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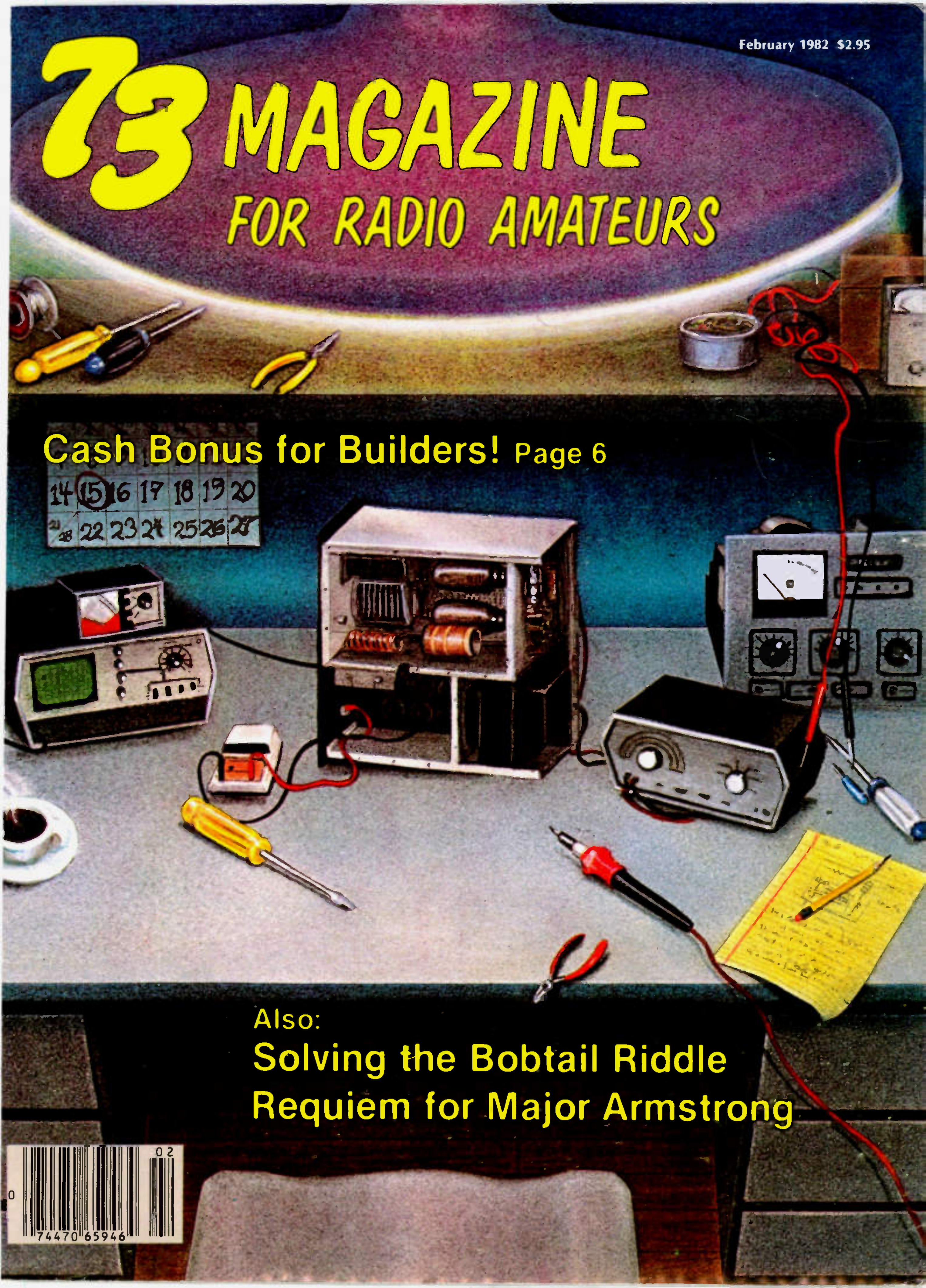
73 MAGAZINE
FOR RADIO AMATEURS



Cash Bonus for Builders! Page 6

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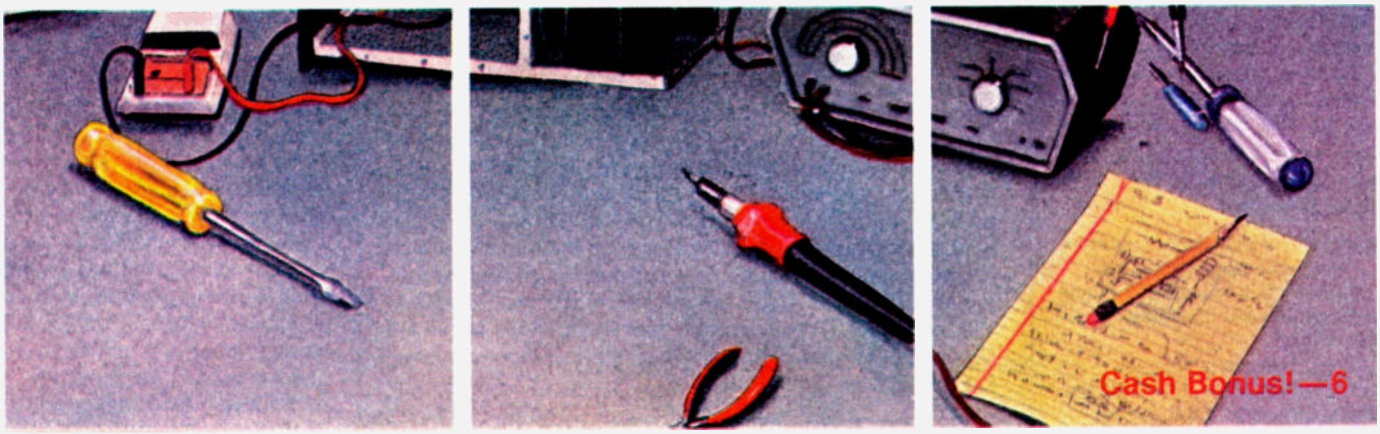
73 MAGAZINE



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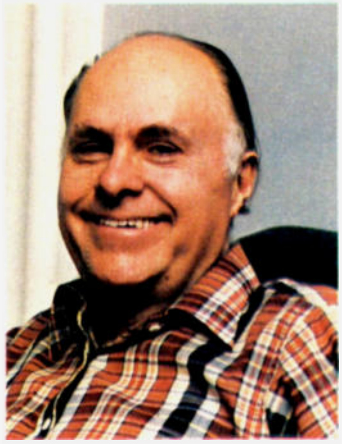
W2NSD/1 NEVER SAY DIE

editorial by Wayne Green



NOW, THE GOOD NEWS

The easy passage of the Goldwater ham bill through the Senate was certainly good news... and will bring closer some badly needed changes in the fundamental rules by which the FCC has had to operate.

Another bright spot was a bill entered in the House (in November) by Rep. Timothy Wirth of Colorado. Let me give you quotes on some of the provisions of this bill...

Authorize use of amateur volunteers for examination preparation

Section 4(f) is amended by adding at the end thereof the following new subsections:

"4(f)(4) Notwithstanding the provisions of Part III of Title 5, United States Code or 31 U.S.C. §665(b), for purposes of administering any examtion for an amateur station operator license, the Commission may accept and employ the voluntary and uncompensated services of any individual who holds an amateur station operator license of an equal or higher class than the class license for which the examination is being prepared. Any person who provides services under this paragraph shall not be considered, by reason of having provided such services, a Federal employee for any purpose."

Explanation

This proposal would provide a statutory basis for present practice at the Commission, and would allow expansion in the Commission's use of volunteers. The amendment would have no discernible effect on our budgetary requirements.

"4(f)(5) Notwithstanding the provisions of Part III of Title 5, United States Code or 31 U.S.C. §665(b), for purposes of administering any examination for any amateur station operator license, the Commission may accept and employ the voluntary and uncompensated services of any individual who holds an amateur station operator license of an equal or higher class than the class license for which the examination is being conducted. Any person who provides voluntary and uncompensated services under this paragraph shall not be considered, by reason of having provided such services, a Federal employee for any purpose."

