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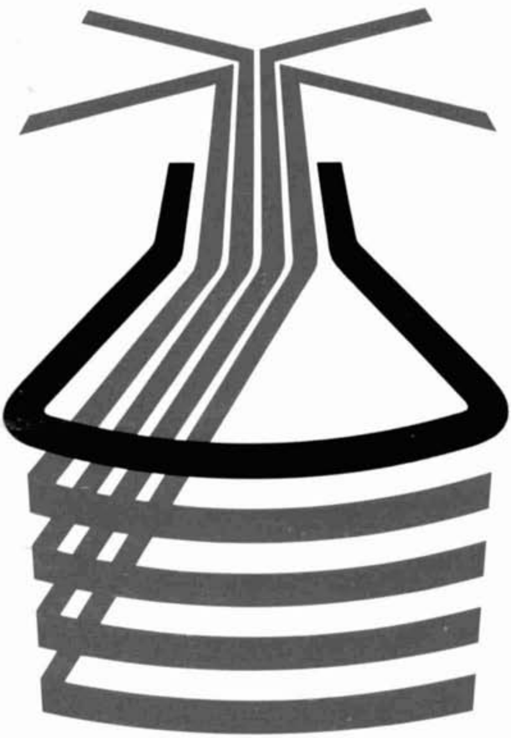

four-channel spectrum analyzer

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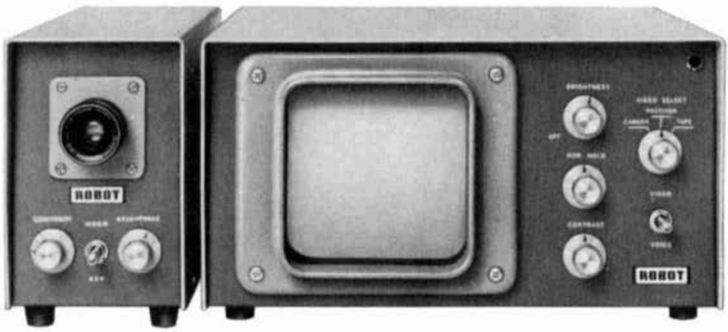

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contents

a second look

by jim fisk

The FCC has finally taken action on the so-called fm repeater docket (Docket 18803) which concerns licensing and operating rules for amateur repeaters. If you will remember, in a notice filed in February, 1970, the Commission invited comments on rules proposed for repeater stations. Since that time there has been a lot of discussion between fm operators and repeater groups, with many counter-proposals and comments submitted to the FCC.

On August 29th the Commission adopted several amendments to Part 97 of the rules. Since the present rules do not specifically refer to repeater stations, up until now it has been FCC policy to permit amateur stations to operate as repeaters under the rules applicable to all amateur stations.

Under the new rules, however, a separate station license will be required for every amateur repeater station (beginning July 1, 1973). These stations will be identified by a callsign having the distinctive prefix WR. To qualify for a repeater station license, an applicant must hold at least a Technician Class amateur license, and must submit certain data concerning the technical and operational provisions of his proposed repeater.

An amateur's license, which now specifies the location of his station and his operator privileges, will also include the privileges authorized for his station. At a minimum, the station privilege would be a *primary station.* Various kinds of station privileges may be combined with a primary station license upon submittal of appropriate information.

The remote-control operator may be any qualified amateur designated by the repeater licensee. The new rules permit a licensee to use his own repeater station while he is operating mobile or portable; they also provide for auxiliary link stations to be used when terrain makes multiple-hop control links necessary. The new rules also provide for *wire* remote control.

Under the new rules, approximately one-half of each amateur vhf band, and 8 MHz of the 420-MHz band, is authorized for repeater usage, and Technician Class licensees will be permitted to operate in the entire 145- to 148-MHz segment of the two-meter band. The new rules also restrict linked repeater operation, place limits on the effective radiated power from a repeater station antenna, and require the licensee to maintain supervision and control of both the technical and operational performance of his repeater.

The new rules also provide for operation of stations by visiting operators and automatic identification of repeater stations by telephony as well as telegraphy. In addition, they provide for continuous monitoring of remotely-controlled repeaters to prevent interference to communications already in progress on a given frequency.

Although the new rules do not prevent amateur stations from being automatically interconnected to a telephone exchange system, the Commission said that, because of numerous violations of rules regarding interconnection, it may be necessary to examine the use of autopatch facilities and possibly restrict the use of such devices in the amateur service. They also warned that, until new regulations are adopted, interconnection devices must be limited to amateur communication, and may not be used for any type of business communication.

The new rules become effective on October 17th, 1972.

Jim Fisk, W1DTY
editor

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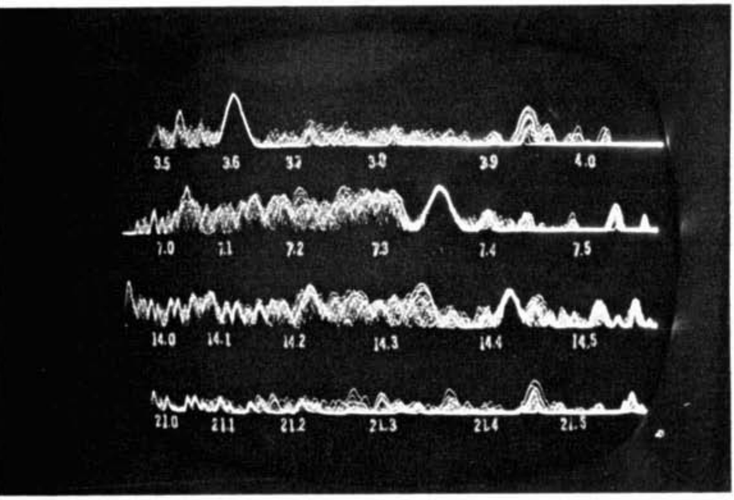


four-channel spectrum analyzer

H. F. Priebe, Jr., W91A, 5040 Wickford Way, Dunwoody, Georgia 30338

This large-screen, four channel spectrum analyzer will display four different amateur bands at one time

The conventional spectrum analyzer displays a portion of the rf spectrum in one continuous sweep. However, for many applications only certain portions of the spectrum are of interest. One such case is the testing and adjustment of frequency-multiplier circuits; another is the monitoring of a particular class of radio service where numerous separate segments or bands are involved. The amateur radio service is just such a service with the popular 80-, 40-, 20-, and 15-meter bands.

Usually, the panoramic adapter[1] or Heathkit *Scanalyzer* has been used in conjunction with the station receiver to provide a number of receiving conveniences. When a-m was popular, the panoramic adapter was exceedingly helpful in net operation. The net-control station could see a signal off frequency when he could not hear him. With the improvements that came with ssb there are far less problems with off-frequency operation. But one of the practical operating problems is that of locating an unused frequency or finding where the action is.

A major shortcoming of the adapter type of panoramic reception is that it is slaved to the station receiver and the display is centered about the received frequency. You can see what is on the band or part of the band you are listening to, but that is all. And, all too often you know what's happening on the band you're operating on but wonder what the activity might be on another band. That's one of the advantages of the large-screen 4-channel spectrum analyzer. While operating on one band, even during transmission, you can tell what is happening on the other bands.

description

A block diagram of the spectrum analyzer is shown in **fig. 1**; specifications are listed in **table 1**. The rf input is connected via an i-f trap to four high-frequency converters, each consisting of a dual-gate, mosfet rf amplifier with agc, a second dual-gate mosfet mixer, and bipolar transistors in an oscillator and switch. An enhancement-mode mosfet in the input circuit switches the antenna so actually only one converter at a time is electrically in the signal path. Converter outputs are 6 to 6.5 MHz, and for simplicity, are broadbanded.

The first i-f, second mixer and second oscillator are electronically tuned with variable-capacitance diodes. Sweep is adjusted to give in excess of 500-kHz dispersion, but even greater range is possible. The two-stage second i-f is at 455-kHz with approximately 10-kHz band-width. A diode detector supplies the rf envelope to the video amplifier. A separate detector is used for agc.

The channel selector and video amplifier consists of suitable synch-pulse shaping circuits, a two-stage binary counter

table 1. Complete specifications of the four-band spectrum analyzer.

frequency coverage	four 500-kHz segments: 3.5-4.0 MHz 7.0-7.5 MHz 14.0-14.5 MHz 21.0-21.5 MHz
sensitivity	1 μV (50-ohm source) provides ¼" deflection 0.1 V (50-ohm source) provides 2" deflection
resolution bandwidth	10 kHz
display flatness	better than 3 dB on any band segment
sweep frequency	60 Hz sequenced through four segments for frame rate of 15 Hz
spurious signals	none for the four band segments

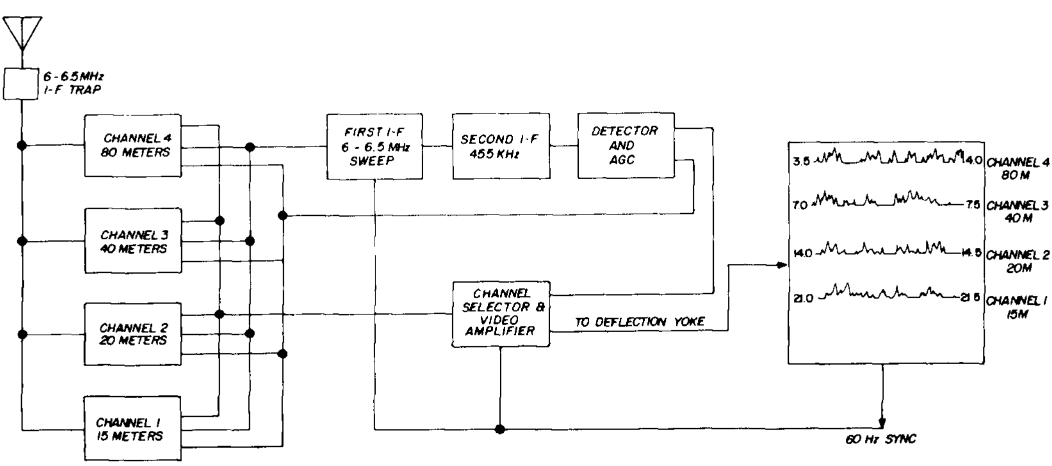


fig. 1. Block diagram of the four-channel spectrum analyzer.

and translator. This system provides the time-division multiplexing of the four converters to the common swept i-f circuit and provides the crt with a four-trace display.

few hundred ohms so the match to a 50-ohm source is not too good, but this has been no problem. The converters are set to the same sensitivity with the rf gain adjustment. However, in actual on-the-air

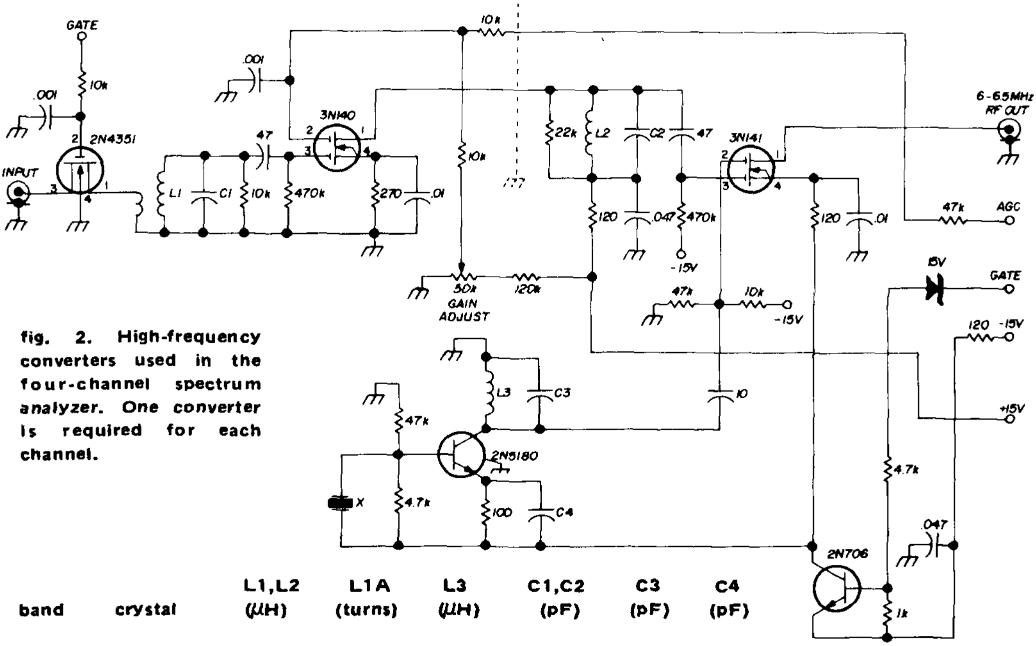


fig. 2. High-frequency converters used in the four-channel spectrum analyzer. One converter is required for each channel.

band	crystal	L1,L2 (µH)	L1A (turns)	L3 (µH)	C1,C2 (pF)	C3 (pF)	C4 (pF)
80	10,005 kHz	16	6	3.2	100	68	220
40	13,505 kHz	8	5	2.5	47	47	200
20	20,505 kHz	4	4	1.5	27	33	82
15	27,505 kHz	2	4	1.1	68	27	68

The display unit is a converted tv set which provides a large picture that is easy to view from across the room. The horizontal sweep is synchronized with the 60-Hz power lines; a pulse from the sweep circuits in the tv set is used to synchronize the receiver.

converters

The circuit diagram of one high-frequency converter is shown in **fig. 2.** All converter circuits are the same; only the tuned circuits and the crystal are different.

The antenna is connected through a normally-off enchancement-mode mosfet which is turned on. The on resistance is a

operation it is desirable to reduce the gain of the lower-frequency units since 1-microvolt sensitivity at these frequencies produces a very noisy base line. A 5- to 10-microvolt senstivity is more realistic.

The output of the mixer stage is connected in parallel with the other converters and each mixer-oscillator combination is gated through a transistor switch. A 15-volt zener diode is used to shift the level of the channel-select gate pulse to operate the switch with negative voltage supply.

sweep i-f amplifier

The sweep circuits are shown in **fig. 3.** Rf input from the converters is 6 to 6.5

MHz. The sweep oscillator is on the low side with a frequency of 5.545 to 6.045 MHz to produce a second i-f of 455 kHz. Each of the three tuned circuits has its own variable-capacitance sweep-voltage .01-μF capacitor via a 2 megohm resistor. Each capacitor is discharged by a clamping transistor with an adjustable emitter potential. The emitter potential is adjusted at the high-frequency end while

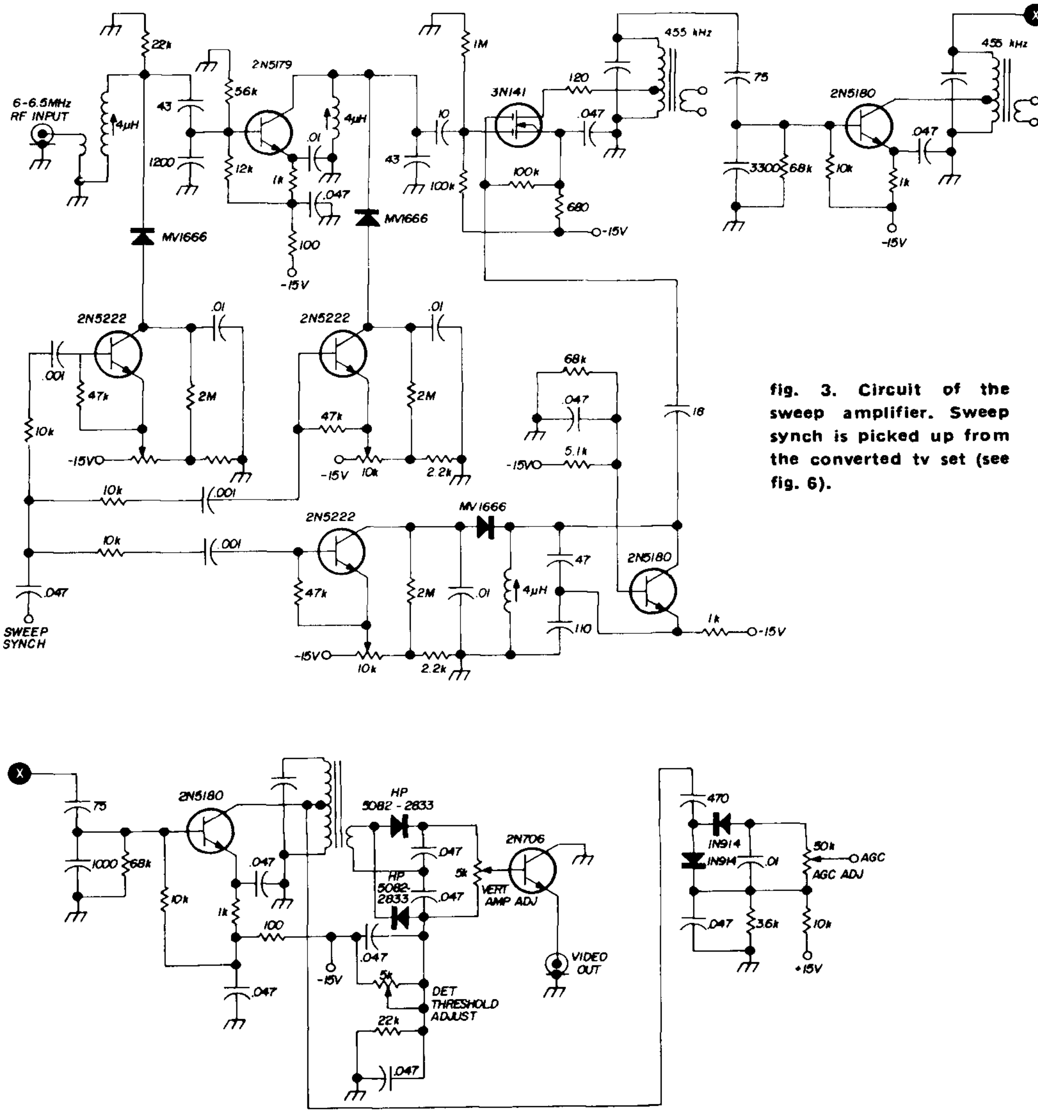


fig. 3. Circuit of the sweep amplifier. Sweep synch is picked up from the converted tv set (see fig. 6).

time-constant components to permit independent adjustment.

The voltage applied to the variable-capacitance diode is developed across a the inductor is adjusted at the low-frequency end. Since the hf oscillator is on the low side of the first i-f frequency, the left-hand side of the crt display is the low

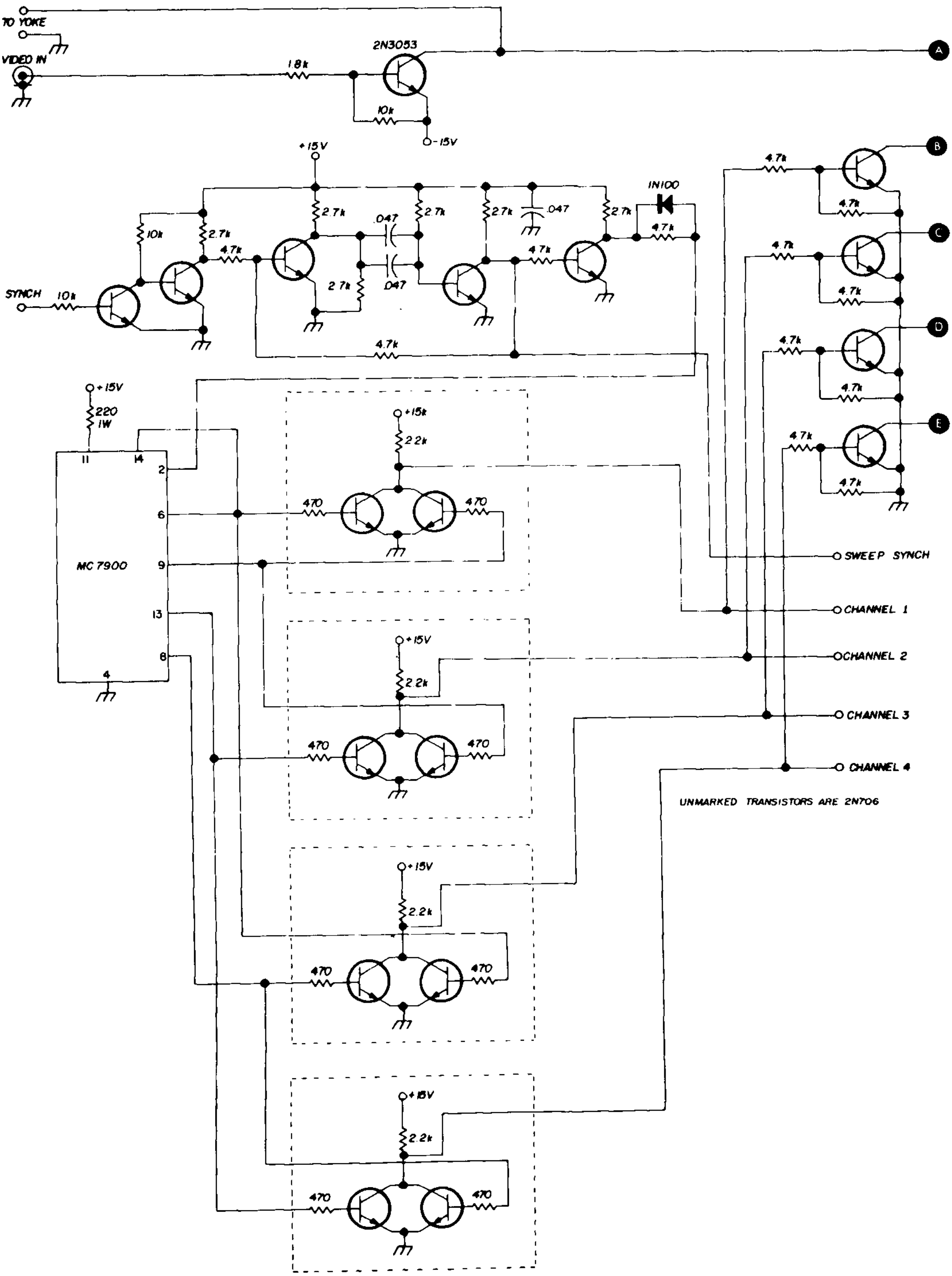
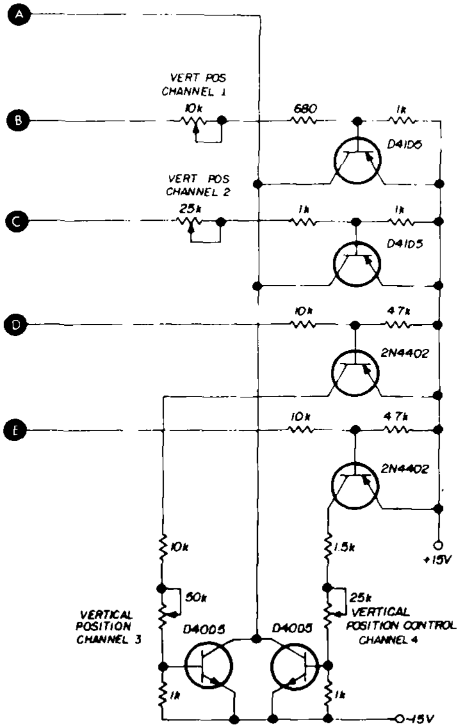


fig. 4. Vertical deflection and channel selector circuits for the spectrum analyzer.



end of the rf input but this corresponds to the high-frequency end of the swept i-f.

The vertical gain adjustment permits use of various size cathode-ray tubes since the larger screens require greater deflection current. The detector threshold adjustment is used to limit base line noise and to offset the input voltage threshold of the video amplifier (vertical deflection amplifier).

channel selector

The four channels are obtained with the circuit shown in **fig. 4**. The 60-Hz synchronizing signal from the tv chassis is shaped by an overdriven amplifier and monopulser. A two-stage binary counter, a MC790P IC, and the four 2-input AND gates provide the four-channel gate signals. Each gate signal drives a constant-current vertical position circuit. Constant-current positioning circuits are used to give maximum band width since the high current, low voltage and rather large yoke inductance would otherwise give a long time constant and consequently, narrowband response.

Each trace is positioned by setting the base current to the constant current transistor. Adequate range is provided to handle a crt size of 16 to 21 inches with reasonable variation in transistor current gain.

Two voltages, +15 and −15 volts, are obtained from a single transformer with two rectifiers and regulators as shown in **fig. 5**. These circuits are conventional.

converting the tv

The portions of the tv receiver which remain are the cathode-ray tube, its high-voltage supply and portions of the verti-

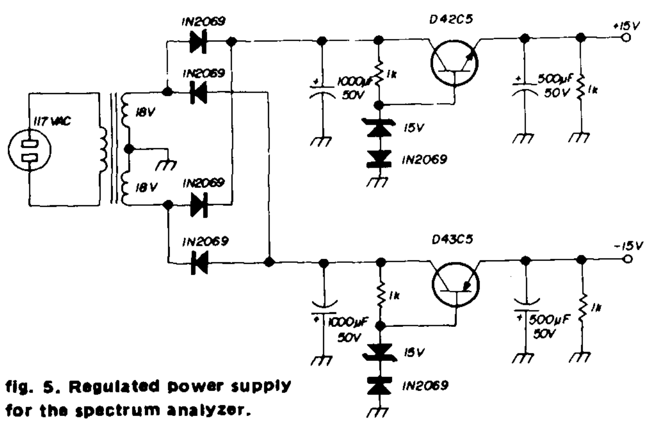


fig. 5. Regulated power supply for the spectrum analyzer.

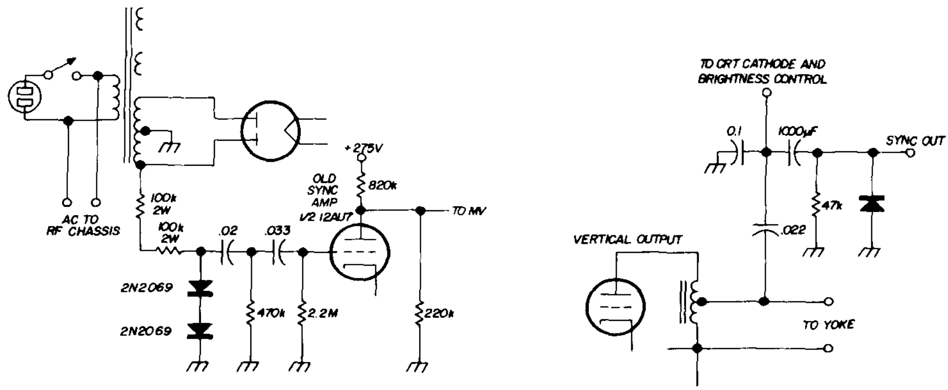


fig. 6. Modifications to the tv set used for display in the four-channel spectrum analyzer. An improved 60-Hz sweep circuit is shown in fig. 7.

cal deflection circuits, as well as the power supply. The conversion involves three steps:

1. The deflection yoke is rotated 90°, and the two leads from the horizontal yoke are brought out to a connector. These are used for the vertical deflection. To insure that the high-voltage flyback supply in the set will function normally, an old yoke, horizontal winding, is connected in place of the yoke wires that are removed.

2. An ac outlet is added on the tv chassis or cabinet and connected to the ac supply in the tv set that is energized through the switch. When the tv set is turned on, power will be applied to this outlet which furnishes power to the panoramic receiver rf unit.

3. A synch pulse is brought out through a shielded lead from the vertical output circuit. These circuit modifications are shown in **fig. 6.**

With these simple modifications sweep linearity and stability are not the best. Although they work, eliminating the vertical multivibrator and adding the changes shown in **fig. 7** are well worthwhile.

When converting the tv set it is advisable to remove all the unused parts, the tuner, the i-f, the audio, speaker, etc. The only functional controls on the tv set are the on-off switch, brightness, vertical linearity and vertical height. However, since

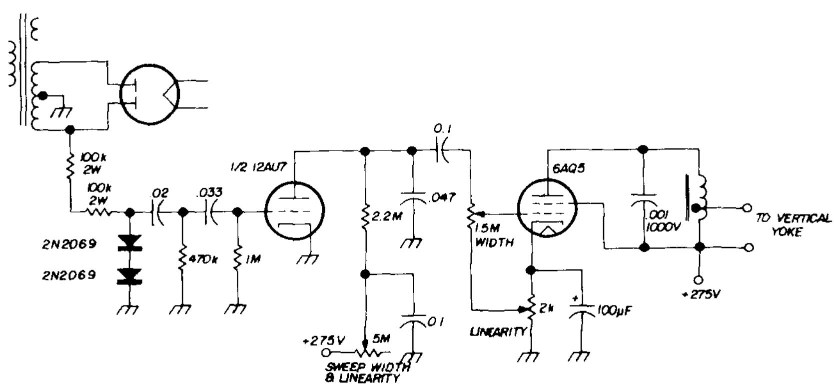


fig. 7. Improved 60-Hz sweep circuit for the modified tv set.

the yoke was rotated 90°, the old vertical linearity and height controls are now horizontal linearity and width adjustments.

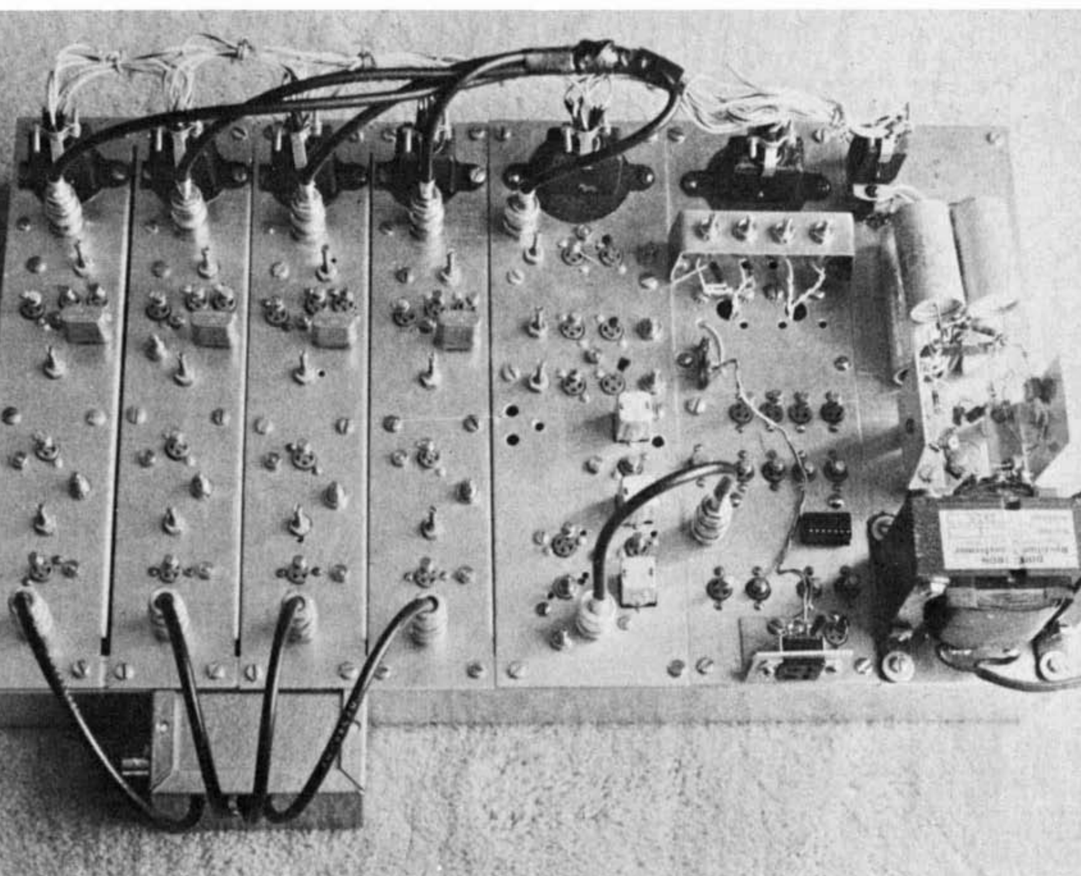
construction

The panoramic receiver, not including the display section, is assembled on seven individual L-shaped subchassis. These are assembled together in a 10- by 17- by 2-inch aluminum chassis. The top of the chassis was cut out and the individual chassis mounted in place of the cutout. The bottom plate is used as this allows troubleshooting the entire assembled unit by merely removing the plate. This could not have been done if the individual subchassis were assembled underneath the chassis, although it would have been a lot easier.

