy to adapt to almost any receiver — no phase-locked loops, no filters, and no other synthesizer-type complications.

The rock-mixer creates two frequencies and combines them to produce a pulse train with which your receiver local oscillator can synchronize. Your job is to determine what combination of frequencies to use, given the modest selection of crystals you might have on hand. You don't even need crystals in table 1. N values and lock-on frequencies produced when the receiver local-oscillator frequency is above the crystal frequency. F_x = 15000 kHz, $F_{i\text{-}f}$ = 1650 kHz.

n	divide-by-n output, F_x/n (kHz)	LO frequency $[F_x + (F_x/n)]$ (kHz)	received frequency $[F_x + (F_x/n)] - F_{i\text{-}f}$ (kHz)
19	789.474	15789.474	14139.474
20	750.000	15750.000	14100.000
21	714.286	15714.286	14064.286
22	681.818	15681.818	14031.818
23	652.174	15652.174	14002.174

F_x = crystal frequency 15000 kHz
$F_{i\text{-}f}$ = intermediate frequency = 1650 kHz

the amateur bands; surplus crystals work fine and are inexpensive.

Fig. 1 is a version of the rock-mixer which includes a variable frequency crystal oscillator, a divide-by-*n* circuit (VXO), a mixer NAND to combine the fundamental and divided frequencies, and a coupling capacitor to your receiver local oscillator (LO). The coupling capacitor can be a gimmick (wire twisted around the grid lead to the LO tube).

operation

The VXO provides a stable frequency, which is tunable over a modest range. The output of the divide-by-*n* is added to or subtracted from the VXO frequency to produce a pulse train from the mixer NAND to which the receiver LO can lock. Example: suppose you wish to tune in a station at 14062 kHz and the crystal you choose is 15000 kHz. To tune 14062 kHz with an i-f of 1650 kHz requires 15712 kHz at the receiver local oscillator, which is a frequency difference of 712 kHz. To get a ballpark value for *n*, divide 15000 by 712, which equals 21.067. Note, however, that only whole numbers can be used in the divide-by-*n* circuit, which must provide a pulse train with a frequency that the receiver local oscillator can lock onto to produce the frequency to be received (14062 kHz).

Table 1 shows what can be expected for *n* between 19 and 23, for example, in the 20-meter band when the local oscillator frequency is above that of the VXO crystal. Note that the integer 21 yields a received frequency of 14064 kHz. But since we wish to receive 14062 kHz, we must find a frequency to which the 15000-kHz crystal can be VXOed to produce 14062 kHz.

When the local oscillator frequency is above the crystal frequency,

$$F_{\Delta x} = \frac{(F_d + F_{i\text{-}f})\, n}{n + 1} \qquad (1)$$

where

$F_{\Delta x}$ = crystal frequency changed by the VXO

F_d = desired frequency (14062 kHz)

$F_{i\text{-}f}$ = intermediate frequency (1650 kHz)

n = number to which the divide-by-*n* circuit is set (21 in the example)

If the local oscillator frequency is below the crystal frequency, simply replace $n + 1$ in the denominator of **eq. 1** with $n - 1$.

Using the example above, in which the local oscillator frequency is above

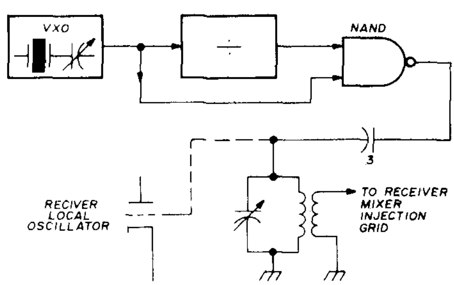


fig. 1. Rock-mixer block diagram. Circuit features surplus crystals and readily available ICs. The value is determined by formula to produce a synchronizing pulse train for the receiver LO.

the crystal frequency, then the frequency to which the crystal must be VXOed to receive 14062 kHz is 14997.818 kHz. By VXOing the 15000-kHz crystal to 14997.818 kHz and setting the divide-by-*n* circuit to 21, a pulse train of 15712 kHz will be

table 2. Receiver frequency ranges for the 20-meter band as a function of n, using a 15-MHz crystal.

n n	frequency tuned by each n (kHz)
21	14001 to 14077
20	14037 to 14113
19	14076 to 14152
18	14120 to 14196
17	14169 to 14245
16	14224 to 14300
15	14286 to 14363
14	14357 to 14434

produced from the mixer NAND to which the receiver local oscillator can lock onto to bring in the station at 14062 kHz.

You'll note that other frequencies will appear in the mixture feeding the local oscillator, but the predominant frequency is the crystal frequency plus the divide-by-*n* output (see **table 1**).

Now let's review what we did. The 15-MHz crystal frequency has been changed by the VXO to 14997.818 kHz. Since *n* is 21, the divide-by-n output is 714.182 kHz; therefore, the sum and difference frequencies are 15712.000 and 14283.637 kHz, respectively.

To attain lock is a simple matter. Tune the dial to a point near the expected place. As you approach it the receiver will lock from as far away as 50 kHz under the right conditions. When a lock has been attained you can tune the receiver knob a modest amount on either side and not lose the desired station. When you exceed the lock-in range you will hear squishing noises as well as other stations, but you won't lose the desired station. If you desire to fine-tune the station, then tweak the VXO knob and the receiver will follow.

When the lock-in condition exists, the receiver tuning will be under complete control of the VXO: thus the VXO knob is now the receive tune knob. The tuning range will be limited to the extent that you can "rubber" the crystal. For a 15-MHz crystal my VXO covers 14940 to 15012 kHz. **Table 2** shows the corresponding ranges that can be covered on 20 meters with the 15-MHz crystal in the VXO and with the divide-by-*n* circuit set as shown. (Remember the i-f was 1650 kHz.)

table 3. Selected frequencies for RTTY using the SX-100 receiver (1650-kHz i-f).

frequency (kHz)	station	speed/shift (wpm/Hz)	n	crystal frequency (MHz)
3600	Autostart net	60/850	22	5.02
3623	W1AW ARRL Headquarters	60/170-850	20	5.02
3223	WBR70 Miami WX	60/850	12	9.00
8105	WBR70 Miami WX	60/850	12	9.00
8105	WBR70 Miami WX	60/850	14	9.10
8105	WBR70 Miami WX	60/850	40	10.00
12175	WBR70 Miami WX	60/850	13	15.00
12175	WBR70 Miami WX	60/850	140	13.92
8183	UPI News in English	66/550	11 or 22	9.01
19537	AP News in English (NYC)	66/400	6 or 12	9.08
5460	Voice of America (USIS)	60/400	64	7.00
5460	Voice of America	60/400	9	8.00
10972	Voice of America	60/400	12	11.65

Table 2 shows that the entire 20-meter band can be received, crystal controlled, using only one crystal. In my case a 15-MHz rock was used, but note that almost any crystal near 15 MHz will work. For example, a 15239 kHz crystal or another oddball like 14875 kHz would work just as well; the only change would be the *n* value required.

You don't need to make a fundamental pulse train, because harmonics and subharmonics are almost as good. In the examples with two *n* values the oscillator is made to lock onto frequencies twice removed from the usual frequencies. Consider a 10-MHz VXO and an *n* value of 10. The receiver oscillator can just as easily lock onto 9.0, 10.0,

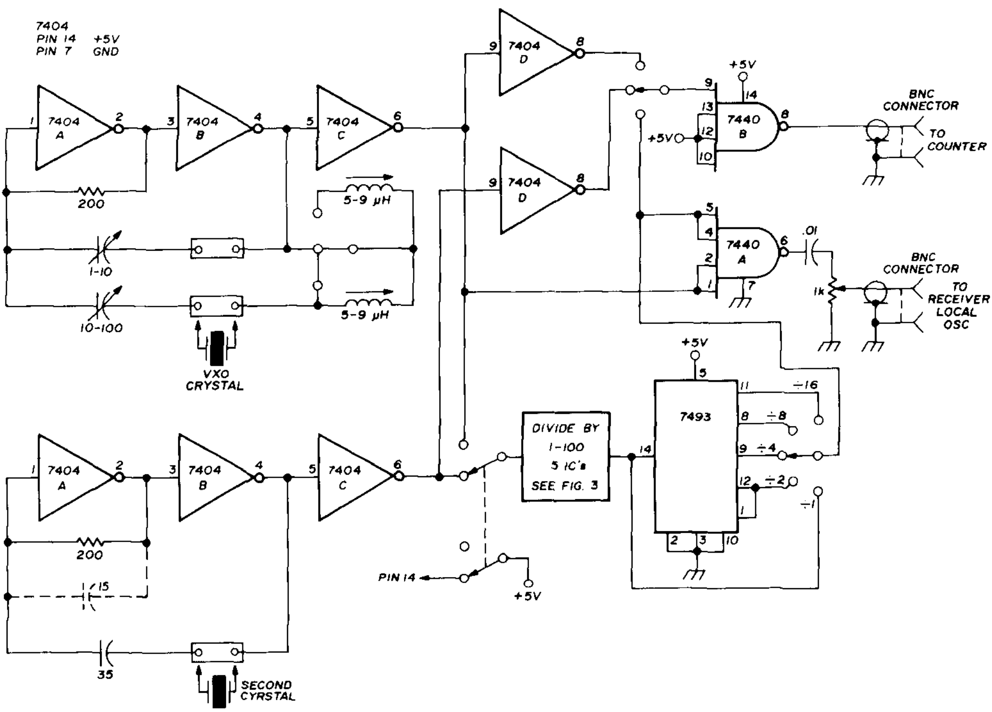


fig. 2. Circuit for one or two crystals. A pair of 7404s form the VXO and the second crystal oscillator. A 7440 drives a counter and provides mixing for the divide-by-n circuit.

Table 3 shows several frequencies I use for RTTY. These are real examples, so included in the list are the *n* values and the nominal crystal frequency to tune in the particular station. Some examples in **table 3** are straightforward and some are a little tricky. The one at 3223 kHz is a case in point. The 9-MHz crystal and the divide-by-12 circuit produce 9746 kHz to which the receiver LO at 4873 kHz can easily lock (i-f is 1650 kHz).

and 11.0 MHz. Now make *n* = 20 and lock-on to the same frequencies occurs as well as to many others, such as 9.5, 10.5, 11.5 MHz, etc. There are other reasons to use the doubled *n* value, which are treated later.

two-crystal rock-mixer

There may come a point when you give up trying to find a good combination of *n* with a crystal you have available. Enter the two-crystal rock-mixer.

In this arrangement you have one crystal in the VXO and a different crystal feeding the divide-by-*n* circuit; thus, you have greatly expanded the rock-mixer capability.

Fig. 2 shows the rock-mixer circuit in which one or two crystals can be used. Two 7404 hex inverters form the VXO[1] and the second crystal oscillator. Two

Table 4 shows the application of the 7493 for this purpose.

Fig. 3 depicts the shift registers and the logic to divide by any number from 1 to 100. This circuit was found in the Fairchild *TTL Applications Handbook*.[2] The only changes I made were to substitute some equivalent ICs instead of those in the reference.

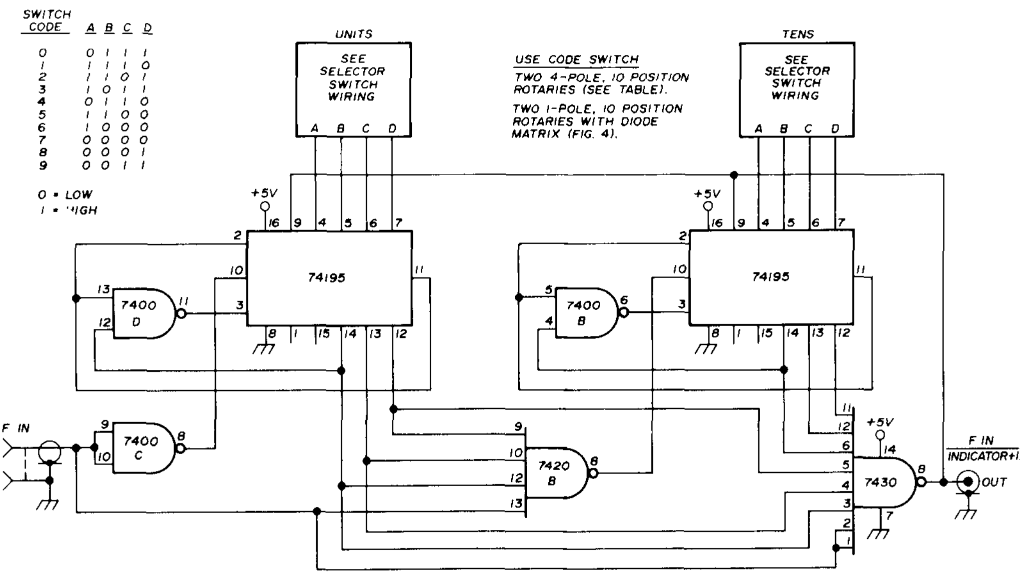


fig. 3. Logic for dividing by any number between 1 and 100. Circuit divides by one more than shown by selector switch (fig. 4), thus dials should be set at 00 to divide by 1; 09 to divide by 10; 29 to divide by 30; etc.

variable capacitors are shown with two crystal sockets. It is important to keep circuit stray capacitance at a minimum when varying the crystal frequency in the high direction. Note that no switch is used for changing crystals, because it's not possible to keep stray capacitance to a low enough value with any type of switch.

The divide-by-*n* circuit consists of two parts: a set of two 74195 shift registers (**fig. 3**) and a 4-bit binary IC (7493) connected to divide by 1, 2, 4, 8, 16. The 7493 is a "division range increaser," but more important is its function as a "duty-cycle improver."

Briefly, the operation of the circuit is as follows. At the end of a divide sequence the registers are loaded with the data from the selector switches connected to wires a, b, c, and d. The registers then clock away until all outputs connected to the 7430 NAND are high, thereby producing an output pulse that loads the data, and the process repeats. The data can be selected by two 4-pole, 10-position selectors wired according to the switch code. A less expensive alternative using diode logic and two 10-position selectors of one pole each is shown in **fig. 4**. The switch code calls for either a 1 or a zero. The zero means to ground the point, and the 1 means to leave it open. The system counts one more than the data loaded, so if you want to divide by 23 you must set the switches for 22.

The rest of the circuit of **fig. 2** is self explanatory. A part of the 7440 NAND is used to drive a counter. The other part of the 7440 is the mixer, whose output connects to a level-adjusting pot, then to the BNC connector, which leads to the receiver local oscillator. The power for the unit is +5 volts at 225 mA maximum when no crystals are in place. At 15 MHz only 170 mA is required. I used an old 6.3-Vac filament transformer, a diode bridge rectifier, a 1000 μF electrolytic, and a three-terminal, 5-volt regulator. This circuit provides adequate power to the regulator; and at the maximum condition of 225 mA, the supply provides 8.3 volts at the regulator input.

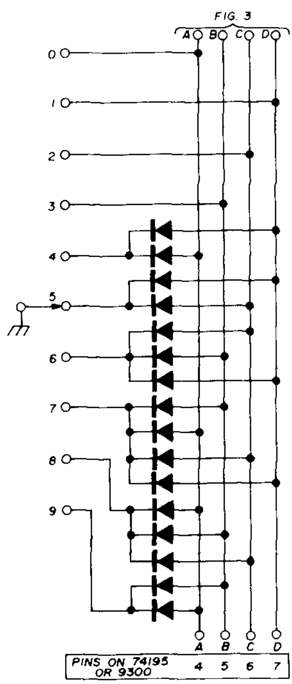
crystal sources

Crystals for the rock-mixer are inexpensive and easy to obtain from a variety of sources. At the Dayton Hamvention, for example, crystals perfect for rock mixing were selling for 15 cents each. The reason the crystals are so inexpensive is because their frequencies are not good for much — except rock-mixing, and you're reading the first account of this now.

Many crystal manufacturers list their surplus crystals at bargain prices, so scan the flyers and you can find lots of "funny-frequency" crystals. Two prime sources I use are the citizens band and surplus fm mobile crystals; for example, some crystals marked for 153 MHz turned out to be 6.38 MHz fundamental mode, and others were 11.6 MHz. In a big bag full of surplus crystals purchased at Dayton were lots of usable ones from 5 to 16 MHz.

connections

Hooking up the rock-mixer to the receiver LO is another of those dealer's choice affairs, because very few amateurs have the same receiver setup. The simplest method, requiring neither holes nor solder, is to run the rock-mixer output coax into the receiver and clip the shield to ground and twist a few inches of the center lead around the wire from the tuning capacitor to the local oscillator coil or tube grid. This



SWITCH CODE	A	B	C	D
0	0	1	1	1
1	1	1	1	0
2	1	1	0	1
3	1	0	1	1
4	0	1	1	0
5	1	1	0	0
6	1	0	0	0
7	0	0	0	0
8	0	0	0	1
9	0	0	1	1

0 = LOW
1 = HIGH

fig. 4. Alternative selector switch and diode matrix circuit.

connection or *gimmick*, injects a weak but significant amount of signal into the oscillator except when the capacitor is nearly meshed.

A better approach is to locate a point in the LO where a ground can be lifted and a 47-ohm resistor inserted. There are many likely spots, such as plate or collector bypass-to-ground capacitors, or emitter or cathode grounds. In the SX-100, for example, the LO has a grounded cathode, tuned-grid, plate-tickler circuit, so in my case a 47-ohm resistor is now between cathode and ground, and the coax is connected directly to the resistor, terminating in a BNC connector on the front panel. This type of low-impedance injection produces excellent lock-in characteristics over the entire receiver range of 0.5 to 30+ MHz as well as no interference with the normal operation of the receiver. Such a connection is also convenient to bring out a small amount of rf from the oscillator to operate a counter.

concluding remarks

The rock-mixer is a simple device for crystal control of almost any receiver. It's easy to set up and use if you have a counter and a calculator. Its ease of operation will depend on the care used in calibrating both the receiver and VXO. Once learned and recorded, the scheme to lock onto a particular band of frequencies, or even a single point, is quite simple and rapid with or without the calculator-counter combination.

Tuning the band under crystal control is simple if you set up a segment schedule similar to the one shown in **table 2**. However, there's a hitch to this unless you calibrate the VXO to suit the situation, because the receiver dial means almost nothing except to show what band you're on. I solved this problem by building a homebrew counter using decades that can be preset instead of the usual type, which reset only to zero. The counter is switched to read all pertinent frequencies in the rock-mixer and the receiver.

When reading frequency per se, the reset pulse from the logic ties to the normal "reset-to-zero" bus line of all the decades. When connected to the receiver LO, the reset pulse is switched to the strobe data inputs, and the complement of the receiver i-f is thereby loaded into the counter decades. For an i-f of 1650 kHz the complement is 9835.00. Therefore, after 16500 input counts the counters read 0000.00 and the ensuing input counts above this point until the end of the gate period. The net effect is to subtract the i-f from the LO frequency and to present the received-station frequency in the display.

The action is similar to that of the divide-by-*n* counter, and the data can be either hard wired with short jumpers to ground the appropriate data points; or some can be fixed and some variable, using diode logic or switches made to provide the BCD information. The addition of the data input system in no way affects the normal usefulness of the counter, because the reset input and the data strobe inputs are independent.