Explanation

The present practice of the Commission is to permit volunteer licensees holding an Amateur Extra, Advanced, or General Class license who are at least 18 years of age to administer Novice Class operator license examinations. The proposed amendment would give statutory recognition to this practice and would allow the Commission to extend the practice to examinations for other classes, at the discretion of the Commission.

This program would help to conserve Commission resources and additional benefits would result from the fact that applicants would likely be able to take examinations within their communities, as opposed to having to travel to FCC field offices for testing.

Once the FCC has been authorized to let amateurs prepare and administer exams, we have the path open to set up a system whereby certain clubs might be able to hold classes to teach the needed theory, rules, and operation skills to prospective hams... followed by oral exams and a demonstration of skills.

While there are some amateurs who believe that the tension and panic of an FCC-administered exam are beneficial in some way, that was not my experience... nor the experience of anyone I've talked with about it. There seems to be a general concept that we should do everything possible to keep enthusiastic people out of the hobby rather than doing all we can to interest people in it... and making their entry an enjoyable experience.

There seems to be some wariness that we will suddenly find ourselves with a system where we are bringing in people who will be rotten hams and thus spoil the hobby. I would say two things to those worriers... first, we already have a fine system for bringing in lousy hams, one which has been working with a high degree of perfection. One has only to visit Los Angeles to get the full flavor of the 1980s-type ham in full bloom. It should be obvious that the present system of filtering out the weirdos is not working worth beans.

Secondly, I know of no one interested in opening the flood gates to CBers to come into amateur radio for a free ride. Not even CBers have suggested anything that preposterous. I do hear hams opposing it, but these chaps are merely fighting their own straw man, not anything ever seriously proposed. If some hams are gullible enough to get excited over such ma-

$$ HOME-BREW CONTEST $$

For some of us, there is no more satisfying experience than designing and building a piece of electronic gear. Now there's a chance for you home-brewers to receive special recognition for your achievements. It's the *73 Magazine* Home-Brew Contest.

Between now and April 1, we'll be looking for articles describing the best home-brew projects in the land for under $100. All useful projects will be published in *73*, and the cream of the crop will share $500 in cash prizes. Top prize in the contest is $250, with $100 going to the second place project and $50 to each of three honorable mentions. These prizes are over and above the payment that all authors receive for having their articles published in *73*.

Contest Rules

1. All entries must be received by April 1, 1982. To enter, write an article describing your best home-brew construction project, and submit the article to *73 Magazine*. Any construction article received before the April 1 deadline is automatically entered in the contest. If you haven't written for *73* before, please send an SASE for a copy of our author's guide.
2. The total cost of the project must not exceed $100, even if all parts are puchased new. Be sure to include a detailed parts list, with prices.
3. All parts used in the project must be available to the average radio amateur or electronics experimenter. To be on the safe side, include sources for any unusual components.
4. Projects will be judged by the *73* technical staff on the basis of usefulness, reproducibility, economy of design, and clarity of presentation. The decision of the judges is final.
5. All projects must be original, i.e., not previously published elsewhere.
6. All rights to articles purchased for publication become the property of *73 Magazine*.

Send your entries to:

Home-Brew Contest
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Peterborough NH 03458

Winners will be announced in the June, 1982, issue of *73*. Have fun!

Digital world clock with two 24-hour displays, quartz time base

The HC-10 digital world clock with dual 24-hour display shows local time and the time in 10 preprogrammed plus two programmable time zones.

R-600

"Now hear this"... digital display, front speaker, easy tuning

The R-600 is a high performance, general coverage communications receiver covering 150 kHz to 30 MHz in 30 bands, at an affordable price. Use of PLL synthesized circuitry provides high accuracy of frequency with maximum ease of operation.

R-600 FEATURES:

- 150 KHz to 30 MHz continuous coverage, AM, SSB, or CW.
- 30 bands, each 1 MHz wide, for easier tuning.
- Five digit frequency display, with 1 KHz resolution.
- 6 kHz IF filter for AM (wide), and 2.7 kHz filter for SSB, CW and AM (narrow).
- Up-conversion PLL circuit, for improved sensitivity, selectivity, and stability.
- Communications type noise blanker eliminates "pulse-type" noise.
- RF Attenuator allows 20 dB attenuation of strong signals.
- Tone control.
- Front mounted speaker.
- "S" meter, with 1 to 5 SINPO-S scale, plus conventional "S" meter scale.
- Coaxial, and wire antenna terminals for low impedance (50 Ω). Wire terminals for high impedance (500 Ω).
- 100, 120, 220, and 240 VAC, 50/60 Hz. Selector switch on rear panel.
- Optional 13.8 VDC operation, using DCK-1 cable kit.
- Other features: carrying handle, headphone jack, and record jack.

OPTIONAL ACCESSORIES:

- DCK-1 DC Cable kit.
- SP-100 External Speaker.

R-1000

"Hear there and everywhere"... easy tuning, digital display

The R-1000 is an amazingly easy-to-operate, high-performance, communications receiver, covering 200 kHz to 30 MHz in 30 bands. This PLL synthesized receiver features a digital frequency display and analog dial, plus a quartz digital clock and timer.

R-1000 FEATURES:

- Covers 200 kHz to 30 MHz continuously.
- 30 bands, each 1 MHz wide.
- Five-digit frequency display with 1-kHz resolution and analog dial with precise gear dial mechanism.
- Built-in 12-hour quartz digital clock with timer to turn on radio for scheduled listening or control a recorder through remote terminal.
- Step attenuator to prevent overload.
- Three IF filters for optimum AM, SSB, CW. 12-kHz and 6-kHz (adaptable to 6-kHz and 2.7-kHz) for AM wide and narrow, and 2.7-kHz filter for high-quality SSB (USB and LSB) and CW reception.
- Effective noise blanker.
- Terminal for external tape recorder.
- Tone control.
- Built-in 4-inch speaker.
- Dimmer switch to control intensity of S-meter and other panel lights and digital display.
- Wire antenna terminals for 200 kHz to 2 MHz and 2 MHz to 30 MHz. Coax terminal for 2 MHz to 30 MHz.
- Voltage selector for 100, 120, 220, and 240 VAC. Also adaptable to operate on 13.8 VDC with optional DCK-1 kit.

OPTIONAL ACCESSORIES:

- SP-100 matching external speaker.
- HS-6 lightweight, open-air headphone set.
- HS-5 and HS-4 headphones.
- DCK-1 modification kit for 12-VDC operation.

SP-100 R-1000 HS-5

KENWOOD

TRIO-KENWOOD COMMUNICATIONS

1111 West Walnut, Compton, California 90220 neuvers, then we should consider them part of the problem, not part of any solutions.

No, I think it is plain to just everyone that our present licensing system stinks. Here we have a Morse code test which a four-year old has passed with flying colors... big deal filter. We have a technical exam that few people even bother to study for... why bother when you can buy the test answers from Bash and just memorize the answers? That includes questions on rules, so we don't even have to know them anymore. It is no wonder that we have jamming of repeaters, foul language on the bands, stupid pileups of DX stations, and a situation on two meters in Los Angeles that has to be heard to be believed.

Not only are things going to hell in a basket, but we have the spectacle of thousands of hams doing all they can to protect this terrible system and make sure that we get even more of the same kind of hams.

Yes, I do have some ideas on what to do about the situation. And I think they will work. They certainly are right up the alley of the current FCC changes. The Commission has two major interests these days... deregulation and cutting expenses. I think that we can take advantage of these and at the same time improve amateur radio substantially.

Let's take a look at some basics. Firstly, yes... we do have some terrible hams in our ranks. But we recognize that, as much of a pain in the ass as these bums are, they are a distinct minority. Okay... there's a hint for us... a clue on how to start getting out of this miserable situation.

