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70-cm EME update

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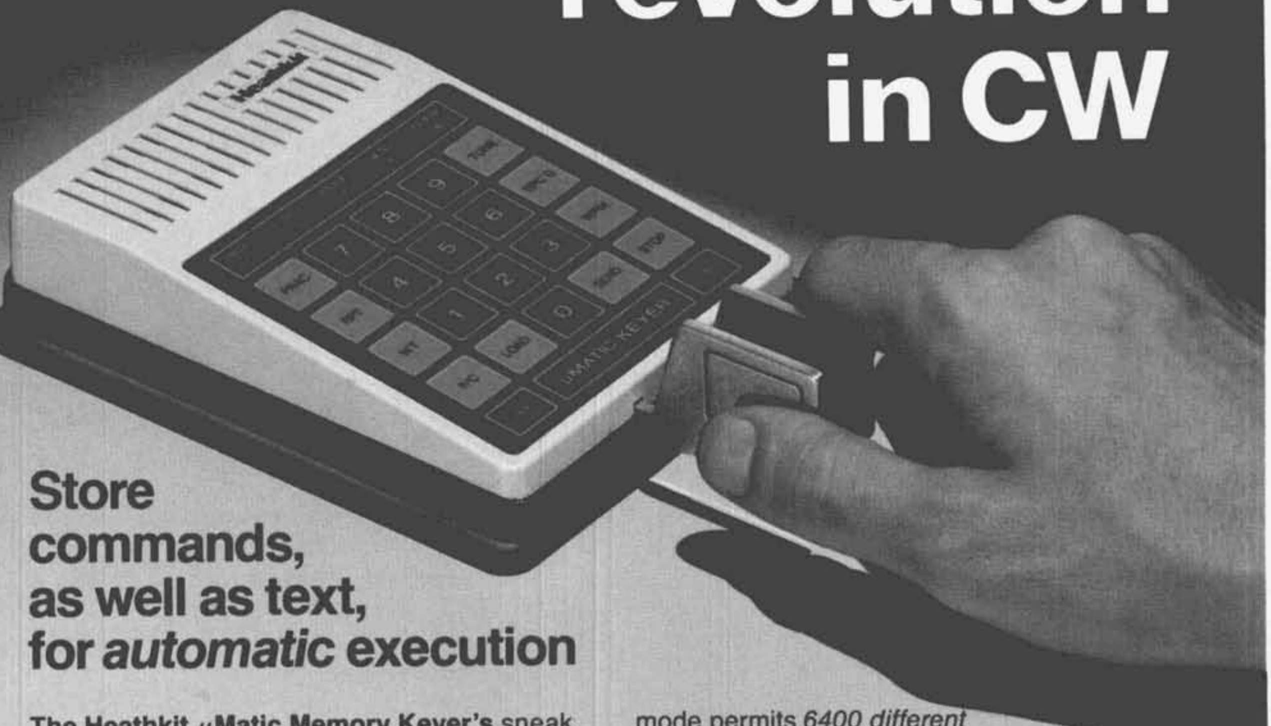
The Memory Keyer that started a revolution in CW



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New! **The very effective NB7 Noise Blanker is now standard.**

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- **CONTINUOUS NO COMPROMISE 0 to 30 MHz frequency coverage.**
- **Full passband tuning (PBT).**

New! **NB7A Noise Blanker supplied as standard.**

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New! **Standard ultimate selectivity choices** include the supplied 2.3 kHz ssb and 500 Hz cw crystal filters, and 9 kHz a-m selectivity. Capability for three accessory crystal filters plus the two supplied, including 300 Hz, 1.8 kHz, 4 kHz, and 6 kHz. The 4 kHz filter, when used with the R7A's Synchro-Phase a-m detector, provides a-m reception with greater frequency response within a narrower bandwidth than conventional a-m detection, and sideband selection to minimize interference potential.

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* Patent pending

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JUNE 1982

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contents

Observation & Opinion

Monday morning, 0500. It's early and cold. Why am I following this man?

"All right you bums. Get your lazy selves out of bed and let's get rolling!" he yelled. Now I know why. I'm in the Army again.

So began my two weeks' Reserve duty with the 39th Engineer Battalion (Combat) at Fort Devens, Massachusetts. I thought you might be interested in what communications are like in the Army these days. With all the billions of dollars that are being spent on defense you'd expect that state-of-the-art would be the byword. T'aint so!

As a captain, I was assigned to be the Assistant Battalion Communications Electronics officer. It was my job to assist the CE officer and sergeant in training their unit to do their job.

At the battalion level, communications are conducted by two basic means: 30-75 MHz fm radio and wire. Since we were detached from our brigade we also had RTTY, or RATT in military jargon. It was our mission to provide all communications that are necessary to accomplish the battalion's assigned task.

Fm radio is probably the most widely used mode of intra-battalion communications. It's easy to install and operate, and it gives you a tremendous amount of flexibility. But because it is radio, it is easy to locate and interfere with. You can encode signals to keep unauthorized reception to a minimum, but you still are using a transmitter. With radio-location a fairly sophisticated art, fm radio is vulnerable to being compromised (translation: destroyed, you and your radio).

The equipment is of fairly modern design. The basic vehicular radio is the RT-524. The RT-524 is an air-cooled, wideband fm transceiver that covers 30-75 MHz. The RT-524 is a fairly bulky radio, about the size of a small suitcase. It's of hybrid design using tubes and transistors. It's also built to take a fair amount of abuse and keep on cooking. You can switch the output to either low power (about 2 watts) or high power (25 watts). It uses either a PL or noise squelch circuit. Signals can be encrypted, but that is more the exception than the rule here in the U.S. Operating these radios is just like being on 2 meters. Range is basically line-of-sight, usually 5-15 miles depending on terrain and other variables.

Would you want to buy one? If you got one at a super cheap price, sure. Otherwise, the more compact equipment available on the Amateur market today is much more cost-effective and useful for Amateur work. I don't know the exact purchase price of the radio, but it is well over $10,000.

Telephone communications hasn't changed much over the last forty years. Wire is still hard to install and a pain to maintain. Usually it is used when you are going to stay in one place for a while. It's just too hard to lay wire, install phones, and connect a switchboard while you're on the move. It can be done, but it's very taxing to put it in one minute and then rip it out soon after.

The real problem with wire comes after it's been installed. Jeeps and trucks seem to have "wire magnets" that draw them to locations where wire is. Invariably, when wire is in place someone will run a vehicle through it and tear it up. This necessitates walking the line searching for the break and then repairing it. That's not bad on a sunny summer afternoon, but it's a real stinker when you have to tramp through the pucker brush on a rainy, pitch black night.

The basic military telephone, the TA312, has been around for years. It's nothing fancy but it's built like a brick. It runs off two D-cell batteries. To ring, you hand crank a 105-volt pulse down the line. At the terminating point we have an SB-22 switchboard. This equipment is reminiscent of the old pictures of Ma Bell's operators sitting behind racks of jacks using plugs to connect the various circuits together. It's the same way in the Army today. When things get hot and heavy, you will find the operator with arms flying all over the place to keep everyone hooked up. It is a sobering experience for anyone who thinks he can handle a pressure situation. Ma Bell's operators of years gone by deserve a round of applause for having been able to handle it day in and day out.

(Continued on page 47.)

Introducing incredible tuning accuracy at an incredibly affordable price: The Command Series RF-3100 31-band AM/FM/SW receiver.* No other shortwave receiver brings in PLL quartz synthesized tuning and all-band digital readout for as low a price.† The tuner tracks and "locks" onto your signal, and the 5-digit display shows exactly what frequency you're on.

There are other ways the RF-3100 commands the airways: It can travel the full length of the shortwave band (that's 1.6 to 30 MHz). It eliminates interference when stations overlap by narrowing the broadcast band. It improves reception in strong signal areas with RF Gain Control. And the RF-3100 catches Morse communications accurately with BFO Pitch Control.


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†Based on a comparison of suggested retail prices.

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comments

transceiver tuning

Dear HR:

Before the advent of today's transceivers, Amateurs used superhet receivers with a separate beat-frequency oscillator (BFO) whose frequency could be varied above and below the intermediate frequency. In this way, an audio beat note could be obtained by either tuning the BFO above or below the i-f. The pitch of the beat note could be varied to suit one's taste. Later designs included crystal or other filters to eliminate one of the potential beat notes on one side caused by a near-frequency interfering signal. Receivers using this system were known as "single-signal" superhets.

Present-day transceivers use the single-signal filtering system to a degree of refinement wherein only one beat-frequency sideband will be used in the receiver. For CW, beat notes are provided at a single, not-readily adjustable frequency: 800 Hz, for example, in my Kenwood TS-180S. (I would like a panel control to adjust this frequency in accordance with my day-to-day or even hour-to-hour taste. Most, if not all transceivers, do not supply such a capability.)

Back to the modern transceiver — in this case the Kenwood TS-180S. The instructions state: "Tune the receiver to the desired incoming signal to obtain an 800-Hz beat note. The transmit frequency is now automatically zeroed to the received signal." This confused me (and others) at first, since upon pressing the key, the digital readout increased by 800 Hz. But on thinking about it, I realized this is normal and correct.

Fig. 1 helps to explain the operation. The receiver is tuned to an incoming signal to obtain maximum response at 800 Hz (or other frequency, depending on the beat frequency selected by your transceiver). The receiver will be actually tuned (as indicated by the dial and digital readout) to a frequency 800 Hz lower than that of the incoming signal. There is no loss of received signal strength, since the signal is still within the i-f passband.

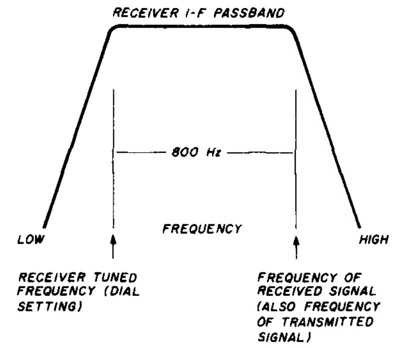

fig. 1. Relationship of dial setting and received (or transmitted) frequency in modern transceivers.

Keying the transceiver provides 800-Hz offset in the direction of higher frequency, thus transmitting a signal that is at the same frequency as the received signal. This makes it easy for the other operator to receive your signal. He can, of course, vary his receive beat frequency (as you can) by using the Receiver Incremental Tuning (RIT) control, which does not affect transmit frequency. This helps in avoiding chasing each other around an initial frequency. If at least one of the two operators uses his RIT, then, once settled, there will be no further need to adjust frequency by either one.

I'm not sure whether there is industry agreement on which sideband to select for use in the CW mode, but it wouldn't make any difference. A technique for using the sideband other than that used in the TS-180S would be to tune the receiver to a higher frequency (by 800 Hz or so) than the received frequency.

Finally, if I had my druthers, this is what I would like:

1. CW pitch variable with a front panel control. It should not vary either receive or transmit frequency.

2. The receive and transmit frequency should be at the *same place on the dial*, as indicated by the analog and digital readouts.

G.W. Legel, N6TO
Fullerton, California

CW nets

Dear HR:

Because of my interest in public service and CW operation, I have compiled a list of groups that operate on Novice/Technician high frequencies (80 through 10 meters) at slower speeds and welcome newcomers. This list is referenced to time (UTC) and contains information involving day(s) of session(s), frequency (kHz), net name and abbreviation, net manager, area of coverage, and purpose of operation.

The list is available from me for an SASE.

Mike Adams, N4EVS
Route 4, Box 764
Panama City, Florida 32405

cancer warning

Dear HR:

In your January, 1982, issue, on page 82, there is an article by Robert Wheaton, W5XW, on metal cleaning. He lists the active ingredient as thiourea.

Well, thiourea is listed in the publication *Cancer Causing Chemicals* by N. Irving Sax (Van Nostrand Reinhold Co., New York, 1981). I think you should warn your readers about its use.

Normal Wells, K6YPD
Inglewood, California

presstop

THE PHASE III-B LAUNCH has been delayed for at least two months. A problem with the MARECS-A, put into orbit by the European Space Agency on board Arianne LO-4 a few months ago, is the cause of the delay. A plasma ring has developed around the satellite, causing a corona discharge and seriously impairing the satellite's operation. The E.S.A. ordered the freeze on future Arianne launches to give its scientists time to investigate the cause of the problem and find a solution.

It Is Believed that an out-gassing effect from the MARECS could be the cause but scientists want to be sure. The launch date for Phase III-B may slip even further, as it's expected that many of the E.S.A.'s other customers will be vying for preferred launch dates on a revised schedule now being prepared by that agency. Phase III-B was scheduled to be placed into orbit on board Arianne LO-6 in late July, but it now must wait for a new launch commitment.

JAPAN WANTS TO ESTABLISH reciprocal operating privileges. Their Ministry of Post and Telecommunications has sent letters to twelve nations requesting information it will then use to formulate plans for operating agreements. The countries approached are Australia, Brazil, Canada, Finland, Germany, Great Britain, Ireland, New Zealand, Norway, Sweden, Switzerland, and the United States.

THE ITU REGION I MEETING was a total success, according to ARRL General Manager Dave Sumner, K1ZZ. While complete details of the April 1st meeting which took place in Manila are not yet available, Sumner says that many important issues were agreed upon. Region 2 was well represented by Victor Clark, W4KFC; Dick Baldwin, W1RU; Carl Smith, WØBWJ; and Noel Eaton, VE3CJ.

THE NEW GENERAL RADIOTELEPHONE operator's license, which replaced the old 1st and 2nd Class licenses, now has a new test as well. The Commission has combined the necessary test elements into one examination to eliminate the need for three separate tests. To obtain the GRT license, an applicant must pass an exam of the same difficulty as that of the old 2nd Class test.

A CODE-FREE AMATEUR LICENSE is still a distinct possibility some time in the near future. The Commissioners were scheduled to take up the question of creating such a new license class at their meeting last week, but action on it was deferred to some later date. No reason was given for the delay.

THE RETURN TIME PERIOD for Novice exams has been extended to sixty days from the current thirty by FCC action. This means an applicant will have sixty days in which to take the exam and return it to the Commission for grading, and it's especially helpful to clubs and schools who order the examinations in bulk for use as a final exam in Amateur Radio training courses.

THE FCC HAS TAKEN ACTION against a licensee in the Grizzly Peak jamming case. Donald E. Gilbeau, N6OZ, has had his station license revoked and his Extra Class operating privileges suspended for what the Commission alleged to be his jamming of the Grizzly Peak repeater in California's northern Central Valley. N6OZ was one of a number of hams charged by the FCC with malicious interference and jamming of the system over one and a half years ago. In May, 1980, N6OZ was monitored by an FCC engineer of the San Francisco field office transmitting "random words, Morse code, and unintelligible sounds" on 146.22 MHz, the input frequency of the repeater. At his show cause hearing last year, N6OZ claimed that all but one of the alleged transmissions were accidental. The administrative law judge who heard Gilbeau's case found otherwise; he agreed with the Private Radio Bureau's contention that Gilbeau's claim was false, and that "any leniency that Gilbeau's long, previously unblemished record as an Amateur might warrant was outweighed by the attempt at deception." The findings in the N6OZ case are the first of many expected in the Grizzly Peak matter.

THE PERSONAL COMMUNICATIONS FOUNDATION seeks data on CATV RFI for their legal library. As they've done in the past with tower and antenna ordinances, they intend to collect information on this subject for Amateurs involved in cable TV RFI problems. Information should be sent to The Personal Communications Foundation; c/o Astor & Merdler, Attorneys; 9036 Reseda Boulevard; Northridge, California 91324; attention: Joseph Merdler, N6AHU.

TWO SECTIONS OF THE RULES have been deleted. Part 97.74, which required a licensee to provide for measurement of his transmitter carrier frequency, and Part 97.71, which required an Amateur to use an adequately filtered DC supply on any transmitter operating below 144 MHz, were both deemed antiquated by the Commission. They feel that Amateurs realize both are simply good operating procedures, and so deleted the language in keeping with the FCC's policy of simplifying regulatory procedures in all services it supervises.


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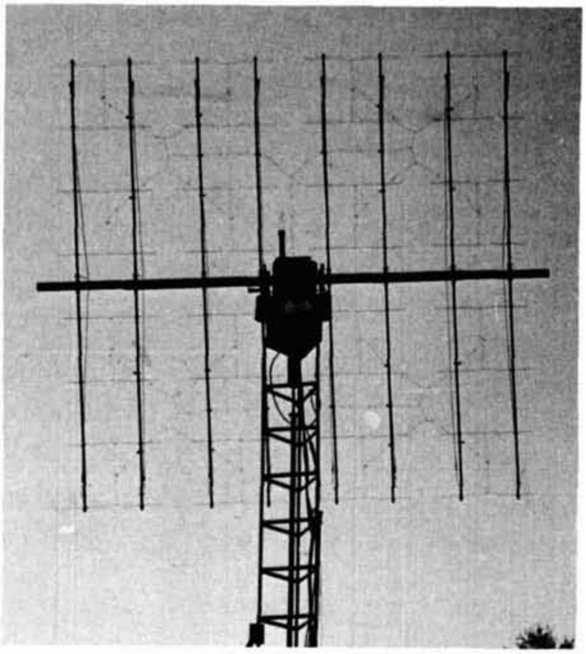
An overview of what's needed for 432-MHz moonbounce operation



This photograph was taken by W1OG while the author was in contact with YV5ZZ on 70-cm EME in July of 1977 at 2300 UTC. Note moon in lower right quadrant. Antenna is a 128-element extended, expanded collinear array (reference 12).

requirements and recommendations for 70-cm EME

Seventy-centimeter EME has really matured since my report in 1973.[1] EME contacts are now routine, with many stations having worked all continents and over twenty-five DXCC countries. By 1980 over 150 different stations had reported two-way contacts, and two-way SSB contacts were quite common. Three stations now have a WAS on 70 cm and others are not far behind. This would have been impossible on 70 cm without EME.

The basic requirements outlined in my original report still stand. However, the state of the art has advanced a great deal since then, and I think it's about time to update the recommended equipment list, consolidate most of the material in one place, and provide a list of selected references on the subject.

While all these improvements were becoming available, many 70-cm EMEers have tried to outdo each other by building larger and more efficient antenna systems than are required to hear their own echoes. As a result, newcomers now can make contacts even if their station is only marginal (not quite capable of hearing one's own echoes). The block diagram in **fig. 1** gives the overall system picture, and you can refer to it as I describe each element in a typical 70-cm EME system.

minimum requirements for 70-cm EME

The ideal plan is to build a station that gives you the capability to hear your own echoes. This will allow you to have a built-in test facility, since you will

By Joe Reisert, W1JR, 17 Mansfield Drive, Chelmsford, Massachusetts 01824

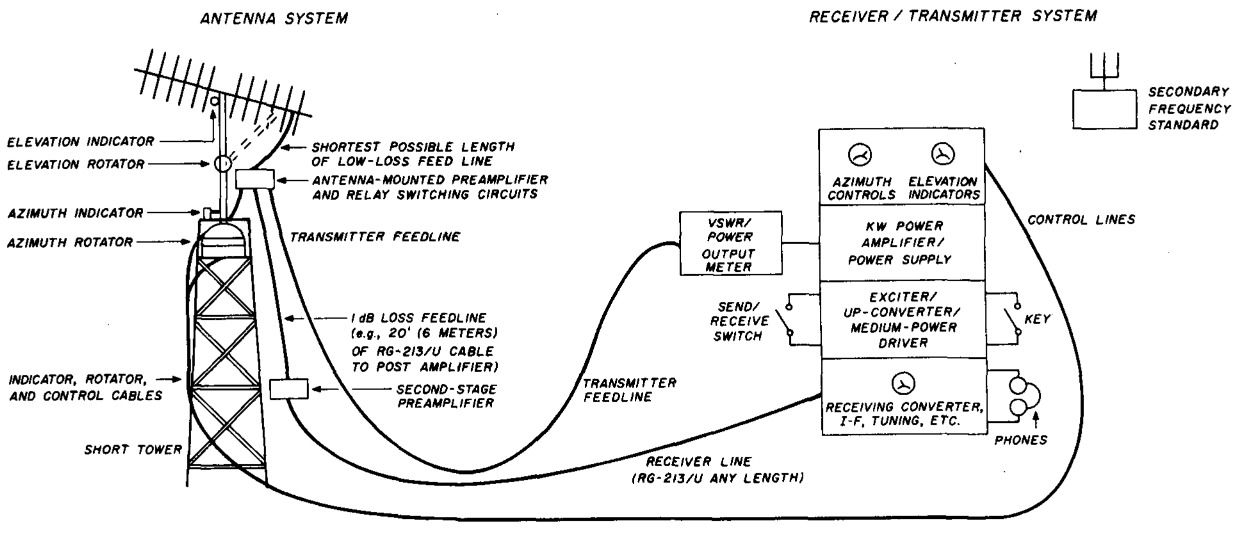


fig. 1. A typical 70-cm EME installation.

be able to evaluate system changes and improvements by echo testing. Based on a 0-dB signal-to-noise ratio and no Faraday rotation (a change in polarization that occurs when a VHF/UHF signal passes through the ionosphere), the following requirements apply:

1. Path loss, 262 ± 1 dB.*

2. Minimum antenna gain, 25 dBi (gain over an isotropic radiator).†

3. Maximum receiver noise figure, 2 dB (referenced to the antenna feed point).

4. Minimum transmit power, 500 watts output (at the antenna feed point).

5. Receiver bandwidth, 500 Hz.

antennas

The most important piece of equipment in an EME station is the antenna system. This is true because the antenna is present in both the received and transmitted paths. Hence a 1-dB antenna gain increase will yield a 2-dB system improvement. It is also desirable that the antenna radiation pattern be as clean as possible. Rear and side grating lobes (lobes that result when you stack identical antennas) should be at least 13 to 15 dB down from the main lobe, and 15 to 20 dB is preferred. A good, clean pattern means that all transmitted power is aimed at the moon and that extraneous noise sources are not picked up by the receiver.

Parabolic antennas. These antennas, with dish diameters of 18 to 40 feet (5.5 to 12 meters), the minimum recommended for 25 dBi gain, are very popular on 70 cm EME. They have a f/d (focal length to diameter) ratio of 0.45 to 0.55. If properly designed, they provide high gain and they are very quiet on receive. They have the extra advantages that they are easily adapted to adjustable polarization feeds (to offset Faraday rotation) and they are usually usable on other frequency bands (for example, 23 cm) by simply changing the feed system. Some stressed dishes[2,3] are in use, but trussed rib designs[4,5] are recommended for improved performance and durability.

Properly feeding a parabolic dish is the secret to success. The most popular and efficient feed for dishes having f/d ratios of 0.45 to 0.55 is the EIA (Electronics Industries Association) dual-dipole reference standard.[4,6] K3BPP has designed a similar feed system,[7] which provides both horizontal and vertical polarization for instantaneous polarity change or circular polarization. It is important to remember that the overall efficiency of a parabolic dish is typically 50 to 55 percent at best.

Yagis. Yagi arrays are also very popular, since such an array is usually smaller than a dish of equivalent gain and is less of a problem to maintain in severe weather areas. The WØEYE Yagi[8] is very popular among homebrewers. It is important that this and

*The one-way path loss to the moon is approximately 197 dB at 70 cm. The moon's surface has a gain of 132 dB as a passive reflector at 70 cm. Hence the round-trip loss is $197 + 197 - 132 = 262$ dB.

†An isotropic antenna is an imaginary mathematical model that radiates power equally in every direction. Generally speaking, a dipole has a gain of 2.14 dB over an isotropic antenna.

other designs be duplicated exactly as shown by the designer to achieve optimum performance. Several persons have taken the liberty of adding extra elements or making other changes to this or other designs only to find out that gain dropped. *Changes should never be made unless adequate testing facilities are available to verify the performance after modification.* Eight of these Yagis properly built will be capable of marginal EME, but sixteen will be quite acceptable. The best stacking distance seems to be about 4-1/2 feet (1.37 meters) in the *E*-plane (horizontal) and 4 feet (1.22 meters) in the *H*-plane (vertical). Other Yagi designs are also available.[9] The quagi, a Yagi with a quad reflector and driven element,[10] is also in use and is inexpensive to build but has 1-dB less gain than claimed. Spacings similar to the WØEYE Yagi are recommended for a quagi array and a minimum array of sixteen quagis is suggested to those interested.

Excellent commercial antennas are now available such as the F9FT twenty-one-element array on a 15-foot (4.5-meter) boom and the K2RIW nineteen-element on a 13-foot (4-meter) boom. Eight of these antennas in an array (four wide and two high or vice versa) spaced at 5 feet (1.5 meters) in the *E*-plane and 4-1/2 feet (1.4 meters) in the *H*-plane will deliver very acceptable performance, while sixteen will put you in the big league. The K2RIW Yagi has recently gone out of production, but a similar design, the TAMA SST-0719, is being imported from Japan and sold by Lunar Electronics.* The K2RIW nineteen-element Yagi has been widely duplicated by home-brewers.†

Other configurations of antennas are also usable.[11] The extended expanded collinear array[12] with 128 elements has been used by several 70-cm EMEers. Additional improvements to this design are available from the author (see note 1 in reference section). It is low in cost, easy to build, and relatively broadbanded, (meaning fewer mechanical tolerance problems). It can be easily set up for polarity rotation. Another choice would be an array of from sixteen to thirty-six, 1-2.2 wavelength long Yagis.[9]

Some closing remarks about antenna systems may be in order (also refer to the system checkout section of this article). High antenna gain implies narrow beamwidths. A 25-dBi-gain antenna will have a half-power beamwidth that will be no greater than 12 degrees (and probably much less) in at least one of the planes. Higher gain antennas will be commensurately narrower. Since gain is so important, it is desirable to keep the antenna aimed within its 1-dB beamwidth, which would be less than 6 degrees. With moderate gain (25-dBi) antennas it is necessary to re-aim your antenna only every 10 to 15 minutes. Beginners can easily do this by using setting circles and going outside to re-aim the antenna when required. It is desirable, however, to have a good rotator and readout for routine and continued operation.

A converted prop-pitch motor[13] with a 1.0-degree readout indicator[14] is satisfactory. Several rotator and readout systems have been published.[15] The sun and the star Polaris (for Northern Hemisphere stations) can be used for rough calibration. A carpenter's level and protractor can be very useful for accurate elevation settings.

receivers

Most 70-cm EMEers prefer to use one or more antenna-mounted preamplifiers with very low noise figure ahead of a crystal-controlled down converter located in the radio room. This is fed into a suitable high-frequency receiver. A desirable converter for EME work should have a noise figure of no greater than 3 dB with at least 15 to 20 dB of image rejection. It is now possible to build a high-quality down converter[16] with adequate filtering, a double-balanced mixer, and a clean local oscillator (a 28.1-MHz i-f is recommended using a 100.975-MHz crystal to prevent spurious beats when calibrating and to give adequate tuning range if the crystal is slightly off frequency).

The most commonly used commercial down converter is the Microwave Modules MMC-432/28S (or the MMT-432/28S transverter described in the transmitter section of this article), also usable on OSCAR. The earlier Microwave Modules converters/transverters (before the S models) had insufficient image rejection or a higher-than-desired noise figure.

Preamplifiers. Low-noise preamplifiers have come a long way in the last few years. The NEC V645 bipolar transistor has been in wide use and easily can yield a 1.0 dB noise figure. If operated in an area with high levels of rf (such as near TV or fm stations) it is susceptible to intermodulation distortion. A low-loss input filter[17] or a built-in filter[18] will help keep unwanted signals out. An acceptable commercial bipolar preamplifier using the V645 is the Lunar Electronics model PAE 432-5.

Recently, GaAs FETs have become readily affordable and available. The NEC V244, Mitsubishi MGF 1400, and the Dexel D-432 are the most popular GaAs FETs, and all are capable of noise figures in the 0.5-1.0 dB region with 18-25 dB gain. Because of the

*Lunar Electronics, 2775 Kurts St., Suite 11, San Diego, California 92110.

†Suitable insulators are manufactured by Amcraft, c/o Bob Johnson, K9KFR, Rt. 4, Road 600 N, Columbia City, Indiana 46725.

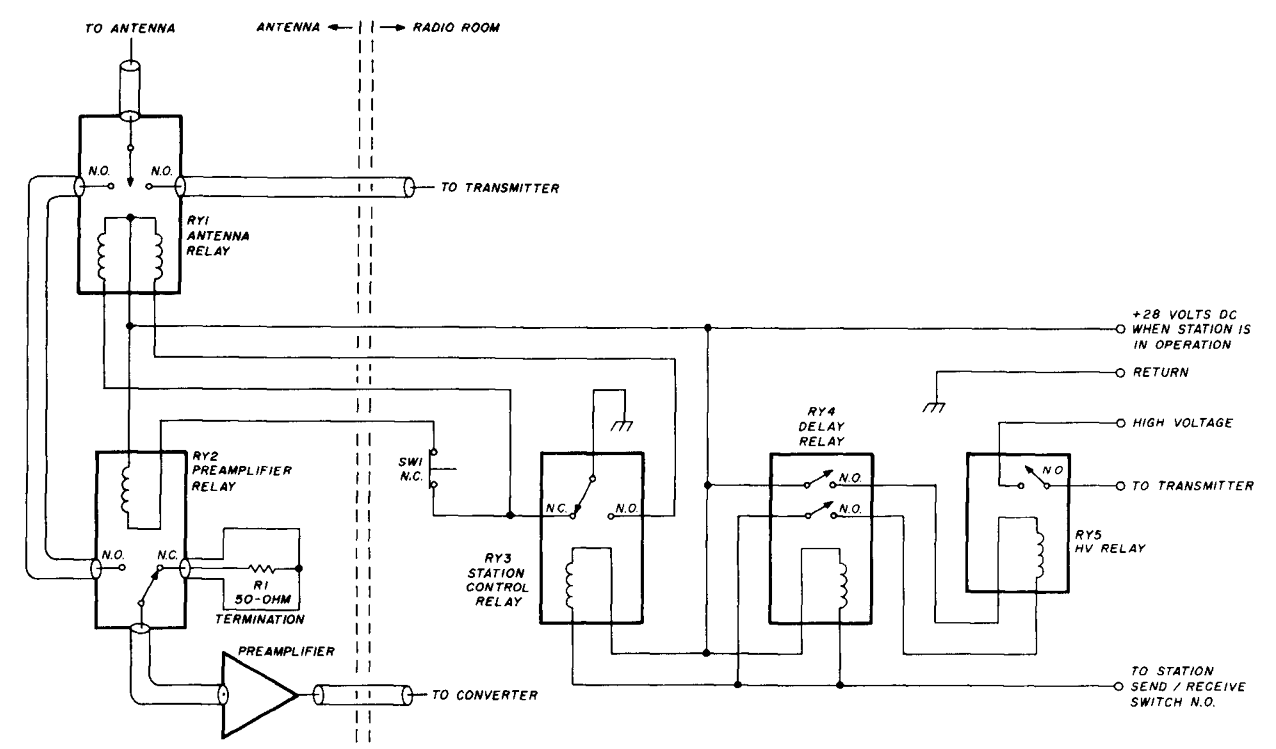


fig. 2. EME antenna relay and switching scheme (from reference 21). Resistor R1 is used to terminate the preamplifier when the latter is on standby, thus providing additional isolation from the transmitter.

higher input impedances of these devices, it is easier to design a preamplifier with a built-in input filter as part of the input-matching network. One of the most popular circuits was developed by W6PO and makes use of a D-432 with a microstrip input circuit and a bifilar-wound transformer on the output.[19] This preamplifier is now available from Lunar Electronics (Model PAG-432).

A few important things should be considered before you spend your time and money on your state-of-the-art preamplifier. I'd recommend that you first build an inexpensive preamplifier with a moderate (1.75-dB) noise figure using a device such as the Motorola MRF 901,[20] which costs less than $3.00. Use this preamplifier, antenna mounted, as your first stage until you have completely debugged your relay switching system (more on this shortly) and have successfully transmitted with full power into your EME antenna. If you do have an accident (as many others have), it will not require a very costly repair. This preamplifier is capable of receiving EME signals as is. After you are confident you have no switching or isolation problems, then you can use this preamplifier for your second stage and put your super-low-noise preamplifier ahead of it with a 1-dB-loss feedline in between (see **fig. 1**). It is also a good idea to keep a spare preamplifier handy just in case it's needed!

Isolation. The low-noise devices we have been discussing are really a breakthrough in the state of the art, and they are far less complex and costly than the parametric amplifiers used during the 1960s. They are very susceptible to burnout from transients or high (100 milliwatt or more) input power, however, and hence must be carefully protected. Never use a power supply for your preamplifier that is also used to control relays, since transients may be induced from the relay coils into the preamplifier and destroy the device. It is preferable not to exceed 1 milliwatt into the preamplifier. With an rf power level of 500 watts, this suggests that the isolation of the antenna transfer relay should be 57 to 60 dB as a minimum. The typical Dow-Key relay, even with type-N, connectors has only 30 dB receiver-to-transmitter isolation (at 432 MHz), while the Transco Y-type relay is generally around 60 dB. This is too marginal. Futhermore, preamplifiers of this type do not like to operate with a shorted or open input during transmit.

A double relay scheme (**fig. 2**) is therefore highly recommended. The preamplifier has its own separate relay (a low-power type is usually adequate) that terminates the preamplifier into a 50-ohm load during transmit and provides additional isolation from the transmitter.[21] To obtain most of the additional isolation from the second relay, the transmission line between relays RY1 and RY2 should be 0.10-0.25

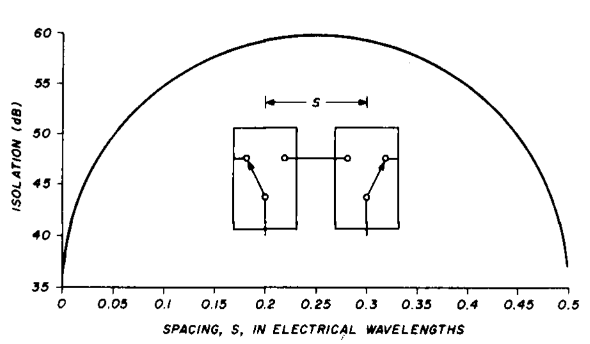


fig. 3. Approximate isolation of two relays (each 30 dB isolation) spaced by the transmission line.

wavelength (see **fig. 3**). Two relays butted closely together will exhibit only 6 dB more isolation than the best one alone.

Last but not least, the preamplifier should always be mounted as close to the antenna as possible, preferably at the central feed point. This is necessary because feedline loss does not add dB for dB to the noise figure with the cold sky (typically 20 to 70 degrees Kelvin) experienced on 70 cm. A feedline loss of 0.25 dB can degrade system receive sensitivity by up to 1.0 dB!

I-f system. The foregoing is all academic unless your i-f system is very stable (25-50 Hz short-term stability) and has slow tuning capability. Also it may be desirable to have an i-f bandwidth of 200-500 Hz for CW work with very weak signals. Special receivers are not required, as most modern receivers meet these requirements. Some operators can use wider i-f bandwidths, while others even add a narrower bandwidth filter (passive or active type) in the audio system. CW operators long ago realized that they can copy weak signals with wider bandwidths even in heavy QRM, because the human ear and brain can be trained to narrow hearing bandwidth to perhaps 20-50 Hz and vary in frequency response at will.[22]

Successful contacts also require good frequency accuracy (±1 kHz is recommended) both on the transmitter and receiver. A very stable 3 or 4 MHz accurate secondary frequency standard (calibrated to WWV) is highly recommended. On 70-cm EME, a received signal can be as much as ±1.5 kHz different from the original transmitted signal frequency due to Doppler shift (the moon is usually approaching or leaving the receiving station; hence the signal frequency varies in a manner similar to that of a moving train whistle). Echoes will be higher in frequency when the moon is east of your local longitude and lower in frequency after the moon transits your longitude. Stations should always set their transmitter to the true scheduled frequency and offset their receiver as required by Doppler shift.

transmitters

Tripling from 144 and 432 MHz is a simple way to build an exciter, but stability is usually not good enough for EME operation. It is now common practice to heterodyne a 28- or 50-MHz exciter to 432 MHz. Not only does this usually improve stability, but it also allows the use of SSB. The most common type of up converter has an output of 5-10 watts. The Microwave Modules MMT-432-28S is one of the most popular commercial types and is all solid state. It also has the desirable feature of a built-in receiving down converter.

Most present-day 70-cm power amplifiers require 25-40 watts of drive power. Many operators use a solid-state power amplifier to increase the transverter-exciter output. Several commercial units are available and most are acceptable; but one that can also be operated as a linear is desirable, since it will be easier to adjust drive level and can also be used for SSB operation. A simple amplifier with a 2C39 equivalent tube is also usable and sometimes available at a reasonable cost. One example is to use the cavity from a Motorola T-44 transmitter strip.[23]

The most popular 70-cm power amplifier is the parallel-tube stripline kilowatt using 4CX250 tubes designed by K2RIW[24] with special modifications.[25] W2GN has made additional improvements to this amplifier and stocks all the required parts necessary for construction. He will even sell a kit or an assembled and tested unit complete with power supply.* In addition, some EMEers have slightly modified the plate line on the K2RIW kilowatt and substituted type 8930 tubes for greater output and better thermal stability. Some of the keys to success are a low-impedance bias supply (1000 ohms or less) for the input grid, good low-loss sockets with built-in screen-grid bypasses and shielding (for example, the Eimac SK-620 or SK-630), a shunt-type screen regulator (VR tube) with 20,000 ohms or less resistance *from each tube screen grid to ground*, and adequate air circulation to prevent thermal drift.

The W1QWJ push-pull amplifier using 4CX250Bs[26] is also capable of high-output power, although some claim it is more difficult to get operational initially. Some recommended improvements are available.[27] ZE5JJ has further increased the output power by shortening the output loop by 1 inch (4.25 versus 5.25 inches), and using separate screen meters to monitor balance.

Some RCA type 7650 or 7651s are in use in a single-tube microstrip configuration. The larger RCA

*Fred Merry, W2GN, ARCOS, Box 546, East Greenbush, New York 12061.

table 1. Transmission-line characteristics of commonly used coaxial cable (note 1).

cable type	loss (dB) (note 3)	power handling capability (watts)	velocity of propagation factor
RG-58C/U	11.5	75	0.659
0.141 semirigid, PTFE dielectric	7.5	1000	0.75
RG-8/U (note 2)	4.75	350	0.659
RG-213/U	4.75	350	0.659
Belden 8214	4.0	350	0.78
RG-17/U	2.0	1000	0.659
1/2 inch (1.3 cm) Alumifoam, RG-231/331/U	2.0	1000	0.80
1/2 inch (1.3 cm) Heliax,* RG-366/U foam dielectric	2.0	1000	0.79
1/2 inch (1.3 cm) Heliax,* air dielectric	1.8	1000	0.914
7/8 inch (2 cm) Alumifoam, RG-332/333/U	1.4	2000	0.80
75-ohm CATV 3/4 inch (1.9 cm) polyethylene dielectric	1.1	1500	0.80
7/8 inch (2 cm) Heliax,* RG-323/U foam dielectric	1.1	2000	0.79
7/8 inch (2 cm) Heliax,* RG-318/U air dielectric	0.85	2500	0.916
75-ohm CATV 1 inch (2.5 cm) polyethylene dielectric	0.85	2000	0.80
1 5/8 inch (4 cm) Heliax,* polyethylene dielectric	0.85	5000	0.79
1 5/8 inch (4 cm) Heliax,* RG-319A/U air dielectric	0.45	6000	0.921

Note 1. These are approximate figures but good for comparison. All the data presented is for 70 cm (432 MHz).