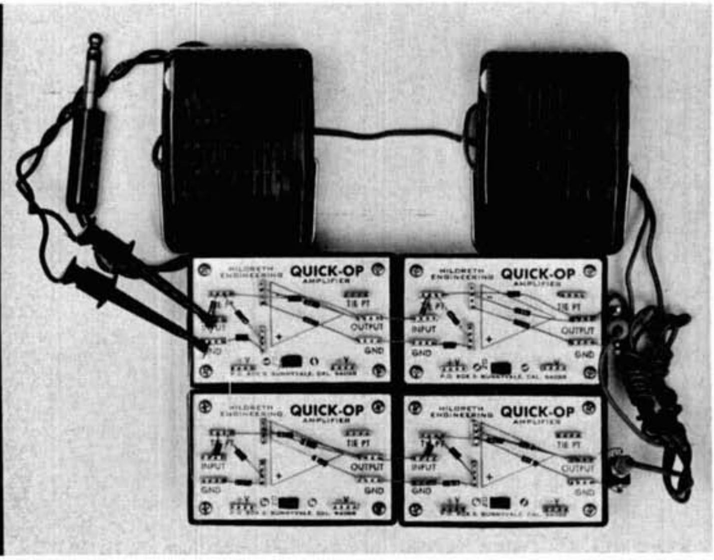
table 4. Receiver lock-in range as a function of division sequence.

received frequency (kHz)	vxo frequency (kHz)	divisor settings shift registers	divisor settings 7493	receiver lock-in range (kHz)
3223	8996	6	2	29.4
3223	8996	6	4	12.2
3223	8996	12	1	5.3
3223	8996	6	1	3.1
3600	5022	11	2	54.1
3600	5022	22	1	4.9
3600	5022	22	2	4.7
8183	9014	11	1	16.0
8183	9014	11	2	12.8
8183	9014	22	2	8.9
8183	9014	22	1	7.9
12175	14977	13	1	38.8
12175	14977	13	2	19.0
12175	14977	13	4	10.0
14030	14998	1	2	59.4
14030	14998	22	1	9.1
14030	14998	22	2	4.1
One case requiring no division:				
8183	9833	1	1	126.0
8183	9833	1	2	88.7
8183	9833	1	4	83.3

references

1. William King, W2LTJ, "Hex Inverter VXO," *ham radio*, April, 1975, page 50.
2. "Multistage Program Divider," *TTL Applications Handbook*, Fairchild Semiconductors, Mountain View, California 94042, August, 1973, pages 9-38.

ham radio



synthesizer for binaural CW reception

Don E. Hildreth, W6NRW, P.O. Box 3, Sunnyvale, California

If you tune your receiver across a CW signal with the bfo centered on a broad i-f passband, the beat note will change from high to low. As you continue tuning, the CW note will progress through zero beat from low to high again.

If, however, instead of using the usual single-channel audio system you provide two channels with the frequency response shown in **fig. 1**, feeding stereo phones or two speakers, an interesting and pleasing result is obtained. Tuning as described, but with the two-channel audio system described here, a signal will move from left (lower frequency) to center, then to the right (higher frequency) followed by the reverse action, spatially as the tone changes. If you switch to a narrower i-f bandwidth and adjust the bfo frequency to equal the crossover point of **fig. 1** away from i-f center, you'll obtain the right-center-left signal movement without the mirror image, and the spatial center of the signal will be at the crossover design frequency.

Thus a new dimension is added to CW signals. Can you imagine how it would be when conversing with several people at once if all the voices came from the same location? We have two ears – let's use them.

With the system described, when interference occurs a few hundred Hz or so removed from the frequency of interest, you tune the signal you want to center, leaving the others to the right, or to the left.

components

Op amp active filter designs make this task easy and predictable. As building blocks I used a class of op amp filters shown in **fig. 2**.* I chose good grade 0.01 μF ceramic capacitors, then selected resistance values from the standard 5 per cent, ¼-watt range to set low- and high-pass filter rolloff fre-

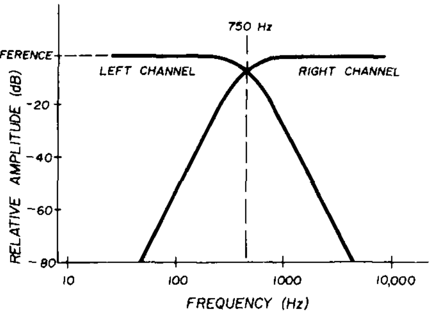


fig. 1. Relative channel frequency responses for right and left binaural CW, voice, or music reception.

quencies. You can use 10 per cent resistors with good results; except that when you try to place the crossover frequency in the center of a narrowband audio filter, or in a very narrowband i-f filter, careful resistance-value pruning enters the picture. I know of no integrated circuit op amp that doesn't loaf in this task — the well-known 741 a good choice.

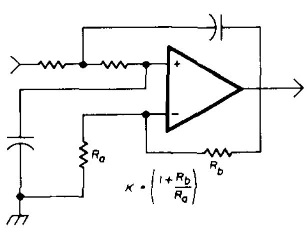
design requirements

How sharp must the frequency rolloff be to get a good stereo effect? I found that two stages each of low- and high-pass filtering provide good separation (four poles, or a rolloff of 24 dB per octave). *More stages and more critical* adjustment would be necessary if this system were fed from a source with bandwidth of less than 200 Hz or so. It can be done, but receiver tuning would become difficult and narrowband noise would begin to sound too much like the desired signal. A binaural system reduces the need for those very sharp filters.

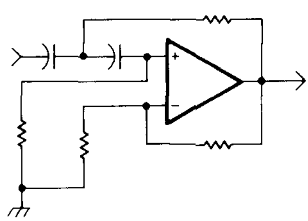
The complete circuit is shown in **fig. 3**. You'll note that the gain setting resistors are of different values for the low- and high-pass channels. Their ratio is the same, but values were selected to obtain parallel resistances in each case that are approximately equal to the op amp's positive input port dc resistance to ground. This condition is desirable to encourage a minimum dc offset at the op amp's output.

exalted operation

If you want to accept some added complexity it's possible to obtain the kind of response shown in **fig. 4**. In this case the gain ratio resistors (those connected to the op amp negative input port) are changed to produce filter peaking. In this way a combination of audio filtering and binaural operation is obtained. The resistance ratio required to provide up to 20 dB of exalted operation is shown (10 dB per stage). It's possible to provide more exaltation effect but adjusting resistance values becomes increasingly critical; at some point you'll have an oscillator.



A LOW-PASS, 2-POLE FILTER



B HIGH-PASS, 2-POLE FILTER

fig. 2. Basic op amp circuits for 3 dB low- and high-pass filters. Center frequency, f_o = $1/2\pi RC$, where network R and C are equal.

*The op amps used in the binaural synthesizer shown in the facing page are available from Hildreth Engineering, Box 3, Sunnyvale, California 94088. Price is $14.95 each, postpaid. These units use two nine-volt transistor batteries.

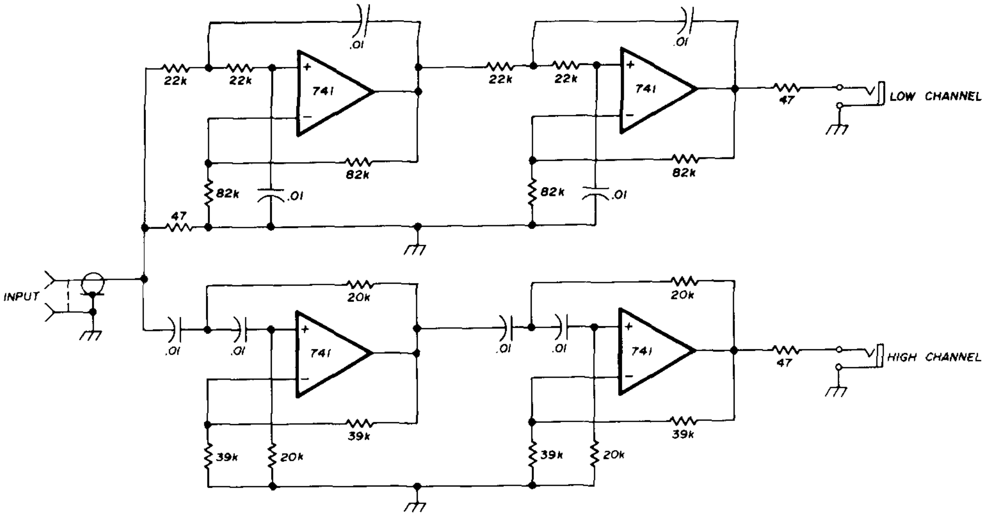


fig. 3. Schematic of the binaural synthesizer. For 750-Hz crossover, R = 21k; low channel is offset 5% high and high channel is offset 5% low to compensate for underlap due to four-pole cascade in each channel and overlap caused by approximately 4 dB of peaking on each side of the crossover point.

The unit shown is designed to work from a low-impedance drive, such as a receiver's speaker output. The 47-ohm resistor at the input is for those who wish to use the design with a solid-state receiver that couples to a speaker through a large capacitor. Op amp input ports must have a dc return path to ground, and this input circuit ensures it. If you want to drive the system from a high-impedance phone circuit, simply connect the receiver to the input through about 2.2k ohms and increase the value of the 47-ohm input resistor to 470 ohms.

The 47-ohm resistors shown in series with the outputs are used to avoid oscillation in the event that 8-ohm headsets or speakers are connected directly to the output. Also, small dc offsets will not produce immediate limiting on the positive or negative audio half cycle if a low-resistance dc path to ground is connected to the outputs. An op amp's output current capability will drive 2k-ohm phones to all the volume you'll need; unfortunately I haven't found any 2k-ohm stereo phones. Moderate levels are possible with 8-ohm loads.

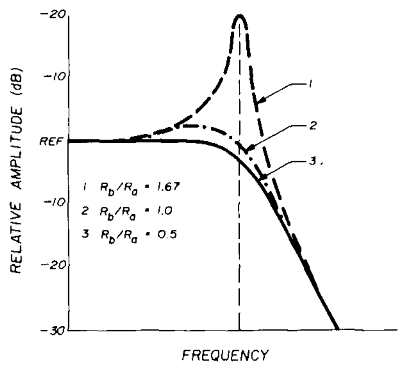


fig. 4. Typical lowpass response shape with peaking adjusted by gain selection of R_b/R_a.

conclusions

This binaural synthesizer provides more advantage as interference increases. When the band becomes crowded you may wonder how you have been able to get along without such a device.

ham radio

multiple band master frequency oscillator

Construction details for a varactor-tuned master frequency oscillator featuring multiple frequency capability

M. A. Chapman, K6SDX, 428 3rd Street, Encinitas, California 92024

The frequency control system for any receiver or transceiver being considered for construction is obviously of prime consideration. The voltage-variable diode (varactor) offers significant flexibility in the design and construction of a variable-frequency oscillator. Parallel-plate capacitors suffer from the effects of mechanical rigidity, temperature, humidity, and just plain volume limitations. The varactor is an order of magnitude smaller in size, and is less sensitive to thermal and mechanical stress. For frequency tuning applications, the varactor is considerably simpler to tune and align than its conventional mechanical equivalent.

When a voltage source is used to reverse bias a P-N diode junction, the width of the diode's depletion region varies in proportion to the applied voltage, with the width of the depletion layer increasing with increased bias. This results in an effective capacitance which acts as if it were in parallel with the diode. The amount of capacitance per unit voltage is a function of the variation of the impurity concentration in the depletion region of the diode's P-N junction. If a diode is coupled to a tank coil and the bias across it is varied, the tank circuit resonance will change in proportion to the change in diode capacitance.

circuit design

Fig. 1 shows a precision variable frequency oscillator suitable for general purpose receiver and transmitter frequency control. All rf generating and control components are completely contained within a standard aluminum chassis box.* Since the oscillation frequency is dependent upon the LC ratio and the tuning capacitance is controlled by a voltage rather than the position of parallel plates, a potentiometer is used to vary the diode bias between two voltage points corresponding to the desired upper and lower capacitance.

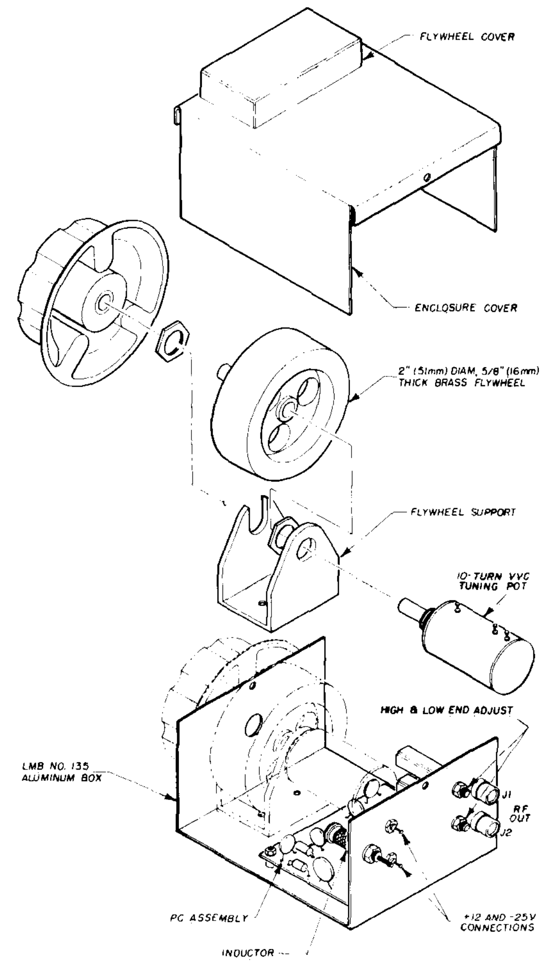


fig. 1. Construction of the varactor tuned master frequency oscillator. Brass flywheel provides very smooth tuning from one end of a band to the other.

If an ordinary single-turn pot is used as the control element, resolution would be very poor, with bandspread similar to a single-turn parallel plate capacitor. To provide additional bandspread in a conventional vfo the frequency-determining capacitor is often mechanically driven by a system of gears so that a single turn of the tuning knob represents a small incremental change in frequency. If a varactor is used as the control element, a small change in voltage will cause a corresponding change in the oscillation frequency.

Although the voltage-control potentiometer for the varactor could be used with a mechanical reduction scheme, most single-turn pots have very poor resolution; at some small discrete points along the wiper surface discontinuities occur which could reflect in an undesirable voltage being applied to the varactor. In addition, many low cost, single-turn pots are often noisy. The noise can be caused by a faulty internal termination, foreign particles or oxidation of the resistance element. The noise then appears as a random voltage, which can cause erratic varactor operation.

If you want to use a single-turn pot in a varactor-tuned vfo, an expensive servo type unit is recommended. The most practical alternative is to use a ten-turn unit, and a wide selection is available at modest cost. With a ten-turn pot to control varactor bias, a full ten rotations of the knob are available for tuning or frequency selection.

All potentiometers have considerable friction associated with the moving element. As shown in **fig. 1**, a simple

*Full-size detail drawings of the chassis are available from the author by sending him a self-addressed, stamped envelope. Etched, single sided, 1/16" printed-circuit boards without holes are also available for $2.00 each, including postage. Write to M. A. Chapman, K6SDX, 428 3rd Street, Encinitas, California 92024.

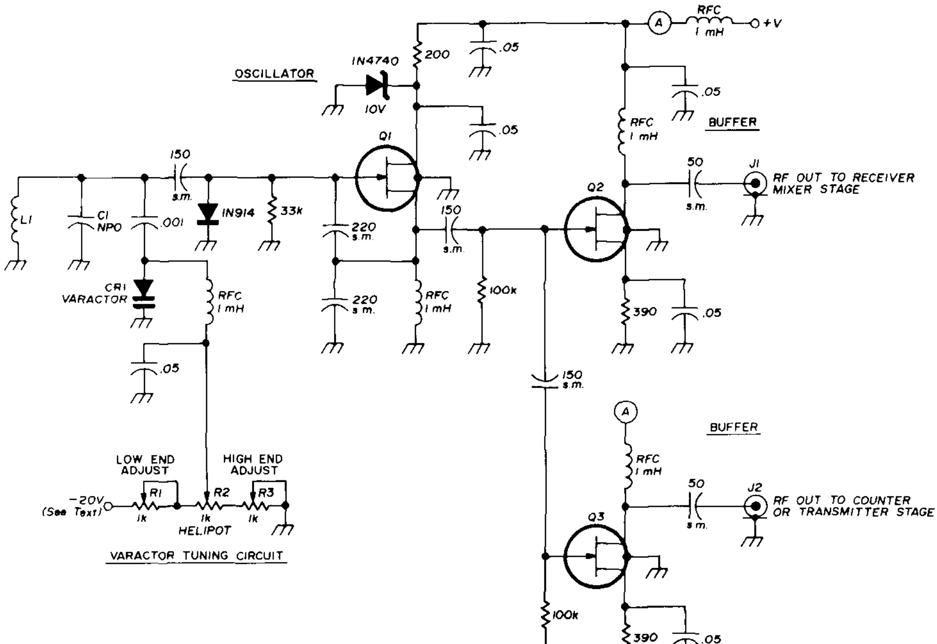


fig. 2. Circuit for the varactor-tuned master frequency oscillator. Varactor CR1 is a Motorola MV1652 or equivalent. Typical tuned circuit values for three popular vfo ranges are listed in table 1. Transistor selection is discussed in the text. R2 is a Beckman model 7426 R1K Helipot; R1 and R3 are Beckman Helitrims, model 78LR1K or equivalent.

flywheel design will provide an exceptionally smooth tuning "feel" for the operator. The suggested 2-inch (50mm) diameter brass flywheel provides enough inertia that a single knob spin will traverse all ten turns of the pot for rapid end to end band tuning.

A circuit for a varactor-tuned master frequency oscillator is shown in **fig. 2** The frequency determining network consists of the inductor, L1, the NPO capacitor C1, and the varactor, A Motorola MV1652.* The 0.001 μF ceramic capacitor provides dc blocking of the varactor control voltage. A 0.005 μF ceramic or similar value will perform as well.

The NPO capacitor, C1, can be small as compared to the total change in varactor capacitance for the desired frequency range, and provides some compensation due to thermal effects in the system. Only slight loss in thermal stability would be apparent if a 10 to 30 pF dipped mica capacitor were used.

The frequency range is adjusted by the resistance network consisting of R1, R2 and R3. Maximum varactor capacitance occurs when the anode is at ground potential; minimum capacitance occurs when the anode is reverse biased at −20 Vdc. Potentiometers R1 and R3 act as voltage dividers for the main tuning pot, R2.

Current through the varactor is negligible, and scaling of the values shown for R1, R2 and R3 is possible. Transistor Q1 is the basic oscillating element

*The Motorola MV1652 is a silicon epicap tuning diode designed for general tuning, trimming and afc applications. Capacitance at −4 volts bias is nominally 120 pF (108 pF minimum, 135 pF maximum). Capacitance ratio from −2 to −20 volts reverse bias is 2.6. The Motorola HEP R2505 closely meets these specifications. **Editor**

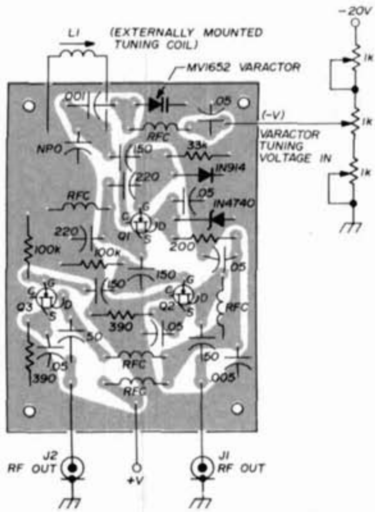


fig. 3. Component placement for the printed-circuit board used for the varactor tuned vfo. Full-sized PC board is shown in fig. 4.

with Q2 and Q3 buffering the output signal to minimize the effects of external loading. The output of Q1 is coupled to both Q2 and Q3 simultaneously so that the buffer stage can drive external circuitry in a receiver or transmitter. The separate buffer stages permit the use of a high level signal from one section in a receiver mixer stage where the conversion gain is dependent upon having an input of 2 volts peak to peak or greater.