To me, one of the foundations of amateur radio is the ham club. I believe that every ham should belong to and support a ham club. This is one of the big strengths we have. This also is a key to our separating the good from the bad and the ugly, for few of the really bad eggs ever join clubs. The same behavior which makes them despicable on the air keeps them from having friends off the air. And what few do have the guts to come to club meetings, knowing what others think of them, are not thought well of for it. Thus, I suspect that the more we can involve our clubs in the training and licensing of newcomers, the better class of hams we will have on our bands. Perhaps we could even consider some sort of trial period for newcomers before their licenses are permanent so that we could observe them on the air.

We already know that the most vicious and obnoxious of people are quite capable of learning the code. In fact, since some of the worst hams we have had have been Extra class, perhaps there is some correlation between ugliness and adaptability to code (I'm kidding... aren't I?). I think that CW is one of the most treasured aspects of amateur radio, but I also think that the ability to copy the code is meaningless as far as determining whether someone is going to be a good ham. I think that once we make code ability honorable and stop forcing people to learn it for the test, we will take a lot more pride in it. Who can really take pride in something which he has to do, whether he wants to or not?

Clubs are an answer to many of our problems. If we are going to get amateur radio into any serious growth pattern we are going to have to have many more and stronger ham clubs. I would like to see ham clubs set up in every high school in the country. I'd like to know that every ham club has classes to teach newcomers the theory, the rules, and how to operate. If the Wirth bill goes through, it will open the way for clubs not only to teach the fundamentals of amateur radio, but also to make up and administer the exams. Talk about a service being self-sustaining!

This also would cut the cost to the FCC substantially. I don't know how much they are paying their people to keep writing new test questions to try to stay ahead of Bash and his cheat-sheets, but it must be a substantial amount. Then there is the cost of printing and distributing the tests. If the field personnel of the Commission did not have to sit around and administer exams they would be freed up for more productive work... or even to go into the private sector and earn money for taxes instead of spending it. We sure have a need for engineers and technicians these days in industry... a desperate need.

Monitoring

Another provision of the Wirth bill is as follows....

Authorize use of amateur volunteers for monitoring

"4(f)(6) For purposes of monitoring any violation of any provision of this Act, and of any regulation made by the Commission pursuant to this Act, relating to the amateur radio service, the Commission, notwithstanding any provisions of Part III of Title 5, United States Code or 31 U.S.C. § 665(b), may (i) recruit and train any individual licensed by the Commission to operate an amateur station; and (ii) accept and employ the voluntary and uncompensated services of such individual. For purposes of recruiting and training such individual, the Commission may also accept and employ the voluntary and uncompensated services of any amateur station operator organization. Any person who provides voluntary and uncompensated services under this paragraph shall not be considered, by reason of having provided such services, a Federal employee for any purpose."

Explanation

The volunteers' monitoring authority should include the monitoring of amateur licensees transmitting on frequencies not assigned to the service and is intended to permit volunteers to collect violation reports and annotate and summarize them for the convenience of the FCC.

Enactment of this proposal would enhance the Commission's enforcement efforts and bolster efforts to detect and prosecute rule violators. To ensure that a volunteer monitoring program helps rather than hinders the enforcement program, it is important that violation reports undergo preliminary review by volunteer organizations to help FCC personnel determine which alleged violations represent the most promising targets for the Commission's limited enforcement resources.

This amendment would not increase our budgetary requirements. It may help us to conserve our enforcement resources or, at least, improve the efficiency of our enforcement program.

If the Commission is to fully utilize the services of volunteer amateur licensees for monitoring, as envisioned by this proposal, there should be *an exception to Section 605 to permit the monitoring groups to receive and disclose information transmitted by amateur licensees and operators. (See proposed amendment to Section 605, infra.)*

Exempt amateur radio communications under certain circumstances

Section 605 is amended by striking the last sentence thereof and adding the following:

Continued on page 131

Introducing the first fully programmable keyer

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The Heathkit µMatic Memory Keyer's custom microprocessor stores up to 240 characters of text or commands. *Variable-length buffers* eliminate wasted memory space. "Command strings" allow text to be stored in several buffers, then strung together in any sequence for most efficient use of memory. Command strings can also select speed, weight, spacing and auto-repeat count.

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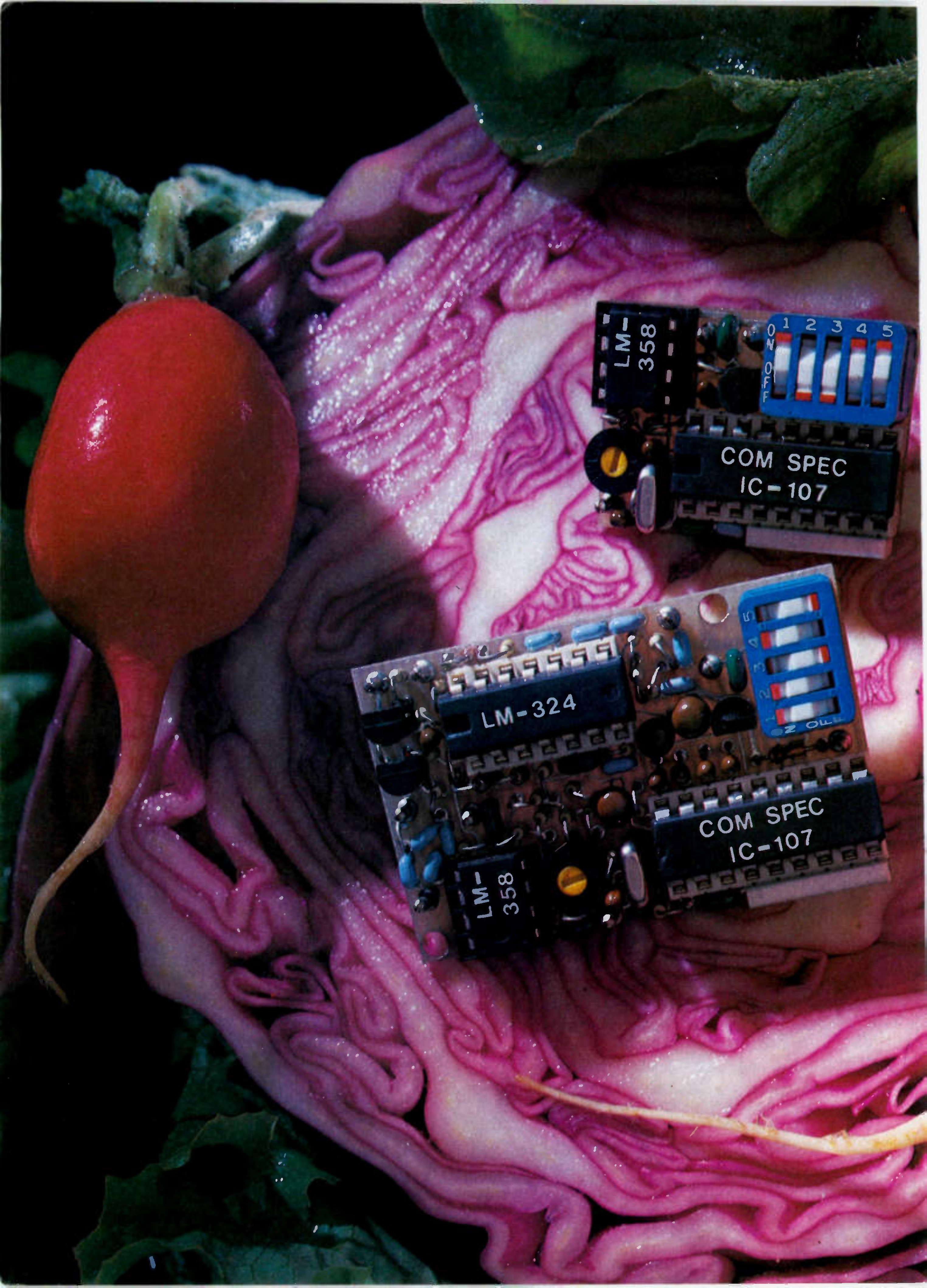

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- Size: 1.25" x 2.0" x .40"
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74.4 WA	97.4 ZB	127.3 3A	167.9 6Z
77.0 XB	100.0 1Z	131.8 3B	173.8 6A
79.7 SP	103.5 1A	136.5 4Z	179.9 6B
82.5 YZ	107.2 1B	141.3 4A	186.2 7Z
85.4 YA	110.9 2Z	146.2 4B	192.8 7A
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The Fun-Oscillator