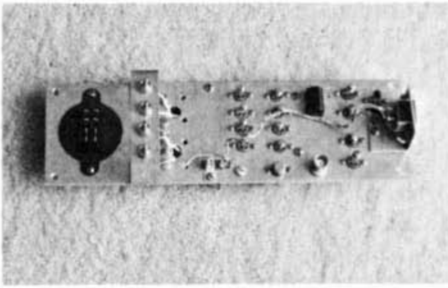
All the subchassis are 2 inches deep by 10 inches long; the rf subchassis are each 2 inches wide, while the sweep, video multiplexer and power supply are each 3 inches wide. All unit interconnections are made through connectors. Rf signals use coax and coaxial connectors and power supply leads and others use Jones plugs.

operation

If you use a large-screen tv set as I did, you will find plenty of room inside the tv cabinet for the receiver circuits. I put the rf chassis in the bottom of the tv cabinet



Complete rf chassis for the spectrum analyzer. Four high-frequency converters are on the left; sweep i-f, vertical deflection, channel selector and power supply are to right.



Vertical deflection and channel selector circuit chassis.

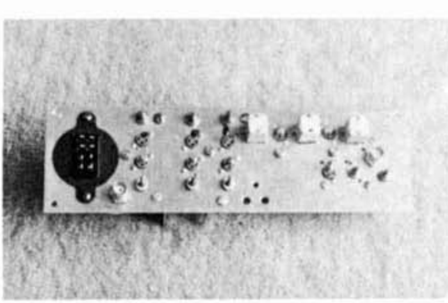
behind the speaker grill. One of the nice things about the console tv is that it doesn't take up any room on the operating table and the large screen can be viewed from anywhere in the radio shack. The unit is excellent for keeping up to the minute on band activities while you are occupied with something else. For the past year I've had mine in operation in the workshop.

The sensitivity of the receiver permits excellent operation with just a short piece of wire for an antenna, although it is designed for a 50-ohm input.

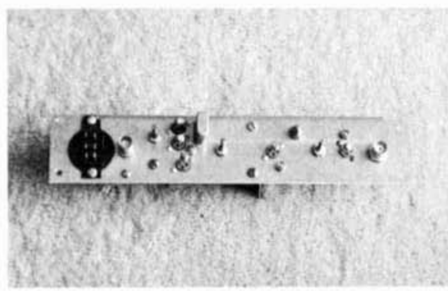
additional uses

The dynamic range is approximately 100 dB. With a 100,000-microvolt signal this results in a 2-inch vertical deflection, while a 1-microvolt signal produces 1/4-inch vertical deflection. The vertical deflection does not give much discrimination between strong signals because of the wide dynamic range.

A very useful application of this multi-band spectrum analyzer is in troubleshooting harmonic-producing circuits such as frequency multipliers, or when measuring harmonics in amplifiers and oscillators. If a conventional frequency analyzer is used to measure the harmonic amplitudes of a 7-MHz fundamental, the second harmonic is 14 MHz and the third harmonic is 21 MHz, etc. Therefore, each pair of pips is separated by 7 MHz. Since, in this example, we are interested in only three frequencies with a slight dispersion to either side of each frequency, the four band segments are more efficient. With four channels, the fundamental appears on one segment, second harmonic on another, and the third on still another. The total dispersion of the four bands is 2 MHz, whereas with a conventional spectrum analyzer, it would be greater than 14 MHz.



Sweep i-f chassis.



High-frequency converter.

conclusion

If you think this would be a worthwhile addition to the radio shack, you will have to build one because none are being manufactured at the present time. The closest you can come with commercial gear is a general-purpose spectrum analyzer at considerable expense, and you still will not have the desirable feature of selecting the segments of the spectrum you are interested in.

reference

1. H. F. Priebe, Jr., "Build Your Own Panoramic Adapter," *QST*, September, 1954.

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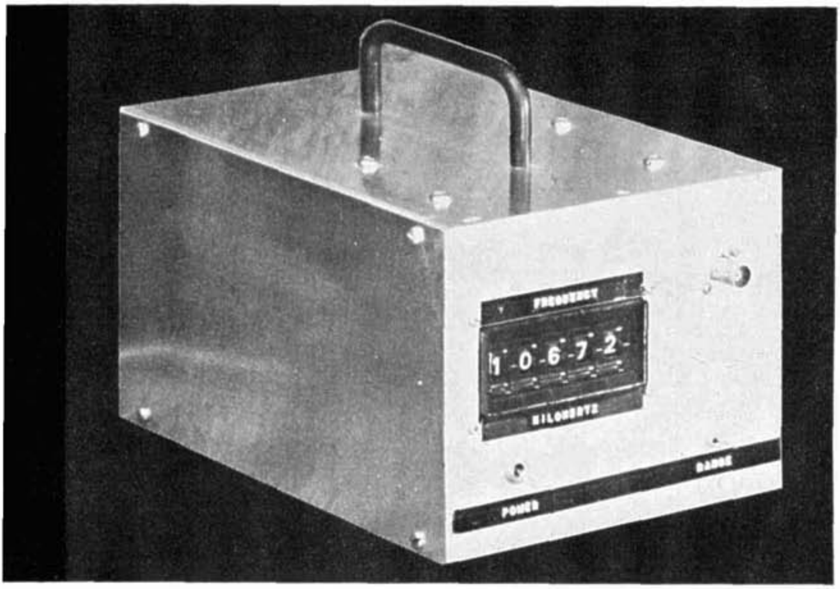


high-frequency frequency synthesizer

This inexpensive frequency-synthesized 300-kHz to 10-MHz signal generator keeps cost low and performance high through the use of low-cost ICs

Albert D. Helfrick, K2BLA, 115B Linn Drive, Verona, New Jersey

Many amateurs own some sort of radio-frequency signal generator. It is used mainly as a source of accurately known frequencies for receiver or transmitter alignment. Most signal generators found in the ham-shack are capable of ±1% accuracy, at best, which is insufficient for modern radio alignment. For example, 455 kHz on the dial of a signal generator of 1% accuracy would actually be somewhere between 459.5 kHz and 450.5 kHz. This sort of accuracy makes the signal generator of little value for aligning a modern ssb receiver with a passband of only 2.1 kHz.

One of the techniques used to remedy this situation is continuous monitoring of the output frequency with a frequency counter, and periodically adjusting to correct for drift of the signal generator. This technique works quite well, but it is *annoying to reset the signal generator* constantly.

It would be nice if an electronic circuit could be made to read the counter and automatically make the frequency change. This is exactly what is done by the phase-locked loop synthesizer. The circuit not only checks the frequency and makes the adjustment, but does it a thousand times per second.

The phase-locked loop frequency synthesizer consists of four basic parts; the voltage-controlled oscillator, the programmable divider, the frequency discriminator and the reference frequency source (see **fig. 1**).

voltage controlled oscillator

The vco is just as its name implies – an oscillator where the frequency is controlled by voltage. This can be achieved in several ways. A varactor diode may be placed across a vfo tank circuit so that the varying diode capacitance with bias voltage changes shifts the vfo frequency. This type of oscillator usually has a limited range and requires considerable bandswitching or manual tuning.

However, integrated circuits have been designed especially for frequency synthesizers; they overcome the narrow tuning range and provide a more than three-to-one frequency range. The Motorola

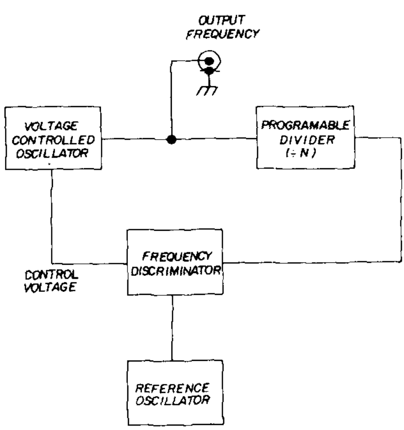


fig. 1. Block diagram of the phase-locked loop frequency synthesizer. Unit goes from 300 kHz to 10 MHz in 1-kHz steps.

MC4024 voltage-controlled multivibrator operates from a single 5-volt supply to frequencies over 30 MHz. A graph of frequency vs voltage for the Motorola 4024 is shown in **fig. 2**.

programmable divider

The output frequency is determined by the programmable divider. The divider produces an output frequency which is

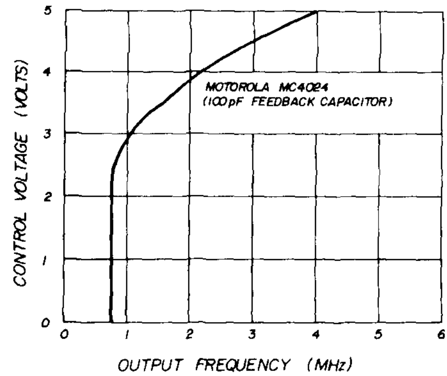


fig. 2. Output frequency vs control voltage of the Motorola MC4024 voltage-controlled multivibrator IC.

the input divided by some N, which is selected by the frequency switches. For example, if the input frequency is 2 MHz, and the switches are set to N = 2000, the output frequency would be

$$f_{out} = \frac{f_{in}}{N} = \frac{2\ \text{MHz}}{2000} = 1000\ \text{Hz}$$

The popular SN74192 decimal counter IC was chosen for this circuit because of its low cost, simple operation and counting speed. A one-shot multivibrator was required to insure proper resetting of the counters. Sometimes the programmable divider is referred to as a frequency-to-frequency converter.

reference frequency

The reference frequency is generated by a 1-MHz crystal oscillator which is divided by 1000 to produce a 1-kHz square wave. Three SN7490s are used to divide the 1-MHz signal to 1000 Hz. A SN7400 gate is used for the crystal oscillator/buffer.

frequency discriminator

The frequency discriminator is a com-

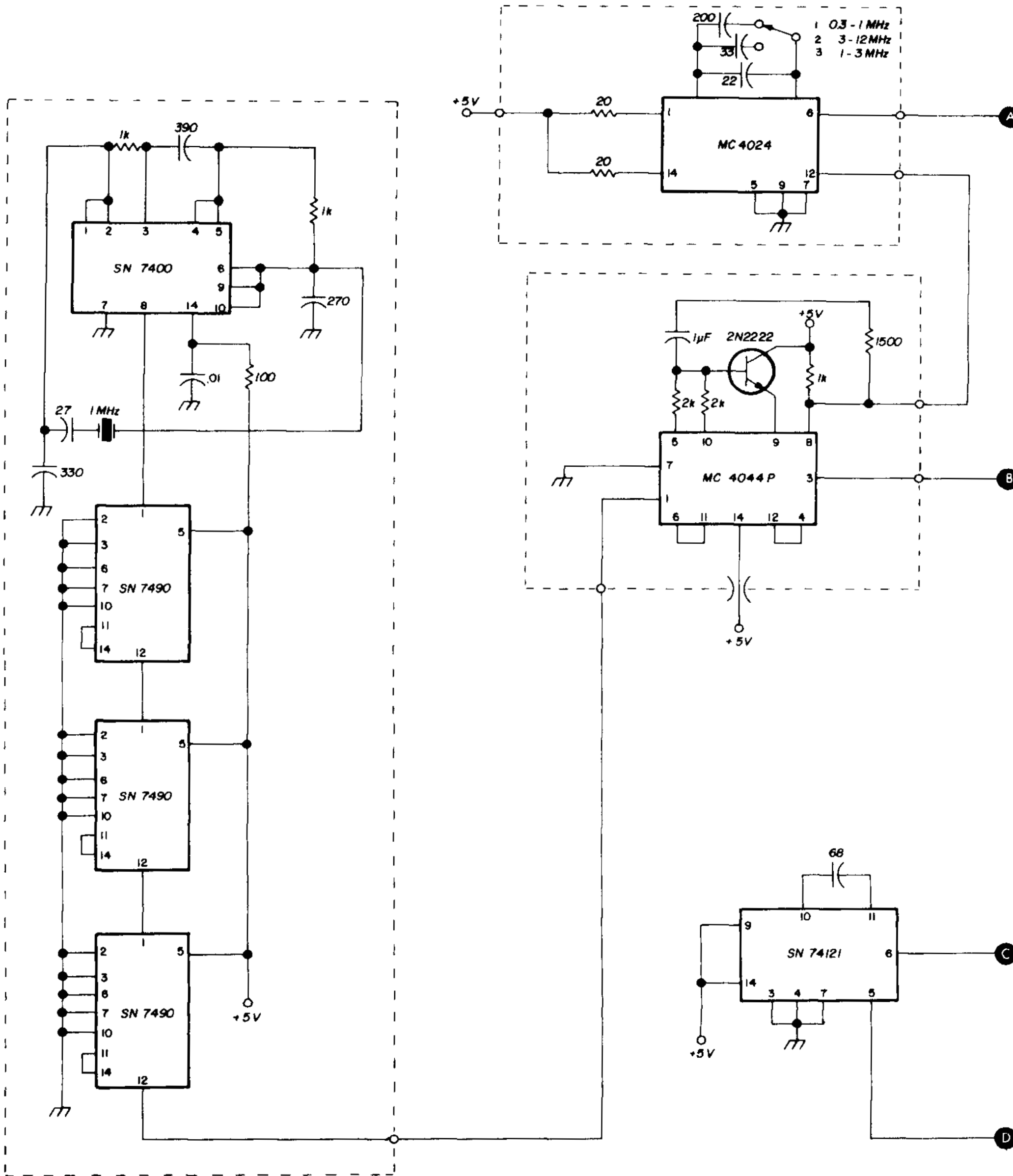
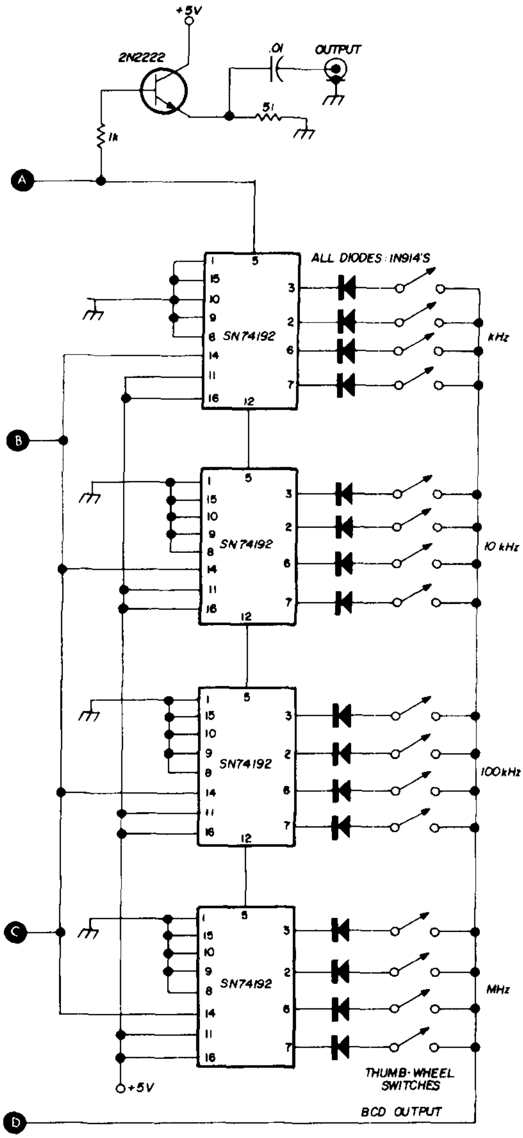


fig. 3. Schematic diagram of the phase-locked loop frequency synthesizer. A major parts list for this unit is given in table 1.

plex integrated digital and analog circuit. Its function will not be completely explained here, but a complete explanation may be found in Motorola Application Notes AN541 and AN535. The frequency discriminator functions as a frequency-to-voltage converter. If the input frequency is *below* the reference, the discriminator produces a *high* output voltage; if the input frequency is *above* the reference, the discriminator produces a *low* output voltage. This voltage is called the control voltage, and determines the vco operating frequency.



Refer to fig. 1 and consider the following: assume the vco is operating at 2.50 MHz, and the programmable divider is set at 3000, corresponding to a frequency of 3.000 MHz. The output frequency of the divider is

$$f_{out} = \frac{f_{in}}{N} = \frac{2.5 \times 10^6}{3.0 \times 10^3} = 833 \text{ Hz}$$

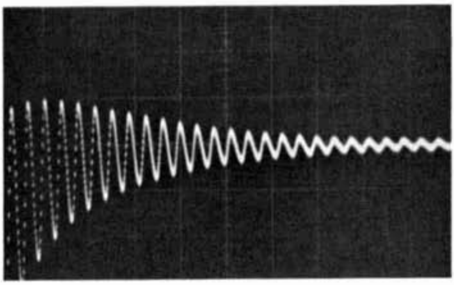
table 1. Parts list and cost breakdown for the frequency synthesizer.

qty	component	price	total
4	SN74192	$2.25	$9.00
3	SN7490	1.40	4.20
1	SN7400	.33	.33
1	MC4024	2.60	2.60
1	MC4044	2.60	2.60
1	SN74121	1.00	1.00
11	IC sockets	.40	4.40
2	2N2222	.50	1.00
1	filament transformer	1.49	1.49
1	LM309K	2.00	2.00
1	1-MHz crystal	4.50	4.50
4	thumb-wheel switches	2.25	9.00
Resistors, capacitors, cabinet end plates, etc.			10.00
			$54.12

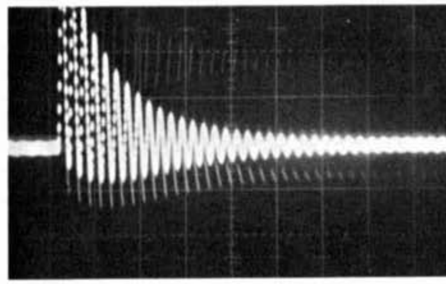
This frequency is lower than the 1000-Hz reference. Therefore, the frequency discriminator will produce a *high* control voltage which will raise the vco frequency. The vco will continue to change until the vco frequency is exactly 3.000 MHz. When that happens, the system is said to be phase-locked. If anything should happen to change the vco frequency the frequency discriminator will correct the fault.

A commercial frequency synthesizer is a very expensive piece of equipment. It must be assumed that such an inexpensive unit as the one described in this article must have shortcomings, and indeed it does. This unit has a range of about 300 kHz to more than 10 MHz in 1-kHz steps. A commercial unit may have a range of a few Hz to hundreds of MHz in fractional Hz steps.

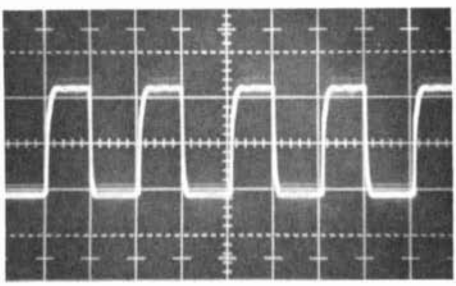
This degree of resolution and wide range is not necessary for amateur builders; neither is the corresponding price tag. The output of my unit is a square wave which may also be a disadvantage. The unit also has a certain amount of frequency modulation generated by noise voltages in the system. For general receiver and transmitter alignment



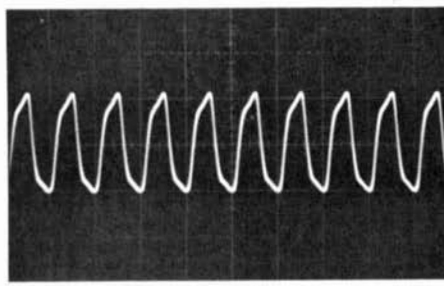
A. Vco control voltage with step frequency change from 510 kHz to 500 kHz.



B. Vco control voltage with step frequency change from 500 kHz to 510 kHz.



C. Output voltage at 500 kHz.



D. Output voltage at 5.000 MHz.

Waveforms of the frequency synthesizer. In A and B time base is 100 milliseconds per division; vertical scale is 50 mV per division. In C and D time base is 1 microsecond per division; vertical scale is 0.5 volt per division. Tektronix 545B oscilloscope with CA plug-in and X1 probe.

this fm is not objectionable. However, the synthesizer should not be used for direct transmitter control.

construction

The entire synthesizer is built on perforated fiber boards as separate modules, carefully shielded and filtered to reduce noise to a minimum. The reference oscillator and divider, the vco and the frequency discriminator should be mounted in separate aluminum boxes

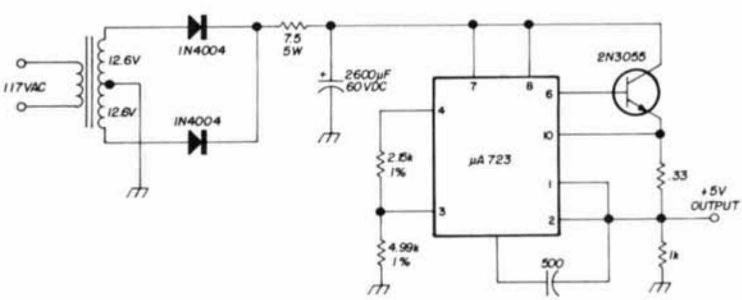
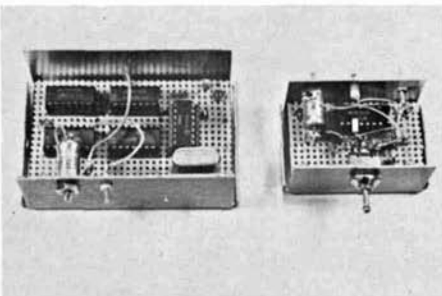


fig. 4. Power supply for the frequency synthesizer.

(see **fig. 3**). The power supply and programmable divider are mounted on the rear and front, respectively, of the cabinet.

It is absolutely necessary that all ground leads for the power supply and the individual modules be returned to a common point to discourage ground loops. This system is susceptible to even the slightest ac ripple, and ground loops are difficult to analyze.

Likewise, a topnotch power supply is in order. My synthesizer uses a μA723 voltage-regulator IC and a pass transistor, although the much easier to use LM309 was tried with success. Both devices are currently available at bargain prices.



The 1000-Hz reference source is on the left, and the voltage-controlled multivibrator is on the right.

If you want a sine wave output, it may be obtained by feeding the square wave into a tuned circuit resonating at the fundamental, or any one of the odd harmonics. However, most alignment jobs can be handled well with the square wave output. In fact, the harmonics are useful for extending the range of the unit. It should be borne in mind, however, that the fm noise is multiplied by the order of the harmonic, so that noise will be five times as bad at the fifth harmonic as at the fundamental, three times as bad at the third, and so on.

The synthesizer is easy to build and is indispensable as a tool for general receiver and transmitter alignment. It is well worth the $50.00 or so it costs to build.

ham radio

an efficient all-band tuned-dipole

Getting maximum efficiency from an outstanding multiband antenna

E.R. Cook, ZS6BT, 32 Grove Road, Gardens, Johannesburg, Republic of South Africa

The most popular antenna for 80 and 40 meters is the dipole. For the higher frequencies, the rotary beam is the favorite. However, there is much to be said for the all-band antenna, and the one described here will outperform a three-band Yagi in the dipole's favored direction and will only be about 6 dB down from the Yagi off the dipole's ends.

The average three-element three-band beam is actually very inefficient in transferring power from the transmitter into the ionosphere; it merely transmits its radiated power in a focused beam. Losses due to standing waves, mismatch and imbalances all reduce the efficiency so that the gain over an efficient reference dipole is not as great as it seems.

A well-balanced, highly-efficient tuned dipole, properly matched to the transmitter, radiates more power than does the untuned, unbalanced, coax fed dipole of a three-band beam. However, it wastes a lot of energy in unwanted directions while the less-efficient tribander makes the best use of whatever power it does radiate. Overall, the tribander does the better job.

The purpose of this article is to describe an all-band dipole which gives normal performance on 80 and 40, but competes favorably with a three-element beam on the higher frequencies. Apart from its ability to lay down a good signal, the antenna has attributes not possessed by a tribander.

basic design

The basic design is simple and well known. Take two pieces of 14 gauge wire 132 feet long, and use anything from 54 to 65 feet of each to form half of a center-fed dipole between 108- and 130-feet long. Use all of the remaining wire to build an open-wire transmission line with six-inch spacing. How to dispose of the feedline is a problem for the individual to solve. The result is an open-wire-fed dipole which is, effectively, a half wave on 80 meters with quarter-wave feeders. If your masts are less than 108 feet apart, arrange matters so that 8 or 10 feet at each end of the dipole drops vertically, but stop these dangling ends from swinging in the wind.

The feedline at ZS6BT is 78-feet long, and the antenna is 40-feet high. There is a six-foot length of feeder in the shack, and 30 feet goes vertically to the dipole. The remaining 42 feet runs horizontally at a height of 10 feet and is strung between the shack and a pole 10 feet high. It is held taut by a pair of turnbuckles, and there are no spreaders on the horizontal feedline.

The antenna is tuned by a balanced-to-unbalanced Z-match tuner connected through six feet of 50-ohm coax to the transmitter. Because of the quarter-wave feedline on 80, parallel tuning is used on all bands. There is no need to describe the tuner as many good designs have already appeared in the various amateur magazines and in the *ARRL Handbook*. The Johnson *Matchbox* does the job well and the tuneup information in this article is based on the *Matchbox.*

It is essential to use an swr bridge in the coax between the transmitter and the tuner. A twin-meter frequency-independant instrument is ideal, but any bridge will do. The idea is to tune the antenna to frequency anywhere in any band and to reduce the standing wave on the coax to zero. This produces a very efficient antenna.

There is no need for diagrams at this stage. A beginner could put up the antenna from the written description, and he would have an excellent all-band antenna. There are probably many such already in use. Radiator length is not important, as can be seen, and we need not be particular to 6 inches with the 132 feet of wire. The secret does lie in having quarter-wave feeders.

What we have done, to date, is describe a normal antenna which is an excellent performer on 80 and 40, and a reasonably good performer on all bands 80 thru 10. By strapping the feeders together and working against a good ground, it does an excellent job on 160 as a T. At ZS6BT, I copy North Americans on 160 and have been heard on that band at 2,000 miles with 10 W input.

improvements

Now, to that wasteful radiation from a dipole. There is nothing we can do about 80 and 40, but much we can do about the other bands. If we stack two dipoles, one above the other, and drive them in phase, we pull down a lot of that wasted upwards power and force it broadside to good effect. Stacked, driven dipoles and all-band performance do not go together very well.

If we sling a parasitic reflector, a half wavelength long and a half wavelength below a dipole, we have the proper phase for broadside performance, even though we do not have the efficiency of the driven array. Moreover, this reflector interferes with the ground effect and tends to alter the angle of radiation beneficially. Once we consider that we can sling two such reflectors in-line for 20, three in-line for 15 and five in-line for 10; we see a chance for considerable improvement.

Neither reflector length nor spacing is all that critical. In fact, if we narrow the spacing we may correct the phase by lengthening the reflector. If we have not sufficient head-room on 20, we may lift the reflectors another 5 feet and lengthen them by about 5 feet without ill effect.

Fig. 1 shows the arrangement and normal dimensions. The idea can be tried out on existing dipoles too.

tuneup

The initial tuneup of the antenna should be done with the aid of a dummy load, in order to calibrate the antenna tuner, and thereafter band changing will be a simple matter.

On each band, tune and load the transmitter into a dummy load until the swr bridge shows maximum forward current; of course, there should be no sign of reflected current.

Do not touch the transmitter tuning and loading controls, but couple up the antenna and tuner and vary the tuner controls until you obtain (a) the same forward current that was seen with dummy load and (b) no sign of reflected current. You see why a twin-meter bridge is best; you can read both directions simultaneously. Make a note of the tuner dial settings for future use.

In normal use, set the tuner controls appropriately and load up. Then tune out the last vestiges of reflected current and leave the bridge measuring reflected power. As you move around in the band, see that you maintain a zero on the bridge meter.

Now, about the bonuses which the tuned dipole can offer. It will attenuate harmonics because it is not tuned to them. If you use a TVI filter the extra tuned circuit between transmitter and antenna will improve the filter performance.

On reception, be sure to tune the antenna to the right band or you may get poor results; you have an extra tuned circuit between antenna and the receiver input. For some, this may be an extra bonus.

Modern receivers do not suffer greatly from images, but there is a possible exception. With shortwave broadcasts running to megawatts, they can break through even though the first i-f is 4 MHz or so. They will do this more easily if the antenna will respond to the broadcâst station's frequency. Even a three-band beam is not very frequency conscious on reception, in part due to pickup on the coax outer shield, but a tuned dipole tends to attenuate signals to which it is not actually tuned.

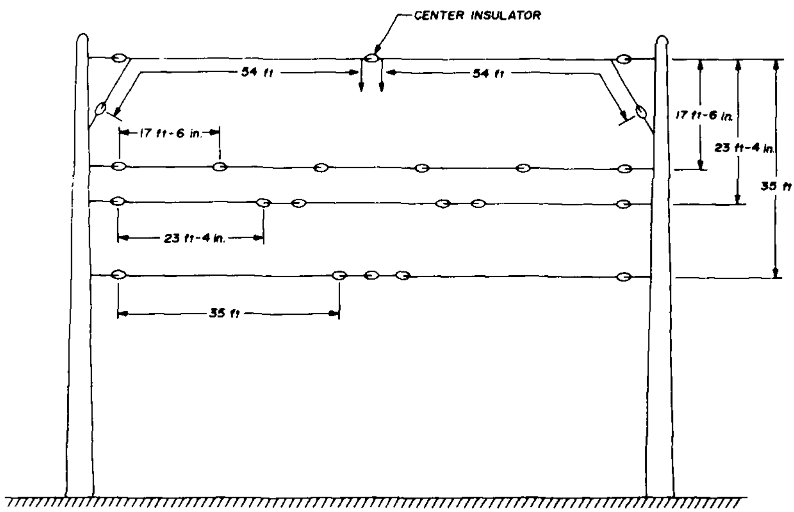


fig. 1. General arrangement and nominal dimensions for ZS6BT's all-band dipole.

There is no need to use particularly heavy guage wire for the reflectors as they are under no strain. The 20 meter, and perhaps the 15 meter reflector may be tied to the masts. The 10 meter ones may require halyards. To prevent unnecessary absorption, it is better to use nylon cord for guy wires and halyards.

160 meter operation

The first essential for 160 is a really good ground connection. Basically, the

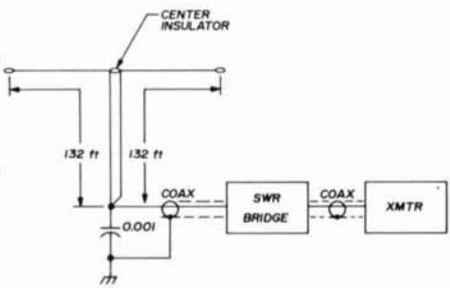


fig. 2. Arrangement for using the all-band dipole on 160 meters.

matching to the coax is done by an L-network. However, with a T antenna of the dimensions given, the L inductance appears to be unnecessary and only the capacitor is used at ZS6BT. Aim for maximum forward current and no reverse current on the bridge. My system is shown in **fig. 2**. The capacitor is an Aerovox Series 1650, 1200 V, 0.001 mF. The matching unit, therefore consists of a coax socket and the mica capacitor. Individual installations would call for some experimentation regarding matching.