The signal from the other buffer stage can be conditioned through filters for transmitter applications requiring lower harmonic content. This is because the normal low-impedance filter will reduce the vfo signal far too much for most receiver mixer applications. The growing popularity of digital frequency displays is also good justification for the separate buffer as it isolates the counter clock from the other receiver circuits.

construction

With the exception of the varactor voltage divider and the inductor, all components are mounted on a printed-circuit board. **Fig. 3** shows component placement on the board. All resistors are 1/4-watt units, although 1/2-watt parts may be used by mounting them vertically. Low-value coupling capacitors are of the dipped-mica type; however, glass or silver-mica units are satisfactory. The 0.05 μF ceramic bypass capacitors are low-voltage (20 volt) types; 50 or 100 volt capacitors are approximately the same size and should fit the board equally well. The rf chokes are miniature low-current types.

The selection of Q1, Q2 and Q3 is not difficult. The 2N4416 is the first choice and matches the board layout with case grounding provisions included to minimize random oscillation. The 2N5459 and similar three-terminal epoxy fets work equally well with only slight reduction in output levels. If you have two or three N-type fets in your junk box, give them a try. Even the most general-purpose chopper types I tried seemed to work well.

fig. 4. Full-size printed-circuit layout for the master frequency oscillator. Component placement is shown in fig. 3.

Before installing the PC board into the enclosure, attach the wire leads for the inductor, +12 volts and the varactor tuning voltage. The inductor can be temporarily attached to the ends of the wire and left to dangle free in the air. Connect +12 volts and an adjustable negative voltage (not greater than −20 volts) to the appropriate leads. Initial testing of the board can be accomplished in this fashion to insure that the circuit is working properly.

By varying the negative voltage between zero and -20 V, and adjusting the slug in the inductor, a 3 to 6 MHz signal should be present at the outputs. Although the design shown here incorporates the entire circuit in a compact package, the voltage divider and varactor-tuning potentiometer do not have to be adjacent to the varactor. This is one of the advantages of this circuit.

Table 1 lists the LC components and the setting of the frequency-control pot, R2, for three different frequency ranges. Final adjustment of R1 and R3 should not be accomplished until the assembly is installed in the receiver or transceiver because thermal gradients will affect the operating frequency. When adjusting R1 and R3 remember that there is a perceptible voltage change at both ends of the varactor control pot. Inexpensive ten-turn trim pots are recommended for precise adjustment. However, single-turn, low wattage units are satisfactory, although they may require a little more tweeking for final frequency selection.

To calibrate the vfo first set R2 to the appropriate voltage level shown in **table 1** and adjust the slug in L1 for either the high or low end of the band by monitoring the output frequency with a digital counter or calibrated receiver. The output signal level at both J1 and J2 should be between 2 and 3 volts peak-to-peak, depending upon the device used at Q1.

table 1. Tuned-circuit values for three popular vfo tuning ranges. The negative voltage levels shown for potentiometer R2 are for initial setting only; final adjustment must be made in the enclosure to compensate for thermal effects. Varactor is a Motorola MV1652 or equivalent.

frequency range (MHz)	inductor L1	capacitor C1 (NPO)	R2 voltage range (-volts)
3.045-3.545	8.85-12.0 μH Miller 20A105RBI	10-30 pF	3.5-17.0
3.500-4.000	8.85-12.0 μH Miller 20A105RBI	10-30 pF	3.3-12.5
5.000-5.500	≈ 8 μH Miller 20A105RBI (slug removed)	15 pF	5.5-14.0

power supply

A well regulated, low ripple -20 volt varactor bias supply is necessary for best results. The reason for this is apparent if you look at the 3.045 to 3.545 MHz oscillator parameters listed in **table 1**. In this case the ends of potentiometer R2 are at -3.5 and -17 volts, a total range of 13.5 volts. If a 13.5 volt change in varactor bias will produce a 500 kHz change in the operating frequency, a simple calculation will indicate how much frequency variation can be expected for each millivolt of ripple on

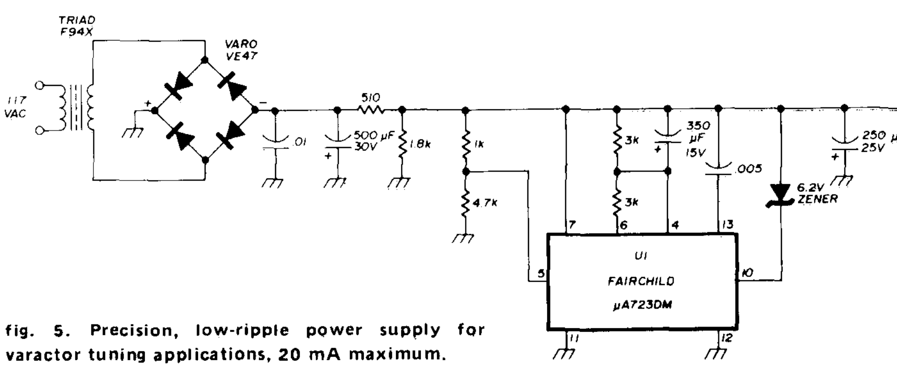


fig. 5. Precision, low-ripple power supply for varactor tuning applications, 20 mA maximum.

the varactor bias supply:

$$\Delta f = \Delta V_B \left(\frac{f_2 - f_1}{V_{B2} - V_{B1}}\right)$$

where Δf is the frequency variation, ΔV_B is the ripple on the bias supply, $(f_2 - f_1)$ is the tuning range, and $(V_{B2} - V_{B1})$ is the change in varactor bias for the tuning range. For the 3.045 to 3.545 MHz vfo

$$\Delta f = 0.001 \left(\frac{500}{13.5}\right) = 37.04 \text{ Hz/mV}$$

Therefore, for each millivolt of ripple on the bias line, there is a corresponding change of about 37 Hz in the oscillation frequency (this would change somewhat at opposite ends of the tuning band). However, the 1 mV ripple across the varactor is related to the ripple on the −20 volt source by the same ratio as the voltage divider. By simple proportion

$$\frac{-20 \text{ volts}}{-13.5 \text{ volts}} = \frac{\Delta V}{1 \text{ mV}} \quad \Delta V \approx 1.5 \text{ mV}$$

For each 1.5 mV of ripple on the −20 volt source you can expect a 37 Hz change in operating frequency. For CW and ssb operation it is desirable to keep the total frequency deviation to less than 150 Hz. This means that the −20 volt bias source should have a ripple content no greater than 6 or 7 mV. This can best be achieved by using precision IC voltage regulators similar to the one shown in **fig. 5**.

parts substitutions

My experience from previous articles indicates that home builders are often faced with parts substitutions, and usually write to the author for advice. A typical case might be the use of a 0.047 μF or other value bypass capacitor as a substitute for 0.05 μF. In this application any value between 0.02 and 0.1 μF should work fine. The 220 and 150 pF units may be replaced with mica capacitors up to approximately 450 pF. The only problem here is board fit, and some capacitors may necessitate some lead bending. The 50 pF mica output capacitors may be replaced with any value from 20 to 500 pF.

ham radio

Yaesu FT101 clarifier

I have just completed the modification to my FT101 as described in *ham radio*[1]. When the modification is completed, depending upon whether the clarifier was turned on or off, the frequency shift may not be a complete zero beat. If the clarifier is turned off when the mod is done, the clarifier will be about 2 kHz high when turned on in the USB mode. If the operator does not care about the calibration of the clarifier, this does not pose a problem, but if he prefers to use the calibration of the clarifier, the following is recommended: Set the clarifier pot to zero before beginning the alignment procedure, and follow the procedure described in *ham radio*. When this is done, and sidebands are changed, the clarifier need not be adjusted to a new zero point and will remain within calibration.

Since I always leave my clarifier turned on, and at the zero position, this is the most comfortable procedure for me. To change sidebands and retune the receiver I just use the clarifier. Otherwise I would have to readjust my thinking when changing sidebands and then turn on the clarifier (as the calibration would not be correct).

Eric Falkof, K1NUN

1. Ernie Schultz, W2MUU, "Yaesu Sideband Switching," *ham radio*, December, 1973, page 56 (short circuit, December, 1974, page 62).

soldering-iron holder

How to build a soldering-iron holder which reduces tip heat when the iron is not in use

E. L. Klein, W2FBW, 137 Ashford Road, Cherry Hill, New Jersey 08003

Perhaps the most important tool used by the electronics experimenter is the soldering iron. It is indispensable when making repairs or building new equipment, and is frequently turned on for hours at a time. This extended time of use takes its toll in corroded tips and burned-out elements.

Radio servicemen learned long ago that they could keep a sharp bright tip on their irons by cutting down the voltage to the iron during those long periods between use. Many old pros would jury-rig a holder on their service bench for this purpose. A bulky heating element was often used in series with the iron when it was at rest in the holder. When the iron was picked up a leaf switch would short out the heating element, allowing full 117 volts to the iron.

In later years commercial holders for soldering irons became available. Some fine thermostatically controlled holders are widely used in the aerospace industry. Printed-circuit boards have called for smaller irons and lower temperatures. Practice has shown that 50 to 70 volts is sufficient to keep the iron ready to go, but low enough to prevent damage to the tip. Variacs have also been widely used to set the iron voltage to the required value.

Described here is a nifty soldering-iron holder that makes use of modern readily available components, and can be assembled in a couple of hours. All parts can be obtained from your hard-

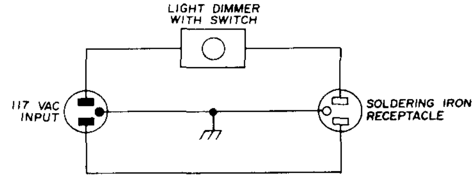


fig. 1. Using a commercial light dimmer to control soldering-iron heat.

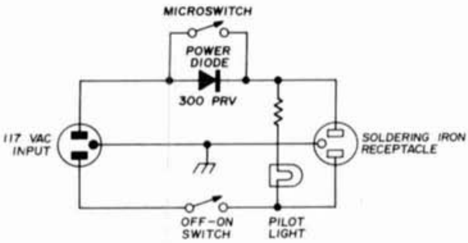


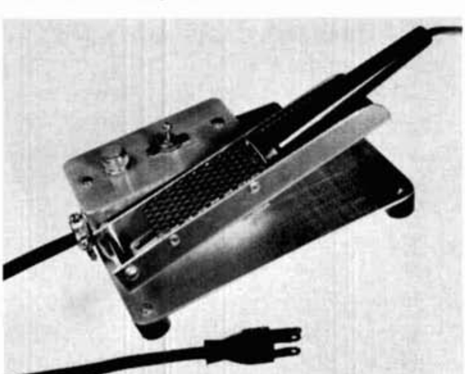
fig. 2. How to use a semiconductor diode to control soldering-iron heat. In this circuit a microswitch shorts out the diode when the soldering iron is lifted for use. When the iron is placed in its holder, the diode is switched into the circuit, reducing the effective power to the iron, by virtue of half-wave rectification.

ware store or radio shop. The sheet metal work is simple and straightforward.

There are two methods for controlling soldering-iron heat. The first simply uses a light dimmer control as shown in **fig. 1**. Find the position of the knob where the desired heat is obtained at the soldering iron's tip. Then remove the knob. Or, place a mark on the box so the knob can be easily reset when desired.

The other method makes use of a series diode to cut the effective power

Soldering-iron holder which uses the circuit of fig. 2 to control tip heat when the soldering-iron is not being used.



to the iron. Any power diode with a PRV rating of at least 300 volts will do. The diode is connected across the normally-closed terminals of a microswitch. When the iron is lifted for use, the internal spring in the microswitch operates, returning the switch to its closed position, shorting out the diode. Full power is then available to the iron (see **fig. 2**). A handy pilot light tells you that power is on and shows the effect of the series diode.

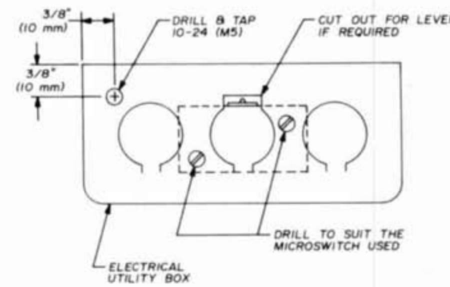


fig. 3. Side view of the utility box which is used to hold the light dimmer (fig. 1) or microswitch/diode circuit (fig. 2). Fig. 4 shows construction details for the soldering-iron holder.

The pilot light shown in **fig. 2** is a surplus 28-volt lamp with a 3k, 2-watt series resistor. A neon pilot light is okay if connected to the input, but only one of its two internal elements will glow on rectified ac. If used with the light dimmer, a neon pilot will extinguish at the lower voltage.

construction

First, start with an electrical utility box. Drill and tap for a 10-24 machine screw in the upper lefthand corner as shown in **fig. 3**. Drill straight through both sides of the box and use a 4-inch (10cm) long screw. This will make a sturdy mount for the holder. A spacer made from 1/4 inch (6.5mm) copper tubing will keep the holder from collapsing when tightening this screw.

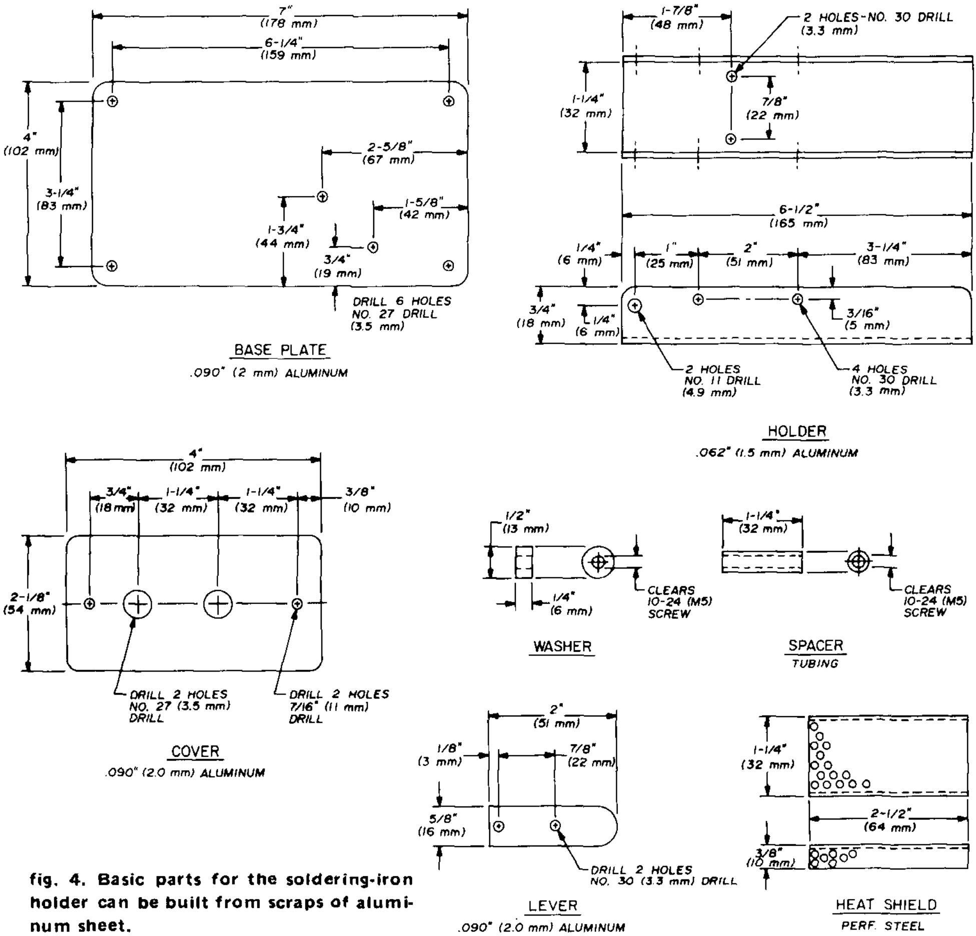


fig. 4. Basic parts for the soldering-iron holder can be built from scraps of aluminum sheet.

Use a conventional wire clamp for the incoming ac line. Choose a socket for the output which has a third wire grounding lug. Use of the ground is important when soldering some ICs and mos semiconductors. Be sure to connect a ground lead from your soldering iron to the circuitry being worked on in these critical applications.

The aluminum parts for the holder can be made from scrap 0.090 and 0.062 inch (2.0 and 1.5mm) aluminum sheet. Other thicknesses can be substituted to satisfy your own design. The heat shield is held in place with four pop-rivets. Two more pop-rivets are used to fasten the lever to the bottom of the iron holder. The lever may have to be shaped slightly to fit through the notch in the side of the utility box so it engages the microswitch. Microswitches are readily available at low cost from many surplus outlets.

Buy a tip cleaner sponge and tray (not shown in the photograph) from a local radio store and cement it on the base just to the left of the ac outlet. Be sure to keep it moistened with a little water. Finally, add rubber feet to the four corners of the base. With your new soldering iron holder you'll have no more burned benches or dull, corroded soldering tips.

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dipole antennas

A few basic ground rules applied to the installation of this simple antenna can pay off in excellent performance

Albert F. Lee, KH6HDM, 204 Makee Road, Honolulu, Hawaii 96815

The halfwave dipole antenna is hard to beat as an effective radiator of rf energy when considered in terms of low cost and ease of construction and tuneup. I'd like to report the results of my experience with this simple antenna for those now using a dipole or who would like to try one. Careful attention to materials, installation, positioning (or orientation), and tuning can make a big difference in performance. Many amateurs swear by the dipole as an antenna for portable work because of its simplicity. The following ideas should be helpful in planning your next dipole or improving your existing installation.

The quarter-wavelength legs of my dipoles have been made of many different materials: insulated copper wire, annunciator wire, aluminum wire, tubing, and even TV twinlead. All will work, but my recommendation is number-14 stranded copper wire. It's easy to handle and causes fewer construction problems than most other materials. Its strength per unit length is excellent and it withstands weather for a long time without failing.

An inexpensive bow and arrow set should be included in your dipole inventory. An 8- or 12-pound (3.6 or 5.4 kg) test nylon fishing line tied to the end of an arrow can be shot over a tree, house roof or similar support. A heavier length of line is then secured to the original line and, in turn, secured to your antenna wire. The whole works is then pulled into position. If the far end of your support is a tree, the arrangement shown in **fig. 1** is one way to eliminate problems with wire breakage due to wind, or wear of the securing line due to friction.

Other antenna supports that can be used are interlocking sections of TV masting, wooden doweling, or the A-frame mast which is described in the *ARRL Handbook*. A husky bamboo pole is another possibility.

installation

I devised the wagonwheel concept (**fig. 2**) to help bring order and logic into resolving the dipole antenna installation problem. Some may think this is a simplistic approach; however, it makes sense to me because any compromise with any segment of the wagonwheel results in a flat wheel, and who needs that? My dipole wagonwheel has five segments. Let's consider them in order.

Positioning. It might sound trite, but the best antenna is one that's located as high as possible and in the clear. This means the radiating (and receiving) wire should be positioned as far as possible from telephone wires, metal house siding, fences, and the like. If the antenna is located close to trees or shrubbery, the electrical characteristic of the reflecting surface will be adversely affected.[1]

Each of my dipoles is constructed for one band; ideally the height above ground for each antenna should be one-quarter wavelength minimum for that band. Notice I said "ideally." The ideal situation is hard to achieve. If you must compromise on antenna height, try to compensate by observing the other installation hints mentioned here. See **fig. 2**.