—a simple, goof-proof vfo for your QRP transmitter

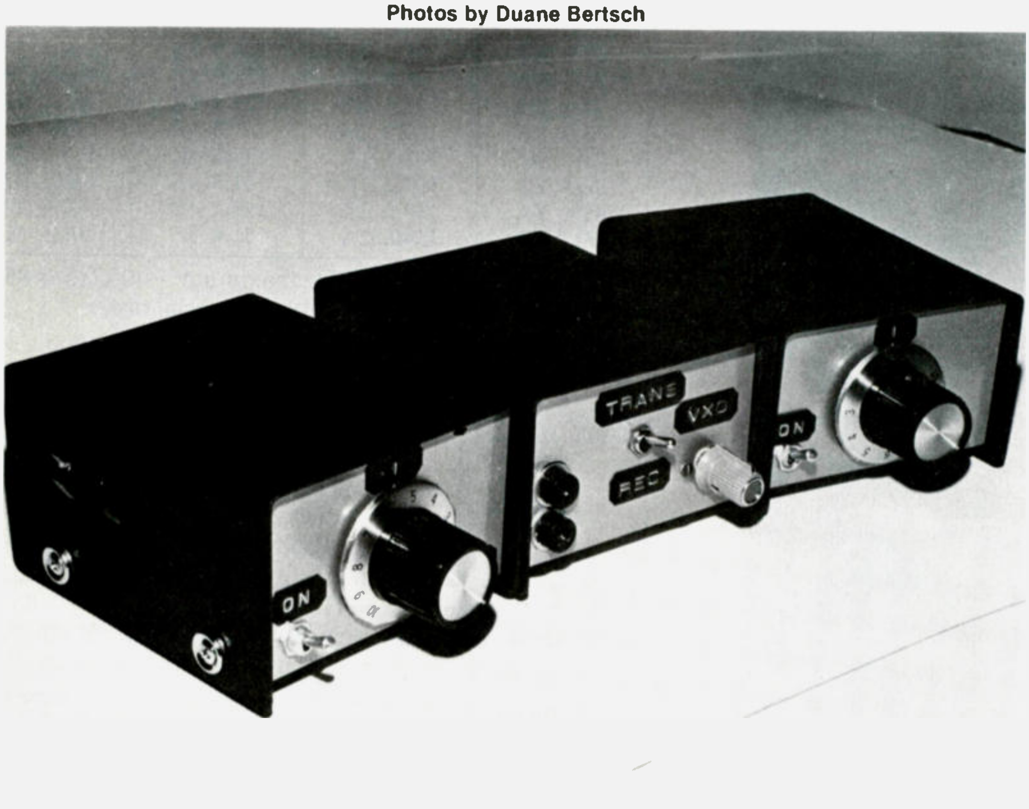
Note: A complete kit of parts, including PC board, is available from RADIOKIT, Box 411S, Greenville NH 03048 for $34.95 plus $2.50 shipping and handling.

The Fun-Mitter (February, 1981, *73*) and Fun-Ceiver (July, 1981, *73*) provided the home-brew-oriented amateur with the basic components for a home-brew station setup.

Many amateurs have responded by saying that they need more frequency flexibility for their Fun-Mitters.

The simple vfo described in this article is the result of those requests. It allows greater frequency excursions than the simple vxo circuit of the Fun-Mitter to provide approximately the same frequency coverage as the companion receiver. The vfo follows the same guidelines as the two previous articles and should be as easy (or easier) to construct and to get operational.

Photos by Duane Bertsch



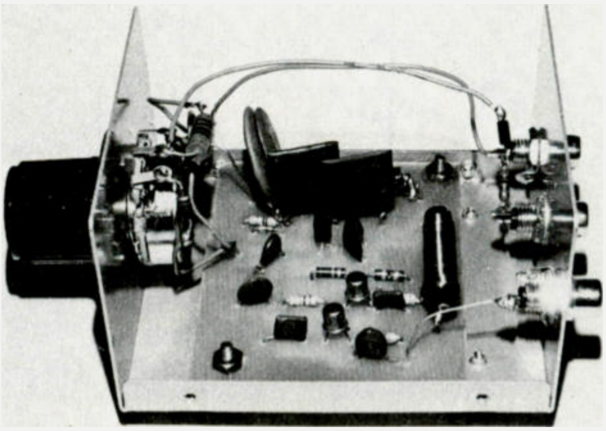
A Fun-Station!

For those unfamiliar with my earlier articles, this series of articles focuses on simple, easy-to-construct, easy-to-operate gear with all parts available from local Radio Shack outlets. Size and appearance of the vfo match the transmitter and receiver to provide a nice looking station package.

Of utmost importance is the fact that no modifications have to be made to the Fun-Mitter to use the vfo. It simply plugs in where the crystal was (unless C_{opt} was installed). This allows for either crystal or vfo operation of the Fun-Mitter. Also, it can be constructed for either 40 or 80 meters. It provides about 70 kHz of coverage on 40 meters and about 50 kHz on 80.

The Circuit

The vfo should be the most goof-proof of all three pieces of gear as evidenced by the schematic of Fig. 1. The basic frequency-determining portion of the vfo is identical to the vfo of the



Internal view of vfo.

Front view of the completed Variable Fun-Oscillator.

Fun-Ceiver. This allows for ease of understanding and construction as well as similar frequency range.

Before I began this series, I developed a set of guidelines for the items to be designed. Based on this criterion of setting goals in advance, I developed the following goals for the simple vfo.

- Good performance (no chirp, minimal draft, clean waveform)
- Simple construction (PC board use, less than four hours total build time, minimum parts count)
- Cost—less than $20 with new parts
- Minimal modification to the Fun-Mitter
- Full output from the Fun-Mitter
- No variable capacitors or inductors

The final version of the vfo meets the above goals.

Only three transistors are used in the vfo, one as the oscillator (Q1), one as a class-A amplifier (Q2), and one as an emitter-follower buffer (Q3). This final version of the vfo went through three revisions from the original form. This was necessary to maintain good performance while still keeping things simple. The original design included only two transistors, but at times chirp was detected on the transmitted signal. The main advantage of the circuit of Fig. 1 is that only one tuned circuit is used (L1). This means modifying only one inductor!

Q1 operates as a parallel-tuned Colpitts oscillator with L1, CR1, CR2, C1, C2, and C3 being the frequency-determining components. The oscillator is tuned by varying the voltage at the junction of the two diodes. This, in turn, varies the capacitance of the diodes which varies the frequency of the oscillator. L1 is a modified Radio Shack 10-μH rf choke. It is modified, as described later, to provide the needed inductance. The last few turns of the modified choke are spread out over the choke body to provide an easy means of setting the oscillator frequency.

As mentioned in the receiver article, the capacitors needed to build a stable vfo are not easily found at Radio Shack. NPO-type capacitors from a large variety pack again are used in parallel and series combinations to obtain the needed capacitance for C1, C2, and C3. Silver-mica or polystyrene capacitors will give even better results.

Output from Q1 is taken through a coupling capacitor, C4. This capacitor should be kept as small as possible to isolate the oscillator from load variations which can cause chirp. The capacitor is attached to the next stage, Q2, a class-A amplifier. This amplifier raises the level of the signal to the level needed to drive the Fun-Mitter.