During the past 45 years, most of the usual, and some unusual, antennas have been tried; most were up less than a year and not one gave six-band results which were acceptable. The present antenna has been in use for over eight years and there is no intention of trying any other. At last I am satisfied.

ham radio

five-frequency crystal deck

for the Sonobaby

By popular demand, here is how to add frequency flexibility to the Sonobaby, and how to make a handy signal generator

Robert Shriner, WAØUZO, Robert Heptig, KØPHF, Earl Gill, WBØEDA

The Sonobaby transmitter, featured in the October 1971 issue of *ham radio,* was an all-transistorized two-meter fm transmitter. Since the article was published, we have had numerous requests for a similar multiple-frequency transmitter. This is understandable in areas served by many repeaters or by the mobiler wishing to operate through the different repeaters encountered in his travels.

The modification described here is applicable to the Sonobaby and other transmitters using 18-MHz crystals, and provides five-channel capability. No parts of the original transmitter need be thrown away and the five-frequency deck is small enough to fit into a hand-held portable as well as a base or mobile unit.

As an added feature, the five-frequency deck can be used as a five-frequency signal generator. In order to do this a separate audio board has been developed allowing the signal generator to have an unmodulated carrier, a constant tone or a microphone input.

The circuit was designed with the idea of not wasting any parts while still enabling the original Sonobabys to be used on five frequencies. The original Sonobaby oscillator is changed to a buffer stage and a new oscillator is built on the five-frequency deck. Mechanical switching offers design simplicity and economy. For those who want only two or three frequencies, the answer is simple – only mount the crystals and trimmer capacitors desired. If more frequencies are needed later, they can be added easily at that time.

The five-frequency deck is soldered directly to the switch tabs thus minimizing lead length capacitance.

Audio and operating voltages are taken from the Sonobaby. The rf output of the deck is taken from the collector of the new oscillator and fed via 50-ohm coax

*An etched and drilled circuit board for the five-frequency deck is available for $2.00. Boards for the frequency deck and audio stage, suitable for making a signal generator, are available for $3.50. Write to Sonobaby, Box 969, Pueblo, Colorado 81002.

and a capacitor to the base of the original Sonobaby oscillator.

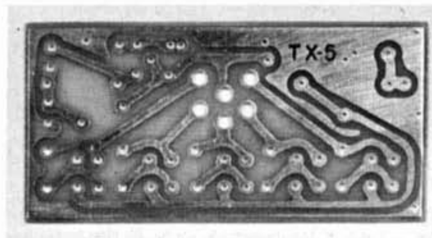
An etched and drilled circuit board is available for the five-frequency deck, or you can make your own following the layouts in the photos.* Construction is very easy and should not take more than an hour. As in all printed-circuit work, clean the board thoroughly first. An ordinary pencil eraser rubbed over the board will facilitate soldering and is well worth the few minutes it takes.

To get started on the five-frequency deck, use a pair of long nose pliers to break off the tab on the back of switch S1 that goes to terminal 6. Mount the switch on the circuit board with the tabs protruding through *to the foil side.* Solder the tabs of the switch to the circuit board.

Install the remainder of the components, with the exception of trimmer capacitors C7 through C11, following the photographs and schematic layout. Be very careful about applying too much solder which might tend to bridge the circuitry. Also, clip all the leads as short as possible after soldering. After a thorough examination of the board for bridged circuits and bad solder joints, install trimmer capacitors C7 through C11. Note that the trimmer capacitors are installed on the foil side of the circuit board instead of the epoxy side as are all the rest of the parts.

Refer to the October 1971 issue of *ham radio* and the schematic diagram of the Sonobaby transmitter. Remove CR1, Y1 and C12. Note that these parts are used on the five-frequency deck, so don't throw them away.

We recommend that at this time you mount the five-frequency deck on your chassis with the original Sonobaby. Mounting is done by drilling a 1/4-inch hole in your chassis in a convenient location. Make sure there is enough room inside the chassis for the circuit board.



Foil side of the frequency deck board. Parts layout can be gleaned from the other photos.

Audio is taken from the Sonobaby at the junction of L1 and C8. Run it over to the audio input of the frequency deck with a piece of shielded wire. Take the operating voltage from the Sonobaby at the junction of R15 and C12. A short piece of hookup wire will do.

The rf output from the oscillator on the frequency deck goes to the point where the crystal Y1 was originally connected to the junction of C9 and C10.

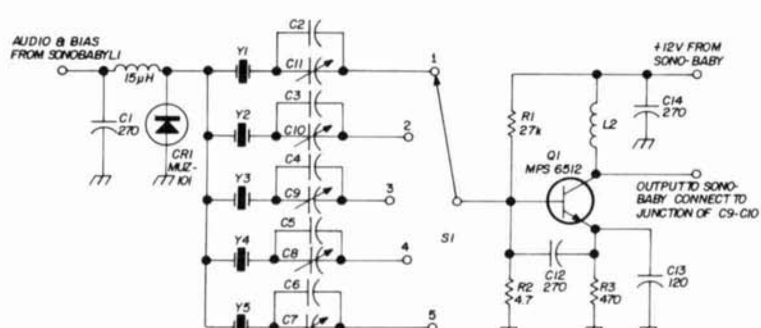


fig. 1. Schematic of the five-frequency deck for the Sonobaby.

C2-C6	15 pF NPO	S1	1P6T switch, Daven 18-KM
C7-C11	5.5 to 18 pF, Erie 538-011A-5.5-18	Y1-Y5	see text
L1,L2	15-µH choke, J.W. Miller 9310-40		

Use a piece of 50-ohm coax for this run and keep it as short as possible – not over ten inches.

Adjust C9 on the original Sonobaby for maximum capacitance, check everything carefully and you are ready to go. Capacitors C2 through C6 are used to put

We ordered our crystals from International Crystal. Besides specifying operating frequency and commercial standard tolerance, mention that the crystals are for a Westinghouse Air Brake Company Carry-phone II, 20TS-1 transmitter.

If you want to go hog wild and have

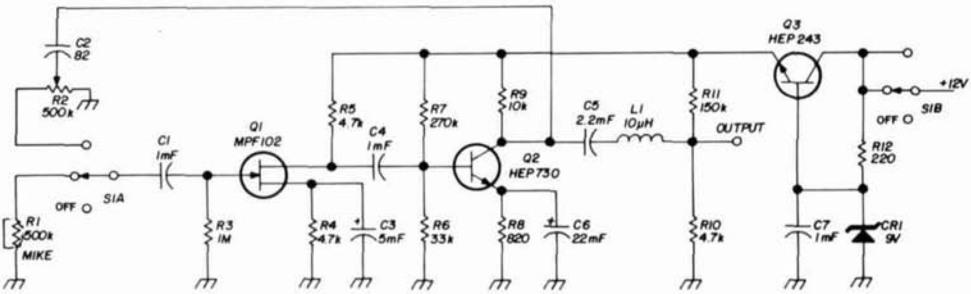
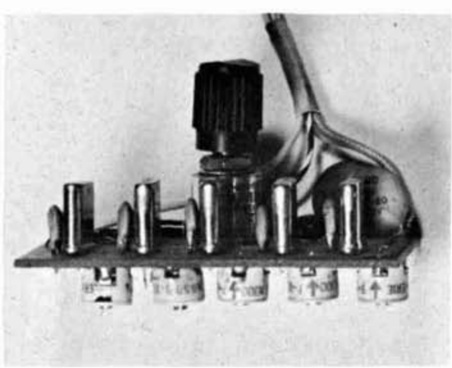


fig. 2. Schematic of the audio board used to turn the frequency deck into a versatile signal generator. C2 can be varied to suit the feedback frequency desired. R1 and R2 are deviation controls. Using quarter-watt, 10% resistors for R3 through R12 helps keep things compact.

each crystal on frequency. Adjust C9 on the original Sonobaby board for best injection voltage to the buffer stage. Check for spurious radiation and adjust C9 for maximum power output and minimum spurii.

We have had no difficulty with the installation of these five-frequency decks. It is a good idea not to attempt to locate the deck over a foot away from the Sonobaby transmitter – the closer the better. The tuning of the Sonobaby should be touched up and it should be peaked on one of the lower frequencies to be used.



Side view of the frequency deck shows switch *mounting and the netting capacitors.*

more than five frequencies, merely install two decks and you'll have ten frequencies. In this instance, set one of the decks at switch position 6. This will turn it off and allow you to use the other board for the next five frequencies.

signal generator

To construct a signal generator that will cover the two-meter band, merely take the frequency deck and add an audio board, **fig. 2** This board supplies the regulated voltage required by the varactor CR1 on the frequency deck. S1A on the audio board selects either a steady tone to the signal generator or a microphone input. A crystal or hi-impedance mike will work fine.

About 50 microvolts of signal can be taken from C1 of the frequency deck, and as the signal is rich in harmonics, it can be injected into the front end of a receiver for tuneup and alignment.

We would like to take this opportunity to thank all of you for your letters praising the original Sonobaby. It is very gratifying to know that we have helped so many get on the air and that you have been so well pleased with the circuit.

ham radio

pulse snap diode impulse generator

Basic data and practical applications of a new and versatile addition to the solid-state diode family

Bernard S. Siegal and Michael K. Turner, Siliconix, Inc.

One of the many interesting devices to make the scene in the world of solid-state components is the pulse snap diode. Also known as a step-recovery diode, this device was included in Hank Olson's review of frequency multipliers that appeared in an earlier issue of *ham radio.*[1] The diode described in the article was the Siliconix SV110. Its use is by no means limited to the application shown, and it's priced within the means of most experimenters. Let's take a look at the SV110 and see what makes it snap.

features

The SV110 was designed to meet the need for an impulse generator that would produce a high-amplitude pulse (up to 70 volts) of subnanosecond width. Some of the applications of the SV110 include:

1. An rf calibrator.

2. Local-oscillator frequency source.

*Since the time this article was submitted, Siliconix has dropped the pulse-snap diode product line. Suitable replacements for the SV110 are the Microwave Associates Snap-varactor 4756, and the Hewlett-Packard Associates Step Recovery Diode 5082-0180. Some slight variation in circuit element values may be required to accomodate either of the two suggested replacement diodes.

3. Accurate signal source for testing components.

4. Clock generator.

5. Phase-locked-loop signal source.

6. Sampling-gate pulse source.

In short, the SV110 is the answer for the designer looking for a stable signal source with usable harmonics over a wide frequency range.

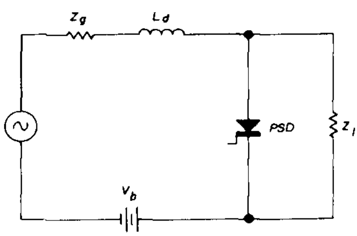


fig. 1. Basic circuit using the pulse snap diode.

basic circuit

All applications of the pulse snap diode rely on the charge-storage characteristics of the device. During forward conduction, the diode stores charge and exhibits a very low impedance (typically less than one ohm). The device maintains its low-impedance state with reverse bias until the charge stored in the junction is depleted. At the instant charge is depleted, the diode will switch from its low impedance state to a high-impedance state.

The time required to complete the change in impedance (approximately 300 picoseconds) is called the transition time. This parameter depends on the amount of charge stored in the diode. More details on operational characteristics will be found in references 2 through 5.

A basic circuit of the impulse generator is shown in **fig. 1**. Parameters are defined as follows: Z_g is the generator impedance, L_d is the driving inductance, Z_l is the load impedance, and V_b is the bias voltage. **Fig. 2** shows waveforms at various operating points in the circuit.

The generator voltage, e_g, and current, i_g, waveforms appear in **fig. 2A** and **fig. 2B**. Generator current i_g lags e_g by approximately 90 degrees due to the inductance, L_d. When V_b is zero, the diode current, i_d, waveform will be the same as the i_g waveform in **fig. 2B.** Charge is stored in the diode junction during the positive half-cycle and removed during the negative half-cycle. The amount of charge removed must always be equal to the charge stored, less recombination losses.

When V_b is greater than zero, as in **fig. 2C**, the diode will not begin to store charge until the voltage across the diode is greater than the sum of V_b and one diode voltage drop. For any given input, the greater the value of V_b, the less charge is stored in the diode, as the diode is forward biased for increasingly smaller portions of the positive half-cycle.

impedance transition

For values of V_b greater than zero and less than the maximum value of e_g minus one diode drop, the time required to remove the charge stored in the diode will

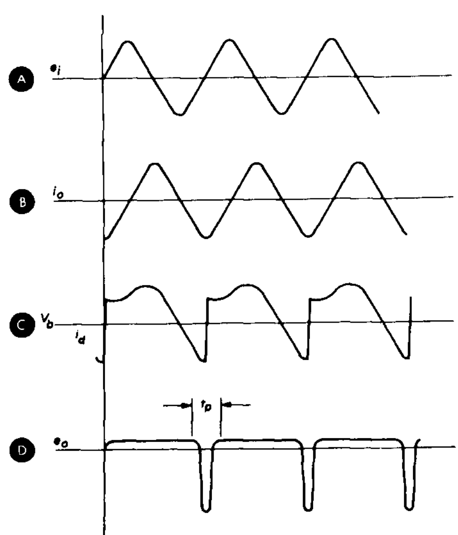


fig. 2. Waveforms at various operating points in the circuit.

be less than one half-cycle. The diode will return to its high-impedance state even though i_d is a negative, non-zero value. By proper selection of V_b, the transition can occur when i_d is at its maximum negative value as shown in **fig. 2C**; this is the point of maximum pulse energy.

A 50-ohm load was used for test equipment convenience. Any value of Z_L between 25 and 75 ohms could be used with only total power output affected. Design equations for Z_L can be found in Hewlett-Packard Application Note 920[3]

At transition, the energy stored in L_d will charge the reverse capacitance of the diode, and a ringing waveform will appear across the load (**fig. 2D**). The characteristics of the ringing waveform are determined by the resonance of L_d and the reverse capacitance of the diode, in combination with the load impedance. Only a single negative pulse is generated for every input cycle, since the positive excursion of the ringing waveform is clipped by the diode. A time-domain profile of the output would show a comb spectrum with a spike at every harmonic of the

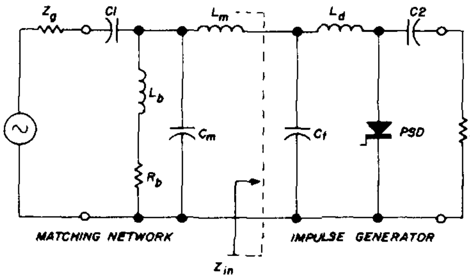


fig. 3. Practical circuit of an impulse generator using the SV110. Component values are described in the text and table 1.

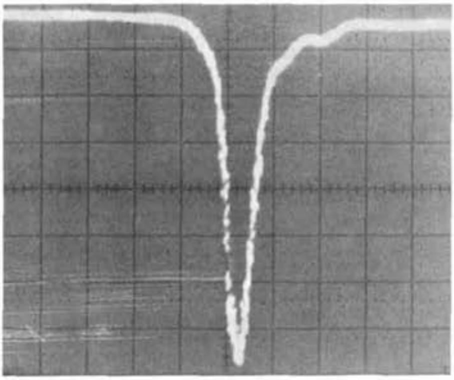
input frequency. The spectral envelope will show a decay in amplitude until a null is reached at 3/2 t_p, where t_p is the pulse width.

practical circuit

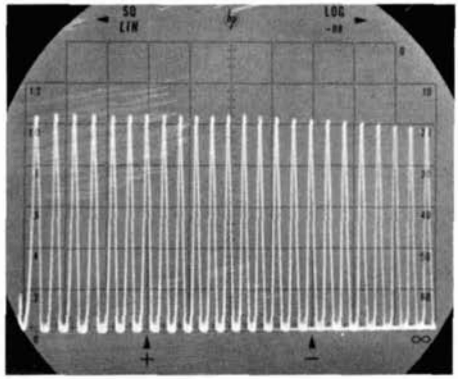
A schematic of a practical impulse generator is shown in **fig. 3**. Parameters C_t, L_d, and the pulse snap diode, PSD, form the impulse generator. The driving inductance, L_d, resonates with the reverse capacitance of the diode to obtain the output pulse. L_d should include any stray

table 1. Calculated values for components in fig. 3.

parameter	equation	example	remarks
t_p	see text	2ns	Determined by application
L_d	$L_d \approx \frac{(t_p^2)}{\pi} \cdot \frac{1}{C_{TR}}$	100 nH	C_{TR} = reverse capacitance of PSD = 4 pF
C_t	$C_t = \frac{C_{TR}}{(2 f_{in} t_p)^2}$	2500 pF	
R_{in}	$R_{in} = 2\, f_{in} L_d$	6.28Ω	Required for matching network
L_m	$L_m = \frac{Z_g Z_{in}}{2\pi f_{in}}$	283 nH	
C_m	$C_m = \frac{1}{2\pi f_{in} Z_g Z_{in}}$	900 pF	
R_b R_b	$R_b =$ $R_b = \frac{2\tau}{\pi N^2 C_{TR}}$	25Ω	τ = minority carrier life-lifetime (ref. 6) $N = \frac{1}{2 f_{in}} / t_p$



Pulse profile from the circuit of fig. 3. Pulse width is near the calculated value of 2 ns.



A slight variation in pulse power is shown, which is caused by uncompensated stray inductance in the test circuit.

inductance as well as the diode package inductance (reference 6). C_t resonates with L_d at f_{in}, the input frequency, for maximum power transfer. C_t must present a good rf short circuit to the output *frequencies.*

L_m, C_m comprise a low-pass matching network between the input impedance and Z_{in}, the impedance of the pulse generator. The matching network is bandwidth limited:

$$BW \cong \frac{2f_{in}}{(Z_g Z_{in} + 1)^{1/2}}$$

where BW *is the* bandwidth. Wideband matching networks may be substituted[7] to obtain a wider spectrum of input frequencies.

bias network

It is important that series resonances are not introduced into the bias network, L_b, R_b **(fig. 3)**. Such resonances, especially those below f_{in}, may cause the diode to act as a *negative* resistance, which would probably result in spurious signals in the output. L_b should present a high impedance at f_{in}. A commercially available molded choke with a self resonance at f_{in} will give the greatest isolation between the bias network and the input to the impulse generator.

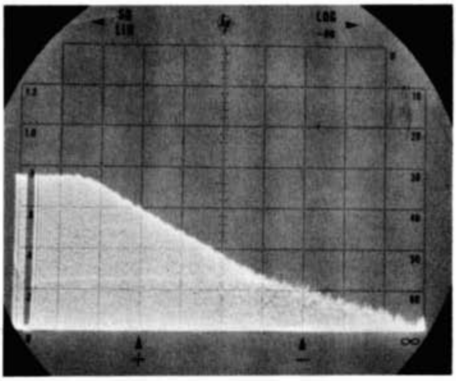
R_b is shown as a simple resistor; however, R_b could be replaced with a variable resistor, external bias-voltage source, or a combination of external and self bias.

impulse width

The impulse width, t_p, *is important.* All critical component values, as well as power variations between harmonics in the impulse train, are determined by t_p. The following design example shows the importance of t_p.

A frequency of 10 MHz was chosen for f_{in}. Any frequency could have been selected, providing the period of f_{in} is less than the minority-carrier lifetime of the PSD (*see reference* 6). For the SV110, the minimum value of f_{in} is approximately 5 MHz. Power variations between f_l and f_{20}; i. e., between the input and its 20th harmonic, were held within 1 dB. A flat power response is desirable if the impulse generator is to be used as a signal source for calibration work. To provide this small power variation over a large number of harmonics, t_p must be quite *small. Reference 3 provides a graphical* method of finding the required t_p.

For the example mentioned, t_p was approximately 2 nanoseconds. Values for minority carrier lifetime, τ =200 ns, and reverse capacitance, C_{TR} = 4 pF, were obtained from the SV110 data sheet.[6] With this information and that in **table 1,** the component values for **fig. 3** were obtained.



The entire spectral envelope, or comb line. Discontinuity near beginning of envelope marks start of comb line.

test results

The circuit of **fig. 3** was constructed on double-clad copper board. Stray capacitances and inductances were kept to a minimum. The oscillographs show circuit performance. Pulse width is very near its calculated value. Variations from the calculated value are caused by uncompensated stray inductance. Power variations in the harmonics can be traced to the same cause.

references

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2. John L. Moll and S. A. Hamilton, "Physical Modeling of Step Recovery Diodes for Pulse and Harmonic Generation Circuits," *Proc. IEEE,* Vol. 57, No. 7, July, 1969, pp. 1250-1259.
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4. B. S. Siegal, "Simple Digital Circuits in a Snap," *Electronics,* June 9, 1969, pp. 105-108.
5. R. E. Winkelman and E. G. Cristal, "Filter Matches to SRD Impulser," *Microwaves,* September, 1970, pp. 34-38.
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7. *Microwave Filters, Impedance Matching Networks, and Coupling Structures,* McGraw-Hill, New York, 1964.
8. "Pulse Shaping with Pulse Snap Diodes," *Design Idea,* Siliconix, Inc., February, 1971.
9. "High Frequency Sine to Square Wave Conversion with Pulse Snap Diode," *Design Idea,* Siliconix, Inc., November, 1970.
10. "Pulse Squaring for Wide Pulses," *Design Idea,* Siliconix, Inc., January, 1971.

ham radio

adding 160-meters

to a

40-meter vertical

Making an inexpensive multi-band antenna with excellent 160-meter performance and hidden benefits

Ken Cornell, W2IMB, 332 West Dudley Avenue, Westfield, New Jersey 07090

It is a myth that only lighthouse keepers *and cattle ranchers can get on 160 meters* because of the real estate needed to erect a really effective 160 meter antenna. *Anyone* can get up an inexpensive and effective 160-meter antenna in a limited space. For my first operating on 160, I used my 80-meter doublet with the feed end shorted and worked against ground as a T antenna. An improvement over this was an end-fed L run out my basement window, up the side of my house and across my yard. It also was operated against ground – provided by a convenient cold water pipe in my basement station.

outline

As I started working real DX with this last scheme – 8's and 9's – I noticed that the best signals on the band invariably were using verticals. I decided to try adding 160 capability to my reliable 40-meter vertical standing in my back yard. The basic plan was to add a 40-meter trap at the top of the existing vertical, add a piece of plastic pipe wound with a 160-meter loading coil and top this combination off with an 8-foot section of aluminum tubing as a top load. I could drive a ten-foot ground stake and use the antenna for both 40 and 160.

40-meter vertical

My 40-meter vertical consists of some World War Two surplus mast sections, labeled AB-85/GRA-4. Each section is 36-inches long, 1 5/8-inch diameter and has a wall thickness of 1/8-inch. One end of each section is swedged down to 1¼-inch diameter for about a six-inch length where the sections join together. The female ends of each section also have four wiper springs that help to insure electrical continuity. These were selling quite inexpensively and I picked up several hundred feet of them one Field Day. While these sections might be hard to find, almost any type of aluminum or galvanized steel pipe will work for the lower 32½-foot mast section. I do not recommend aluminum tubing with less than 1/8-inch thick walls (12 gauge). Most of the aluminum TV mast sections I have seen look pretty skimpy, but could probably be used with proper guying and support.

construction

The first order of business was to find the plastic pipe for the loading coil. I called several warehouses that stock this item, but they have a $25 minimum order gimmick. I finally found a local plumbing supply house that had one piece of 1¼-inch PVC pipe twenty-feet long. I had to take the whole piece (for $7.80), but they cut it into three equal pieces for me. The 1¼-inch inner diameter of this plastic pipe made a nice tight telescopic fit to the swedged end of my mast section.

If you have trouble getting the proper inside and outside diameters of the plastic pipe and tubing, I would suggest that you get the plastic pipe with a larger inside diameter than your top and bottom mast sections. By wrapping several bands of tire tape spaced about 4- to 6-inches apart, you can adjust the diameter of the masts for a snug telescopic fit into the plastic pipe. Once fitted, secure the joints with a bolt.

Assembling the mast material should not be difficult. Remember to install a bolt and solder lug at the top of the 32½-foot mast, one about three inches above the bottom of the plastic pipe (jumper these two lugs), one about three-inches higher (for the 40-meter trap), one at the top of the plastic pipe and one at the start of the 160-meter loading coil (jumper these last two lugs).

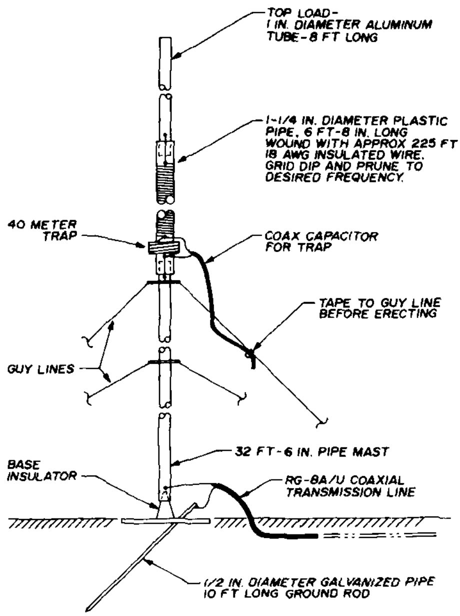

fig. 1. The arrangement of the 40- and 160-meter antenna.

The lugs and jumpers provide the electrical continuity between the masts and the coils.

40-meter trap

I had a few 40-meter traps left over from an old Field Day antenna. The traps were originally described in an old *QST* article and they used sections from commercially available air-wound coil stock. The coil in one trap consists of nine turns of number twelve wire with a 2½-inch diameter and with the turns are spaced about 1/8-inch apart. The coil was shunted with a 100-pF high-voltage type TV capacitor.

Feeling that these capacitors might not weather well, I decided to use a piece of RG-8/U as the capacitor. RG-8 has a capacitance of 29.5-pF per foot and RG-II has a capacitance of 20.5-pF per foot. I cut a piece of RG-8 about four-feet long, dressed one end and soldered the shield to one end of the coil and the inner conductor to the other end of the coil. The grid-dip meter indicated resonance too low, so I trimmed the coax until I zeroed in on 7250 kHz. Be sure that the shield does not short to the inner conductor while you are trimming the cable. When you are finished, seal both ends of the coax with plastic cement to waterproof the cable.

Mount the trap concentric with the plastic pipe between the two lugs spaced at three inches, and just below where the 160-meter coil will go. Before erecting the antenna, tape the coax to one of the guy wires — allowing a little slack. Do not make the mistake I made of using RG-58 or RG-59 for the trap capacitor. It will work well with low power, but mine simply went *poof* when I fired up my linear on forty meters.

160-meter loading coil

Now for the fun of winding the 160-meter loading coil. *The ARRL Handbook* states that a helically-wound vertical antenna needs twice as much wire length as a normal quarter wavelength. Since my bottom section and top section added up to about forty feet, I figured I would need some 167 feet of wire in the trap to hit 1812 kHz. I had a new 175-foot roll of plastic-coated number-18 wire. I decided to wrap up the whole roll on the PVC pipe and grid dip it out to see where it resonated. The coil was more or less scramble wound and both ends were soldered to the lugs.

The next step was to check the assembly with a grid-dip meter. I leaned the antenna up against my garage, and using a step ladder, checked the coil for resonance. I was quite surprised that it tuned high. I then added another fifty feet of wire to the coil, and now I was too low. I began to prune ten turns at a time, then five and finally one turn at a time until I zeroed in on the desired frequency. This step requires patience, but for a good antenna, it is the most critical operation of all.

installation

The antenna is not too difficult to raise with a few helpers. The base, of course, should sit on a suitable insulator and foundation. I use two sets of non-conducting guys. One set is connected to a guy ring close to the top of the bottom mast section just below the PVC pipe and another set is connected half-way down the mast. I already had three 34-foot radials buried in the ground for the 40-meter vertical, but I added the ten-foot long half-inch diameter pipe as an extra ground for 160. We have a very heavy shale strata here about six feet below the surface, so I flattened one end of the ground rod and ground it sharp and drove it in at a 45-degree angle to get better exposure. I feed the antenna in the normal manner with RG-8/U buried under the turf.

operation

For some reason, this antenna works very well on all other amateur bands, including two meters. I also find that contrary to my expectation, it picks up less man-made noise than the inverted L, which is basically horizontal. I put this antenna up in the fall of 1970 and it has done a terrific job for me ever since. My basic feelings regarding the vertical versus the inverted L are as follows: Locally, the inverted L is stronger by several S points. From 400 to 800 miles I get conflicting reports. Over 1000 miles, however, the vertical vastly out-performs the horizontal. A final sneaky report, would be to state that the inverted L gives my wife some BCI, but I can be on the air all night with the vertical without a bit of BCI.

ham radio

FACTORY NEW
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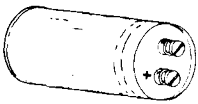
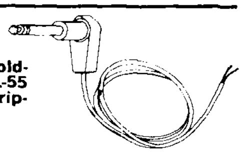
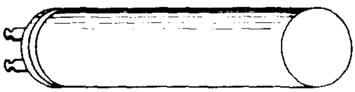


10,000 MFD @ 40 Volts. Size is 2″ dia. x 3″ high. Just right for that power supply. $1.75 ea. or 3 for $4.50 ppd.

HIGH QUALITY PATCH CORD
6 Foot Gray shielded cord with molded Right angle PL-55 Plug. Other end stripped and tinned. 75¢ each or 3 for $2.00 ppd.





3000 MFD @ 30 VOLT CAPACITORS
Size: 1″ Diameter x 3″ Long. 75¢ each or 3 for $2.00 ppd.

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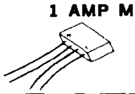
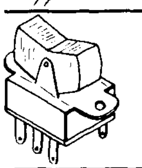
1 AMP MOLDED BRIDGE RECTIFIER

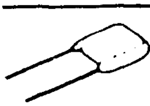


200 Volt PIV Small Size — Manufactured By General Instrument. Ideal For P.C. Board. 50¢ Each, 3 For $1.25 ppd.



ILLUMINATED ROCKER SWITCH
American made UL approved 125 Volt 3 A ac Illuminated S.P.D.T. rocker switch. Separate built-in S.P.D.T. switch operates built-in 115 VAC lamp. 75¢ ea. 3 for $2.00

Disc Ceramic Capacitors. Very Small — About ½″ Diameter. All Full Leads.
.01 MFD @ 500 Volts
.001 MFD @ 500 Volts
.015 MFD @ 500 Volts
Your Choice! 20 for $1.00 ppd.



NEW
Dipped Mylar Capacitors.
.1 MFD @ 100 Volts
.15 MFD @ 100 Volts
.22 MFD @ 100 Volts
Your Choice! 16 for $1.00 ppd.

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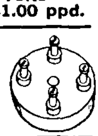
1 AMP BRIDGE RECTIFIER
SEMTECH # SCBR 1
Very nice. ¾″ d.
100 Volt PIV
50¢ ea. ppd.



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PRICE is a low — $6.00 for half pound ppd. or $10.00 for a full pound ppd.

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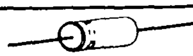

CDE TYPE WMF MYLAR CAPACITORS
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.033 MFD @ 100V	8¢ ea.	14 for $1.00
.1 MFD @ 100V	10¢ ea.	12 for $1.00
.22 MFD @ 100V	10¢ ea.	12 for $1.00
1.0 MFD @ 100V	25¢ ea.	5 for $1.00

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PIV	TOP-HAT 1.5 AMP	EPOXY 1.5 AMP	EPOXY 3 AMP	STUD-MOUNT 6 AMP
50	.04	.06	.12	.15
100	.06	.08	.16	.20
200	.08	.10	.20	.25
400	.12	.14	.28	.50
600	.14	.16	.32	.58
800		.20	.40	.65
1000		.24	.48	.75

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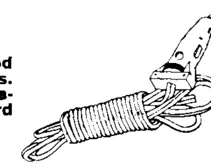
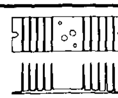
400 MILLIWATT UNITS — 3, 3.3, 3.6, 3.9, 4.3, 4.7, 5.6, 6.2, 6.8, 7.5, 8.2, 9.1, 18, 22, 24, 27, Volts.