Note 2. The RG-8/U coax produced in recent years may have higher losses than quoted. See text for further information.

Note 3. *All losses are nominal for 100 feet* (30.5 meters). Air dielectric Heliax* loss figures apply only if the cable is moisture free and is pressurized with dry air or nitrogen.

*Registered trademark of the Andrew Corporation.

7213 or 7214s have been used in some cavity amplifier designs. Others have used the Eimac 8938.[28]

feedlines

No article on 70-cm EME would be complete without a few words on recommended feedlines. *All* antenna feedline losses must be kept to a bare minimum. Yagi arrays are usually fed with the shortest possible length of RG-213/U (the current military version of RG-8/U) or Belden 8214 foam dielectric coax. The latter uses a slightly larger inner conductor (a UG-21B connector is recommended). Also the lower dielectric constant (foam versus polyethelene) is more prone to phasing variations. Some operators are now switching back to open-wire line, which is virtually lossless except during wet weather. RG-8/U coax should be avoided because it is no longer made to military specifications, and the shield coverage has been reduced. In addition, a plasticizer in the jacket will contaminate the dielectric and losses will increase with time. Larger and lower-loss coax is recommended, especially after the first power divider in a Yagi array. For comparison I have included various feedlines and their characteristics in **table 1**.

If the preamplifier is mounted at the antenna feed, its output can go to the next stage through a 1-dB-loss coax cable (for example, 20 feet, or 6 meters, of RG-213/U) to both stabilize the preamplifier and to allow it to be mounted in a more convenient place outside the antenna feed system. The losses ahead of the first preamplifier must be kept low (and should never exceed 0.5 dB). The transmitter feedline loss is on a dB-for-dB basis and should be low enough (typically 1 to 1.5 dB) to obtain the recommended 500 watts output at the antenna. One-half inch (1.3 cm) or larger hardline is definitely recommended, and air dielectric Heliax™ (if you can afford it) is preferred but must be pressurized with dry air or nitrogen if its low-loss properties are to be maintained. Recently there has been a surplus of large (3/4-1 inch or 1.9-2.5 cm) 75-ohm foam dielectric CATV feedline. This is definitely usable if suitable impedance transformers[29] and connectors are obtainable.

scheduling

Seventy-cm EME schedules are usually conducted between 432 and 432.05 MHz and are thirty minutes in duration with most westerly station (with respect to the international date line) transmitting the first 2-1/2 minutes of each five-minute period. *The last thirty seconds of each transmitting period is reserved exclusively for signal reports. Do not transmit during this time if you are not sending a signal report.* The reporting system is quite similar to meteor-scatter procedures. The letters T-M-O are used, with T meaning detectable signal or letters, M meaning the call signs have been positively identified, and O meaning signals are Q5 copy. For a valid contact, both stations must send and receive an M or O plus a receipt acknowledgment (an R or roger). Schedules are coordinated through the 70-cm EME net, which meets from 1600 to 1700 UTC every Saturday and Sunday on 14.345 MHz, or through the various schedule coordinators, who are published in the 70-cm EME newsletter.* Most activity takes place on the weekend when the moon is nearest perigee (closest to the earth) and at positive delination (north of the earth's equator), excepting the new moon. Additional information on scheduling and locating the moon has also been published.[30,31]

system checkout

Now that you are all ready, you're probably asking yourself, "How do I know it's all working?" If you have followed all the above and have a station that meets the minimum recommended requirements, you may try echo testing. The round trip time for the EME path is just over 2.5 seconds, so letters or long dahs can be sent and listened for (don't forget to compensate for Doppler shift on your receiver). Hearing echoes is great, but don't be discouraged if you do not hear signals right off. Be patient! The Faraday rotation may not be right. It may take hours for the correct polarization to occur and could be longer during the nighttime when ionization changes at a slow rate. Better yet, set up a schedule and see if you or the other station hear each other.

Other tests can and should be conducted to verify system performance. First, measure your transmitter output power and antenna VSWR *at the feedpoint.*

*The 70-cm *EME Newsletter* is published monthly by Allen Katz, K2UYH, 326 Old Trenton Road, RD 4, Trenton, New Jersey 08691. A sample copy is available for a business sized (No. 10) envelope with 1 ounce postage.

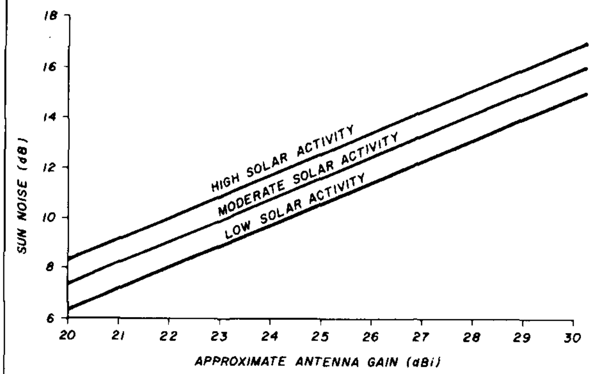


fig. 4. Approximate antenna gain as a function of sun noise referenced to cold sky. Frequency is 432 MHz, noise figure is approximately 1 dB, and side/grating lobes are less than − 13 dB.

Caution: Do not stand in front of the antenna with transmitter power applied, since your body may absorb hazardous levels of rf radiation.

The sun is a convenient signal source for testing receiver sensitivity as well as antenna gain. **Fig. 4** has been prepared only as a crude guide to assist you in this test. First set your receiver to the CW/SSB mode, remove the AGC and noise limiter and select a wide (2 or 3 kHz) bandwidth. Then measure the receiver audio output with a dB meter while making sure the receiver system is not in compression. Next aim your antenna to a cold spot in the sky; that is, away from the sun, local objects, the ground, or the galactic plane, and note the dB meter reading. Then aim your antenna at the sun and peak for maximum sun noise (note: maximum noise should be right on boresite. If not, you may have antenna phasing errors.) For example, with a reasonable noise figure and an antenna-mounted preamplifier (as described earlier) and moderate solar activity (1981), a 25-dBi antenna should yield about an 11-dB noise increase between the cold sky and the sun. It is best to compare your measurements with a similar station on the same day and time for better accuracy. Note that when the sun drops below 10 dB, it no longer drops in a linear fashion.

summary

I have tried to cover a lot of bases and naturally I have probably missed some. Many of us have spent five or ten years or more, and a lot of time and money, trying to perfect our stations and operating techniques. The purpose of this guide is to help you avoid some of the pitfalls by telling you things that have worked for other 70-cm operators. There may be other ways to go, but I believe this information is the path to success with the least number of problems. I would particularly like to thank Lewis Collins, W1GXT, and Allen Katz, K2UYH, for their review of this article and thoughtful suggestions. Good luck. See you on 70-cm EME soon.

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Notes:

1. Requests for additional information can be made to the author but they will not be answered without an SASE.
2. This publication had limited distribution but copies are available (note 1).
3. EIMAC EME notes can be obtained by writing William Orr, W6SAI, c/o Varian, EIMAC, 301 Industrial Way, San Carlos, California 94070.

ham radio

A look at
the future of
slow-scan television

applying microcomputers to SSTV

Slow-scan television (SSTV) is a medium for transmitting still pictures via Amateur Radio. It is almost identical to facsimile in concept. The standards commonly used in Amateur SSTV are listed in **table 1**.

table 1. Amateur slow-scan standards (from the *ARRL Handbook*).

	60-Hz areas	50-Hz areas
sweep rates:		
horizontal	15 Hz (60 Hz/4)	16-2/3 Hz (50 Hz/3)
vertical	8 sec.	7.2 sec.
No. of scanning lines	120	120
aspect ratio	1:1	1:1
direction of scan:		
horizontal	left to right	left to right
vertical	top to bottom	top to bottom
sync pulse duration:		
horizontal	5 millisec.	5 millisec.
vertical	30 millisec.	30 millisec.
subcarrier frequency:		
sync	1200 Hz	1200 Hz
black	1500 Hz	1500 Hz
white	2300 Hz	2300 Hz
required transmitter bandwidth	1.0 to 2.5 kHz	1.0 to 2.5 kHz

table 2. Digital picture transmission header. Each byte contains eight bits.

item	no. bytes	code
sync vector	4	binary
receiving-station callsign	10	ASCII
sending-station callsign	10	ASCII
horizontal resolution	2	binary
vertical resolution	2	binary
colors	1	binary
luminance	1	binary
spare	2	
total	32	

This article presents some ideas on how microcomputers can be used to improve this mode of Amateur communications.

background

Fig. 1 depicts three generations of an Amateur SSTV receiving setup. In the early days of SSTV, the picture was displayed on a cathode-ray tube having a long persistence. Once the novelty of receiving pictures had worn off, the display was seen to be crude and inconvenient. The tube had to be viewed in a darkened room. The picture was updated slowly (every eight seconds) and faded rapidly. Most people, in fact, photographed the picture and viewed the photograph rather than the screen. The second generation of SSTV equipment incorporated scan converters. These are relatively expensive, but convert the SSTV pictures into a form displayable on a standard fast-scan TV monitor.

The advent of the microcomputer introduces the third generation of SSTV equipment, which will improve the capabilities of the medium by at least an order of magnitude. It will allow image-processing techniques to be used to cut down the effects of interference, and it will allow real-time color displays using a field-sequential color transmitting scheme.

Basic SSTV equipment comprises a picture source and display. Many Amateurs, when first entering the mode, purchase a display and generate a tape recording on a friend's system to use as a video source. Later, as funds permit, they add cameras, electronic pattern generators and other signal sources.

the microcomputer and SSTV

The microcomputer can be added to the SSTV sta-

By Joe Kasser, G3ZCZ/4X, Mercaz Klita 49A, Mevasseret Zion, Israel

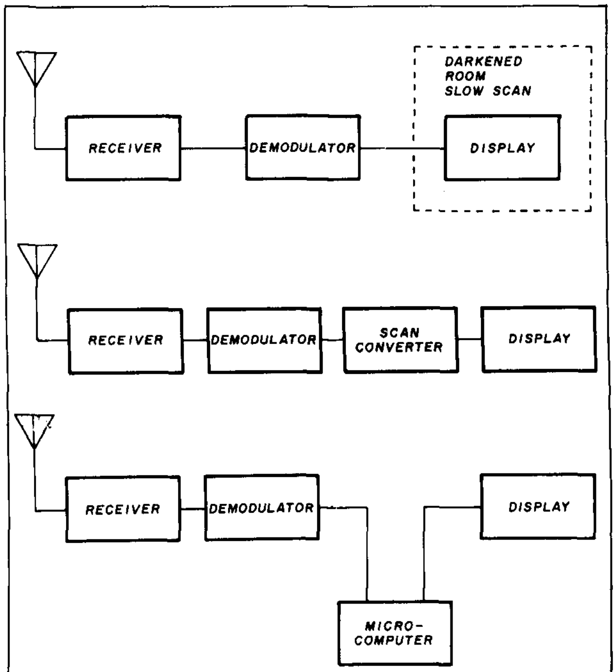

fig. 1. First, second and third generation slow-scan TV receiving arrangements.

tion in stages. It can be used to generate patterns or characters. For example, it can display any characters typed in at the console. It could digitize and scan convert incoming pictures. A picture library could be built up on floppy disks. Then, as image processing software is added, interesting things begin to happen. Initially, the use would be to compensate for interference on received signals. Simple techniques (algorithms), such as displaying the average picture received over a number of sequential frames, could be used. Gray-scale adjustments could be made. A whole picture editing system could be developed using the console or a light pen or both as control inputs.

Color could be added if three pictures (red, blue, and green) can be stored separately and combined in the display. A fast-scan display at the system console makes the pictures much more viewable. Later additions to the software could include overlaying one picture upon another, merging pictures, or merging sections of different pictures. A picture of a person could be overlaid onto different backgrounds. Composites could be built up. Data could be added to annotate the picture. The narrow bandwidth of the transmission medium, as well as the visual impact of the display when used with the microcomputer, have the potential to make SSTV as popular as SSB voice in the Amateur field. It offers new capabilities in other areas such as law enforcement, whereby pictures of suspects (stored in computers) could be transmitted via conventional VHF/UHF voice quality links.

color

Slow-scan color may be transmitted using a field sequential technique. The picture to be transmitted is separated into blue, red, and green components. Each component is transmitted as a separate picture frame and assembled at the receiving station into a color picture. The transmission of one slow-scan color picture thus requires three frames.

Transmission is quite simple because the regular station camera can be used. Color separation is performed by inserting a filter between the camera and the subject. Three filters are required: green, red, and blue. The filters can be cemented to a disk and rotated by a stepping motor, so that the disk is advanced one filter band for each field sync pulse, as shown in **fig. 2**. The more filter bands present on the disk, the fewer steps the motor must sequence to switch colors. This simple technique allows the transmission of live color pictures, but ignores the problem of the receiving station deciding which frame is allocated to which color. This problem can be resolved by always transmitting the colors in the same sequence and verbally announcing which color is coming first, or by transmitting some kind of color-reference synchronizing signal. Since color slow-scan television is still in its infancy, these standards still have to be worked out.

digital slow pictures

Videographic displays and digital communications can be merged to provide picture transmission

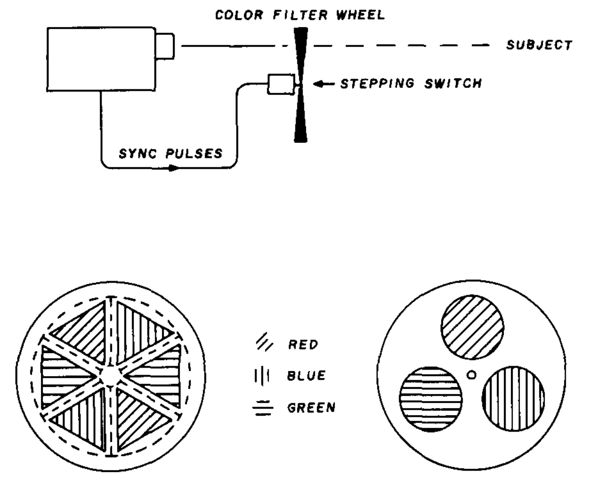

fig. 2. Color filter-wheel possibilities. Filters may be cemented onto a disk, which is rotated by a stepping motor so that the disk is advanced one filter band for each sync pulse.

capabilities. A videographic display causes the contents of a memory area in the computer to be displayed on a TV screen. The display may be color or black and white with gray scales. If the contents of a display memory in one computer can be transmitted to the display memory of another one, a picture will have been transferred.

If two Amateur Radio stations have the same video display hardware, the transfer of the contents of the video memory in one computer to the other one in effect transmits a picture from one station to the other. If the displays have 1024 x 1024 pixel resolution with color and luminance, then a very high-resolution picture can be transmitted, although at a slow rate. The majority of videographic displays at this time have resolutions of the order of 128 x 128 or 256 x 192, and so forth. Some may be color, some may be black and white, and some may be color but viewable as black and white on a black and white monitor. Now it is desirable that anyone with a graphics video display capability in his computer should be able to transmit and receive pictures if a suitable modem is available.

transmission format

The digital format of transmission means that any format could be used providing that suitable software exists. To avoid resolution problems, it is desirable that the formats be compatible with all kinds of displays, a situation that is hardly likely to occur in practice.

The digital format is really a digitized analog signal. Thus, a zero level, or a sync pulse level will always be a 00 signal and a very bright signal would always be an OFF Hex or a maximum. If signals are transmitted in consecutive lines with a header in the first line, format independent pictures can be transmitted. The header would contain the data as shown in **table 2**.

The sync vector of four bytes synchronizes the system and notifies the receiver that a header is coming. The callsigns of the sender and recipient are then transmitted in the next 20 bytes. Ten bytes are sufficient for 99.9 percent of the Amateur Radio callsigns allocated today. GW3ZCZ/KH6 is only ten bytes long, for example.

The next two bytes contain in binary code the number of pixels per line, followed by two bytes that contain the number of lines in a frame, also in binary. One byte each is allocated to color and luminance information. The color byte could be an ASCII R, G or B to signify which frame of a field-sequential color picture is being transmitted or any other information. The luminance byte contains information about how many gray levels are present in the picture. Two spare bytes are allocated at this time to bring the byte count to 32.

fig. 3. Digital line transmission format. A sync vector synchronizes the receiving-station software, the pixels are transmitted, and the sync vector is again transmitted to ensure that the receiver stays in sync with the transmitter.

picture information

A sync vector synchronizes the receiving-station software (**fig. 3**) and the pixels are then transmitted. The number of pixels is known from the header, and when the line is completed, the sync vector is again transmitted to ensure that the receiver stays in sync with the transmitter. When a whole frame has been transmitted, the sequence may stop, or another frame may be transmitted.

The picture transmission has been defined in terms of memory-to-memory transfer. If both stations have identical videographics hardware, they can display the same picture. What happens, however, if the second station does not have the same hardware as the first?

If the receiving station has hardware with the same resolution as that of the transmitting station, the same picture can be displayed. If color or luminance are the same, they will be lucky. If the receiving station does not have color, it will probably be able to display a black-and-white picture.

If the receiving station has a resolution different than that of the transmitting station, a number of choices are open. Assume that the picture being transmitted is 256 x 256 pixels, and the receiving station has a 128 x 128 display. The receiving station has a number of options. The first option is to perform some kind of signal processing on the picture data to combine two pixels in both horizontal and vertical directions to reduce the resolution of the picture. This will allow the whole picture to be displayed, but at a lower resolution. The remaining options are shown in **fig. 4**. Here a reduced area of the picture is displayed. A corner, as shown in **fig. 4A** or a middle section, as shown in **fig. 4B** may be chosen. This technique is sometimes used to zoom in on selected portions of a high-resolution picture. As the display options are in software, the receiving station has a choice of how to display the picture.

If the receiving system has better resolution than that of the sending station, similar techniques can be used either to display the picture in a part of the screen together with other desired information (such as callsigns) in the remaining portions of the screen, or the picture information can be doubled both

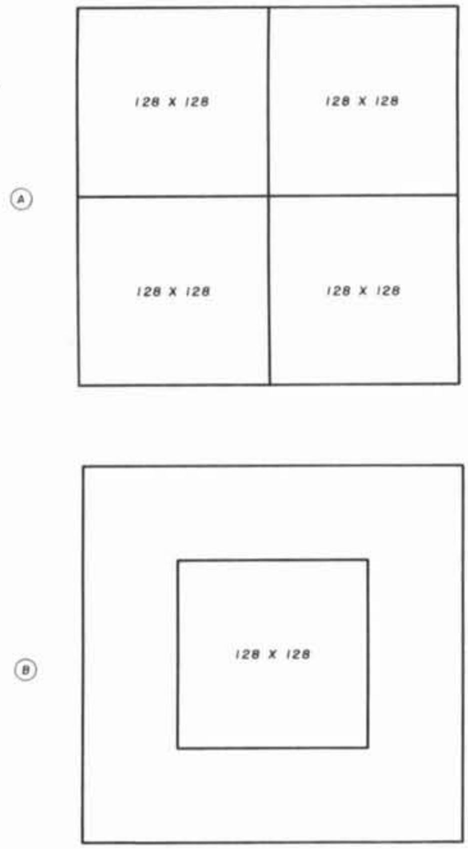

fig. 4. Lower-resolution receiving options. In this example, the transmitted picture contains 256 × 256 pixels, and the receiving station has a 128 × 128 display capability. A corner, as in *A*, may be chosen — or a middle section, as in *B*.

horizontally and vertically to fill the screen. If the receiving station has a 256 x 192 resolution for example, the choices can be applied to the vertical portion only.

The picture has been transmitted as a memory-to-memory transfer. The software in the receiving station can thus decide if processing must be performed for the display. The processing can be performed on the picture as it is received in systems with minimal amounts of memory, or the picture can be stored in memory and moved to the video display area by the processing algorithm.

The mode of transmission of the digital data can be ASCII, RTTY, or packet, depending on what is available to the users. The use of digital transmission formats for slow scan television changes the meaning of "slow," for it no longer applies to low-resolution pictures but can now refer to the slow data rate for transferring a picture of any resolution.

ham radio

the radiation of radio signals

An explanation of how a radio transmitter puts a signal into space

What, exactly, is flying around when you key your rig? How does that high-frequency alternating current in the final amplifier tank circuit manage to propagate its effects far into space? We all have a vague idea of what happens, but misconceptions abound. This article will explain, in understandable but rigorous terms, how that signal gets to bounce around the world — and, perhaps, into the receiver of a rare DX station.

the antenna system

Of course, the antenna system is responsible for putting your signal into space. When speaking of the antenna system, we refer to two components: the transmission line and the antenna. The purpose of *the transmission line*, or feed line, is to get the signal from the rig to the antenna. The purpose of the antenna is to get as much of the signal as possible into space.

the transmission line

Rare is the station that uses no transmission line between the rig and the antenna. Of those few stations with antennas that run right down to the transmitter, rare indeed is the one without "rf-in-the-shack" troubles. The antenna, in performing its function of radiating the signal, will put some of that signal right into the shack unless the antenna is far enough away. The feed line allows you to put the antenna far away from the rig, so the signal will go where it should and not where it shouldn't.

How does the feed line transfer the signal? An alternating voltage is present at the input of the line,

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and this causes alternating currents to flow in the conductors. But the actual propagation of the signal along the line is not because of these currents and voltages themselves. It is not current, or voltage, or even power, that travels along the line. It is an electromagnetic field that travels.

Fig. 1 is a "stop-action" diagram of the currents and voltages, and the resulting electric and magnetic fields, in a short section of parallel-wire feed line. The currents in the two wires are equal in amplitude, but opposite in direction. A magnetic field (M) is produced around each conductor. A voltage exists between the two conductors, producing an electric field (E). The E and M fields vary in intensity as the currents and voltages alternate, but the fields are always perpendicular to each other. You should recall from high school physics that this situation produces a unique type of energy field, an electromagnetic field (EM). EM fields regenerate themselves in a sort of "leapfrog" manner, and thus they can travel great distances with much less attenuation than can either E or M fields by themselves. The EM field travels in a direction perpendicular to both the E and M fields. From **fig. 1**, we can see that this direction runs right along the transmission line. The voltage at the line input causes an EM field to propagate down the line away from the rig. This field is restricted to the immediate vicinity of the conductors because it can travel only exactly in line with them. Hence the line does not radiate, and serves as a sort of guide for the EM field.

Fig. 2 shows what happens in a coaxial line. The E and M fields, although confined to the inside of the cable, are still perpendicular at every point. The EM field is thus produced in line with the cable. It can't escape the outer conductor, and so it is entirely confined within the dielectric material in the coax.

how fast does it move?

Electromagnetic fields travel at the speed of light — about 300,000,000 meters per second in a vacuum. Through air, they travel about 97.5 percent as fast as they do in a vacuum. EM fields travel more slowly through dielectric materials (non conductors) such as glass or polyethylene. In solid polyethylene they go about 66 percent of their speed in a vacuum; in foamed polyethylene the figure varies between 75 and 80 percent. The velocity factor for a given material is the ratio of the speed of the EM field through the material divided by the speed through a vacuum.

Since commercially prefabricated feed lines usually have either a foamed or solid polyethylene dielectric, the speed of EM fields along such lines is somewhat less than their speed in free space. In a coaxial line, all of the EM field is confined to the dielectric material. In a two-wire line, such as TV ribbon, some of the EM field travels through the dielectric and some travels through the air near the line. Thus, the

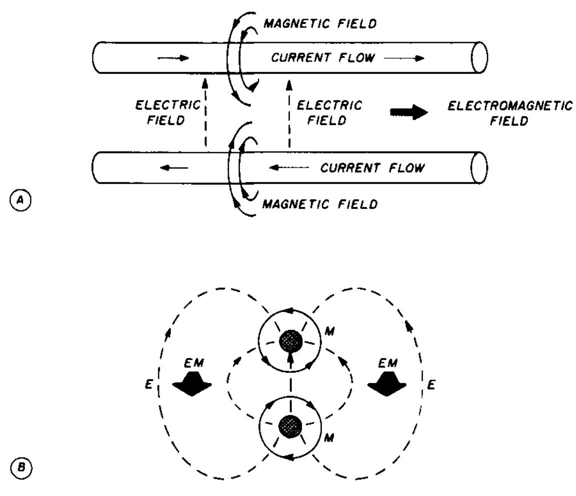


fig. 1. Generation of an EM field in a parallel-wire transmission line. Thin arrows represent currents in the conductors. The dotted line shows the electric (E) field and the curved lines show the magnetic (M) field. *A* is a side view; *B* is the view along the conductors. The heavy arrow represents the EM field, which travels along the conductors in their immediate vicinity. Because the EM field can move only parallel to the conductors, the line does not radiate as long as the currents in the conductors are equal in magnitude and opposite in direction.

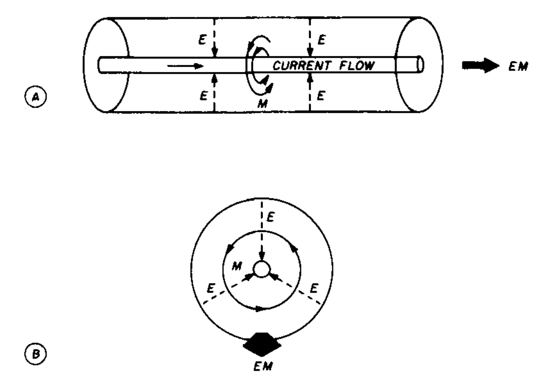


fig. 2. Generation of an EM field in a coaxial line. *A* is a side view (assuming transparent shield material); *B* is the view along the line. As in *fig. 1*, thin arrows represent current in the center conductor, dotted lines represent E fields and curved lines represent M fields. The heavy arrows show the direction of the EM field. The fields are entirely confined to the inside of the cable, assuming a solid tube of metal constitutes the shield. With braided shielding, as is used in most commercially made line, a tiny amount of the EM field "leaks out," but it is insignificant.

velocity factor for two-wire line is usually greater, for a given dielectric material, than it is for coax. **Table 1** shows the velocity factors of several common types of transmission line.

table 1. Surge impedance and velocity factor for common types of transmission lines used by Amateurs. In the line type column, SP stands for solid polyethylene dielectric and FP stands for foamed polyethylene dielectric. The term open wire refers to parallel-wire line where the dielectric is predominantly air.

line type	Z_0, ohms	velocity factor
open wire, no spacers	70 - 800	0.975
open wire, plastic spacers	70 - 800	0.95 - 0.97
RG-8/U, SP	52	0.66
RG-8/U, FP	52	0.80
RG-58/U, SP	52	0.66
RG-58/U, FP	52	0.80
RG-59/U, SP	73	0.66
TV twinlead, SP	300	0.82

characteristic impedance

Suppose, for a moment, that the transmission line extending from the transmitter is infinitely long, so that a signal will continue along it without end. Suppose also that the conductors and dielectric material have no loss, so the signal will remain at the same intensity forever. As the EM field travels down the line away from the rig, there is a certain current (I) in the conductors, and a voltage (E) across them. The product EI is equal to the transmitter output power. The ratio E/I depends on the size and spacing of the feed-line conductors, and also on the nature of the dielectric material. For a two-wire line, the ratio E/I may be as low as about 70 or as high as about 800; for coaxial line it ranges between roughly 30 and 100. The ratio E/I is called the characteristic, or surge impedance, of the line. It is abbreviated Z_0.

Of course, a real feed line has some loss. Because of loss, we will observe that both the voltage and current decrease as we get farther away from the rig. However, their ratio will stay the same, since the Z_0 of the line is constant.

Naturally, it is impossible to have a line that is infinitely long. Suppose that the line is terminated by a resistor at the far end, whose value in ohms is equal to Z_0. Then when the EM field arrives at the resistor, it will all be absorbed and dissipated as heat. This situation is encountered in practice when we connect our rigs to matched "dummy loads."

radiation resistance of the antenna

Putting a resistor at the far end of a transmission line won't do much if we want to get on the air. We usually want the EM field to be radiated, not used up heating resistors!

If we put the right kind of antenna at the far end of the line, the EM field along the line will behave exactly as it does when the line is terminated by a resistor with an ohmic value of Z_0. In radiating the EM field, all antennas seem to display a certain resistance. This resistance is called the radiation resistance (R_R) of the antenna. In order for an antenna to radiate all of the EM field arriving from the feed line, R_R must be equal to the line Z_0, and the antenna must also be resonant at the operating frequency. If both of these requirements are not met, some of the EM field will be reflected back toward the rig. This complicates the pattern of voltage and current along the line. We'll look at this in more detail shortly.

The R_R of an antenna is a function of its physical length in wavelengths. This function is illustrated by **fig. 3**. A half-wavelength dipole in free space, fed at the center, displays a radiation resistance of about 73 ohms. As far as the EM field on the transmission line is concerned, this kind of antenna is just like a 73-ohm noninductive resistor (of sufficient power-handling capacity!). But of course there is quite a difference once the field gets to the antenna. A resistor condemns the field to an unceremonious death; the antenna sets it free.

into the antenna

Once the EM field has completed its journey from the input end of the feed line to the antenna — a matter of nano- or microseconds — it is ready to be radiated. If we're lucky enough to have a perfect match between Z_0 and R_R, along with resonance, the situation is fairly simple. So for now we'll make that assumption.

Once the field reaches the antenna feed point, it continues outward along the antenna wire. But, while the fields were forced to move straight along the feed line, they are not restricted to any particular path once they get to the antenna. **Fig. 4** shows the configuration of the EM fields in the vicinity of a dipole. The E and M fields exist in a rather complicated pattern that allows some radiation in all directions, except exactly in line with the wire, where no E or M fields exist. The greatest EM field intensity is in directions perpendicular to the wire.

into space

Once the EM field has left the antenna, it will propagate into space in ever-expanding wavefronts. How effective is an antenna in radiating EM energy? That depends on many things: the resistance of the conductors in the antenna, obstructions near the antenna, the height of the antenna above ground, and the physical length of the antenna. We can control all of these factors. But we can use conductors that are only so hefty; we can put the antenna up only so high. Ultimately, the efficiency of a common dipole can be made almost 100 percent. But there will always be some loss of signal. The efficiency of an antenna system, mathematically, is given by:

$$Eff = (P_T - P_L)/P_T$$

where P_T is the transmitter output power and P_L is the power lost in the feed line, antenna, and surrounding obstructions, including the ground. The power $P_T - P_L$ is given up as EM radiation.

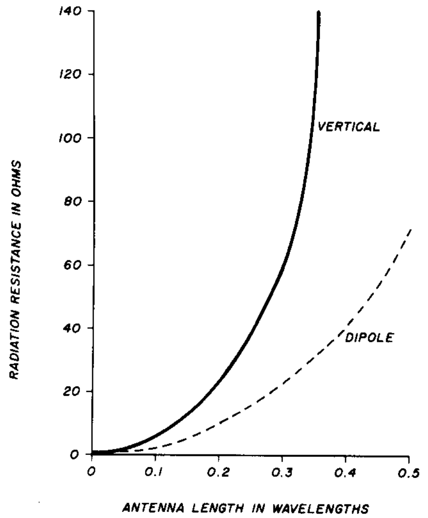


fig. 3. Radiation resistance of antennas as a function of length. The solid line represents a vertical antenna over a ground plane; the dotted line represents a dipole fed at the center. The data is for antennas without nearby obstructions. This graph is adapted from information in *The ARRL Antenna Book*, 13th Edition, 4th Printing, 1977, page 60.

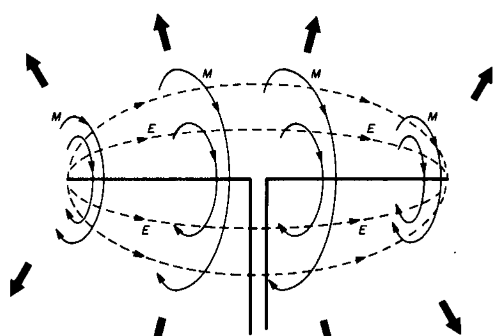


fig. 4. Radiation of EM field from a dipole antenna. A two-wire feed line is shown. The M field, produced by the current in the antenna wire, is shown by the solid circular arrows. The E field, caused by the voltage difference between different points in the dipole, is shown by the dotted lines. Heavy solid arrows show the direction of EM field radiation. EM radiation occurs in all directions except right along the axis of the wire; the greatest amount of EM radiation is in directions perpendicular to the wire.

standing waves

Usually, the line Z_0 and the antenna R_R are not exactly equal, or the antenna is not exactly resonant at the operating frequency. In this case, when the EM field arrives at the antenna feed point, some of it will be reflected back toward the transmitter. The proportion of the EM field that is reflected depends on the severity of the mismatch; the greater the mismatch, the more of the EM field is reflected.

When the reflected EM field gets back to the rig, it is all re-reflected toward the antenna.* When this re-reflected field arrives again at the antenna, it will be reflected partially again, in the same proportions as on its first encounter with the feed point. This process will continue on and on, until line loss reduces the reflecting EM field intensity to practically zero. (This usually takes only a few microseconds.)

The total EM field received by the antenna is the sum of the EM fields received on each encounter.

The reflecting EM fields produce an interference pattern in the voltage E and the current I along the feed line. Instead of being uniformly distributed, there are points of current and voltage minima and maxima. The more severe the mismatch, the worse this nonuniformity. If the mismatch is bad enough, the current may get so high that the conductors overheat and melt the dielectric material. Or the voltage may get so high that an arc occurs and puts a hole in the dielectric. This increase in E and I causes the overall temperature of the feed line to rise, the result of loss in the line under mismatch conditions. This loss may or may not be enough to matter in practice.†

The voltage standing-wave ratio (VSWR) is the ratio of the maximum voltage to the minimum voltage along a feed line. If the VSWR is 1, the voltage is the same all along the line. If it is 3, then the maximum voltage is three times the minimum voltage. We can measure VSWR in a transmission line with rf voltmeters at various points, or with a reflectometer such as the common SWR indicator.

It is commonly thought that the transmission line transfers *power* from the transmitter to the antenna, and that some power is reflected when the line and antenna are not perfectly matched. In fact, many

*Assuming the transmitter is tuned properly.
†Gibilisco, "How Important is Low SWR?", *ham radio*, August, 1981.

SWR meters actually have "forward" and "reflected" power scales calibrated in watts. But the feed line is not really transferring power; it is the EM field that moves along the line. The currents and voltages in any feed line are always alternating back and forth; to say that these currents and voltages, or the power represented by their product EI, is going "forward" or "backward" in any continuous manner, doesn't really make any sense. If the SWR is such that a reflectometer shows 100 watts "forward" and 25 watts "reflected," this means that the forward-moving EM field is four times as intense as the backward-moving EM field. It also tells us something about the relative intensity of the fields; if we reduce the transmitter drive the meter readings might change to 80 watts "forward" and 20 watts "reflected," or some other 4-to-1 ratio.

conclusions

The dipole antenna of **fig. 4** has its own characteristic radiation pattern. Other antennas have different radiation patterns, but they all have been designed to radiate an EM field.

All transmission lines share the property of being good carriers, but poor radiators, of EM fields. Sometimes, however, if an antenna system is not properly designed, the feed line can allow quite a lot of signal to be radiated. Improper balance is the most common cause of feed-line radiation. Of course, we can deliberately design an antenna system so that part or all of the transmission line radiates.

Once the EM field has left the antenna, we no longer have control over where it will go, or whose receiving system it might end up in. The frequency band we use will give us a certain amount of choice as to where the EM field can go (on 2-meter FM it probably won't be heard in India); but we cannot choose, within its characteristic range, whose receiver it will enter and whose it will not. If someone wants to hear our signal, and he's in range, then he can tune it in.

On some frequencies, our signal escapes through the ionosphere into outer space. Theoretically, it goes on forever. One of the bands where this happens is 2 meters. Perhaps a few centuries from now, on a planet orbiting a distant star, some scientists may be experimenting with their first radio-communication devices for VHF. They may be just discovering fm. They may tune in your transmission, boosted by the help of your local repeater. They may have had, from previous hf experiments, exposure to our potpourri of rf energy, and they may have deciphered our languages.

How will they react to the news that traffic is flowing smoothly on I-95?

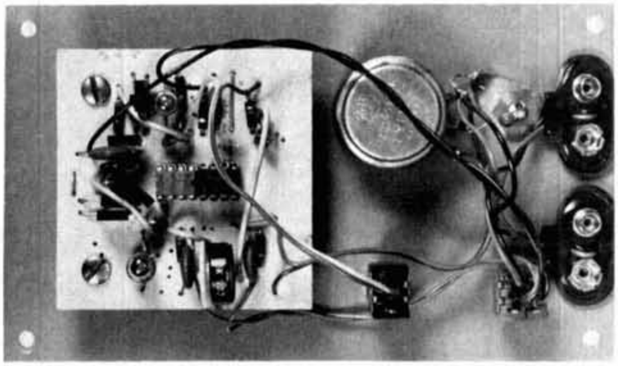
ham radio

Using inexpensive parts
you can build this device
in only a few hours

a simple two-tone generator

Today's integrated ham stations include sophisticated accessories such as an oscilloscope for signal monitoring. Usually not included, however, is the two-tone generator needed to test a single sideband (SSB) transmitter and its linear amplifier. A suitable generator can be constructed in a few hours from inexpensive parts.

A single tone injected into the microphone jack of an SSB transmitter will produce CW rf output. Adding a second tone will produce rf output on two frequencies. These two frequencies, when viewed on an oscilloscope, will produce an interference pattern. If one or more stages in the transmitter are nonlinear, new frequencies that are products of the original two will be generated. These new frequencies will modify the oscilloscope pattern perceptibly. Thus, a two-tone generator and a 'scope are the primary tools needed to test and evaluate SSB equipment.



The main portion of the two-tone audio generator is constructed on a universal circuit board. The pc board is mounted via two ½-inch stand-off posts. The output control, switches, and output jack are mounted on the aluminum panel from an "experimenter" box.

circuit description

The heart of the generator is a Wien bridge audio oscillator. This circuit was first described in Amateur literature in the early 1950s. It uses two resistors and two capacitors to establish an audio frequency. A nonlinear resistance (an incandescent lamp) in a feedback loop stabilizes operation and reduces harmonic content.