Q2 is direct-coupled to the final stage, Q3, an emitter follower. This stage provides excellent isolation between the oscillator and the transmitter as well as providing an impedance match between the two. Without Q3, as in the original design,

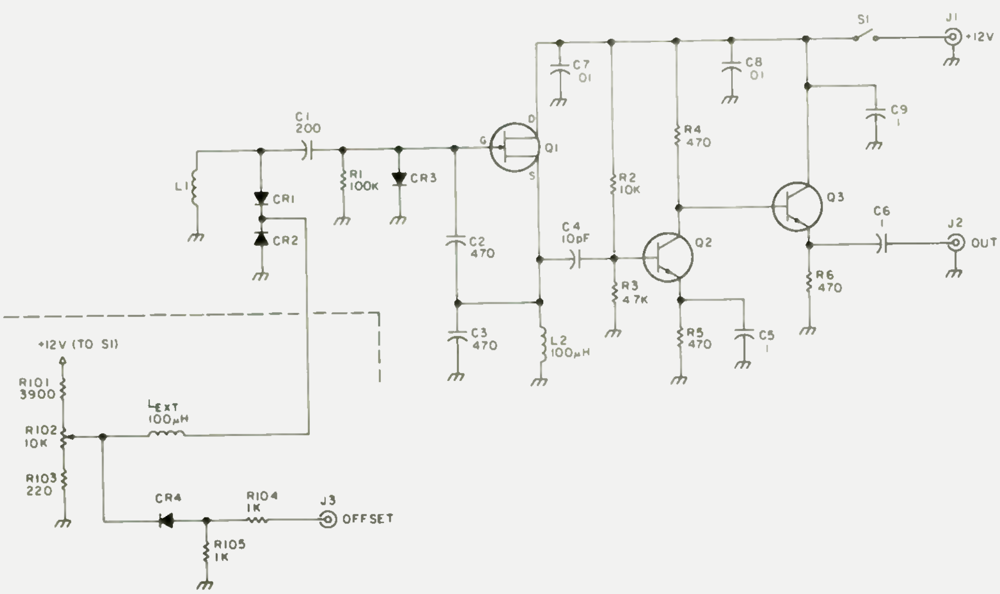
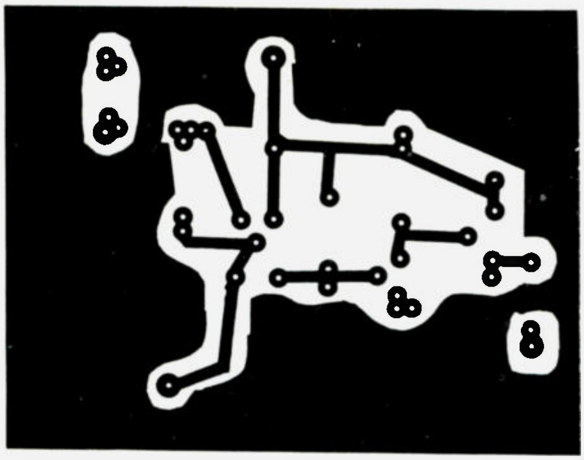
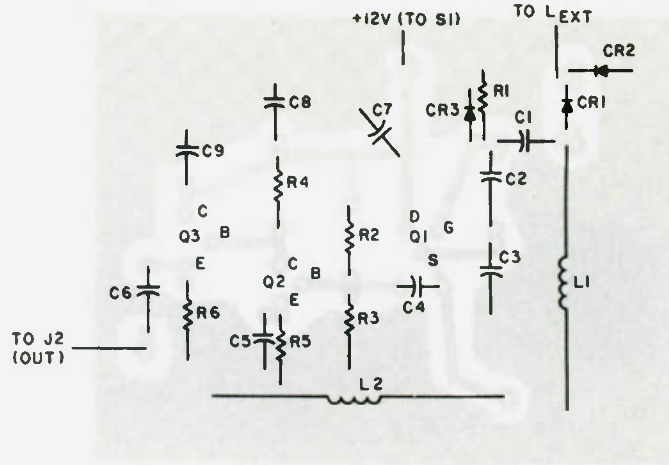


Fig. 1. Schematic of vfo.



PC layout for vfo.



Component location.

PC boards for the vfo are available from the author for $7 ppd. PC boards for the previous articles also are available as follows: Fun-Mitter—$7 ppd; Fun-Ceiver—$7 ppd; Filter—$3.50 ppd.

Parts List

Designator	Value	Radio Shack Part Number
C1	200 pF NPO (approx.)	272-801
C2, C3	470 pF NPO	272-801
C4	10 pF (use two 4.7 in parallel)	2-272-120
C5, C6, C9	0.1 µF	272-135
C7, C8	0.01 µF	272-131
CR1-CR4	1N914	276-1122
	On 80 meters, for CR1 and CR2, use two 1N914s in parallel for each (piggyback)	
J1-J3	phono jack	274-346
L1	80m: Two 273-101 inductors in series; one with no turns removed, one with 10 turns removed	
	40m: 10 turns removed from 273-101 inductor.	
	For both 80 and 40 m the last 3 turns of the modified inductor should be spread out over rest of the form	
L2	100-µH inductor	273-102
Q1	FET	276-2035
Q2, Q3	RS2033	276-2033
R1	100k, 1/4-W	271-1347
R2	10k, 1/4-W	271-1335
R3	4.7k, 1/4-W	271-1330
R4-R6	470Ω, 1/4-W	271-1317
Not on PC board:		
L_{ext}	100-µH inductor	273-102
R101	3.9k, 1/4-W	271-1329
R102	10k linear pot	271-1721
R103	220Ω, 1/4-W	271-1313
R104, R105	1k, 1/4-W	271-1321
S1	SPST switch	275-612
case		270-251
knob		274-392

the vfo is not stable when the transmitter is keyed.

CR4 is used to shift the frequency of the vfo when the transmitter is not in use and you are listening to the receiver. It does this by changing the voltage at the junction of CR1 and CR2, which shifts the oscillator frequency. Without this feature, the vfo signal would appear on the listening frequency and make listening impossible!

Construction

The construction of the vfo is intended to be goof-proof. It is built on a 2¼″ × 3″ single-sided board just as the transmitter and receiver were. It cannot be overemphasized that the circuit should be built on a PC board. Nearly all of the problems that readers had in building the previous two pieces of gear were due to breadboard or point-to-point construction. If you are an inexperienced home-brewer, it is fairly easy to make mistakes when wiring the circuit apart from a printed circuit board.

I built my vfo in an enclosure that matches the enclosures used for both the transmitter and receiver. Also, the front-panel layout was made compatible to enhance the appearance of the gear.

As can be seen in the photographs, the tuning potentiometer (R7) is mounted on the front panel. The associated resistors and inductor (R6, R8, L3) are also mounted on this potentiometer, and wires run from there to the appropriate circuit points.

The rear panel contains three jacks. One is for the vfo output signal, and one is for the vfo offset. The connection between the vfo and transmitter should be made with coaxial cable (RG-174 or RG-58).

Operation

The vfo is best operated with a battery rather than an ac supply. This eliminates any possibility of ac hum on the transmitted signal. It also helps improve frequency stability. Two 6-volt lantern batteries in series will power the vfo for a long period of time. If the Fun-Mitter is powered by batteries, the needed 12 volts can be tapped from those batteries.

Tuning and operation are very easy: Only one adjustment needs to be made—setting the vfo on frequency. This is accomplished in the same manner as was done in the receiver. Using a separate receiver, listen on the frequency you want the low end of the vfo to be set on (for example, 7100 kHz). Drape a length of wire near the vfo and attach the other end to the receiver antenna input. With the vfo on and warmed up, slowly spread or compress the last few turns of L1 until the vfo signal is heard in the receiver. This adjustment should be done with the tuning potentiometer (R7) fully counterclockwise. Finally, verify that the vfo covers approximately 70 kHz if built for 40 meters and 50 kHz if built for 80. That's all there is to the adjustment.

To operate the vfo, two connections need to be made—one to the transmitter crystal socket and one from the vfo offset input to J3 of the Fun-Mitter. (This jack was added to provide receiver mute operation for the Fun-Ceiver.)

If C_{opt} was not included in the Fun-Mitter, then the vfo signal can be applied directly to the crystal socket terminals (see Fig. 2). If C_{opt} was included, remove its connection and connect that terminal of the crystal socket to ground. An inspection of the Fun-Mitter schematic will reveal that even this step is not necessary if a method can be derived to connect the shield of the vfo cable to ground of the Fun-Mitter. Alternatives such as a rear-panel phono connector on the Fun-Mitter also can be used. A plug can be made easily from two ½" to ¾" lengths of #12 gauge copper wire. Solder the vfo signal and ground leads to these wires and plug them into the appropriate crystal socket pins.