1 WATT UNITS — 10, 11, 12, 13, 15, 16, 18, 20, 22, 27, 30, 33, 39, 43, 47, 51, 56, 62, 68, 75, 82, 91, 100, 110, 120, 130, 150, 160, 180, Volts. ALL UNITS 10% — 4 for $1.00 ppd. 5% — 3 for $1.00 ppd.

HIGHEST QUALITY, AMERICAN MADE POWER CORD
6 Foot Gray Cord. Good For At Least 7 Amps. Plugs Into Auto Cigarette Lighter. A Hard To Find Item. 75¢ Each or 3 For $2.00 ppd.





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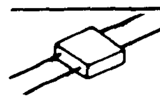
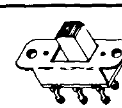
Black, Aluminum, Anodized, Heat Sink. Size Approximately 4¾″ x 1⅜″ h. x 1½″ w. Predrilled For TO-3 Transistors. Delco Factory New. 75¢ Each 3 for $2.00 ppd.



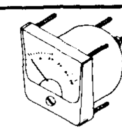
1.5 AMP BRIDGE RECTIFIER
1200 Volts PIV per leg.
$1.00 ea. or 3 for $2.50 ppd.

DPDT SLIDE SWITCHES
UL Approve American Made 3 Amp Slide switches. Your choice of RED or Black.
20¢ ea. or 6 for $1.00 ppd.



Extruded Aluminum Heat Sink for TO-5 Transistors. 2 for 25¢ ppd.

Very nice American made 1¾″ square meters. Mount in 1½″ dia. hole. Your choice 5ma or 50ma.
$2.40 ea. ppd.



Power Transformer. 115 Volt AC Primary. Secondary #1: 32-0-32 Volt @ 1 Amp. Secondary #2: 6.3 Volts. Low Current For Pilot Lights. Size 2½″ x 2½″ x 3″.
Price: $2.50 Each ppd.

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More Details? CHECK—OFF Page 110

new system for predicting six-meter sporadic-E openings

Here's a unique system for predicting six-meter sporadic-E propagation well in advance

Morrie S. Goldman, WA9RAQ, 5815 North Christiana, Chicago, Illinois 60659

The concept of using beacon transmitters to alert operators of the presence of vhf openings is certainly not a new one. For years, vhf enthusiasts have left their receivers parked on beacon frequencies, hoping to hear one of the relatively few low-power vhf beacons. Well known vhf experimenter Bob Cooper described such a beacon in *ham radio.*[1]

The use of amateur beacon transmitters is not, however, without its drawbacks. It goes without saying that one of the greatest problems with this early warning system is the low number of amateur beacons. It takes a devoted vhfer to build and maintain a device which will help others far more than it helps him.

Another reality is that it really isn't an early warning system. A warning yes – early, no. By the time you start to hear six-meter activity, the band is already open; not about to open! This means that you have probably already missed a great deal of the opening. Skip propagation is often quite selective, and the opening may have been to a relatively small geographic area.

If the notion of actually predicting a sporadic-E opening sounds far fetched, you're only partially correct. Long-range predictions for non-auroral related sporadic-E are still experimental, very involved and largely unproven. However, very short range predictions *are* practical. Predictions on the order of hours or minutes can be made with a high degree of accuracy and often you can pinpoint the affected geographic areas.

The sporadic E-(Es) maximum usable frequency (muf) begins low, and as ionization density increases, the muf increases. Es will appear on 11 meters before it developes on 10, and on 10 meters before reaching 6, and so on. However, just because it occurs on 27 and 28 MHz does not always mean that it will reach 50 MHz. During the summer months, you can hear a residual level of short-skip on Citizen Band – a mass of hetrodynes and squeals, and a multitude of accents from different transmitters. Opening on 6 meters, or for that matter, 10 meters, are not nearly so common.

So the question, and the main point of this article, is, how can we effectively put to use this known fact to predict Es?

Clearly, we need a more accurate means of following the maximum usable frequency. It should also require little attention and be continuously operative.

I began by discussing amateur beacons and their shortcomings. There is a substitute for these beacons which can be far more effective. It consists of transmitters staggered across the 30- to 50-MHz range, operating 24 hours a day with, by amateur standards, moderate to high power. These pseudo-beacons are provided by commercial paging stations.

These paging stations are operated by commercial companies to relay messages to their customers. Customers carry small receivers which are activated by a tone squelch or selective calling units, alerting them to repair orders, telephoned messages, etc. When there are no messages to transmit, many of the stations continue to transmit their call letters and location.

Vhf operators will be concerned primarily with those paging stations operating on 35.22, 35.58, 43.22 and 43.58 MHz. These four channels are the standardized low-band paging channels and will prove most effective for unattended monitoring.

Fortunately, receivers for this range are plentiful. They range from small inexpensive handheld portables to higher priced automatic-scanning monitors. Many older tube-type 30- to 50-MHz monitors can be found at bargain prices at hamfests. In many cases they are not as sensitive as the new portables, but most have effective squelch circuits and far better image rejection. These receivers are all designed for fm but a few have a-m-fm switches.

Most of the paging stations use a-m, which would seem to be a problem, but it isn't. All of the public-service-band receivers designed for consumer use that I've used have had such poor discriminator circuits that they also received a-m quite well. A well designed receiver might cause a problem, but I haven't run across one!

Unfortunately, all paging stations do not identify. Some operate on a tone-only system, and you never hear a human voice. Hearing a station of this type will alert you to Es, but not to where it's coming from. Some stations give their call letters in modulated CW but not their location. However, most pagers are still using voice and give both call and location. Many use names such as, "Paging Orlando," Air Call Chicago," "Fresno Radio Page," etc. After awhile you will start to recognize the voices of operators from some of the stations most commonly received in your area.

From various sources, including my own observations and those of members of The Worldwide TV-FM DX Association,* I have compiled a list of paging stations shown in **table 1**. It is not a complete list by any means, but it should give you a good start. Accurate lists are nearly impossible to obtain, and I believe that the latest record of paging stations kept by the Chicago FCC Field Office is dated 1963!

Callsign prefixes are not as clearly defined as in the amateur service as far as geographical area is concerned, but there is a general pattern, as shown in **table 2.**

The messages, callsign and other information broadcast by paging stations are usually recorded on a magnetic metal strip or endless tape cartridge, and continue to repeat until new messages come in. Many stations, as we mentioned earlier, transmit a recording of their callsign when there is no other traffic. Most of the MCW stations (or perhaps all) are off the air more often than on. When KSC645 in Chicago switched to tone-only operation, I finally began to hear weak signals on 35.58 MHz. Previously, only the strongest signals overrode the KSC645 signal. When the tones are on, however, nothing can make it through!

The procedure for using paging stations to monitor vhf conditions is a simple one. If you're using a tunable receiver, or a manually switchable crystal controlled receiver, set it to 35.22 MHz

*The Worldwide TV-FM DX Association publishes a monthly "Vhf-Uhf Digest" which includes technical articles, FCC news and reports on all phases of vhf and uhf DX. Sample copy is \$.50; one-year subscription is \$6.00 from WTFDA, Post Office Box 163, Deerfield, Illinios 60015.

table 1. Partial list of vhf paging stations in the United States. Corrections are welcomed by the author.

35.22 MHz

KIY757 a-m Birmingham, AL
KCH280 a-m Phoenix, AZ
KKX708 a-m Little Rock, AR
KMD342 a-m Fresno, CA
KMD998 a-m Lodi, CA
KMD681 a-m San Diego, CA
KMD305 a-m San Francisco, CA
KDN407 MCW Colorado Springs, CO
KCI299 a-m New Haven, CT
KIN645 a-m Miami, FL
KIY508 a-m Orlando, FL
KIY719 fm Pensacola, FL
KOK344 a-m Boise, ID
KSA623 a-m Ft. Wayne, IN
KSD320 a-m South Bend, IN
KAI934 a-m Des Monies, IA
KLB760 a-m Baton Rouge, LA
KKT407 MCW New Orleans, LA
KLB319 a-m Shreveport, LA
KGA807 a-m Baltimore, MD
KQD303 a-m Detroit, MI
KAH661 a-m Minneapolis, MN
KBM313 a-m Omaha, NE
KCC482 a-m Concord, NH
KEC925 MCW Buffalo, NY
KEA860 a-m New York City, NY
KIM905 a-m Charlotte, NC
KQD600 MCW Mansfield, OH
KGC266 a-m Allentown, PA
KGC223 a-m Philadelphia, PA
KFL880 a-m Greenville, SC
KKJ460 a-m Dallas, TX
KCF341 a-m Salt Lake City, UT
KCP253 fm Seattle, WA
KON908 a-m Cheyenne, WY
WWA335 a-m San Juan, PR

35.58 MHz

KOF328 a-m Tucson, AZ
KMD344 a-m Long Beach, CA
KME437 a-m Santa Cruz, CA
KMD347 a-m Stockton, CA
KAQ606 MCW Denver, CO
KIF651 a-m Ft. Lauderdale, FL
KIQ518 a-m Jacksonville, FL
KIE953 a-m Atlanta, GA
KIG844 a-m Augusta, GA
KUA217 a-m Honolulu, HI
KSC645 MCW Chicago, IL
KSC864 a-m Peoria, IL
KSD322 a-m Evansville, IN
KSD326 MCW Indianapolis, IN
KAD927 a-m Wichita, KS
KGA807 a-m Baltimore, MD
KCC266 a-m Springfield, MA
KQD601 a-m Flint, MI
KAD931 a-m Kansas City, KS
KEC935 a-m/MCW Newark, NJ
KED352 a-m Trenton, NJ
KEC519 a-m Rochester, NY
KEC515 a-m Troy, NY
KKT403 a-m Albuquerque, NM
KIY775 a-m Greensboro, NC
KKM248 a-m Oklahoma City, OK
KOA796 a-m Portland, OR
KGH861 MCW Chester, PA
KGC400 a-m Scranton, PA
KIG837 a-m Nashville, TN
KLB716 a-m Abilene, TX
KKV688 a-m Amarillo, TX
KKI445 a-m Houston, TX
KKQ965 MCW Lubbock, TX
KLB578 a-m San Angelo, TX
KIG297 a-m Norfolk, VA
KSD318 a-m Madison, WI

43.22 MHz

KMB309 a-m Los Angeles, CA
KMM960 a-m San Rafael, CA
KMM660 a-m Taylor Mountain, CA
KCC802 fm Waterbury, CT
KIN645 fm Miami, FL
KCI295 fm Manchester, NH
KEC745 MCW New York City, NY
KIY792 a-m Winston Salem, NC
KGC223 a-m Philadelphia, PA
KOP258 a-m Tacoma, WA

43.58 MHz

KOE257 a-m Phoenix, AZ
KMD986 a-m Sacramento, CA
KGA806 a-m Washington, DC
KIE367 a-m Miami, FL
KIG300 a-m Atlanta, GA
KSC644 a-m Chicago, IL
KSJ816 a-m Ft. Wayne, IN
KIF656 a-m Louisville, KY
KCB890 fm Boston, MA
KQC884 a-m Detroit, MI
KAF245 a-m Kansas City, MO
KAA893 a-m St. Louis, MO
KEA777 a-m Buffalo, NY
KEA627 a-m New York City, NY
KEC516 a-m Lafayette, NY
KEC518 a-m Rochester, NY
KQC877 a-m Cincinnati, OH
KQK593 a-m Cleveland, OH
KFJ891 MCW Columbus, OH
KGA804 a-m Philadelphia, PA
KGA805 a-m Pittsburg, PA
KIF653 a-m Memphis, TN
KKJ460 a-m Dallas, TX

table 2. Paging station callsigns by general geographic area.

KA Midwest, including Colorado, Iowa, Kansas, Missouri, Minnesota, North Dakota and South Dakota
KC New England, including Maine, Massachusetts, Connecticut, New Hampshire, Rhode Island and Vermont
KE Mid-Atlantic, including New York and New Jersey
KI Southeast, including Alabama, Georgia, Florida, Kentucky, North Carolina, South Carolina, Tennessee and Virginia
KG Mid-Atlantic, including District of Columbia, Delaware, Maryland and Pennsylvania
KK Gulf Coast, including Arkansas, Louisiana, Mississippi, New Mexico, Oklahoma and Texas
KM West Coast, including California
KO West, including, Arizona, Idaho, Montana, Nevada, Utah, Washington, Wyoming and Oregon
KQ East central, including Ohio, Michigan and West Virginia
KS Central, including Illinois, Indiana and Wisconsin
KU Pacific, including Hawaii
KW Alaska
WW Puerto Rico

(if 35.22 is not used in your area, use 35.58). If you are using a tunable receiver the calibration will probably not be accurate enough. In this case, you'll have to mark your dial for these channels when skip, and pagers, are in.

Once you've set your dial on 35.22 or 35.58 MHz, turn the squelch up slightly and leave it on. When conditions start to pick up, you'll hear activity. Now flip up to the 43-MHz channels and lock in. If activity is not noted on these channels within the next hour or so, periodically check back to the 35-MHz channels. The muf may never have made it much beyond 35 MHz.

On the other hand, the Es may be into an area with no 43-MHz pagers (or worse yet, with no pagers!). So, when 35 MHz is active, alert yourself to a *possible* sporadic-E opening on six meters. When 43 MHz is active, watch for a *probable* six meter Es opening within the next few minutes!

If you're using a scanning receiver, and one that will cover an eight MHz stretch on low band, let it scan all the paging channels open in your area. If it sticks on one of the 35-MHz channels, switch that position off, and let the receiver scan the 43 MHz channels only. With some practice you'll start to get an idea when six-meter Es is likely.

General directions of the Es origin can be plotted for the expected six-meter opening. As you might expect, the 43-MHz channels are of greatest help for this task; 35 MHz is of less use as refractive angles are substantially sharper. In addition, ionization patches that affect 35 MHz may allow 50 MHz or 43 MHz to pass.

Actually, there are an almost infinite number of stations operating within this frequency range. When Es is strong, numerous public service stations and other two-way stations pour in, adding useful information about the potential opening. A mobile phone channel around 35.35 MHz is also very helpful, as mobile radiotelephone operators identify by their cities. Europeon tv audio channels can be monitored as well. BBC audio is transmitted on 41.5 MHz (BBC-1 service is scheduled to be discontinued before the next sunspot maximum) and the French ORTF is on 41.25 MHz.

During the recent sunspot peak, BBC and ORTF were both received on many occasions across the US. BBC-1 has also been received on the East Coast via auroral E. Over most of that sunspot peak, the 30- to 50-MHz range was quite lively. Paging stations on 35-MHz were received here in Chicago on a daily basis from Hawaii, California, Puerto Rico and other locations. Of course, changes in sunspot activity affect reception greatly, often creating a mass of hetrodynes on the paging channels. Most common here were Fresno, California and San Juan, Puerto Rico, both on 35.22 MHz.

Armed with this tool for catching six-meter Es openings you're set for more vhf fun than you ever bargained for!

references

1. Bob Cooper, KV4FU, "An Automatic Two-Way DX Beacon for VHF," *ham radio*, October, 1969, page 52.
2. Ed. Noll, W3FQJ, "VHF Beacons," *ham radio*, December, 1971, page 66.

ham radio

low swr dipole pairs for 1.8 through 30 MHz

A simple antenna system for the hf bands that offers low swr and broad bandwidth without a tuner

F. J. Bauer, Jr., W6FPO, Box 1080, Felton, California 95018

After reading Bill Orr's article on multiband dipoles for 10, 15 and 20 meters, I decided to try some of his ideas on the lower-frequency bands, together with a few innovations needed to solve the bandwidth problem.[1] If you calculate the percentage bandwidth of each amateur band from 160 through 10 meters, you come up with the figures in **table 1**.

Reference to the table tells us immediately that the only amateur bands requiring broadband treatment are 80 and possibly 10 meters, since conventional dipoles will readily meet the bandwidth and swr requirements for bandwidths of 5% or less.

The first dipole pair to be considered in an all-band installation is the 160- and 80-meter combination, since it is the biggest and is usually mounted near the top of the mast or tower. Both antennas may be mounted as inverted Vs as long as a minimum angle of thirty degrees is maintained between them. The thirty degree separation is necessary to keep antenna interaction to a minimum.

The 160-meter section is a simple wire dipole cut for 1850 kHz and then adjusted for minimum swr with the 80-meter dipole connected and mounted in place.

The 80-meter dipole is a standard broadband double bazooka.[2,3] This antenna has a fairly good broadband characteristic and works well with the 160-meter dipole as a two-band antenna system.

Construction details for my antenna are shown in **fig. 1** and **tables 2** and **3**. They depart somewhat from the original design, but mine are simpler and perform

table 1. Bandwidths of the hf amateur bands. Percentages were determined by dividing the bandwidth in MHz by the center frequency.

band	bandwidth (percent)
160	5.1
80	13.3
40	4.2
20	2.7
15	2.1
10	5.9

just as well. I used twinlead for the ends instead of ladder line because twinlead was more readily available.

The antenna is most easily set up by cutting the coaxial center section for 3750 kHz according to the formula in **table 3** and then adjusting the length of *the end sections for identical swr at each* band edge. This final adjustment must be made with the antenna connected to the 160-meter dipole. The result should be an swr curve similar to **fig. 2** for both dipoles. If the 2:1 swr on the band edges is objectionable, the curve may be modified by lengthening or shortening the twinlead ends slightly to favor that portion of the band used most frequently.

The double bazooka is a fine antenna for this application – but, as usual, there is a catch. It works well in conjunction with any dipole that is *lower* in frequency than the double bazooka. Thus, a 10-meter double bazooka will work well with a 20-meter dipole, just as an 80-meter double bazooka will work with a 160-meter dipole. However, any attempt to use the antenna with a *higher* frequency dipole will result in an absolutely unmanageable swr on the higher-frequency band. This peculiar behavior is caused by the center conductor of the *coaxial section acting as a pair* of short-circuited quarter-wave stubs on the second harmonic. Therefore, if 160-meter operation is not desired, the 80-meter double bazooka will have to be run on a transmission line separate from the other dipole pairs.

40 and 15 meters

Well accepted theory states that dipoles working from a common feedline or balun must be harmonically related to be effective, the implication being that the relationship usually involves the fundamental and the second harmonic. The question arose, when developing these dipole pairs, what to do about fifteen meters? The only amateur band to which

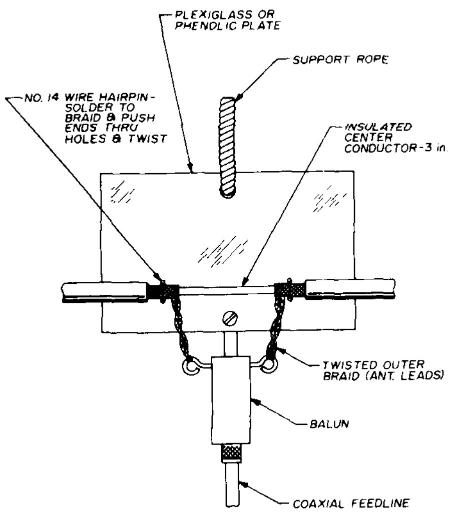
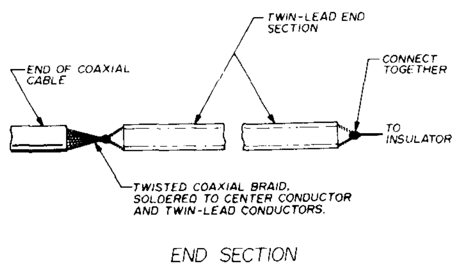


fig. 1. Construction details for the 80- and 10-meter broadband dipoles. Table 3 includes the necessary formulas and some typical dimensions. The end segments (D3) will vary somewhat from the calculated values and, like all dipoles, *may need pruning once the antenna is* in place.



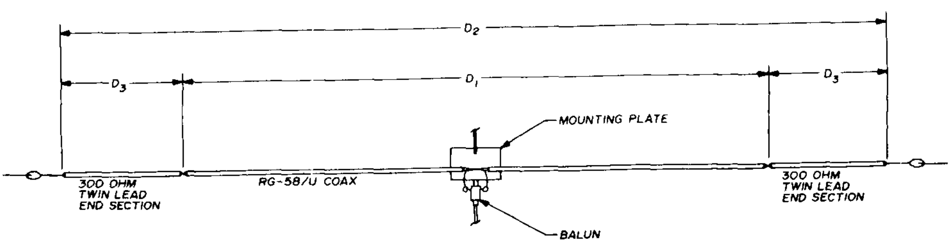


table 2. Wire dipole lengths.

band	overall length
160	243' 0"
40	64' 2"
20	33' 0"
15	22' 0"

it is harmonically related is forty, so I set up a 40-meter dipole with a low swr. When I tried operating on fifteen, the swr jumped to 3:1 and higher. This should really not be surprising since theory again tells us that the radiation resistance of an antenna increases as the number of half waves increases. The thought then occurred that the addition of a 15-meter dipole to the 40-meter dipole might solve the problem. This worked out very well indeed, as a reference to **fig. 3** will reveal.

The 40- and 15-meter combination, unlike the previous dipole pair, does not require the application of broadband techniques. Conventional single-wire dipoles will do the job and, if carefully adjusted, will result in a swr of 1.5:1 or less on both bands. Incidentally, I did not attempt to center the swr curves as in the previous case. The 40-meter dipole is a little short and the 15-meter dipole a little too long, a situation readily corrected by the perfectionist.

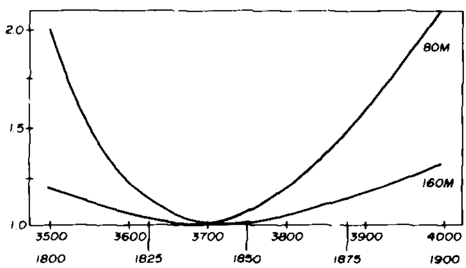


fig. 2. Swr curves for the 160- and 80-meter dipole pair. Dimensions of the final antenna lengths are given in tables 2 and 3.

To set up the pair, begin by adjusting the 40-meter dipole for equal swr at the band edges. This should be done with a pre-cut 15-meter dipole connected to the 40-meter dipole. Also, be sure to space the ends of the 15-meter dipole at least 8 feet from the 40-meter dipole, otherwise severe antenna interaction may result. This will show up as an excessive swr, usually on 15 meters. After obtaining a satisfactory swr curve on forty, proceed to adjust the 15-meter dipole. Usually very little adjustment of the 15-meter element will be required.

20 and 10 meters

The 10- and 20-meter dipole combination may be regarded as a scaled-down version of the 160- and 80-meter dipole pair, since both pairs use a simple wire dipole for the lower-frequency band and a broadband antenna for the higher-frequency band. The similarity ends there. You will find that the dipoles of this antenna pair are more interdependent and therefore more critical to adjust.

Begin by cutting both antennas to their calculated length. Connect both to a common balun, and make sure that the ends of the 10-meter dipole are at least 10 feet from the 20-meter dipole.

Adjust the 20-meter antenna for minimum swr. After obtaining a satisfactory swr similar to **fig. 4**, proceed to adjust the 10-meter dipole for minimum swr by adjusting the lengths of the twinlead ends. As a final touch, check both bands once again to see if any significant shift has occurred in either swr curve. By following this procedure you will experience little difficulty in setting up this last dipole pair.

The dipole pairs described in this article are the direct result of much experimentation done while developing a

table 3. Bazooka antenna dimensions. D1, D2 and D3 are shown in fig. 1. The formulas used to compute these lengths initially are D1=492/f(MHz) for foam coax and D1=325/f(MHz) for polyethylene coax. D2=460/f(MHz) and D3=(D2D1)/2.

band	D1	D2	D3	cable
80	105'	125'	10'	foam
10	11' 2"	15' 6"	26"	poly

simple, effective, all-band antenna system for Doc, WB6UWK. Doc is a blind amateur who likes to work all bands on all modes without the need for fooling

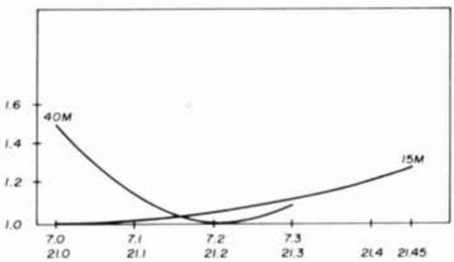


fig. 3. Swr curve for the 40- and 15- meter dipole pair.

with couplers or matching gimmicks of any kind. A coaxial switch makes antenna switching extremely simple.

The dipole pairs have been in service for about a year now and have given no trouble, even when running the legal

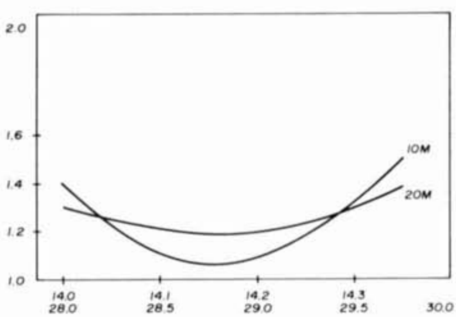


fig. 4. Swr curve for the 20- and 10- meter dipole pair.

power limit. No superlative DX claims are made for this system, but on each band it seems to perform as well as a simple dipole.

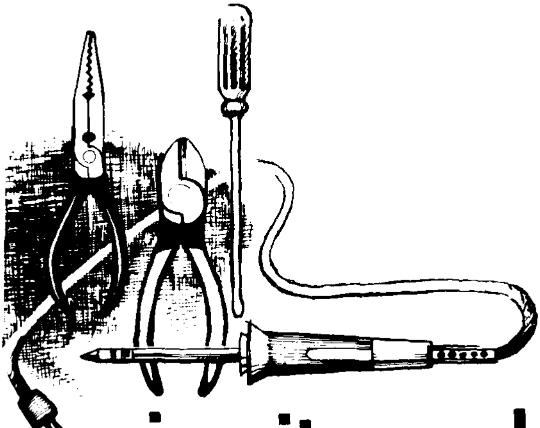
references

1. William I. Orr, W6SAI, "Multiband Dipoles for Portable Use," *ham radio*, May, 1970, page 12.

2. "The Radio Amateur's Handbook," 48th edition, ARRL, 1971, pages 368-369.

3. Charles C. Whysall, W8TV, "The Double Bazooka Antenna," *QST*, July, 1968, page 38.

ham radio



circuits and techniques

ed noll, W3FQJ

multi-function ICs

Multi-function integrated circuits comprise two or more basic functional systems within the same case. Input, output and control leads from each system are brought out. Hence, the internal systems can be interwired externally to serve a variety of applications. These versatile devices are a specialty of the Exar Corporation. Last month the XR-205 Waveform Generator was introduced. Several additional circuits of this 16-pin in-line device are described this month. Also covered is their multi-function XR-S200, mounted in a 24-pin, in-line package. This is an extraordinary unit planned for communications systems.

XR-205 applications

In the XR-205 circuits covered previously the upper frequency limit was no more than several megahertz. A modified circuit, **fig. 1**, permits a sinusoidal output up to at least 10 MHz. Output level at pin 11 is less in this circuit arrangement being approximately 700 mV. Frequency capability is now in the amateur vfo spectrum for either high-frequency or vhf operation. This single device can serve as a vfo (keyed or unkeyed), double-sideband *a-m*, suppressed carrier (for single-sideband application), or fm signal source. All are tied together in one neat package. Furthermore, it makes available a variety of non-sinusoid signals for transmitter test circuits, synchronizing or other applications.

Such a basic signal source could be

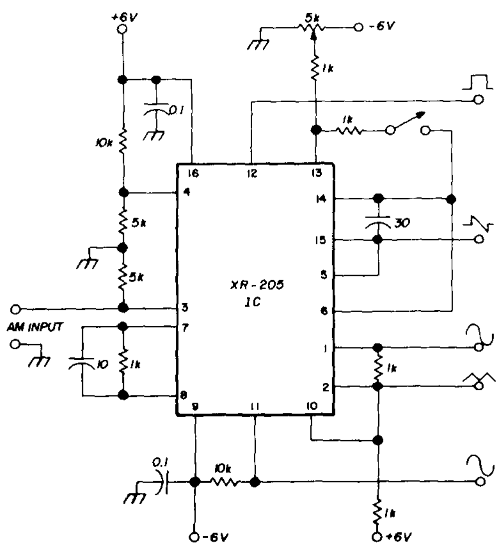


fig. 1. High-frequency operation of the Exar XR-205 waveform generator IC.

followed by a chain of linear amplifier and mixer-oscillator integrated circuit stages, **fig. 2**. The final power amplifiers of such a transmitter could be designed to operate either in the linear or class-C

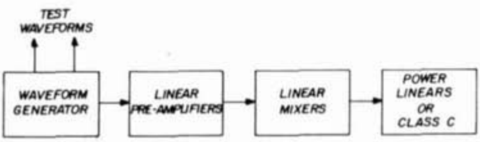


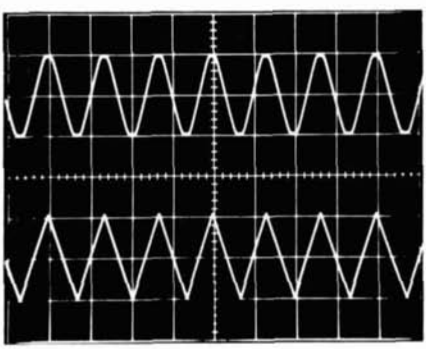
fig. 2. Block diagram of a transmitter using the waveform generator IC.

amplifier mode. The latter would permit more efficient CW and fm signal amplification when desired. Several basic and modulated wave-forms are given in **fig. 3**. Also, the circuit for single-supply operation is given in **fig. 4**. This circuit has an upper frequency limit of 2 to 4 MHz and an output voltage of 2 to 3 volts peak-to-peak. Characteristics are given in **table 1.**

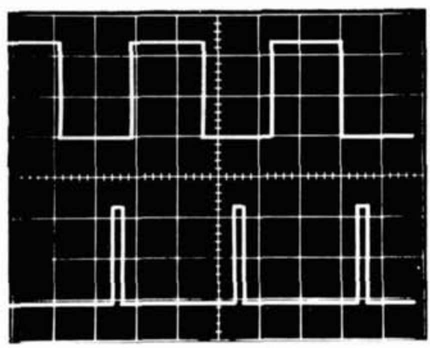
The single unit cost of $16.00 might jar you. But how much would it cost to duplicate this versatility with discrete transistors? What a tremendous fortune it would take to duplicate this performance with vacuum tubes!

Exar makes available an a-m/fm generator design kit for $28.00. This includes two XR-205 generators, a printed circuit board (etched and drilled), detailed components parts list, and assembly instructions. Estimated cost of additional parts is approximately $27.00.

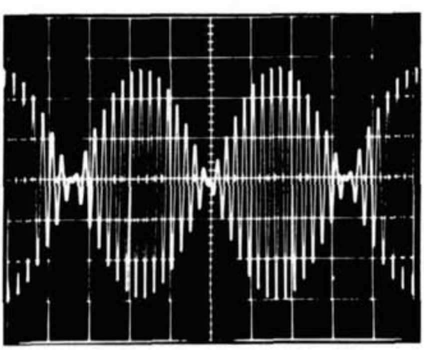
The basic circuit is given in **fig. 5**. The IC on the left provides a modulating signal. Sine, square, triangle or ramp type is selected with switch S1. Frequency of



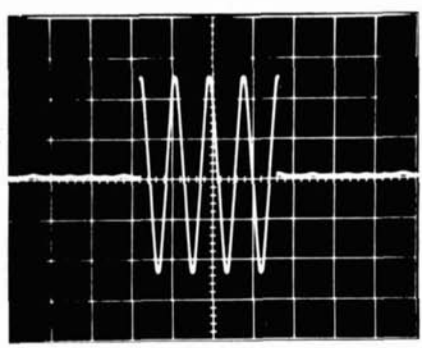
Sine and triangle



Pulse



Suppressed-carrier a-m



CW

fig. 3. Typical waveforms generated by the XR-205 IC.