One problem with some Wien bridge designs is that they often call for unusual lamps that are often

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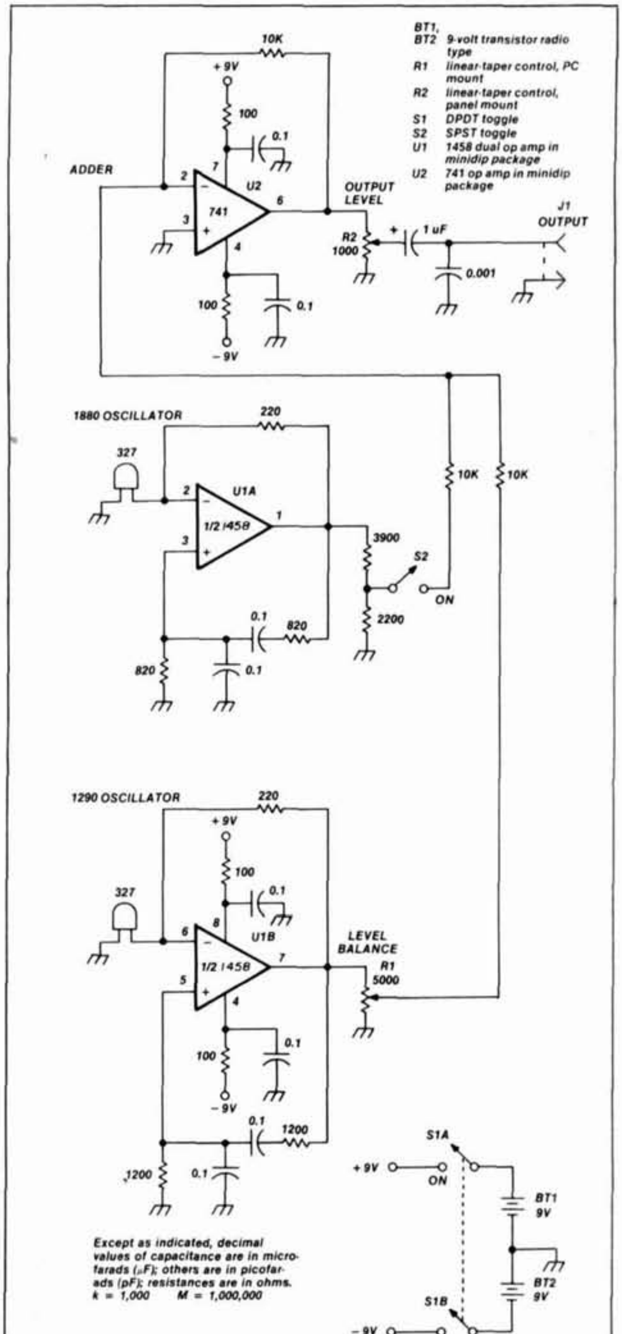


fig. 1. Circuit diagram of the two-tone generator.

difficult to obtain. An exception is the circuit which has appeared in the *ARRL Handbook* in recent years; it uses the 327 bulb, a 24-volt lamp widely used in telephone equipment.

The circuit for the two-tone generator is shown in **fig. 1**. The ever-popular 741 op amps are used for the active elements. (The 1458 is the dual version of the 741.) The frequencies of the two oscillators were chosen to fit standard component values. Other frequencies can be employed; they should be between 500 and 2000 Hz and should not be harmonically related.

The output level of U1A is set by a resistive divider, while the output of U1B is adjustable in amplitude through R1. The output of the two oscillators is combined in U2, an op-amp adder with unity gain. The output from U2 can be adjusted using R2.

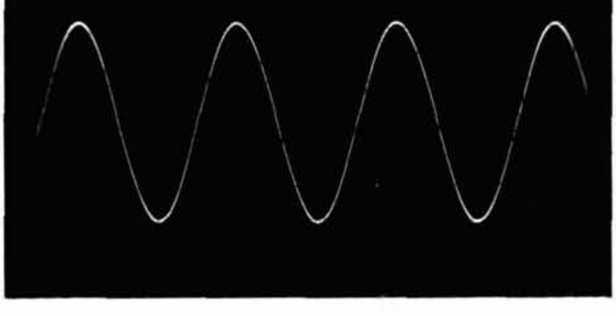
Power for the generator is provided by two 9-volt transistor radio batteries. The power leads to the op-amp packages are decoupled with 100-ohm resistors and 0.1μF capacitors. These components are required to ensure stable operation. The 741-type op-amps are available in single, dual, and quad packages. A quad package can be substituted for the single and dual used in **fig. 1**, or three singles can be employed, with appropriate changes in component arrangement.

construction

The generator is assembled on a universal circuit board. The board was cut in half, with the second half relegated to the "junk box" for a future project. The parts layout of **fig. 2** was employed. Holes were drilled for all component leads with a No. 60 bit. (Be sure to mount the drill bit well down into the chuck, as it is easily broken.) Parts can be tack soldered to the isolated pads rather than drilling holes, but this assembly procedure is somewhat lacking in neatness.

Before any parts are mounted, the circuit board should be brushed with fine steel wool until all pads are bright and shiny. Then, mount the components a few at a time, bending the leads slightly to hold the components in place. Solder each connection, making sure to use sufficient heat so that the solder flows freely. Any solder joint that appears dull or matted should be reheated.

The two-tone generator can be housed in any metal or plastic housing of sufficient size. A coat of paint for the box and a few decals will improve the



Output from a single oscillator shows a "clean," low-distortion sine wave.

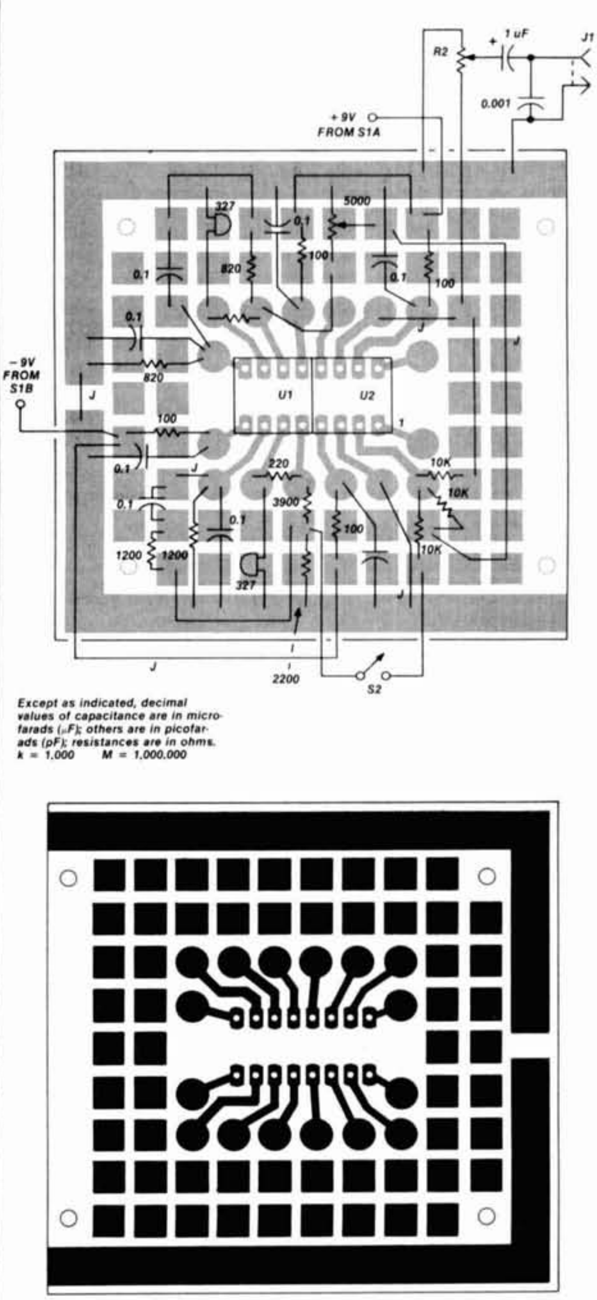


fig. 2. Component layout for the audio generator.

appearance of the finished product.

Only one adjustment is required for the unit — to balance the two tones for equal amplitudes. Adjust R1 for zero output from U1B. Close S2, set R2 at mid scale, and observe the level of audio at J1 using an ac voltmeter or an oscilloscope. Record the reading. Open S2 and adjust R1 until an identical level is obtained. The two tones are now of equal amplitude, and your unit is ready for use.

ham radio

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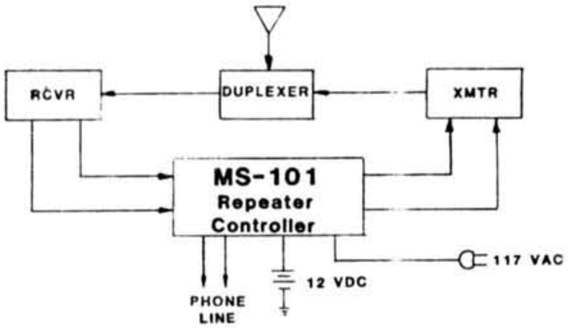

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July 23, 24, 25, 1982

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the hybrid coupler

Evolution of and practical applications for a versatile circuit

Originally, the term *hybrid* was telephone company shorthand for *hybrid coil* or *hybrid transformer*. This device was invented (before the development of vacuum-tube amplifiers) to make it possible to put amplifiers in a two-way telephone line. A similar use is found in some phone patches.

The coil of **fig. 1** is such a hybrid — if **C** and **D** feed identical lines; and if the amplifier input is connected to **B**, and the output to **A**, then any signal coming from **C** will be amplified and sent out to **C** and **D**. In the case of a trancontinental system, **C** will get a strong echo, but if **C** and **D** are close to equal impedance, the amplifier will not "sing" (oscillate). It's similar to a Wheatstone bridge, except that the center-tapped winding eliminates two resistors and their power losses.

The point is, the network has four ports (terminal pairs). With matched loads on any three, the fourth is matched; and with matched loads on the two others, opposite ports are not coupled (are isolated). **Fig. 1** shows the circuit of a 2 to 20 MHz ferrite-core transformer hybrid, called a 180-degree type.

Fig. 2 shows a coax-cable equivalent (at a single frequency).[1] If there are 50-ohm loads on **C** and **D**, then power into **B** will be divided between them equally, and the input impedance at **B** will be about 50 ohms. If a dummy load (50 ohms) is put on **A**, we have an in-phase power divider, in which **C** and **D** are isolated from each other; that is, shorting out **C** will not affect the signal delivered to **D**. If **C** and **D** feed two receivers from a common antenna or preamp coming in at **B**, the local oscillator radiation from the receiver at **C** will be considerably attenuated at **D**. The two arms feeding **A**, and the load, provide the isolation without absorbing any of the input power. When the 70-ohm lines are not a quarter and three-quarter wave, say ten percent off frequency, it doesn't work as well.

Now suppose this 50-ohm 180-degree hybrid has a quarter wave of 50-ohm line added on (this will work only at one frequency, but that's OK for hams), as in **fig. 3**. The power still divides between **C** and **D′**, but they are 90 (or 270) degrees out of phase (depending on how you measure); that is, in quadrature. At the frequency chosen, this is known as a *quadrature hybrid*, one of many kinds.

an experiment

Let's put two identical 20-ohm loads on the ports **C** and **D′**. That means that power will be reflected

By Henry H. Cross, W1OOP, 111 Bird's Hill Avenue, Needham, Massachusetts 02192

from each load (about 18 percent), but the reflection from **D′** occurs 180 degrees later than it would have without the quarter-wave line. The result is that a signal from **A** will show up at **B** after being reflected; or if the signal were coming from **B**, it would show up at **A**. The isolation between **A** and **B** is degraded

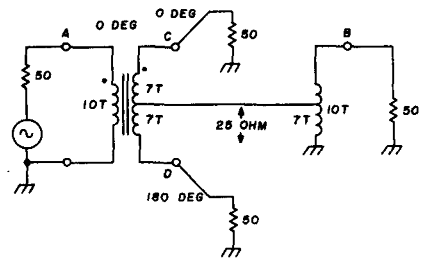

fig. 1. A 2- to 20-MHz 180-degree hybrid using a ferrite-core transformer.

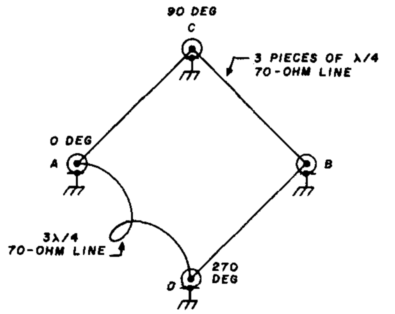

fig. 2. A coaxial-cable equivalent of the hybrid shown in *fig. 1* (narrowband type). Line lengths shown are important for optimum operation at a single frequency.

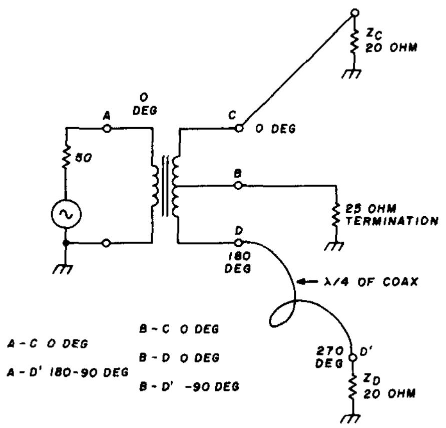

fig. 3. One example of a 90-degree, or quadrature hybrid. The reflections from Z_C and Z_D cancel at *A* and add at *B*. A 1:1 VSWR is presented to *A*.

by the mismatch, but if the added line is an exact quarter wave, the reflection at **A** is cancelled. If and only if the mismatches at **C** and **D′** are identical, **A** still sees a good match.

The more common type of quadrature hybrid is most familiar to hams as a "directional coupler," which is used in measuring antenna power and VSWR.

the quadrature coupler

Fig. 4 shows schematically the type of directional coupler found in a Bird wattmeter. The loop picks up the magnetic field and the capacitive coupling of the loop to the center conductor picks up the electric field. If constructed right, these components add for a wave going down the coax one way and cancel for a wave coming back — that's why it's directional. **Fig. 5A** shows the same thing carried to the extreme — a quarter wave of main line and a quarter wave of "pickup loop".

Notice that in both cases the coupled signal comes out in the reverse direction. If the proportions are right, it's possible to get half the input power to come out the coupled port — and of course the main line has only the other half coming out. That's a "3-dB directional coupler." If the phase of such a loop coupler is investigated, it will be found that the coupled output is 90 degrees out of phase from the main-line output. Thus it's a *quadrature* coupler. It has equal power division and an isolated port, as in the circuit of **fig. 3**. Unlike that hybrid, however, the quarter-wave coupler works well from 2/3 to 4/3 of center frequency, which is two to one, or an octave. The capacitance between the two inner connections must be fairly high to obtain the 50-percent power split.

Some hybrids are made by printing strip conductors on either side of the dielectric, as in **fig. 5B**, and some are made by using solid strip with a thin dielectric sheet between, in a cast housing. Another type is built much like coaxial cable. Two wires are twisted together with a thin insulation between them, then Teflon covers the wire pair. The assembly is shielded by a copper wrap, braid or tubing. The trade name of

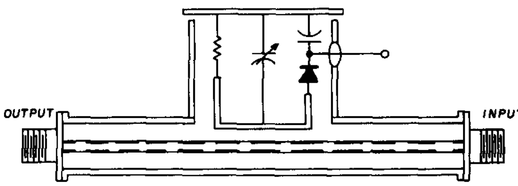

fig. 4. Version of the quad hybrid as a directional coupler used in the Bird wattmeter.

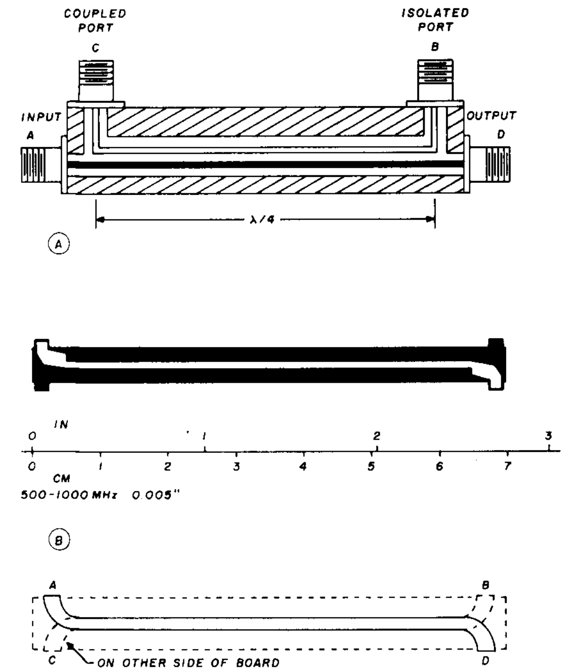

fig. 5. The directional coupler of *fig. 4* carried to the extreme, using a quarter wavelength of main line and a quarter wavelength of "pickup loop," *A*. In both cases the coupled signal comes out in the reverse direction. In *B* a hybrid is shown that is made by printing strip conductors on a fiber glass-filled teflon sheet.

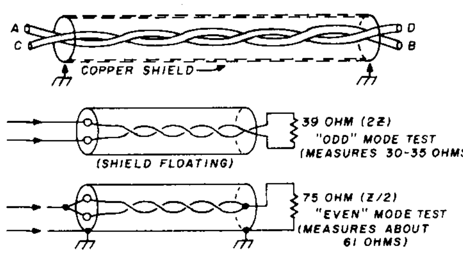

fig. 6. Construction of the Wireline® hybrid. Measurements were made using a Hewlett-Packard time-domain reflectometer.

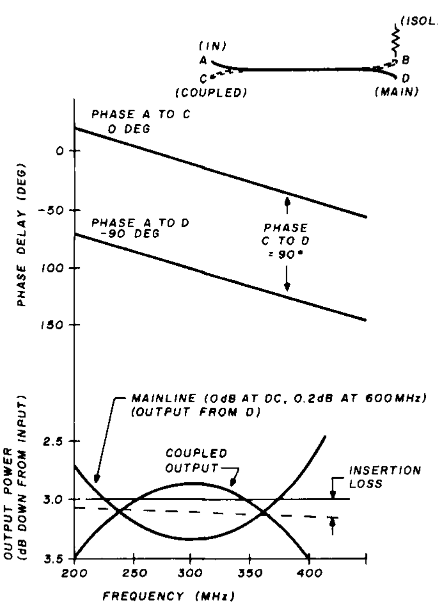

fig. 7. Response of a typical quarter-wave hybrid coupler.

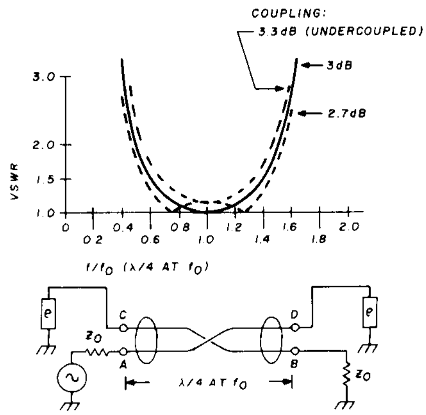

fig. 8. VSWR versus frequency for 100-percent (identical) reflections at the reflection coefficient point for a quad hybrid.

this hybrid is Wireline,* and the length can be cut for any frequency range as long as it's less than two to one.

Fig. 6 shows the Wireline® construction and shows how to check a length (if you make it yourself) with a time-domain reflectometer. The twisted pair should perform as a balanced 40-ohm line; while with the center wires shorted together, it should appear as a piece of 60-ohm coax.

*Wireline is a trademark of Sage Laboratories, Inc.

phase relationships

In case of a quarter-wavelength coupler (about 16 cm of Wireline® for a center frequency of 300 MHz), the voltage at the coupled port (the wire adjacent to the input, labled **C**) is approximately in phase with the input voltage at center frequency. The voltage at **D**, at the far end of the input line, is 90 degrees late and varies with frequency, as one would expect of a constant time delay. The phase between **C** and **D**, with a matched termination on the isolated port, is

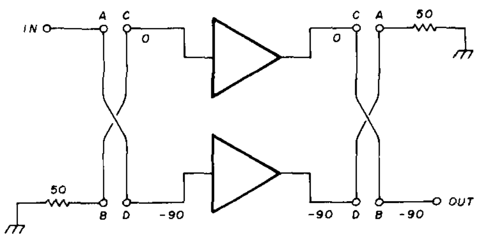

fig. 9. Two identical amplifiers in "parallel." Power gain and noise figure are the same as for one amplifier (except for hybrid coupler losses). Maximum input and output power is twice that of one amplifier.

almost exactly 90 degrees and independent of frequency as long as there is enough voltage to measure at the coupled output. This is shown, for a typical 3-dB hybrid, in **fig. 7**. It's true for any coupling factor for simple couplers. **Fig. 8** shows why a slightly overcoupled hybrid, such as that in **fig. 7**, is desirable for most applications.

some applications

Quadrature hybrids for VHF are made in various packages and frequency ranges, by a number of manufacturers. I'm familiar with Anaren, Anzac, Merrimac, Microwave Associates, Olektron, Sage (of course), and there are many others. The small size (you can get one in a TO-5 can) usually has a bit more loss, so if that's important get a big one. Some popular types cost as little as $15.00, but most are fairly expensive by ham standards.

For use at intermediate frequencies, such as would be required for a single-sideband up- or down-converter, a lumped-constant network may be handier. Anzac and Merrimac sell such devices, including ranges as wide as 2-32 MHz.

The obvious use for the quadrature hybrid is to combine a pair of power amplifiers (because of the isolation, one transistor failing won't cause the other one to blow), but the same layout is good for linear amplifiers (match is important for linearity) and for low-noise or broadband amplifiers (see **fig. 9**).

A balanced mixer is shown in **fig. 10**. This mixer is "balanced" in that noise in the local-oscillator is cancelled, and the local-oscillator fundamental is balanced out at the i-f port. A lot of local-oscillator power will come out the rf port unless the mixer is carefully adjusted, but the VSWR is good, and the noise figure can be excellent (that is, 6 dB) without much effort. The i-f port output impedance is about 100 ohms for 4 milliwatts of oscillator drive.

Quadrature hybrids (one for the local oscillator and one for the i-f) are needed to make the image-cancelled (SSB) mixer. One reason for wanting an image-cancelled mixer is that there has to be something that takes out the amplified noise at the image frequency that is coming from the rf stages. It could be an image filter (which will have loss, and may have to be retuned as you change frequency) or it could be a mixer in which the image response is suppressed by 16 dB or more. For moderate values of rf gain, the SSB mixer may give better over-all noise figure (and you can't measure the effect of image noise easily) than the best real filter, which has some loss.

make your own i-f hybrid

In **fig. 11A** the coil is a bifilar inductor, a transmission line (two wires, twisted a few turns per inch) wound on a coil form or a carbonyl-iron or ferrite toroid. The end-to-end inductance of one wire is the important parameter. The inductive reactance should be equal to 50 ohms at the frequency of interest, if you are making a 50-ohm coupler. Two capacitors are connected across the bifilar line at the ends, and the total capacitance (both capacitors plus the distributed capacitance of the twisted pair) should be the value that would resonate with that value of inductance. The coupling has a fast change with frequency, but it's useful over ten percent bandwidth. U.S. patent 3,452,301 probably covers these.

Two of the above couplers with a twin coax line between them (23 degrees at center frequency) make an octave-wide unit, as described by Reed Fisher, W2CQH. **Fig. 11B** shows a version with an artificial line (a lowpass filter) between couplers. Because the values are not very critical, the coils could be air-core types wound to calculated turns, or they could be set up with a grid dip meter. I had access to a *Q*-meter, which made it easy. (U.S. patent 3,452,300, assigned to Merrimac Industries, Inc.)

Fig. 11C shows how two quad hybrids and two commercial double-balanced mixers can be used to make an image-cancelled mixer. I built one at 1296

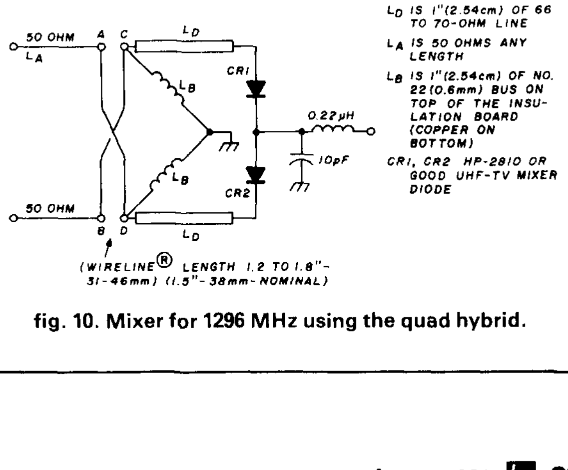

fig. 10. Mixer for 1296 MHz using the quad hybrid.

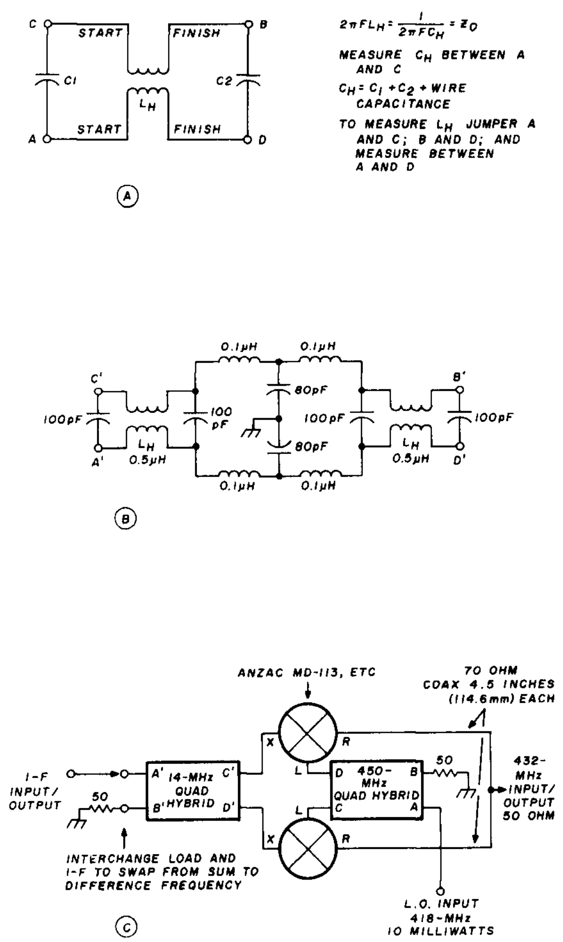

fig. 11. Practical uses for the hybrid. A 3-dB i-f hybrid is shown in *A*; a 12-20 MHz 3-dB hybrid in *B*; and an SSB mixer for 432 MHz in *C*. The 450-MHz hybrid can be Wireline® (any length from 3.6 to 5.6 inches, or 9 to 14 cm will work).

MHz for 14-18 MHz i-f, which had about 16-dB image ratio (0.107 dB of added noise from the image for a 2-dB rf stage). If the mixer noise figure were 7 dB, the image-cancelled arrangement would be as good as a perfect image filter with 0.8-dB loss, assuming 13-dB gain in the rf amplifier. (With two rf amplifiers, and 20 or more dB gain, the filter would be better, but where do you get a filter with 40-dB rejection 28 MHz away at 1296 MHz?)

references

1. Henry S. Keen, W2CTK, "Microwave Hybrids and Couplers for Amateur Use," *ham radio*, July, 1970, page 57. (Reprinted in *ham radio*, March, 1978, page 72.)

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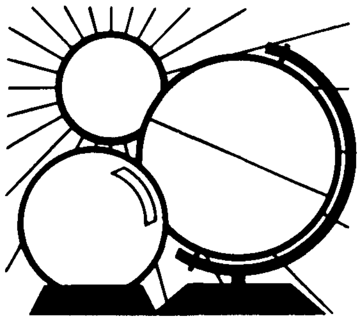


DX FORECASTER

Garth Stonehocker, KØRYW

events of the month

Several interesting geophysical events occur on June 21st, affecting radio propagation and therefore DX. Lunar perigee is on the 21st at 1200 UT. The summer solstice occurs at 1723 UT. And there will be a partial solar eclipse from 1028 to 1340 UT.

The eclipse path is obscured 62 percent at maximum. It begins in the extreme south Atlantic Ocean, then moves on to South Africa and the Indian Ocean. Not many U.S. hams will be in the eclipse path, but our southern friends may find some lowering of maximum usable frequencies (MUFs) in the first half and some short-skip DX (from the ionospheric hole created) in the second half of the eclipse.

The full moon will be on the 6th of June. The solar activity and flux maximum is expected to be about the 18th. Solar-flare-induced geomagnetic/ionospheric disturbances may occur around the 14th and 22nd through 24th. Solar flux minimum is expected about the 5th through 8th and may be accompanied by a long geomagnetic disturbance from a weak coronal hole.

last-minute forecast

Solar-geophysical events translate into varying DX conditions throughout the month. The higher-frequency bands (10 and 20 meters) are expected to be excellent later, after the 15th, following a marginally good beginning. If 6 meters has openings at all, it will be Sporadic E propagation (Es) near midday. The solar cycle is far enough down from the minimum that the summertime ionosphere may not provide support for 50 MHz. The F region requires twice the density that the Es does to provide usable paths. The lower frequency bands (40-160 meters) should be the best during the first two weeks of the month. Noise (QRN) from summer thunderstorms may erupt in the evenings.

Since the Es propagation season is just now underway, let's have a look at some of its DX characteristics. In the major area for Es production and paths, south-east Asia, a frequency as high as 15 MHz will propagate continuously on a 2500-km east/west path twenty-four hours a day. During the hours of daylight into late evening, the F region mode propagates radio signals. Enough Es is then available to keep that frequency alive through the early morning hours, when the F region density normally becomes too low. This early-morning decrease is usually called the pre-sunrise dip, and it is caused by the temperature dipping down just prior to sunrise. Loss of signal is common if the path is being worked near its MUF, but in this case Es holds the signal in with very high signal strengths across the dip. The pre-sunrise dip is usually a propagation problem for a fixed communications circuit. The problem requires at least two frequency changes, one down and another back up, resulting in time lost. If you're not skilled you may lose the other fellow, but Es propagation solves the problem in summer. See last month's, or last year's, May and July *ham radio* magazine DX Forecaster for more on Es.

band-by-band summary

Ten and fifteen meters should give excellent daytime openings to most worldwide locations on both F-region long skip to 2500 miles (4000 km) and sporadic-E short skip to 1200 miles (2000 km) or multiples thereof on many days of the month. Don't expect as much one-hop trans-equatorial DX during disturbed periods this time of year.

Twenty meters will be open to some areas of the world for nearly all hours of the day and night. Sporadic-E propagation will fill in the pre-sunrise dip in usable frequencies during many mornings to make round-the-clock openings possible. The direction of the openings will not be much different than usual, and the openings will be extended in time.

Forty meters will give the best DX during the night from sunset until just after sunrise. Static levels may be high at times. Watch for local storms and operate near Sporadic-E peaks around sunrise and sunset (particularly sunrise, when fewer thunderstorms have built up).

Eighty meters on some nights can have DX openings to areas of interest. Static from thunderstorm activity, long distance and local, may limit working the rare ones when propagation is otherwise right. Coastal stations usually have more favorable propagation geometry under summer conditions for working the rare DX than inland stations. Sporadic-E propagation around sunrise and sunset is good for this band also. Daytime work will be limited to within about 220 miles (360 km).

One-sixty-meter DX activities really require a lot of work this time of year. During hours of darkness between storm-front passages, you may work 1000 miles (1600 km) if your ears hold up. DX takes on a new meaning here. You may want to give it a try.

ham radio

JUNE

WESTERN USA

GMT	PDT	ASIA FAR EAST (N)	EUROPE (NE)	S. AFRICA (E)	S. AMERICA (SE)	ANTARCTICA (S)	NEW ZEALAND (SW)	OCEANIA AUSTRALIA (W)	JAPAN (NW)
0000	5:00	—	20	20	15	15	10	10	—
0100	6:00	—	20	20	15	15	10	10	—
0200	7:00	—	20	20	15	15	10	10	15
0300	8:00	15	20	—	15	20	10	10	15
0400	9:00	15	20	—	15	20	15*	15	15
0500	10:00	15	20	—	15	20	15	15	—
0600	11:00	—	20	—	15	20	15	15	—
0700	12:00	—	—	20	20	20	15	15	—
0800	1:00	20	—	20	20	20	15	15	—
0900	2:00	20	—	—	40	40	15	20	20
1000	3:00	20	—	—	40	40	20	20	20
1100	4:00	20	—	—	—	40	20	20	20
1200	5:00	20	—	—	—	40	20	20	—
1300	6:00	20	20	—	—	—	20	20	—
1400	7:00	20	20	—	—	—	20	20	—
1500	8:00	20	20	20	—	—	40	20	—
1600	9:00	15	20	20	—	—	40	—	—
1700	10:00	15	20	20	—	—	40	—	20
1800	11:00	15	20	15	15	—	20	—	15
1900	12:00	15	20	15	10	—	20	—	15
2000	1:00	—	15	15	10	—	20	15	20
2100	2:00	—	15	15	10	20	15	15	20
2200	3:00	—	15	15	15	20	10	10	20
2300	4:00	—	20	20	15	15	10	10	20

MID USA

GMT	MDT	CDT	ASIA FAR EAST (N)	EUROPE (NE)	S. AFRICA (E)	S. AMERICA (SE)	ANTARCTICA (S)	NEW ZEALAND (SW)	OCEANIA AUSTRALIA (W)	JAPAN (NW)
0000	6:00	7:00	15	20*	15	15	15	10	15	15
0100	7:00	8:00	15	20	20	15	20	10	15	15
0200	8:00	9:00	15	20	20	15	20	15*	15	15
0300	9:00	10:00	15	20	—	15	20	15	15	20
0400	10:00	11:00	20	20	—	15	20	15	15	20
0500	11:00	12:00	20	20	40	20	20	15	15	20
0600	12:00	1:00	20	20	40	20	20	15	20	—
0700	1:00	2:00	—	20	20	20	20	15	20	—
0800	2:00	3:00	—	—	20	20	40	15	20	—
0900	3:00	4:00	—	—	—	40*	40	15	20	—
1000	4:00	5:00	—	—	—	40	40	20	40*	40
1100	5:00	6:00	—	20	—	40	—	20	40	40
1200	6:00	7:00	—	20	—	20	—	20	40	40
1300	7:00	8:00	20	20	20	20	—	40	40	40
1400	8:00	9:00	20	20	20	20	—	40	—	20
1500	9:00	10:00	20	—	20	20	—	—	—	20
1600	10:00	11:00	20	—	15	20	—	—	—	20
1700	11:00	12:00	20	—	15	15	—	—	—	20
1800	12:00	1:00	20	—	15	15	—	—	—	—
1900	1:00	2:00	15	15	15	15	20	15	—	—
2000	2:00	3:00	15	15	15	10	20	10	10	—
2100	3:00	4:00	—	15	15	10	20	10	15*	—
2200	4:00	5:00	—	15	15	10	20	10	15*	15
2300	5:00	6:00	—	15	15	15	15	10	15*	15

EASTERN USA

GMT	EDT	ASIA FAR EAST (N)	EUROPE (NE)	S. AFRICA (E)	CARIBBEAN S. AMERICA (SE)	ANTARCTICA (S)	NEW ZEALAND (SW)	OCEANIA AUSTRALIA (W)	JAPAN (NW)
0000	8:00	15	20	20	15	20	15	15	20
0100	9:00	15	20	40	15	20	15*	15	20
0200	10:00	20*	20	40	15	20	15	15	20
0300	11:00	20	20	40	20	20	15	15	20
0400	12:00	20	40	—	20	20	15	15	20
0500	1:00	20	40	—	20	20	15	20	20
0600	2:00	—	40	20	20	40	15	20	20
0700	3:00	—	40	20	40*	40	20	40	40
0800	4:00	—	40	20	40	40	20	40	40
0900	5:00	—	20	—	40	40	20	40	40
1000	6:00	—	20	—	40	40	20	40	40
1100	7:00	20	20	—	40	—	40	40	20
1200	8:00	20	15	—	20	—	40	40	20
1300	9:00	20	15	15	15	—	40	40	20
1400	10:00	20	15	15	15	—	40	20	—
1500	11:00	20	20	15	15	—	—	—	—
1600	12:00	20	20	15	15	—	—	—	—
1700	1:00	20	20	15	15	—	—	—	—
1800	2:00	15	15	15	10	20	—	—	20
1900	3:00	15	15	15	10	20	15	—	20
2000	4:00	20	15	15	15*	15	15	—	20
2100	5:00	20	15	15	15	15	15	15	20
2200	6:00	20	15	15	15	20	15	15	15
2300	7:00	20	15	15	15	20	15	15	15

*Look at next **higher** band for possible openings.

UTIC
MINI STEREO AM/FM RECEIVER
WITH HEADPHONES

For Joggers, Cyclists, Skaters & Sports Events!

FEATURES: Lightweight headphones. Left/right balance control. Full fidelity stereo sound. Additional black soft carrying case & shoulder strap. Belt clip (hands free). Operates on 3 AA cell batteries (not incl.). Compact size: 3⅜" x 4⅞" x 1". Wt. 6 oz.

Model 2830 List Price $89.95 .... **$34.95**

SPEAKERS

Part #		1	2-9
A0201	2¼" Round — 8 Ohm, .25 Watt (4" Leads), Size: 2¼" x ⅞"	1.25	.99
SF-25016	2½" Square — 16 Ohm, .25 Watt (4 mount. holes), Large Ceramic Magnet, Size: 2⅝" x 2⅝" x ⅞"	1.39	1.25

National Semiconductor
RAM SALE

STATIC RAMS

MM2114N-2 4K (200NS) .... **$2.49 each**
(8 EACH $16.95/lot) (100 EACH $195.95/lot)

MM2114N-2L 4K (200NS) Low Power .... **$2.95 each**
(8 EACH $19.95/lot) (100 EACH $225.00/lot)

MM2147N 4K (70NS) .... **$4.95 each**
(8 EACH $34.95/lot) (100 EACH $419.95/lot)

MM6116P-4 16K (200NS) .... **$14.95 each**
(8 EACH $99.95/lot) (100 EACH $1195.00/lot)

DYNAMIC RAMS

MM4164N-20 64K (200NS) .... **$14.95 each**
(8 EACH $99.95/lot) (100 EACH $1195.00/lot)

MM5290N-2 16K (150NS) 4116 .... **$2.95 each**
(8 EACH $19.95/lot) (100 EACH $225.00/lot)

MM5290N-4 16K (250NS) 4116 .... **$1.95 each**
(8 EACH $14.95/lot) (100 each $175.00/lot)

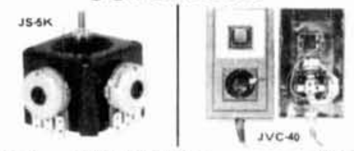
EPROM Erasing Lamp

- **Erases 2708, 2716, 1702A, 5203Q, 5204Q, etc.**
- **Erases up to 4 chips within 20 minutes.**
- **Maintains constant exposure distance of one inch.**
- **Special conductive foam liner eliminates static build-up.**
- **Built-in safety lock to prevent UV exposure.**
- **Compact — only 7-5/8" x 2-7/8" x 2"**
- **Complete with holding tray for 4 chips.**

UVS-11EL Replacement Bulb $16.95

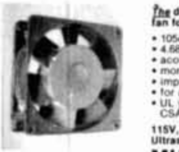
UVS-11E **$79.95**

JOYSTICKS



JS-5K	5K Linear Taper Pots	$5.25
JS-100K	100K Linear Taper Pots	$4.95
JVC-40	40K (2) Video Controller in case	$4.95

MUFFIN® FAN



The dependable, low cost, largest selling fan for commercial cooling applications.