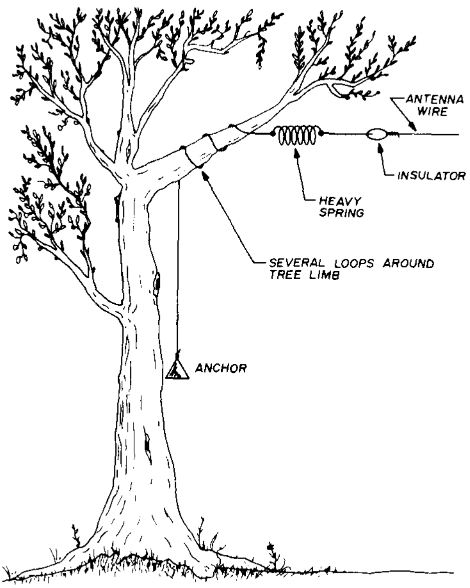

fig. 1. Suggested method of securing the far end (or both ends) of a dipole antenna, using nature's remedy.

Another consideration is the placement of two or more antennas. I once tested a long-wire antenna that had an antenna tuner and an swr meter in the transmission line. I was transmitting using a dipole about 15-feet (4.58m) away. It turned out that the long-wire antenna was absorbing a great portion of the signal radiated from the dipole. This makes me wonder how much power is lost in direct and harmonic absorption. So now my rule is, "Keep antennas separated and preferably oriented in a different plane of transmission."

Resonant frequency. This is the second segment in the dipole wagonwheel (**fig. 2**). After selecting your desired band and the part of that band in which you wish to work, the leg lengths of your dipole are easily determined from formulas in the *ARRL Handbook*. The lengths given in these formulas are usually somewhat long, which is fine for cut-and-try installation.

The resonant frequency is most accurately determined when measurements are made as close as possible to the base of your antenna. You'll need an rf source and, depending on the technique you wish to use, an swr meter, grid-dip meter/antenna bridge, or noise bridge.

The swr technique is easiest to use in testing a dipole antenna. However, there are restrictions as to the readings because there is no direct method of exactly reading either frequency or impedance. After the dipole has been placed in its operating position, a test length of coax cable is attached to the feedpoint, which should be a balun (see the discussion on wagonwheel segment 4). The other end of the test coax line is attached to your rf source (a transceiver in my case).

My test piece of coax is cut for a multiple of one-half electrical wavelength at the frequency at which I wish to test my antenna. I cut the coax test line slightly longer than a multiple of one-half wavelength, then made a shorting device from a straightened safety pin to obtain this length exactly. This test line can be used for all three methods of antenna testing.

With the test line attached to the swr meter and the rf generator, tune across the band in 100-kHz increments with the set tuned to maximum output, then

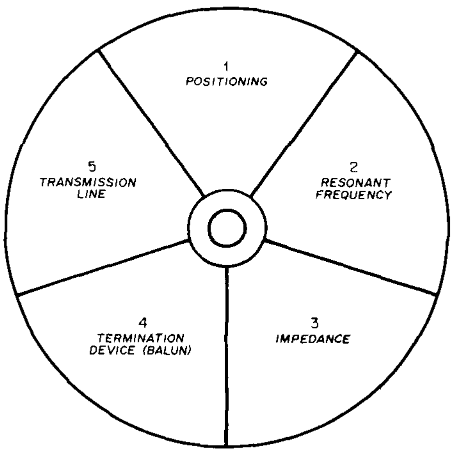

fig. 2. The dipole wagonwheel — a useful adjunct to the installation problem.

reduce power. The swr meter is set at full forward reading, then reflected power is recorded. Where the lowest reflected-power reading occurs is the antenna resonant frequency. If the swr is more than unity, don't worry. An swr of 3 or 4 is acceptable in amateur work.

Impedance. Using the grid-dip meter/antenna bridge method, select the correct frequency probe for the grid-dip meter, and with the meter turned on, you can spot your desired frequency on the transceiver. The grid-dip meter acts as a transmitter for your desired frequency. Connect the test line to the antenna bridge. By varying the grid-dip meter dial, you'll get a dip on the antenna bridge at the antenna resonant frequency and you'll know whether the wire is too long or too short. The antenna bridge will also show antenna impedance.

In the noise bridge method, an a-m receiver signal is used. The bridge is attached to the receiver and turned on. The noise bridge will produce an output that is like atmospheric noise. As you tune the receiver across the band for which your antenna is cut, you'll obtain a null in the noise at the antenna resonant frequency. As with the antenna bridge, the noise bridge has an impedance dial that, when set to your antenna impedance, will produce a noise null. You can read an antenna resonant frequency and impedance fairly accurately.

At this point I'd like to include two personal notes. First, the bridge operates only with an older type a-m receiver. Second, be sure your leads from the receiver to the bridge are short (not over 10 to 12 inches or 25.4 - 30.5 cm). I made these notes not from textbook directions but from yardwork failures.

Antenna impedance matching can fill a large textbook. With a dipole you can approach 50 ohms by changing the angle of the legs from the horizontal or by using a matching system. With my 20-meter dipoles, I use a piece of wire 42 inches (1.07) long with a clip at each end. One clip goes to each side of the

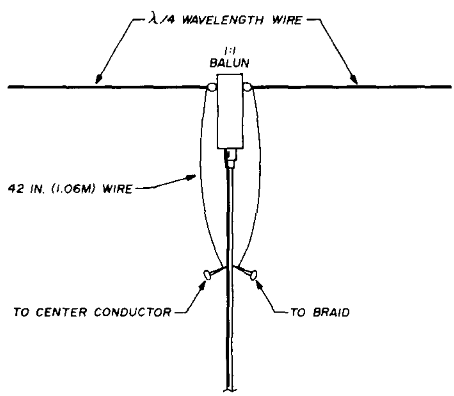

fig. 3. Delta match. Pins are used to obtain correct impedance match. Permanent installation should be soldered and weatherproofed.

balun connection (**fig. 3**). This matching system works well for me. An alternative is a matching stub as shown in **fig. 4**.

Balun. For quite a time I didn't understand about the balun and therefore didn't use it. Later I used the balun incorrectly thinking that it tuned out all of my antenna faults. However, the balun is a necessary device in a balanced antenna system such as a dipole. Radio-frequency energy propagates along the coax at a different rate in the shield compared to that in the center conductor. The result is that antenna currents will appear on the outside of the shield braid, and these currents will radiate.[2] Such radiation causes undesirable antenna performance and is often the culprit in TVI. The balun will often reduce rf radiation from the coax.

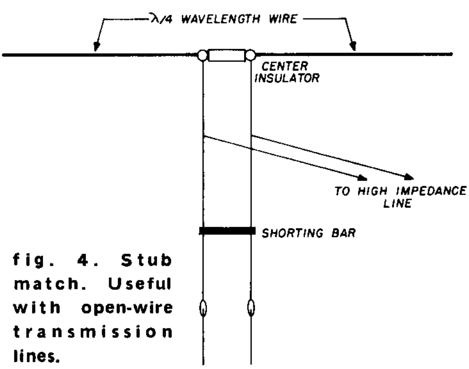

fig. 4. Stub match. Useful with open-wire transmission lines.

Transmission line. Use only top-quality foam-dielectric RG-8A/U coax cable. I have lengths of cable to reach from the antenna to my swr meter, which are cut in multiples of one-half electrical wavelength determined from charts in coax cable handbooks and checked with a grounding pin made by straightening a safetypin. Using the grid-dip meter and antenna bridge test described earlier will produce such a length of coax.

In testing the correct length of coax to use, start at the signal source with the antenna bridge/grid-dip meter setup and include swr meter, in-line wattmeter, and lowpass filter. Coax transmission line lengths can also be measured in one-half electrical wavelengths by using an antenna noise bridge.

dipole variations

The dipole is the basis of all high-frequency antenna systems. This simple structure can be expanded almost without limit to produce extremely complex directive arrays. For example, a directive antenna used in France in the early 1940s for shortwave transmitters operating around 8 MHz had three horizontally oriented bays of six dipoles each, with each set of dipoles arranged in a diamond configuration. Each bay of six dipoles constituted one element of a three-element beam antenna — director, driven element, and reflector. This system was known as a Chireix-Mesny array.[3]

The currents along any diagonal of each diamond had to be exactly in phase, so that the antenna wires served both as radiators and transmission line — truly an installer's nightmare. Such arrangements were popular for a short time but were eventually abandoned because of construction expense and tuning difficulties.

I have installed wire directors and reflectors in my dipole systems, used coil traps, and tried to decrease physical space requirements by installing the dipole ends at different angles from the horizontal. I still like the simple half-wavelength dipole as described and built according to the wagonwheel concept shown in **fig. 2**. This is the antenna I use today — simple and effective.

references

1. Arnold B. Bailey, *TV and Other Receiving Antennas*, pp. 182 - 183, John F. Rider, Inc., New York.
2. *The Radio Amateur's Handbook*, ARRL, Newington, Connecticut.
3. F.E. Terman, *Radio Engineers' Handbook*, McGraw-Hill, New York, 1943.

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Collins R390A modifications

Several simple modifications for the R-390A which can considerably improve performance

Alexander MacLean, WA2SUT, 18 Indian Spring Trail, Denville, New Jersey 07834

With the R390A receiver, it sometimes pays to work around a built-in problem or known trouble, rather than make extensive repairs. Here are some simple and somewhat complex modifications that may help, depending on the trouble you have.

Audio section. If you have audio problems, it may be due to a mismatch. All of the audio outputs are 600 ohm. A pair of high-impedance (3000 ohm) headphones will work as is. For low-impedance (8 ohm) speaker or phone use, the output transformer from a small tube type receiver or one of the universal replacement types will provide a reasonable match.

If there is still trouble, the entire audio section can be completely bypassed by using the diode load terminal at the back of the set. Leave the jumper connected and couple the signal to an outboard amplifier and speaker through a suitable blocking capacitor (**fig. 1**). A hi-fi amplifier used with the R-390A will give you beautiful shortwave broadcast-band listening. The added clarity will help amateur band reception too.

I-f section. Ssb reception with the R-390A has a mushy audio quality because of the envelope detector and the low bfo-to-signal ratio. One solution is to rewire the detector as a product detector.[1]

The set can also be used with a companion ssb adapter fed by the i-f output jack. There are advantages to building an adapter for the set rather than converting the existing circuit: you will have more room to work with; you can choose your own parts layout; and, you can build as elaborately as you want. More important, you should be able to get better performance from a totally outboard unit than by piece-meal modifications to the set.

Originally these sets were stagger tuned to improve the bandwidth characteristic. For amateur use the i-f stages can be retuned to the same frequency, which noticeably increases gain.

Rf section. When you increase the gain you also increase the noise. The rf gain control works in both the rf and i-f sections. As the set is now there is no way to vary the i-f gain without adversely affecting the rf stage.

The rf stage determines the overall sensitivity and noise level of the set. Removing the rf amplifier cathode circuit from the rf gain control and grounding it directly lets the stage work at its maximum gain and sensitivity. The cathode resistor (**fig. 2**) runs from the tube socket to a nearby standoff insulator where it connects with the rf gain control wiring.

Remove the wire from the standoff and tape it out of the way so it can't short. Then run a short wire from the resistor end on the standoff to a convenient ground lug. It would be a bit fussy, but you could run a shielded cable to a switch on the front panel and make the modification optional.

While the modifications are simple to make, you will need the manual to safely disassemble and reassemble the rf deck. Without it, it is too easy to damage the set or misalign the tuning mechanism.

It is possible to position the rf deck on its side in the main chassis so that the cables will just reach and you will be able to get at the bottom of the subsection chassis for testing or trying modifications with the set in operation.

Be careful when doing this as there is almost no slack in the cables and it is very easy to break one or damage some other part. Replacing one of the coax cables would try the patience of a saint.

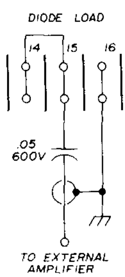


fig. 1. Diode load audio tap for use with an external audio amplifier.

Low sensitivity. If your R-390 seems to have lower sensitivity and higher noise below 8 MHz, and no fault can be found, try bridging either C281 or C282 (first mixer output coupling capacitors) with a higher value; the gain may come right up. The value probably isn't critical; I replaced both capacitors with 100 pF.

Antenna matching. The unbalanced antenna jack, J103, was intended for a whip antenna with a very short lead-in or a random length of wire. If you are using a longer length of coaxial cable you may be losing most of the signal.

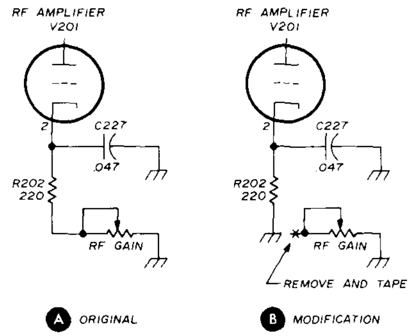


fig. 2. Modifications for the R390A rf amplifier.

A UG-970/U adapter, used with balanced input jack J104, makes the necessary changes with a substantial improvement. The following modification, originally issued by the Navy as a field change, does much the same thing.

1. Disconnect plugs P205 and P206 from the antenna box inside the set and reverse them: P205 to J106 and P206 to J105.

2. Connect a shorting plug to J104.

3. Connect the antenna to J103 which, because of the internal changes, provides a much better match to the antenna.

reference

1. Eugene A. Hubbell, W7DI, "Improving the R390A Product Detector," *ham radio*, July, 1974, page 12.

ham radio

the ham notebook

trig functions on a pocket calculator

There are several ways of evaluating log, exponential and trig functions on small hand-held calculators. Here is a method for trig functions which offers some advantages if the calculator has square-root capability. Methods for finding square roots on four-function machines were previously described in *ham radio*.[1]

The usual scheme is to run out the calculations using the series expansion for the sine or cosine. For the simple four-function machine this has the advantage of requiring only four basic operations. However, it has some disadvantages. The infinite series expressions are difficult to remember. Also, a number of terms of the series must be added together to arrive at a value accurate to three or four decimal places.

With square-root capability sine, cosine and tangent can be done quite simply by making use of a few trig identities. A useful approximation is that for small angles, the sine, the tangent and the angle, expressed in radians, are equal. **Table 1** lists some values along with the error for using the angle (in radians) rather than the sine or tangent function. Note that the values for the sine are somewhat closer to the actual values than for the tangent – about a two to one difference. Up to 20 degrees the maximum error is 4 per cent; limiting the angle to 15 degrees keeps the sine error within 1 per cent.

To convert degrees to radians simply multiply the angle by pi and divide by 180. If the angle is 15 degrees or less this immediately gives the approximate sine or tangent. To evaluate the cosine use relation (3) after obtaining the sine. This is very simple on a calculator with square-root capability.

For angles between 15 and 45 degrees use relation (5). First calculate the sine and cosine for an angle that is half the desired angle. Then multiply these two together and times 2 to obtain the sine of the angle. Memory is useful during this double calculation to store the intermediate value for the sine.

To increase the accuracy of the re-

1. John Sego, K9DHD, "Finding Square Roots," *ham radio*, September, 1973, page 67.

table 1. Values for the tangent and sine of small angles are very close to the angle expressed in radians, as shown here. Trig identities for calculating other functions are shown below.

θ (degrees)	θ (radians)	sin θ	error	tan θ	error
1°	.01745	.0175	0	.0175	0
2°	.03491	.0349	0	.0349	0
5°	.08727	.0872	0.1%	.0875	0.3%
10°	.17453	.1736	0.5%	.1763	1.0%
15°	.26180	.2588	1.2%	.2679	2.3%
20°	.34906	.3420	2.1%	.3640	4.1%

$$\theta(\mathrm{RAD}) = \frac{\pi}{180} \times \theta(\mathrm{DEG}) \qquad (1)$$

$$\mathrm{FOR}\ 0 \leqslant \theta \leqslant 15^\circ\ \sin\theta \approx \tan\theta \approx \theta(\mathrm{RAD}) \qquad (2)$$

$$\cos\theta = \sqrt{1 - \sin^2\theta} \qquad (3)$$

$$\tan\theta = \frac{\sin\theta}{\cos\theta} \qquad (4)$$

$$\sin 2\theta = 2\sin\theta\cos\theta \qquad (5)$$

$$\sin\theta = \cos(90^\circ - \theta) \qquad (6)$$

sult, the above procedure is done in two steps at angles one quarter and one half the desired angle. Between 30 and 45 degrees this method is almost mandatory since the error above 15 degrees is fairly large. An example, **table 2**, has been worked out for the sine of 45 degrees. The calculated value differs by only 0.5 percent from the actual value.

For angles between 45 and 90 degrees use relation (6). Find the sine and then the cosine of the complement of the angle desired.

table 2. Using the trig identities shown in table 1 to calculate the sine of 45 degrees. Steps can be accomplished easily on a pocket calculator with square-root capability.

$$\sin 22.5^\circ = 2(\sin 11.25^\circ)(\cos 11.25^\circ)$$

$$11.25^\circ = \frac{\pi \times 11.25}{180} \text{ rad} = 0.19635 \approx \sin 11.25^\circ$$

$$\cos 11.25^\circ = \sqrt{1-(0.19635)^2} = 0.98053$$

$$\sin 22.5^\circ = 2 \times 0.19635 \times 0.98053 = 0.38505$$

$$\sin 45^\circ = 2(\sin 22.5^\circ)(\cos 22.5^\circ)$$

$$\cos 22.5^\circ = \sqrt{1-(.38505)^2} = 0.92289$$

$$\sin 45^\circ = 2(0.38505)(0.92289) = 0.71073$$

$$\sin 45^\circ \text{ (from trig table)} = 0.70711$$

$$\text{error} = \frac{0.71073 - 0.70711}{0.70711} \times 100\% = 0.512\%$$

As indicated in **table 1**, the error for the tangent is somewhat larger than for the sine when using the angle in place of the function. Since the above steps provide simple calculations for both the sine and cosine, relation (4) can be used to find the tangent of any angle.

The trig identities shown here should be at least as familiar as the series expansions for sine, cosine and tangent. In fact, relation (5) is really the only special identity in the group; the others come from trigonometry definitions.

Cal Sondgeroth, W9ZTK

copper-plated circuit boards with terminal inserts

Perfboard with terminal inserts has served well for many projects. What it lacks is the all-important ground plane that an etched board provides. This ground plane can be the difference between a quiet and a noisy mike preamp or the difference between a smoothly acting rf or converter stage and one that has a will of its own.

The answer I developed is a marriage of a circuit board copper plated on one side only with the perf board insert terminals. Insulated islands for the terminals was the immediate problem. The solution for this was to use a bit designed to rout channels in wood. Chucked in the drill press, this routing bit takes perfect ¼-inch (6.5mm) circles of copper from the board. Holes are then drilled in the center of the newly created insulated islands and the perf board terminals are inserted. The circuit is then wired point-to-point, with any components requiring a ground being terminated in a hole in the copper ground plane and soldered directly to the copper.

Layout is a common sense approach. Merely pencil a grid on the copper surface, determine where you want the islands, and apply the router bit. A few moments practice on a scrap piece of board will quickly give you the feel of just how much pressure to apply with the router bit to get perfect removal of copper without biting into the board proper.

Duplicate boards may be made by applying identical grids to the blanks. After the islands have been created, the boards may be stacked and drilled in one operation for terminal insertion. If you use care, this method may be used with board material plated on both sides.