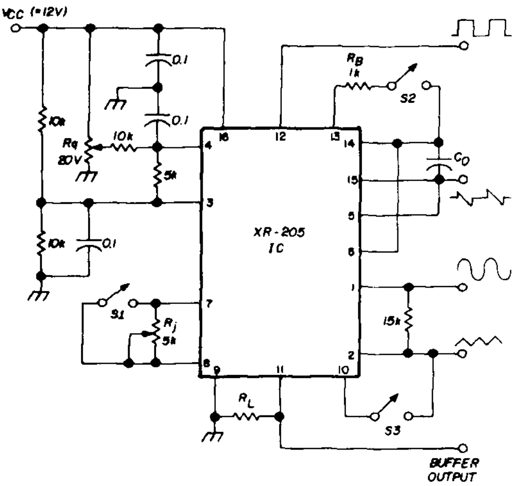


fig. 4. Test circuit for single-supply operation of the XR-205.

operation is set by capacitor C1. A combination of switched and variable capacitors at this point permits adjustment of modulating wave frequency. In the formation of non-sinusoidal modulating waves switch S2 selects a duty cycle of either 20 or 50 percent. Switch S3 is the modulation mode selector, fm, a-m or CW.

The second waveform generator operates at high frequency. It includes switches S4 for setting the duty cycle of non-sinusoidal output, and S5, which determines the output waveform. Capacitor C2 determines the output frequency. Again, switched capacitors and a variable capacitor permit frequency control. The adjustment of the modulation and carrier waveforms can be made with potentiometers R4 and R5. Potentiometer R1 sets the level of the modulating signal while potentiometer R3 sets the output carrier level. Potentiometer R2 is a carrier zero adjustment for use with suppressed-carrier modulation.

multi-function XR-S200 IC

The XR-S200 is also a three-function unit which includes an analog multiplier, vco and operational amplifier. More versatility, including operation as phase-locked loop (PLL), is present as compared to the XR-205, which consists of a voltage-controlled oscillator, balanced modulator and buffer amplifier. A number of additional applications are possible, and fre-

table 1. Characteristics of the XR205 circuit shown in fig. 4.

	min	typ	max		
Sinusoidal:					
Upper Frequency Limit	2	4		MHz	Measured at Pin 11
Peak Output Swing	2	3		V pp	S1, S3 closed
Distortion (THD)		2.5	4	%	S2 open
Triangle:					
Peak Swing	2	3		V pp	S1, S2 open
Non-Linearity		±1		%	S3 closed
Asymmetry		±1		%	f = 10 kHz
Sawtooth:					
Peak Swing	2	3		V pp	S2 open
Non-Linearity		1.5		%	S2 and S3 closed
Ramp:					
Peak Swing	1	1.4		V pp	S2 and S3 open pin 10
Non-Linearity		1		%	shorted to pin 15
Squarewave (Low Level):					
Output Swing	0.5	0.7		V pp	S2 and S3 open, pin
Duty Cycle Asymmetry		±1	±4	%	10 shorted to pin 12
Rise Time		20		ns	10 pF connected from
Fall Time		20		ns	pin 11 to ground

quency range is extended to 30 or 40 MHz. The additional versatility requires a 24-pin case and unit cost of $28.00.

Applications for the XR-S200 include phase-locked loops, fm demodulation, FSK detection, PSK demodulation, signal conditioning, tracking filters, frequency synthesis, telemetry coding and decoding, a-m detection, (quadrature and synchronous detectors), linear sweep and fm generation, tone generation and detection, waveform generation and analog multiplication. That's quite a list, and you say there is no more room for experimentation in ham radio?

How many applications for amateur radio use could you come up with using this device? Maybe it would help us to be frank and admit that often we don't want to assign the time, or we have lost or never developed the patience and perseverance that experimentation requires.

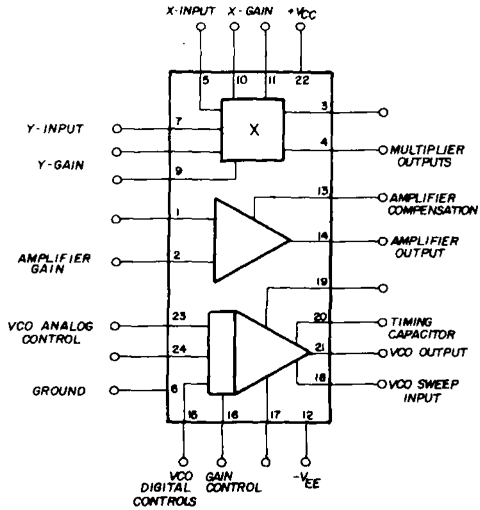


fig. 6. Diagram of the multi-function Exar XR-S200 IC.

typical circuits

The pin-out diagram for the multiplier, amplifier and vco is given in **fig. 6**. The analog multiplier is an especially versatile section which can be used as detector, balanced modulator/demodulator, frequency multiplier, etc. Several external components permit you to assemble a phase-comparator very simply as shown in **fig. 7**. You will obtain an output voltage that corresponds to the relative phase of reference and signal inputs.

The three quite similar schematics of **fig. 8** show how the multiplier section can be used as suppressed-carrier modulator,

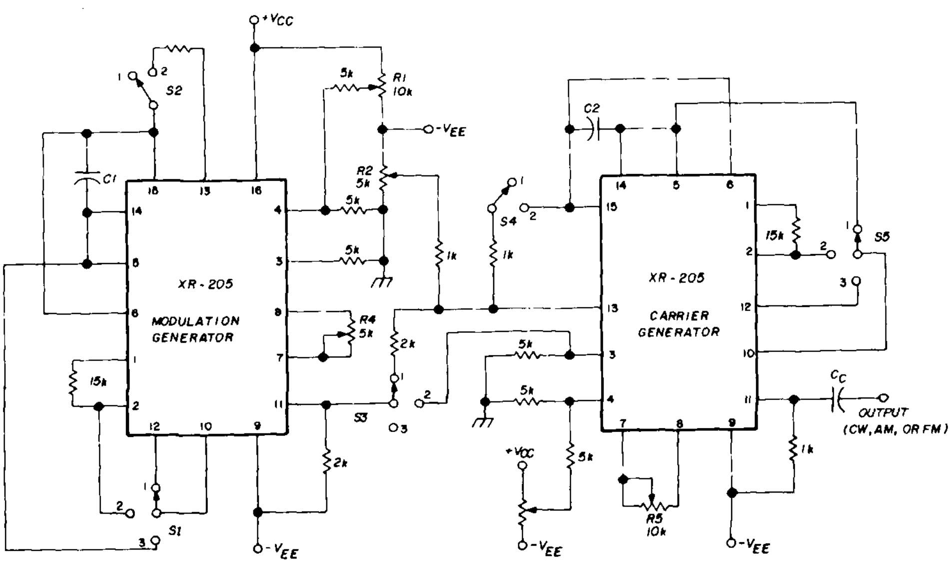


fig. 5. Self-contained a-m/fm generator using two XR-205 ICs.

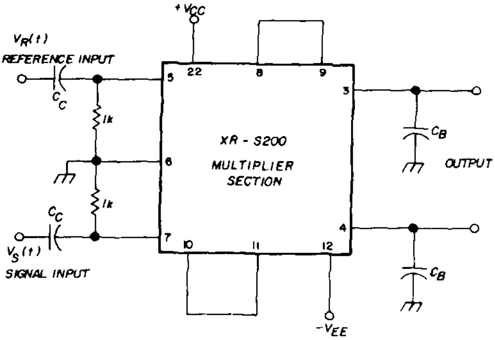


fig. 7. Phase comparator circuit based on the multiplier section of the XR-S200 multifunction IC.

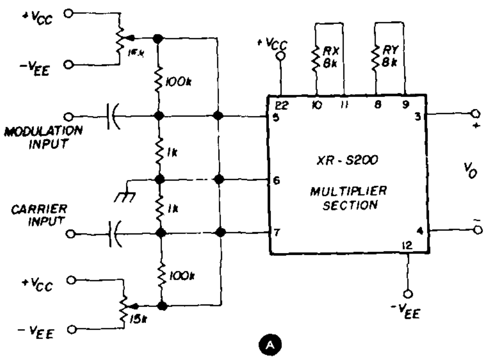
double-sideband a-m modulator and frequency doubler. Your source of carrier signal can be the vco section. Come up with a simple switching arrangement and you will have a versatile CW, a-m and dsb signal source. Inasmuch as the vco can be frequency modulated, you will also have an fm signal source. Since the vco can also be crystal controlled you can generate a signal source with crystal stability. The simple circuit of **fig. 9** will do the job.

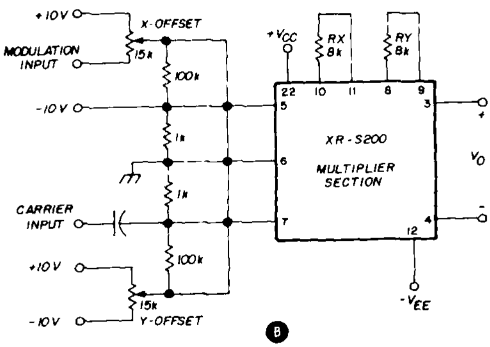
The device also has receiver applications and, therefore, versatile transceiver possibilities. A simple a-m detector using only the multiplier is given in **fig. 10**. The PLL connection arrangement, **fig. 11**, is appropriate for demodulating CW, ssb, dsb and FSK. A PLL fm demodulation system, **fig. 12**, uses the multiplier section as the phase detector. The voltage-controlled oscillator and external resistor-capacitor filter provides fm demodulation. The amplifier section increases the level of the demodulated audio.

There is more. The same device can be used as a waveform generator, forming the same variety of signals possible with the XR-205.

three-sided antennas

A letter from Jim Gray, W2EUQ, indicates that he has become an eager three-sided antenna experimenter. His open-loop configuration is shown in **fig. 13.** He corner-feeds at the apex. This differs from the usual triangle and its feed point at the center of one of the sides. The antenna operates 5/2-wavelength on 15 meters, and 3/2-wavelength on 20. Jim uses a knife switch to add an extension for proper resonance on 14 MHz.





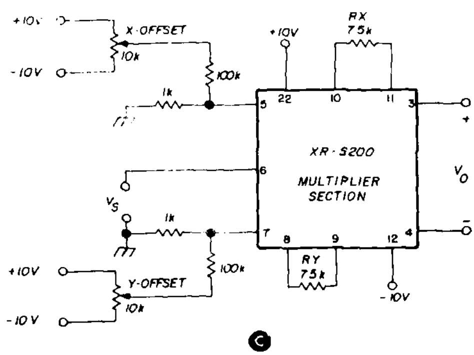


fig. 8. Using the multiplier section of the XR-S200 as a suppressed-carrier a-m modulator (A), double-sideband a-m modulator (B) and frequency doubler (C).

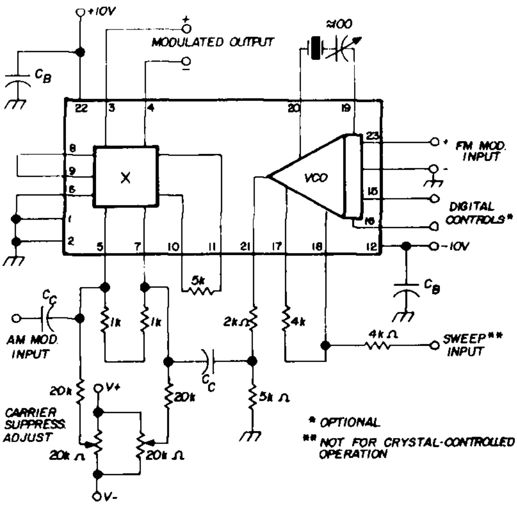


fig. 9. Circuit diagram of an a-m and fm signal source based on the XR-S200 integrated circuit.

When the end of the extension is shorted, the assembly becomes a closed full-wave loop on 40 meters. In this case it operates as a delta loop because of the corner feed point.

Another three-sided arrangement comes from the South Australian Wireless Institute Journal by way of Leo Gunther, VK7RG. This 160-meter antenna was designed by VK5EF for a site with space limitations. As shown in **fig. 14** it is fundamentally an 80-meter inverted dipole with two sides folded around

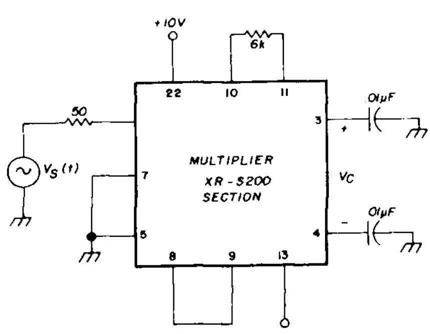


fig. 10. A-m detector circuit.

toward the mast. These include an 80-meter trap and an appropriate wire extension to obtain 160-meter resonance. VK5EF resonates his trap on 3.6 MHz. With the dimensions given there is also short-length resonance on 1.82 MHz. No antenna tuner is required.

interference-reducing antennas

The catv industry has been doing

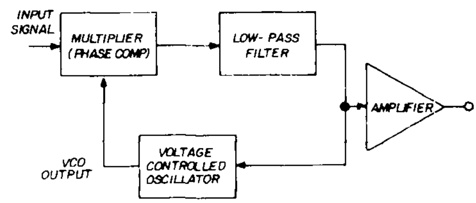


fig. 11. Phased lock loop is suitable for demodulating CW, a-m, ssb, dsb and FSK.

much research in the development of co-channel interference-reducing antenna systems. Two techniques that have possible application in radio amateur circles appeared in the June, 1972 issue of *Communications News*.[3,4] The work is

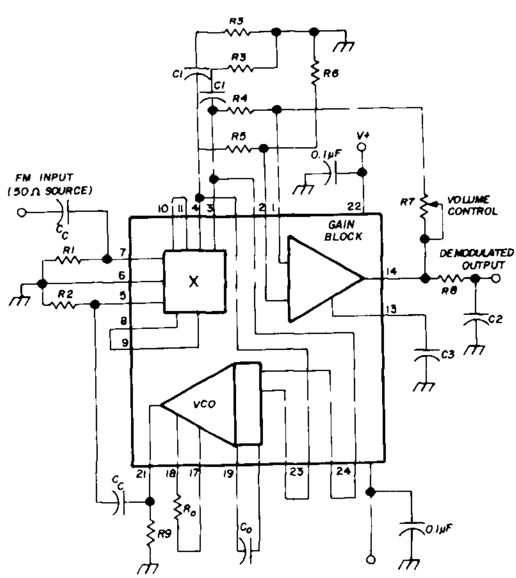


fig. 12. Fm demodulator using the phased-lock loop.

being conducted at Scala Radio by its president Bruno Zucconi and project engineer Charles B. Carter. An improvement in front-to-back ratio is accomplished by placing the top antenna one-quarter wavelength in front of the bottom one as shown in **fig. 15**. This top

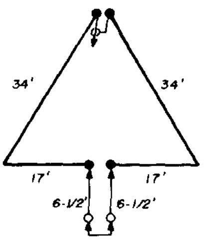


fig. 13. Three-sided antenna designed by W2EUQ for use on both 15 and 20 meters. The 6½-foot extension is switched in with a knife switch to provide resonance on 20 meters.

antenna is also fed 90° later than the bottom one. **Table 2** provides useful dimensions for the amateur bands from two through twenty meters. Values are for band center.

If your interference is largely from the forward direction, two Yagis or other narrow-beam, high-gain antennas are fed in phase, **fig. 16**. With suitable horizontal displacement there is signal cancellation from some specific receive angle off the beam direction. You only have to know the angle of arrival of your most troublesome QRM. The information in **table 3** then permits you to so space the two

table 2. Antenna spacing and feedline length for increasing front-to-back ratio of stacked Yagi antennas.

band	2 meters	6 meters	10 meters	15 meters	20 meters
¼-wave free space	20¼"	57"	8'6"	11'7"	17'4"
¼-wave line*	13¼"	37½"	5'8"	7'7"	11'6"

*based on 0.66 velocity factor.

antennas to give the most rejection at a particular angle off the forward beam direction.

The pattern of **fig. 17** shows the type of deep null that can be obtained 20° off the beam direction. With your antenna system mounted on a rotator, you can do some fine nulling of interference coming from the same general direction. Perhaps

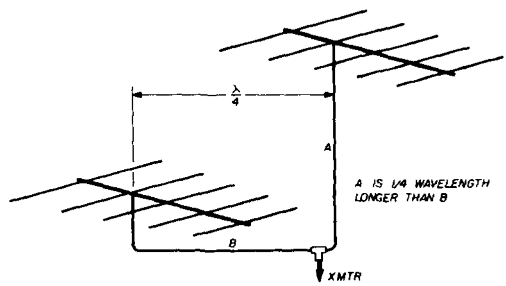


fig. 15. Improving the front-to-back ratio of stacked Yagi antennas with offset vertical mounting.

20 degrees is not the ideal angle in amateur operation. Some experimentation with horizontal displacement of the two Yagis may help you decide on the most favorable null angle for your particular location.

By the laws of reciprocity your trans-

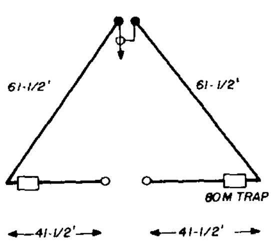


fig. 14. This 160-meter loaded delta antenna built by VK5EF is used on both 80 and 160 meters.

table 3. Spacing of Yagi antennas to obtain desired null angles as described in the text.

null angle	10°	15°	20°	25°	30°	35°	40°	45°	50°	55°	60°
spacing in wave-lengths	2.5	1.75	1.5	1.25	1.0	.85	.75	2.25	1.9	1.7	1.65

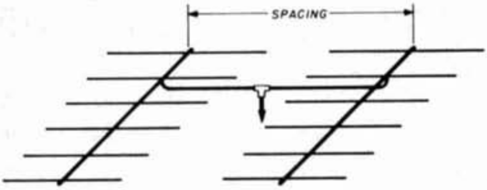


fig. 16. Desired null angle as shown in Table 3 is determined by the spacing between the two Yagi antennas.

mit pattern will be similar. On 2-meter fm these techniques have great possibility in areas crowded with repeaters operating on the same and adjacent channels. Your antenna could be made to beam on your particular repeater, and still have nulls in the directions of the repeaters you do not wish to activate. Operate your base station with two antennas, one omnidirectional for simplex and one highly directional for repeater communications.

fig. 17. Response of two five-element Yagi antennas positioned for a 20° pattern null.

references

1. "XR-205 Monolithic Waveform Generator Kit," Exar, 733 North Pastoriz Avenue, Sunnyvale, California 94086.
2. "XR-S200 Multi-Function Integrated Circuit Specifications and Application Notes," Exar, 733 North Pastoriz Avenue, Sunnyvale, California 94086.
3. Charles B. Carter, "Increasing Front-to-Back Ratio," *Communications News,* June, 1972, page 56.
4. Bruno Zucconi, "Reducing Co-Channel Interference by Spacing Antennas on Same Plane," *Communications News,* June, 1972, page 54.

ham radio

printed-circuit board

for the RTTY electronic speed converter

A printed-circuit board is now available for this versatile and accurate RTTY speed converter originally described by WA6JYJ

Earl E. Palmer, W7POG

The RTTY electronic speed converter described by WA6JYJ in a recent issue of *ham radio*[1] provides an inexpensive method of converting low-speed RTTY signals for printout on a higher speed teleprinter. This is much more simple than the mechanical gear shifts that are usually required for this purpose.

The circuit, which uses ten ICs, seven transistors and a bunch of other components, is quite sophisticated and strains the ability of the most proficient home builder. I attempted to simplify construction by replacing the point-to-point wiring with a printed-circuit board. With the exception of rearranging the IC pin numbers to simplify the board layout, this was easily accomplished. Drilled printed-circuit boards are now being made available to other interested RTTY amateurs.*

construction

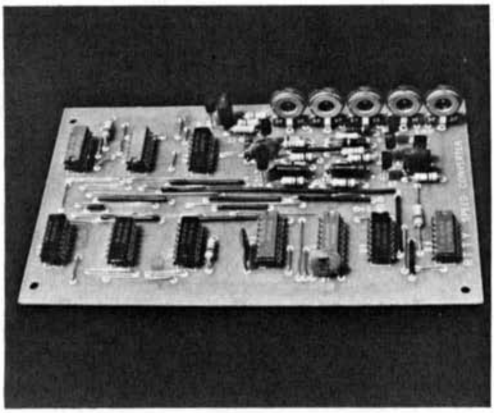
To keep construction costs down, a single-sided printed-circuit board is used. This requires jumpers between some of the pads on the board. These jumpers should be made with insulated, tinned number-20 hookup wire. Complete instructions are furnished with the boards.

The board is designed for inexpensive, vertically-mounted 50,000-ohm trimmers. These are used to set the unijunction oscillator frequency. To install the miniature 20-turn trimmers suggested by WA6JYJ, the board must be re-drilled to accept their terminals, and jumpers installed to make the necessary connections.

*Drilled, fiberglass printed-circuit boards for the RTTY speed converter are available from P&M Electronics, Inc., 519 South Austin, Seattle, Washington 98108. The price is $6.00. The board includes a schematic of the converter as well as a component layout diagram.

The unijunction oscillator frequency is determined by R1, C2 and the 50k trimmer (see **fig. 1** of WA6JYJ's article). With the inexpensive board-mounted trimmers I used (CTS type Z-201-R503B), a 10% Mylar capacitor and 5% deposited-carbon resistor resulted in satisfactory long-term frequency stability for the normal ambient temperatures found in most ham shacks. If the speed converter must be installed where wider temperature variations are encountered, precision components should be used.

The following suggestions are the results of building two separate speed converters. First of all, buy 100% tested integrated circuits. They cost a little more, between 10 and 50 cents each, but it's money well spent. ICs that are 100% tested are marked by the manufacturer with a "T" suffix or some other means, and must be specified when they are purchased.



Printed-circuit RTTY speed converter built by W7POG. Printed-circuit boards are available to interested readers.

Many manufacturers only sample test their ICs, and a few bad ones are bound to turn up in any production run. Of the ten ICs I purchased for my original speed converter, one was bad (a shift register), and many unnecessary hours were spent in locating the problem.

Also, when building the speed converter, be generous with noise-suppression capacitors. Noise problems exhibit themselves as unexplained, consistent garbles which defy troubleshooting. In addition, short leads to a well-regulated power supply are a must. The power supply suggested by WA6JYJ in his article is very satisfactory.

Two .01-μF noise-suppression capacitors are mounted on the printed-circuit board near each shift-register IC. If noise problems are still suspected, solder additional .01-μF, 600-volt disc ceramic bypass capacitors directly across the V_{CC} and V_{ee} IC pins on the copper side of the PC board. The shift registers and flip-flops are usually the source of noise problems.

When building the unit, be sure you use IC sockets. Use them if for no other reason than troubleshooting. The continuous-strip IC sockets manufactured by Molex are inexpensive and quite satisfactory for printed-circuit construction.

operation

When incorporating the RTTY speed converter into your station, make sure that the input of the converter is *after* the normal-reverse switch. The speed converter requires normal (not reverse) input for proper operation.

When snooping around for press copy, it's often difficult to determine what speed you are receiving. The best method I have found is to measure the period of the incoming bauds with an oscilloscope with a calibrated time base. For 67 wpm, the period is 20 milliseconds, slightly longer for 60 wpm, and slightly shorter for 75 wpm. The period for 100 wpm is 13 milliseconds.

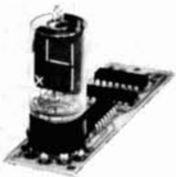
Multiple-speed conversion greatly enhances the versatility of any RTTY station, and it is especially useful when looking around the amateur bands. More and more multiple-speed stations are now being heard as amateurs add the ability to operate at high speeds. As more RTTY enthusiasts learn of the advantages of higher speeds, amateur usage is expected to increase still further.

reference

1. L.H. Laitinen, WA6JYJ, "Electronic Speed Conversion for RTTY Teleprinters," *ham radio,* December, 1971, page 36.

ham radio

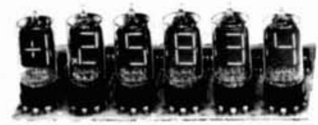
epd MOD-KITS



UNIVERSAL DCU/DRIVER

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

NR-3 Modulo 10 Counter 20 MHz $7.95
NR-3A Modulo 6 Counter 20 MHz 7.95
NR-3H Modulo 10 Counter 70 MHz 8.95
NR-3B Modulo 12 Counter clock 12.95



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

NR-3FM Muitl-Stage Counting Unit $33.95

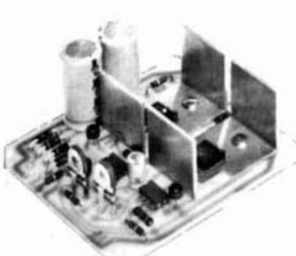
CRYSTAL FREQUENCY STANDARD

Contains a .002% crystal oscillator with TTL decade dividers to give output frequencies of 10, 1 MHz, 100, 10, 1 kHz, 100, 10, 1, & 0.1 Hz. Kit requires 5 volt supply @ 175mA. Uses low TC components and has zero-beat trimmer. Great for freq. meter, digital clock, etc. W/ complete instructions. CRO-1D $22.95

LINE CLOCK SOURCE

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

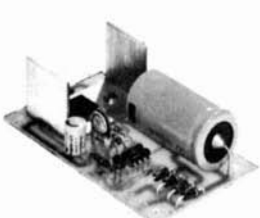
DCC-2B Line Frequency Standard $9.95



ANALOG POWER SUPPLY

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

APS-5A Op-amp Power Regulator $13.95
TR-200 Transformer for APS-5A 3.95

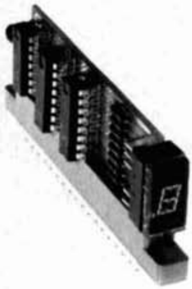


LOGIC SUPPLY REGULATOR

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

DPS-1A Output current 0.6A $7.95
DPS-2A Output current 2.2A 10.95
TR100 Transformer for DPS-1A 2.29
TR1500 Transformer for DPS-2A 4.50

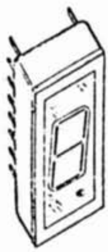
More Details? CHECK—OFF Page 110



LED READOUT MODULE · COUNTER · LATCH · DRIVER

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

$15.95



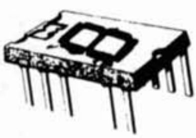
Miniature 7 segment display mounts in 16 pin dual in-line socket. 5V operation at 8 mA. per segment. 100,000 hr. life. W/decimal pt.

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

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

2010 7 Segment Display 0-9 DP $4.45

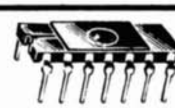
2020 As above except "1" "+" "–" 3.95



LED

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

LED700 7 Segment LED Display $6.95
(QUANTITY DISCOUNTS AVAILABLE)

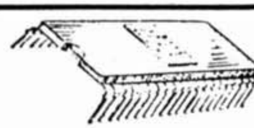


The 1101 Random Access Memory (RAM) will store and readout 256 bits. The chip is TTL compatible and comes with a complete spec sheet w/applications.

1101 256 Bit RAM $8.95

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

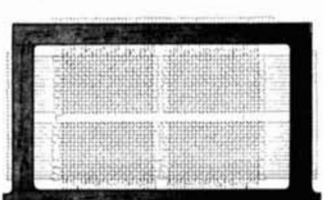
- Four decade counters + overrange
- Four 4 bit latches w/BCD outputs
- Seven segment decoder
- Display multiplexing circuitry
- Two programmable oscillators
- Single 5 volt supply at 5mA ! ! !
- Inputs TTL compatible
- Housed in 28 pin dual in-line pak



LSI

Comes with 16 p. booklet of specs & app notes. Booklet contains interfacing info on all seven segment displays made.

5002 LSI Chip $19.95



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

MP-1A 4000 Bit Core Plane $12.95
MP-2A 16K Core Stack 47.50
MPB-1 80 Page Core Memory Booklet 5.00

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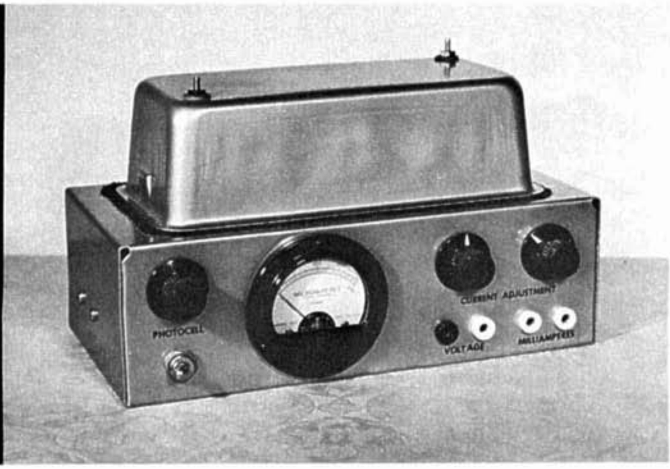


an accurate rf power meter for very low power experiments

This inexpensive meter will measure low power levels up to 148-MHz without expensive calibration equipment

Howard F. Burgess, W5WGF

If you are fascinated by the miles per watt statistics of very low-power communication or if you just enjoy building miniature transmitters, you will have a lot more fun if you really know how much power your little rig is putting out. Rf power is not easy to measure, and most of us have had our troubles even at moderate power levels. With power below a watt a good measurement is a real problem. There are many good designs for rf power meters, but most of them require a precision load resistor accurate at your operating frequency. In addition, a good rf voltmeter or another wattmeter is usually required to complete the calibration. Not many hams have access to these items.

My simple meter requires no special test equipment or calibration, and all of the parts can be found in any Radio Shack or similar store. I decided to drag an ancient technique out of the cobwebs and combine it with a few pieces of modern hardware. The results were even better than I had hoped for. The final model measures power as low as one milliwatt and works as well on two meters as it does on eighty. With care the accuracy of the readings can approach 1%.

theory

For many years experimenters have known that a small lamp with a short filament will require the same amount of rf, dc or audio *power* to bring the filament to a given temperature. To make an accurate power measurement, load the transmitter into a suitable lamp and record the light level with a photocell and meter. Remove the rf and substitute enough metered dc to give the same light reading.

Yes, it is true that the bulb will probably never have a resistance even close to 52 ohms, and that the resistance will change as the power level changes. This is no great problem. Most transmitters have enough tuning range to match the bulb for maximum output. This same tuning that gives you maximum output will also tune out any small reactance which may be in the power meter. Just keep the lead from transmitter to power meter as short as possible.

circuit

Originally, I had visions of photo transistors, transistor dc amplifiers and expensive meters to get the sensitivity that I thought the unit should have. Happily the schematic in **fig. 1** shows how simple life can be at times.

The cadmium-sulphide photocell acts as a light-sensitive resistor: the more light, the less resistance. The battery, two resistors and meter form a simple ohmmeter circuit to indicate the change of resistance in the photocell. With moderate light on the cell, the meter can be set to full scale (similar to zeroing an ohmmeter). With no light on the cell, the meter will read 0. The capacitor across the cell is just to bypass stray rf from the cell.

In the rf portion of the circuit, the power to be measured is connected to J1 and is fed to the load lamp through the 0.01 blocking capacitor. When dc is substituted for the rf, it is adjusted to the correct value with the 30- and 100-ohm variable resistors. The dc connections to the load lamp are through the rf chokes which keep the transmitter rf out of the battery and meter circuits.

The dc meters that are used to read the input power to the lamp were left external for convenience. In this way any meters which happen to be handy can be pressed into service. Meter M2 should be capable of reading the maximum voltage that will be used on the bulb, and M3 must be able to read the current required by the bulb at maximum voltage.