- 105cfm free air delivery
- 4.68" sq. x 1.50" depth. Weight - 17 oz.
- acoustical rating as low as NC-38
- more than 10 yrs. cont. duty at 10°C
- impedance protected
- for ambients to 70°C
- UL yellow card recognized & CSA approved

115V, 50/60Hz, 14 Watts, 105cfm — Ultrasonically cleaned & tested.

MU2A1 .... $9.95 ea.

NEW! JE215 Adjustable Dual Power Supply

General Description: The JE215 is a Dual Power Supply with independent adjustable positive and negative output voltages. A separate adjustment for each of the supplies provides the user unlimited applications for IC current voltage requirements. The supply can also be used as a general all-purpose variable power supply.

FEATURES:
- Adjustable regulated power supplies, pos. and neg. 1.2VDC to 15VDC.
- Power Output (each supply): 5VDC @ 500mA, 10VDC @ 750mA, 12VDC @ 500mA, and 15VDC @ 175mA.
- Two, 3-terminal adj. IC regulators with thermal overload protection.
- Heat sink regulator cooling
- LED "on" indicator
- Printed Board Construction
- 120VAC input
- Size: 3 1/2"w x 5-1/16"L x 2"H

JE215 Adj. Dual Power Supply Kit (as shown) .. **$24.95**
(Picture not shown but similar in construction to above)
JE200 Reg. Power Supply Kit (5VDC, 1 amp) .. $14.95
JE205 Adapter Brd. (to JE200) ±5, ±9 & ±12V. $12.95
JE210 Var. Pwr. Sply. Kit, 5-15VDC, to 1.5amp. $19.95

MICROPROCESSOR COMPONENTS

8080A/8080A SUPPORT DEVICES

INS8080A	CPU	4.95
DP8212	8-Bit Input/Output	3.25
DP8214	Priority Interrupt Control	5.95
DP8216	Bi-Directional Bus Driver	3.49
DP8224	Clock Generator/Driver	3.95
DP8226	Bus Driver	3.49
DP8228	System Controller/Bus Driver	4.95
DP8238	System Controller	5.95
INS8243	I/O Expander for 48 Series	8.95
INS8250	Asynchronous Comm. Element	16.95
DP8251	Prog. Comm. I/O (USART)	6.95
DP8253	Prog. Interval Timer	8.95
DP8255	Prog. Peripheral I/O (PPI)	5.95
DP8257	Prog. DMA Control	9.95
DP8259	Prog. Interrupt Control	9.95
DP8275	Prog. CRT Controller	29.95
DP8279	Prog. Keyboard/Display Interface	9.95
DP8303	System Timing Element	6.95
DP8304	8-Bit Bi-Directional Receiver	3.95
DP8307	8-Bit Bi-Directional Receiver	3.95
DP8308	8-Bit Bi-Directional Receiver	3.95
DP8310	Octal Latched Peripheral Driver	5.25
DP8311	Octal Latched Peripheral Driver	5.25

6800/6800 SUPPORT DEVICES

MC6800	MPU	7.95
MC6802CP	MPU with Clock and RAM	14.95
MC6810AP1	128x8 Static RAM	4.95
MC6821	Peripheral Inter. Adapt (MC6820)	7.49
MC6828	Priority Interrupt Controller	17.95
MC6830L8	1024x8-Bit ROM (MC68A30-8)	14.95
MC6850	Asynchronous Comm. Adapter	6.95
MC6852	Synchronous Serial Data Adapter	6.95
MC6860	0-600bps Digital MODEM	10.95
MC6862	2400bps Modulator	12.95
MC6880A	Quad 3-State Bus. Trans. (MC8T26)	3.25

MICROPROCESSOR CHIPS

Z80 (780C)	CPU (MK3880N) (2MHz)	11.95
Z80A (780-1)	CPU (MK3880N-4) (4MHz)	13.95
CDP1802	CPU	19.95
2650	MPU	18.95
IDM2901ADC	CPU—4-Bit Slice (Com. Temp. Grade)	19.95
MC56502	MPU w/Clock (65K Bytes Memory)	11.95
INS8035N-6	MPU—8-Bit (6MHz)	7.95
INS8039N-6	CPU—Sgl. Chip 8-Bit (128bytes RAM)	9.95
INS8040N-6	CPU (256 Bytes RAM)	24.95
INS8070N	CPU—64 Bytes RAM	24.95
INS8073N	CPU w/Basic Micro Interpreter	29.95
P8085	CPU	9.95
TMS9900JL	MPU—16-Bit	39.95

1173AN-1 30 Tune Musical MPU Chip 8.95

SHIFT REGISTERS

MM500H	Dual 25-Bit Dynamic	.50
MM503H	Dual 50-Bit Dynamic	.50
MM506H	Dual 100-Bit Static	.50
MM510H	Dual 64-Bit Accumulator	.50
MM1402N	256-Bit Dynamic	2.95
MM5013N	1024-Bit Dynamic/Accumulator	1.95
MM5016N	500/512-Bit Dynamic	1.95
MM5034N	Octal 80-Bit	9.95
MM5035N	Octal 80-Bit	9.95
2504V (1404A)	1024-Bit Dynamic	1.95
2518N	Hex 32-Bit Static	3.95
2522V	Dual 132-Bit Static	2.95
2524V	512-Bit Dynamic	.99
3341PC	Fifo (Dual 80)	6.95

DATA ACQUISITION

DC10	Mostek DC/DC Convert. +5V to 9V	$2.95
MC3470P	Floppy Disc Read AMP System	4.95
MC1408L7	7-Bit D/A Converter (DAC0807LCN)	4.95
MC1408L8	8-Bit D/A Converter (DAC0808LCN)	5.75
AF100-1CN	Universal Active Filter 2.5%	5.95
AF121-1CJ	Touch Tone Low Band Filter	19.95
AF122-1CJ	Touch Tone High Band Filter	19.95
LM308CH	Super Gain Op Amp	1.15
LM334Z	Constant Current Source	1.30
LM335Z	Temperature Transducer	1.40
LF356N	JFET Input Op Amp	1.10
LF398N	Sample & Hold Amplifiers	3.95
LM399H	Temp. Comp. Prec. Ref. (.5ppm/C°)	5.00
ADC0804LCN	8-Bit A/D Converter (1 LSB)	4.95
DAC0806LCN	8-Bit D/A Converter (0.78% Lin.)	2.25

DATA ACQUISITION (CONTINUED)

ADC0809CCN	8-Bit A/D Converter (8-Ch. Multi.)	5.25
ADC0817CCN	8-Bit A/D Converter (16-Ch. Multi.)	10.95
DAC1000LCN	10-Bit D/A Conv. Micro. Comp. (0.05%)	13.95
DAC1008LCN	10-Bit D/A Conv. Micro. Comp. (0.20%)	8.95
DAC1020LCN	10-Bit D/A Converter (0.05% Lin.)	8.49
DAC1022LCN	10-Bit D/A Converter (0.20% Lin.)	5.95
DAC1222LCN	12-Bit D/A Converter (0.20% Lin.)	9.95
CD4051N	8-Channel Multiplexer	1.19
AY-5-1013	30K BAUD UART	6.95

RAM'S

1101	256x1 Static	1.49
1103	1024x1 Dynamic	.99
2101 (8101)	256x4 Static	3.95
2102	1024x1 Static	1.75
21L02	1024x1 Static	1.95
2111 (8111)	256x4 Static	3.95
2112	256x4 Static MOS	4.95
2114	1024x4 Static 450ns	2.25
2114L	1024x4 Static 450ns Low Power	2.49
2114-2	1024x4 Static 200ns	2.49
2114L-2	1024x4 Static 200ns Low Power	2.95
74S200	256x1 Static	6.95
4116N-4 (UPD416)	16K Dynamic 250ns (MM5290N-4)	1.95
4164N-3	64K Dynamic 200ns	14.95
MM2147N	4096x1 Fast 70ns	4.95
5101	256x4 Static	7.95
MM5261	1024x1 Dynamic Fully Decoded	.99
MM5262	2Kx1 Dynamic	.49
MM5280/2107	4096x1 Dynamic	4.95
MM5290N-2 (4116)	16K Dynamic 150ns (UPD416C-3)	2.95
MM5298J-3A	8K Dyn. 200ns (lower ½ of MM5290J)	1.95
HM6116-4	16K (2Kx8) Static 200ns	14.95
82S25	64 Bit RAM (16x4OC)	3.49
UPD414/MK4027	4K Dynamic 16-pin	4.95
TMS4044-45NL	4K Static	9.95
TMS4045	1024x4 Static	9.95

PROMS/EPROMS

1702A	2K UV Erasable PROM	5.95
2708	8K EPROM	7.95
TMS2716	16K EPROM (-5V, +5V, +12V)	9.95
2716Intel(2516)TI	16K EPROM (Single +5V)	8.95
2732Intel TI	32K EPROM	17.95
2758	8K EPROM (450ns) (Single +5V)	7.49
2764Q	64K EPROM (Hitachi HN462764)	49.95
5203	2048 PROM	14.95
82S23(74S188)	32x8 PROM (Open Collector)	3.95
82S115	4096 Bipolar PROM	14.95
82S123(74S288)	32x8 Tri-State Bipolar PROM	3.95
82S185	8K PROM	16.95

— Over 30 More PROMS Listed in Our Catalog —

ROM'S

2513(2140)	Character Generator (Upper Case)	9.95
2513(3021)	Character Generator (Lower Case)	9.95

NMOS READ ONLY MEMORIES

MCM66710P	128x9x7 ASCII Shifted w/Greek	13.50
MCM66740P	128x9x7 Math Symbol & Pictures	13.50
MCM66750P	128x9x7 Alpha. Control Char. Gen.	13.50

MICROPROCESSOR MANUALS

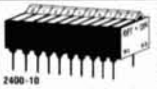
M-Z80	User Manual	7.50
M-CDP1802	User Manual	7.50
M-2650	User Manual	5.00

SPECIAL FUNCTION

DS0025CN	Dual MOS Clock Driver (5MZ)	3.50
DS0026CN	Dual MOS Clock Driver (5MZ)	1.95
INS1771N-1	Floppy Disc Controller	24.95
INS2651N	Communication Chip	19.95
MM58167N	Microprocessor Real Time Clock	8.95
MM58174N	Microprocessor Compatible Clock	11.95
COP402N	Microcontroller with 64-Digit RAM and Direct LED Drive	6.95
COP402MN	Microcontroller with 64-Digit RAM & Direct LED Drive w/N Buss Int.	7.49
COP470N	32-Seg. VAC Fluor. Driver (20-pin pkg.)	3.25

TELEPHONE/KEYBOARD CHIPS

AY-5-9100	Push Button Telephone Dialer	14.95
AY-5-9200	Repertory Dialer	14.95
AY-5-9500	CMOS Clock Generator	4.95
AY-5-2376	Keyboard Encoder (88 keys)	11.95
HD0165-5	Keyboard Encoder (16 keys)	7.95
74C922	Keyboard Encoder (16 keys)	5.49
74C923	Keyboard Encoder (20 keys)	5.75
MM53190N	Push Button Pulse Dialer	7.95
MM57499N	96/144-Key Serial Keyboard Encoder	8.95



EECO Rocker DIP Switch — "Mini-Dip™" 2400 Series
THE MOST UNIQUE DIP SWITCH AVAILABLE!

MINI-DIP is designed to retrofit all major brands of Dip switches. Unique features include locking rod design to prevent accidental actuation and gold self-wiping contact. One-piece housing and press-fit terminals prevent contamination. 2-10 station Form "A" and 1-5 station Form "C".
• Terminals on .100 x .300 (2.54 x 7.62) centers • PCB or dip socket mountable • Positive cleaning/wiping action with gold contact • Total seal and bottom seal

Part No.	Pos.	Configuration	Socket	Price
2400-2	2	12	8 pin	.79 - 10/ 6.95
2400-3	3	123	8 pin	.89 - 10/ 7.95
2400-4	4	1234	8 pin	.99 - 10/ 8.95
2400-ABCD	4	ABCD	8 pin	.99 - 10/ 8.95
2400-5C	6	C54321	14 pin	1.09 - 10/ 9.95
2400-6	6	123456	14 pin	1.09 - 10/ 9.95
2400-7	7	1234567	14 pin	1.19 - 10/10.95
2400-8	8	12345678	16 pin	1.29 - 10/11.95
2400-9	9	123456789	18 pin	1.39 - 10/12.95
2400-10	10	0123456789	20 pin	1.49 - 10/13.95

GRAB BAG SPECIALS

GB180 100 pieces Robot/Slot Car Gears, Shafts, Wheels, Motors **$9.95**

CAPACITORS

Part No.	Description	Price
GB100	100 each Ceramic Disc (10pf - 1mf)	$2.00
GB101	80 each Mylar	4.00
GB102	80 each Electrolytics	4.00
GB103	40 each Tantalum (tubular & dipped)	4.00
GB176	40 each Dipped Micas (10pf-1000pf @ 100-500V)	4.00

INTEGRATED CIRCUITS

GB108	50 each TTL Series — marked (7400, 74107, 74123, etc.)	$4.00
GB109	30 each Linear — marked (LM301, 307, 741, 308, etc.)	4.00
GB148	30 each Exar — marked (XR320, 1310, 4136, etc.)	4.00
GB150	20 each Shift Registers — marked (2510, 2518, 2522, 2533, etc.)	4.00
GB157	50 each DTL Series — marked (DM830, 932, 936, 946, etc.)	3.00
GB158	8 pcs. Positive Voltage Regulators (TO-3 case) (7805, 06, 12, 15, 18, 24, etc.) Linear marked	4.25
GB188	8 pcs. Negative Voltage Regulators (TO-3 case) (7905, 06, 12, 15, 18, 24, etc.) Linear marked	4.00
GB170	25 each Assorted 74LS TTL Series	4.00
GB172	10 pcs. 78M Positive Volt. Reg. (TO-5 case) (78M05, 8, 12, 15, 20, 24, etc.) Linear marked	5.00

LEDS — LAMPS — READOUTS

GB110	100 each Assorted LEDs (colors & sizes) (XC556, XC526, etc.)	$6.00
GB111	40 each NE-2 Neon Type Lamps	3.00
GB112	20 ea. Multiple Readouts (calculators, clocks, timers, LEDS to Panaplex — new, used and rejects	4.00
GB162	50 each 7 Segment Displays (various colors and sizes)	5.00

POTENTIOMETERS

GB113	30 each Miniature Trimmers (100 ohm-1 Meg)	$4.00
GB134	24 each 3/8" square single-turn PC Mount (untested — 10 ohm to 500 ohm) marked	3.00
GB135	24 each 3/8" square single-turn PC Mount (untested — 1K to 50K) marked	3.00
GB136	24 each 3/8" square single-turn PC Mount (untested — 100K to 5 Meg) marked	3.00
GB173	100 ea. 3/8" sq. single-turn (Ni Tan & Sort)	5.00
GB174	25 ea. ½ watt thumbwheel single-turn (500 ohm-5 Meg)	2.00

DIODES

GB177	80 each Assorted Germanium (1N34, 1N68, 1N270)	$2.00
GB107	100 each Silicon (1N914/1N4148)	2.00
GB164	300 each marked, unmarked rectifiers & zeners	2.00
GB175	100 ea. 1 amp - 3 amp (cathode band) silicon rectifiers	3.00

RESISTORS

Part No.	Description	Price
GB116	200 each 1/4 watt resistor assortment	$2.00
GB117	200 each 1/2 watt resistor assortment	2.00
GB118	30 ea. Wire Wound 5,10,20W (1-1,100 ohm)	4.00
GB184	100 each 1 and 2 watt resistor assortment	2.00
GB178	500 each 1/4, 1/2, 1 watt (marked/unmarked) resistors	4.00

SWITCHES

GB120	25 each Miniature slide	$3.00
GB122	20 ea. Reed relays with coil and magnet — glass tube	5.00
GB165	40 asst. toggle, rocker, pushbutton	10.00
GB179	20 each Dip Switches (asst. positions)	6.95

HARDWARE

GB139	40 each Terminal Strips solder and screw types (2 to 8 terminals)	$2.00
GB140	150 each Spacers, standoff, insulators (metal, nylon and plastic)	2.00
GB141	200 each Washers and Spacers (nylon and teflon)	2.00
GB142	50 ea. Chassis mounting feet (rubber and plastic)	2.00
GB144	200 each Solder lugs (small)	2.00
GB145	100 each Lugs — crimp on (some insulated)	2.00
GB146	100 each Grommets, cord strain reliefs and hole plugs	3.00
GB147	500 each Hardware mix (nuts, bolts, screws, lugs)	6.00
GB166	48 Threaded metal and plastic spacers (¼-2" long)	2.00
GB167	200 pcs. sheet metal and metal tapping screws	2.00
GB168	200 pcs. angle bkts, clip insulators, etc.	3.00
GB169	100 pcs. tie wraps and harness clips (3-6")	3.00
GB180	100 pcs. Robot/Slot Car gears, shafts, wheels, motors	9.95

MISCELLANEOUS

GB122	30 each Heat Sinks — assorted sizes	$3.00
GB124	6 each assorted calculator type keyboards	5.00
GB126	50 each Opto-isolators — IL-1 Series (untested)	2.00
GB127	100 each Transistors — plastic and power	3.00
GB128	30 each Toroid Cores — iron and tape	4.00
GB129	50 each Photo Transistors (LPT1)	4.00
GB130	1 each Tape Drive — 6V motor with read/write erase head and 2 cassette tapes (no amplifier)	5.00
GB131	30 each 6" shrink tubing, asst. sizes and colors	4.00
GB137	50 each Chokes, coils and inductors (molded-wire-adjustable)	2.00
GB138	2 each Speakers, 2½", 8 ohm, 1/4 watt	1.95
GB158	300 each mixed resistors, capacitors, diodes, transistors, chokes	5.00
GB160	Printed Circuit Board Contains 50-75 components on each board	2.00
GB163	30 ea. Sockets (Asst. IC and transistor)	4.00
GB171	200 each 1" Shrink tubing, asst. colors and sizes	3.00

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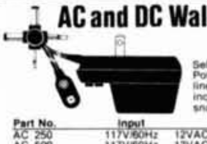
BOOKS
National Semiconductor — Intersil — Intel

30001	**National CMOS Data Book** (640 pages) 74C, CD4000, and A/D Converters	$5.95
30002	**National Interface Data Book** (704 pages) DP, DS8000, DS3600, DS75000, etc.	$5.95
30003	**National Linear Data Book** (1376 pages) LM, LF, ADC, DAC, LH Series	$11.95
30004	**National Series 80 — Board Level Computer** (224 pages)	$4.95
30005	**National TTL Logic Data Book** (624 pages) 7400, LS, L, H, S, and DM8000 Series	$8.95

30006 Above (3) 30001,3,5 as set $24.95/lot

010400	**Intel Component Data Catalog** Full data sheets for Intel's products incl. memory devices, microproc., peripherals & indust./mil. products (1328 pages)	$14.95
205610	**Intel Peripheral Design Handbook** Full data sheets, appl. notes for Intel peripheral device components (644 pages)	$9.95

AC and DC Wall Transformers



With Universal Plug and 9V Battery Snap

Selective voltages: 6,9,12VDC. Polarity selection (+/-), six-foot line from adapter to plugs — six-inch line from adapter to battery snap. 120V/60Hz, 300mA.

Part No.	Input	Output	Price
AC 250	117V/60Hz	12VAC 250mA	$3.95
AC 500	117V/60Hz	12VAC 500mA	$4.95
AC1000	117V/60Hz	12VAC 1 amp	$5.95
AC1700	117V/60Hz	9VAC 1.7 amp	$3.95
DC 800	120V/60Hz	8VDC 400mA (batt. charger)	$1.95
DC6912 (above)	120V/60Hz	6,9,12VDC 300mA	$9.95
DV9200	117V/60Hz	9VDC 200mA	$3.25
DC900	120V/60Hz	9VDC 500mA	$3.95
DC1200	120V/60Hz	12VDC 300mA	$2.95

CONNECTORS

DB25P	D-Subminiature Plug	$2.95
DB25S	D-Subminiature Socket	$3.50
D20418-2	Screw Lock Hdwr. (2) DB25S/P	2/$.99
DB51226	Cover for DB25P/S	$1.75
22/44SE	P.C. Edge (22/44 Pin)	$2.95
UG88/U	BNC Plug	$1.79
UG89/U	BNC Jack	$3.79
UG175/U	UHF Adapter	$ .49
SO239	UHF Panel Recp.	$1.29
PL258	UHF Adapter	$1.60
PL259	UHF Plug	$1.60
UG260/U	BNC Plug	$1.79
UG1094/U	BNC Bulkhead Recp.	$1.29

TRS-80 16K Conversion Kit
Expand your 4K TRS-80 System to 16K
Kit comes complete with:

- **8 ea. MM5290 (UPD416/4116) 16K Dyn. Ram (*ns)**
- **Documentation for conversion**

TRS-16K2 *150ns 19.95
TRS-16K3 *200ns 16.95
TRS-16K4 *250ns 14.95

KEYBOARDS

Datanectics 74-Key Keyboard

Uses EA 20134 Chip (Electronic Arrays). Size: 16¾"L x 5½"W x 1-3/8"H. White, black, blue, grey key caps. (No Data Sheet) —

Part No. KB354 .... **$29.95 ea.**

Micro Switch 69-Key Keyboard

Uses AMI SW20350K Chip. Size: 16-3/8"L x 5¼"W x 1-5/8"H Metal Frame. Light & dark grey key caps (No Data Sheet)

Part No. KB69SD12-2 .... **$19.95 ea.**

Boschert Multi-Voltage Power Supply
5VDC, 12VDC and 24VDC

FEATURES: Voltages*: 5VDC @ 25amps, 12VDC @ 4amps, & 24VDC @ 4amps. Reg. Load: +5V out ±1%, +12 & 24V out ±5% (20-100% load). Overvolt. & overcurr. protection. 115 or 230VAC input. Wt. 4 lbs. Size: 4.95" x 2.50" x 15.00"
***Total average output shall not exceed 200 watts.**

General Description: The "Boschert" Power Supply was originally designed for application with ITT Advance Terminal Controller (ATC). This open frame switching power supply provides user with high current requirements common in use with computer systems. Its compact size provides versatility for mounting into electronic enclosures. Each supply has 6 threaded fasteners (pem nut type) for mounting. Specification requirements to be used with ATC enclosed.

Part No. 200-3010 .... **$69.95 each**
— *MANY OTHERS AVAILABLE • WRITE FOR INFORMATION* —

JE600 Hexadecimal Encoder Kit

FULL 8-BIT LATCHED OUTPUT 19-KEY KEYBOARD

The JE600 Encoder Keyboard Kit provides two separate hexadecimal digits produced from sequential key entries to allow direct programming for 8-bit microprocessor or 8-bit memory circuits. Three additional keys are provided for user operations with one having a bistable output available. The outputs are latched and monitored with 9 LED readouts. Also included is a key entry strobe. Features: Full 8-bit latched output for microprocessor use. Three user-define keys with one being bistable operation. Debounce circuit provided for all 19 keys. 9 LED readouts to verify entries. Easy interfacing with standard 16-pin IC connector. Only +5VDC required for operation. Size: 3½"H x 8¼"W x 8¾"D

JE600/DTE-HK (After assembled as pictured above) **$99.95**
JE600 Kit 19-Key Hexadec. Keyboard, PC Board & Cmpnts. (no case) .. **$59.95**
K19 19-Key Keyboard (Keyboard only) **$14.95**
DTE-HK (case only — 3½"Hx8¼"Wx8¾"D) **$44.95**

New Drake TR5 Transceiver

far above average!

COMING SOON:
RV75 Synthesized VFO
featuring the Drake "VRTO"

• Frequency Synthesized for crystal-controlled stability • VRTO (Variable Rate Tuning Oscillator*) adjusts tuning rate as function of tuning speed. • Resolution to 10 Hz • Three programmable fixed frequencies for MARS, etc. • Split or Transceive operation with main transceiver PTO or RV75

* Patent pending

With the new TR5
versatility and value are spelled D-R-A-K-E . . .

DYNAMIC RANGE

The dynamic range of the TR5 is unexcelled by any transceiver in its class. The TR5's greater than 0 dBm third order intercept point (85 dB two-tone dynamic range) at 20 kHz spacing can be achieved only by the use of a passive diode-ring double balanced mixer. Drake was the first to bring this technology to the Amateur market with a high-level mixer in the TR7.

RELIABLE SERVICE

When you purchase a TR5, or any Drake product, you acquire a product of the latest production techniques, which provide reliable performance.

Yet with a product as sophisticated as one of today's transceivers, after-sales service is a must. Ask any Drake owner. Our Customer Service Department has a reputation second to none.

ACCESSORIES

Drake is the only Amateur Radio manufacturer who offers a full complement of accessories to satisfy almost every desire the HF Amateur may have. This wide selection allows any operator to assemble a station which meets his needs, and assures compatible interfacing and styling instead of a desk full of equipment with a variety of styling and poor operation as a system.

KILOWATT AMPLIFIER

Everyone wants to be heard! The accessory L75 and its 3-500Z (1200 watts PEP input) and a decent antenna will do the trick. This rugged self-contained amplifier / power supply will put the TR5 on an even footing with the best of them.

ENGINEERING

The TR5 and all Drake Transceivers, are backed by the best in engineering. The TR5 is the result of an extensive engineering effort, combining proven past techniques and ideas with new state of the art concepts.

As a result, the TR5 will not be superceded by a new model every six months. It represents a true radio communications value that will provide many years of operating enjoyment.

Features, availability and prices subject to change without notice or obligation.

See your Drake dealer or write for additional information.

R. L. DRAKE COMPANY DRAKE

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

(Continued from page 6.)

Our last method of communications is RATT, or RTTY. Teletype is tasked with being the workhorse of battalion-to-higher-headquarters communications. You'll find everything from command instructions to orders for repair parts being transmitted by RATT. In many instances the RATT operators are the busiest of all the platoon members.

The RATT van is a Dodge pickup truck with a mobile shelter in the bed. Power for the radios can come from either a 100-amp generator hooked to the truck's engine or from a towable 5-kW generator. You would figure that you could tow the generator with the truck but you can't. It's too heavy. So you always have to depend on someone else to pull your generator and, as you'd expect, this causes problems. A vertical is used for mobile stations and a dipole when staying in one place. The teletype units are model GGC-3s, so hams familiar with RTTY would be at home with them.

Since RATT is the workhorse, or most important element, in battalion-to-higher-headquarters communications, you have to ensure that it is fully protected from enemy interception. Inside the van there is equipment that will code the RATT signals. And it's policy that whenever the radio is used it will be coded. Enough said about that! Because of this security equipment, you really can't hop in the van, go out in the boonies, and play field day. It's a shame because, for a ham, it would be a nice diversion from the day to day routine.

That's about it for my summer camp. Two weeks spent in the field putting systems in and taking them down. And a lot of time spent hurrying up and waiting. Some things never change. That's for sure! It was an interesting experience and I hope a learning one for all involved. I know I learned quite a bit. I just hope we never have to go to war for me to use that experience.

J. Craig Clark, Jr., N1ACH
assistant publisher

NEW

"DX-traordinary."

Superior dynamic range, auto. antenna tuner, QSK, dual NB, 2 VFO's, general coverage receiver.

TS-930S

The TS-930S is a superlative, high performance, all-solid state, HF transceiver keyed to the exacting requirements of the DX and contest operator. It covers all Amateur bands from 160 through 10 meters, and incorporates a 150 kHz to 30 MHz general coverage receiver having an excellent dynamic range.
Among its other important features are, SSB slope tuning, CW VBT, IF notch filter, CW pitch control, dual digital VFO's, CW full break-in, automatic antenna tuner, and a higher voltage operated solid state final amplifier. It is available with or without the AT-930 automatic antenna tuner built-in.

TS-930S FEATURES:

- **160-10 Meters, with 150 kHz - 30 MHz general coverage receiver.**
  Covers all Amateur frequencies from 160-10 meters, including new WARC, 30, 17, and 12 meter bands, on SSB, CW, FSK, and AM. Features 150 kHz - 30 MHz general coverage receiver. Separate Amateur band access keys allow speedy band selection. UP/DOWN bandswitch changes in 1-MHz steps. A new, innovative, quadruple conversion, digital PLL synthesized circuit provides superior frequency accuracy and stability, plus greatly enhanced selectivity.
- **Excellent receiver dynamic range.**
  Receiver two-tone dynamic range, 100 dB typical (20 meters, 500 Hz CW bandwidth, at sensitivity of 0.25 μv, S/N 10 dB), provides the ultimate in rejection of IM distortion.
- **All solid state, 28 volt operated final amplifier.**
  The final amplifier operates on 28 VDC for lowest IM distortion. Power input rated at 250 W on SSB, CW, and FSK, and at 80 W on AM. Final amplifier protection circuit with cooling fan, SWR/Power meter built-in.
- **Automatic antenna tuner, built-in.**
  Available with AT-930 antenna tuner built-in, or as an option. Covers Amateur bands 80-10 meters, including the new WARC bands. Tuning range automatically pre-selected with band selection to minimize tuning time. "AUTO-THRU" switch on front panel.
- **CW full break-in.**
  CW full break-in circuit uses CMOS logic IC plus reed relay for maximum flexibility, coupled with smooth, quiet operation. Switchable to semi-break-in.
- **Dual digital VFO's.**
  10-Hz step dual digital VFO's include band information. Each VFO tunes continuously from band to band. A large, heavy, flywheel type knob is used for improved tuning ease. T.F. Set switch allows fast transmit frequency setting for split-frequency operations. A=B switch for equalizing one VFO frequency to the other. VFO "Lock" switch provided. RIT control for ±9.9 kHz receive frequency shift.
- **Eight memory channels.**
  Stores both frequency and band information. VFO-MEMO switch allows use of each memory as an independent VFO, (the original memory frequency can be recalled at will), or as a fixed frequency. Internal Battery memory back-up, estimated 1 year life. (Batteries not Kenwood supplied).
- **Dual mode noise blanker ("pulse" or "woodpecker").**
  NB-1, with threshold control, for pulse-type noise. NB-2 for longer duration "woodpecker" type noise.
- **SSB IF slope tuning.**
  Allows independent adjustment of the low and/or high frequency slopes of the IF passband, for best interference rejection.
- **CW VBT and pitch controls.**
  CW VBT (Variable Bandwidth Tuning) control tunes out interfering signals. CW pitch controls shifts IF passband and simultaneously changes the pitch of the beat frequency. A "Narrow/Wide" filter selector switch is provided.
- **IF notch filter.**
  100-kHz IF notch circuit gives deep, sharp, notch, better than -40 dB.
- **Audio filter built-in.**
  Tuneable, peak-type audio filter for CW.
- **AC power supply built-in.**
  120, 220, or 240 VAC, switch selected (operates on AC only).
- **Fluorescent tube digital display.**
  Fluorescent tube digital display has analog type sub-scale with 20-kHz steps. Separate 2 digit display indicates RIT frequency shift.
- **RF speech processor.**
  RF clipper type processor provides higher average "talk-power," plus improved intelligibility. Separate "IN" and "OUT" front panel level controls.
- **One year warranty.**
  The TS-930S carries a one year limited warranty on parts and labor.

Other features:

- SSB monitor circuit, 3 step RF attenuator, VOX, and 100-kHz marker.

Optional accessories:

- AT-930 automatic antenna tuner.
- SP-930 external speaker with selectable audio filters.
- YG-455C-1 (500 Hz) or YG-455CN-1 (250 Hz) plug-in CW filters for 455-kHz IF.
- YK-88C-1 (500 Hz) CW plug-in filter for 8.83-MHz IF.
- YK-88A-1 (6 kHz) AM plug-in filter for 8.83-MHz IF.
- MC-60 (S-8) deluxe desk microphone with UP/DOWN switch.
- TL-922A linear amplifier.
- SM-220 station monitor.
- HC-10 digital world clock.
- HS-6, HS-5, HS-4 headphones.

More information on the TS-930S is available from all authorized dealers of Trio-Kenwood Communications
1111 West Walnut Street,
Compton, California 90220

KENWOOD
...pacesetter in amateur radio

Specifications and prices are subject to change without notice or obligation.

TR-2500

size, smaller price!

The TR-2500 is a compact 2 meter FM handheld transceiver featuring an LCD readout, 10 memories, lithium battery memory back-up, memory scan, programmable automatic band-scan, Hi/Lo power switch and built-in sub-tone encoder.

TR-2500 FEATURES:

- Extremely compact and light weight 66 (2-5/8) W x 168 (6-5/8) H x 40 (1-5/8) D, mm (inches), 540 g, (1.2 lbs) with NiCd pack.
- LCD digital frequency readout.
- Ten memories includes "MO" memory for non-standard split repeaters.
- Lithium battery memory back-up, built-in, (est. 5 year life).
- Memory scan.
- Programmable automatic band scan allows upper and lower frequency limits and scan steps of 5 kHz and larger (5, 10, 15, 20, 30 kHz ... etc) to be programmed.
- UP/DOWN manual scan.
- Repeater reverse operation.
- 2.5 W or 300 mW RF output. (HI/LOW power switch).
- Built-in tunable (with variable resistor) sub-tone encoder.
- Built-in 16-key autopatch.
- Slide-lock battery pack.
- Keyboard frequency selection.
- Covers 143.900 to 148.995 MHz in 5 kHz steps.
- Optional power source, MS-1 mobile or ST-2 AC charger/ power supply allows operation while charging. (Automatic drop-in connections.)
- High impact plastic case.
- Battery status indicator.
- Two lock switches for keyboard and transmit.

CONVENIENT TOP CONTROLS

Standard accessories:

- Flexible rubberized antenna with BNC connector.
- 400 mAH heavy-duty Ni-Cd battery pack.
- AC Charger.

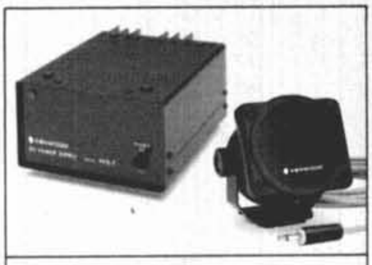
Optional accessories:

- VB-2530 25 W RF Power amp, BNC-BNC cables, and mounting bracket, supplied.
- MS-1 13.8 VDC mobile stand/ charger/power supply.

Optional accessories:

- ST-2 Base station power supply and quick charger (approx 1 hr.)
- TU-1 Programmable "DIP switch" (CTCSS) encoder.
- SMC-25 Speaker microphone.
- LH-2 Deluxe leather case.
- PB-25 Extra Ni-Cd battery pack, 400 mAH, heavy-duty.
- BT-1 Battery case for AA manganese or alkaline cells.
- BH-2 Belt hook.
- WS-1 Wrist strap.
- EP-1 Earphone.

NEW



Optional accessories:

- KPS-7 DC power supply for TR-9130 base station operation. 7 A intermittent, 6 A continuous, protection circuit built-in.
- SP-40 compact mobile speaker. Only 2-11/16 W x 2-1/2 H x 2-1/8 D (inches). Handles 3 watts of audio.
- TK-1 AC adapter for memory back-up (not shown).

TR-9130

All mode (FM/SSB/CW) 25 watts, plus...!!!

The TR-9130 is a powerful, yet compact, 25 watt FM/USB/LSB/ CW transceiver, featuring six memories, memory scan, memory back-up capability, automatic band scan, all-mode squelch, and CW semi break-in. Available with a 16-key autopatch UP/ DOWN microphone (MC-46), or a basic UP/DOWN microphone.

TR-9130 FEATURES:

- 25 Watts RF output on all modes, (FM/SSB/CW).
- FM/USB/LSB/CW all mode. The mode switch, with the digital step (DS) switch, determines the size (100 Hz, 1 kHz, 5 kHz, 10 kHz) of the tuning step.
- Six memories. On FM, memories 1-5 for simplex or ±600 kHz offset, using OFFSET switch. Memory 6 for non-standard offset. All six memories may be simplex, any mode.
- Memory scan. Scans memories in which data is stored.
- Internal battery memory back-up, using 9 V Ni-Cd battery, (not KENWOOD supplied). Memories are retained approx. 24 hours, adequate for the typical move from base to mobile. External back-up terminal on the rear.
- Automatic band scan. Scans within whole 1 MHz segments (ie., 144.0-144.999 MHz).
- Dual digital VFO's.
- Transmit frequency tuning while transmitting, for OSCAR operations.
- Squelch circuit, all modes (FM/SSB/CW).
- Repeater reverse switch.
- Tone switch.
- CW semi break-in circuit with sidetone.
- Digital display with green LED's.
- Compact size and lightweight. 170 (6-11/16) W x 68 (2-11/16) H x 241 (9-1/2) D mm (inch). 2.4 kg (5.3 lbs.) weight.
- Covers 143.9 to 148.9999 MHz.
- HI/LOW power switch. 25 or 5 watts on FM or CW.
- Transmit offset switch.
- High performance noise blanker.
- RF gain control. • RIT circuit.

KENWOOD

TRIO-KENWOOD COMMUNICATIONS
1111 West Walnut, Compton, California 90220

More Details? CHECK—OFF Page 92

HAM CALENDAR

June

SUNDAY | MON | TUES | WED | THUR | FRI | SATURDAY

W1AW Schedule

October 25, 1981-April 24, 1982 MTWThFSSn = Days of Week Dy = Daily
W1AW code practice and bulletin transmissions are sent on the following schedule:

EST	Slow Code Practice	MWF: 9 A.M., 7 P.M.; TThSSn: 4 P.M., 10 P.M
	Fast Code Practice	MWF: 4 P.M., 10 P.M.; TTh: 9 A.M.; TThSSn: 7 P.M
	CW Bulletins	Dy: 5 P.M., 8 P.M., 11 P.M.; MTWThF: 10 A.M
	RTTY Bulletins	Dy: 6 P.M., 9 P.M., 12 P.M.; MTWThF: 11 A.M.
	Voice Bulletins	Dy: 9:30 P.M., 12:30 A.M.
CST	Slow Code Practice	MWF: 8 A.M., 6 P.M.; TThSSn: 3 P.M., 9 P.M
	Fast Code Practice	MWF: 3 P.M., 9 P.M.; TTh: 8 A.M., TThSSn: 6 P.M
	CW Bulletins	Dy: 4 P.M., 7 P.M., 10 P.M.; MTWThF: 9 A.M.
	RTTY Bulletins	Dy: 5 P.M., 8 P.M., 11 P.M.; MTWThF: 10 A.M
	Voice Bulletins	Dy: 8:30 P.M., 11:30 P.M.
PST	Slow Code Practice	MWF: 6 A.M., 4 P.M., TThSSn: 1 P.M., 7 P.M
	Fast Code Practice	MWF: 1 P.M., 7 P.M., TTh: 6 A.M.; TThSSn: 4 P.M
	CW Bulletins	Dy: 2 P.M., 5 P.M., 8 P.M.; MTWThF: 7 A.M.
	RTTY Bulletins	Dy: 3 P.M., 6 P.M., 9 P.M.; MTWThF: 8 A.M.
	Voice Bulletins	Dy: 6:30 P.M., 9:30 P.M

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OREGON STATE HAM CONVENTION — Seaside Convention Center, Seaside, OR. For information contact Doc McLendon, W7GWC, POB 920, Seaside, OR 97123 — **4-6**.