Once the vfo is plugged in and turned on, verify that the transmitter operates as it did before. With the vfo in use and all connections in place, the vfo signal should be heard only when the transmitter is in the transmit mode (due to the vfo offset feature). Zero-beat the vfo with the transmitter in the transmit position and the key down. Remember that when using a direct-conversion receiver, you must zero-beat the correct side of the signal you are listening to.

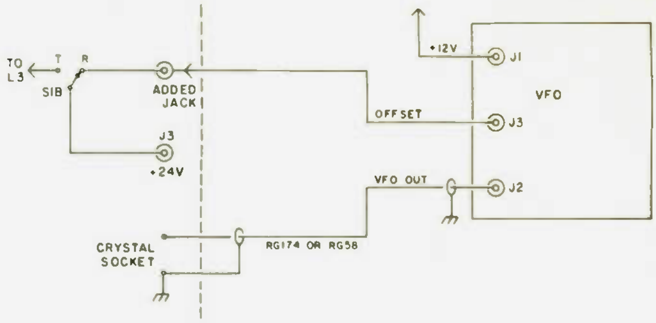


Fig. 2. Connections between vfo and Fun-Mitter.

Crystal operation still can be used by simply removing the vfo leads and plugging the crystal back in.

It should be possible to use the vfo with low-power solid-state transmitters other than the Fun-Mitter. However, modifications may be necessary to the transmitter if the oscillator is not configured as in the Fun-Mitter.

Conclusion

The vfo should be simple to build and goof-proof in its operation. Many more contacts now should be possible due to the ability to move to the frequency the other station is on. This series will be continuing in the months to come with additional goof-proof projects. Meanwhile, enjoy the Variable Fun Oscillator! ■

Build this Antennalyzer

—you'll need a weekend

Photos by W1GSL

Penn Clower W1BC
459 Lowell Street
Andover MA 01810

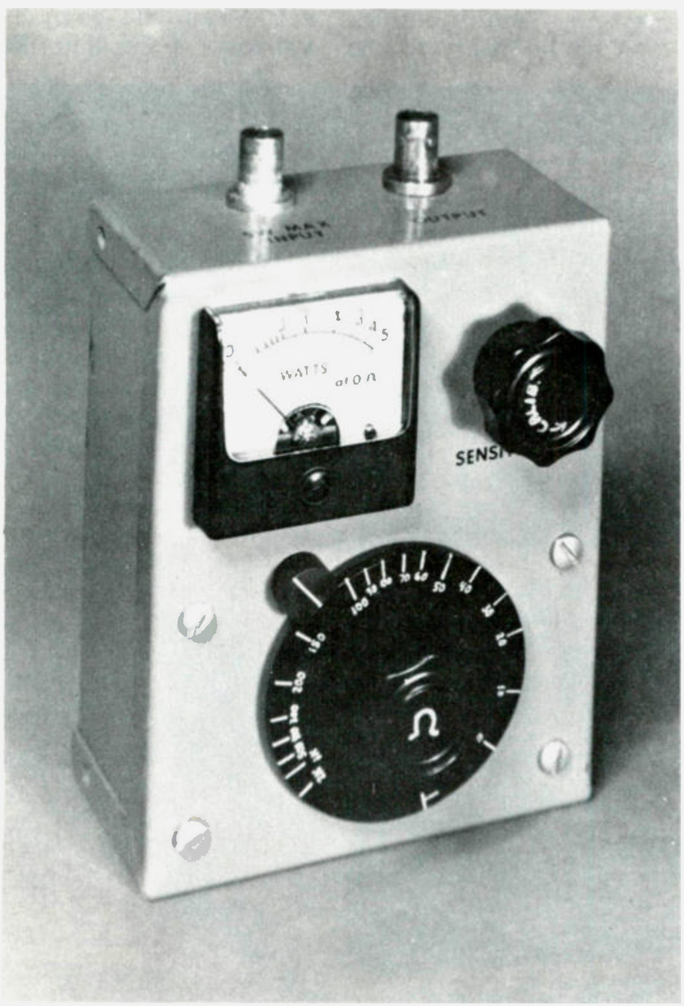


Photo A. Front view of the dummy load/wattmeter/rf bridge. The resistance dial is a 2-1/4" diameter plastic skirt attached to a standard knob.

Here is a weekend project that combines two instruments and an old technique into a very handy gadget to have around the shack. First, it's an 8-to-10 Watt 52-Ohm dummy load with a calibrated wattmeter: perfect for tuning up low-power transmitters. Second, it's also a calibrated rf resistance bridge which can make antenna adjustments a lot easier by telling you more about the nature of a mismatch than a plain swr bridge will. The old technique provides a nice tie-in between these two instruments and gives some benefits besides: The dummy load is also a resistive power divider that provides a low-level driving signal for the rf bridge.

One benefit of this arrangement is that the power source sees a load which is essentially independent of the bridge load. That means you can load your QRP transmitter into this instrument, put that new antenna on the bridge output, and fool around to your heart's content without risk of damaging the transmitter or even detuning its output stage. In addition, the power delivered to a 50-Ohm load is only about 40 mW when the power coming out of the transmitter is 5 Watts. That is a 21 dB reduction, and it means that any signal you radiate while adjusting the antenna is 3-1/2 S-units less than it might have been—certainly a neighborly gesture on today's crowded bands.

Background Theory and Circuit Description

There is nothing new or unique about the circuits described here. Rf resistance bridges have been around longer than the more familiar high-power swr bridges and there are several examples in recent publications.[1,2] The dummy load/power divider technique was described in *Solid State Design for the*

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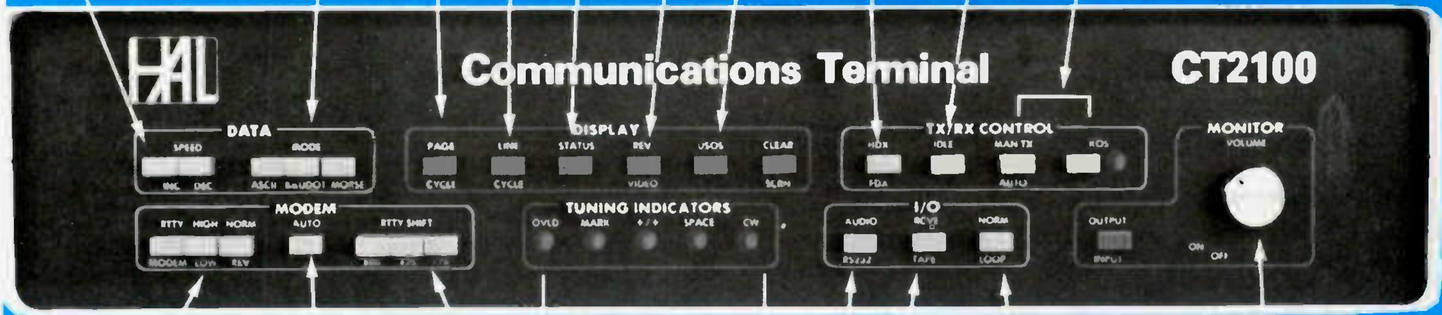

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Radio Amateur (ARRL) and recently used in a transmatch tuning circuit described in *QST*.[3]

What I hope to emphasize here is this instrument's usefulness as a matching aid, the simple and inexpensive nature of the circuit, and the fact that the same circuit can be used as a dummy load with a built-in calibrated wattmeter. It's like getting two instruments for the price of one, and the final result is a very handy piece of test gear.

The resistive rf bridge is a simple modification of the classic low-power swr bridge, so before getting down to circuit details let's consider swr bridges in general for a moment. There are two main types of bridges used for measuring swr, and the most common type is a high-power handling circuit meant to be left in the transmission line for continuous monitoring. Usually, this type of bridge requires a minimum of 5 Watts or so driving the load before the meter readings are large enough to interpret accurately. This occurs because the bridge itself is very loosely coupled to the transmission line, typically through a few picofarads or several inches of wire running parallel to the center conductor of the main line.