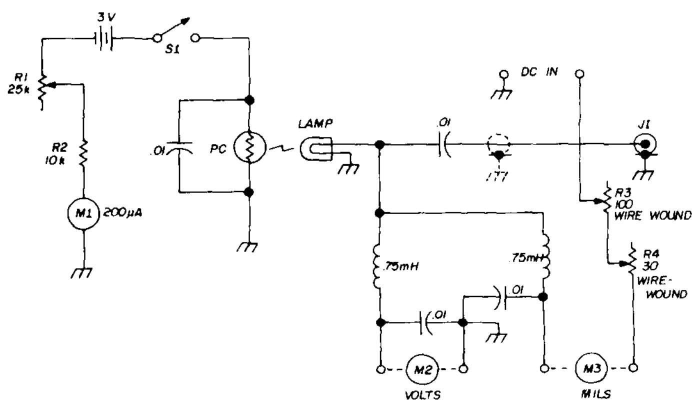
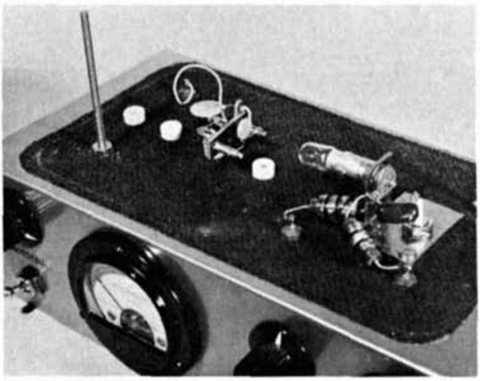


fig. 1. The schematic of the power meter.

construction

I built the unit on an aluminum chassis, but it could just as well have been built on a piece of plywood. If you are not interested in the measurement of very low power, the system can be as simple as an old photo exposure meter and a load bulb. There are only two precautions to consider. Keep the rf leads short and heavy and enclose the photo cell and lamp in a light-tight compartment while making a measurement.



The photocell can be adjusted both for distance and angle by plugging the mount into the desired tip jack.

All of the parts are mounted on a 3 x 5 x 9-inch chassis. There is lots of empty space, but this makes life a little easier. A bread pan from the variety store makes a good chassis. The load lamp and photocell are mounted on top of the chassis to facilitate the bulb changing and photocell adjustment. The cover which forms a light tight compartment is a dime store cake pan. All surfaces inside of this compartment are painted flat black to prevent reflections.

The photocell is mounted on a small three-terminal strip. A single phone tip is soldered to the center terminal of this strip. To adjust the distance from the load lamp to the photocell, plug the phone tip into any of the four tip jacks as shown in the photo. The position and angle of the cell can be adjusted for the desired light pickup from the load bulb. The photocell is a Vactec cadmium sulphide unit and came from a Radio Shack No. 276-600 package which contains four cells (for only $1.19). However, there are many other similar cells that will work just as well. The other components are standard, and the schematic is self-explanatory.

The two variable resistors in the dc circuit of the load lamp are wire wound and should have at least two watts dissipation rating. All capacitors must be mica or ceramic suitable for high-frequency use. The variable resistor in the photocell circuit is an ordinary carbon control. The rf chokes are the ordinary pie-wound variety and are not critical. A value of 1 mH will work just as well, but the chokes must be of good quality for good vhf performance.

operation

Operation of the meter is simple. Select a bulb from **table 1** with a power rating higher than the power that you plan to measure. The bulb must be operated below full brilliance for the best results. Just couple the output of the transmitter to J1 and adjust for maximum output (as indicated by the bulb) while maintaining the dc input to the transmitter at the desired level. At this point, if the bulb appears to be near full brilliance, replace it with a higher wattage bulb.

Turn the transmitter off and expose the photocell to room light. This can be either daylight or artificial light of about the same level as you would use to read

table 1. Pilot bulb characteristics.

No.	bead color	volts	amps	max power (watts)	resistance (ohms)
40A	Brown	6-8	.15	1.0	40
43	White	2.5	.50	1.25	5
44	Blue	6-8	.25	1.5	25
47	Brown	6-9	.15	1.0	40
49	Pink	2.0	.06	.12	33
49A	White	2.1	.12	.25	17
51	White	6-8	.20	1.2	33
53		14	.12	1.7	110

Resistance is for the power shown and will vary with a change of input current.

this magazine. Turn S1 on and set the meter M1 to full scale by adjusting R1.

Replace the light tight cover and turn the transmitter on. If the meter reads more than about 85% of full scale or less than 20%, change the distance or position of the photocell until the reading is somewhere between these two values. If the meter reads too low, an accurate reading cannot be made. If it reads too high, small changes cannot be seen.

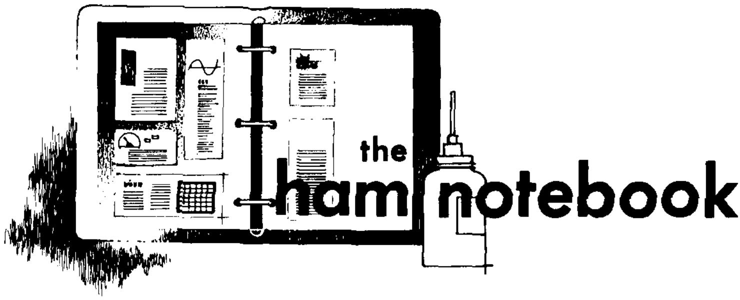
Note the meter reading and shut down the transmitter. With a battery or low voltage supply connected to *DC IN*, adjust R2 and R3 until M1 reads the same value as noted for the transmitter. The dc power computed from M2 and M3 will now be the power output of the transmitter.

A somewhat different method is used for very low power. Use a type 49 pilot lamp as a load and position the photocell as close to the lamp as possible for the best transfer of light. Adjust the dc lamp current to make the photocell meter read about mid scale. Note the dc power as read by M2 and M3. With the dc power still on, the rf power is applied to the bulb. The reading of M1 will increase. Reduce the dc input to the lamp until the meter M1 returns to its original reading (the reading before rf was applied). The difference between the first dc-input reading and the second dc-input reading is the amount of power removed to keep the filament level constant. This is equal to the amount of rf power that was added.

Many amateurs will feel that the photocell method of dc substitution is too long and involved for power measurement. They are right. However, it is just about the only accurate way to measure low power over such a wide frequency range and at a cost that the ordinary experimenter can afford. It is one of the very few methods that can be put in operation anyplace without using rf calibration standards.

Laboratory work has shown this method to be about as accurate or as sloppy as you care to make it.

ham radio



scr load protection

The unit described here uses a silicon-controlled rectifier with a biased gate as the heart of a circuit-breaker system which trips when *any* predetermined voltage has been reached. It can be used to trip at overloads or underloads. This is accomplished by using a biasing voltage between cathode and gate in connection with a second voltage which either adds to or subtracts from it. When adding voltages the device trips on overload; when subtracting, on underload.

R1 is a voltage divider and R2 a dropping resistor (**fig. 1**). It is the supply voltage minus the voltage between the anode side of R1 and the gate side of R2 that establishes the firing voltage of the SCR. If another voltage source is inserted between R2 and the gate, it can become the critical voltage in the firing of the SCR. This voltage can be introduced to reinforce or buck the voltage between the anode and the gate side of R2. This process determines whether the SCR fires on increasing or decreasing current in the monitored circuit. The voltage is developed across Rx and should be about one volt. As an example, take a transmitter whose plate current is not to rise above 150 mA. Then Rx = E/I = 1/.15 = 6.6 ohms.

R1 is adjusted so that the SCR *just* fires when 150 mA flows through Rx. Current through both the SCR and Rx is then turned off briefly, and R1 is backed off a degree or two. Current through the SCR and Rx is again turned on. The SCR should not fire. If the current through Rx has to be increased too much to fire the SCR, move the slider back toward the original firing position just a shade. A position should be found where the SCR does not fire until the maximum allowable current is exceeded.

If the unit is to be used to cut off current to a circuit when current in that circuit drops to some level, Rx is attached to buck the voltage between the anode and the gate side of R2. Again, adjust R1 after the proper current has been established through Rx. R1 is adjusted, as before, this time getting the SCR to fire when the current through Rx drops to the predetermined level.

When the monitored circuit is low voltage and low current (say a driving transistor in an audio or rf stage), a relatively high-impedance input dc amplifier (**fig. 2**) can be used to provide the voltage across what was called Rx earlier. An n-channel fet (MPF-103) and a germanium pnp transistor (HEP 3) do the job nicely. Rx here is a 300-ohm resistor which can be connected into the circuit

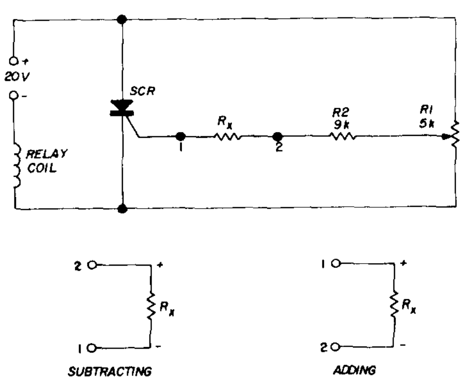


fig. 1. Basic SCR and relay circuit along with ways of inserting Rx.

of fig. 1 to reinforce or buck just as in the situation described earlier. The 20k variable resistor is adjusted (with nothing across the 5k variable resistor) to the point where current through Rx *just* reaches a minimum. Then the 5k resistor (with the load which it is monitoring connected across it) is adjusted to provide a reading of between one and three volts across Rx. The two rf chokes isolate the circuit from rf which might cause erratic triggering of the SCR.

The power supply should be capable of supplying the current and voltage necessary to actuate the relay, and the scr should be capable of handling these quantities, too. The power supply for the dc amplifier – if one is used – should be separate from the one for the relay. I use a model racing car power pack rated at 20 VA output, and a heavy-duty 24 V 6pdt relay with a 180-ohm coil. For the dc amplifier I use a small battery pack with eight AA cells in series. Since only three to eight mils are drawn, the battery should last quite a while.

George Hirshfield, W5OZF

sequential switching

This switching circuit provides delay in the make *and* break modes of switching and can be used to protect frontend transistors, diodes and coils due to momentary simultaneous operation of receiver and transmitter. The operation of

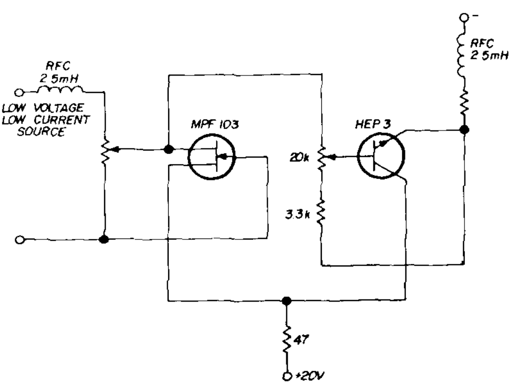


fig. 2. The dc amplifier.

the circuit is very simple, and the device is not at all delicate.

When S1 is thrown from receive to transmit, current flows to both the relay coil and the capacitor. The large capaci-

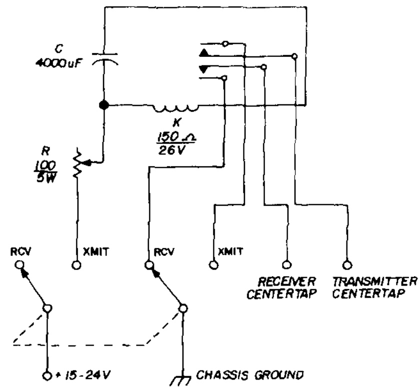


fig. 3. This circuit provides delay in make and brake switching.

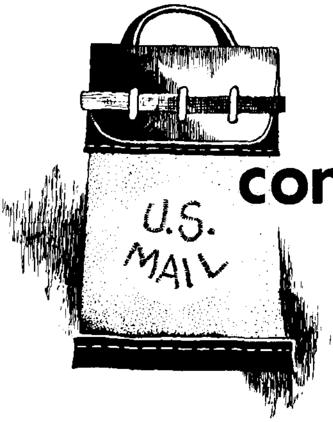
tance across the coil has the effect of acting as a near short circuit until, while charging through R, the energizing voltage for the relay is reached. When S1 is thrown from transmit to receive, the capacitor is discharged through the relay coil. Both processes occur, of course, in a finite and adjustable amount of time. The net effect here is about one-third of a second delay when switching from *either* mode to the other. The values shown are not critical. Voltages and resistances may vary according to relay requirements, but operation should be similar to what is described here.

The actual switching takes place when the centertaps of the receiver and transmitter power transformers are grounded through S1 *and* the contacts of the relay.

Contacts of the relay may be ganged for operation of additional circuits such as indicator lights, antenna switching or other relays for additional sequencing of other circuits.

The parts for this gimmick are generally available and can probably either be found in the junkbox or purchased from a single supplier.

George Hirshfield, W5OZF



comments

past is prologue

Dear HR:

I can't resist a few comments on your June editorial. The old timers you heard on 40 meters expressed the opinion that amateur radio today lacks the allure it used to have, that it has less uniqueness and fewer opportunities to offer. As a private pilot I hear the same song around airports. In part time marine radio work I hear much the same thing among boatmen.

I think the whole gang had better join a group I met last summer. I was invited to display a 66 year old car steam engine I've been saving to put in a boat. I met a gang of enthusiatic old timers who really get a kick out of their hobby. If amateurs feel jaded at the thought of competing in the technology race, pick up a hobby where the technology hasn't seen much change in the last 60 years, and isn't likely to change much in the next 60, either.

To me, the complaints of hobbyists who are caught up in the technological race are symptomatic of the state of the nation. There never has been an era when so many had so much yet were so dissatisfied. By comparison, I get a kick out of my wife's gardening adventures. Year in and year out she never tires of creating a riot of color from frost to frost. It is a tremendous source of satisfaction for her, and, perhaps more important, a chance to get away from the everyday rat race.

I think we are beginning to see a glimmer of that same thing in amateur radio today. The QRP gang are tossing aside all the usual equipment in order to create something different. They're having fun, but only because they've broken away from the crowd. Instead of saying, "Me, too," they are once again individualists. We need that sort of thing badly.

I've been in radio for 40 years, yet I wish I had 40 more years. The opportunities in amateur radio today are to me, incredible. I only hope that the QRP movement is only the start of a move towards greater individualism that will lead to new performance criteria, and once again, the opportunity for technical advances by the amateur body.

Your editorial suggests one such advance. "We at *Ham Radio* note that the day of the amateur-built receiver may have passed in favor of the vastly superior and less expensive commercial version." You are correct in this respect: The available receivers today could be compared to a luxurious car with power everything and loaded with accessories satisfactory to a majority of buyers, and perhaps to many a status symbol. Yet any one of maybe 100,000 kids could "homebrew" a performance car that could cream that Detroit iron on a drag strip.

Maybe we might see conditions in amateur radio reach the point where the individualists see the situation correctly. That the best receivers built today, while excellent, are not in truth "vastly superior" in performance. In fact, many of the most expensive receivers are indeed inferior.

A rabid DX man could, for instance,

settle for a single band receiver — maybe 20 meters. Many fine commercial receivers have sensitivity greater than you can use, due to the limitations of atmospheric noise level. However, over the span of frequencies the 20-meter band represents, noise distribution will be relatively uniform. If so, suppose he narrows the front end passband to half that of the commercial receiver? In a given situation, his receiver will show a 3-dB improvement in signal to noise ratio. If he cuts that bandwidth again in half, the improvement is 6 dB. If he can cut the front end passband by a factor of 8 he is 9 dB better. Of course, at this point the receiver front end may have to be re-peaked for relatively minor changes in frequency. Already his cross-modulation capability is improving. Careful selection of rf and mixer will enable him to top any commercial receiver in this respect. It would take some care in determining optimum gain distribution, too. In the same manner he can top the best receivers in stablity and selectivity, and still not have as much invested in parts cost.

If a trend developed in the direction of true "competition" receivers, I wouldn't be surprised to find a parallel to today's automotive performance parts business. It wouldn't be big business any more than the speed shops are in comparison to Detroit. Such a trend would sure separate the men from the boys on the amateur bands, particularly if as much care were devoted to antenna design.

That's one example, and there are a lot more loopholes in amateur radio that enterprising individuals can plug to their own advantage. I just hope we are seeing the start of a trend.

Bill Wildenhein, W8YFB

ground-plane antenna footnote

Dear HR:

I was intrigued by the simple elegance of Peter Brekken's ground-plane antenna in the May, 1972, issue and built the single-band, 20-meter version. I had a reasonable duplicate of the vertical element already mounted on my roof — a 40-foot heavy-duty tv mast that had supported a variety of wire antennas. Brekken's design calls for 75-ohm coax for the transmission line; however, I wanted to use RG-8/U 50-ohm line, which I had on hand. I also wanted to use existing materials and junkbox parts to keep expense at a minimum. The total cash outlay for my version of the antenna was $1.85. The following comments are offered for those who might want to try this excellent antenna with the more common 50-ohm coax cable.

The feed point of my antenna is almost exactly ¼ wavelength above ground at the design frequency (14.15 MHz). I built a tuning unit based on the formula in Brekken's article, but added a few extra turns to the coil. The entire arrangement was made of odds and ends available around the house — nothing sophisticated — just ordinary hardware and the usual junkbox parts.

For example, the coil was made from tv "ground wire," which is no. 8 soft-drawn aluminum wire. This material is self-supporting if a reasonable form factor is used for a coil. My coil is 3 inches in diameter by 6 inches long, supported at both ends by standoff insulators. A short length of RG-8/U coax connected between an appropriate tap on the coil and the antenna vertical element adds support to the coil. The coil, which is about 3 μH, was wound over a quart beer bottle (empty) and hand formed. A weather shield covers the entire assembly.

The impedance characteristics of my 5/8λ vertical antenna were measured with a General Radio model 916A bridge. Check points are:

Frequency (MHz)	resistance (ohms)	reactance (ohms)
14.0	128	-j305
14.05	118	-j223
14.15	108	-j215
14.20	92	-j196
14.25	82	-j175
14.30	74	-j158

The capacitive reactance of -j215 ohms at 14.15 MHz was tuned out by making many trips between the transmitter and the coil at the antenna base until a minimum swr was achieved by adjusting the coil tap. The lowest swr obtainable was 2.5. This meant that the -jX component of impedance was accounted for, but the resistive component, 108 ohms, still had to be compensated to achieve a good match at the antenna resonant frequency.

A ¼λ transformer made of RG-8/U cable connected in series with the transmission line and antenna feed point solved this problem. The ¼λ transformer was made according to

$$Z_t = \sqrt{Z_a Z_o}$$

where

Z_t = characteristic impedance of transformer (ohms)
Z_a = antenna resistance (ohms)
Z_o = characteristic impedance of transmission line (ohms)

Substituting values,

$$Z_t = \sqrt{(108)\ (52)} = \sqrt{5610} = 75$$

A 17-foot length of RG-11/U cable was used to make the matching transformer. This was purchased from a local surplus house for $1.00. With the ¼λ transformer installed between the 5/8λ vertical and the RG-8/U transmission line, the swr between 14.0 and 14.3 MHz was pretty low; the mean value was measured at 1.15.

A simple weather shield completes the assembly. I found a plastic tub in a local supermarket for 85c, which I mounted over the tuning assembly at the base of the antenna.

If you don't have the exact materials on hand that are called for in published articles, try substitutes. That is what makes ham radio fun.

Alf Wilson, W6NIF
San Diego, California

microwave equipment

Dear HR:

I wish to point out that if you are willing to search out suppliers and take your time, the equipment listed in the article by W. T. Roubal in your June, 1972, issue on "Getting Started in Microwaves" can be purchased for 10% or less of the costs listed in his article.

I have many 2K25 formerly 723A/B Klystrons that I have purchased for 50c to $1.00 (Do not tune the cavity too often as the bellows will fatigue and let air into the tube.)

I have several variable attenuators bought for less than $5.60.

The only problem with this equipment is that it has not been checked out for its working condition. This means that you must do the checking yourself. The procedures for doing the checking can be found in the Berkley Lab series books A, B and C or, for a much deeper explanation, the MIT Radiation Laboratory series now put out by Doer Press for 2 to 4 dollars each.

The procedures are fairly simple if you ignore the math in these books. Many tests can be run with nothing more than a 2K25, its power supply and waveguide mount, a waveguide mounted detector and a meter to measure detector current.

If you want to make swept frequency measurements you must have an oscilloscope that has at least a dc to 1-kHz bandwidth.

The slide screw tuner of fig. 5 in Roubal's article can be made into a slotted line by replacing the micrometer with a detector diode and a small antenna that sticks into the guide like the plunger of the micrometer.

This setup will allow you to measure standing waves in the wave guide. For an sase I am willing to answer any questions on the above subject.

Edward A. Benjamin, WA1HYX/4
1010 13th Street North
St. Petersburg, Florida 33705

prologue to the future

Dear HR:

It has been my observation that it is *participation* in the act of communication, rather than the material communicated, that has been the unique attraction of amateur radio over the decades. I think your editorial in the June issue strongly (and correctly) points up the attrition of this aspect of the game, but I cannot share your optimism.

We all seem to agree that, whether we like it or not, amateur radio is losing its unique flavor. In fact, it is tending to become just another communications system, operating roughly in parallel with Ma Bell and her sisters.

It is the intimate contact with the inner techniques and difficulties that enthralls most of us who read *ham radio*. We enjoy building gear, however simple, tuning it up, and solving real problems in the communications process. For a large number of us this may even be the whole game.

After we've gotten things working as we think they should, it's time to tackle another problem. What gets communicated via the system is, for the most part, incidental. Unfortunately, the rapidly advancing techniques place most of us further and further from as many significant problems as were formerly within our reach – day by day we're being phased out.

It is my personal belief that no sophistication of technique nor improvement of communications efficiency can ever, in any way, replace genuine human satisfaction. The proven pleasures of personal involvement, even of the simplest sort, are irreplaceable by mere machinery, no matter how sophisticated. When Mr. Walker's vaunted satellite is up there, it will be fun to "work through" a few times, just to satisfy ourselves, but then what?

Just as the finest product of American professional engineering cannot truly replace the beloved haywire in the true home-brewer's heart, so the finest satellite will never, for many of us, replace the inefficient, capricious ionosphere. For the satellite is only machinery, while the ionosphere, like the haywire, is *adventure.* And adventure is the priceless ingredient in amateur radio.

C.F. Rockey, W9SCH
Deerfield, Illinois

tape head cleaning

Dear HR:

The Multiple Audio Distribution (MAD) System at Western Michigan University consists of Magnecord 1048 tape machines which are in use almost continuously. Currently, seventeen machines are in use, with eleven machines in use 24 hours a day, 7 days a week, 48 weeks a year. Some of the machines are six years old, while the newest is three years old.

The machines are cleaned Monday through Friday with alcohol and xylene. Xylene is used on the tape heads, *metal* tape guides, stabilizer rollers and capstan. The xylene, as mentioned in your May issue, requires care in use as it is damaging to plastics and some paints. The ability to dissolve the binder in the tape oxide is what makes the xylene worth the care needed in use. A Q-tip full of xylene will remove the biggest glob of dirt and oxide.

Alcohol is used on the pinch wheel, because, when it is used often, it is sufficiently strong to dissolve the oxide without drying out the pinch wheel. The staff at WMU-TV uses xylene on their video tape recorders, but in an emergency when a head clogs during playback they give it a shot of Freon TF* which loosens the clog without dissolving the oxide on the tape as xylene would do.

James R. Buchanan
Western Michigan University

*Freon TF is manufactured by the Tex-Wipe Company, Hillsdale, New Jersey.

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More Details? CHECK—OFF Page 110

More Details? CHECK—OFF Page 110

new products

transistor curve generator

A new easy-to-use transistor curve generator, known as the Model TCG-1, is now available from Caringella Electronics, Inc. This high performance instrument is designed for experimenters, hobbyists, schools, engineering labs and service shops. Transistors and other semiconductor devices can be tested in or out of circuit with this versatile new test instrument. The transistor curve generator is used with any oscilloscope, and displays the dynamic characteristics of both npn and pnp transistors, fets, mosfets and dual-gate mosfets, diodes, zener diodes, tunnel diodes and other devices.

The instrument incorporates all the circuits required to generate the base steps and collector sweeps. The collector sweep generator provides a ± 10-volt saw-tooth, operating at a frequency of 550 Hz, for a flicker-free display. A fully regulated power supply, utilizing a ± 15-volt IC regulator, and a solid-state LED panel indicator light, are also features of the solid-state design. Operation is simple and straightforward due to the minimum number of front panel controls. Several unique features highlight the Model TCG-1: direct transistor "beta" readout is provided on the front panel base-drive control, npn and pnp transistors can be tested consecutively without changing controls or switches and vertical and horizontal channels of the oscilloscope are calibrated simultaneously for accurate readings.

In addition to displaying the collector current versus collector voltage family of curves, the instrument also tests transistor "open base" and "shorted base" collector breakdown voltage. Two TO-5 transistor test sockets and a set of three binding posts are provided on the front panel and are selected by a 3-position lever switch.

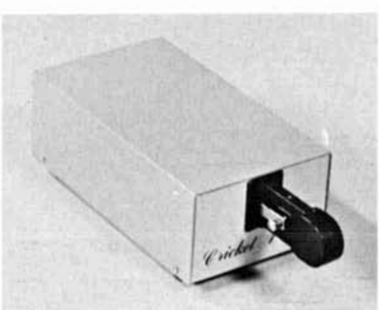
More Details? CHECK—OFF Page 110

Semiconductor devices can be compared or matched easily, and even unknown transistors types can be identified quickly. The versatile binding posts will accommodate external test leads or a variety of test fixtures for production testing. A set of three color-coded test leads is provided with each instrument.

The Model TCG-1 is available in kit form, complete with all parts, high quality glass-epoxy printed circuit board, wire, solder and step-by-step assembly instructions. Kit price is only $79.95 complete. Factory wired and tested units are only $99.95 complete. All shipments are F.O.B. Upland, California, and the kits and wired units are available for immediate delivery from stock.

A free data sheet, complete with technical specifications, schematic diagram and circuit description, is available on request. For further information contact: Caringella Electronics, Inc., Box 327, Upland, California 91786 or use *check-off* on page 110.

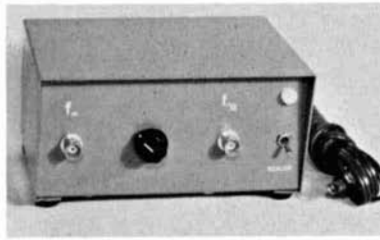
cricket keyer



Data Engineering has introduced a new small keyer with a built-in key, sidetone oscillator, speaker and ac power supply. The key features jam-proof spacing, self-completing dots and dashes, a heavy duty 300V, 1A relay, speed range from 3.5 to 50 wpm and a jack for powering the unit directly from 12 Vdc.

Ready-built and with Data Engineerings five-year guarantee, the unit sells for $49.94. For more information write to Data Engineering, Box 1245, Springfield, Virginia 22151 or use *check-off* on page 110.

uhf digital frequency scalers



A ten-fold increase in the range of many frequency counters is possible with the use of Belmont Spectrum Research frequency scalers.

Two Models are offered. The *Model A* includes a two-stage preamplifier and is the more sensitive. Typically, it requires inputs of less than 3 mV up to 100 MHz, 15 mV at 200MHz, 45 mV at 250 MHz, 75 mV at 275 MHz and 120 mV at 300 MHz. Guaranteed to 280 MHz. $90 plus California sales tax and shipping charge of $1.50.

The Model B has no preamplifier and thus requires greater signal input. Typically, it requires 20 mV up to 100 MHz, 140 mV at 200 MHz, 260 mV at 250 MHz, 340 mV at 275 MHz and 800 mV at 300 MHz. Guaranteed to 260 MHz. $70 plus California sales tax and shipping charge of $1.50.

These scalers use Fairchild's 95H90, high-speed, ECL, MSI devices for the basic divide-by-ten function. Each model also uses Fairchild's 7805 regulator, thus assuring a highly reliable and constant 5.0-volt power supply. They were first introduced at the 1972 West Coast VHF/UHF conference in May.

For more information, contact Belmont Spectrum Research, 1709 Notre Dame Avenue, Belmont, California 94002, or use *check-off* on page 110.

proximity detectors and metal locators

Written in a comprehensive but easy-to-read style, the updated second edition of "How To Build Proximity Detectors and Metal Locators" by John Peter

Shields, contains a reservoir of valuable information on the principles and circuits used in proximity detectors and metal locators. It also covers the closely related theremin, the source of many of the eerie sound effects heard on the radio, on television and in the movies.

This handy guide begins with a simple explanation on the basic types and functions of proximity detectors and metal locators, and elementary proximity detector and metal locator projects are given. Here any novice or experienced electronics enthusiast can learn how to build basic one or two stage circuits. Then the more complicated or advanced electronics projects containing additional stages or more complex circuitry are included. Examples of two advanced circuits analyzed are the Hall-effect metal detector and the fm-discriminator proximity detector.

These circuits are used for a wide variety of purposes including burglar alarms, touchswitches for activating lights and other electric devices, locators for finding pipes and studs in walls and floors and for locating lost metal objects such as coins, jewelry, keys and tools in the ground or under water. In addition, this edition has important facts on several new circuits, some of which utilize a modern development in solid-state components — the silicon triac thyristor.

Each circuit has been thoroughly tested and uses components that are available at most electronic parts distributors. Complete parts lists and illustrated assembly instructions are included for each project reviewed.

Students, technicians, hobbyists or anyone else interested in learning about or building proximity detectors and metal locators will enjoy this "do-it-yourself" book.

This 160-page softbound book is available from Comtec Books, Greenville, New Hampshire 03048 for $3.95.

abc's of electronics

Howard Sams has introduced a second edition of "ABC's of Electronics" by Earl

More Details? CHECK–OFF Page 110

J. Waters. This new edition is an easy-to-grasp, but comprehensive introduction to the broad field of electronics. The author avoids complicated technical concepts and mathematical terms as much as possible and relies on simple language and analogies familiar to everyone.

The text presents a detailed analysis of the principles of electricity, functions of atoms and electrons, magnetism and solid-state physics. Individual chapters are devoted to electrical resistance, capacitance and inductance. The remainder of the book deals with alternating currents, circuit impedances, electromagnetic radiation, vacuum tubes, transistors, integrated circuits, radio wave production and propagations and the various electro-mechanical devices.

Each chapter concludes with a number of review questions; the corresponding answers are located in an appendix. The appendices also contain valuable reference data on electronic standards, mathematical formulas and color codes of resistors and capacitors.

The new edition is a reservoir of knowledge supplemented by many illustrations; it was written to keep up with the rapidly changing field of electronics.

The 160-page, softbound book is available from Comtec Books, Greenville, New Hampshire 03048 for $3.95.

crystal filter

Housed entirely in a standard HC-6/U can, the new SM 107S04 crystal filter offers a four-pole crystal filter centered on 10.7 MHz. The new unit features a minimum ±7 kHz bandwidth at -40 dB, ±12 kHz maximum bandwidth at -40 dB and a maximum 3 dB insertion loss. Maximum ripple is 1 dB, ultimate attenuation is 60 dB minimum. The attractive packaging of the filter uses one of the pigtail leads for input, one for output and the case is grounded. Units are available from stock postpaid for $15.95. More information is available from Spectrum International, Box 87, Topsfield, Massachusetts 01983 or by using *check-off* on page 110.

Hallicrafters catalog

The Hallicrafters Company has issued a four-page, well-illustrated, short-form catalog "You should be talking with a Hallicrafters." It features the company's entire line of shortwave receivers and amateur radio equipment.

Designed for both the beginner and the experienced amateur, the easy-to-read catalog gives the major features of the SR-2000 "Hurricane" transceiver, HA-20 remote vfo/swr console, HA-1A T.O. keyer, SR-400A "Cyclone III" transceiver plus the entire line of accessory equipment.

Also featured in the catalog are the company's SX-122A communications receiver and the SX-133 high-performance receiver. The latest addition to the Hallicrafters line, the FPM-300 solid-state hf ssb/CW transceiver, is also included in the catalog as well as in a separate data sheet.