Allan S. Joffe, W3KBM

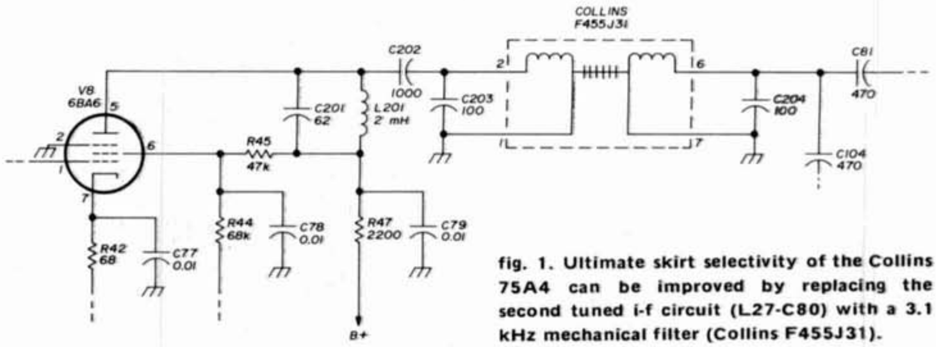


fig. 1. Ultimate skirt selectivity of the Collins 75A4 can be improved by replacing the second tuned i-f circuit (L27-C80) with a 3.1 kHz mechanical filter (Collins F455J31).

headphone cords

For some time I have tried to purchase replacement earphone cords for my headphones. Over one dozen New York merchants told me they didn't stock them.

Various alternatives (including four-wire rotator cable) were tried, but none of them were satisfactory. If you are faced with a similar problem I would suggest trying Trimm, Inc., for suitable replacement cords.

I tried both their no. 811, standard pin tip terminals, black cotton braid, 4½ feet (1.4m) long; and their no. 870, similar but 5 feet (1.5m) long with a waterproof outer braid. Costs range from $2.00 plus postage. A card to Trimm, Inc., Post Office Box 489, Libertyville, Illinois 60048 could save you a lot of exasperation.

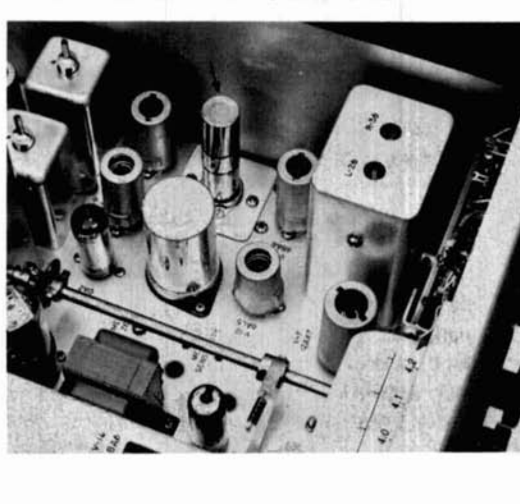
Neil Johnson, W2OLU

increased selectivity for the Collins 75A4

The ultimate skirt response of the 75A4 selectivity curve can be improved considerably by replacing the second 455-kHz i-f amplifier tank circuit (L27-C80) with a 3.1-kHz Collins mechanical filter (F455J31) as shown in **fig. 1** (modification suggested by W4ZKI). Since most amateurs who use the 75A4 for ssb operation have replaced the original 3.1-kHz filter with a 2.1-kHz filter, the 3.1-kHz unit is seldom used. If a 3.1-kHz filter is not available, a 4.0 kHz filter (F455J40) will still provide a noticeable improvement in skirt response. The L27-C80 tuned circuit is in the i-f can next to the filter capacitor, C94.

Remove the bottom panel of the receiver, disconnect all the leads which go to the L27 i-f can, and remove the two retaining nuts (don't discard the i-f can – you may want to restore the receiver in the future). Cut out a small piece of thin aluminum, 1-3/4 inch (4.4cm) square, and punch a 3/4-inch (2cm) hole in the center for a 9-pin tube socket. Drill the two chassis-mounting holes and position the tube socket so pins 1-2 and 6-7 are aligned with them. Install the

Filter installation in the Collins 75A4.



socket on the plate and fabricate a small brass shield about 5/8 inch (1.6cm) high. This shield is placed across the tube socket between pins 3-4 and 8-9 and soldered in place (see mechanical filter sockets A, B and C for reference). Ground all unused socket pins.

Wiring the new filter into the circuit is straightforward and requires only four mica capacitors and one inductor. (C201-C204 and L201 in **fig. 1**). Install the two 100 pF filter resonator capacitors at the input and output socket pins (the filter is symmertical so either set of pins may be used as the input). Install a small terminal strip next to V8 for the junction of R45, R47, C70, C210 and L201. Delete C69 and R46 as they are not used in the new mechanical filter circuit.

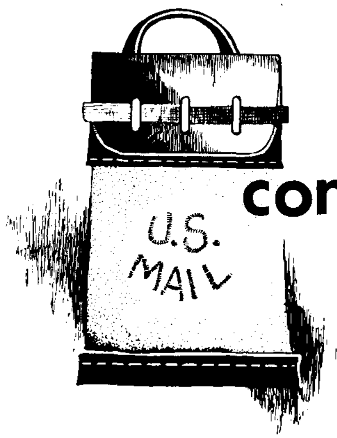
An improvement in i-f gain can be obtained by removing resistor R29 from the plate circuit of V6. This resistor swamps out the Q of L24 and increases the bandwidth for a-m reception; it is not required for ssb or CW operation.

Jim Fisk, W1DTY

muting microphones

Other amateurs must be faced occasionally with the same problem I was: that of disturbing others in the household when talking into a microphone. Headphones, of course, eliminate any speaker disturbance. The microphone problem was solved by attaching a heavy-walled cardboard tube (of the proper diameter) about 3 inches (10cm) long to the face of the microphone, making sure the joint is completely sealed. By pressing your lips into the open end of the tube, and speaking in a whisper, no sound can be heard in the shack. The fact that the voice is completely retained within the tube compresses the sound, resulting in increased talk power, although it may sound like you're in a barrel. Microphone gain must be reduced considerably.

Ralph Cabanillas, Jr., W6IL



comments

speech processing

Dear HR:

ZL1BN's article on speech processing in the February, 1975, issue of *ham radio* covered much of the knowledge which has been available in the literature to the amateur. However, a few ideas to which I have been exposed were omitted. First, no reference was made to the excellent article in *QST*[1] which developed a theoretical and empirical model of *intelligibility*, a concept which continues to be confusing to most hams with whom I have had relevant discussions.

Secondly, ZL1BN is well justified in his concern for problems of signal-to-noise degradation and power inefficiency resulting from heavy clipping levels, as can be attested by those who have heard, say, a Signal One under full clipping and power in heavy competition. One method which I have found effective in reducing extraneous noise in conjunction with my rf clipping system is the use of an "inverted" audio compressor; that is, an expander. A moderate amount of expansion (5 to 10 dB) seems to keep ambient noise to a minimum without degrading intelligibility. Adapting a good-quality audio compressor such as the RP Electronics RPC-3* to the expansion mode is extremely easy as shown in **fig. 1**.

Thirdly, an important factor in

1. Harold G. Collins, W6JES, "Ordinary and Processed Speech in SSB Application," *QST*, January, 1969, page 17.

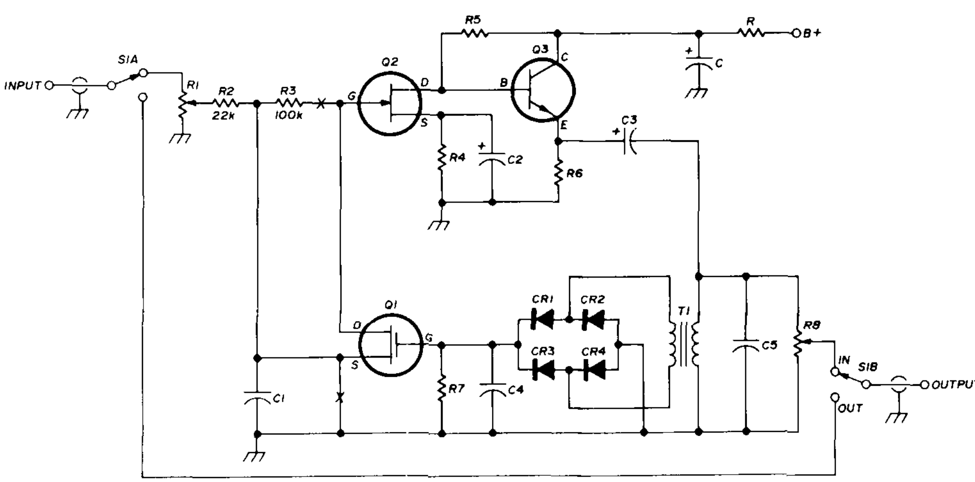


fig. 1. Basic circuit of the RP Electronics RPC-3 speech processor. Expand function is added by breaking connections between R3 and Q2 gate and between Q1 source and ground and connecting Q1 source to the junction of R2 and C1.

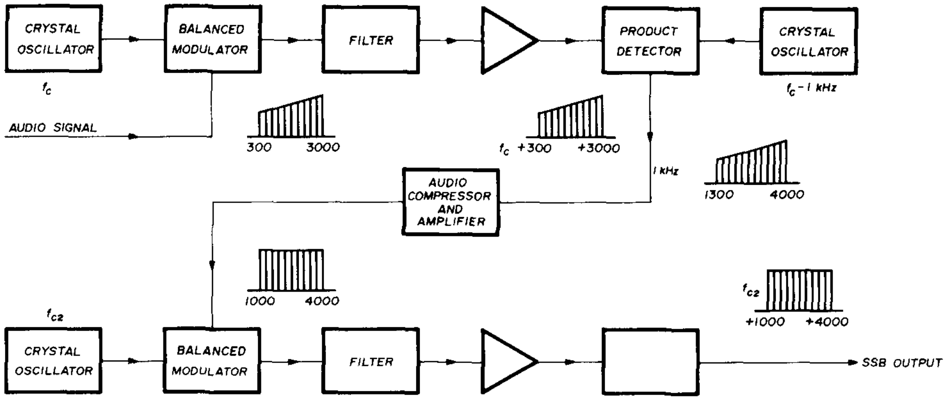


fig. 2. Block diagram of PAØKT's method of achieving an ssb signal with constant amplitude using a fast-acting audio compressor with an offset technique that produces a residual carrier at 1 kHz so that full output can be obtained during pauses in speech.

communications theory (but almost entirely overlooked in the amateur literature) is the role of redundancy in effective transmission of information. On several occasions I chanced to overhear a weak signal of a young amateur who was using a reverbration system in the audio string and was very much impressed at the apparent readability improvement of his signal. I have also heard the use of reverbration by foreign broadcast stations with apparent improvement of intelligibility. Parity testing, a form of redundancy, is standard practice in computer data transmission.

Finally, it has been mentioned that rf clipping simulates a form of variable pulse-width modulation, which is essentially digital, as opposed to the analog waveform characteristics of unprocessed audio. With the recent introduction of relatively low-cost but powerful and fast mini-computer systems, it may be feasible at this time to develop a real-time speech-processing algorithm for precise computerized control of speech processing parameters.

James G. Limber, K9ZAT
Chicago, Illinois

*Available from RP Electronics, Box 1201, Champaign, Illinois 61820.

rf interference

Dear HR:

One common type of RFI to which hi-fi equipment is susceptible is the "thumps and bangs" which come from the thermostats in refrigerators and central heating systems. It is not generally realized that these noises are usually caused by rectification of the radio-frequency component of the unwanted signals, and that any hi-fi equipment which is susceptible to "fridge crunch" is almost certainly also susceptible to other forms of rf interference.

If your neighbor complains of interference, it is a good approach psychologically to say something along the lines of, "Yes, it is a problem with some hi-fi equipment – it probably picks up your refrigerator as well." Nine times out of ten you will hit the nail on the head and get your point across. Your neighbor's displeasure at having to get his hi-fi fixed to remove your transmissions will be reduced if you point out that standard RFI measures will usually remove other unwanted noises as well.

clipping and rfi

It may come as a surprise that while a speech clipper makes your signal sound louder to other amateurs, it actually reduces the level of interference picked up on high-fidelity installation. With an ssb signal the hi-fi system registers the difference between the peaks and the troughs of your voice, and so theoretically if you clip sufficiently (enough to lift the noise between words to peak level), all amplitude variations will be cancelled, and the RFI will disappear.

In practice, if an rf speech clipper is used with around 6 to 10 dB of high-frequency pre-emphasis,[2] about 30 dB of clipping can be applied without objectionable distortion. At this level of clipping, unless you run a *very substantial* linear, input power has to be reduced somewhat and a combination of this with the clipping can result in a considerable reduction in RFI along with a net gain in talk power.

Some experimenting has been done along these lines in Europe where the clipping has been taken to the extreme of being infinite – a block diagram of the system developed by PAØKT is shown in **fig. 2.**[3] Although all the audio components are at the same level, the signal is still quite readable. This may seem like a drastic approach, but in difficult interference problems where unsympathetic licensing authorities are involved, it has solved the problem.

Harry Leeming, G3LLL
Holdings Audio Center
Blackburn, England

2. B. Kirkwood, ZL1BN, "Principles of Speech Processing," *ham radio*, February, 1975, page 28.

3. P. Hawker, G3VA, "Constant-Amplitude SSB," *Radio Communicatios*, November, 1974, page 762.

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Hew Packard 400C, VTVM, recent cal.	**80.00**
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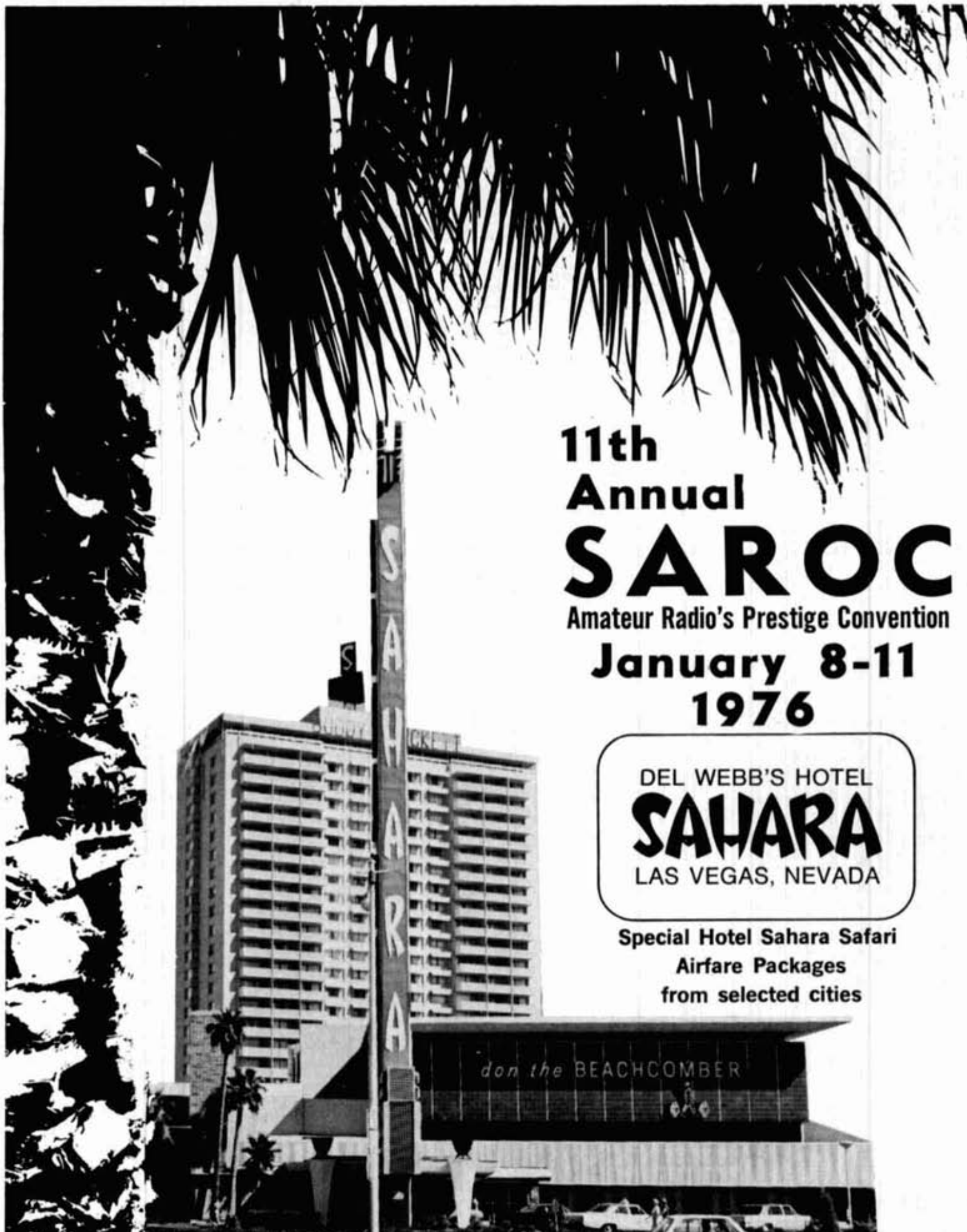
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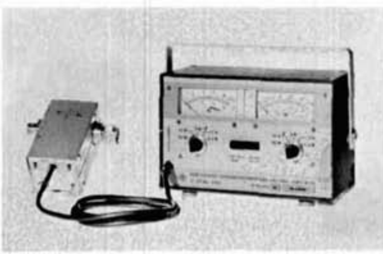

The new Rohde & Schwarz directional rf power meter, type NAUS-80, provides simultaneous measurement of incident and reflected power over the frequency range from 25 to 1000 MHz without any switching or changing measuring heads. The indication accuracy of the power meter is within 4% of the *reading* and ±1% of full scale – this is a vast improvement over the accuracy of most rf power meters which is usually specified only as a percentage of full-scale deflection. Although the NAUS-80 power meter is designed for operation over the range from 25 to 525 MHz, it is usable to 1000 MHz. If desired, the factory can calibrate the instrument to 1500 MHz at slight additional charge. Power ranges are 3.2, 10, 32, 100 and 320 watts full scale.

The NAUS-80 rf power meter consists of two units: the measuring head, and the indicating unit. The measuring head contains a symmetrical directional coupler which measures both incident and reflected power. Networks within the measuring head compensate for the voltage coupled out, which rises with frequency. The coupling attenuation and voltage division in the directional coupler are adjusted so that the rf rectifying diodes operate only in the square-law region. This permits the use of easy-to-read, linear meter scales.

The small rectified voltage (10 μV to 25 mV) from the directional coupler is amplified in a chopper amplifier which converts the dc input voltage to a square wave which is boosted 50 dB in a series-connected amplifier. The amplified signal is then applied to an attenuator which is ganged with another attenuator in the feedback path. In the 3.2 watt position attenuation is 0 dB, increasing 10 dB with each measurement range. Since the attenuation in the feedback path is reduced simultaneously in corresponding amounts to the main attenuator, the loop gain of the chopper amplifier is the same on all measurement ranges so the meter indications are free of oscillation and transient response remains constant.

The attenuator is followed by the final amplifier where the signal is boosted by another 50 dB and then fed to a synchronous detector. The transistors in the synchronous detector are driven together with the same square-wave generator which drives the chopper amplifier. The synchronous detector operates into a charging capacitor; a series resistor is included to form a low-pass filter with a low cutoff frequency. The voltage at the output of the lowpass filter (approximately 300 mV on all measurement ranges for full-scale deflection) is connected to the panel meter.