The other type of bridge is inherently a low-power instrument. The driving signal runs right through the resistive elements which make up the bridge, so the bridge itself must be able to absorb a large fraction of the input power. The resistive bridge doesn't find much use in amateur circles because it requires only a Watt or less of drive and can't be left permanently in the line; it's strictly an occasional-use test instrument.

There is nothing wrong with continuous swr monitoring. After all, the familiar deflections of the high-power monitor do give a constant verification that the transmitter is tuned and the antenna connected. The low-power test instrument described here has some advantages over the usual swr bridge, though, especially for initial antenna adjustments, because it tells you more than just the magnitude of a mismatch.

Swr can be defined several ways, and one is the ratio of a load impedance to the transmission line's characteristic impedance (which is almost always near 50 Ohms in current amateur usage). For example, to cause a 3:1 swr, a 50-Ohm cable could be terminated with either 150 or 16.6 Ohms. These are purely resistive loads, but there is also an infinite number of reactive loads which would give the same 3:1 swr, and a common swr bridge can't tell the difference between any of them. You can build a bridge to measure both the reactance and resistance present in a load,[4,5,6] but such bridges tend to be too complex for my taste and requirements.

When matching a load to a 50-Ohm line, I generally have two questions. Is it resonant, and what's its resistance? If a load is resonant (and that's how I want all my antennas to be), then it has no reactive component—just resistance. If I know the value of that resistance, then I know the swr and whether I need more or less resistance to get a match. I'll give an example at the end of the article, but right now let's look at the schematic shown in Fig. 1.

There really isn't much to the circuit diagram. The input signal is terminated in a 53-Ohm dummy load constructed with a series-parallel resistor assortment. The voltage development across the 10-Ohm portion of that dummy load drives a simple bridge circuit made up from a 250-Ohm pot, a 51-Ohm standard resistor, and the load impedance. The bridge error signal appears between the output connector and the potentiometer arm and is detected by a germanium diode. The result is then indicated by a 100-uA meter in a voltmeter circuit.

Bridge operation is equally straightforward. When input power is applied to the instrument, it develops a voltage across the 53-Ohm dummy load. About 1/5 of this voltage appears across the 10-Ohm portion of the dummy, and this is the driving voltage for the resistance bridge. Some fraction of this driving voltage shows up between the potentiometer arm and ground, the exact amount depending, of course, on the shaft position. Similarly, there is some other fraction of the bridge driving voltage appearing across the load terminal, this fraction depending on the load resistance connected there.

If there is no load connected, then the entire source voltage appears there and we'll make use of that fact later to calibrate the wattmeter portion of this instrument. If a 51-Ohm load is connected, then exactly half the source voltage will be there. The difference between the output voltage and the potentiometer arm voltage is rectified by the diode and drives the meter through the sensitivity control, so with the 51-Ohm load the bridge will show a null when the pot travel is exactly centered. Other load resistances will show nulls at other positions and the potentiometer dial may be calibrated by marking the nulls corresponding to a whole series of load resistances. In theory, the bridge should show nulls for every load resistance between zero and infinity, but in practice this doesn't happen because the potentiometer isn't infinitely adjustable.

The circuit can be calibrated pretty accurately for resistances between 5 Ohms and 1k, with the best resolution around the center of the dial at 20 to 150 Ohms. Notice that the bridge cannot be nulled completely if the load has a capacitive or inductive component since such a load would introduce a phase shift between the bridge source voltage and the bridge load voltage. As there is no corresponding phase shift between the bridge source voltage and the potentiometer arm voltage, there never will be a point where the diode voltage will be zero and the meter nulled. Even when the voltages at each end of the diode are equal in amplitude, the fact that they are phase-shifted with respect to each other guarantees that there will be a sine wave or error voltage for the diode to rectify. In practice this means that unless the load is a pure resistance there will not be a true null but only a partial dip in the meter reading as the potentiometer shaft is turned.

A true rf impedance bridge would have two null adjustments: one for rf resistance and one for reactance. With such a bridge you can completely define any mismatch, but, as noted earlier, that's often unnecessary, especially in antenna work where the goal is to tune out reactance by resonating the antenna. You can always tell when a load is resonant with the resistance bridge because at resonance the null will be complete. Then steps can be taken if necessary to transform the remaining impedance to match a 50-Ohm line.

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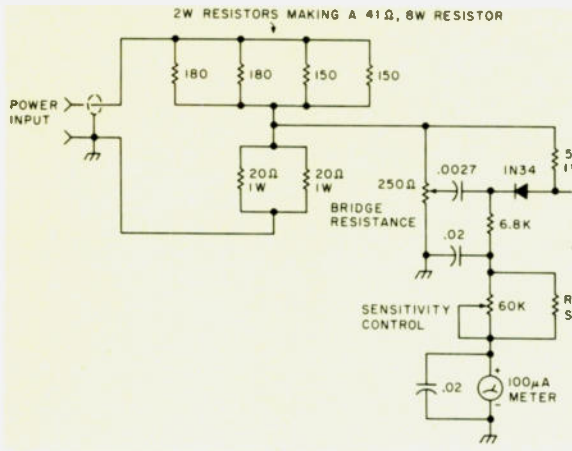

Fig. 1. Schematic diagram of dummy load/wattmeter/rf bridge. R1 is chosen as necessary to calibrate the wattmeter.

This same bridge circuit can be used to measure the power delivered to the dummy load by the transmitter. A glance at the schematic will assure you that with no load connected to the bridge and the resistance dial set to zero Ohms, the voltmeter circuit will indicate the rf voltage across the 10-Ohm portion of the dummy load. Knowing that voltage, we can easily calculate the voltage across the whole dummy resistance, and knowing that, we can calculate the power there from $P = V^2/R$. The calibration can be accomplished using only a dc voltmeter and will be described shortly.

Construction

A lot of articles begin their construction description with the assurance that "the layout is completely noncritical." That is certainly not true here, but "critical" is also too strong of a word, so let me just caution you to be careful with layout. There are three main areas that can cause trouble.

First, it's best to arrange the dummy load portion of the circuit so that current flowing in the ground path from the bottom of the dummy load back to the input terminal does not share any conductor with part of the bridge circuit. If it does, then variations in the input power will shift the null positions on the resistance dial. Photo B shows one way to solve that problem by bringing the input power and its ground return to the dummy resistors on a single piece of coax, thus avoiding the temptation to ground the bottom resistors to some point on the chassis.

Second, the detector diode should have one end connected directly to the output jack. My first few attempts had more compact physical arrangements with the diode connected to the bridge output terminal with lengths of wire or brass strips. This always interfered with getting good deep nulls on both ends of the resistance range.

Third, the detector should not be a silicon diode, since the 0.6-volt threshold of a silicon diode will cause the bridge nulls to be too wide. With a given load termination there should be a single, sharp deep null on the dial, not a dead zone covering several degrees of rotation. My collection of diodes is pretty large, and the best of the lot turned out to be some germanium 1N34 equivalents I paid 10¢ each for some 15 years ago! Radio Shack's 276-1123 diodes cost the same today and should work as well.

The dummy load nominal value is about 51 Ohms with the circuit shown. I used an assortment of resistors from the junk box, so feel free to substitute values, but do observe a few simple rules. Wire-wound resistors are definitely out because they look like coils at radio frequencies. Also, stick with carbon resistors having values less than 1k. When paralleling resistors, try to have them all of the same value so they dissipate equal amounts of power. Keep the leads short and the wiring direct; this keeps the dummy load looking resistive at the higher frequencies and prevents stray coupling which might interfere with the bridge nulls.

The rest of the physical arrangement is pretty clear from the photographs with the exception of the bridge potentiometer mounting. A similar bridge is described in W6SAI's 1962 *Radio Handbook*[7] and the author there cautions that stray capacitive coupling between the potentiometer resistive element and ground can cause frequency sensitive errors in calibration.