For a copy of "You should be talking with a Hallicrafters" or the FPM-300 data sheet, write The Hallicrafters Company, Department PR-300, 600 Hicks Road, Rolling Meadows, Illinois 60008 or use *check-off* on page 110.

iambic keyer

An iambic keyer with many new convenience features has been announced by Curtis Electro Devices. The EK-404 is an offshoot of the EK-402 programmable keyer introduced about a year ago and employs the same styling and features with the exception of the message memory.

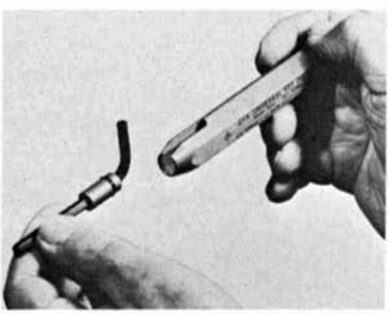
Standard features in the EK-404 in-

More Details? CHECK—OFF Page 110

clude jam-proof dots, dashes and spaces; iambic or standard operation; dot memory; variable weighting; tune switch; built-in sidetone and speaker; a self-contained 115-Vac power supply and complete rf immunity. New features include a connection for 12-Vdc mobile or portable operation, front panel control of sidetone pitch, a self-test mode, two sidetone outputs (Hi-Z, Lo-Z) and provision for either grid block and cathode keyed or solid state rigs. A manual key jack is also provided.

Price of the EK-404 is $124.95 complete with all cables and connectors. It is available direct from the factory or from dealers. For further information write Curtis Electro Devices, Box 4090, Mountain View, California 94040 or use *check-off* on page 110.

universal key driver



A new hand tool for driving L-keys has been introduced by Jensen Tools and Alloys. Known as the GLA Universal Key Driver, this new tool will be found particularly useful to anyone who uses special screws in his hobby or vocation.

The GLA tool is a common sense, high-torque driver for any type of English or metric screw key up to 0.217 inch (5.5 mm). It accomodates hex (Allen), spline (Bristol), clutch-head, Scrulox, cross recessed (Phillips), Reed and Prince, or any other type of L-key within its dimensional capability. The key is simply slipped into one of nine different bushings (any one which clears), the bushing is slid into the handle and the tool is ready for use. There are no set screws to tighten and no broached holes or plastic to strip or break.

Torque is tremendously increased over that of conventional driver designs, being limited only by the ultimate strength of the key being driven (over 30 foot-pounds). The tool may be used as a "T" driver by applying the short arm of the key to the screw and rotating the handle in propeller fashion instead of axially. Also, a socket wrench can be applied to the handle hex, to obtain any desired reach. The GLA tool is 5 inches long by 3/4-inch hex and is made of hard aluminum. Standard O-rings keep the bushings in place. Bushings have graded hole sizes to accept all keys of any cross section type, up through 3/16-inch hex.

A twenty-piece set is offered which includes the basic GLA tool, nine bushings, a nine-piece hex-key set including all sizes from 0.050 to 3/16 inch and a wooden box. The wood box serves as an island stand. The set sells for $14.25 postpaid. For further information, contact Jensen Tools and Alloys, 4117 North 44th Street, Phoenix, Arizona 85018 or use *check-off* on page 110.

HEP data sheets

Engineering and design data sheets are now available for many Motorola HEP semiconductor products. These descriptive sheets contain complete and comprehensive information on the specified devices including design curves, rating charts and application schematics. A Motorola spokesman explained, "We believe that we are the only manufacturer specializing in this type of sales, to make information this comprehensive available to the hobbyist and radio amateur. These data sheets will help eliminate guesswork and 'make do' applications."

Copies of the data sheets and additional information are available from HEP representatives throughout the country. HEP is Motorola's sales program for making semiconductor devices readily available to the hobbyist-experimenter and to professional service dealers through a nationwide network of authorized suppliers. Motorola HEP Semiconductors, Box 20924, Phoenix, Arizona 85001.

More Details? CHECK—OFF Page 110

breadboards

EL Instruments has a very comprehensive line of electronic breadboards, semiconductors and experimental power supplies. Features of the electronic breadboards include solderless connections and adaptability to all standard electronic components including direct plug-in of DIP ICs. Interconnections are made either by internal ties or externally with ordinary hookup wire – no special cords are needed. The units are completely reusable and the nickel-silver contacts are designed for over 10,000 component insertions.

Boards come in many different forms including plug-in boards for card racks, a standard screw-mounted plain breadboard and a number of deluxe breadboxes which include boards and cabinets for more complex or more permanent circuits.

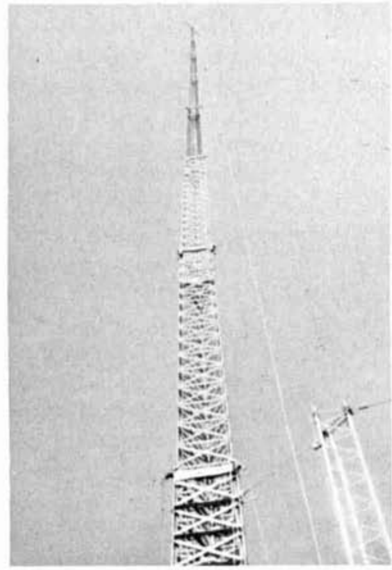
The complete catalog gives more details on all these units and on other experimenter's supplies. The catalog is free from EL Instruments, Inc., 61 First Street, Derby, Connecticut 06418 or by using *check-off* on page 110.

antenna catalog

A comprehensive, new 96-page general catalog listing over 250 models of professional communications antennas has been released by The Antenna Specialists Company. Complete mechanical and electrical specifications and radiation patterns are provided, along with full details of mounting options. The catalog covers full lines for all land-mobile antennas, plus selected base and mobile antennas for professional monitoring, marine, avionics and CB.

Of particular interest to amateurs, there is plenty of general information on transmission line characteristics, side-mounting patterns and element cutting charts. The catalog is available on request to Professional Communications Department, The Antenna Specialists Company, 12435 Euclid Avenue, Cleveland, Ohio 44106 or by using *check-off* on page 110.

atmospheric probe



Tri-Ex Tower Corporation has completed field tests on their new 205 foot XM-205 "Atmospheric-Probe" crank-up tower. This new tower has been under development for several months and was designed, engineered and manufactured by Tri-Ex.

The three lower sections of the new tower are X braced and the upper five sections are M braced. The tower has a total standing weight of 2500 pounds. At the start of erection, the tower stands 40-feet high with a triangular base of 27¾ inches and reaches a 205-foot full erection height with 9¾ inch triangular top section.

The new "Atmospheric-Probe" tower features "safety lock fixtures" at every one of the seven levels and is raised approximately three feet per minute by a self-contained motorized winch.

This tower's stiffness and strength is enhanced by the use of a generous five-foot overlap between sections. The tower is progressively guyed, as the sections extend upwards.

This tower, to date, is the largest and tallest crank-up tower manufactured by Tri-Ex. Other models in the XM series

More Details? CHECK—OFF Page 110

will soon be available.

Complete information is available by contacting Tri-Ex Tower Corporation, 7182 Rasmussen Avenue, Visalia, California 93277 or by using *check-off* on page 110.

scr manual

General Electric has produced a new fifth edition of its "SCR Manual." This latest edition, issued on the fifteenth anniversary of General Electric's invention of the SCR, consists of over 75% new text and covers SCRs, TRIACs, uninjunctions and triggers.

An idea of the comprehensiveness of this new book can be gathered from this list of the *major* chapters: Construction and Basic Theory of Operation; Symbols and Terminology; Ratings and Characteristics of Thyristors; Gate Trigger Characteristics, Ratings and Methods; Dynamic Characteristics of SCRs; Series and Parallel Operation; The Triac; Static Switching Circuits; AC Phase Control; Motor Control Employing Phase Control; Zero Voltage Switching; Choppers, Inverters and Cycloconverters; Solid State Temperature and Air Conditioning Control; Light Activated Thyristor Applications; Protecting the Thyristor Against Overloads and Faults; Voltage Transients in Thyristor Circuits; Radio Frequency Interference and Interaction of Thyristors; Mounting and Cooling the Power Semiconductor; SCR Reliability; Test Circuits for Thyristors; Selecting the Proper Thyristor and Checking the Completed Circuit Design. There is a final chapter on garnering specific device application notes.

Copies of the book can be obtained from any authorized General Electric Component distributor or by sending $3.00 plus applicable tax to General Electric Company, SCR Manual, Department B, 3600 North Milwaukee Avenue, Chicago, Illinois 60641.

new HEP catalog

Approximately 38,000 semiconductor devices are cross-referenced to HEP replacements in the new 1972 Motorola HEP Semiconductor Cross-Reference Guide and Catalog. Included in the catalog are 1N, 2N, 3N, JEDEC, manufacturers' regular and special *house* numbers as well as many international devices, with particular emphasis on Japanese types.

A total of 467 different HEP items are included in this guide, including hardware, accessories, technical manuals and hobby project books. As in previous editions, the Motorola HEP devices are listed by type number with a packaging index, device dimension drawings and selection guide information.

This cross-reference guide and catalog is available free at local Motorola HEP suppliers throughout the country. It should be of particular interest to the electronic hobbyist and radio experimenter since it gives the minimum/maximum ratings and the electrical characteristics for the HEP devices as well as cross-reference information.

W9IOP's second op

The new, 6th edition of W9IOP's famous and useful Second Op is available now. This 10½-inch circular operating aid is covered with up-to-date information for the active DXer. The user sets the pointer to the call-letter prefix, and the Second Op displays the country name, WAZ zone number, continent and great circle beam headings from four different United States population centers. Also shown is the local-time to tocal-time conversion factor between the DX location and three United States time zones. Postage information for letters and QSL cards by air and sea mail along with the number of International Reply Coupons necessary for an airmail letter reply is also displayed. There are two boxes next to every prefix for recording the prefix worked and the prefix confirmed. Printed on the Second Op are complete instructions for its use and a list of North

American and worldwide QSL bureaus.

Previous editions of the Second Op have earned it a reputation as a valuable operating aid to identify, work and QSL DX stations. The operating aid is printed in three colors on sturdy card stock. Produced by Publications in Electronics, it is available for $2.00 from Comtec Books, Greenville, New Hampshire 03048.

pocket receiver

Old ideas seem to come back in many new forms. Induction wireless has reappeared in the Lowcom Systems wireless induction pocket receiver. The receiver, a tiny and attractively packaged unit, is designed to allow you to monitor a receiver, audio system, radio or TV without being confined to the immediate vicinity of the unit. The audio output of the receiver (or other system) is fed into a wire induction system. The pocket-sized receiver is inductively coupled to this output loop and feeds its output through an amplifier to a personal earpiece. This system allows complete freedom of movement while monitoring a receiver *without* bothering anyone else with a blaring speaker.

This particular system is patented, confirming one's suspicion that this particular little device is a spin-off of Lowcom's industrial paging and audio distribution systems. The unit is attractively packaged and comes with a brass plate neatly engraved with your call letters. For those who can remenber experimenting with large coils of wire, dry cells and old telephone microphones; it is quite a sight to see some of the old schemes existing in this modern, tiny, commercial box.

The unit sells for $24.95, postpaid with batteries, case, earphone, installation instructions and engraved call plate. Quantity discounts are available.

For more information write to Lowcom Systems, Inc., 10727 Indian Head Industrial Boulevard, Saint Louis, Missouri 63132 or use *check-off* on page 110.

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Go all the way into the REPEATER

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

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261 Commercial duty 1/4 wave, claw mounted roof top whip. Precision tunable to any discrete frequency 108 thru 470 MHz. Complete with 18′ of coax and connector. 17-7 ph stainless steel whip.

260 Same as above. Furnished without coax.

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

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

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

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

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

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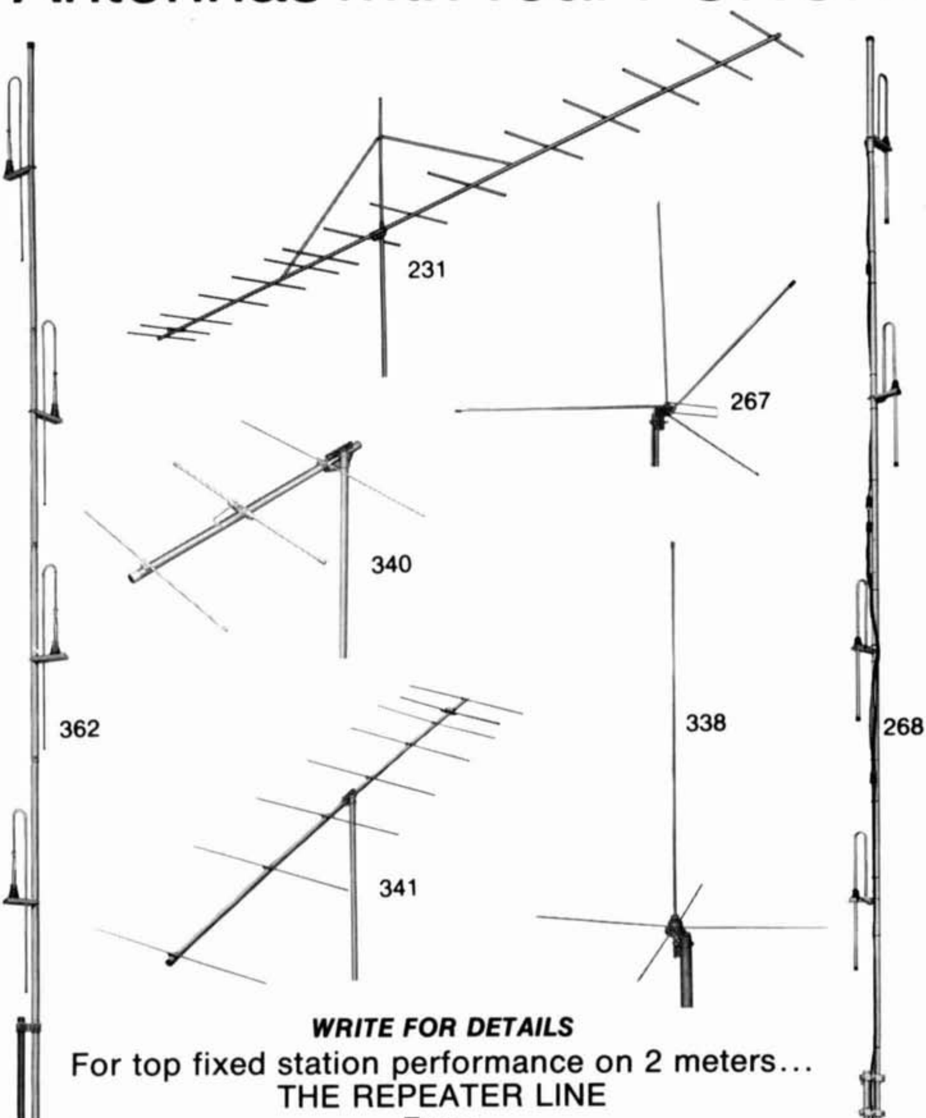

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MEMORY-MATIC 8000 DELUXE Capacity for 8000 bits in 8 Read/Write Pluggable Memories. Each memory can store either a single message or a number of sequential messages. Near-full and Overload alarms, "Message Stop" for char. insertion, "Full Control" weight ratio, message interrupt switch, var. trans. delay, 115/220 VAC, 50/60 Hz, Incl. SM-21B and MST-60 features. Sh. wt. 8 lbs. **$398.50** (Incl. 3-500 and 1-1000 bit memories.)

Additional Memories 500 bit **$21.50**
1000 bit **$37.50**

MEMORY-MATIC 500-B 500 or 800 bit R/W memory. Stores either a single message or a number of sequential messages. "Message Stop" for char. insertion, Near-full and Overload alarms, remote control for Stop/Start of message. Incl. SM-21B features. Sh. Wt. 4 lbs. **$198.50 (500-bit memory)**
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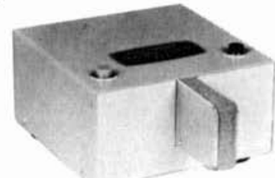
SPACE-MATIC 21-B This SWITCHABLE keyer gives you "eight-keyers-in-one". Rear switches can delete dot or dash memories or char./word spacing. Instant start, self-completing dots, dashes and char./word spacing, Adj. weighting, sidetone/speaker, dot-dash memories Iambic, 115 VAC or 12 VDC (SM-21B only.) Sh. wt. 4 lbs. **$89.50**

CRICKET 1 The "feature-packed" moderately-priced keyer! Keyed time base, jam-proof spacing, sidetone/speaker. Rear controls for weight, speed, volume, tone, auto-semi-auto., tune. 115 VAC or 12 VDC. Sh. wt. 3 lbs. **$49.95**

VHF FREQUENCY STANDARD — FMS-5 Cal. receive and transmit crystals in 10, 6, 2 and 1¼ meter FM bands. Markers for all FM channels. Check deviation. Precision 12 MHz crystal. No unwanted markers. Osc. and output buffered. Sh. wt. 2 lbs. **$44.50** (Less Batteries)

METEORIC SCATTER TIMER — MST-60 Precision timer for meteoric scatter communications. 60 Hz time base provides 15, 20, 30, and 60 second output. Synchronized to WWV. Automatic and manual outputs. Sh. wt. 2 lbs. **$49.50**



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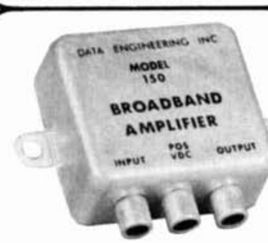

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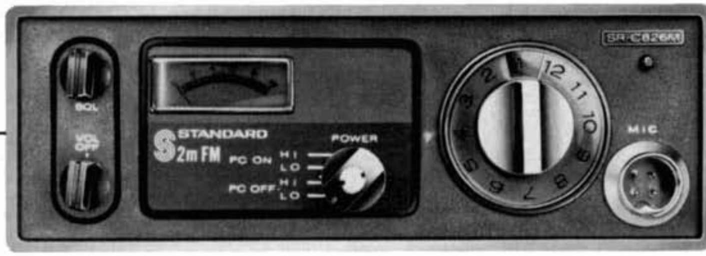

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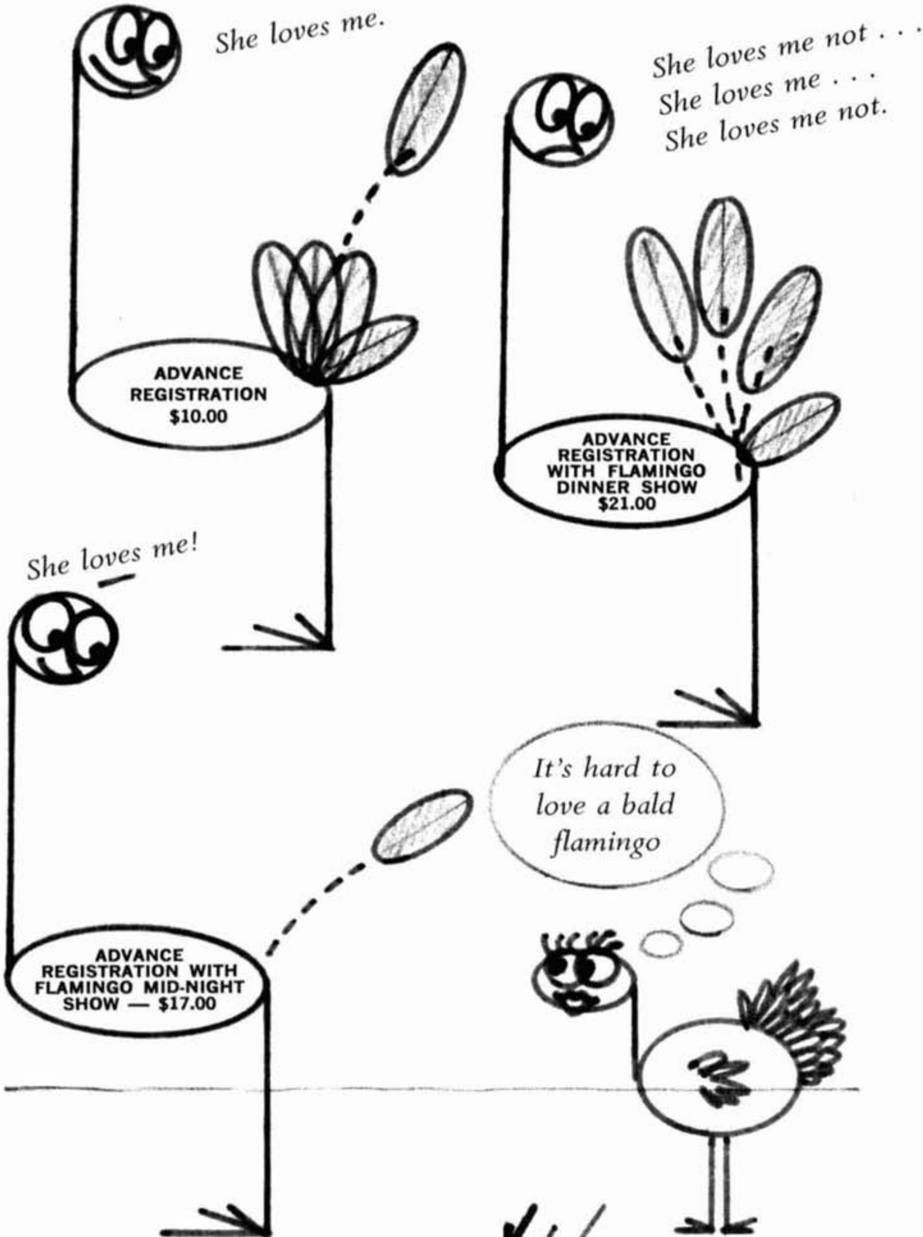

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MC799P	Dual Buffer RTL	**$1.00**
MC780/880	RTL decade counter	**$3.00**
MC1013P	85 MHz Flip-flop MECL	**$3.25**

OCTOBER FLEA MARKET

Build a 50-W booster for 2 meter FM — See May of 72 QST.

2N6084	Motorola 50-W RF power	**$18.00**
7490	Decade Counter	**.70**
7400	Gates	**.22**
N5111A	Signetics FM Det	**$1.60**
NE555	Signetics Timer	**$1.10**
1N914	Silicon diodes	**16 for $1.00**
1N270	Germanium diode	**6 for $1.00**
MBD101	Motorola Hot Carrier diode	**$1.00**

MORE RCA IC's

CA3088E	AM rcvr subsystem	**$2.50**
CA3089E	FM IF system with circuits for IF amp., Det., AF preamp., AFC, Squelch, & tuning meter	**$3.90**
CA3018	Transistor array	**$1.55**

NEW FAIRCHILD ECL HIGH SPEED DIGITAL IC's

9528	Dual "D" FF toggles beyond 160MHz	**$4.65**
9582	Multi-function gate & amplifier	**$3.15**
95H90	300 MHz decade counter	**$16.00**

A 95H90 & 9582 makes an excellent prescaler to extend low frequency counters to VHF — or use two 9528s for a 160 MHz prescaler.

Box 3047, Scottsdale, AZ 85257

CIRCUIT SPECIALISTS CO.

Please add 35¢ for shipping

FACTORY AUTHORIZED
HEP-CIRCUIT-STIK
DISTRIBUTOR

More Details? CHECK—OFF Page 110

flea market

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

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

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

THE HALL OF SCIENCE will conduct a series of twelve lessons for Teens and Adults in Amateur Radio beginning September 30th at the Hall, 111th Street and 48th Ave., Flushing Meadows Corona Park, Flushing, N. Y. 11352. Courses for the Novice, Technician, General and Advanced class Amateur Radio licenses with all courses scheduled from 10 a.m. to 12 noon and repeated from 1 p.m. to 3 p. m. on consecutive Saturdays. There is a registration fee of $5.00 and a nominal charge for text books and code practice equipment for participants who require these materials.

"DON AND BOB" GUARANTEED BUYS: SBE 144 (249.00L) 209.95; SBE 450 (399.95L) 399.00; Gladding 25 212.50, with AC 255.00; Standard SR826M 299.95; Motorola HEP 170 epoxy diode 2.5A/1000 PIV 39¢; Ham-M 99.00; TR 44 59.95; Belden 8448 Rotor Cable 10¢/ft: Mosley CL 33 124.00; CL 36 149.00; Hygain TH6DXX 139.00; Hyquad 109.95; 400 Rotor 179.00; 204 BA 129.00; Airdux 2408T coil 5.00; Belden 8237 RG8 15¢/ft: 8412 RG8 foam 16¢/ft; Collins 75A4 (used) 345.00; Cetron 572B/T160L 13.95; KY65 Code Id 5.95; Sangamo 600MF/450V 4.95; Mot MC12709CG Opamp 58¢; write quote note. Prices collect. Mastercharge, BAC. Full warranty. Madison Electronics, 1508 McKinney, Houston, Texas 77002 (713) 224-2668.

RESISTORS: Carbon Composition brand new. All standard values stocked. ½ watt 10% 50/$1.00; ¼ watt 10% 40/$1.00. 10 resistors per value please. Minimum order $5.00. Post paid. Pace Electronic Products, Box 161-H, Ontario Center, New York 14520

WE BUY ELECTRON TUBES, diodes, transistors, integrated circuits, semiconductors. ASTRAL ELECTRONICS, 150 Miller Street, Elizabeth, N. J. 07207. (201) 354-2420.

COPY MORSE CODE automatically, (Ham Radio November 1971) detailed construction plans $14.95. VMG Electronics, 2138 West Sunnyside, Phoenix, Arizona 85029.

2 METER FM GE MA36 w/4 freq. strip and accessories $150., also, 6 meter MA13 $35. Bob Avezzie, WA1OWL, 5 N.W. Fld., Feeding Hls., MA 01030, tel. 413-786-2162.

AN AWARD is available for making contacts with (5) five St. Joseph operators. General class and above can look for contacts individually or on the CHF-FHC Service Net on 3943 kHz about 0200 Z. There are only six novice operators who are active. Novices can look for WNOHNO, DPS, DNE, DNC, HEF, GGD on the following freqs: 3710, 20, 30. 7158, 66, 68, 70, 76, 80, 86. 21110, 120, 132, 150, 170, 177, 180, 200, 220, 240. Send application to WNOGGD.

WORLD QSL — See ad page 108.

DX'ERS — Dig then out of the Mud. New low noise Dual Gate Mosfet Preamplifier. Nominal 20 db gain. 10-30 MHz. Complete in cabinet. $29.96. Dynacomm, 1183 Wall Street, Webster, N.Y. 14580.

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

VQ9FOS will be operating from Mahe, during the period October 2nd-5th 1972, inclusive. Contacts will be on 10, 15 & 20 continuously throughout the period, and on other bands by arrangement. A Festival QSL card will be sent to all contacts and your return QSL card should be sent to P.O. Box 321, MAHE, Seychelles.

ROBOT MODEL 70 SLOW SCAN TELEVISION MONITOR, $375. Hamfest prize, never used, factory warranty, original box. Phil Irvine, 2103 Suzanne Terrace, Huntsville, Alabama 35810.

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

RTTY PICTURE TAPES. Stamp for list. John Sheetz, 5 Hansell, New Providence, NJ 07974.

F.C.C. TYPE EXAMS GUARANTEED to prepare you for the F.C.C. 3rd., ($7.00), 2nd. ($12.00), and 1st ($16.00), phone Exams; complete package, $25.00. Research Company, Dept. D. Rt. 2, Box 448, Calera, Alabama 35040

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160 TO 190 KHZ. The experimenter's "QRP" Band. Mini-Handbook with "Facts". Receiving, Transmitting, Antenna Dope, etc. $1.75 postpaid. Ken Cornell, Box 721, Westfield, N. J. 07091.

TECH MANUALS — only $6.50 each: R-220/URR, R-388/URR, R-389/URR, R-390/URR, R-390A/URR, URM-25D, TT-63A/FGC, LP-5, CV-519A/URR, BC-639A, R-274/FRR, LM-21, TS-34A/AP, TS-413A/U. Hundreds more available. Send 50¢ (coin) for 20-page list. W3IHD, 4905 Roanne Drive, Washington, DC 20021.

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

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

EXPERIMENTERS — Make etched dual-in-line printed circuit patterns on your board at home. Quick! Easy! Inexpensive! No taping! Details: Stamp-a-circuit, Box 113H, Westchester, Ohio 45069.

TOUCHTONE trimline dial assembly, complete. Ideal for walkie-talkie, mobile. $29.50. Jacobs, 1301 Estes, Chicago 60626.

DISCOUNTS! Standard, Sonar, Clegg, Robyn, Mosley, Cush Craft, Rohn, Gladding, others. Also Marine and CB. Arena Communications, Dept. H, 1169 N. Military Hwy., Norfolk, Va. 23502.

TWO CHANNEL G. E. POCKETMATE, 2¼ x 7 x ¾ in., easy conv. to 2m. First $150 M. O. takes. Ken Prouty, WB4SPD, Greensboro, N. C. 27407.

TELL YOUR FRIENDS about Ham Radio Magazine.

More Details? CHECK—OFF Page 110

HOOSIER ELECTRONICS — Your ham headquarters of the Midwest. Individual, personal service by experienced and active hams. Factory-authorized dealers for the finest ham gear on the market — Drake, Regency, Standard, Hy-Gain, Ten-Tec, Galaxy, Cush-Craft, and accessories. Write today for our quote and try our personal, friendly Hoosier service. We accept Master-Charge and BankAmericard. Hoosier Electronics, R.R. 25, Box 403, Terre Haute, Indiana 47802.

SB-102 TRANSCEIVER, HP-23A supply, HDP-21A *mic and SB-600. Complete station factory aligned* and tested. New never used! $530. or best offer. Jim Carollo, 611 Smith Street, Iron Mountain, Mich. 49801.

$3,000.00 in FREE PRIZES! On October 7 & 8, 1972, SWAN ELECTRONICS will host its second Annual Open House. Enjoy refreshments, plant tours, technical talks, movies, etc. Free prize drawings for licensed amateur radio operators . . . also, ladies and kids. Located next to Oceanside Airport, overnight trailer and camper facilities will be available. Join the "Talk-In" on 7260 kHz and 146.94 MHz. Don't miss this family affair — include this visit to SWAN in your vacation plans. Any questions? Call: (714) 757-7525. SWAN ELECTRONICS — 305 Airport Road, Oceanside, California 92054.

WANTED: Collins 351D-1 mobile mount for KWM-1. VE2ADH, 75 Charleswood Drive. Beaconsfield 870. Quebec, Canada.

COLLINS 351D-2 mobile mounting w/cables f/KWM-2/2A, new $25.00. W5KE 5905 NW 42nd Oklahoma City, OK 73122 (405-789-6702).

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

RECIPROCATING DETECTOR PARTS KIT. Write Peter Meacham Associates, 19 Loretta Road, Waltham, Mass. 02154.

FOR SALE: Hammarlund HQ-170 $100. good condition WA2TLT, Richard Sauter. Tel. (914) 358-0313 TNX.

COUNT DOWN! Only Days, Hours, Minutes before the spectacular opening of the ARRL Hudson Division Convention, October 21-22, Hilton Inn, Tarrytown, N. Y. Plenty of Free Parking. Exhibits, lectures, contests, YL-XYL Events, gabfests, 2-Meter FM, RTTY, banquet, N. Y. sightseeing. Prominent Banquet Speaker. Fun! Don't miss the blastoff! Free gifts to early registrants. Info from Dave Popkin, WA2CCF, 303 Tenafly Road, Englewood, N. J. 07631.

AMATEUR SALES & SERVICE. Start with discount prices and get service after the sale. We stock such leading names as Clegg, Drake, Kenwood, Regency, SBE, Signal/One, Tempo One. Antennas by Cush Craft and Mosley. Towers by Rohn. Write or call today Amateur Sales and Service, 111 Rand Mill Road, Garner, North Carolina 27529, Tel. 1-919-772-6044.