The feedback voltage to the chopper amplifier is fed back through a thermistor which compensates for the slight

More Details? CHECK–OFF Page 126

temperature effect on the rf rectifying diode in the directional coupler. Temperature effect on the meter indication is less than 0.25% (referenced to indication at 25°C).

Although the directivity of the directional coupler is 30 dB or more above 30 MHz, finite reflected power would be indicated when working with matched terminations. The designers compensated for this effect by connecting the inverting output of one channel to the non-inverting input of the other channel through resistors. The rectified voltage of the incident power being measured in channel A is attenuated such that the voltage available at the inverting input of the channel B chopper (reverse power channel) is virtually the same as the voltage present at the non-inverting input which develops because of the finite directivity of the directional coupler. The two voltages balance out and, as a result, there is no indication on the reflected power meter. The effect is the same as if the measurement were made with a match-terminated directional coupler with infinite directivity.

Our staff had an opportunity to evaluate the NAUS-80 recently, and it proved invaluable in setting up the tuned input circuit of a high-power two-meter linear for minimum vswr, and measuring drive power. Its high reflected power sensitivity and panel meters for both incident and reflected power are especially helpful in quickly evaluating the effect of circuit adjustments. Since the instrument is completely portable, it can also be taken to the top of your tower for precise antenna checks.

The Rohde & Schwarz NAUS-80 rf power meter is available for 50, 60 or 75 ohms. Various types of connectors are available including type N, BNC and UHF, and may be changed in the field. The built-in power supply uses five 1.5-volt D-size dry cells with an estimated operating life greater than 7000 hours (total power drain is 1 mA or less, depending upon the measurement range). The vswr of the measuring head is 1.03 or less, and insertion loss up to 300 MHz is 0.1 dB or less (0.25 dB or less to 525 MHz). The instrument is covered by a five-year warranty.

Also available from Rohde and Schwarz is the type NAN high-frequency wattmeter and matching indicator which provides direct power and reflection coefficient measurements over the high-frequency range. Accuracy is within 5% of full scale and frequency response is flat within 3% over the range from 1.5 to 30 MHz. The instrument is available with a characteristic impedance of 50, 60 or 75 ohms. Reflection due to the coupling system is less than 2%. The instrument has four selectable power scales up to a maximum of 1200 watts.

For more information on the NAUS or NAN rf power meters, write to Rohde & Schwartz Sales Company, 14 Gloria Lane, Fairfield, New Jersey 07006 or use *check-off* on page 126.

two-meter fm transceiver

The Horizon 2 is a new, 12-channel, 25-watt two-meter radio developed by Standard Communications Corporation. This rig is an outgrowth of Standard Communications' land/mobile and maritime equipments, which must meet rigid FCC type acceptance requirements for the transmitter section. The receiver section meets the proposed maritime FCC receiver specifications as well as the current receiver DOC type acceptance requirements for use in Canada.

Some of the features of the Horizon 2 include 25 watts *nominal* output; 23 watts *minimum*. The unit is capable of using 12 channels; three are included: 94/94, 52/52, and 16/76. Crystal net capacitors are included for both transmit and receive. The receiver front end has a selective ceramic filter that provides −65 dB minimum selectivity.

More Details? CHECK—OFF Page 126

Plenty of audio power is available — more than 3 watts — perfect for the noisiest mobile installation. The rig is center tuned to 146.94 MHz and will operate on the low and high ends of CAP and MARS frequencies.

The Horizon-2 amateur net price is $225.00, which includes the three channels mentioned above. For other channel options and more data, write Standard Communications Corporation, P.O. Box 92151, Los Angeles, California 90009, or use *check-off* on page 126.

250-MHz frequency counter

The K-Enterprises model 4X6 six-digit frequency counter covers the frequency range from 500 kHz to 250 MHz with sensitivity of 80 mV or less at 150 MHz. The input impedance of the counter is 50 ohms and maximum input voltage is 15 Vrms or 50 Vdc. The time base uses a crystal clock with an accuracy of 10 ppm over the temperature range from zero to +40°C. The model 4X6, which contains a built-in power supply for operation from 117 Vac, is priced at $250. The model 4X6C, which includes a temperature compensated crystal oscillator with 0.0005% accuracy from −30° to +60°C, is priced at $270. Add $2.50 to cover postage and insurance.

For more information on the K-Enterprises 250-MHz frequency counters, write to them at 1401 East Highland, Shawnee, Oklahoma 74801, or use *check-off* on page 126.

fm power amplifier

Specialty Communications Systems has introduced a new Porta-Pack 25-watt power amplifier system with a self-contained battery pack which can be carried over your shoulder. Designed for use with the popular H-T fm transceiver, the amplifier can also be used with other similar hand-held fm transceivers, and covers the complete two-meter band without retuning. The battery pack provides 45 minutes of "talk" time and can be recharged in four hours. Included with the $199.95 package price are the 25-watt power amplifier, 12-volt Gates cell energy source, external constant-voltage charger, flexible antenna and a leather case with belt loop and shoulder strap. For more information, write to Louis Anciaux, WB6NMT, Specialty Communications Systems, 4519 Narragansett Avenue, San Diego, California 92107, or use *check-off* on page 126.

radio-sentry mini-meter

Mini-Meter, a new amateur fm transmitter monitor, has been introduced by Electronic Specialists. The transmitter field strength is continuously monitored, with the status displayed on a miniature meter. Ultra compact, *Mini-Meter* operates without batteries or wires and can be carried in your pocket for on-the-spot transmitter checks. Deteriorating performance can be spotted early, allowing timely maintenance. The unit is supplied with a convenient, detachable mounting arrangement. State frequency. $27.95 postpaid from Electronic Specialists, Box 122, Natick, Massachusetts 01760.

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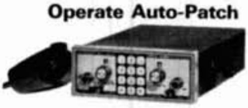

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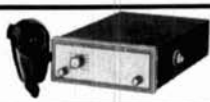

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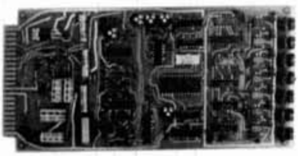
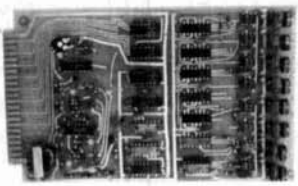
TOUCH TONE TO DIAL PULSE CONVERTER



Convert standard 0-9 touch tone digits to Bell System compatible dial pulse code. Completely solid state. Includes state-of-the-art Phased Locked Loop anti-falsing touch tone decoder, large capacity 64-digit memory and solid state pulsing. Starts dialing on first incoming digit. Memory will not become congested due to rapid succession of incoming digits. Cancel and redial function. * and # digits are decoded and provided for remote control purposes. Available as p.c. board or rack mounting.

DPC-121	P.C. Board	**$195.00**
DPC-121R	Rack Mount	**$285.00**

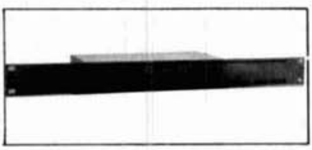
ANTI-FALSING TOUCH TONE DECODER



Now, a true anti-falsing decoder/receiver. Virtually immune to high noise or audio falsing. Twelve or 16 digit capability. Completely solid state, uses latest Phased Locked Loop decoding. Single 5-volt power supply. Heavy duty transistor output. Available as p.c. board or 19″ rack.

TTD-126-12	12 digit	P.C. **$149.95**	Rack **$219.95**
TTD-126-16	16 digit	P.C. **$169.95**	Rack **$239.95**

REPEATER AUTO PATCH



It's complete — a single digit access/disconnect Auto Patch facility. All you need is a repeater and the phone line. Complete with automatic disconnect, dialing capability, two way audio monitor plus remote control. When used with a rotary dial exchange, Data Signal's DPC-121 dial converter is also required. P.C. board or Rack Mount available.

RAP-2	PC **$99.50** Sh. Wt. 2 lbs.	Rack **$149.50** Sh. Wt. 8 lbs.

DELUXE P.C. KEYER

In either a 5 volt TTL or a 9 volt C-MOS version this new module type IC keyer can be easily adapted to your own custom package or equipment.

Versatile controls allow wide character weight variation, speeds from 5 to 50 w.p.m. plus volume and tone control.

Solid-state output switching saves power, eliminates all those annoying relay problems and is compatible with both grid block and solid-state circuitry.

With its side-tone monitor and 90 day warranty the Data Signal PC Keyer is the one for you.

TTL Keyer Wired $19.95
Kit $14.95
C-MOS Keyer Wired $24.95
Kit $19.95

FREQ. (MHz)	USE	STAGES	DELUXE PREAMPLIFIER GAIN dB	NF dB	KIT	WIRED
14, 21 or 28	HIGH FREQ.	SINGLE	25	2	$10.50	$13.50
		DOUBLE	48	2	$20.50	$26.50
28 to 30	OSCAR SPECIAL	SINGLE	25	2	$12.50	$15.50
		DOUBLE	48	2	$24.50	$30.50
50 to 54	6 METER	SINGLE	25	2	$10.50	$13.50
		DOUBLE	48	2	$20.50	$26.50
108 to 144	VHF AIRCRAFT	SINGLE	20	2.5	$ 9.50	$12.50
		DOUBLE	40	2.5	$18.50	$24.50
135 to 139	SATELLITE	SINGLE	20	2.5	$ 9.50	$12.50
		DOUBLE	40	2.5	$18.50	$24.50
144 to 148	2 METER	SINGLE	20	2.5	$ 9.50	$12.50
		DOUBLE	40	2.5	$18.50	$24.50
146 to 174	HIGH BAND	SINGLE	20	2.5	$ 9.50	$12.50
		DOUBLE	40	2.5	$18.50	$24.50
220 to 225	1¼ METER	SINGLE	18	2.5	$ 9.50	$12.50
		DOUBLE	35	2.5	$18.50	$24.50
225 to 300	UHF AIRCRAFT	SINGLE	15	2.5	$ 9.50	$12.50
		DOUBLE	30	2.5	$18.50	$24.50
1 thru 30	HF BROADBAND		19-36	3	—	$17.95

DELUXE RECEIVER PREAMP

Specially made for both OLD and NEW receivers. The smallest and most powerful single and dual stage preamps available. Bring in the weakest signal with a Data Preamp.

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DATA SIGNAL, INC.

master charge

2212 PALMYRA ROAD, ALBANY, GA. 31701

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wire to interconnect discrete components . . . resistors, transistors, linear/digital ICs in TO5 or DIP packages (8-40 pins), and more. Plus, you get 5-15VDC up to 600ma (9 watts) of variable regulated power, with a built-in 0-15V voltmeter to monitor internal power and/or external circuits. Now, that's design flexibility! And look at the low, low price!

49^{95}
Add $2.50
shipping/handling

SPECIFICATIONS
Power Supply: Output: 5-15V @ 600ma. **Ripple and Noise:** less than 20mv @ full load. Load/Line regulation: <1%. Meter: 0-15V DC. **Connectors:** 1 QT-59S, 2 QT-59B, 2 power supply 5-way binding posts, 2 meter 5-way binding posts. **Wght:** 3 lbs. **Power Needed:** 117V, AC @ 60 Hz 12W.* **Patent #235,554.**

Add $2.50
shipping/handling

DESIGN MATE 2

FUNCTION GENERATOR

Troubleshooting? Design Testing? DM-2 gives you all the signal source capacity you need . . . at a very modest price. This 3-wave form Function Generator has: short-proof output, variable signal amplitude and constant output impedance. Completely wired, tested, calibrated, ready to test audio amplifiers, op-amp and educational lab designs . . . as well as complex industrial lab projects. Complete with easy-to-read instructions/operations manual, application notes, operation theory and more, DM-2 works hand-in-hand with DM-1 for total versatility.

SPECIFICATIONS
Frequency Range: 1Hz-100KHz (5 ranges: 1-10Hz, 10-100Hz, 100-1000Hz, 1-10KHz, 10-100KHz). **Dial Accuracy:** Calibrated @ 10Hz, 100Hz, 1KHz, 10KHz, freq. accurate to 5% of dial setting. **Wave Forms:** Sine <2% THD over freq. range. **Triangle** wave linearity, <1% over range. **Square** wave rise/fall <0.5 microseconds — 600Ω-20pf termination. **Output Amplitude:** (all wave forms) variable-0.1V-10V peak to peak into open circuit. **Output Impedance:** 600Ω-constant over ampl./freq. ranges. **Wght.:** 2 lbs. **Power Needed:** 117V, AC @ 60Hz 5W.*

Have you been bugged by color codes or unreadable component markings? Forget it! DM-3, the low cost R/C Bridge, measures true component values . . . in seconds . . . to better than 5%. And, it's all done with only 2 operating controls and a unique solid-state null detector, to zero-in on exact component selection . . . instantly! Completely wired, calibrated and tested, DM-3 includes an extensive instruction/applications manual, and operational theory too.

SPECIFICATIONS
Resistance Range: 10Ω-100 megΩ. (6 Ranges: 10-100Ω, 100-1000Ω, 1K-10KΩ, 100K-1 megΩ, 1 megΩ-10 megΩ) **Capacitance Range:** 10pFd-1mFd- (5 Ranges: 10-100 pFd, 100-1000pFd, .001-.01 mFd, .01mFd-.1mFd, .1- 1.mFd.) **Null Detector:** 2 hi-intensity LEDs-hi/lo markings. **Accuracy:** <5% of null dial, range switch setting. **Wght.** 2 lbs. **Power Needed:** 117V, AC @ 60Hz 3W.*

54^{95}
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shipping/handling

Each measures 6.75''L x 7.5''W x 3.25'' H.; completely assembled, ready to start testing at once. Order your DESIGN MATES today!
**220V @ 50Hz available at slightly higher cost.*

All DESIGN MATES are made in USA; available off-the-shelf from your local distributor. Direct purchases from CSC can be charged on Bank Americard, Master Charge, American Express. Plus, you get a FREE English/Metric Conversion Slide Rule with each order. Foreign orders please add 10% for shipping/handling. Prices are subject to change.

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West Coast Office: Box 7809, San Francisco, CA 94119 • 415/421-8872
Canada: Len Finkler Ltd., Ontario

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Semiconductor Supermarket

ALL DEVICES AND COMPONENTS ARE FACTORY FIRSTS — NO SECONDS OR FALLOUTS

VHF PRESCALER DEVICES AND KITS

95H90	300 MHz 10 prescaler	$15.95
9582	Preamp/gate	$3.25
95H91	Prescaler	$15.95
11C06	500 Mz scaler	$21.95
2N5179	Wideband preamp trans.	$.80

250 MHz SCALER KIT includes 95H90, 2N5179 Circuit Board, small parts and instructions. Requires 5V power source — not included. ONLY **$24.95**

500 MHz Prescaler **$43.95**

7-SEGMENT READOUT SALE

JUMBO 747
Large .6″ high seven segment characters for wide angle and distance viewing. Choice of red, yellow or green
$3.25 each

KING SIZE
An industry first. Full 1″ high characters. High contrast ratio for long distance viewing. Specify common anode or cathode. Red only. **$3.95 each**

REGULAR SIZE
Standard .3″ characters. Available in red, green or yellow.
$1.99 each

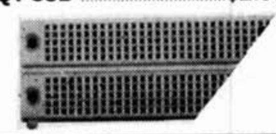
BARGINS

16 IN914	$1.00
20 .01 TTL bypass	$1.00
10 .1 TTL bypass	$1.00
RCA 40673	$1.25

8038 FUNCTION GENERATOR WITH FREE CIRCUIT BOARD **$5.50**

Continental Specialties QT Breadboards

QT-59S	$12.50
QT59B	$2.50
QT-47S	$10.00
QT-47B	$2.25
QT-35S	$8.50
QT-35B	$2.00



TOROID CORES

PRICE — $1.00 PACKS

Quantity	Core	Color	Frequency
3	T50-2	Red	To 20 MHz
3	T68-2	Red	To 20 MHz
3	T50-6	Yellow	To 75 MHz
3	T50-10	Black	To 200 MHz
3	T44-10	Black	To 200 MHz

ALSO
T200-2 ONLY $2.00 ea.

2194F 10.7 MHz Crystal Filter For FM RCVRS ~~$7.95~~ **$3.99** USE WITH CA3089E

SIGNETICS **NE555 $1.00** PRIME QUALITY

POPULAR IC's

MC1550	Motorola RF amp	$1.50
CA3020	RCA ½ W audio	$2.99
CA3020A	RCA 1 audio	$3.49
CA3028A	RCA RF amp	$1.77
CA3001	RCA	$6.00
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.	$2.00
MFC9020	Motorola 2-Watt audio	$2.50
MFC4010	Multi-purpose wide-band amp	$1.25
MFC8040	Low noise preamp	$1.99
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	$1.40
MFE3007	Dual-gate	$1.98
40673		$1.25
3N140	Dual-gate	$1.95
3N141	Dual-gate	$1.86

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MC4044 PHASE DET	$2.95
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MC1648 VCO	$3.75

RCA ICs

CA3130T	$1.45
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CA3132EM 5W AUDIO AMP with heat sink	$4.50

SEND FOR FREE CATALOG

Please add 40¢ for shipping

CIRCUIT SPECIALISTS CO.
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7400N TTL

SN7400N	.16	SN7451N	.27	SN74151N	1.25
SN7401N	.16	SN7453N	.27	SN74153N	1.35
SN7402N	.21	SN7454N	.41	SN74154N	1.25
SN7403N	.16	SN7459A	.25	SN74155N	1.21
SN7404N	.21	SN7460N	.22	SN74156N	1.30
SN7405N	.24	SN7470N	.45	SN74157N	1.30
SN7406N	.45	SN7472N	.39	SN74160N	1.75
SN7407N	.45	SN7473N	.45	SN74161N	1.45
SN7408N	.25	SN7474N	.45	SN74163N	1.65
SN7409N	.25	SN7475N	.80	SN74164N	1.65
SN7410N	.20	SN7476N	.47	SN74165N	1.65
SN7411N	.30	SN7480N	.50	SN74166N	1.70
SN7412N	.42	SN7482N	1.75	SN74167N	5.50
SN7413N	.85	SN7483N	1.15	SN74170N	3.00
SN7414N	.70	SN7485N	1.12	SN74172N	18.00
SN7416N	.43	SN7486N	.45	SN74173N	1.70
SN7417N	.43	SN7488N	3.50	SN74174N	1.95
SN7418N	.25	SN7489N	3.00	SN74175N	1.95
SN7420N	.21	SN7490N	.59	SN74176N	.90
SN7421N	.39	SN7491N	1.20	SN74177N	.90
SN7423N	.37	SN7492N	.82	SN74180N	1.05
SN7425N	.43	SN7493N	.82	SN74181N	3.55
SN7426N	.31	SN7494N	.91	SN74182N	.95
SN7427N	.37	SN7495N	.91	SN74184N	2.30
SN7429N	.42	SN7496N	.91	SN74185N	2.20
SN7430N	.26	SN74100N	1.25	SN74187N	6.00
SN7432N	.31	SN74107N	.49	SN74190N	1.50
SN7437N	.47	SN74121N	.55	SN74191N	1.50
SN7438N	.40	SN74122N	.49	SN74192N	1.50
SN7439A	.25	SN74123N	1.05	SN74193N	1.40
SN7440N	.21	SN74125N	.60	SN74194N	1.45
SN7441N	1.10	SN74126N	.81	SN74195N	1.00
SN7442N	1.08	SN74132N	3.00	SN74196N	1.25
SN7443N	1.05	SN74141N	1.15	SN74197N	1.00
SN7444N	1.10	SN74142N	6.50	SN74198N	2.25
SN7445N	1.10	SN74143N	7.00	SN74199N	2.25
SN7446N	1.15	SN74144N	7.00	SN74200N	7.00
SN7447N	.89	SN74145N	1.15	SN74251N	2.50
SN7448N	.99	SN74148N	2.50	SN74284N	6.00
SN7450N	.26	SN74150N	1.10	SN74285N	6.00