5

PENNYROYAL ARS ANNUAL JEFFERSON DAVIS QSO PARTY — 1500 to 2400 UTC. Suggested frequencies: 3.940, 7.260, 14.310, 21.410, and 28.610 MHz phone and 3.730 MHz CW — **5**.*

SUPERFEST 4 — by Northern Colorado ARC at the McMillen Bldg., Larimer County Fairgrounds, Loveland, CO. Contact Gene Bellamy, WDØDRM, 3124 West 6th St., Greeley, CO — **5**.

GRAND RAPIDS FESTIVAL SWAP & SHOP — by the Independent Repeater Association at the Kentwood Field House south of 60th St. on Kalamazoo Ave. Contact I.R.A. SWAP, 562-92nd St. SE, Byron Ctr., MI 49315 — **5**.

THE NORTH AREA REPEATER ASSOCIATION'S SWAPFEST & EXPO — Minnesota State Fairgrounds, St. Paul. Contact Amateur Fair, POB 30054, St. Paul, MN 55175 — **5**.

PEA PATCH ISLAND MINI EXPEDITION – by Wilmington-area hams using your own call and the Fort Delaware identifier. See Operating Events – **5-6**.

THE ARCTIC ARC OF FAIRBANKS HAMFEST — Kiwanis AG Hall, Tanana Valley Fairgrounds. Contact Herb Walls, KL7JLF, POB 1625 Fairbanks, AK 99707 — **5**.

6

11TH ANNUAL MILTON ARC HAMFEST — Allenwood Firemen's Fairgrounds, U.S. Route 15. Contact Jerry Williamson, WA3SXQ, 10 Old Farm Lane, Milton, PA 17847 – **6**.

HUMBOLDT ARC ANNUAL HAMFEST — Bailey Park, N. 22nd Ave., Humboldt, TN. Contact Ed Holmes, W4IGW, 501 N. 18th Ave., Humboldt, TN 38343 — **6**.

CHELSEA SWAP & SHOP – Chelsea Fairgrounds, Chelsea, MI. Contact Bill Altenberndt, 3132 Timberline, Jackson, MI 49201 - **6**.

JERSEY SHORE HAMFEST & ELECTRONIC FLEA MARKET – By The Fort Monmouth ARC and Haverim. Contact Jersey Shore Hamfest, POB 2078, Ocean, NJ 07712 – **6**.

ROME HAM FAMILY DAY – sponsored by the Rome ARC, Beck's Grove, Oswego Road, Rome, NY. Contact Rome Radio Club, POB 721, Rome, NY 13440 – **6**.

MID-ATLANTIC AREA QUALITY HAMFEST – Prince William County Fairgrounds, sponsored by The Ole Virginia Hams ARC of Manassas Contact Jim Lascaris, WA2QEJ, 11053 Camfield Court, Manassas, VA 22110 – **6**.

7

WEST COAST BULLETIN – 9 PM PDT (8 PM PST, 0400 UTC) 354C KCS A 1 22 WPM – **7**

8

AMSAT East Coast Net 3850 kHz 8PM EST (0100Z Wednesday Morning)

AMSAT Mid-Continent Net 3850 kHz 8PM CST (0200Z Wednesday Morning)

AMSAT West Coast Net 3850 kHz 7PM PST (0300Z Wednesday Morning)

9

10

11

HARBORFEST-TRICENTENNIAL SPECIAL EVENT STATION – by the Tidewater-area Amateur clubs. The station will operate 24 hours a day 80 through 2 meters CW and SSB. Contact Bill Verebely, KC4YX, 3101 Petre Rd., Chesapeake, VA 23325 – **11-14**.*

12

CENTRAL MICHIGAN AMATEUR REPEATER ASSOCIATION'S 8TH ANNUAL HAMFEST — Valley Plaza Complex off Rt. 10, Midland, MI. Contact Carol Hall, WD8DQG, 4651 Cardinal Dr., Mt. Pleasant, MI 48858 — **12**.

KOOTENAI ARC HAMFEST '82 — Kootenai County Fairgrounds, north of Coeur D'Alene on old Hwy. 95. Contact Avon Anderson (SASE), WB7WBZ, N. 1035 Highland Ct., Post Falls, ID 83854 — **12**.

STATEN ISLAND ARA FLEA MARKET – All Saints Episcopal Church, Staten Island, NY. Contact George Rice, Jr., WA2AMJ – **12**.

STAR SPANGLED BANNER SPECIAL EVENTS STATION – Station WB3KUH will operate from Ft. McHenry, Baltimore, MD. Both SSB and CW will be used on 20, 15, 40, 2, and 6 meters – **12-13**.*

WORLDWIDE SOUTH AMERICA CW CONTEST – **12-13**.

ARRL VHF QSO PARTY – **12-13**.

13

15TH ANNUAL GOODYEAR ARC HAMFEST — Goodyear Wingfoot Lake Park, near SR224 and 43 east of Akron. Contact Don W. Rogers (SASE), WA8SXJ, 161 S. Hawkins Ave., Akron, OH 44313 – **13**

HALL OF SCIENCE ARC INDOOR/OUTDOOR HAMFEST – Municipal Parking Lot, 80-25 126th St., Kew Gardens, Queens, NY. Contact KA2DTB — **13**.

MONROE COUNTY RADIO COMMUNICATIONS HAMFEST at Monroe Community College, Raisinville Rd., Monroe, MI. Contact Fred Lux, WD8ITZ, POB 982, Monroe, MI 48161 – **13**

THE 6-METER CLUB OF CHICAGO'S SILVER ANNIVERSARY HAMFEST — Santa Fe Park, 91st and Wolf Rd., Willow Springs, IL. Contact Val Hellwig, K9ZWV, South 60th Court, Cicero, IL 60650 – **13**.

TRI-STATE ARA 20TH ANNUAL HUNTINGTON HAMFEST – Camden Park off route 60 West. Contact T.A.R.A. Inc., POB 4100, Huntington, WV 25729 - **13**

CHAMPAIGN LOGAN ARC ANNUAL HAMFEST & FLEA MARKET – Logan County Fairgrounds, Bellefontaine, OH. Contact M.A. Griswold, W8JXM, POB 301, Urbana, OH 43078 – **13**

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15

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AMSAT West Coast Net 3850 kHz 7PM PST (0300Z Wednesday Morning)

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18

SUMMER SMIRK PARTY – **18-20**

19

RARITAN VALLEY RADIO CLUB'S 11TH ANNUAL HAMFEST & FLEA MARKET – Columbia Park, Dunellen, NJ. Contact Bob, KB2EF – **19**

THIRD ANNUAL YANKEE HAMFEST — Sponsored by the Yankee Radio Club, Oxford County Fairgrounds, Oxford, ME – **19**.

FIFTH ANNUAL TREASURE VALLEY HAMFEST – sponsored by the Voice of Idaho ARC and the Treasure Valley Radio Association. Contact Samuel K. Sower, N7DOV, 1909 Grant St., Caldwell, ID 83605 – **19-20**

CAPE FEAR ARS SPECIAL EVENT STATION — Club Call WB4YZF from the 14th annual National Hollerin' Contest, Spivey's Corner, NC. Operation will be on 7235 MHz between 1300 and 2100 UTC — **19**.*

20

A5 MAGAZINE WORLDWIDE SSTV DX CONTEST – **20-21**

LANCASTER & FAIRFIELD COUNTY ARC ANNUAL LANCASTER HAMFEST – *Fairfield County Fairgrounds, Lancaster, OH. Contact Box #3, Lancaster, OH 43130* – **20**.

LAKE COUNTY ARC 10TH ANNUAL DAD'S DAY HAMFEST — Lake County Fairgrounds, Industrial Arts Bldg., Crown Point, IN. Contact Walley Kozol, KA9FDC, 624 N. Rensselear St., Griffith, IN 46319 – **20**

21

WEST COAST BULLETIN – 9 PM PDT (8 PM PST, 0400 UTC) 354C KCS A-1 22 WPM – **21**

22

AMSAT East Coast Net 3850 kHz 8PM EST (0100Z Wednesday Morning)

AMSAT Mid-Continent Net 3850 kHz 8PM CST (0200Z Wednesday Morning)

AMSAT West Coast Net 3850 kHz 7PM PST (0300Z Wednesday Morning)

23

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26

TRI-CITY ARC SPECIAL EVENTS DAY – Goodnoe Wind Turbine Site, 10 miles E of Goldendale, WA – **26-27**.*

ARRL FIELD DAY – **26-27**.

27

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29

AMSAT East Coast Net 3850 kHz 8PM EST (0100Z Wednesday Morning)

AMSAT Mid-Continent Net 3850 kHz 8PM CST (0200Z Wednesday Morning)

AMSAT West Coast Net 3850 kHz 7PM PST (0300Z Wednesday Morning)

30

SEE COMING EVENTS

operation upgrade: part 7

In this month's issue, Bob discusses the basics of transmitter design

This article is aimed *at helping you with the fundamentals of ham radio.* With this information you should understand the subjects on the FCC test questions better. The subjects explained are specifically for Novice, Technician/General, and Advanced class license aspirants. After the fundamentals are presented, in as simple a form as possible, there will be a short series of Extra-class license subject articles.

The first article, or Part 1, in the September, 1981, issue, discussed basic direct current (dc) circuits involving resistors and voltage sources. Part 2 (October) investigated some alternating current (ac) circuits with inductors, capacitors, and resistors. Part 3 (January) took a broad look at active devices such as diodes, transistors, and vacuum tubes. Part 4 (February) went into the basic power supplies and a few simple amplifier circuits. Part 5 (March) developed the theory of oscillators. Part 6 (April) was an overall outline of a variety of amplifier forms including classes of operation. In Part 7 we will put some of the basic theory to work in explaining radiotelegraph (CW or A1) transmitters of various types, and include a little about antennas. This is really the first "radio" article. Prior subjects were used to lay the groundwork, so that you might have a better chance of understanding how "systems" composed of two or more circuits can function. It might be a good idea to go back and thumb through the last few articles so that the terms we used will be fresh in your mind.

a basic transmitter

To communicate on the Amateur bands with some other Amateur down the street, across town, across the country, or across the oceans, you must have: (1) something to generate a radio frequency ac, (2) an antenna to radiate the rf energy into space, (3) some way of controlling the rf ac to make it carry intelligence for you, and (4) a device which will make received rf ac signals audible to you (a receiver).

Let's look at the simplest kind of rf ac generator — an oscillator — that will allow you to actually communicate with someone else. The Hartley oscillator of **fig. 1** should work satisfactorily on the 160, 80, and 40 meter Amateur bands. As a transmitter it may not have much power output, but you might be able to communicate up to 500 miles with it if conditions are right.

When the key is closed the rf power-type bipolar *junction transistor* (BJT) circuit starts oscillating. You can check to see if it is oscillating with a two-turn loop of wire connected across a low power flashlight lamp, shown in the box. When the loop is coupled (held near) to the LC circuit coil, the lamp should glow.

The rf ac developed in the tuned LC circuit is coupled through the 20-pF capacitor to the antenna wire. If the antenna wire is cut to a half-wavelength ($\lambda/2$) to make it resonant at 7 MHz, where $\lambda/2$ *in feet* $= 468/f_{MHz}$ *(66 ft* $\pm$*)*, or $\lambda/2$ *in meters* $= 142.5/f_{MHz}$ *(20.4 m)*, electrons will oscillate back and forth along the antenna producing 7-MHz electromagnetic fields around the wire, and 7-MHz electrostatic fields from

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end to end. These fields expand and radiate out into the space surrounding the antenna. This forms the radio wave that travels outward with a maximum strength at right angles to a $\lambda/2$ antenna, and minimum strength in the direction of the wire. The velocity of radio wave travel in a vacuum is roughly 186,000 mi/s, or 300,000,000 m/s.

If the key is closed and opened to produce Morse code letters, it is possible to communicate with other Amateurs. There are, however, some difficulties with this simple circuit. For one thing, any change in the emitter-collector voltage will change the frequency of oscillation a little. The frequency is also affected by the voltage built up across the 200-pF base-to-LC coupling capacitor. As a result, when the key is closed the emitter-collector voltage (E_C) rises to 12 volts as soon as the 0.01-μF capacitor between collector and ground charges to this value. The 200-pF capacitor must also rise to its operating voltage. Until these final voltages are attained the frequency will continually be changing. It may be only a few hundred hertz of frequency variation and may occur in a few milliseconds, but it is usually noticeable to the listener as a rising or falling chirping tone at the make and break of each stroke. We say the signal sounds chirpy. This is not good.

[Before we go any further, it's important to say that you may build such a QRP (low power) transmitter, but without a license you cannot legally use it if you connect it to an antenna. You must have at least a Novice or Technician license before you can operate it on the Novice bands (3700-3750 kHz for the 80-meter band, and 7100-7150 kHz on the 40-meter band). If you have a General or higher class license you may use it to transmit code on the 160-meter band (1800-2000 kHz), or the 80-meter band (3525-3775 and 3800-4000 kHz), or the 40-meter band (7025-7300 kHz). See FCC Rules and Regulations, Part 97 for the complete list of Amateur frequencies.]

Another unsatisfactory feature about a simple transmitter like this is the frequency instability it will have. For example, if the power supply (battery) changes voltage when under a load (key down) the frequency will change. If you put your hand near the LC circuit you will be substituting the dielectric coefficient of your hand for that of the air surrounding the LC circuit. As a result the overall capacitance of this circuit increases and the frequency will decrease. If the antenna swings in the wind its capacitance to ground will change and this will be felt by the LC circuit as a change in capacitance across it, resulting in a swinging of the transmitting frequency. As the components (BJT, capacitors, coil, resistors) warm or cool, their values may change slightly, usually causing a slow drift of frequency.

All in all, it doesn't seem like a worthwhile rig to be using. But by employing mica or air dielectric capacitors, a heavy-duty battery or a voltage-regulated power supply, by using a good heatsink on the transistor, by shielding the oscillator (building it inside a metal box, dashed lines), by grounding the shield, and by stretching and holding the antenna tight, such a little transmitter can be a lot of fun to play with. If you use a crystal oscillator instead of the Hartley circuit, it will usually result in a stable output, but on only the one frequency to which the crystal has been ground.

Although an oscillator can be made that will operate with the maximum of one kilowatt (1 kW) dc power input permitted for Amateur transmitters, increasing the power output of an oscillator above a few watts will usually result in very poor frequency stability characteristics and bad key clicks.

Briefly, if it takes 100 cycles of the 7-MHz rf ac being generated to build up to the maximum carrier ac level after the key is pressed, this represents the first quarter cycle of a modulating wave having a frequency of about 4×100, or 7,000,000/400, or 17.5 kHz. As a result, when keying you would not only be transmitting energy at the 7-MHz carrier frequency, but also "sideband" energy out 17.5 kHz on both sides of the carrier. These broad-bandwidth spurious signals will sound like clicks to anyone having a receiver tuned to anywhere within at least 17.5 kHz of your carrier frequency. Furthermore, when the key opens, the carrier amplitude drops very rapidly, causing even higher frequency sidebands and key clicks that extend out even further.

A method of reducing key clicks is to slow the buildup and the drop-off of the carrier ac. This can be accomplished by using a key-click filter: an inductor (which opposes any change in current) in series with the key, and a capacitor (which opposes any change in voltage) across the key, as shown below the key symbol in **fig. 1**. The resistor reduces the discharge current when the key closes across the charged capacitor, preventing pitting of the key contacts. Unfortunately, slowing the rise and fall of the carrier strength of an oscillator also accentuates the chirping. Transmitters up to perhaps 10 watts output will not usually produce bothersome key clicks. Above this power level they may begin to give trouble unless some improved form of keying is used.

an MOPA transmitter

The next step in producing a more desirable transmitter is to add an amplifier after the oscillator. This makes up a system called a master-oscillator-power-amplifier, or an MOPA. The MOPA can deliver much more power to the antenna and still be relatively stable.

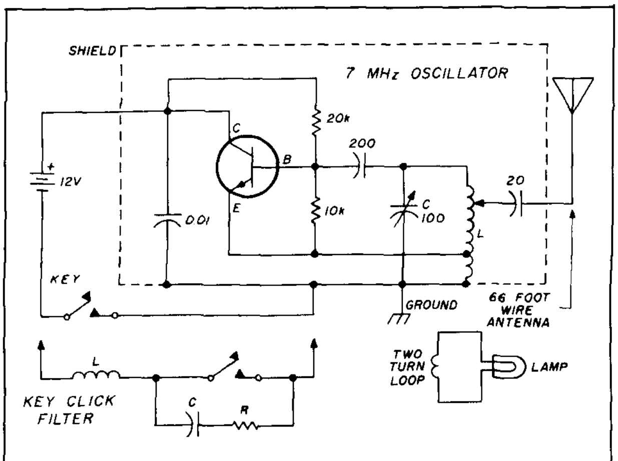

fig. 1. Simple self-excited oscillator 7 MHz band CW transmitter.

With an MOPA, in most cases the oscillator is allowed to operate all of the time that the transmitter is turned on. Keying is usually accomplished by switching the power amplifier on and off with a telegraph key, as in **fig. 2**, or more likely, with a keying relay, shown dashed. This diagram illustrates a possible MOPA that could be used to transmit CW signals. The term CW means continuous-amplitude waves, and is used to indicate code transmissions. In the "good old days" of radio, spark transmitters were used to send code. But spark oscillators generated rf ac in 120 to 1000 wave trains (dying out rf ac bursts) per second. Because of the nonsinusoidal damped characteristics of these rf pulses the emitted wave was very broad. When vacuum tubes (VTs) were developed they produced constant amplitude (strength) carriers. When not carrying intelligence (on-off code, or speech "modulation") a carrier has essentially zero bandwidth and is termed AØ (A-zero) by the FCC. When broken up into code signals the emission is called A1. The A indicates a carrier having its amplitude varied, and the 1 indicates that intelligence is being conveyed by using some kind of a code. The bandwidth of such an emission will be broader the faster the code speed used.

The MOPA circuit is shown in both block diagram form and as a schematic diagram. In both cases there is a transmit-receive (TR) switch to throw the antenna from receiver to transmitter when it is desired to change from receive to transmit or back.

Do you recognize the oscillator to be a JFET Hartley? It is shown capacitively coupled to the grid of a triode VT, which in turn is inductively coupled to a tuned antenna circuit.

Although shown as a JFET, the active device in the oscillator might just as well be a BJT or a VT. This stage determines the transmitting frequency of the transmitter. The output power of the oscillator might be about 1 watt of rf ac. With active devices made for higher power, the oscillator output may produce several watts of rf ac drive to the input of the amplifier. Usually, the less the power output of an oscillator the better its stability (and the less frequency drift, chirp, etc.).

The amplifier is shown as a "neutralized" VT triode. It might have been shown as a VMOS or other power FET, a power BJT, or a beam power tetrode. The FETs would have essentially the same circuitry as the triode VT, but the BJTs, being a lower impedance type device, would require some variations in the circuit impedances (tapped down coils, greater capacitance values, etc.). As explained in Part 5, the capacitance which exists between plate and grid of a VT triode (drain-to-gate of an FET) can feed back ac energy and cause an amplifier to oscillate rather than amplify. To prevent this, the electrical center of the output tuned circuit can be tapped and bypassed to

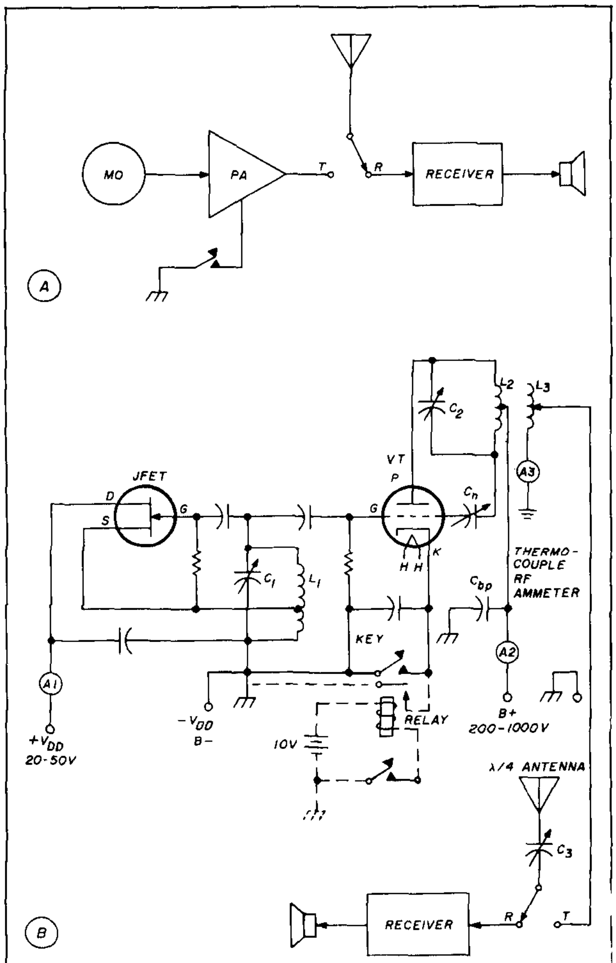

fig. 2. MOPA transmitter with power amplifier keying, *A* in block form, and *B* in schematic form showing relay keying dashed.

ground. Now the plate current pulses coming down through the top half of L_2 start LC circuit flywheel oscillations. The rf ac is developed at the frequency of the pulses, which are at the frequency of the oscillator's ac that is driving the grid or input circuit of the PA. Since the center of the LC circuit is at ground potential due to bypass capacitor C_{bp}, when the top of the coil is ac positive the bottom of the coil will be equally ac negative. Any feedback from plate to grid due to interelectrode capacitance can be completely cancelled, provided the neutralizing capacitor C_n is set to whatever the value of the P-G feedback capacitance happens to be.

Although we say the feedback capacitance is the interelectrode capacitance of the active device, actually it is somewhat more because of nearness of connecting wires and components external to the active device. If the P-G capacitance is 5 pF, there might also be 3 pF of external capacitance, requiring a setting of 8 pF for C_n. For this reason C_n is almost always a small variable capacitor.

The keying is accomplished by closing and opening the PA cathode-to-ground connection. Can you see that if you happened to get your fingers across the open key that you would be between ground (B−) and high voltage (B+) through the conductance of the triode? This will really jar your teeth! So, whenever there is more than 100 or possibly 200 volts involved, a keying relay should be used, shown dashed. The low voltage of the keying circuit will cause no physical discomfort, since *with dry hands* you will normally feel no current shock with potentials up to perhaps 40 to 50 volts. (With really good electrical contact to your two hands 12 to 15 volts might kill you!)

If you can imagine the relay as having two sets of arms and contacts (the second connected to the antenna), can you see that it would be possible, by pushing the key down, to not only close the cathode lead, but also to shift the antenna's relay arm from receive to transmit at the same time? When your key is up you would be able to hear incoming signals because the antenna would then be connected to the receiver. When the key is down the transmitter is coupled to the antenna and all you would hear is your own transmitter. This is known as "full break-in" (or QSK, meaning, I can hear you between my dots or dashes), which is the only way to go on CW. The other Amateur can stop you by merely pushing his or her key down for a second and you will hear the signal and stop transmitting. If other Amateurs start tuning up on your frequency while you are sending you will know it and can move away from the QRM (interference).

To tune an MOPA transmitter like this you would go through a series of steps somewhat as follows:

1. Turn on the oscillator power supply (not the PA supply) and adjust C_1 until you hear your signal (usually a whistle) on the spot on the band where you want to operate.

2. Listen to your signal on the receiver and adjust C_2 until you obtain a maximum received signal of the oscillator feeding or leaking through the amplifier stage.

3. Rotate the neutralizing capacitor to minimum received signal, which indicates proper amplifier neutralization.

4. Turn on the PA power supply, and, as soon as you press the key, adjust C_2 for parallel resonance, shown by a minimum plate current on A_2. (The oscillator meter A_1 should change very little at any time if the amplifier is neutralized.)

5. With this quarter-wavelength antenna (33 ft for 7 MHz) adjust C_3 to antenna series resonance, shown by a maximum current indication on the rf ammeter A_3. You will find that this will also produce an increase in the A_2 reading because now the amplifier is being more heavily loaded. Under a load the PA LC circuit Q goes down, and it presents a lower impedance to the VT, resulting in greater plate current (I_p).

Always be sure to listen to the frequency on which you plan to work before you transmit anything. Even if the frequency is clear do not hold your key down any longer than about five seconds, and then immediately send TEST DE followed by your call sign. If the band is busy or your testing is going to take a protracted time, couple your PA to a dummy load instead of the antenna. Tune up on low power (low B+). A 100-watt lamp has a cold resistance of about 20 ohms and a hot resistance of about 144 ohms. With a few-turn loop across it, it can be used as a dummy load for transmitters that emit 10 to 100 watts of rf. Keep in mind that even with a dummy load your signal may be carrying quite a few miles. If you are using an antenna that requires no tuning, it will usually require a 50-ohm or a 70-ohm dummy load. Actually, a 2:1 to 3:1 impedance mismatch will not matter too much for a dummy load (50 ohms to 100 ohms represents a 2:1 mismatch and a standing wave ratio, or SWR, of 2:1. This will be discussed more in later articles.)

Actually, the antenna ammeter is not necessary except that it can be used to tell you your approximate power output by computing power from $P = I^2R$. You can use 40 ohms for the impedance at ground for a quarter-wavelength antenna.

The amount or degree of coupling to the antenna can be adjusted by changing the number of turns you use on the antenna coil. With only one turn you will couple very little energy to the antenna. As you move the tap (arrow) up the coil you will be able to couple more energy out of the L_2C_2 tank circuit, but you will also be increasing the length of the antenna circuit and its inductance. We say you are making the antenna more inductive (increasing its X_L value). To compensate for this you will have to decrease the antenna capacitor C_3 a little (increasing its X_C) to bring the antenna circuit back into resonance. How much coupling is required is determined by how much plate (drain, collector) current you want to use. If the tube manual says use 100 mA (milliamperes) and you find that at L_2C_2 resonance and I_p minimum you read only 80 mA on meter A_2, you can safely increase coupling. If your I_p value is 110 mA when the rig is tuned you are overcoupled and should back off on the coupling or you may shorten the life of the tube needlessly. The difference between any increase in power for those extra 10 mA will not be noticeable to the Amateur at the receiving end.

Another method of varying the coupling is to physically move the antenna coil closer or farther away from the PA tank circuit. If you are very clever you can arrange the antenna coil so that it rotates inside, or at the end, of the LC tank coil. When the antenna coil is in line with the PA coil the coupling will be at a maximum. When turned 90°, the coupling will drop to zero. Such an arrangement is known as a variocoupler, but is rarely seen anymore.

improving the MOPA

While the MOPA is a great improvement over a simple oscillator as a transmitter, it has some drawbacks. For one thing, unless the neutralization is perfect and the oscillator and the PA are completely shielded, there will be some leak-through of the oscillator signal when the PA key contacts are open. Even with the best neutralization and shielding there may be enough oscillator leak-through signal to block out reception of weak signals on the receiver. This "backwave" can be eliminated by keying the oscillator, but then chirps and instabilities become a problem again. When neutralization is not complete on some other Amateur's transmitter, you may sometimes hear the backwave signal if relay type break-in keying is not being used at that station. The backwave is transmitted in such a case because the antenna switch is connected to the transmitter as long as that station is transmitting.

The addition of a buffer amplifier between the oscillator and the PA improves things greatly. Now the oscillator is further isolated from the PA and the antenna. A buffer amplifier might be a neutralized triode tube, FET, or BJT stage, or it may be a tetrode or pentode tube amplifier which may need no neutralization. Since the buffer is an amplifier, it will allow the oscillator to operate at a lower power output level, which helps frequency stability. It may also drive the PA harder, which means greater output possibilities for the PA. If the buffer is keyed instead of the PA, the backwave will usually be reduced to insignificance if all stages are properly neutralized and shielded.

If the buffer amplifier is used as a frequency multiplier (doubler, tripler, etc.) frequency stability and backwave difficulties will be improved still more. The diagram of **fig. 3** illustrates a doubler stage link coupled to a tuned LC tank of the next stage's input circuit. If a 3.5 MHz oscillator's rf ac is fed to the gate of the JFET, while the gate is driven positive, as indicated on C_c, the right plate of this capacitor picks up electrons from the JFET's source. When the rf ac alternates it drives the electrons away from the right-hand plate and they travel down the biasing resistor R. Since electrons always move from negative to positive, the top of R must be more negative than the source. The bias voltage developed across R can be great enough to bias the JFET into class C operation. This means that the drain current pulses flowing down through the LC circuit are far less than 180° in width, usually more like 100° to 120° (considering 360° as the complete rf ac cycle). With narrow pulses there is a relatively long zero-current period of time in between pulses. As a result, if the LC circuit is tuned to resonate at 7 MHz (twice 3.5 MHz), the 3.5 MHz pulses will drive down through the coil to $+V_{DD}$ and then the JFET waits while the LC circuit oscillates (flywheel effect) for *two* cycles of 7 MHz ac before another pulse arrives to start the next oscillations. The stage is operating as a frequency doubler. If the value of R is increased (from about 50 kilohms to perhaps 75 kilohms) the bias voltage will increase and the drain pulses will be still narrower, allowing more rest time for the JFET. There should now be time for the LC circuit to oscillate three times before the next pulse arrives. In this case the frequency multiplier is called a tripler. The rf ac power output from a doubler is roughly half what the stage would produce as a straight-through amplifier. It puts out about one-third as much when operating as a tripler. Since the input and output circuits are not resonant to the same frequency, no neutralization is required in frequency multipliers.

As might be expected, any output from a frequency multiplier will be rich in harmonics. One method of reducing unwanted higher harmonic output signals is to use tuned circuits at the desired operating frequency. The link coupling shown in **fig. 3** is one method of discriminating against the transmission of higher-frequency harmonics. Link coupling is actually a step-down tuned transformer coupled to a step-

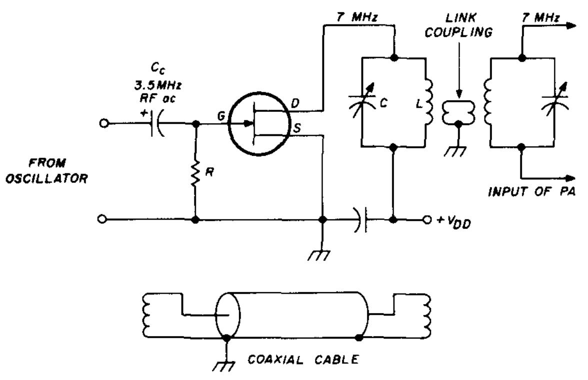

fig. 3. A frequency multiplier stage with link coupling to the next amplifier stage.

up tuned transformer (the number of link turns is not too important as long as both are similar). Link coupling is also advantageous to transfer rf ac from one place to another with minimum losses. The links can also be interconnected by coaxial line with the outer braid grounded, as indicated in **fig. 3**. Usually any form of inductive coupling is superior to capacitive coupling in preventing transmission of unwanted higher harmonic frequencies.

By using a multiplier between the oscillator and the PA, and keying the multiplier, almost all leak-through or backwave will be eliminated.

a heterodyne CW transmitter

Most commercially constructed Amateur transmitters today utilize the heterodyning of two frequencies to obtain a desired third frequency, which is then transmitted. The terms heterodyning, mixing, and beating all mean essentially the same thing. They mean that if one frequency is mixed with another in a nonlinear device (diode, triode type device, etc.) the output will be basically four frequencies: (1) the first frequency, (2) the second frequency, (3) the *sum* of the two frequencies, and (4) the *difference* of the two frequencies. A basic heterodyne CW transmitter is shown in semi-block form in **fig. 4**. The two frequencies to be heterodyned are developed by a 5-MHz variable frequency oscillator (VFO) and a 12-MHz crystal (XTAL) oscillator. Both of these frequencies are fed to the mixer BJT. In the collector circuit will appear the 5 MHz, the 12 MHz, a 17 MHz (sum), and a 7 MHz (difference) frequency. Since only one of these frequencies (7 MHz) is in any of the Amateur bands, L_1C_1 is tuned to that frequency. With both L_1C_1 and L_2C_2 tuned to 7 MHz they discriminate against transmission of all of the other frequencies. As a result, only the 7 MHz signal is amplified by the BJT PA.

Note that the buffer amplifier between the crystal oscillator and the mixer is being keyed. When the key is up there is no 12 MHz signal to be mixed, so there is no 7 MHz output. Inasmuch as there is no 7 MHz being generated anywhere, with the key up there can be no backwave at all. When the buffer is keyed there should be no chirping or frequency instabilities, and (one hopes) no key clicks. Both oscillators are running all of the time, so there is no warm-up frequency drifting after the transmitter has been turned on for a few minutes. It might be noted, however, that if the equipment is not shielded and grounded there might be some radiation of the 5-MHz variable oscillator signal at all times, and some 12 MHz output particularly when the key is down. So shielding is important in all transmitters. In this case we are keying a 12-MHz signal and changing or "translating" it to 7 MHz. We will find translation of frequencies in many radio systems. It is the result of heterodyning.

In the interests of simplicity we have not included any buffer or driver amplifiers between the mixer and the PA. The BJT amplifier shown is worthy of some further explanation. Notice that there is no bias in the

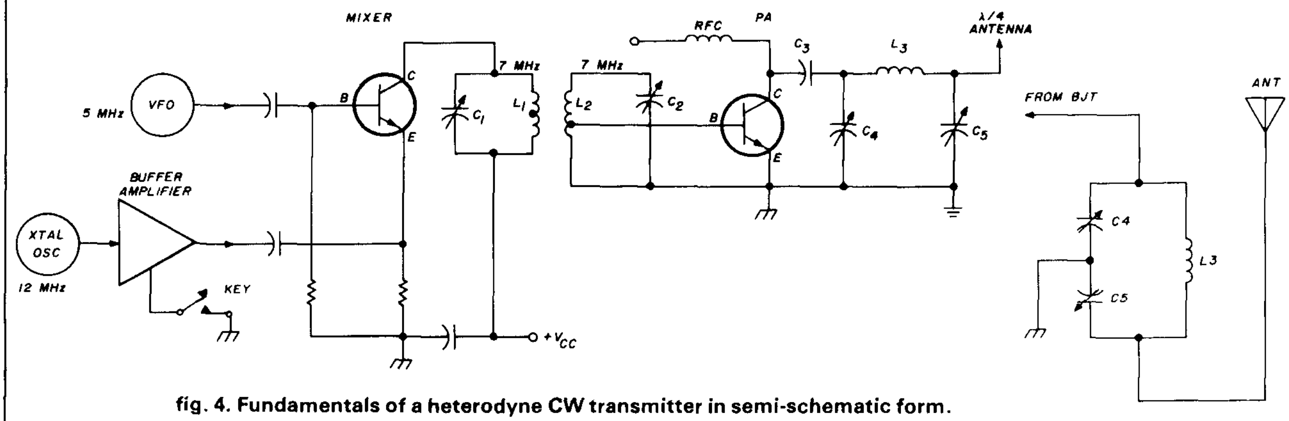

fig. 4. Fundamentals of a heterodyne CW transmitter in semi-schematic form.

base-emitter circuit. The reason for this is that with no forward bias there can be no collector current (I_C) flowing and no output from the stage. It requires about 0.6 volt of forward bias before I_C starts to flow in a silicon type BJT. So BJT stages with no bias are automatically in class C. This can be good in CW transmitters but may be a disadvantage in SSB transmitters. It is important that the voltage driving the base not be so high that so much I_C and I_B flow that the junctions of the BJT melt. A resistor in series with the base may help to protect these junctions, or protective diodes can be used to limit the base driving voltages. Be very careful how hard you drive a BJT. Start with minimum coupling and sneak up to the desired value in small steps.

Note the output tuned circuit in the PA stage. It is coupled directly to a quarter-wave ($\lambda/4$) length antenna wire, which should have an impedance at its base (coupling point) of about 37 ohms. Therefore the part of the tuned circuit feeding it should also have a 37-ohm impedance. The output LC circuit has been redrawn to the right of the PA. Can you see that the PA LC circuit consists of C_4 and C_5 in series across L_3? The values of these components must be chosen so that at resonance the impedance seen by the antenna is 37 ohms across C_5 and that seen by the BJT across C_4 might be perhaps a little more than this value to match a somewhat higher BJT output impedance. As a result, C_5 will need a somewhat higher capacitance value (lower X_C) than C_4 will have. The coil must have the correct inductance to produce resonance at 7 MHz when the two capacitors are set to their correct values. In some equipment C_5 will be a fixed capacitor, while C_4 is variable to tune the circuit to resonance. Capacitor C_5 in many circuits is also variable and functions as a degree-of-coupling control. The greater its capacitance the lower the coupling coefficient to the antenna. For higher frequency bands the L and C values will be proportionally smaller.

The radio frequency choke coil (RFC) has a high impedance to all Amateur bands and therefore develops high 7-MHz ac voltage drops across it when 7-MHz I_C pulses flow through it. These voltages are coupled to the LC circuit by coupling capacitor C_3. This is called a shunt-fed amplifier circuit because no I_C flows through the tuned circuit inductor. Because of its configuration a circuit of this type is known as a pi-network (π-network) tuned circuit.

Note that an earth ground symbol is shown at the base of C_5 which completes the quarter-wave (or $3\lambda/4$) antenna to earth ground to make it resonate properly. This same line is also shown as being at chassis (and metal shielding cabinet) ground.

Can you see that if the 5-MHz variable oscillator is changed to 4.9 MHz the difference signal would then be 12 minus 4.9, or 7.1 MHz? If changed to 4.7 MHz the output would be 12 minus 4.7, or 7.3 MHz. So, if the variable oscillator is tunable from 5 MHz to 4.7 MHz, the resulting output heterodyne signal will cover all of the frequencies in the 40-meter Amateur band (7.0 to 7.3 MHz). If the 12-MHz crystal is changed to an 8.5 MHz crystal (assuming a broadly tuned buffer) the difference signal between 5 MHz and 8.5 MHz will be 3.5 MHz, which is in the 80-meter ham band (3.5-4 MHz). If the crystal is changed to a 17-MHz crystal the difference frequency is 14 MHz and is in the 20-meter ham band (14-14.35 MHz). It is necessary only to switch in different crystals (and amplifier tuned circuits) to change bands in this type of transmitter. Tuning across all bands is accomplished by varying only the frequency of the VFO stage.