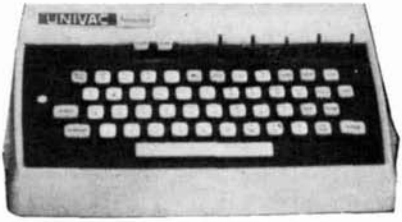
VHF NOISE BLANKER — See Westcom ad in Dec. '70 and Mar. '71 Ham Radio.

SELL: Drake R-4, T4-X, MS-4, AC-4, 10 xtals and manuals all perfect xmtr recently factory aligned new finals also Johnson Valiant and manual good condition also RME Model 69 .55 to 32.0 MHz receiver ser. # 534 and manual good condition. Best reasonable offer F. O. B. Dennis Vaughn 806 Park Ave., Ladysmith, Wis. 54848.

FOR SALE: Drake 2-B $155, 2-NT $85 with manuals and 11 crystals. Mosley 15 meter beam $15 WN2SKK (914) 358-8254 after 6 p.m.

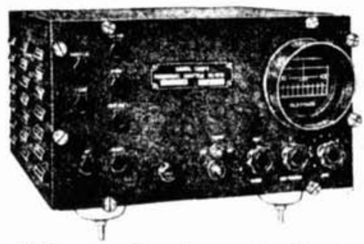
SAVE MONEY *on parts and* transmitting-receiving tubes. Foreign-Domestic. Send 25¢ for giant catalog. Refunded first order. United Radio Company, 56-HR Ferry Street, Newark, N.J. 07105.

FILTERS — Panasonic Ceramic ladder type 455 kHz, bandwidth 15 kHz @ 6 db. $5.00 each. Post paid. Pace Electronic Products, Box 161, Ontario Center, New York 14520.



COMPUTER KEYBOARD W/ENCODER $35
Another shipment just received. Alpha-numerics keyboard excellent condition. Once again we expect an early sellout. Price of $35 includes prepaid shipment in the US and shipment made within 24 hours of receipt of order.

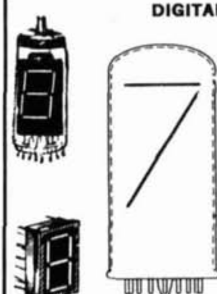
COMPUTER KEYSWITCHES
Another fantastic bargain for the builder. We have brand new bounce-less micro switch keys, spares from the above units, less key-tops. Make up your own keyboards. Made for PC mount. Package of 48 brand new key-switches only **$12.00 postpaid.**



We still have a few Panoramic Adapters BC 1031 excellent condition, "IF" 450-470 Kc, operate from standard 115 volt 60 cycle. $45 each complete with schematic, FOB Lynn, Mass. (60 lbs.)

POWER TUNEABLE VARACTOR $5.00
Similar to MA-4060, used in doublers, triplers, amplifiers, etc. Fully guaranteed, with specs and some circuits. **$5 each or 6 for $25 pp.**

DIGITAL READOUTS



GE Y 4075 25V Miniature **$1.75 ea.**

GE Y 1938 24V Standard **$1.75 ea.**

RAY CK 1905 Standard **$1.75 ea.**

MAN-3 1.7V Miniature LED **$3.50 ea. 10/$30**

GIANT ALPHA NUMERIC **$1.75 ea.**

MAGNO STRICTIVE MEMORY
Good for 7116.5 Bits Storage **Like New $10**

LASER DIODE 3 WATT
RCA TA-2628 w/specs. **$5**

ROPE MEMORY MODULE
From APOLLO project **$10**

All material f.o.b. Lynn, Mass. Send self-addressed envelope for complete list.

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

SIGNAL/ONE CX7A — $2,395.00 — IN STOCK FOR IMMEDIATE SHIPMENT. REALISTIC, GOOD TRADE-INS WELCOME

DRAKE
T4XB ... new, $495.00
R4B ... new, $475.00
TR4 ... new, $599.95
AC4 ... new, $ 99.95
MS4 ... new, $ 22.00
MN4 ... new, $ 99.00
729SRD ... new, $ 17.00
W4 ... new, $ 61.95
WV4 ... new, $ 73.50
TR22 ... new, $199.95
ML2 ... new, $299.95
SW4A ... good, $250.00
The above items are just those that are in stock. We can order any others needed.

TEN TEC
ARGONAUT ... new, $288.00
210 POWER SUPPLY ... new, $ 24.95
TX100 ... new, $109.95
RX10 ... new, $ 59.95
AC4 ... new, $ 14.95
KR1 ... new, $ 18.95
KR2 ... new, $ 12.95
KR5 ... new, $ 34.95
KR20 ... new, $ 59.95
KR40 ... new, $ 89.95

COLLINS
75S3C ... orig. box — unused, write
75A4 ... mint, with 500 kc filter, write
KWM2 with 516F2 ... good, $625.00
MP1 mobile supply ... xlnt, $125.00
351D2 mobile mount ... fair, $ 75.00
180U3 Antenna Tuner, Collins, military $ 49.95
DL1 Dummy Load ... good, $ 49.95
R388/URR ... looks new, $425.00
30L1 spare parts kit less chassis/cab. etc. $ 99.95

HAMMARLUND
HQ 215 RECEIVER w/speaker — mint, $250.00

HALLICRAFTERS
HT44 TRANSMITTER with P.S. ... good, $250.00
S-36 RECEIVER, AM/FM 27-144MHz ok, $ 65.00
"TO" KEYER ... xlnt, $ 55.00

INSTRUMENTS
HP 415CR SWR METER ... good, $ 65.00
HP 430CR POWER METER ... good, $ 65.00
DIGIPET 60MHz COUNTER ... new, $299.00
DIGIPET SCALER ... new, $ 50.00
HP 130C 200uV SCOPE ... mint, $225.00
GR 1001A SIGNAL GEN ... mint, $595.00
TEKTRONIX P6006 PROBE ... new, $ 14.95
HEATH IO-18 SCOPE ... good, $ 85.00
DUMONT 304H DUAL BEAM SCOPE ok, $150.00
HEATH IP-17 POWER SUPPLY ... ok, $ 64.95
HEATH IG-82 GENERATOR ... good, $ 40.00
HICKOK 455 VOM ... good, $ 39.00
BOONTON AM/FM GEN ... good, $225.00
HP 355C ATTENUATOR ... good, $ 75.00
HP 355D ATTENUATOR ... good, $ 75.00
HP DY5003 XBAND TEST SET ... ok, $450.00
HP 540B TRANSFER OSC ... good, $275.00
HEATH IP-32 POWER SUP ... good, $ 40.00
HP 685A H BAND OSC ... good, $275.00
GR 1208A UNIT OSC ... good, $ 95.00
MEASUREMENTS 78E GEN ... fair, $ 75.00
HP 416A RATIOMETER ... good, $250.00
HP 492A TWT AMPLIFIER ... good, $125.00
FR-114U COUNTER, FREQ ... good, $225.00
HP KS19353 TEST OSC ... mint, $225.00

12 VOLT DC POWER SUPPLIES: 110 AC INPUT
MODEL 102, is a 4 amp overload protected power supply that automatically resets itself when the overload is removed ... new, $24.95
MODEL 104R, is a regulated power supply with the same electronic overload protection as the model 102. MODEL 104R ... new, $34.95
MODEL 107M is a heavier duty supply with the same features as the 10w but puts out 6 amps new, $27.95

INVERTER/CONVERTER:
MODEL 612 is a special purpose unit to provide 12 VDC negative ground power in automobiles with either 6 volt negative ground or 12 volt positive ground. 10 amp surge, 3 amp continuous ... new, $22.95

HONEYWELL
0-25 VDC Voltmeter ... new, $3.95

MISC.
COLLINS 30L-1 ... xlnt-(Round Decal), $350.00
AUTRONIC KEYER ... new, $ 79.50
SBE SB-36 TRANSCEIVER ... new, $895.00
JOHNSON KW MATCHBOX* ... mint, $105.00
JOHNSON 250W MATCHBOX ... mint, $ 90.00
*without coupler (swr)
2 METER VHF DUMMY LOAD/WATTMETER Good up to 15 watts — w/SO-239 CONNECTOR $19.95

ANTENNAS
2M MAGNETIC MOUNT w/RG58 & PL259 $ 9.95
AR-2 RINGO ... $ 13.50
AR-25 RINGO (KW RINGO) ... $ 17.00
DI-2 DIPLOMAT ... $ 13.35
12AVQ VERTICAL ... $ 29.95
14AVQ/WB VERTICAL ... $ 47.95
18AVT/WB VERTICAL ... $ 69.95
TH3Mk3 10/20/40 BEAM ... $144.95
A144-7 2 METER BEAM ... $ 13.95
All of the above antennas are in stock here. In addition, we can order any antenna made by Antenna Specialists, Cush Craft, Hy Gain, Mosley or Newtronics.

DX ENGINEERING SPEECH COMPRESSORS
DIRECT PLUG-IN FOR COLLINS 32S ... $79.50
DIRECT PLUG-IN FOR KWM — 2 ... $79.50
DIRECT PLUG-IN FOR DRAKE TR3 OR DRAKE TR4 ... $98.50
HEATH HW-101 w/AC & DC P. S. all MINT all @ $350.00
C.D HAM "M" ROTATORS, new, complete $99.95
HAM "M" CABLE ... @ 12¢/ft.
RG8A/U — 65 feet with PL-259 CONNECTORS ON EACH END ... $9.50
C.D. TR-44 ROTATORS, new, complete $63.95
CABLE FOR TR-44 ... 6¢/ft.

Bird Ham Mate VHF-1 Wattmeter ... $ 79.00

Mor-Gain Antenna Distributor ... Write for Details

Overseas friends. Barry can demonstrate and help you with the purchase of **ROBOT** SSTV Gear. Write or drop in when you are in NYC.

500 PIV 12 Amp Diodes ... 75¢

MPC POWER SUPPLIES
All brand new, full factory warranty, with 6' line cord.

Model 102 - 115 VAC in, 12 VDC 4 Amp out $ 24.95

Model 107M - 115 VAC in, 12 VDC 6 Amp out $ 27.95

Model 12-115 - 12 VDC 20 Amp in, 110-117 VAC 60 Hz 200 Watts out ... $ 45.00

Look for us in Tarrytown, Oct. 21-22. Hudson Division Convention at Hilton Inn. Barry and Robot are donating a Model 70 SSTV monitor as a prize. Don't miss out!

CASH PAID . . . FAST! For your unused TUBES, Semiconductors, RECEIVERS, VAC. VARIABLES, Test Equipment, ETC. Write or call Now! Barry, W2LN1. We Buy!

We ship all over the World. DX Hams only. See Barry for the new Alpha 77.

☐ Send 35¢ for 104 page catalog #20.

BARRY ELECTRONICS CORP.
DEPT. H-10 — PHONE A/C 212-925-7000
512 BROADWAY, NEW YORK, N. Y. 10012

More Details? CHECK—OFF Page 110

"RTTY SPEED CONVERTER" A drilled, fiberglass 4" x 6½" printed circuit board now available for the WA6JYJ speed converter in the Dec. 71 issue of Ham Radio. $6.00 post paid. Complete parts kit including PCB $40.00, post paid. P & M Electronics, 519 South Austin, Seattle, WA 98108.

WANTED — M15 and M32 TELEPRINTERS in any quantity in good condition for use by deaf people . . . will accept donations or for fair prices . . . can be picked up anywhere . . . write Lee Brody, New York-New Jersey Phone-TTY for the Deaf, 15-06 Radburn Rd., Fair Lawn, New Jersey 07410 or call 201-796-5414 evenings.

JFD PISTON TRIMMERS Perfect for VHF/UHF preamps and converters. Very low prices. All items postpaid. S.A.S.E. for list of these and other first quality components. CPO Surplus, Box 189, Braintree, Mass. 02184.

FOR SALE: Drake Station, original owner mint condition R-4B $345, T-4XB $360 RP Speech compress. $18 AC-4 $80, MS-4 $16. YAESU FT-101 Transceiver. Brand new complete with mike, built in AC and DC supply and SPKR $495. EIKO 717 Electronic Keyer, new $60. All manuals. Prices prepaid in USA. WB6LQB 370 N. Bundy, Los Angeles, Cal. 90049 (213) 472-5990.

"AFSK GENERATOR" — PCB and all components except input output jacks, power supply and chassis. $6.60. P & M Electronics, 519 South Austin, Seattle, WA 98108.

FIGHT TVI with the RSO Low Pass Filter — p115 March 73 — write for brochure — Taylor Communications Manufacturing Company, Box 126, Agincourt, Ontario, Canada.

THE EIGHTEENTH (18th) ANNUAL V. H. F. CONFERENCE at Western Michigan University, Kalamazoo, Michigan, will be held October 21, 1972 (Saturday). Flea market, speaker from Amsat, etc. For full details write: V. H. F. Conference, Post Office Box 934, Battle Creek, Michigan 49016.

URGENTLY NEEDED: solid state VLF receiver, RAK, AN/URM-6, Rustrak recorder and/or tape, professional weather instruments, for research programs by children. Dr. R. B. Ammons, 411 Keith, Missoula, Montana. 59801. Or call collect evenings.

1KV DIODES: HEP 170 2½ Amp 30¢, $25/100; 1N4007 1 Amp 20¢, $15/100. FET's 40673 $1.01; MPF 102 60¢. Nurmi Electronic Supply, 1727 Donna Road, West Palm Beach, Florida 33401.

FOR SALE: Yaesu FTDX401, FV 401 VFO, Spkr, new cond. $400. Collins 75A-4 Ser. 4788 excellent cond. $350 -W7UR, 12945 SW 135th Ave., Tigard, Ore. 97223. Tel. 503-643-1460.

NEMS-CLARKE 1671 FM RCVR 175-260 MHz like new condition $145. RT-271/PRC-14 and PP-855 pwr supply. 225-400 MHz, 4 channel. $45. Larry Smith 44100 20th St. E., Lancaster, Calif. 93534. (805) WH 2-9859.

SSTV, RTTY, CW, WWV, CHU tone to logic decoder projects. Chassis, plans, hardware, eight 2" x 3" epoxy cards, $6. Hornung, 1630 Bowling Lane, San Jose, Calif. 95118.

NOSTALGIA. A handsome series of books to bring back yesteryear. Reprints of old Sears, Montgomery Ward & Marshall Field catalogs. Books on old time autos, toys, and ladies fashions. Write today for full details. Comtec, Greenville, NH 03048.

SELL: Dumont scope, 5 in., #304H, w/manual - $60.00; surplus Navy 3 in. scope, #OS8C/U, w/schem - $50.00; Kiethley RMS voltmeter, #124R, w/manual - $100.00; Receivers w/schem - BC-348-R, modified for 120VAC - $75.00, Hallicrafters R-274/FRR - $285.00, R-390/URR - $750.00; RTTY audio TU, #CV-60/URR, w/schem - $70.00; gas driven alternator, 2.5 KW, 120 VAC, 1 ph., 60 cyc. - $250; microswitches, 230 pcs., 5A-125VAC, SPDT - $.50 ea, $5.00/doz. All excellent, prices FOB Nanticoke. Stan Gritsevicz, 11 New Pine St., Nanticoke, Pa., 18634, 717-735-3190.

All I.C.'s are marked with manufacturer's date code and identification. Your guarantee of first run, brand new, fully tested I.C.'s.

We accept C.O.D.'s, BankAmericard and Master Charge. No minimum order.

Catalog Number	Any Quantity Per Item (Mix) 1-99	100-999	1000 up	Multiples of 10 Per Item (Mix) 100-990	1000-9990	10000 up
7400	.26	.25	.23	.22	.21	.20
7401	.26	.25	.23	.22	.21	.20
7402	.26	.25	.23	.22	.21	.20
7403	.26	.25	.23	.22	.21	.20
7404	.28	.27	.25	.24	.22	.21
7405	.28	.27	.25	.24	.22	.21
7406	.52	.50	.47	.44	.42	.39
7407	.52	.50	.47	.44	.42	.39
7408	.32	.30	.29	.27	.26	.24
7409	.32	.30	.29	.27	.26	.24
7410	.26	.25	.23	.22	.21	.20
7411	.28	.27	.25	.24	.22	.21
7413	.58	.55	.52	.49	.46	.44
7416	.52	.50	.47	.44	.42	.39
7417	.52	.50	.47	.44	.42	.39
7420	.26	.25	.23	.22	.21	.20
7421	.26	.25	.23	.22	.21	.20
7423	.80	.76	.72	.68	.64	.60
7425	.50	.48	.45	.43	.40	.38
7426	.34	.32	.31	.29	.27	.26
7430	.26	.25	.23	.22	.21	.20
7437	.56	.53	.50	.48	.45	.42
7438	.56	.53	.50	.48	.45	.42
7440	.26	.25	.23	.22	.21	.20
7441	1.73	1.64	1.55	1.46	1.37	1.27
7442	1.27	1.21	1.14	1.07	1.01	.94
7443	1.27	1.21	1.14	1.07	1.01	.94
7444	1.27	1.21	1.14	1.07	1.01	.94
7445	1.71	1.62	1.53	1.44	1.35	1.26
7446	1.24	1.17	1.11	1.04	.98	.91
7447	1.16	1.10	1.04	.98	.92	.85
7448	1.44	1.37	1.29	1.22	1.14	1.06
7450	.26	.25	.23	.22	.21	.20
7451	.26	.25	.23	.22	.21	.20
7453	.26	.25	.23	.22	.21	.20
7454	.26	.25	.23	.22	.21	.20
7460	.26	.25	.23	.22	.21	.20
7470	.42	.40	.38	.36	.34	.32
7472	.38	.36	.34	.32	.30	.29
7473	.50	.48	.45	.43	.40	.38
7474	.50	.48	.45	.43	.40	.38
7475	.80	.76	.72	.68	.64	.60
7476	.56	.53	.50	.48	.45	.42
7480	.76	.72	.68	.65	.61	.57
7482	.99	.94	.88	.83	.78	.73
7483	1.63	1.55	1.46	1.38	1.29	1.20
7485	1.43	1.35	1.28	1.20	1.13	1.05
7486	.58	.55	.52	.49	.46	.44
7490	.80	.76	.72	.68	.64	.60
7491	1.43	1.35	1.28	1.20	1.13	1.05
7492	.80	.76	.72	.68	.64	.60
7493	.80	.76	.72	.68	.64	.60
7494	1.18	1.12	1.05	.99	.93	.87
7495	1.18	1.12	1.05	.99	.93	.87
7496	1.18	1.12	1.05	.99	.93	.87
74100	1.52	1.44	1.36	1.28	1.20	1.12
74107	.52	.49	.47	.44	.42	.39
74121	.56	.53	.50	.48	.45	.42
74122	.70	.67	.63	.60	.56	.53
74123	1.21	1.06	1.00	.94	.89	.83
74141	1.63	1.55	1.46	1.38	1.29	1.20
74145	1.41	1.33	1.26	1.18	1.11	1.04
74150	1.63	1.55	1.46	1.38	1.29	1.20
74151	1.20	1.13	1.07	1.01	.95	.88
74153	1.63	1.55	1.46	1.38	1.29	1.20
74154	2.43	2.30	2.16	2.03	1.89	1.76
74155	1.46	1.39	1.31	1.23	1.16	1.08
74156	1.46	1.39	1.31	1.23	1.16	1.08
74157	1.56	1.48	1.39	1.31	1.23	1.15
74158	1.56	1.48	1.39	1.31	1.23	1.15
74160	1.89	1.79	1.68	1.58	1.47	1.37
74164	1.89	1.79	1.68	1.58	1.47	1.37
74166	1.98	1.87	1.76	1.65	1.54	1.43
74176	1.62	1.53	1.45	1.36	1.28	1.19
74177	1.62	1.53	1.45	1.36	1.28	1.19
74180	1.20	1.13	1.07	1.01	.95	.88
74181	5.20	4.90	4.59	4.28	3.98	3.67
74182	1.20	1.13	1.07	1.01	.95	.88
74192	1.98	1.87	1.76	1.65	1.54	1.43
74193	1.98	1.87	1.76	1.65	1.54	1.43
74196	1.98	1.87	1.76	1.65	1.54	1.43
74197	1.98	1.87	1.76	1.65	1.54	1.43
74198	2.81	2.65	2.50	2.34	2.18	2.03
74199	2.81	2.65	2.50	2.34	2.18	2.03
SCHOTTKY TTL						
74S00	1.14	1.08	1.02	.96	.90	.84
74S01	1.14	1.08	1.02	.96	.90	.84
74S03	1.14	1.08	1.02	.96	.90	.84
74S04	1.37	1.30	1.22	1.15	1.08	1.01
74S05	1.37	1.30	1.22	1.15	1.08	1.01
74S08	1.14	1.08	1.02	.96	.90	.84
74S09	1.14	1.08	1.02	.96	.90	.84
74S10	1.14	1.08	1.02	.96	.90	.84
74S15	1.14	1.08	1.02	.96	.90	.84
74S20	1.14	1.08	1.02	.96	.90	.84
74S21	1.14	1.08	1.02	.96	.90	.84
74S40	1.37	1.30	1.22	1.15	1.08	1.01
74S50	1.14	1.08	1.02	.96	.90	.84
74S51	1.14	1.08	1.02	.96	.90	.84
74S60	1.14	1.08	1.02	.96	.90	.84
74S64	1.14	1.08	1.02	.96	.90	.84
74665	1.14	1.08	1.02	.96	.90	.84
74S73	1.98	1.87	1.76	1.65	1.54	1.43
74S74	1.98	1.87	1.76	1.65	1.54	1.43
74S76	1.98	1.87	1.76	1.65	1.54	1.43
74S78	1.98	1.87	1.76	1.65	1.54	1.43
74S107	1.98	1.87	1.76	1.65	1.54	1.43
74S112	1.98	1.87	1.76	1.65	1.54	1.43
74S113	1.98	1.87	1.76	1.65	1.54	1.43
74S114	1.98	1.87	1.76	1.65	1.54	1.43
74S140	1.37	1.30	1.22	1.15	1.08	1.01
LINEAR IC'S						
NE501	2.99	2.82	2.66	2.49	2.32	2.16
NE526	3.59	3.38	3.17	2.95	2.74	2.53
NE531	3.81	3.58	3.36	3.14	2.91	2.69
NE533	3.81	3.58	3.36	3.14	2.91	2.69
NE536	7.31	6.88	6.45	6.02	5.59	5.16
NE537	7.53	7.09	6.65	6.20	5.76	5.32
NE540	2.16	2.04	1.92	1.80	1.68	1.56
NE555	.98	.93	.88	.83	.78	.73
NE560	3.57	3.36	3.15	2.94	2.73	2.52
NE561	3.57	3.36	3.15	2.94	2.73	2.52
NE562	3.57	3.36	3.15	2.94	2.73	2.52
NE565	3.57	3.36	3.15	2.94	2.73	2.52
NE566	3.57	3.36	3.15	2.94	2.73	2.52
NE567	3.57	3.36	3.15	2.94	2.73	2.52
N5111	.90	.86	.81	.77	.72	.68
N5556	1.87	1.77	1.66	1.56	1.46	1.35
N5558	.80	.76	.72	.68	.64	.60
N5595	3.40	3.20	3.00	2.80	2.60	2.40
N5596	1.87	1.77	1.66	1.56	1.46	1.35
709	.42	.40	.38	.36	.34	.32
710	.42	.40	.38	.36	.34	.32
711	.44	.42	.40	.37	.35	.33
723	1.00	.95	.90	.85	.80	.75
733	1.90	1.80	1.70	1.60	1.50	1.40
741	.44	.42	.40	.37	.35	.33
747	1.05	.99	.94	.88	.83	.77
748	.48	.46	.43	.41	.38	.36
TRANSISTORS & DIODES						
1N270	.15	.14	.13	.12	.11	.10
1N751A	.30	.28	.26	.24	.22	.20
1N914	.10	.09	.08	.07	.06	.05
1N4001	.10	.09	.08	.07	.06	.05
1N4002	.11	.10	.09	.08	.07	.06
1N4003	.13	.12	.11	.10	.09	.08
1N4006	.15	.14	.13	.12	.11	.10
1N4154	.15	.14	.13	.12	.11	.10
2N3860	.25	.23	.21	.19	.17	.15

All IC's are supplied in 8 , 14-, 16-, or 24 pin DIP (Dual-in-line) plastic or ceramic package except for NE533, NE536, NE537, and NE540 which come in TO 5 package.

We give FREE data sheets upon request, so ask for those data sheets that you NEED, even for those listed IC's that you are not buying. On orders over $25.00 we'll send you a new 270-page COMPLETE TTL IC data book FREE. Or, you may obtain a new 240-page LINEAR data book instead. Orders over $50.00 will receive both books. Orders over $100.00 will receive a complete LIBRARY of DIGITAL & LINEAR data & application books totaling 1,000 pages FREE. PLEASE NOTE: Data books are shipped separate from your order. Please allow two weeks for delivery.

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3. Plug-in Module.
4. Molex Sockets for all IC's and Readout.
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6. Your choice of 1 to 6 decades on one P. C. Board.
7. Grouping of 2 or more readouts on the same display board.
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9. Up/Down counting and counter preset functions available with 74192.
10. 60 MHZ typical toggle rate with 74196.
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12. First in a series of Universal plug-in modules: for frequency counting, time measurements, event counting, DVM, magnitude comparison, etc.
13. P. C. Boards only are available for $3.00 per decade.

Price (Per Decade):

Basic Unit consisting of 7490, 7447, Filament-Type 7-Segment Readout. $9.00

Options:
For LED Readouts instead of Filament-Type, add $2.00
For 7475 Latch, add $1.25
For 74176 instead of 7490, add $0.50
For 74192 instead of 7490, add $1.00
For 74196 instead of 7490, add $0.75
For Fully assembled and tested unit, add $2.50

LED 7-SEGMENT DISPLAY

$4.95 Each

50-99	*$4.75*
100-999	*$4.50*
1000-	*$4.25*

Large ¼" 7-segment LED readout similar to the popular MAN-1 but with improved brightness. Has left-hand decimal point. Fits in a DIP socket. Expected life: Over 100 Yrs. Regularly $12.95 in single Lots. These are BRAND NEW with full data sheet and 4-page MULTIPLEXING Application Note. Needs a 7447 for driver and ONE CURRENT-LIMITING RESISTOR PER SEGMENT. We can supply you with one or ten thousand FROM STOCK. Also available, ±1 OVERFLOW digit at the same prices. Mixing of Regular & Overflow digit allowed.

Package of 8, ¼W Limiting R's .... 30¢

Incandescent Type of 7-segment display. With right-hand decimal point. Rated 8mA per segment at TTL supply of 5V. Design life of 50,000 hours. Needs a 7447 as a driver. In DIP Package. Each $3.25

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100 for $1.00; 200 for $1.80; 300 for $2.60;400 for $3.40; 500 for $4.20; 600 for $5.00;700 for $5.80; 800 for $6.60; 900 for $7.40;1000 for $8.20. Each Additional 1000 $7.50

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EACH .... 10¢ 0.02μF. EACH .... 12¢
0.01μF. EACH .... 11¢

LOW VOLTAGE DISCS, Type UK.
1.0 μF, 3V .... 25¢ 2.2 μF, 3V .... 30¢
0.1 μF, 10V .... 12¢ 0.2 μF, 10V .... 20¢
0.47μF, 3V .... 25¢ 0.01μF, 16V .... 10¢

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

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More Details? CHECK—OFF Page 110

THE EIGHTH ALEXANDER VOLTA RTTY DX CONTEST. 14.00 GMT December 2 to 20.00 GMT December 3, 1972, in the 3.5-7-14-21-28 MHz amateur bands. Messages: check (RST); zone number. Contacts: once on each band; additional contacts with same station if different band is used. Two-way contacts with stations in one's own zone two points; with stations outside one's own zone the points stated in the Exchange Points Table. A multiplier of one for each Country contacted. A separate multiplier for the same country if different band is used. ARRL Country-list except KL7, KH6, VO to be considered as separate countries. Scoring: total exchange points times number of multipliers. Use one log for each band. Free log forms and score sheets available on request from: SSB & RTTY Club, Box 144, 22100 Como (Italy). The contest is valid also for SWL RTTYers. Logs must be received not later January 20th 1973, and go to: Prof. Franco Fanti il LCF Via Dallolio 19-40139 Bologna (Italy).

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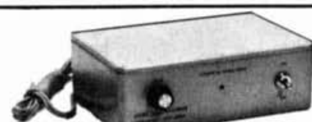

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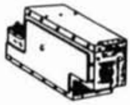

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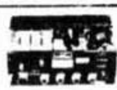

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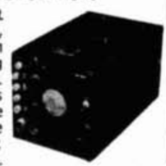

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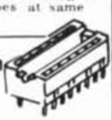

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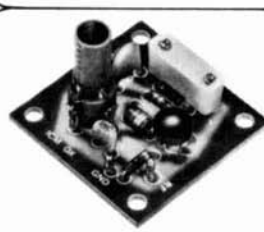

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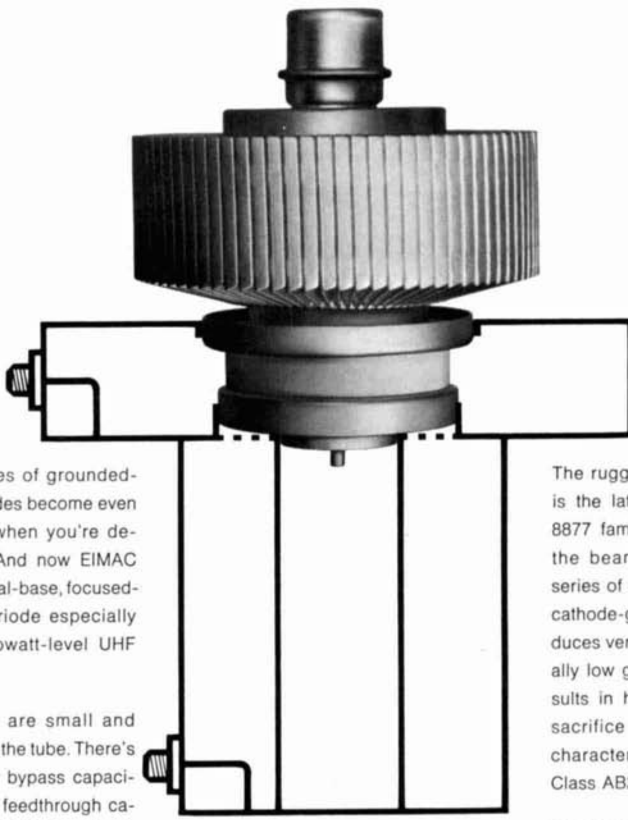

All the advantages of grounded-grid, high-mu triodes become even more important when you're designing at UHF. And now EIMAC introduces a coaxial-base, focused-beam, high-mu triode especially designed for kilowatt-level UHF applications.

At UHF, cavities are small and closely coupled to the tube. There's no room for bulky bypass capacitors, rf chokes, or feedthrough capacitors. With the 8938 in cathode driven (grounded-grid) service, there's no need for the grid circuit bypass capacitor; and no need for screen capacitors, bias or screen power supplies and associated decoupling circuitry. The internal tube structure is simple and the surrounding circuitry is much less complicated.

The rugged, ceramic/metal 8938 is the latest addition to EIMAC's 8877 family of tubes. Because of the beam focusing action of a series of strip electron guns in the cathode-grid region, the 8938 produces very high mu with exceptionally low grid interception. This results in high power gain with no sacrifice of low intermodulation characteristics in cathode-driven Class AB2 amplifier service.

It's one more example of EIMAC's ability to provide tomorrow's tube today. For details, contact EIMAC Division of Varian, 301 Industrial Way, San Carlos, California 94070, (415) 592-1221. Or any of the more than 30 Varian/EIMAC Electron Tube and Device Group Sales Offices throughout the world.

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