20% Discount for 100 Combined 7400's

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CD4000	.25	CD4030	.65	74C10N	.65
CD4001	.25	CD4035	1.85	74C20N	.65
CD4002	.25	CD4040	2.45	74C30N	.65
CD4006	2.50	CD4042	1.90	74C42N	2.15
CD4007	.25	CD4044	1.50	74C73N	1.50
CD4009	.59	CD4046	2.51	74C74	1.15
CD4010	.59	CD4047	2.75	74C90N	3.00
CD4011	.25	CD4049	.79	74C95N	2.00
CD4012	.25	CD4050	.79	74C107N	1.25
CD4013	.47	CD4051	2.98	74C151	2.90
CD4016	.56	CD4053	2.98	74C154	3.00
CD4017	1.35	CD4060	3.25	74C157	2.15
CD4019	.55	CD4066	1.75	74C160	3.25
CD4020	1.49	CD4069	.45	74C161	3.25
CD4022	1.25	CD4071	.45	74C163	3.00
CD4023	.25	CD4081	.45	74C164	3.25
CD4024	1.50	74C00N	.39	74C173	2.60
CD4025	.25	74C02N	.55	74C193	2.75
CD4027	.69	74C04N	.75	74C195	2.75
CD4028	1.65			80C97	1.50
CD4029	2.90				

JAMES NOVEMBER SPECIALS

DIODES

IN4001	50V @ 1 Amp	15/$1.00
IN4002	100V @ 1 Amp	15/$1.00
IN4003	200V @ 1 Amp	15/$1.00
IN4004	400V @ 1 Amp	15/$1.00
IN4148	Switching	20/$1.00

TRANSISTORS

2N2907A	PNP Switching	6/$1.00
2N2222A	NPN Switching	6/$1.00
2N3904	NPN Amp	6/$1.00
2N3906	PNP Amp	6/$1.00
2N918	NPN RF	6/$1.00
2N5951	NJ Fet	6/$1.00
C106B1	3.6 Amp SCR	2/$1.00

TTL/LINEAR

7400	Gate	7/$1.00
7447	Decoder	.79
7490	Counter	.49
74100	8 Bit Latch	.99
74154	Decoder	.99
74197	Counter	.75
LM301H - LM741H		4/$1.00
LM324N - Quad 741 -		1.19
LM309H	5V Reg TO-5	.79
LM309K	5V Reg TO-3	.99

DYNAMIC SHIFT REGISTERS

MM500H MM504H MM510H **2 FOR**
MM503H MM506H MM5016H **$1.00**

CLOCK & CALC. CHIPS

MM5311N	6 Digit	$2.95
MM5312N	4 Digit	2.95
MM5313N	6 Digit	2.95
MM5314N	6 Digit	2.95
MM5316N	6 Digit Alarm	3.95
MM5725N	8 Digit-4 Funt.	1.98
MM5736N	6 Digit-4 Funt.	3.95
MM5738N	8 Digit-5 Funt.	4.95

26 Awg RIBBON CABLE

1 Ft. Minimum	1-9 ft.	10 ft.
4 Cond.	.29 ft.	.25 ft.
8 Cond.	.59 ft.	.49 ft.
16 Cond.	.89 ft.	.79 ft.
32 Cond.	1.89 ft.	1.69 ft.

PARTS SURVEY

I read the letter from Robert Briner in the June issue of **R-E** about his problem of obtaining parts overseas for projects. I now have nine months experience with several firms and received all the parts I ordered. The time it took to receive the parts varied from firm to firm. Here is a list of my experiences with the firms.

James Electronics	Belmont, CA	7–10 days
Poly Paks	Lynnfield, MA	2–3 weeks (getting better)
International Electronics Unlimited	Monterey, CA	2–3 weeks
Southwest Technical Products	San Antonio, TX	3–4 weeks
Meshna Electronics	Lynnfield, MA	2–3 weeks
Delta Electronics	Lynnfield, MA	3–4 weeks
Solid State Sales	Somerville, MA	3–4 weeks
Howard W. Sams & Co.	Indianapolis, IN	7 weeks
Altaj Electronics	Dallas, TX	1–1½ months

All the times are from the day I wrote the letter until I received the parts.

H. K. BERKHOUDT
Rotterdam (23)
Holland

Reprinted From Radio & Electronics September 1975

HP-5082-7300

HP-5082-7300
.3" Dot Matrix type numeric readouts with decoder/driver/latch built on the chip. Only 8 bins (BCD in, DP, Latch, +5v, ground).
HP 5082-7300 **$5.95**

HP 5082-7304
+ 1 version of 7300 **4.95**

1¼" x 1½" XFMERS

P.C. Mount

That were designed for clock type applications. 110 Vac primary @60 Hz.
Secondaries: 8-10 Vac @ 300 mA-500 mA
50 Vac @ 30 mA-50 mA
Excellent for miniature power supplies & gas discharge displays

SPECIAL $.99

1/16 VECTOR BOARD

P-Pattern
0.1" Hole Spacing

PHENOLIC	64P44-062XXXP	4.50	6.50	1.72	1.54
	169P44-062XXXP	4.50	17.00	3.86	3.22
EPOXY GLASS	64P44-062	4.50	6.50	2.07	1.86
	84P44-062	4.50	8.50	2.56	2.31
	169P44-062	4.50	17.00	5.04	4.53
	169P84-062	8.50	17.00	9.23	8.26
EPOXY GLASS COPPER CLAD	169P44-062C1	4.50	17.00	6.80	6.12

DPST C & K ROCKER SWITCH

They are rated at 125 Vac @ 5A. Thev are excellent in application suc'i as Microcomputer Panel Switches

Dim: 1" x 1" x ¼" **$0.69**

PROTO BOARD-100

Here's a low cost, big 10 IC capacity breadboard kit with all the quality of QT Sockets and the best of the Proto Board series . . . complete down to the last nut, bolt and screw. Includes 2 QT-35S Sockets; 1 QT-35B Bus Strip; 2 5-way binding posts; 4 rubber feet; screws, nuts, bolts; and easy assembly instructions.

COMPLETE KIT . . . $17.95
***Special**

MICROPROCESSOR COMPONENTS

8008 – $19.95 **2102 – $2.95**

CPU'S

8008	8 bit CPU	$19.95
8080	8 bit Super 8008	149.95
4040	4 bit 8080	39.95

UARTS

AY-5-1013	6.95

PROM'S

8223	32x8 Prom	3.00
1702A	2K E Prom	17.95
5203Q	2K E Prom	14.95
74S287	1Kx1 Prom	7.95

SR'S

2401	2K DSR	9.95
2533	1K SSR	7.95

RAM'S

1101	256x1	Static	$2.25
1103	1Kx1	Dynamic	2.95
2102	1Kx1	Static	2.95
2107	4Kx1	Dynamic	19.95
7010	1Kx1	Mnmos	29.95
7489	16x4	Static	2.49
8101	1Kx1	Static	7.95
8111	1Kx1	Static	7.95
8599	16x4	Tristate	3.49
91L02	1Kx1	Low Power	3.95
74200	256x1	Static	6.95
74LS670	4x4	Register	3.95
93410	256x1	Static	2.95

91L02 1K Static RAM Direct Replacement for 2102-1 with 40% Less Current Drawn. **3.95**

Vector General Purpose Logic CARD Board 14.95
*Very High Noise Immunity *Holds 12 ea. 14 pin DIPS
*44 pin Edge Connection

THE KILOBYTE RAM CARD Per Kit **$49.95**
*Complete 1Kx8 Memory * High Noise Immunity Components
*Single 5v supply *500NS Access Time & Kit includes sockets, ICS & Board

FREE $12.00 Value With each $75 order of Microprocessor components, get a one year subscription to **BYTE** the magazine for computer PHREAKS FREE FREE FREE

KITS EXAR ICS

XR-2206KA **SPECIAL $17.95**
Includes monolithic function generator IC, PC board, and assembly instruction manual.

XR-2206KB **SPECIAL $27.95**
Same as XR-2206KA above and includes external components for PC board.

TIMERS

XR-555CP	**SPECIAL**	$ .69
XR-320P		1.55
XR-556CP		1.85
XR-2556CP		3.20
XR-2240CP	**SPECIAL**	3.25

PHASE LOCKED LOOPS

XR-210		5.20
XR-215		6.60
XR-567CP		1.95
XR-2567CP	**SPECIAL**	2.99

STEREO DECODERS

XR-1310P		$3.20
XR-1310EP		3.20
XR-1800P		3.20

WAVEFORM GENERATORS

XR-205		8.40
XR-2206CP	**SPECIAL**	4.49
XR-2207CP		3.85

MISCELLANEOUS

XR-2211CP		6.70
XR-2261		3.79

Special Requested Items

RC4194	Dual Track V Reg	$5.95	N8T97	$3.00	2533	$7.95
RC4195	±15V Track Reg	3.25	4024P	2.25	8263	5.95
F9368	Decoder	3.95	2513	11.00	8267	2.75
LD110/111	DVM Chip Set	28.00	2518	7.00	8288	1.15
CA3130	Super CMOS Op Amp	1.49	2524	3.50	8826	3.00
MC1408L7	A/D	9.95	2525	6.00	8880	1.35
F3341	FIFO	8.95	2527	5.00	7497	5.00

LINEAR

LM100H	15.00			LM1310N	2.95
LM106H	2.50			LM1351N	1.65
LM171H	3.75	LM373N	3.25	LM1414N	1.75
LM212H	7.00	LM377N	4.00	LM1458C	.65
LM300H	.80	LM380N	1.39	LM1496N	.95
LM301H	3/1.00	LM380CN	1.05	LM1556V	1.85
LM301CN	3/1.00	LM381N	1.79	LM2111N	1.95
LM302H	.75	LM382N	1.79	LM2901N	2.95
LM304H	1.00	NE501K	8.00	LM3065N	.69
LM305H	.95	NE510A	6.00	LM3900N	.55
LM307CN	.35	NE531H	3.00	LM3905N	.60
LM308H	1.00	NE536T	6.00	LM5556N	1.85
LM308CN	1.00	NE540L	6.00	MC5558V	1.00
LM309H	1.10	NE550N	.79	LM7525N	.90
LM309K	1.25	NE553	2.50	LM7528N	2.20
LM310CN	1.15	NE555V	.49	LM7534N	2.20
LM311H	.90	NE565H	.99	LM7535N	1.25
LM311N	.90	NE565N	1.25	8038B	4.95
LM318CN	1.50	NE566CN	1.95	LM75450	.49
LM319N	1.30	NE567H	1.25	75451CN	.39
LM319D	9.00	NE567V	1.50	75452CN	.39
LM320K 5	1.35	LM703CN	.45	75453CN	.39
LM320K 5.2	1.35	LM709H	.29	75454CN	.39
LM320K 12	1.35	LM709N	.29	75491CN	.79
LM320K 15	1.35	LM710N	.79	75492CN	.89
LM323K 5	10.50	LM711N	.39	75494CN	.89
LM324N	1.80	LM723N	.55	**RCA LINEAR**	
LM339N	1.70	LM723H	.55	CA3013	1.70
LM340K 5	1.95	LM733N	1.00	CA3023	2.15
LM340K 12	1.95	LM739N	1.29	CA3035	2.25
LM340K 15	1.95	LM741CH	3/1.00	CA3039	1.35
LM340K 24	1.95	LM741CN	3/1.00	CA3046	1.15
LM340T 5	1.75	LM741 14N	.39	CA3059	2.46
LM340T 6	1.75	LM747H	.79	CA3060	2.80
LM340T 12	1.75	LM747N	.79	CA3080	.85
LM340T 15	1.75	LM748H	.39	CA3083	1.60
LM340T 24	1.75	LM748N	.39	CA3086	.59
LM350N	1.00	LM1303N	.90	CA3089	3.25
LM351CN	.65	LM1304N	1.19	CA3091	8.25
LM370N	1.15	LM1305N	1.40	CA3123	1.85
LM370H	1.15	LM1307N	.85	CA3600	1.75

DATA HANDBOOKS

7400	Pin-out & Description of 5400/7400 ICS	**$2.95**
CMOS	Pin-out & Description of 4000 Series ICS	**$2.95**
LINEAR	Pin-out & Functional Description of Linear Circuits	**$2.95**

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2 CONDUCTORS

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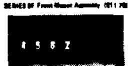
THUMBWHEEL SWITCHES

THUMBWHEEL SWITCH ONLY
SF – Front Mount SR – Rear Mount

Part No.	Description	Price
SF 12	Single Pole 10 Position	$2.50
SR 12	Decimal	3.00
SF 21	10 Position BCD only	2.50
SR 21		3.00

Snap together – No Hardware

SERIES SF Front Mount Assembly ($11.70)



Note: Picture to the left has the following 4 ea. SF 12, 1 ea. SF EP, 1 ea. SF BB, 1 ea. SF DP and 1 ea. SF HB

ACCESSORIES

Part No.	Description	Price
SF EP	End Plate (Pair)	.50
SF DP	Divider Plate (each)	.40
SF BB	Blank Body (each)	.40
SF HB	Half Body (each)	.40

SERIES SR Rear Mount Assembly ($12.70)

Note: Picture to the left has the following 4 ea. SR 12, 1 ea. SR EP, 1 ea. SR BB, 1 ea. SR DP and 1 ea. SR HB

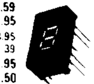
ACCESSORIES

Part No.	Description	Price
SR EP	End Plate (pair)	$ .50
SR DP	Divider Plate (each)	.40
SR BB	Blank Body (each)	.40
SR HB	Half Body (each)	.40

Ordering: Order desired switch or switches and add necessary accessories for your particular application

DISPLAY LEDS

FND70	Com. Cath.	.250	.59
MAN 1	Com. Ano.	.270	$1.95
MAN 2	5x7 Matrix	.300	3.95
MAN 3	Com. Cath.	.125	.39
MAN 4	Com. Cath.	.187	1.95
MAN 7	Com. Ano.	.30	1.50
DL33	Com. Cath.	.125	1.95
DL747	Com. Ano.	.625	1.95



DISCRETE LEDS

MV 10	Red	5/$1.00
MV 50	Red	6/$1.00
MV 5024	Red	5/$1.00
MV 5024	Green	4/$1.00
MV 5024	Yellow	4/$1.00
MV 5024	Orange	4/$1.00
MV 50*	Red 1¼″ Leads	5/$1.00

IC SOLDERTAIL – LOW PROFILE (TIN) SOCKETS

	1-24	25-49	50-100		1-24	25-49	50-100
8 pin	$.17	.16	.15	24 pin	$.38	.37	.36
14 pin	.20	.19	.18	28 pin	.45	.44	.43
16 pin	.22	.23	.22	36 pin	.60	.59	.58
18 pin	.29	.28	.27	40 pin	.63	.62	.61
22 pin	.36	.37	.36				

SOLDERTAIL STANDARD (GOLD)

8 pin	$.30	.27	.24	24 pin	$.70	.63	.57
14 pin	.35	.32	.29	28 pin	1.10	1.00	.90
16 pin	.38	.35	.32	36 pin	1.55	1.40	1.26
18 pin	.52	.47	.43	40 pin	1.75	1.59	1.45

WIRE WRAP SOCKETS (GOLD) LEVEL #3

10 pin	$.45	.41	.37	24 pin	$1.05	.95	.85
14 pin	.39	.38	.37	28 pin	1.40	1.25	1.10
16 pin	.43	.42	.41	36 pin	1.59	1.45	1.30
18 pin	.75	.68	.62	40 pin	1.75	1.55	1.40

50 PCS. RESISTOR ASSORTMENTS $1.75 PER ASST.

ASST. 1	5 ea.	10 OHM 12 OHM 15 OHM 18 OHM 22 OHM 27 OHM 33 OHM 39 OHM 47 OHM 56 OHM	1/4 WATT 5% = 50 PCS.
ASST. 2	5 ea.	68 OHM 82 OHM 100 OHM 120 OHM 150 OHM 180 OHM 220 OHM 270 OHM 330 OHM 390 OHM	1/4 WATT 5% = 50 PCS.
ASST. 3	5 ea.	470 OHM 560 OHM 680 OHM 820 OHM 1K 1.2K 1.5K 1.8K 2.2K 2.7K	1/4 WATT 5% = 50 PCS.
ASST. 4	5 ea.	3.3K 3.9K 4.7K 5.6K 6.8K 8.2K 10K 12K 15K 18K	1/4 WATT 5% = 50 PCS.
ASST. 5	5 ea.	22K 27K 33K 39K 47K 56K 68K 82K 100K 120K	1/4 WATT 5% = 50 PCS.
ASST. 6	5 ea.	150K 180K 220K 270K 330K 390K 470K 560K 680K 820K	1/4 WATT 5% = 50 PCS.
ASST. 7	5 ea.	1M 1.2M 1.5M 1.8M 2.2M 2.7M 3.3M 3.9M 4.7M 5.6M	1/4 WATT 5% = 50 PCS.