The circuit described will work nicely for normal CW (A1), for narrow-band fm (F3) voice communications, and for frequency-shift keying (F1) using any of the various codes such as Morse (CW) Baudot (RTTY), and ASCII (computer). The circuit can also be used for amplitude voice modulation if the PA is the stage to which modulation is applied. To use single-sideband (SSB) amplitude modulation the PA bias must be changed to class A or AB by forward biasing the BJT base. Although modulation is dealt with in later articles, we might point out that if the power supply feeding the PA (or any amplifier stage) is not adequately filtered, its dc voltage output will have a ripple or variation in it. As a result the output signal of the transmitter will be alternately stronger and weaker at the frequency of the ripple. We say the carrier is "modulated" in strength by the ripple. To a receiver the signal would have an audible tone component equivalent to the ripple frequency. Assuming 60-Hz ac as the power source, the ripple frequency would be 60 Hz if the power supply is half-wave rectified, and 120 Hz if it is full-wave rectified. The resulting low-frequency tones produced in the receiver is known as a hum, or as hum modulation. This is an amplitude modulation since it varies the strength of the signal being radiated. If the oscillator power supply has ripple in it, the result may be both an amplitude modulation plus a slight variation of frequency of the oscillator, which would be known as frequency modulation.

an electronic TR switch

When full break-in CW is desired, but without the use of the electromechanical relay mentioned previously, an electronic TR switch can be used. There are a variety of such devices. A simple form is shown in **fig. 5**. These circuits have no connection with the keying circuit at all. The transmitter can be oscillator, buffer, or PA keyed. The antenna input for the re-

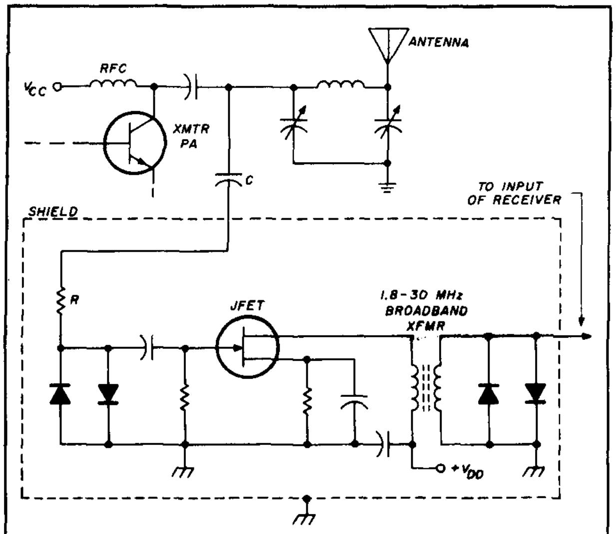

fig. 5. Electronic TR switch feeds received signals to a receiver from a transmitter output LC circuit when PA is not on.

ceiver is taken from the output tuned circuit of the transmitter stage. The TR switch has essentially no effect on the transmission of energy from the transmitter into the antenna. However, it does allow the receiver to be fed received signals from the antenna when the key is up. While the key is down the signal fed to the TR switch would be overwhelming for the receiver's input except for the limiting of this rf by the TR switch circuitry. With the key down, a relatively high-amplitude signal is fed from the π-network tuned circuit to the input of the TR switch. If the two input diodes are silicon types, the maximum rf ac voltage that can be developed across them will be limited to 0.6 volt (0.3 volt for germanium diodes). This limited signal voltage is amplified and fed through the broadband (1.8-30 MHz) transformer (XFMR), is limited again by the two output diodes and is fed to the receiver as an rf ac signal of no more than 0.6 (or 0.3) peak volts, which will not damage any normal receiver.

With the key up the PA has no power output. Now received signals in the antenna at the resonant frequency of the π-network LC circuit are fed to the TR switch. These will usually be in the micro- or low-millivolt range. They will be fed through C and R to the input diodes. Although there is some loss of signal because of the series resistor R, the JFET amplifier can more than make up for that and feed a relatively strong received signal to the receiver. Because almost all received signal voltages developed in an antenna will be well below the 0.6-volt barrier voltage of the diodes, the diodes have no effect on such signals, although it is possible that they might limit extremely strong local signals. With a well designed TR switch, full break-in operation is possible with any CW transmitter. However, PA stages using VTs must be biased to class C to prevent the receiver (discussed next month) from picking up "white noise" generated by random electron movements in resistors or between elements in active devices.

FCC test topics

The following Novice test topics are discussed in this article, but should be understood by Technician/General and Advanced applicants also:

- emission type A1
- block diagram of stages in a simple telegraphy transmitter
- superimposed hum, cause and cure
- backwave, cause and cure
- key clicks, cause and cure
- chirp, cause and cure
- vacuum tube applications, symbols
- quartz crystal applications
- undesirable harmonic output
- functional layout of a Novice CW transmitter including antenna switching, antenna, and telegraph key.
- transmitter tune-up procedure

The following Technician/General class FCC test topics are discussed in this article, but should be understood by Advanced class license applicants also:

- emission types AØ, F1, F3
- neutralizing final amplifiers
- sidebands
- physical dimensions of antennas
- transformer applications and symbols
- antenna tuning
- use of a nonradiating load or dummy antenna
- full break-in telegraphy
- electronic TR switch
- frequency translation, mixing, multiplication
- modulation, amplitude, frequency
- bandwidth

The following Advanced class FCC license test topics are discussed in this article, but should be understood by Extra class license applicants also:

- electromagnetic radiation
- transmitter final amplifiers
- oscillators, applications, stability
- rf amplifier stages

For additional information on these subjects you can refer to *Electronic Communication*, or to *Amateur Radio Theory And Practice*, by Robert L. Shrader, W6BNB, McGraw-Hill Book Company, available through Ham Radio's Bookstore.

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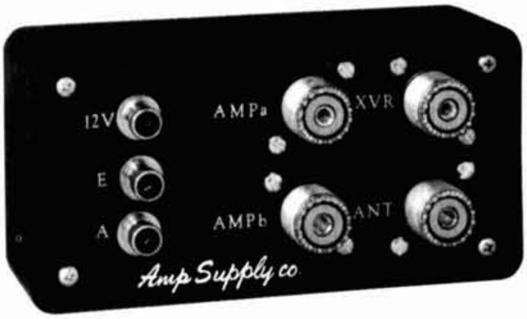

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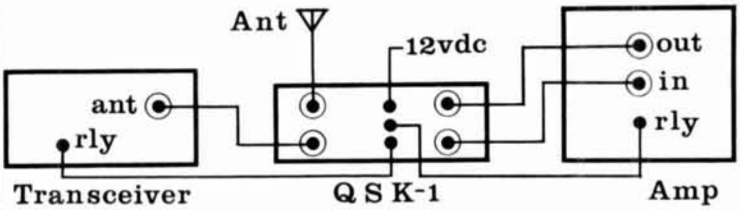

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ORR BOOKS

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Recommended reading. Commonly asked questions like: What is the best element spacing? Can different yagi antennas be stacked without losing performance? Do monoband beams outperform tribanders? Lots of construction projects, diagrams, and photos. 198 pages. ©1977. 1st edition.

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SIMPLE LOW-COST WIRE ANTENNAS
by Bill Orr, W6SAI

Learn how to build simple, economical wire antennas. Apartment dwellers take note! Fool your landlord and your neighbors with some of the "invisible" antennas found here. Well diagramed. 192 pages. ©1972.

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THE RADIO AMATEUR ANTENNA HANDBOOK
by William I. Orr, W6SAI and Stuart Cowan, W2LX

Contains lots of well illustrated construction projects for vertical, long wire, and HF/VHF beam antennas. There is an honest judgment of antenna gain figures, information on the best and worst antenna locations and heights, a long look at the quad vs. the yagi antenna, information on baluns and how to use them, and new information on the popular Sloper and Delta Loop antennas. The text is based on proven data plus practical, on-the-air experience. **The Radio Amateur Antenna Handbook** will make a valuable and often consulted reference. 190 pages. ©1978.

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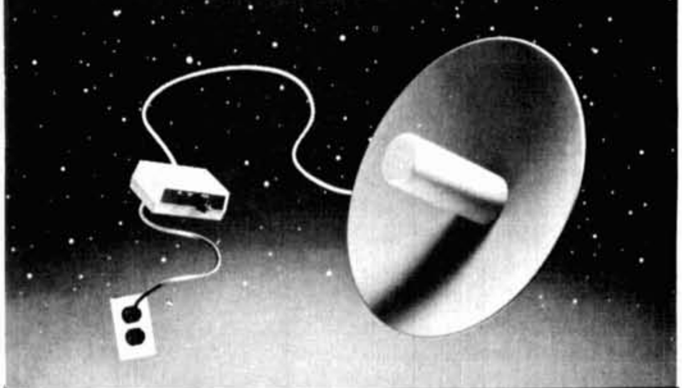

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More Details? CHECK—OFF Page 92

what about the big-amplifier power supply?

Design tips for this all-important piece of equipment

You are planning the construction of that ultimate high-power amplifier with the big triodes. Researching the library and ham journals has been completed, but you are still unsure of the power supply. Almost all articles on the subject skim through the power supply, treating it as a necessary evil.

If you think about it, you'll realize that the power supply is far and away the most important part of the amplifier. The initial problems found in a newly completed amplifier generally point to power supply deficiencies. This article will not only provide you with the complete circuit of the supply but will guide you through the complete relay sequence and point out pitfalls, alternatives, and consequences so that you, on your own, can build the supply you need.

You've already decided upon the plate voltage to be used in your amplifier and have procured that ugly thing known as a power transformer. It weighs between 35 pounds (if you're lucky) and 110 pounds (16-50 kg). The transformer is probably an irritating subject by now, as it won't fit properly into any plans you have formulated. But one way or another you will manage to get it into the supply.

The purpose of this article is not to tell you how to determine the secondary voltage you'll need for a particular dc loaded voltage, as it never comes out correct anyway. One of the reasons for this is that the transformer used by most hams has a secondary resistance that's too high and a current-carrying capacity that's too low — but is good enough for Amateur intermittent service. The no-load to full-load voltage may vary from 200 to 1500 volts. For more information on this subject, I would suggest you read the Intermittent Voice Service (IVS) rating section in the power supply chapter of the *Radio Handbook* by Bill Orr, W6SAI.

input requirements

Let's now proceed with what's vital for a reliable power supply. The very first consideration is a negative one. Don't even think of using a supply with 120-volt line power. Primary power of 240 volts is a must, and a 25-amp circuit breaker should be incorporated into the power supply chassis or cabinet. I assume that there's a 30-amp unit in your main breaker box. Other fuses in the power supply are a 2-amp fuse for 120-volt line overload protection, and a 1½ amp fuse, generally used in the rf cathode circuit in the rf deck.

Referring to the schematic of **fig. 1**, you will note a full-wave bridge circuit. This may not be consistent with the secondary voltage of your transformer. You

Caution! This type of power supply contains voltages that can cause death or paralysis. Handle with all precautions, respect, and care.
Editor

By Robert E. Bloom, W6YUY, 8622 Rubio Avenue, Sepulveda, California 91343

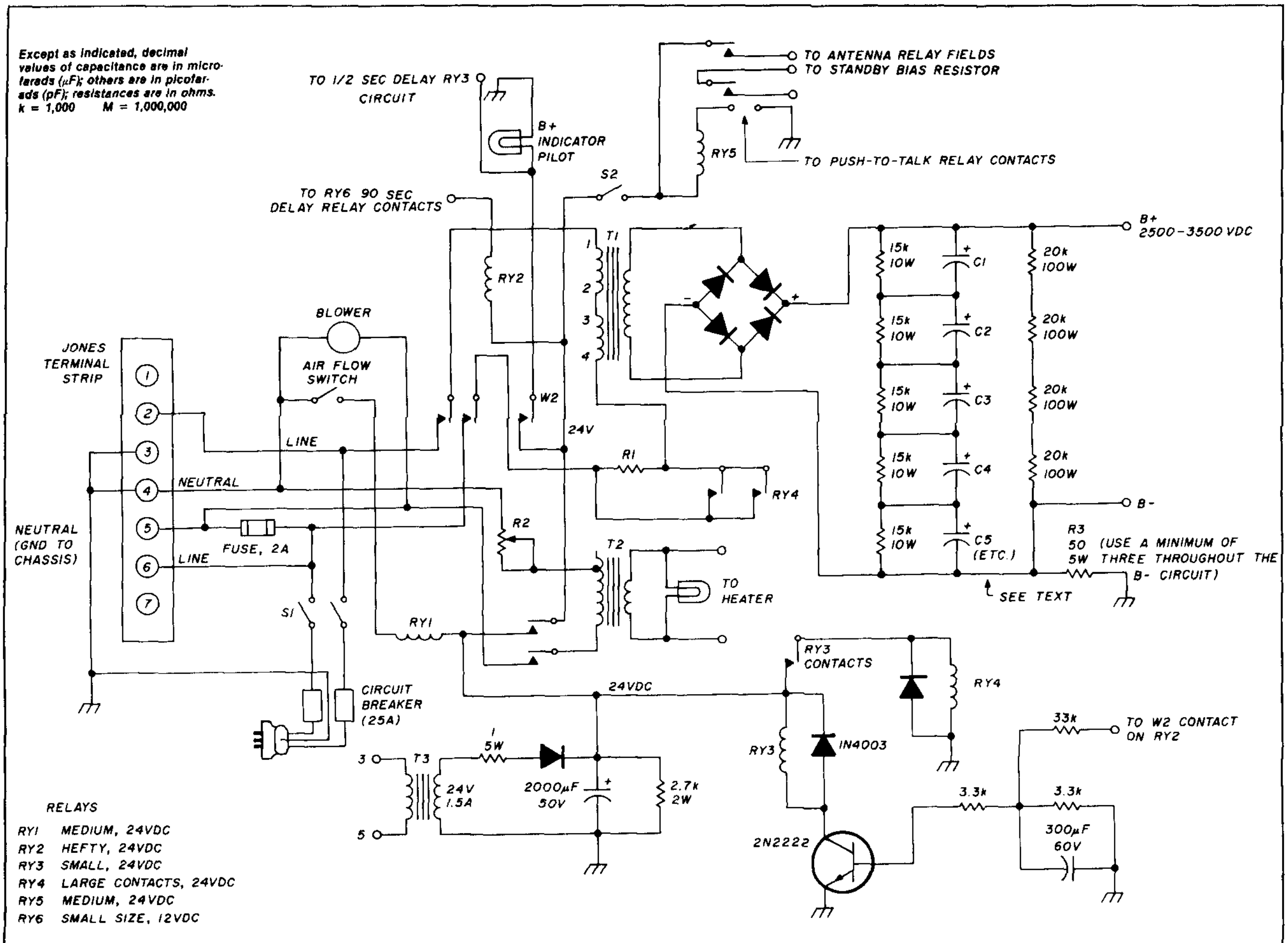


fig. 1. Schematic diagram of the big-amplifier supply. Circuit features safety precautions and relay switching logic for complete power-amplifier control. The rectifier circuit is a commercially available bridge rather than a diode string. Resistor R1 is a heater element, which protects the power-transformer from inrush current surges during turn-on. Relay timing and event sequences are discussed in the text.

may need a voltage doubler circuit, or perhaps the secondary ac voltage is high enough for just a simple full-wave circuit. At any rate, remember that a 2-kilovolt-ampere RMS transformer will put out only 2 kilowatts of power RMS. The transformer may have a tapped primary to reduce the power-supply voltage for tune up. Remember that the rf-load impedance changes downward when the supply is switched back to the higher voltage. The amplifier's circuit Q now must be brought back up, requiring an increase in plate as well as load capacitance.

If your amplifier uses a ceramic-type tube or tubes, you'll be using a squirrel-cage blower for cooling. Should the blower fail during operation, the chances are that the amplifier tube will too, and that's an expensive failure. Thus an air-flow switch is a must. If the blower fails, the air-flow switch shuts down both the plate and heater voltages, protecting your expensive tube from seal fracture.

filter system

The filter circuit is the next important item in the supply. A swinging choke is nice to have, as it provides better voltage regulation and also provides a means for obtaining an increase in output voltage (by shorting out the choke). However the choke is large and takes up a lot of room, so I'd eliminate it. The filter capacitors can be the high-voltage oil type (they are expensive). Series capacitors are often used. These are most always high-capacitance electrolytic types with a working voltage of 450 volts and a surge voltage rating of 500 volts. The total capacitance of the series string is equal to the value of one capacitor divided by the total number used, assuming all are of the same capacitance rating. The voltage rating of the string is the working voltage of one unit multiplied by the total number in the string.

The total voltage should be at least equal to the peak voltage of the supply (1.4 times the RMS value) plus a 10 percent safety factor. Each capacitor should be shunted with a 10 to 20 kilohm, 10-watt resistor — approximately 25 kilohms to 50 kilohms total per thousand volts of supply. These resistors are important: they equally divide the supply voltage across each capacitor, thus preventing any one from exceeding its rating. An additional high-wattage bleeder resistor should be used to bleed the voltage from the capacitors. This resistor should draw about 50 mA of bleeder current. By rule of thumb, use 100-watt, 20 kilohms for each 1000 volts of supply voltage.

rectifiers

Most articles in the Amateur handbooks show a string of 1000-volt, 3-ampere (30-amperes surge) rated diodes in series for the high-voltage rectifiers. One determines the peak ac voltage plus a safety factor in each branch of the circuit. These articles suggest a series string of enough diodes to satisfy the voltage requirement. A 250k, 1/2-watt resistor and a 0.01-μF, 1000-volt or higher rating ceramic capacitor are placed across each diode to make up a rectifier stack. The resistors divide the voltage between the diodes, while the capacitor suppresses any spikes or transients.

I've seen this arrangement work satisfactorily in medium-size supplies, but in big supplies I've seen the diodes disintegrate despite the quantity used. I recommend purchasing a 10,000-volt, 100-ampere surge commercial stick rectifier. It is so much neater, takes up less space, probably costs the same and one doesn't have to worry. I believe a double bridge stick runs about $35.00 (possibly available at Henry Radio*). This is inexpensive when you consider what you've already spent on the amplifier.

inrush current

When power is first applied to the supply, the rectified voltage out of the diodes looks into the filter capacitor bank, which at this first instant, is a short circuit. The impedance of the capacitors increases as they take on a charge. The current surge through the rectifiers at the instant of turn-on may well exceed 50 amperes or more. However, with a series string of 3-ampere diodes with a surge rating of only 30 amperes, there is no question as to why things explode. There have been several instances that I know of where the diodes did not blow up; however, the power-line fuse did. The comments heard go something like this: "This has happened before, but when I change the fuse or reset the breaker, the problem goes away." Until, of course, it happens again.

*Henry Radio, 2050 S. Bundy Drive, Los Angeles, California 90025, (213) 820-1234.

Whether or not the fuse blows depends upon the line voltage phase at the instant power is applied to the transformer. If you catch this at the top of the power cycle, you transform the maximum peak current and then — instant disaster.

There are a number of circuits that will prevent this from happening. The one I prefer is to place a heating element in series with one side of the high-voltage transformer primary. This added resistance absorbs inrush current. This resistor in my supply (R1 in **fig.1**) is shorted out by the relay contact of RY4 about a half second after RY2 activates. The timing of this half second is controlled by the time constants of the resistors and capacitor in the base circuit of the 2N2222 transistor. I believe these resistor elements can be purchased at most electrical supply houses and are available in both 120- and 240-volt versions. A very heavy duty relay (RY2) should be used in the high-voltage transformer primary circuit. A third set of contacts on this relay is used to furnish 24 volts to other parts of the circuit at the proper time.

In addition to the one-half-second delay relay used to short out R1, there is a requirement for a second delay circuit of 90 seconds. This 90-second delay allows the rf amplifier tube heater to attain the proper temperature before B+ is applied.

Most power supplies I have seen use an Amperex time-delay relay that has the physical configuration of a vacuum tube. The circuit I use has an accurate electronic time delay, which can be altered as one pleases simply by selecting the correct resistor value. This circuit uses the well-known 555 timer integrated circuit chip (refer to **fig. 2**). Varying the value of R4 will change the timing to suit one's requirements.

switching logic and timing

Referring to **fig. 1**, let's follow carefully through the complete sequence of events that occur when the main power switch is thrown. Activating the main power switch, S1, applies 120-volt and 240-volt single phase power to the supply. One hundred twenty volts is immediately applied to the 24-volt dc relay supply and blower. The air flow switch comes on, activating RY1. One set of RY1's contacts apply 120 volts primary power to tube-heater transformer T2, and a pilot light on the rf deck indicates the heaters are on. Resistor R2 in the transformer primary is used to adjust the voltage at the tube heater pins to the correct value. A second set of RY1's contacts makes 24 volts dc available at various relay coils and contacts, including the high-voltage primary relay RY2. RY3's field coil and contacts receive 24 volts, but the relay does not activate at this time.

Twenty-four volts dc are also applied to RY6 by RY1. The 90-second delay circuit of RY6 is now

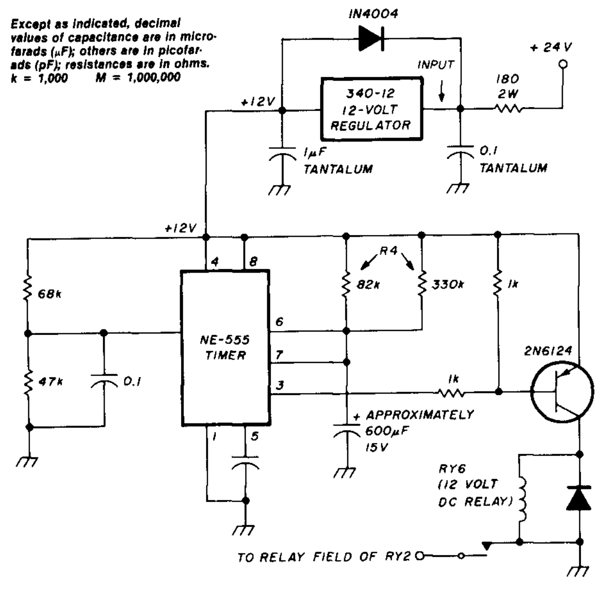


fig. 2. A 90-second time-delay relay circuit makes use of the popular NE-555 timer IC. This circuit allows the amplifier tube heaters to come up to temperature before high voltage is applied.

energized and the countdown begins. When the time has expired, RY6's contacts close, connecting the RY2's coil return to ground, activating it. The two sets of contacts of RY2 apply 240 volts ac to the high-voltage transformer primary through surge resistor R1. The filter capacitors start to charge and as they do, their impedance begins to increase. A third set of contacts of RY2 apply 24 volts to the one-half-second transistor timer delay circuit. In one-half second, the 2N2222 switching transistor conducts and completes the return circuit of the small, high-impedance coil of relay RY3, which in turn activates its small contacts, providing 24 volts to RY4. The heavy paralleled contacts of RY4 close, which shorts out the T1's primary inrush surge current resistor, R1. Full power is then applied to transformer T1. A second pilot light on the rf deck illuminates, indicating that full B+ voltage is present at the amplifier tube. However, no resting plate current will show on the plate meter as yet.

A third set of contacts on RY2 made 24 volts dc available at S2. (S2 is preferably located on the rf panel.) Throwing this switch applies 24 volts dc to RY5's field coil. However, RY5 does not activate because the field return must be closed by push-to-talk relay contacts from the transceiver. The two sets of contacts of RY5 apply 24 volts to the input and output antenna relays in the rf amplifier and also short out the amplifier's standby bias resistor. S2 on the rf panel in its OFF state prevents RY5 from being activated should the push-to-talk circuit in the transceiver be energized. This is necessary so that the exciter (or transceiver) can be tuned without activating the amplifier.

After the exciter has been tuned to frequency, reduce the carrier to zero, and activate S2 on the amplifier panel. RY5 then closes, shorts out the standby cutoff bias, and activates the antenna relay. The plate meter indicates standby plate current and the final amplifier is now ready to be tuned to frequency.

some final suggestions

There are a few points of interest that may not be evident in the schematic. First, it is important to have a 0.002 to 0.01 μF ceramic capacitor of appropriate voltage rating placed at each of the transformer primary terminals to ground. These caps prevent transients, other hash and rf from getting into the supply or onto the power lines.

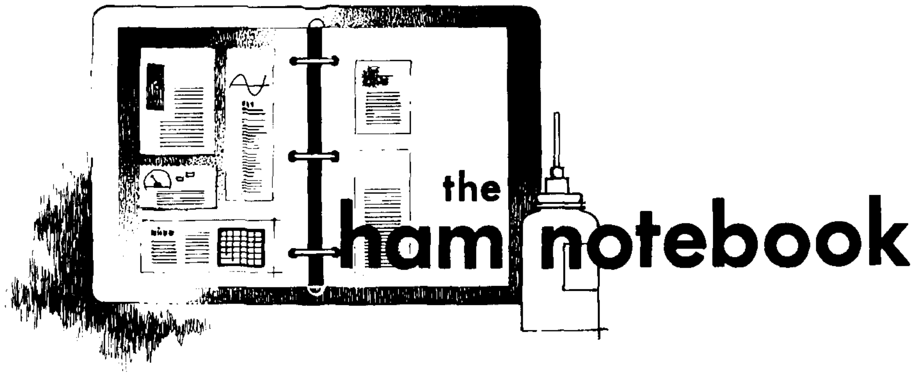
It is suggested that a good location for RY1 and RY5 would be on or in the rf deck. The 50-ohm resistor in the ground circuit of the B minus line should really consist of three 50-ohm resistors placed throughout the B minus circuit. Suggested locations would be: from the bridge rectifier circuit to chassis, from the supply cable connector B minus pin to ground, and one at the same connector point on the rf-deck. The use of several 50-ohm resistors could save your grid meter should one of the resistors become open.

It is a good idea to use more than one connector pin for B minus and ground connections and to run at least two separate wires for each from the power supply to the rf deck. It could save your life should one of the wires in the cables become open circuited.

Resistor R2 in the primary of tube-heater transformer T2 will probably be less than 30 ohms but should be about 20 watts. The resistance I required was about 12 ohms, so I connected it so that two portions of the one resistor were paralleled, increasing its power dissipation. Lastly, the terminal strip shown in my supply is a very handy addition for connecting all of the power wires. That's why I show extra terminals — use it.

The supply described here presently powers a newly completed 8877 amplifier. It is the final result of five separate kW amplifier and power-supply projects, each with its own theme and goals. The first four phases of this long project used Eimac tetrodes, all having screen supplies. Each was individual and different. I've been exceptionally well pleased with the last three phases of the project and as always, the last seemed to be the ultimate.

ham radio



a computer for the blind

Often a computer can be viewed as a huge breadboard wired by software. So if one is experimentally inclined yet blind, the computer would appear to be an ideal playground. Thus I suggested to my friend Randy, N8KL, that we attempt to adapt some micro for his use.

My AIM-65 has a user-alterable vector (DILINK) in the display routine, which would make a Morse-code-display routine an easy construction. However, a not insignificant portion of the cost of the AIM-65 is the "smart" LED display and the printer, both useless to the blind.

The machine that caught our attention was the Ohio Scientific OSI 1-P, which in its 8K BASIC form, can be bought for $349 – truly a remarkable value. Once it had been purchased, I tried in vain to wedge into the display routine a Morse-code echo. Next we turned to hardware.

From WD8DTL we borrowed a Xitex MRS-100 Morse-code transceiver and connected it to the OSI as in **fig. 1**; the computer and Xitex now communicated through TTL levels.

This arrangement was usable but not handy – the computer overran the 32-character buffer of the Xitex. So, following an idea of WA8LMF, we let the Xitex toggle the clear-to-send of the ACIA, as in **fig. 2**. If desired you can omit the emitter follower on the OSI board and pull C-T-S down wth a 1.5k. You must, in any case, break the jumper (W3) connecting pin 24 of the ACIA (U14) to ground.

The start-up procedure is as follows: turn on both the OSI and the Xitex. On the OSI type *BREAK*, *C*, *RETURN*, *RETURN*, *SAVE*, *RETURN*, and Morse will output. Reset the Xitex, then on the OSI type *$*, your desired speed in wpm, then *SPACE*. The display will now echo in Morse.

One negative note. The TTY output routines exist only in BASIC. You'll need a software assembler to do machine language programming. Randy and I will soon report to you on our success with a Braille printer.

C.R. Mac Cluer, W8MQW

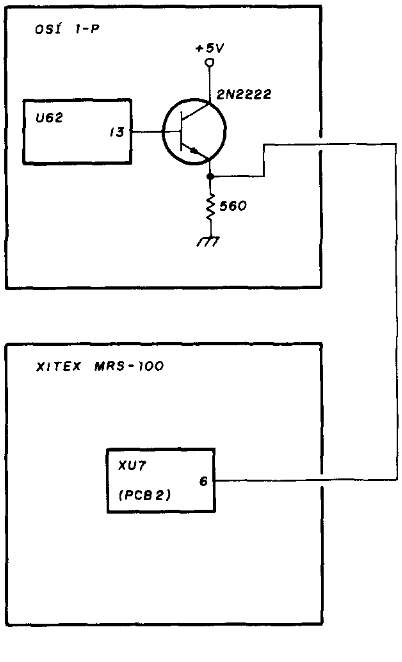


fig. 1. The display is echoed in Morse code.

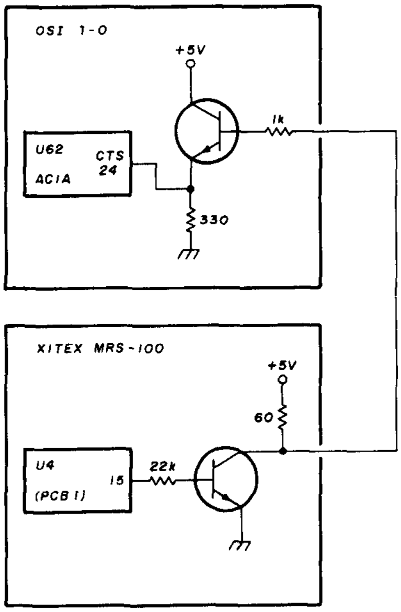


fig. 2. Handshake. Both transistors are 2N2222.

(Continued on page 70)

noise reduction for the SB-303 receiver

If you have a Heathkit SB-303 receiver, you may have noticed a rather high internal noise level. The mods described below will eliminate the noise, although at a sacrifice in audio output power. However, after the mods were made in my set, more than adequate audio was available for headphone operation. To make the modifications, refer to **fig. 3** and proceed as follows:

1. Remove the cabinet, turn power on, and listen to the noise level using headphones.

2. Set function switch to STBY, rf and af gain controls to their full counter clockwise stops, and converter switch to VHF1.

3. Set mode switch to USB, AGC switch to FAST, preselector to peaked position on any band, and speaker disable switch to DISABLE position. Now the noise will be most pronounced in your headphones.

4. Remove the two white wires from the AUD OUT terminal, which is located on one of the three terminal strips for the i-f/audio amplifier circuit board on top of the unit. Refer to pictorial 13-14 in the Heath manual. Now the headphones will be completely silent.

5. Connect a 1-watt, 100-ohm resistor between the two white wires just removed and the AUD OUT terminal (**fig. 1**). Use insulation tubing.

Now you will notice substantial noise reduction through your headphones. You'll also notice a reduction in audio level when you set the controls and switches to their normal receiving positions.

6. Now set the controls and switches back to the positions described in **steps 2** and 3. The hum and noise level will still be high. Place the unit upside down.

7. Connect one end of a piece of No. 14 (1.6 mm) hookup wire (about 10 inches or 25 cm long) to the ground terminal of the af gain control, now positioned at the lower left-hand corner. Route the wire along the chassis and connect the other end to the ground terminal of the CW SHIFT phone jack on the rear panel. This ground connection makes a good rf-current return and the receiver will become very quiet.

8. Now place the unit back to the normal operation position.

9. Connect a 2000-μF, 50-volt electrolytic capacitor across the +35 volt terminal and the ground terminal at the top of the chassis on the power supply, BFO, calibrator circuit board side. This completes the modifications.

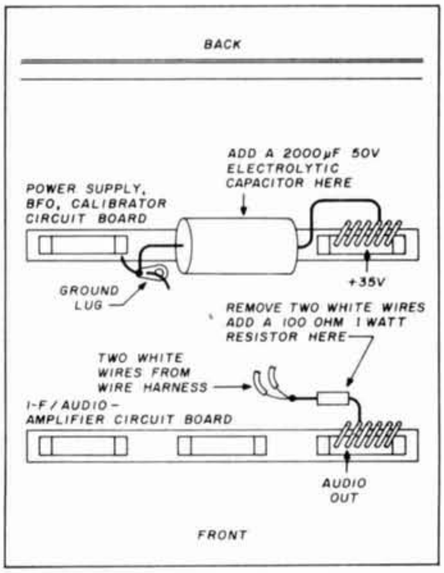


fig. 3. Modifications to the SB-303 to reduce noise.

My set is now almost completely free from hum and other noise. Operation of the af gain control is smoother, and its 10-o'clock setting produces ample gain for weak-signal reception.

I checked the set's sensitivity after the modification and found that I could copy signals as low as −20 dB.

Hajime Suzuki, (SWL)

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WANTED — MILITARY SURPLUS RADIOS. We need Wilcox 807A or RT857/ARC-134, ARC-114, ARC-115, ARC-164, RT-823/ARC-131 or FM622, RT-712/ARC-105, RT-859/APX-72, APN-171, RT-1388/ARN-82, R-1391/ARN-83, Antenna couplers Collins 490T, CU-1658A, CU-1669A. Top dollar paid or trade for new Amateur gear. Write or phone Bill Slep, 704-524-7519, Slep Electronics Company, Highway 441, Otto, NC 28763.

MOBILE OPERATORS: Anteck's Mobile Antennas cover 3.2 to 30 MHz inclusive, with no coil changing. 50 Ohms input. Two models, the MT-1 MANUAL, MT-1RT REMOTE-TUNED from the operators position. Uses two Hyd. Pumps and Motors. MT-1 $129.95, MT-1RT $240.00 plus UPS postage. Check your local dealer or write for Dealer List and Brochure. ANTECK, INC., Route One, Box 415, Hansen, ID 83334. 208-423-4100.

VHF-HT's: 4 DuMount HH-300 5 channel 150-170 MHz, extra clean units with nicads and charger. Perfect for volunteer fire dept. $825. K6KZT, 2255 Alexander, Los Osos, CA 93402. 805-528-3181.

WANTED: Micor and Mstr II Base Stations 406-420 and 450-470 MHz. Also 2 and 6 GHz solid state microwave equipment. AK7B, 4 Ajax Place, Berkeley, CA 94708.

RELAX receiving Morse. Converter uses tone or direct inputs, gives ASCII serial, parallel, outputs. Also speed, ratio. $169. Telecraft Laboratories, Box 1185, E. Dennis, Mass. 02641.

AMP-LETTER: Devoted to designing, building, and operating Amateur Radio Amplifiers. Sample $2.00. AMP-LETTER, RR2 Box 39A, Thompsonville, IL 62890.

VHF COMMUNICATIONS MAGAZINE: A quarterly radio magazine, catering to VHF-UHF-SHF technology. Published in spring, summer, autumn, and winter. Subscription — $20 per year. Make check payable to: Selecto Inc., 372 Bel Marin Keys, Novato, CA 94947.

TUBES, TUBES wanted for cash or trade. 304TL, 4CX1000A, 4PR60C, 7F7, 7N7, 53, 6L6M. Any high power or special purpose tubes of Eimac/Varian. DCO, 10 Schuyler Avenue, No. Arlington, NJ 07032. (800) 526-1270.

FOR SALE: Signal/One CX7A, UFO Control, 2 valves and additional spares. Price $800.00. Reply to Douglas Cahen, 231 West 46 Street, New York, NY 10036. 212-221-5983.

WANTED: Hammerlund HQ145. Call Arnie (212) 925-6048.

"NEW" Kt5B Multi-band Dipole 80-10 (WARC), Mini-8 Coax $17.25/100′, 450 Ohm open wire $14.75/100′. Details — Kilo-Tec, P.O. Box 1001, Oak View, CA 93022.

ATLAS 350XL, DD6XL, AUXVFO305 $850. Icom IC211 $450. SASE for list. K4TO, Dave Sublette, 1207 Monte Sano Blvd., Huntsville, AL 35801.

FOR SALE: HP 805C slotted line $45.00. HP 478A Termistor mount $125.00. HP 416A ratio meter for swept gain/SWR $45.00. HP 415 SWR meter $25.00. Stoddard MN50A .375-1 GHz field strength meter $80.00. AIL 132 noise receiver and preamp $95.00. X12, X13, 726 Klystrons $20.00. 5722 noise tube $5.00. WR 90 Isolator $20.00. Kurt Bittmann, WB2YVY, 147 McGaw Ave., Centereach, NY 11720. (516) 585-9775.

CONNECTICUT'S Ham Store — Rogus Electronics, 250 Meriden-Waterbury Turnpike, (Rt. 66) Southington. (203) 621-2252.

ATLAS 350-XL transceiver with digital dial, auxiliary VFO, power supply $780.00 FOB. WA6TKT, 1012 Olmo Ct., San Jose, CA 95129.

WANTED: Surplus 1-3 kW HF transmitter type FRT-15, Collins TDH or equivalent, or higher power up to 20kW SSB not necessary. P.J. Plishner, 2 Lake Ave. Ext., Danbury, CT 06810. WA1LDU.

YAESU FRG-7000 receiver, synthesized, mint. $280.00 FOB. WA6TKT, 1012 Olmo Ct., San Jose, CA 95129.

RTTY JOURNAL-EXCLUSIVELY AMATEUR RADIOTELETYPE, one year subscription $7.00. Beginners RTTY Handbook $5.00, RTTY Index $1.50. P.O. Box RY, Cardiff, CA 92007.

SANTEC HT-1200 with case. Fine. $235 ppd. cont. USA. KD4WA, (803) 279-6513.

CUSTOM EMBROIDERED EMBLEMS — Your design, low minimum. Informational booklet. Emblems, Dept 65, Littleton, New Hampshire 03561. (603) 444-3423.

KNOW FIRST! Ham fanatics, you need The Pink Sheets — twice-monthly award-winning Hot Insider Newsletter! Ten pages, acclaimed best! Confidential facts, ideas, insights, news, technology, predictions, alerts! Quoted coast-to-coast! We print what you don't get elsewhere! $18.00 annually w/money back guarantee! Free sample — SASE (two stamps) W5YI, Box #10101-H, Dallas, TX 75207.

PACKET RADIO — Start a network with our hardware and free software using HDLC, ASCII. Smart terminal controller pcb $30, parts $112. 1200 baud radio modem pcb $15, tested $70. Newsletter $10. VADCG, 818 Rondeau St., Coquitlam, B.C. Canada V3J 5Z3.