PRIME INTEGRATED CIRCUIT ASSORTMENTS

ASST. 8	3 ea.	SN7400 7401 7402 7403 7404 SN7410 7430 7438 7440 7472	SSI/TTL	$5.95 ASST
ASST. 9	2 ea.	SN7447 7490 7491 74100 74121 SN74145 74175 74180 74191 74193	MSI/TTL	$9.95 ASST.
ASST. 10	2 ea.	CD4001 4002 4011 4012 4013 CD4016 4017 4019 4023 4030	CMOS	$7.95 ASST
ASST. 11	2 ea.	LM301T 301N 302T 307T 309K LM311T 565T 567T 741T 741N	LINEAR	$10.95 ASST

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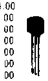
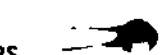
TYPE	VOLTS	W	PRICE	TYPE	VOLTS	W	PRICE
IN746	3.3	400m	4/1.00	IN4003	200 PIV	1 AMP	.10
IN751A	5.1	400m	4/1.00	IN4004	400 PIV	1 AMP	.10
IN752	5.6	400m	4/1.00	IN3600	50	200m	6/1.00
IN753	6.2	400m	4/1.00	IN4148	75	10m	15/1.00
IN754	6.8	400m	4/1.00	IN4154	35	10m	12/1.00
IN965B	15	400m	4/1.00	IN4734	5.6	1w	.28
IN5232	5.6	500m	.28	IN4735	6.2	1w	.28
IN5234	6.2	500m	.28	IN4736	6.8	1w	.28
IN5235	6.8	500m	.28	IN4738	8.2	1w	.28
IN5236	7.5	500m	.28	IN4742	12	1w	.28
IN456	25	40m	6/1.00	IN4744	15	1w	.28
IN458	150	7m	6/1.00	IN1183	50 PIV	35 AMP	1.60
IN485A	180	10m	5/1.00	IN1184	100 PIV	35 AMP	1.70
IN4001	50 PIV	1 AMP	.09	IN1186	200 PIV	35 AMP	1.80
IN4002	100 PIV	1 AMP	.10	IN1188	400 PIV	35 AMP	3.00

TRANSISTORS




MPS A05	5/1.00			PN4249	4/$1.00
MPS A06	5/$1.00	PN3567	3/$1.00	PN4250	4/$1.00
2N2219A	3/$1.00	PN3568	4/$1.00	2N4400	4/$1.00
2N2221	4/$1.00	PN3569	4/$1.00	2N4401	4/$1.00
2N2222A	5/$1.00	2N3704	5/$1.00	2N4402	4/$1.00
2N2369	5/$1.00	2N3705	5/$1.00	2N4403	4/$1.00
2N2369A	4/$1.00	2N3700	5/$1.00	2N4409	5/$1.00
FN2415	5/$1.00	2N3707	5/$1.00	2N5086	4/$1.00
2N2484	4/$1.00	2N3711	5/$1.00	2N5087	4/$1.00
2N2906A	4/$1.00	2N3724	$.65	2N5088	4/$1.00
2N2907A	5/$1.00	2N3725	$1.00	2N5089	4/$1.00
2N2925	5/$1.00	2N3903	5/$1.00	2N5129	5/$1.00
2N3053	2/$1.00	2N3904	4/$1.00	2N5138	5/$1.00
2N3055	$.89	2N3905	4/$1.00	2N5139	5/$1.00
MJE3055	$.89	2N3906	4/$1.00	2N5209	5/$1.00
2N3392	5/$1.00	2N4013	3/$1.00	2N5951	5/$1.00
2N3398	5/$1.00	2N4014	3/$1.00	C106B1 SCR	2/$1.00

CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

	1-9	10-49	50-100		1-9	10-49	50-100
10pf	.05	.04	.03	.001	.05	.04	.035
22 pf	.05	.04	.03	.0047	.05	.04	.035
47 pf	.05	.04	.03	.01	.05	.04	.035
100 pf	.05	.04	.03	.022	.06	.05	.04
220 pf	.05	.04	.03	.047	.06	.05	.04
470 pf	.05	.04	.035	.1	.12	.09	.075

100 VOLT MYLAR FILM CAPACITORS

.001mf	.12	.10	.07	.022mf	.13	.11	.08
.0022	.12	.10	.07	.047mf	.21	.17	.13
.0047mf	.12	.10	.07	.1mf	.27	.23	.17
.01mf	.12	.10	.07	.22mf	.33	.27	.22

+ 20% DIPPED TANTALUMS (SOLID) CAPACITORS

.1	35V	.28	.23	.17	1.5	35V	.30	.26	.21
.15	35V	.28	.23	.17	2.2	25V	.31	.27	.22
.22	35V	.28	.23	.17	3.3	25V	.31	.27	.22
.33	35V	.28	.23	.17	4.7	25V	.32	.28	.23
.47	35V	.28	.23	.17	6.8	25V	.36	.31	.25
.68	35V	.28	.23	.17	10	25V	.40	.35	.29
1.0	35V	.28	.23	.17	15	25V	.63	.50	.40

MINIATURE ALUMINUM ELECTROLYTIC CAPACITORS

Axial Lead					Radial Lead				
.47	50	.15	.13	.10	.47	25	.15	.13	.10
1	50	.16	.14	.11	.47	50	.16	.14	.11
3.3	50	.15	.13	.10	1	16	.15	.13	.10
4.7	25	.16	.14	.12	1	25	.16	.14	.11
10	25	.15	.13	.10	1	50	.16	.14	.11
10	50	.16	.14	.12	4.7	16	.15	.13	.10
22	25	.17	.15	.12	4.7	25	.15	.13	.10
22	50	.24	.20	.18	4.7	50	.16	.14	.11
47	25	.19	.17	.15	10	16	.14	.12	.09
47	50	.25	.21	.19	10	25	.15	.13	.10
100	25	.24	.20	.18	10	50	.16	.14	.12
100	50	.35	.30	.28	47	50	.24	.21	.19
220	25	.32	.28	.25	100	16	.19	.15	.14
220	50	.45	.41	.38	100	25	.24	.20	.18
470	25	.33	.29	.27	100	50	.35	.30	.28
1000	16	.55	.50	.45	220	16	.23	.17	.16
2200	16	.70	.62	.55	470	25	.31	.28	.26

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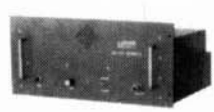

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MODEL 25 - 30W - 7db - $167.	MODEL E - 35W - 10db - $80.
MODEL 30 - 30W - 9db - $194.	SUPER E KIT - 40W - 11db - $60.
MODEL 50 - 50W - 5db - $251.	MODEL ES - 40W - 11db - $115.
OTHER PRODUCTS	10-0 - 100W - 7db - $209.
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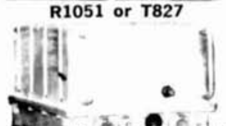
R1051 or T827



ARC-51 Transceiver

618-T Transceiver (also known as MRC95, ARC94, ARC102, or VC102)

Highest price paid for these units. Parts purchased. Phone **Ted, W2KUW collect.** We will trade for new amateur gear. GRC106 and PRC74 also required. See HR last issue for other equipment required.

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MT-15, MT-25, & AQUAFONE Transceiver

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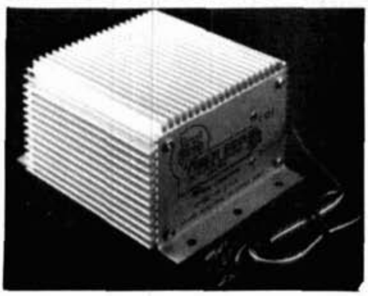

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flea market

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

DEAF HAMS. I would like to know about deaf hams' experiences as amateurs, how they got interested in the hobby, any problems had in obtaining licenses, and whether there are deaf hams using modes other than CW, such as ATV or RTTY. Please write to Jerry Lane, WN9NPC, 922 Suburban Apts., DeKalb, IL 60115.

RTTY — Model 32 ASR - $300.00, Model 33 ASR - $600.00. Both like new and working perfectly. Can arrange shipping. K9HJV, Tony, 312-349-9002.

PLEASE HELP. We are in the process of publishing a book which will contain as many awards as possible that are offered to ham radio operators. We therefore would like to hear from you regarding any award your club, net, or organization may have available. Also, if you know of any awards we would appreciate this information. The information needed is as follows: Name of the award, given by whom (net, club, etc.), description of the award, requirements, price, and name of awards chairman. Also list the time, dates, and frequencies of your net or club meetings. Send information to Joseph F. Williams, WA9TSG, 114 East Brown Street, Milwaukee, Wisconsin 53212. We want to be ready for the printers by December 1st. Your help will be greatly appreciated. Thank you.

HOMEBREWERS: Stamp brings list of high quality components. CPO Surplus, Box 189, Braintree, Mass. 02184.

CANADIAN JUMBO SURPLUS and Parts Catalogs. Bargains Galore. Send $1. ETCO-HR, Box 741, Montreal "A" H3c 2V2.

RTTY NS-1 PLL TU (HR 2/75) wired/tested $29.95 ppd. Nat Stinnette Electronics, Tavares, FL 32778.

UHF ¼KW REPEATER, Motorola $395, TTL/2 RTTY demodulator $75, Touchtone decoder $100, Speedcall Touchtone to dial pulse converter $150, 3½" Questar telescope $1200. Tom Pappan, Box 147, Corunna, MI 48817, 517-743-4607.

ROCHESTER HAMFEST 1976 is Saturday, May 22. Your name added to mailing list or information — write: Rochester Hamfest, Box 1388, Rochester, N. Y. 14603.

ATTENTION HOBBIEST: Complete line of high quality low cost universal printed circuit boards. NOT a kit, but complete ready to use. Boards complete with 22 single sided contacts, all holes drilled (over 700), tin plated copper, FR-4 glass epoxy. For as low as $5.50. Each board guaranteed, or your money back. Will quote on custom work. Write for complete catalog. Camp Control Company, P. O. Box 174, Garland, Texas 75040.

SELL — Quality nylon cable ties 6 inch for $2.75 pp/hundred. New Manuals for AN/ARC-3, AN/ARC-12, AN/TRC-1 for $5.00 pp. W4VQD/Ø, 106 Sheridan Ct., Leavenworth, Ks. 66048.

JAPANESE TRANSISTORS — All Transistors original factory made. Over 500 types available. Write for free catalog. West Pacific Electronics, P. O. Box 25837, W. Los Angeles, CA 90025.

SELL: Heath SB 610 monitor $70, you ship. C. Dyson, 5748 N.E. 62nd, Seattle, Wash. 98115.

PORTA-PAK the accessory that makes your mobile really portable. $59.95 and $39.95. Dealer inquiries invited. P. O. Box 67, Somers, Wisc. 53171.

MODERN 60 MIN. CODE CASSETTES. Novice 0-5 wpm, Progressive 5-13 wpm, General 13-15 wpm, Extra 20-22 wpm. $3 each, 4/$10. Royal, Box 2174, Sandusky, Ohio 44870.

VIDEO RECORDER-REPRODUCER ELECTRONIC ASSEMBLY. Contains power supply with adjustable, regulated outputs of ± 10 to 18 VDC (± 15 VDC @ 1½ amps.). Third output is 10 VDC at 3 amps. Perfect for CMOS, TTL, Op-amps. Contains over 900 useable parts with extremely long leads. Includes 182 transistors IC's, diodes, and FET's, numerous resistors, capacitors, crystals, inductors, delay lines and varicaps. Transistors will operate in HEATHKIT TV's. Schematics and semiconductor cross reference supplied upon request. Total price including shipping is $15.00. Write to Madison Electronics Company Inc., P. O. Box 369, Madison, Alabama 35758 for a free brochure.

SAROC ELEVENTH NATIONAL CONVENTION — Hotel Sahara Space Center, Las Vegas, Nevada, January 8-11, 1976. ADVANCE REGISTRATION, $12.00 per person includes: Advance and regular registration tickets; Option to purchase up to ten additional tickets for main prize drawing @$2.00 each; Admission to Friday social hour hosted by T.P.L. Communications and Tri-Ex Tower Corp., with SAROC, adults only; Admission to exhibit area and technical sessions; Admission to Saturday social hour, hosted by Ham Radio Magazine with SAROC, adults only; Hotel Sahara Safari Brunch for Sunday; Accommodations reservations card for SAROC special room rate at Hotel Sahara @$17.00 or Thunderbird Hotel @$14.00 per night, plus room tax, single or double occupancy; Tax and gratuity on all items listed except hotel room tax. ADVANCE REGISTRATION, with Midnight Show, $22.00 per person includes all items above plus Hotel Sahara's Midnight Show, with two drinks in Hotel Sahara Congo Show Room. ADVANCE REGISTRATION: with Dinner Show, $29.00 per person includes all items listed above plus Hotel Sahara's Dinner Show, Prime Rib (no drinks) in Hotel Sahara Congo Show Room. Advance registrations accepted if received in SAROC P. O. Box on or before January 1, 1976. Full refund on advance registration (after convention is over) if written request is received in SAROC P. O. Box on or before January 8. Regular registrations will be accepted at the door for an additional $2.00 each, so why not send your registration now. Special SAROC Hotel Sahara modified Safari package via most scheduled airlines serving Las Vegas from selected principal cities. Write for details. SAROC, P. O. Box 945, Boulder City, NV 89005.

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- HI VALUE

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2N3506	TO-5	6	5	40	40-200	60	11.	2.95
2N4896	TO-5	6	5	60	100-300	80	11.	3.50
2N3675	TO-5	6	5	55	12-60	60	11.	2.95
2N5327*	TO-5	5	10	80	100-300	100	25.	4.95
2N5326*	TO-59	50	5	80	50-150	80	16.	3.95
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2N3997**	TO-111	30	5	80	80-240	40	54.	6.95
2N3621*	TO-61	50	10	40	40min	200	15.	5.95
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SVT-350-3B*	TO-61	116	3	350	15	30	19.	6.50
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SVT-20010B*	TO-61	140	10	200	15	30	25.	8.50
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☐ 1N4003	200	10 for 65c
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☐ 1N4005	600	10 for 85c
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4-DIGIT AM-PM FLUORESCENT CLOCK PANEL

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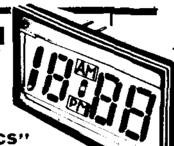
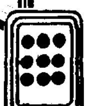
YOU ASKED FOR IT! Found only at Poly Paks at this l-o-w price! It's ONLY 1 3/4 x 1 3/16 x 3/8" deep panel. Designed specifically for our MM-5316 fluorescent driving clock chip. Indicates 4-digits, AM-PM, pulsating second indicator, requires minimum of parts to build. Color: *BLUE-GREEN; you can use RED or* GREEN filters. Character height: 0.5". Filament voltage is 1.75 VAC or DC @ 160 mils. Anode voltage 25V @ 250 microamps per segment. With spec sheets, clock construction diagrams, P.C. board layouts, specs. A DIGITAL CLOCK BUILDER'S SPECIAL.



POSTAGE STAMP MOBILE SPKR MIKE ☐ $1.98

This unit is not advertised — anywhere! Made for Motorola Communications at the original cost of $4.50 each (for insertion in their Walkie Talkie Program). It's a 60-ohm imp MIKE. It's an excellent speaker too, covering broad range in sound.



4½ DIGIT DVM CHIP ☐ $14.95

Type MM5330 by National utilizes P channel low-threshold enchancement mode devices and ion implanted depletion mode devices. Provides logic circuit for 4½ digit DVM. *TTL compatible.*
With instruction sheets and diagram on "how-to-build a 4½ digit DVM". Ideal with our Litronix ½" single, 1½" and dual digits. 16-pin DIP.

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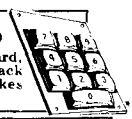
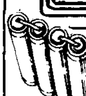


☐ 555 Timer 2 for $1

OR

☐ 558 Dual 741 3 for $1



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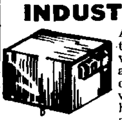
INDUSTRIAL SPEED CONTROL ☐ $4.95



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- All fit into 14-pin IC socket.

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☐ MAN-4AB	.27	Red	1.95	5.00
☐ MAN-5	.27	Green	1.50	4.00
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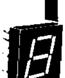
☐ 746F	.6	Red	3.95	11.00
☐ 747	.6	Red	3.95	11.00



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QRP TRANSMATCH for HW7, Ten-Tec, and others. Send stamp for details to Peter Meacham Associates, 19 Loretta Road, Waltham, Mass. 02154.

AUCTION. Erie Amateur Radio Society's fourth annual Thanksgiving Auction will be held on Sunday, 11 a.m. - 1:30 p.m., November 30, 1975 at the Laborer's Union Hall, 2109 West Perkins Avenue, Sandusky, Ohio, across from the New Departure plant. Admission $1.00.

1000V 1 AMP DIODES, 10/$1.00. Zeners, capacitors, resistors, cmos & switches for projects, free catalog. NuData Electronics, 104 N. Emerson, Mt. Prospect, IL 60056.

WANTED: TOWER, motorized crank up, 80' WØPDI, Route 2, Box 218, Buffalo, Mo. 65622.

SOCIETY OF WIRELESS PIONEERS offers Life Membership to active and former C.W. operators on comm'l., military, gov't., etc. wireless/radio circuits. Contact: Society of Wireless Pioneers, Dept. H, P. O. Box 530, Santa Rosa, California 95402.

DRILLS — Carbide and high speed steel for PC work. Send SASE, Bob's Electronic Repair, Box 393, Bay City, MI 48706.

PC's, Send large S.A.S.E. for list. Semtronics, Rt. #3, Box 1, Bellaire, Ohio 43906.

BLIND HAM, would really appreciate any donated 160M thru 70cM transceivers. Send to WAØYQO, 137 N. Lawn, Apt. 1Q, Kansas City, Mo. 64123.

OSCAR SLIDES, set of 5, $1.25. Launch and spacecraft. Proceeds AMSAT. K6PGX, P. O. Box 463, Pasadena, CA 91102.

DC-4 POWER SUPPLY for sale at $90. Call Bob, WB2PRC at 914-477-3927 or write Maple St., Greenwood Lake, N. Y. 10925.

RECONDITIONED TEST EQUIPMENT for sale. Catalog $.50. Walter, 2697 Nickel, San Pablo, Ca. 94806.

FREE Catalog. LEDS, microphones, headsets, IC's, relays, ultrasonic devices, precision trimmer capacitors, unique components. Low Prices! Chaney's, Box 15431, Lakewood, Colo. 80215.

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QSL'S — BROWNIE W3CJI — 3035B Lehigh, Allentown, Pa. 18103. Samples with cut catalog 35¢.

PROMS PROGRAMMED: Your 1702A programmed for $5.00 or 10 for $30. Money back guarantee. Send for information including simple octal form. MLT systems, P. O. Box 1522, Canyon Country, CA. 91351.

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NEW CANADIAN MAGAZINE. "Electronics Work Shop". $5.00 yearly, sample $1.00. ETCOB, Box 741, Montreal, H3C 2V2.

More Details? CHECK—OFF Page 126

HT-220 — Mint condition, 2 frequency slimline with flexible antenna and rapid-charge Ni-Cad. $400. T. Eifert, WB7AHI, P. O. Box 5441, Eugene, Oregon 97405.

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CLOSE OUT SALE — J-beam antennas. Model 2/14P, 2 meters, 15.2 dB over dipole. $45.00 each. Free stacking harness included with two antennas. VHF Communications, 53 St. Andrew, Rapid City, S. D. 57701.

TRAVEL-PAK QSL KIT — Send call and 25¢; receive your call sample kit in return. Samco, Box 203, Wynantskill, N. Y. 12198.

HW-101, $250; mint HP-23, $40; HD-15 (phonepatch), $25; 275 watt matchbox, $50; TWOER, $35 with DC supply. SASE for info and more items. K6SRM, 272 4th St. East, Sonoma, CA. 95476.

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

CONTESTERS: Announcing the W7BBX programmable contest keyer - four 512-bit memories, paddle programming, no-fail power supply, high rf immunity, designed for smooth synchronous operation, 10-60 wpm. SASE to HFB Enterprises, 12002 Cheviot Dr., Herndon, Virginia 22070.

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COLLINS; 30S-1 in excellent operating and physical condx for Bendix R-1051B/E receiver. Sid Sidman, 3571 Gresham Court, Pleasanton, Calif. 94566.

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

TELETYPEWRITER PARTS, gears, manuals, supplies, tape, toroids. SASE list. Typetronics, Box 8873, Ft. Lauderdale, Fl. 33310. Buy parts, late machines.

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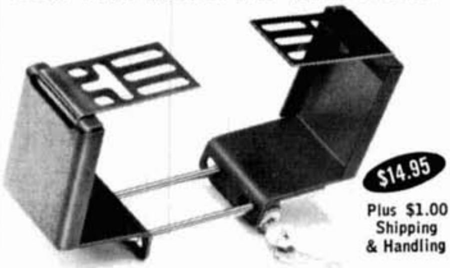

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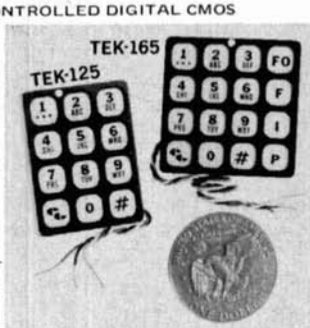

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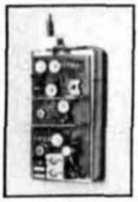

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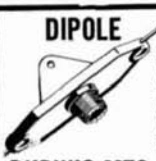

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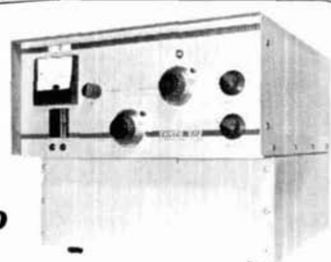

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