ROSS'S SECRET: Price, selection, and service mean more than size of ad. NEW: Kenwood 130SE $569.90. Used: FT101B, CW, for $489.00. Huge selection, your call will save $$$ or send .37 stamps for 5 pages used, or .95 stamps for 63 pages new. Closed Monday at 2:00. Ross Distributing Co., Preston, ID 83263. (208) 852-0830.

OUR KEYERS turn difficult DX into logged contacts. SASE for information. Webco, Box 740211, Houston, Texas 77274.

HEATH HW-12A 75m 200W SSB transceiver with fixed/mobile power supplies, speakers, mikes, and Xtal calibrator $75. Wilson T-1405SM 1 & 5 watt, 6-channel 2m HT with case, charger, mobile mike and 3 antennas $65. Heath SB-303 80-10m receiver with SSB and CW filters $150. Trac electronic keyer and Vibroplex paddle $40. Best offer over the above amounts within 30 days of publication date takes it. John Efird, WB4WIS, 1109 SE Cypress Lane, Palm Bay, FL 32905. (305) 724-9092.

WANTED: Pre-1950 TV sets and old TV Guides. Jeff Kadet, W3CRH, Box 90-HR, Rockville, MD 20850. (301) 654-1876.

TELETYPE Model 28 ASR with dome reperferater, $300.00, model 37 full ASCII KSR with stand, $325.00. Central Electronics 200V transmitter, $275.00. Tony Sperduti, WB2MPZ, 4071 Fairview Pkwy., Blasdell, NY 14219.

SINCLAIR RADIO LABS MR-344B four cavity 450 MHz duplexers. Mint condition, $25. Alan Brown, K5MW, Route 4, Box 200-A, College Station, Texas 77840.

ICOM/KENWOOD owners. We have a newsletter for you. SASE please Users International Radio Club, 364H Kilpatrick Ave., Port St. Lucie, FL 33452.

RTTY FOR SALE: Several machines remaining. Model 15, Model 19, 28RO w/gearshift, p.s. for ROBOT 800, deluxe 34ASR, 28KSR, 28 keyboard typing reperf, 28TD's, 33KSR, 33ASR, 35KSR, several demodulators, video RTTY. Model 28 gearshifts, parts and supplies. Send SASE for complete list and prices. Lawrence R. Pfleger, K9WJB, 2600 S. 14th Street, St. Cloud, MN 56301. Phone (612) 255-9794.

WORLDWIDE AWARDS DIRECTORY — Complete information on over 400 different worldwide awards. $12.95. Larry Kebel, KBØZP, 736 - 39th Street, West Des Moines, IA 50265.

MANUALS for most ham gear made 1937/1970. Send $1.00 for 18 page "Manual List", postpaid. HI-MANUALS, Box R802, Council Bluffs, Iowa 51502.

KENWOOD TS-520SE. Very good condition with new finals, 10 meter beam, and accessories. Paul Budlong, KA2IMR. (609) 443-4319.

DON'T GET STRANDED! Battery Watchdog's alarm informs you of excess power drain. $19.95. J.F. Ratcliff, 3600 Meadow N., Renton, WA 98056. SASE brochure.

ELECTRONIC BONANZA: Police-Fire-Aircraft scanners. Bearcat, Regency. Frequency directories. Shortwave receivers. Sony, Kenwood, Yaesu, Panasonic. True discount prices and free UPS shipping in the continental U.S. Write: Galaxy Electronics, Box 1202, Akron, OH 44309.

WANTED: Early Hallicrafter "Skyriders" and "Super Skyriders" with silver panels, also "Skyrider Commercial", early transmitters such as HT-1, HT-3, HT-19, and other Hallicrafter gear, parts, accessories, manuals. Chuck Dachis, WD5EOG, The Hallicrafter Collector, 4500 Russell Drive, Austin, Texas 78745.

WANTED: Collins 32S3 transmitter. Either operational or In-Op. Price and condition to: Cal Moss, KL7HEM, P.O. Box 11560, Reno, NV. (702) 329-0019 or 786-1296.

YAESU OWNERS: Join your International Fox-Tango Club, now in its eleventh year. Calendar year dues still only $8 US, $9 Canada, $12 airmail elsewhere. Don't miss out, get 1982 top-rated FT Newsletters packed with modifications monthly, catalog of past modifications, free advertisements, technical consultation, FT net (Saturdays, 17ØØZ, 14.325 MHz), more. Go Fox-Tango! To join, send dues to FT Club, Box 15944, W. Palm Beach, FL 33406.

FOR SALE: Seven Micor Hi Band mobiles with all acc'y. 100 watt units model T83RTA1200A, 8 channel $700 each. Excellent condition. Cal Moss, P.O. Box 11560, Reno, NV. (702) 329-0019 or 786-1296.

HAM RADIO REPAIR, experienced, reasonable, commercial licensed. Robert Hall Electronics, P.O. Box 8363, San Francisco, CA 94128. W6BSH, (408) 292-6000.

FOR SALE: A complete Micor mobile radio, 25-50 MHz, with Systems 90 electronic siren and public address system. All equipment new, never installed. Comes with manuals, cables, covert antenna, 100 watt external speaker. Best offer. Write: Dean, P.O. Box 3403, APO New York, NY 09009.

RUBBER STAMPS: 3 lines $3.25 PPD. Send check or MO to G.L. Pierce, 5521 Birkdale Way, San Diego, CA 92117. SASE brings information.

SELL: Excellent Triton IV digital power supply, blanker, filters. Best offer over $350. Also want telegraph sounder in resonator box. Cleveland, KC7IW, 12585 Jones Bar Rd., Nevada City, CA 95959.

HAM-AD-FEST™ — Next 6 issues, $2.00. WA4OSR, Box 973, Mobile, AL 36601.

MODERNIZE YOUR TRANSCEIVER — With Protronics RIT kit, for only $15.90 postpaid. Kit comes complete with custom potentiometer and simple step by step instructions. Add $2.50 for XIT. Visa/MasterCard. Protronics, 20 Monte Vista, Buckley, WA 98321. 1-206-829-0056.

MOBILE IGNITION SHIELDING provides more range with no noise. Available most engines. Many other suppression accessories. Literature, Estes Engineering, 930 Marine Dr., Port Angeles, WA 98362.

SAFETY BELTS. $35.00 and up. Free information. Avatar Co., (W9JVF) 1147 - (H) N. Emerson, Indianapolis, IN 46219.

CONTESTERS: Package of programs designed for the ARRL DX, CQWW, CQWPX and IARU Radio Sport Contests produces scored, duped log, dupe sheet, QSLs and many valuable operator statistics. TRS-80 Model 1, 48k, 1 or more discs, MX-80 printer required. $69.95 plus tax non-refundable. Sample printout with SASE. P. Chamalian, W1RM, P.O. Box 1188, Burlington, CT 06013.

SALE — HW-16 $125 (w/crystals $150). 2 Johnson matchbox tuners, best $50, other (needs repair) $25. Heath 2 meter mobile amp $30. 10-40 vertical $25. You pay shipping. KA4EBW, Jim Howell, 18 Dan Street, Salisbury, NC 28144.

WANTED: New or used MS and coaxial connectors, synchros, tubes, components, military surplus equipment. Bill Williams, PO #7057, Norfolk, VA 23509.

VERY in-ter-est-ing! Next 5 issues $2. Ham Trader "Yellow Sheets", POB356, Wheaton, IL 60187.

CB TO 10 METER PROFESSIONALS: Your rig or buy ours — AM/SSB/CW. Certified Communications, 4138 So. Ferris, Fremont, Michigan 49412; (616) 924-4561.

AFC SEMI-KITS! Stop VFO drift. See June 1979 HR. $55.00 plus $3.00 UPS. Mical Devices, P.O. Box 343, Vista, CA 92083.

HAMS FOR CHRIST — Reach other Hams with a Gospel Tract sure to please. Clyde Stanfield, WA6HEG, 1570 N. Albright, Upland, CA 91786.

PURPLE HEART VETERANS: Organizing national Amateur Radio Chapter and Net to be affiliated with Military Order of the Purple Heart, Inc. For information and applications contact Clem Harris, KC5MM (ex WB5VDL), 6110 Pecan Trail Dr., San Antonio, TX 78249. (512) 699-1420.

BUY-SELL-TRADE. Send $1.00 for catalog. Give name, address, and call letters. Complete stock of major brands new and reconditioned amateur radio equipment. Call for best deals. We buy Collins, Drake, Swan, etc. Associated Radio, 8012 Conser, Overland Park, KS 66204. (913) 381-5900.

DRAKE READOUTS: Direct digital readouts provide accurate 6 digit frequency display for Drake rigs. Model FR-4 for the "Twins" just $169.95. Model FR-4TR for the TR-3 and TR-4 series transceivers $179.95. Include $2.50 shipping and handling. e-tek, P.O. Box 625, Marietta, Ohio 45750.

REQUEST FOR INFORMATION: The Viroplex Company's records were destroyed by fire and the company has no way to determine the year of manufacture by serial number on their units. I would appreciate hearing from anyone having this kind of information. K6ARE, 1263 Lakehurst Rd., Livermore, CA 94550.

Coming Events
ACTIVITIES
"Places to go..."

IDAHO: The Fifth annual Treasure Valley Hamfest sponsored by the Voice of Idaho Amateur Radio Club and the Treasure Valley Radio Association, June 19 and 20, 9 AM Saturday to 3 PM Sunday, Mini-dome, Payette. $15.00 pre-registration, $20.00 registration at door includes breakfast, dinner and prize tickets. Swap tables, dealers, transmitter hunts, ladies' and children's activities, games, contests, prizes, banquet Saturday, breakfast Sunday, cocktail party Friday evening and picnic Saturday. Talk in on 147.84/24, (WB7NSE/R), 147.72/12 (K7OJI/R), 146.52 simplex. For information: Samuel K. Sower, N7DOV, 1909 Grant St., Caldwell, ID 83605. (208) 459-8132.

ILLINOIS: The Six Meter Club of Chicago's Silver Anniversary Hamfest, Sunday, June 13, Santa Fe Park, 91st and Wolf Road, Willow Springs. Advance registration $2.00; $3.00 gate. Swappers' row, picnicking, displays, refreshments, AFMARS meeting. First prize: color TV; second: IC-2A or Bearcat 210XL and other goodies. Talk-in on 146.52 or K9ONA/R 37-97. Advance tickets: Val Hellwig, K9ZWV, 3420 South 60th Court, Cicero, IL 60650.

INDIANA: The Indiana State Amateur Radio Convention in conjunction with the Indianapolis Hamfest and Computer Show, Sunday, July 11, Marion County Fairgrounds, southeast intersection I-74 and 465. Inside/outside flea markets. Separate computer show and flea market. Camper hookups available on grounds. Technical forums, club activities, ladies' activities. Gate ticket $4.00, for all activities and major prize drawing plus hourly prizes. For information: Indianapolis Hamfest, Box 11086, Indianapolis, IN 46201.

INDIANA: The Lake County Amateur Radio Club's 10th annual "Dad's Day" Hamfest, June 20, Lake County Fairgrounds, Industrial Arts Building, Crown Point. Prizes. Talk-in on 147.84/24 or 52. Tickets $2.50. Mail check to: Lake County ARC, c/o Walley Kozol, KA9FDC, 624 N. Rensselear St., Griffith, IN 46319.

MAINE: The third annual Yankee Hamfest, sponsored by the Yankee Radio Club, Saturday, June 19, 9 AM to 5 PM, Oxford County Fairgrounds, Oxford. Admission $1.50. Camper hookups available Friday and Saturday nights, $3.00 per night. Flea Market, displays, women's activities, swap tables, CW contest, food available, many prizes. Ham of the Year Award. Talk-in by Don Dean, W1BYK on 146.28/88 and 146.52.

MICHIGAN: The annual Monroe County Radio Communications Hamfest, June 13, 8 AM to 3 PM, Monroe Community College, Raisinville Road, Monroe. Tickets $2.00 gate, $1.50 advance. XYLs and children free. Free parking. Contests, auctions and displays. Plenty of table space. Talk-in on 146.13/73 and 52. For information: Fred Lux, WD8ITZ, P.O. Box 982, Monroe, MI 48161 or call 1-313-243-1088 Hot Line.

NEW JERSEY: The Raritan Valley Radio Club's 11th annual Hamfest and Flea Market, June 19, 8:30 AM to 4 PM, Columbia Park, Dunellen. Door prizes and snack bar. Admission $3.00 sellers; $2.00 lookers. Talk-in on 146.625/025 (W2QW) and 146.52 direct. For information call Bob, KB2EF, 201-369-7038.

NEW YORK CITY: The annual Hall of Science Amateur Radio Club's indoor/outdoor, rain or shine Hamfest, Sunday, June 13, 9 AM to 4 PM, Municipal Parking Lot, 80-25 126th Street (1 block off Queens Blvd.), Kew Gardens, Queens. Sellers' donation $3.00. Buyers $2.00. XYLs, kids free. Walk/talk-in on 145.520. For information KA2DTB. (212) 738-8887.

NEW YORK: The Genesee Radio Amateurs' second annual ARRL approved Batavia Hamfest, Sunday, July 11, 7 AM to 5 PM, Alexander Firemen's Grounds, Route 98, Alexander. Registration $2.00 advance, $3.00 gate. Flea market $1.00. Prizes, exhibits, OM and YL programs, contests, food, overnight camping, boat anchor auction at 3 PM. Fun for all. Talk-in to W2RCX on 4.71/5.31 and 52 simplex. For advance tickets make checks payable to: Batavia Hamfest, c/o GRAM, Inc., Box 572, Batavia, NY 14020.

NEW YORK: The Staten Island Amateur Radio Association's Flea Market, June 12, 9 AM to 3 PM, All Saints Episcopal Church, Staten Island. Free admission for buyers. Sellers $3.00 per space, own table. $1.00 for electricity. Raffle, refreshments. Talk-in on 146.52 and 146.28/.88. For information SASE to: George Rice, Jr., WA2AMJ, 480 Jewett Ave., Staten Island, New York 10302.

More Details? CHECK—OFF Page 92

NORTH DAKOTA/MANITOBA: The 19th annual International Hamfest, July 10 and 11, International Peace Gardens between Dunseith, North Dakota, and Boissevain, Manitoba, at the Canadian Pavilion on the north side of the Gardens. Excellent camping available. Transmitter hunts, mobile judging, CW and QLF contests, flea markets, seminars, Saturday night dance, Sunday morning breakfast, lots of prizes and more. For information contact WDØGMD or WDØGRC.

OHIO: The 8th annual Hall of Fame Hamfest, Sunday, July 18, Nimishillen Grange, 6461 Easton Street, Louisville. Tickets $2.50 advance, $3.00 gate. Under 16 free. Flea market opens 9 AM. Reserved tables available for rent. Awards, forums, food, dealers, XYL activities and more. Mobile check-in on 146.19/79, 146.52/52 simplex, and 147.72/12. For tickets/information: WA8SHP, 10877 Hazelview Avenue, Alliance, Ohio 44601. (216) 821-8794.

OHIO: The Lancaster and Fairfield County Amateur Radio Club's annual Lancaster Hamfest, Sunday, June 20, 9 AM to 5 PM, Fairfield County Fairgrounds, Lancaster. Tickets $2.00 advance, $3.00 door. Hourly drawings, refreshments available. Flea market tables available or bring your own. Talk-in on 147.03/63 or 146.52 simplex. For information: Box #3, Lancaster, Ohio 43130.

OKLAHOMA: The 25th reunion of the VHF Radio Amateurs who were members of the Oklahoma Central 6 Meter Club, later known as the Central VHF Club. Please send name, address and present call, and whether you intend to attend the reunion, to: T.W. Stevens, W5VCJ, P.O. Box 976, Edmond, OK 73083. The reunion will be held at the same time but not in conjunction with the Oklahoma City Ham Holiday on the last weekend in July.

OREGON: Lane County Ham Fair, July 17 and 18, Oregon National Guard Armory, 2515 Centennial, Eugene. Doors open 8 AM. Swap and shop tables $5.00. 2 meter bunny hunt, women's activities, children's corner, computer demos, all day snack bar, free parking for RVs, no hook-ups. Saturday potluck supper. Grand Prize: Icom 730 low band Mobile rig and many other prizes. Tickets purchased before July 1 receive one extra drawing ticket free. Talk-in on 146.28/88, 147.86/26 and 52/52. 3.910 HF. For tickets send checks to Eunice Brown, WA7MOK, 2456 Corral Ct., Springfield, OR 97477. Phone 747-7939.

PENNSYLVANIA: Harrisburg annual Firecracker Hamfest, Sunday, July 4, sponsored by the Harrisburg Radio Amateur Club, Shellsville VFW Picnic Grounds, exit 27, interstate 81, north of Harrisburg. Talk-in on 16/76 or simplex 52/52. Tables available or bring your own. Admission: $3.00. XYL and children free. Tailgating $1.50. Door prizes and Grand Prize drawings. For details: KA3HZW, 131 Livingston Street, Harrisburg, PA 17113 or phone (717) 939-4957.

PENNSYLVANIA: The Nittany Amateur Radio Club Ham Festival, July 10, 8 AM to 4 PM. First prize: Radio Shack color computer; second prize: reconditioned Tempo 2-meter amplifier; many more prizes. Talk-in on 146.16/.76, 146.25/85 and 146.52. Tickets $3.00; tailgating/tables $5.00. Information from NARC, P.O. Box 614, State College, PA 16801.

PLAYBOY RESORT at Great Gorge, McAfee, NJ — the place to relax and enjoy — see all the manufacturers' and dealers' exhibits — attend the vital and informative forums — renew old acquaintances and make new ones — all at the ARRL Hudson Division Convention, October 30-31. Send SASE now for complete details to HARC, Box 528, Englewood, NJ 07631.

SOUTH DAKOTA: The annual South Dakota Hamfest, sponsored by the Black Hills ARC, July 10 and 11, Surbeck Center, SD School of Mines & Technology, Rapid City. Pre-registration $7.00; $8.00 door. Prize drawing for pre-registrants. Free tables for flea market. Forums, contests, picnic, prizes. WØBLK call-in 34/94. For information: Rudy, WBØPWA, Black Hills ARC, 4822 Capitol, Rapid City, SD 57701.

WEST VIRGINIA: Hamfest WV's "biggie". TSRAC Wheeling WV Hamfest, Sunday, July 25, 9 AM to 4 PM. Major and door prizes, indoor dealer displays, flea market, auction, refreshments. Park attractions — family affair. Reasonable motel accommodations, catch WWVA Jamboree, Saturday night. Donation $2.00, children 12 & under free. Contact: TSRAC, Box 240, RD 2, Adena, OH 43901.

WISCONSIN: Swapfest '82 sponsored by the South Milwaukee Amateur Radio Club, Saturday, July 10, 7 AM, American Legion Post 434, Oak Creek. Tickets $2.00. Buy, sell, swap. Refreshments, prizes, camping. Happy Hour (free beer and soda). First prize $100; second prize $50 plus hourly prizes. Talk-in WA9TXE/9 146.94. For details and a map: South Milwaukee Amateur Radio Club, P.O. Box 102, South Milwaukee, WI 53172.

BRITISH COLUMBIA: Hamfest '82 sponsored by the Maple Ridge ARC, July 10 and 11, Maple Ridge Fairgrounds, 30 miles east of Vancouver. Hams $5.00; non-Hams over 12 years $2.00. Food, prizes, swap & shop, displays, bunny hunt, ladies' and children's programs and much more. Main prize Kenwood TR-2500. Camper space available. Talk-in on 146.34/94 and 146.20/80. For information and registration: Maple Ridge ARC, Box 292, Maple Ridge, BC V2X 7G2.

OPERATING EVENTS

"Things to do..."

JUNE 19: The Cape Fear Amateur Radio Society of Fayetteville, NC, will operate a special event station, club call WB4YZF, from the 14th annual National Hollerin' Contest, Spivey's Corner, NC. Operation will be on 7235 MHz between 1300-2100 UTC. For a special certificate send QSL and $1.00 US to: Sonny Bartron, Rt. 2, Box 532, Fayetteville, NC 28301.

JUNE 26 & 27: A special events day of the Tri-City Amateur Radio Club will be held at the Goodnoe Wind Turbine Site, ten miles east of Goldendale, WA. The power usage is sponsored and special permission granted from NASA, Boneville Power Administration, Department of Energy, and Boeing Aircraft Co.

JULY 3 & 4: The Hannibal Amateur Radio Club's second annual special certificate from the National Tom Sawyer Days celebration in Mark Twain's boyhood home town, Hannibal, MO. House 1500-2100 UTC both days. Frequencies: Phone 7.245, 14.290, 21.400, 28.770. CW 7.125 and 21.125. The club is also observing its 50th anniversary. For a certificate, send large SASE and QSL card confirming contact to: Hannibal Amateur Radio Club, WØKEM, 2108 Orchard Avenue, Hannibal, MO 63401.

JULY 4: Commemorative Amateur Radio Station, Bonfield, Illinois, Centennial Celebration. Frequencies: 223.50, 144.250, 146.520, 50.115, 28.600, 21.400, 14.325, 7.275, 3.8-3.9. SASE to WB9WOC, QSL Manager.

JULY 4 & 5: The High Plains ARC will have a special events station K7YPT at historic Fort Laramie, Wyoming, starting 0000Z, July 4 to 0000Z, July 5. Frequencies: Phone 28550, 21300, 21360, 14250, 14300, 7250, 3850, 3900. CW 50 kHz up from lower band edge. Novice — middle of band. For a special certificate for QSL send large SASE to: K7YPT, P.O. Drawer T, Torrington, WY 82240.

OCTOBER 31 TO NOVEMBER 10: The Penn Wireless Association is sponsoring a HAM DXPEDITION AT SEA aboard the Royal Caribbean Line's Sun Viking. All hams are invited to participate in this exciting adventure. For more information contact: Bill Buckley, WA2ALG, 1158 Oxford Valley Road, Levittown, PA 19057. See April HR, page 95.

More Details? CHECK—OFF Page 92

ham radio TECHNIQUES Bill Orr W6SAI

Spring is on the way, and with the advent of milder weather the thoughts of many Amateurs turn toward antennas. A lot of interesting antenna experiments and tests should be underway this summer. And all of them will probably include the use of an SWR meter to help determine antenna operation.

My discussion of the SWR meter and its problems in the April column raised several inquiries concerning an accuracy test for the SWR meter. How can the owner of such a device determine if the readings he gets are meaningful? Fortunately, there is a simple and inexpensive test procedure that will determine the excellence of any SWR meter. You can run the test in a few hours' time.

Consider the situation in **fig. 1**. Three SWR meters are placed at random spots along a transmission line to an antenna. At any given value of SWR the three devices should provide the same indicated reading. Does this happen in real life? Probably not. In addition to inherent error mechanisms such as meter movement and the linearity of the diodes in the SWR indicators, the directivity of the individual couplers in each SWR meter enters the picture. By directivity I mean the ability of the coupler to discriminate between opposite directions of rf power flow. Since most simple SWR meters have both a "forward" and a "reverse" coupler built in them, the directivity factor assumes great importance.

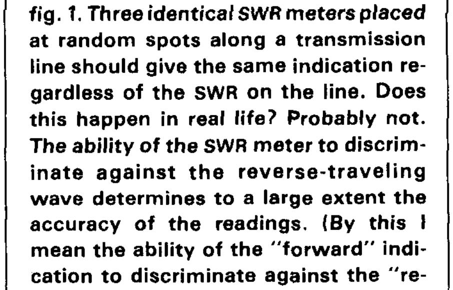

fig. 1. ***Three identical SWR meters placed*** **at random spots along a transmission line should give the same indication regardless of the SWR on the line. Does this happen in real life? Probably not. The ability of the SWR meter to discriminate against the reverse-traveling wave determines to a large extent the accuracy of the readings. (By this I mean the ability of the "forward" indication to discriminate against the "reverse" indication, and the ability of the "reverse" indication to discriminate against the "forward" indication). This discrimination is termed directivity.**

A sketch of a representative SWR meter showing the two couplers is given in **fig. 2**.

the SWR meter test

The idea shown in **fig. 1** is a good check for an SWR meter. Move the meter along the transmission line and note any change in indicated SWR. This, however, is a cumbersome idea that is hard to accomplish in most cases, and the results may not be reproducible because of the interaction between the field of the antenna and the outer shield of the transmission line.

A more practical test for the SWR meter is shown in **fig. 3**. A deliberate mismatch is measured through various lengths of transmission line. A dummy load is used to eliminate the interaction between antenna field and the line. The degree of mismatch SWR is known and repeatable. And

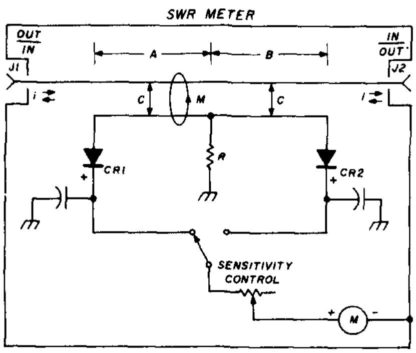

fig. 2. Simple SWR meter uses two direction couplers (A and B) to sense forward and reflected wave components in a transmission line. Reflected components of voltage and current are 180 degrees out of phase while the forward components of voltage and current are in phase. Inductive (M) and capacitive (C) pickup between transmission line and pickup line provide voltage that is rectified by diodes (CR1,CR2) to provide "forward" and "reflected" readings on meter M. Couplers are terminated in a common resistor, R.

best of all, the test is easy to run and inexpensive to set up.

Note that a second harmonic filter is required between the signal generator (your transmitter or exciter) and the test setup. This is because the second harmonic energy, small though it may be, is sufficient to disrupt the results of the investigation. See **fig. 4**.

The mismatched load is made up of a 50-ohm dummy load and a quarter-wave section of 75-ohm coaxial line. The line section serves as an impedance transformer, providing a terminal impedance of 112.5 ohms at the open end. If this value of load is measured through a 50-ohm SWR meter, the indicated SWR should be the ratio of the load to the line impedance, or:

$$\frac{112.5}{50} = 2.25\text{-to-}1$$

The test is conducted as shown in the illustration. The mismatch load is measured directly, and then remeasured through various lengths of 50-ohm line. If the SWR meter is perfect (and none of them are) the SWR reading will remain constant at each observation point. The amount of variation in the indicated SWR reading from the true reading determines the excellence of the SWR meter.

preparing for the test

It is understood that the test is run at 14.0 MHz in this example. The 75-ohm mismatch line section is made from an 11-foot 7-inch (3.54-meter) section of either RG-59B/U or RG-11/U. (Other versions of RG-59 coax are not suitable, as their impedances may be as low as 73 ohms.)

Suitable connectors are placed on each end of the line and line length is measured from tip to tip of the center conductor. Next, three sections of 50-ohm line are made up. Two are one-eighth-wavelength long (5 feet 9-1/2 inches, or 1.77 meters) and the third is one-quarter-wavelength long (11 feet 7 inches, or 3.54 meters). Again, suitable plugs are placed on the line and length is measured from tip to tip of the center conductor. An accuracy of plus-or-minus one-half inch is satisfactory. Suggested cable types are RG-8A/U, RG-213/U, RG-58/U, or RG-58C/U. Don't use the old cable designation of RG-8/U or "RG-8-type" cable. That usually runs close to 52 ohms impedance.

When the cables are complete, label the 75-ohm cable A, the two short 50-ohm cables B and C, and the long 50-ohm cable D. You can make

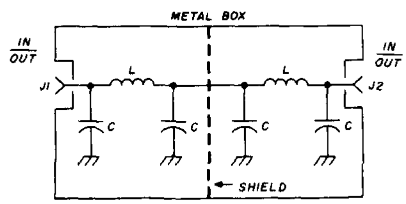

fig. 4. A harmonic filter for 14 MHz. An attenuation of about 30 dB is provided for the second harmonic. Each capacitor (C) is 220 pF. Each inductor (L) is 0.55 μH seven turns, No. 16 (1.3-mm) wire 3/4-inch (19-mm) diameter, 7/8-inch (22-mm) long. Suitable coaxial connectors are placed on the ends of the box (J1,J2) and the filter sections are separated by a shield plate placed across the middle of the box. Filter wire passes through a small hole drilled in the shield.

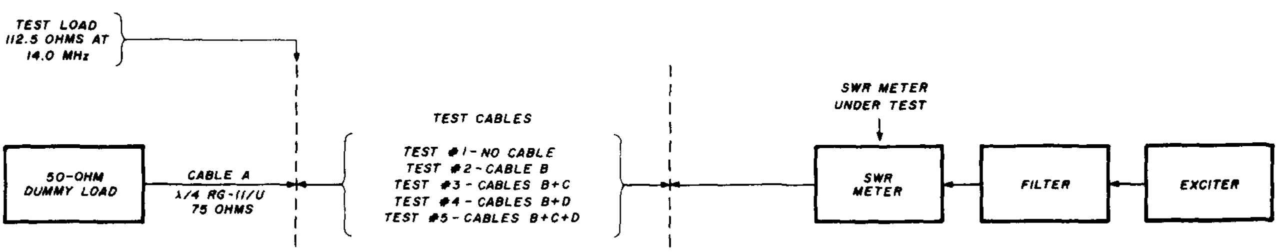

fig. 3. A representation of the test procedure. At the left is the 112.5-ohm dummy load made up of a 50-ohm load and a quarter-wave section of transmission line acting as an impedance transformer. At the right is the test setup for the SWR meter. See *fig. 4* for filter data. The test arena is the area between the vertical dashed lines. Five tests are conducted: One test requires no interconnecting lines, and the other four tests require line sections representing 1/8-, 1/4-, 3/8-, and 1/2-wave line sections.

TEST NUMBER	CABLES	LENGTH (λ)	INDICATED SWR
1	0	0	3.35
2	B	1/8	2.00
3	B+C	1/4	1.50
4	B+D	3/8	2.75
5	B+C+D	1/2	3.35

fig. 5. Representative SWR readings recorded with a "Brand X" SWR meter as various cable lengths are added between the meter and an unmatched load, as shown in *fig. 3*. Actual value of SWR in each case is 2.25-to-1.

up paper labels and tape them directly over the jacket of the lines with transparent tape.

The last step is to make up the second harmonic filter. A suitable filter is shown in **fig. 4**. It is made of air-wound coils and mica capacitors and built in a small metal box. A shield is placed between the filter sections, as shown, and suitable coaxial receptacles are placed on the ends of the box. The filter is rated for a power level of about 150 watts.

running the test

Test number 1 consists of measuring the SWR directly at the end of cable A. Make up a suitable chart and record all your readings on it. Later, a graph can be drawn from the chart data (**fig. 5**).

For test number 2, cable B is added between the SWR meter and cable A, and an SWR reading is taken and logged. Test number 3 consists of using cables B and C in series. Test number 4 consists of cables B and D in series. Test number 5 consists of using cables B, C, and D in series. The numbers in **fig. 5** were derived by testing a cheap, imported SWR meter.

What you have just finished doing, in effect, is to add eighth-wavelength sections of coax line between the "mismatch" line section and the SWR meter. This is electrically equivalent to moving the SWR meter along the line, as discussed in **fig. 1**.

results of the test

A representative test on two SWR meters is charted in **fig. 6**. The second instrument is a Bird 43 coupler.

The variations of the indicated reading from the true SWR values are obvious and startling!

This graph explains one of the reasons that the indicated SWR will vary with the placement of the instrument in the line. It also gives lie to the popular but incorrect belief that changing line length changes the SWR on the line! Changing line length changes the indicated SWR reading to a degree, depending upon the accuracy of the SWR meter, but the actual SWR on the line remains the same. (It is true that actual SWR will decrease with line length due to line attenuation, but this is another matter and may be ignored in the high-frequency spectrum. Most Amateur handbooks provide tables of line attenuation for those interested in pursuing that subject further.)

interpreting the results

The graph shows that even an excellent SWR coupler such as the Bird

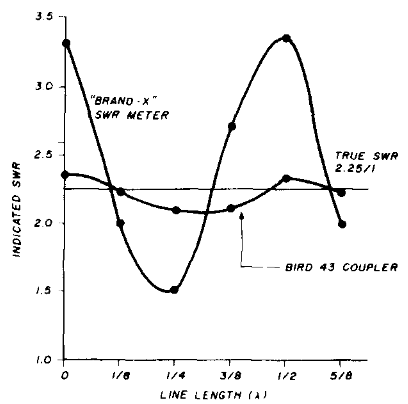

fig. 6. Using the data in *fig. 5*, plus a second test run on a Bird 43 coupler, produces the chart shown. The indicated SWR measurements (Y-axis) are plotted against cable length (X-axis). An additional section of cable was used to extend the plot to 5/8-wavelength. Note that the plot is not symmetrical about the true SWR value.

provides a reading that varies with line length to a small degree. The inexpensive "Brand-X" SWR meter, however, is not to be trusted. The indicated reading varies between a low value of 1.5-to-1 and a high value of 3.35-to-1 for a true SWR value of 2.25-to-1. You can get almost any reading you wish by merely moving the instrument back and forth along the line!

The test results are based upon a single frequency measurement (14.0 MHz) and the variations in SWR reading change with frequency, growing worse as the frequency of operation is raised. This is why most cheap SWR meters provide gibberish at 10 meters and higher. The Bird coupler, on the other hand, has frequency-rated, plug-in detectors which provide good accuracy in the VHF and UHF regions.

The indicated SWR excursions determined by the just-completed tests can be used to determine the directivity factor of the SWR meter (directional coupler), with the aid of **fig. 7**. (This drawing is reproduced, with thanks, from the November, 1959, issue of *QST*. It was in an article entitled "Possible Errors in V.S.W.R. Measurement" by Louis D. Breetz, W3KDZ/W8QLP.)

The directivity is found by locating the maximum excursions of SWR on the graph you have made and finding them on the Y-axis (vertical) of **fig. 7**. For example, the Bird Coupler has a SWR excursion of 2.35-to-1 to 2.1-to-1. Find the true value of SWR (2.25-to-1) on the X-axis (horizontal) and proceed upward until you cross the points you have located on the Y-axis. This indicates a directivity of almost 40 dB, which is excellent.

On the other hand, the indicated maximum SWR excursions of the "Brand-X" SWR meter are 3.35-to-1 and 1.5-to-1. Locating these points on **fig. 7** indicates a directivity of about 15 dB, which is very poor!

As you can see from an inspection of your graph, and also **fig. 7**, a directivity of about 40 dB is required to

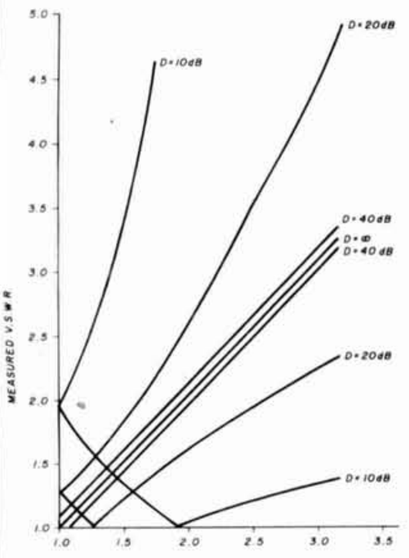

fig. 7. A reproduction of the chart in the November, 1959, issue of *QST*, showing the relationship between true SWR and measured SWR. A good directional coupler has a directivity figure of close to 40 dB. (Reprinted courtesy of *QST* magazine).

give a meaningful SWR reading, and even that degree of excellence allows an error of about 5 percent in the reading. Note, too, that the indicated SWR curve plotted for both instruments is not symmetrical about the true SWR value, further complicating interpretation of data to a degree.

SWR meter wrap-up

This simple experiment illustrates that only a good SWR meter (or directional coupler, if you wish) will provide meaningful SWR numbers. My April column pointed out some of the pitfalls in making SWR measurements. This column explores the limitations of the SWR meter itself. Armed with this information, it should be possible for any Amateur to make *meaningful* SWR measurements.

(Note: Thanks to Willy Sayer, WA6BAN, for deriving this test setup and for making the measurements on the two SWR meters.)

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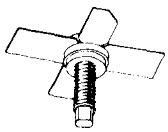

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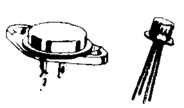

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7453	.28
7454	.28
7460	.44
7470	.39
7472	.42
7473	.41
7474	.42
7475	.42
7476	.42
7480	.64
7483	.60
7485	.70
7486	.44
7489	1.80
7490	.99
7491	.70
7492	.77
7493	.54
7494	.77
7495	.70
7496	.77
7497	.77
74100	1.04
74105	.37
74107	.58
74109	.37

74116	2.30
74120	2.00
74122	.64
74123	.64
74125	.49
74126	.62
74132	.74
74141	.74
74145	.67
74148	1.25
74150	1.04
74153	.72
74154	1.24
74155	.87
74157	.74
74158	1.70
74161	1.00
74163	.92
74164	1.02
74165	1.02
74166	1.25
74172	6.00
74173	.84
74174	.94
74175	.94
74177	.90
74180	.80
74181	1.80
74182	.80
74185	2.00
74186	10.00
74190	1.20
74191	1.20
74193	.90
74194	.90
74195	.90
74196	.90
74197	.90
74273	1.10
74279	.84
74283	2.20
74298	3.22
74366	.73
74367	.84
74368	.84
Series 74LS	
74LS00	.40
74LS01	.33
74LS02	.33
74LS04	.44
74LS05	.33
74LS08	.44
74LS09	.43
74LS10	.33
74LS11	.44
74LS14	1.30
74LS20	.31
74LS21	.43
74LS27	.44
74LS30	.31
74LS32	.44
74LS37	.84
74LS38	.44
74LS42	.84
74LS49	1.43
74LS51	.31
74LS54	.40
74LS73	.50
74LS74	.64
74LS75	.73
74LS76	.50
74LS85	1.24
74LS86	.50
74LS90	.80
74LS93	.80
74LS95	.93
74LS96	1.03
74LS107	.50
74LS109	.50
74LS112	.64
74LS123	1.24
74LS125	.94
74LS132	.84
74LS138	.94
74LS139	.68
74LS145	1.30
74LS151	.84
74LS153	.84

74LS155	1.24
74LS156	1.04
74LS157	1.04
74LS158	.80
74LS160	1.03
74LS161	1.20
74LS163	1.03
74LS164	.94
74LS165	.94
74LS173	.94
74LS174	1.04
74LS175	1.04
74LS181	2.25
74LS191	1.20
74LS193	1.03
74LS194	1.20
74LS195	1.00
74LS196	.94
74LS197	.94
74LS221	1.54
74LS240	3.04
74LS244	3.00
74LS245	8.95
74LS251	1.84
74LS253	1.03
74LS257	1.03
74LS258	1.03
74LS259	3.00
74LS266	.64
74LS273	1.80
74LS282	2.10
74LS283	1.15
74LS293	2.00
74LS298	1.34
74LS323	4.79
74LS353	1.70
74LS366	1.04
74LS367	1.04
74LS368	1.04
74LS373	2.80
74LS374	2.80
74LS378	1.33
74LS393	2.00
74LS670	2.34
4001	.34
4002	.34
4007	.34
4009	.64
4011	.34
4012	.34
4013	.54
4015	1.44
4017	1.24
4021	1.54
4023	.42
4024	.84
4025	.43
4027	.84
4028	1.04
4029	1.34
4030	.74
4040	1.34
4046	2.30
4049	.74
4050	.74
4052	1.15
4060	1.44
4069	.44
4081	.40
4093	1.04
7520L	1.35
75107	.84
75108	.84
75113	2.25
75115	
75123/8T23	1.49
75151	
75154	2.00
75350	
75368	2.95
75369	
75427	
75451	2.10
75452	2.10
75454	2.10
75480	
75492	.93

MODULES & SOLID STATE DEVICES

RCA CA3028A .... $1.00 each
Cascade Amplifier. DC-500 MHz

Analog Devices AD580 IC......... $1.00 each
Low drift voltage reference.
3-terminal device: V. out=2.5 V ± 1%
4.5 V < V. in < 30 V

MEM 631......................... $.50 each
Dual gate MOS Fet
Vds = 25V, Id = 30 mA
Mhos 800(min)

LM3909 LED Flasher IC .... $1.25 each

TCA440 AM Receiver IC .... $2.19 each
with RF, AGC, mixer, low current draw.

Microwave Pin Switching Diodes
MPN 3401 .... .52 each or 3/1.00

MRF511
1500 MHz, 7.3 dB noise at 200 MHz
Sale price at.................... $3.99 each

2N5179
900 MHz, 4.5 dB noise at 200 MHz
Sale price at...................... $.69 each

MEM 712 Fet $1.00

2N5638 Fet "N" Channel........... 3/$1.00

MPF102 Fet "N" Channel .... 3/$1.00

2N5458 Fet "N" Channel .... 3/$1.00

MC1590G .... $6.00 each
RF-IF Audio Amp. w AGE.

MC1550G .... $1.00 each
RF-IF Amp.

#W1605 MAC15-6................ $1.00 each
TO-220 Triac, 15 Amps 400 V

CAPACITORS

Elpac Paper Caps................ $1.69 each
Part #CQ 20A104,*. 10 @ 2 KV

Sprague/Goodman Ceramic Caps. .. $.69 each
#GKR50000, 5.1 to 50 pF

Sprague/Goodman Piston Caps.... $1.99 each
#GGP12000, .8 to 12 pF

Erie #1270-016 .... $1.00 each
Min. attenuation: 50 dB from 200 MHz
to 10 GHz, 5000 pF 200 VDC

Erie #1201-785 .... $1.00 each
Min. attenuation: 50 dB from 100 MHz
to 10 GHz, 5500 pF 200 VDC

NEW Sanghmd Type 2A Caps ...... $1.00 each
#CM560333J, .033 MFD 600 VDC
1/2"H x 1 3/4"L x 1 1/4"W

New High Voltage Oil Filled Capacitor
Mfr. #4W308T, Mfr. - CSI
53.3 MFD, 3.5 KVDC, Length - 4 1/2",
width - 3 3/4", height - 11"
$29.99 each

Dip Tantalum Capacitors
15 MFD @ 25 VDC................. 7/$1.00

UNELCO CAPS

6.8pF	47pF	13pF	240pF
8.2pF	62pF	14pF	360pF
10pF	160pF	20pF	470pF
12pF	180pF	24pF	1000pF

-350V $1.00 each

TRIMMER CAPS

Sprague. Stable Polypropylene.
.50 each or 10/4.00
not sold mixed

1.2 to 13pF	3.9 to 40pF
2 to 30pF	3.9 to 55pF
3.9 to 18pF	

MOTOROLA RF MODULES

MHW 591
1 to 250 MHz frequency range, 35/36.5 dB gain. 13.6 VDC input. 700/100 output level 1 dB compression. 5 dB noise @ 250 MHz.

MHW592
1 to 250 MHz frequency range, 34.5/36 dB gain. 24 VDC input. 900/100 output level 1 dB compression. 5 dB noise @ 250 MHz.

MRF450 & MRF450A .... $13.80 each
4 Watts input. 50 Watts output.
11 dB gain, 13.6 VDC.

BFR91.......................... $1.65 each
5000 MHz
1.9 noise @ 500 MHz
16 dB gain @ 500 MHz

MRF901 .... $2.15 each
4500 MHz
2.0 noise @ 1000 MHz
10 dB gain @ 1000 MHz

MHW252 .... $39.99 each
.3 Watts input power
25 Watts output power
144-148 MHz, 19.2 Gp power gain
13.6 VDC input

MHW 612A .... $39.99 each
.2 Watts input power
20 Watts output power
146-174 MHz, 20 Gp power gain
12.5 VDC input

AIR VARIABLE CAPACITORS

.1- 10pF	189-6-1	1.50
.5- 12pF	160-107-16	1.50
.9- 15pF		1.50
1- 5pF	T-3-5 187-103-5	1.50
1.3- 6.7pF	189-502-4	1.50
1.4- 9.2pF	189-503-105	1.50
1.4- 13pF	193-3	1.50
1.7- 11pF	T6-5	1.50
1.7- 14pF		2/1.50
1.7-14.1pF	189-505-107	1.50
1.8- 9.2pF	189-509-105	1.50
1.8-11.4pF	545-043	1.50
1.8-16.7pF	189-506-103	1.50
2-19.3pF	189-507-105	1.50
2.1-22.9pF	189-509-5	1.50
2.2- 34pF	193-10-104	1.50
2.2- 34pF	193-10-6, 3/16"x3" shaft	2.50
2.4-24.5pF	189-509-5	1.50
3- 105pF	1000 VDC, 1/4"x6" shaft	4.99

HIGH VOLTAGE CAPS.

22 MFD @ 500 VDC	$1.69
150 MFD @ 450 VDC	$3.29
225 MFD @ 450 VDC	$4.29
600 MFD @ 360 VDC	
800 MFD @ 360 VDC	$2.99
850 MFD @ 330 VDC	$3.59
2000 MFD @ 350 VDC	$7.99 each
2000 MFD @ 450 VDC	$22.99 each
3200 MFD @ 350 VDC	$9.99 each
3100 MFD @ 450 VDC	$29.99 each
6200 MFD @ 150 VDC	$6.99 each
110,000 MFD @ 25 VDC	$6.99 each

ARCO CAPACITORS

# 304	100- 550pF	$1.50
# 400	.9- 7pF	$1.00
# 402	1.5- 20pF	$1.00
# 404	8- 60pF	$1.00
# 405	5- 80pF	$1.00
# 420	1- 12pF	$1.00
# 422	4- 40pF	$1.00
# 423	7- 100pF	$1.00
# 426	37- 250pF	$1.00
# 429	80- 300pF	$1.00
# 464	25- 200pF	$1.00
# 465	50- 380pF	$1.00
# 467	110- 580pF	$1.00
#2564	75- 280pF	$2.00
#4615	390-1400pF	$2.00

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2822 North 32nd Street, #1 • Phoenix, Arizona 85008 • Phone 602-956-9423

SEMICONDUCTORS SURPLUS

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more capacitors

FEED THRU CAPACITORS

Solder Type .... 5/$1.99

3pF	47pF	1000pF
20pF	82pF	2000pF
27pF	100pF	

Stud Mount - 1.5 KV............... $1.99 ea.
.01uF, 1000pF, 2200pF

DOOR KNOB CAPACITORS

100 pF @ 5 KV......................... $3.99
470 pF @ 15 KV $3.99
Dual 500 pF @ 15 KV.................. $3.99
680 pF @ 6 KV.......................... $1.99
800 pF @ 15 KV......................... $3.99

CERAMIC CAPS.

.001 uF @ 10 KVDC.............. .89
.001 uF @ 2 KV............... 4/1.00
.0015 uF @ 3 KV............... 3/1.00
.01 uF @ 4 KV.................. .79
.01 uF @ 1.6 KV............... 4/1.00
.01 uF @ 1 KV............... 6/1.00
.05 uF @ 3 KV Electro-cube 3.99
.1 uF @ 2 KV Electro-cube 3.99

CHIP CAPS. $1.00 ea. or 10/$7.50

.033 pF	8.2 pF	47 pF
.047 pF	10 pF	51 pF
.068 pF	11 pF	56 pF
.01 pF	12 pF	62 pF
.3 pF	13 pF	68 pF
1 pF	15 pF	75 pF
1.2 pF	16 pF	82 pF
1.5 pF	20 pF	91 pF
1.8 pF	22 pF	100 pF
2.2 pF	24 pF	150 pF
2.7 pF	27 pF	300 pF
3.3 pF	30 pF	330 pF
3.9 pF	33 pF	1000 pF
4.7 pF	36 pF	1200 pF
5.6 pF	39 pF	1500 pF
6.8 pF	43 pF	1800 pF

PISTON TRIMMERS

.5 - 10 pF... LRC 682418........... $1.99
.5 - 7.5 pF........... 2.99 ea. or 10/20.00
2 - 27 pF.......................... $2.99
.6 - 6 pF... SFD VCJ2819A......... $1.99
1 - 3 pF... SFD VCJ2281 .... $1.99
.5 - 12 pF... PCB mount $2.99
1 - 8 pF... SFD VCJ988 .... $1.50
SFD VCJ1983 .... $2.99
.8 - 12 pF... SGE7906.............. $1.99
.8 - 18 pF... 567-013 .... $2.99
.5 - 10 pF... PCB mount $1.29
1.2 - 10 pF... PCB mount $1.00
.2 - 1.5 pF... with 100 pF lap $1.99
.5 - 12 pF... PCB mount $2.99
.5 - 10 pF.......................... $1.99
.5 - 7.5 pF............2.99 ea. or 10/20.00
2 - 27 pF.......................... $2.99
.6 - 6 pF... SFD VCJ2819A......... $1.99
1 - 3 pF... SFD VCJ2881 .... $1.99

Miniature Ceramic Trimmers
.50 each or 10/$4.00

CV31D350	2 to 8 pF
HM00-4075-03	3.5 to 11 pF
300425	3.5 to 13 pF
E5-25A	5 to 25 pF
	5.1 to 40 pF
	3.5 to 15 pF
	5.2 to 40 pF
	2.5 to 6 pF

PANEL METERS

RF Power output 0-1000 scale
1 MA movement $5.99 ea.

Large 8" scale meter
50 MV movement $6.99 ea.

DC amp meter 0-1 Amp
#2MAS-DAA-001 $4.99 ea.

DC MA meter 0-5 MA
Emico $2.99 ea.

3 assorted 50 uA meter movements, one each: zero center, linear display, and signal strength 3/$8.99

CERAMIC COIL FORMS

CAMBION WITH SLUGS
LST-P/530-2020-03 .... $1.50
3/16"d x 1/2", 20-50 MHz
Green slug with hardware.

LST-H/530-1532-01 .... $1.50
3/16"d x 1/2", 1-20 MHz
Red slug with hardware.

LS6-E/530-1535-02 .... $1.50
1/4" x 3/4", 1-20 MHz
Red slug with hardware.

LST-H/530-2020-02 .... $1.99
3/16"d x 5/16" with terminals
1-20 MHz, red slug

PLST-1 530-1532-01 .... $1.99
3/16"d x 5/16" with terminals
.2-1.5 MHz

PLS5-B - 2 Cyl., 1-20 MHz $1.99
3/8"dia. x 5/8" with terminals and hardware, red slug

PLS5-C - 2 Cyl., .2-1.5 MHz......... $1.99
3/8" dia. x 5/8" with terminals
yellow slug

LST-1 - Yellow slug, .2-1.5 MHz...... $1.99

CERAMIC COIL FORMS - No Slug

#1......... 3/16" x 5/8"............. 1.00
#2......... 3/16" x 1/2"............. 1.00
#3......... 1/4" x 5/8"............... 1.00
#4......... 3/8" x 1"................. 1.00
#5......... 1/2" x 1 1/2" 1.00

PAPER COIL FORMS - With Slug

#6......... 1/4" x 3/4"............... 1.00
#7......... 3/16" x 3/4" 1.00

VHF/UHF/MICROWAVE COMPONENTS

J-Fet #J310...................... 3/$1.00
N-Channel, 450 MHz. Good for UHF/VHF amplifiers, oscillator and mixers.

2N6083......................... $10.00 ea.
8.1 Watts input, 30 Watts output.
5.7 dB gain, 12.5 VDC

Motorola RF Amp. Modules........ $29.99 ea.
#544-4001-002
Similar to type MHW401-2
1.5 Watts output, .047 Watts input.
440-512 MHz, 15 dB gain, 7.5 VDC

TRW CA602/CA 2601BV........... $29.99 ea.
Microelectronics Broadband Amp.
15 to 270 MHz, 30 dB gain max.
30 VDC supply voltage

New Microwave Diode
Microwave Associates, Inc. - MA41482 and MA41482R, 10 GHz to 40 GHz

DIODES

1N4148/1N914
Switching diode
30/$1.00 or 100/$3.00

HEP 170
2.5 A, 1000 PIV
.20 ea., 100 for $15.00

HVK 1153
25 mA, 20,000 PIV
$1.00 ea., 10 for $8.00

Motorola MA 752 Rectifier
6 Amps, 200 PIV
4/$1.00

High-voltage diode EK500
5000 Volts, 50 mA
2/.99 each

DG-1005
1.5 A, 1000 PIV
.15 ea., 100 for $12.00

SCMS 10K
15 mA, 10,000 PIV
$1.69 ea., 10 for $12.50

Fairchild LEDs
FLV 5007 & 5009 red.
Case type TO-92.
6/$1.00

Motorola SCR
TO-92 Case, 0.8 Amp, 30 V.
Igt 0.2 Vgt 0.8.
Same as 2N5060.
4/$1.00 or 100/$15.00

10 KV at 1.5 Amps $3.99
High Voltage Diode

CRYSTALS

$3.00 each

5.120	10.010	11.855
7.3435	10.020	11.900
7.4585	10.030	11.905
7.4615	10.040	11.955
7.4625	10.0525	12.000
7.4665	10.130	12.050
7.4685	10.140	12.100
7.4715	10.150	16.965
7.4725	10.160	17.015
7.4765	10.170	17.065
7.4785	10.180	17.165
7.4815	10.240	17.215
7.4825	10.245	17.265
7.4865	10.595	17.315
7.4925	10.605	17.355
7.4985	10.615	17.365
7.5015	10.625	37.600
7.5025	10.635	37.650
7.5065	11.155	37.700
7.7985	11.275	37.750
7.8025	11.700	37.800
9.545	11.705	37.850
9.555	11.730	37.900
9.565	11.750	37.950
9.575	11.755	38.000
9.585	11.800	60.000
10.000	11.850	

CRYSTAL FILTERS

EFCL455K13E	3.99
EFCL455K40B2	2.99
FX-07800L, 7.8 MHz	12.99
FHA103-4, 10.7 MHz	12.99

ORDERING INSTRUCTIONS

Check, money order, or credit cards welcome. (Master Charge and VISA only.) No personal checks or certified personal checks for foreign countries accepted. Money order or cashiers check in U.S. funds only. Letters of credit are not acceptable.

Minimum shipping by UPS is $2.35 with insurance. Please allow extra shipping charges for heavy or long items.

All parts returned due to customer error or decision will be subject to a 15% restock charge. If we are out of an item ordered, we will try to replace it with an equal or better part unless you specify not to, or we will back order the item, or refund your money.

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We now have a toll free number, but we ask that it be used for *charge orders only*. If you have any questions please use our other number. We are open from 8:00 a.m. - 5:00 p.m. Monday thru Saturday.

Our toll free number for *charge orders only* is 800-528-3611.

MINIMUM ORDER $10.00

NEW products

audio processor/ descrambler

The Grove Enterprises DSC-2 Code Breaker is a second-generation audio processor designed for use with scanner or shortwave receivers when monitoring speech inversion scrambling systems. This specialized accessory allows restoration of speech inverted messages to recognizable transmissions.

The low cost of the DSC-2 makes it ideal for monitoring posts that need to be alerted to operations of other departments using speech inverted security systems when a scrambled reply is not necessary (the DSC-2 is designed for receive only). Surveillance and other low profile intelligence operations will find the DSC-2 Code Breaker most valuable when monitoring speech-inverted messages frequently used by suspects either on mobile radiotelephone or over telephone lines when used in conjunction with standard electronic monitoring equipment.

An additional feature of the new DSC-2 is a tunable audio notch filter which permits the user to further clarify signals by removing masking tones which are often used to detract from recognizable speech. When used with shortwave receivers, this same audio notch filter is effective in removing heterodyne interference from adjacent-frequency signals without the need for using narrow i-f selectivity and its attendant muffled quality.

Additionally, the DSC-2 may be used for reversing sidebands to reduce interference. Similarly, close-spaced CW signals may be isolated by adjusting the receiver to zero-beat the unwanted signal, then the Code Breaker is adjusted to change the pitch of the received signal to any desired frequency for comfortable copy.

For more information contact Grove Enterprises, Inc., Dept. D, Brasstown, North Carolina 28902; telephone 704-837-2216.

AEA model MM-2 keyer

Advanced Electronic Applications, Inc., announces the latest generation of MorseMatic™ keyer, the MM-2. The MM-2 is a full-feature paddle input keyer that offers virtually all the features of the MM-1 predecessor plus CMOS memory and at a new low price. The new MM-2 features two powerful pre-programmed microcomputers with copyrighted AEA "firmware."

Like the MM-1, the new MM-2 offers more exclusive features than any other keyer on the market: an automatic serial number generator, an automatic beacon mode, and an automatic speed increasing Morse trainer mode.

The MM-2 permits the operator to vary all of the following from the control keypad: stepped variable monitor tone; dot ratio; dash ratio (for full independent weighting control); dot memory enable or disable; dash memory enable or disable; semi-automatic ("bug") or full automatic operation; speed select from 02 to 99 WPM to 1 WPM increments; and more.

memory

Like its predecessor, the new MorseMatic MM-2 keyer offers a message storage mode with many exclusive AEA features never before offered. Some of these include: ten soft-partitioned™ memory locations; selectable real time message loading or automatic word space loading mode; additional word or character space insertion for perfect formatting in the automatic words space mode; and much more.

The new model MM-2 MorseMatic keyer comes in a handsome metal package that offers the same rf protection that earned the MM-1 such a good reputation for being "bullet-proof." The MM-2 also has a new extended-life, highly reliable sixteen-button keypad. All integrated circuits are mounted on sockets for easy repair if ever necessary. The unit operates from 10 to 16 Vdc or use the optional AEA model AC-1 wall adaptor for 110 Vac.

Perhaps the biggest change between the MM-2 and MM-1 is the price. The new model MM-2 carries a manufacturer's suggested price of $139.95. For further information, contact Advanced Electronic Applications, Inc., P.O. Box 2160, Lynnwood, Washington 98036; telephone 206-775-7373.

portable transceiver

The Santec ST series of radios (both the 2-meter and 440-MHz versions) are the first units to incorporate accurate digital clocks within the programs to control the operation of the radio. The ST-144 contains some of the finest features and easy-to-use functions to be found in a 2-meter portable.

The ten memories store both the frequency information and the instructions to the transmitter as to which way to offset the transmit frequency for repeater use. Once this information is set, the operator no longer has to worry about the offset switches. Bandscan is handled by three different microprocessor programs. The manual mode is for stepping through the band one step at a time; the search mode will automati-

NEW products

cally find the first station talking and stop scanning further. In addition, there is the scan mode which steps through the band and pauses for a while at each busy station to sample the conversation and then moves on. The upper and lower frequency limits of this scan are settable by the user through stored values in the microprocessor.

The microprocessor itself is a very versatile CMOS four-bit CPU. This means that it doesn't eat much current, and it can handle any of the data functions and drive the crisp, clear liquid crystal display as well as process all the commands given it by the user through the keyboard. In addition, if you turn the radio off and put it down, it can stay there for about six months before it needs to be recharged — and it can still remember what you told it to memorize six months before!

For those who are involved in the public service programs of MARS or CAP, the ST-144/uP provides frequency coverage external to the 2-meter Amateur band down to 142.000 MHz and up to 149.995 MHz. In this band range there are three selectable power levels of 100 mW, 1 watt (medium), and 3.5 watts (high).

Memory one is treated as a priority memory in the SCAN mode and signals on this frequency (whatever you stored there) are given priority treatment. When you're listening to one channel at a time, the computer detects an absence of activity and turns off the unneeded circuitry of the unit. At a later time, the computer checks to see if the circuitry is again called for and returns the radio to normal operation. This results in a very low receiver current drain in quiet standby of only 8 mA. Add to this the full sixteen-key keypad, the variable offsets and the big 500 mA-hr (8 cell) NiCad pack plus the easy installation of tone burst or subaudible tone and you have the most exciting, most versatile radio to come along yet.

For more information, contact Encomm, 2000 Avenue G, Suite 800, Plano, Texas 75074; telephone 214-423-0024.

IC-730 HF transceiver

ICOM announces the IC-730 compact solid state high-frequency transceiver. The IC-730 is specifically designed for the budget-minded ham. It's priced at $829.00, making it affordable as a second transceiver for mobile/portable operation, or as the main high-frequency base station transceiver.

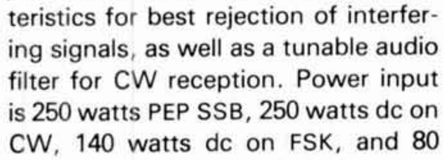
The IC-730 is compact, only 9.5 × 3.7 × 10.8 inches. It has 10-80-meter frequency coverage including all three new WARC bands; it has fully synthesized tuning for stability in mobile operation (1 kHz, 100 Hz, 10 Hz steps). Other features include dual VFOs standard; eight-frequency memory storage (one frequency per band); fully solid-state circuitry with automatic final protection; and i-f shift standard with passband tuning optional.

For more information, write ICOM, Suite 307, 3331 Towerwood, Dallas, Texas 75234.

TS-930S

Trio-Kenwood has just announced the new top-of-the-line model TS-930S all solid-state high frequency transceiver. Designed to cover all Amateur bands from 160 through 10 meters, the TS-930S also incorporates a 150 kHz to 30 MHz general-coverage receiver having an excellent dynamic range.

Among the more interesting features to be found on this model is an automatic built-in antenna tuner, dual digital VFOs, eight-memory channels, dual model noise blanker, i-f notch filter, fluorescent tube display, rf-type speech processor, rf step attenuator, 100-kHz marker, and voice controlled operation. Special circuitry is also in-



corporated that allows operator adjustment of the i-f passband characteristics for best rejection of interfering signals, as well as a tunable audio filter for CW reception. Power input is 250 watts PEP SSB, 250 watts dc on CW, 140 watts dc on FSK, and 80 watts dc on a-m. The built-in power supply operates on 120, 220, or 240 Vac only.

For further information, write Trio-Kenwood Communications, P.O. Box 7065, Compton, California 90224.

general coverage receiver

Trio-Kenwood Communications has just announced a new general-coverage communications receiver, the Model R-600, covering 150 kHz to 30 MHz in thirty bands. It will be available in mid December. The use

of PLL synthesized circuitry results in highly accurate frequency control and maximum tuning ease. The unit features an easy-to-read digital display, a-m, SSB, and CW reception, built-in i-f filters, noise blanker, rf attenuator, S-meter, and front mounted speaker. It can be operated from power sources of 100, 120, 220, and 240 Vdc, 50/60 Hz. Operation on 13.8 Vdc is also possible, using the optional DCK-1 dc power cable kit.

For more information, contact Trio-Kenwood Communications, P.O. Box 7065, Compton, California 90220.

Supercw

Supercw offers computer-aided-instruction in International Morse Code with sound and graphics. You should be able to reach 5 WPM in 12 hours, 13 WPM in 48 hours, and 20 WPM in 72 hours (time varies with users).

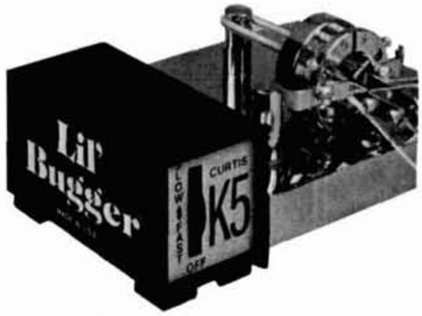
Features include introduction to International Morse Code, individualized learning methodology, random burst word practice, unlimited random word copying, and lots more.

Supercw is compatible to TRS-80 Model I or Model III, 48k and one disk drive. For more information, contact Frontier Enterprises, 3511 Gallows Road, Falls Church, Virginia 22042; telephone 703-573-8086.

NEW products

flea-size keyer

The tiny but rugged low-priced keyer from Curtis Electro Devices, the "Lil' Bugger," is only 1.5 inches square, 3 inches deep, and 3.5 ounces in weight. It offers many of the features found on full-sized keyers, plus a few of its own. The front panel contains only a thumbwheel speed control. Sidetone pitch, volume and weighting are adjustable internally via small trimmers. The tungsten output relay will easily key any Amateur transmitter, including the really tough cases such as old shipboard transmitters.



Jacks are provided for the keyline, sidetone output, and an external ac adaptor, although the case contains a compartment for an ordinary 9-volt transistor radio battery. The standard model, K5, is equipped with the Curtis 8044 chip. A second version of the unit (model K5B), uses the new Curtis 8044B IC, which provides the squeeze keying characteristics of the Ten-Tec, Heath, Nye and Accukeyer. Provision for a straight key is also made.

Both the K5 and K5B are priced at $39.95 plus shipping and are available from stocking dealers or direct from the factory. For more detailed information, contact Curtis Electro Devices, Inc., Box 4090, Mountain View, California 94040 or telephone 415-494-7223.

TR-5

The R.L. Drake Company announces the introduction of the new TR-5 Amateur Radio. This solid-state transceiver is broadbanded, operates on single sideband or CW, and covers all the Amateur bands, even the proposed 12, 17, and 30 meter bands.

Features include excellent sensitivity and selectivity, high dynamic range, digital frequency readout, and full break-in CW operation. AGC time constants are selectable and RIT is front panel selectable. Most Drake 7-line accessories are compatible. Nominal power input is 150 watts. Price is $1099.

For more information, contact R.L. Drake Company, 540 Richard St., Miamisburg, Ohio 45342; telephone 513-866-2421.

low-cost etching system

Stellmaker Enterprises has designed a high-quality power etching system that is reasonably priced. The kit includes an air pump, air disperser, base with support for 4½-pint plastic tank with cover, mounting screws, and all necessary instructions.

This compact system will etch PC boards up to 6 × 6 inches, the size featured in most magazine articles. The acid agitated by the air pump makes for fast and more even etching.

This kit sells for $34.50 plus $3.50 shipping and handling from Stellmaker Enterprises, 250 Pequot Trail, Westerly, Rhode Island 02891; telephone 203-599-1283.

NEW products

manual antenna tuners

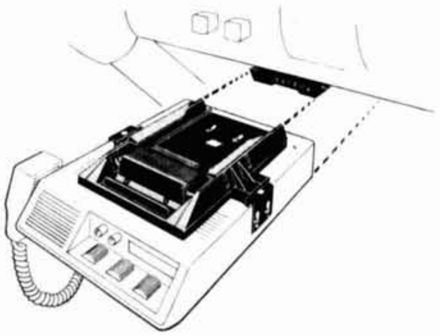
Daiwa announces two new manual antenna tuners. The CNW-518 is a lightweight, rugged tuner rated at 2.5 kW (PEP), 1 kW CW (50 percent duty). It will match unbalanced lines from 10 to 250 ohms impedance and features 80 through 10 meter coverage *including* the new WARC bands. Features include attractive styling and planetary gearing. Insertion loss is less than 0.5 dB.

The new CNW-18 is rated at 500 watts (PEP), 200 watts CW, and incorporates the same features as the CNW-518 except planetary gearing. Both manual tuners feature the unique Daiwa cross needle meter that

shows forward power, reflected power, and resultant SWR at a single glance. For more information, contact EMCM, 858 E. Congress Park Dr., Centerville, Ohio 45459, or telephone 513-434-0031.

Larsen Quik Change

Larsen Antennas' new Quik Change Radio Mount system lets you change your mind — and your radio — fast. The innovative new mount permits temporary expansion of a delivery fleet, interchangeable use on farm equipment, or easy removal for protection against theft from unattended vehicles. It's a flexible product with flexible use. Transfers take only a minute. Radio malfunctions can be checked quickly and replacements installed easily in any vehicle. The Quik Change is tough enough to stand heavy equipment vibration.



There are no manual connections, just a simple latch release that disconnects the positive power lead, then the ground and speaker leads and the antenna connection. Reinsertion connects positive power last to protect the radio. First-class connectors are used throughout with connections provided for power, ground, and speaker screw terminals.

For more information, contact Larsen Antennas, P.O. Box 1799, Vancouver, Washington 98668.

VHF fm transceivers

Hamtronics, Inc., well known for high quality fm transmitter, receiver, and power amplifier modules, now has a complete VHF fm transceiver all on one PC board. The new model FM-5 transceiver kit is available for the 6-meter, and 220-MHz ham bands and may also be used in some countries on adjacent commercial bands. It operates on up to five channels at 10 watts output. The receiver uses ten poles of i-f filtering and dual gate MOSFETS for superior selectivity and cross-mod rejection.

Because all components, including controls and heatsinks, are mounted right on the main PC board, construction is simplified and cost is reduced. The complete kit costs only $159.95. Cabinets, microphones, and crystals are readily available as options.

For further information, including a forty-page catalogue of all Hamtronics kits, contact Hamtronics, Inc., 65F Moul Rd., Hilton, New York 14468; telephone 716-392-9430.

MFJ-955 VLF/MW/SWL antenna

The new MFJ-955 VLF/MW/SWL preselecting antenna tuner greatly improves reception of 10-kHz through 30-MHz signals.

The MFJ-955 connects between your receiver and antenna. You can peak desired signals while rejecting interference and reducing overload, background noise, cross modulation, and inter-modulation. VLF signals come roaring in. Front panel switching allows push button selection of two antennas and two receivers.

The MFJ-955 sells for $59.95 (plus $4.00 shipping and handling), has a money back guarantee (less shipping and handling) and a one-year unconditional warranty.

For more information, contact MFJ Enterprises, Inc., P.O. Box 494, Mississippi State, Mississippi 39762; telephone 800-647-1800.

catalogs

Long known as an excellent source of coaxial cable and other products, Nemal Electronics has just released their latest catalog. Catalog B is chock full of interesting items for all electronic enthusiasts. They have a full line of coax cable and connectors for ham and TV use. Write today or check number 968 on Reader Service card for more information. Nemal Electronics, 3685 SW 80th St., Miami, Florida 33134.

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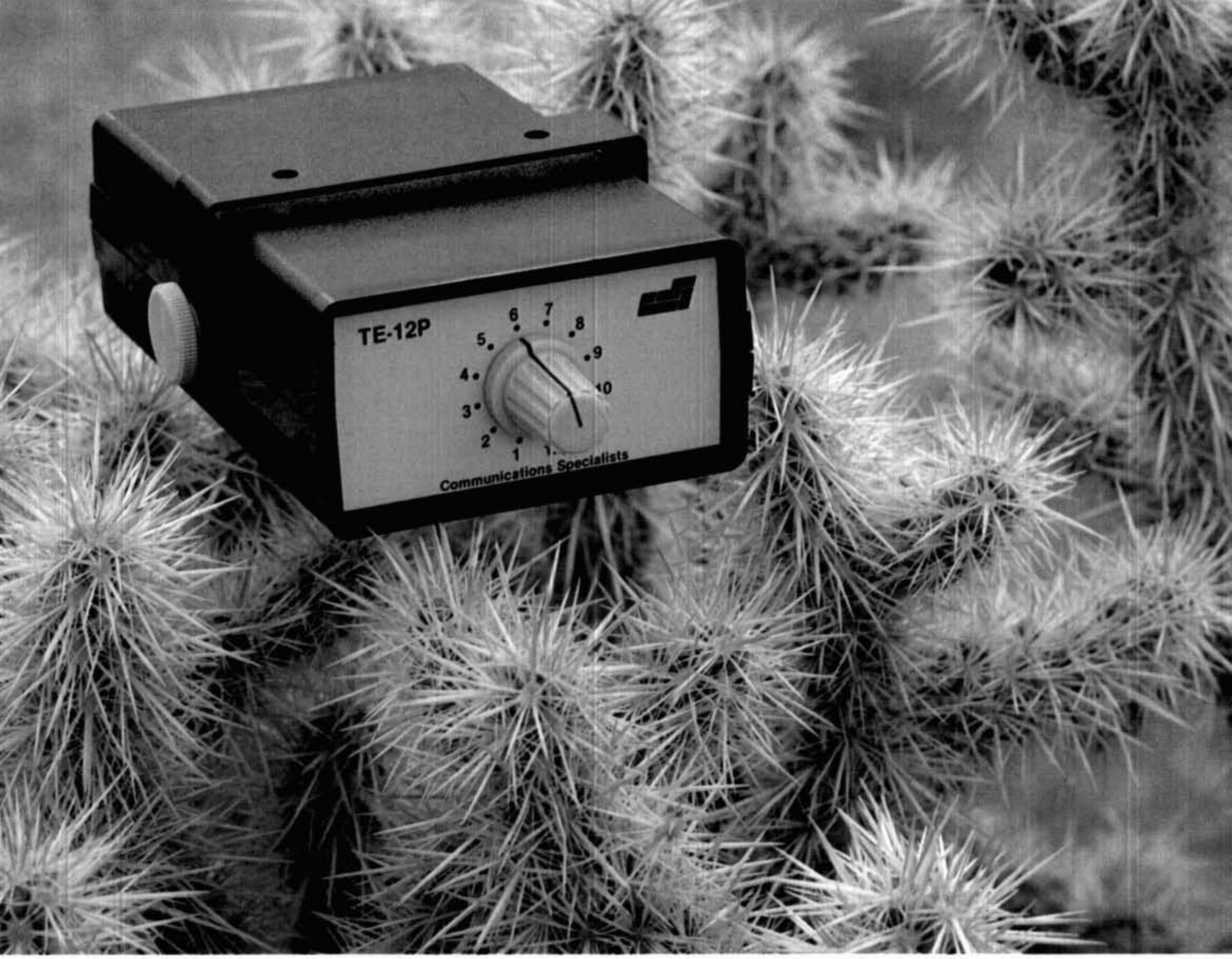
TE-12P
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New Yaesu FT-102 Series
Transceiver of Champions!

The long-awaited new generation of Yaesu HF technology has arrived! New research in improved receiver filtering and spectral purity is brought to bear in the competition-bred FT-102, the HF transceiver designed for active Amateurs on today's intensely active bands!

Unique Cascaded Filter System
The FT-102 utilizes an advanced 8.2 MHz and 455 kHz IF system, capable of accepting as many as three filters in cascade. Optional filters of 2.9 kHz, 1.8 kHz, 600 Hz, and 300 Hz may be combined with the two stock 2.9 kHz filters for operating flexibility you've never seen in an HF transceiver before now!

All New Receiver Front End
Utilizing husky junction field-effect transistors in a 24 volt, high-current design, the FT-102 front end features a low-distortion RF preamplifier that may be bypassed via a front panel switch when not needed.

IF Notch and Audio Peak Filter
A highly effective 455 kHz IF Notch Filter provides superb rejection of heterodynes, carriers, and other annoying interference appearing within the IF passband. On CW, the Audio Peak Filter may be switched in during extremely tight pile-up conditions for post-detection signal enhancement.

Variable IF Bandwidth with IF Shift
The FT-102's double conversion receiver features Yaesu's time-proven Variable Bandwidth System, which utilizes the cascaded IF filters to provide intermediate bandwidths such as 2.1 kHz, 1.5 kHz, or 800 Hz simply by twisting a dial. The Variable Bandwidth System is used in conjunction with the IF Shift control, which allows the operator to center the IF passband frequency response without varying the incoming signal pitch.

Wide/Narrow Filter Selection
Depending on the exact combination of optional filters you choose, a variety of wide/narrow operating modes may be selected. For example, you may set up 2.9 kHz in SSB/WIDE, 1.8 kHz in SSB/NARROW, then select 1.8 kHz for CW/WIDE, and 600 Hz or 300 Hz for CW/NARROW. Or use the Variable Bandwidth to set your SSB bandwidth, and use 600 Hz for CW/WIDE and 300 Hz for CW/NARROW! No other manufacturer gives you so much flexibility in selecting filter responses!

Variable Pulse Width Noise Blanker
Ignition noise, the "Woodpecker," and power line noise are modern-day enemies of effective Amateur operation. The FT-102 Noise Blanker offers improved blanking action on today's man-made noise sources (though no blanker can eliminate all forms of band noise) for more solid copy under adverse conditions.

Low Distortion Audio/IF Stage Design
Now that dynamic range, stability, and AGC problems have been largely eliminated thanks to improved technology, Yaesu's engineers have put particular attention on maximizing intelligence recovery in the receiver. While elementary filter cascading schemes often degrade performance, the FT-102's unique blend of crystal and ceramic IF filters plus audio tone control provides very low phase delay, reduced passband ripple, and hence increased recovery of information.

Heavy Duty Three-Tube Final Amplifier
The FT-102 final amplifier uses three 6146B tubes for more consistent power output and improved reliability. Using up to 10 dB of RF negative feedback, the FT-102 transmitter third-order distortion products are typically 40 dB down, giving you a studio quality output signal.

Dual Metering System
Adopted from the new FT-ONE transceiver, the Dual Metering System provides simultaneous display of ALC voltage on one meter along with metering of plate voltage, cathode current, relative power output, or clipping level on the other. This system greatly simplifies proper adjustment of the transmitter.

Microphone Amplifier Tone Control
Recognizing the differences in voice characteristics of Amateur operators, Yaesu's engineers have incorporated an ingenious microphone amplifier tone control circuit, which allows you to tailor the treble and bass response of the FT-102 transmitter for best fidelity on *your* speech pattern.

RF Speech Processor
The built-in RF Speech Processor uses true RF clipping, for improved talk power under difficult conditions. The clipping type speech processor provides cleaner, more effective "punch" for your signal than simpler circuits used in other transmitters.

VOX with Front Panel Controls
The FT-102 standard package includes VOX for hands-free operation. Both the VOX Gain and VOX Delay controls are located on the front panel, for maximum operator convenience.

IF Monitor Circuit
For easy adjustment of the RF Speech Processor or for recording both sides of a conversation, an IF monitor circuit is provided in the transmiter section. When the optional AM/FM unit is installed, the IF monitor may be used for proper setting of the FM deviation and AM mic gain.

WARC Bands Factory Installed
The FT-102 is factory equipped for operation on all present and proposed Amateur bands, so you won't have to worry about retrofitting capability on your transceiver. An extra AUX band position is available on the bandswitch for special applications.

Full Line Of Accessories
For maximum operating flexibility, see your Authorized Dealer for details of the complete line of FT-102 accessories. Coming soon are the FV-102DM Synthesized VFO, SP-102 Speaker/Audio Filter, a full line of optional filters and microphones, and the AM/FM Unit.

Price And Specifications Subject To Change Without Notice Or Obligation

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