The suggestion made there, and followed here, is to cut a large hole in the box (say, 1-1/2" in diameter) and mount the pot in the center of this open space using a piece of insulating plastic, bakelite sheet, or unplated circuit board for support. This insulates the pot body from ground and thereby greatly reduces the capacitive coupling between the pot resistive element and ground. It seemed like a good suggestion so I followed it. I can't strictly say it is necessary because I didn't try it the other way, but it sure can't hurt.

The skirt on the resistance dial covers the hole from the front of the box. If you want to use a smaller knob with a pointer, you could mount a rectangle of insulation over the hole from the front side of the panel and use that to hold the pot and the calibration marks. The actual value of the bridge potentiometer is not too critical. It should be at least 50-Ohms so that it doesn't draw too much power, and anything over 1k is probably asking for trouble with stray capacitance. If you have anything inside that range, try it before you buy a new 250-Ohm unit.

The box shown is a cut-down Bud minibox that started out as 3" × 4" × 5". The 3" height was reduced to just under 2" because it fit the hand better, but there is nothing magic about these dimensions. Use anything of roughly the same size as long as it is made of metal. You also will note in the photographs that BNC connectors are used instead of the more common (in amateur circles, anyway) UHF series. I don't run enough power to require RG-8, and I find the smaller quick-connect BNC connectors more convenient for my home-brew projects. Naturally, if all of your antenna cables have UHF connectors, then you also should use them on your bridge.

Calibration

There are two things to calibrate here: the wattmeter and the bridge scale. The meter serves as a null indicator when using the bridge, so the wattmeter calibration can be done after the bridge has been checked out.

The bridge dial can be as simple or fancy as desired but it should be large enough to read easily. The skirt on my dial is 2-1/4" in diameter. You probably will want to start with a paper scale and save the fancy artwork until everything is working properly.

Assemble a collection of carbon resistors covering as many values as possible between 5 and 1000 Ohms and then cut the leads to about 1" in length. The leads are bent so the resistors can be spring loaded into contact with the bridge output connector. If you have a lot of spare connectors, you also could make up a number of dummy loads with the different resistors similar to the one shown next to the bridge in Photo B.

Any layout problems will be more pronounced at the higher frequencies, so fire up a 10-meter rig if you have one and feed several Watts of rf into the bridge. (I've used this instrument only on 10 meters, but it might work all right up to 6 meters.) With the bridge excited, check the nulls at both ends of the range, say, with a 10-Ohm then a 680-Ohm load.

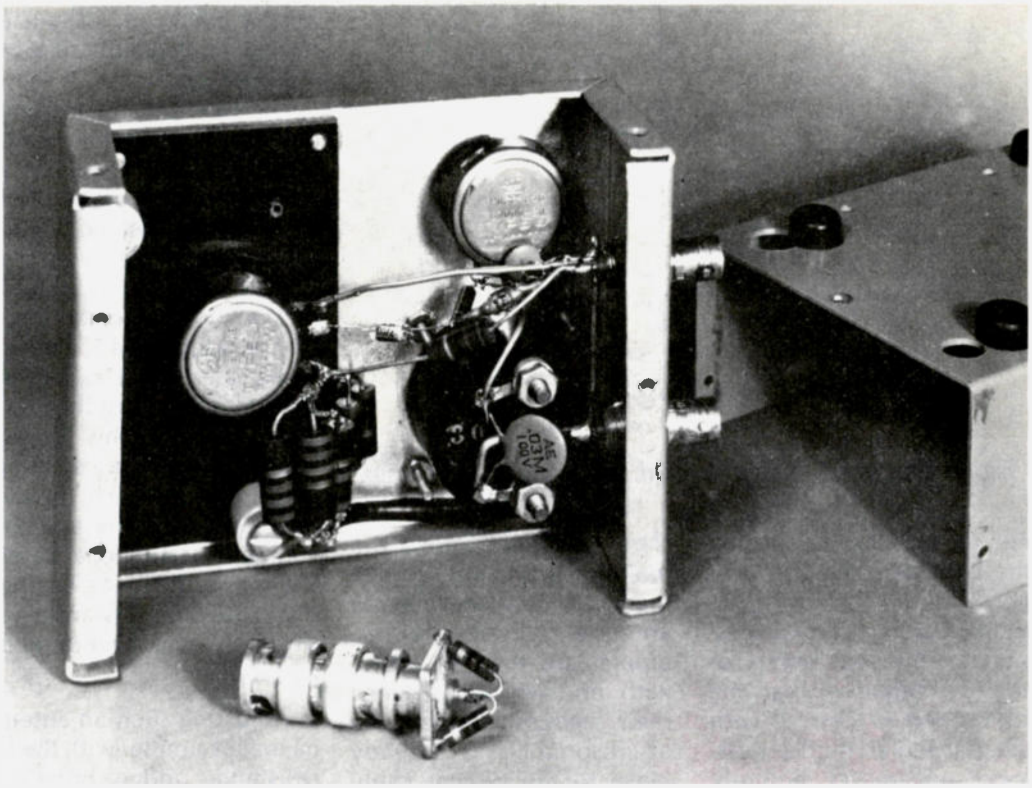
Photo B. Interior of the instrument, showing layout and construction details. The object in the foreground is a dummy load typical of those used during calibration.

Both nulls should be deep and well defined. If one isn't as deep as the other, then there is probably something wrong with the physical layout of the bridge elements. Try moving things around some or try another ground routing. If you followed the layout shown, then there really shouldn't be any trouble. Remember that this is an rf resistance bridge and with resistors on the bridge output, the nulls theoretically should be right down to zero meter movement. In practice, stray reactances prevent the nulls from being perfect but they should come pretty close to it. If the load does contain some reactance, there still will be a dip but it won't be to zero as previously mentioned.

When you're satisfied with the basic bridge operation, make a temporary scale and mark off the positions of the nulls due to the collection of sample resistors. Standard resistor values aren't nice round numbers, but with enough calibration marks you can make a final scale with lines at 5, 10, 20, 30, etc., Ohms as shown on the front panel in Photo A.

The wattmeter scale can be calibrated easily using a dc power supply and a good dc voltmeter. Remember that the wattmeter is actually reading the rf voltage across the 10-Ohm portion of the dummy load when there is no bridge load and the bridge pot is set to zero Ohms. Under these conditions, the 0.0027-uF coupling capacitor (that's not a critical value—anything from 0.001 to 0.05 will work as well) will charge to the peak value of the rf sine wave.

Since the peak value of a sine wave is 1.414 times the rms value, it is easy to calculate a dc value which, when fed into the instrument, will read the same on the meter as some given rf power. A conversion chart for the 53-Ohm dummy load is given in Table 1 along with the equation necessary to calculate your own equivalents should you use some other combination of resistors. Since I was interested in converting CB sets, I calibrated my wattmeter for a full-scale reading of 5 Watts, even though the resistors can handle 10 Watts for short periods. To make the 5-Watt calibration, feed a measured 22.9 volts into the unit, turn the sensitivity control all the way down (maximum resistance), and select a value for R1 that gives a full-scale meter reading.

Now comes the hardest part: making the meter face. I don't like conversion charts so I made a whole new face for my meter. It's not as difficult as you might think, but it does require a steady pair of hands.

Open the meter, remove the two screws holding the faceplate in place, and remove the faceplate while taking care not to damage the meter pointer. Glue a clean piece of white paper over the old faceplate using paper paste and not liquid white glue (which tends to dampen the paper so much that it wrinkles). Be sure to cover the faceplate evenly with paste so the paper won't have a chance to wrinkle. The pointer travels close enough to the faceplate that it can get stuck on wrinkles.

When the paste is dry, use a sharp knife to trim off the excess paper, and a pin to punch through the screw holes. Now a drawing set with an ink compass can be used to draw in a nice arc for the baseline of the new scale. Remount the faceplate, center the meter zero adjustment, and make a light pencil mark under the pointer tip to define the zero rest position. Reapply the 22.9 volts and make another pencil mark to spot the 5-Watt full-scale position. Now go down the list in Table 1 and mark off each intermediate point, checking occasionally that all of the points are repeatable and properly marked.

Finally, remove the faceplate again and finish off the scale graduations with

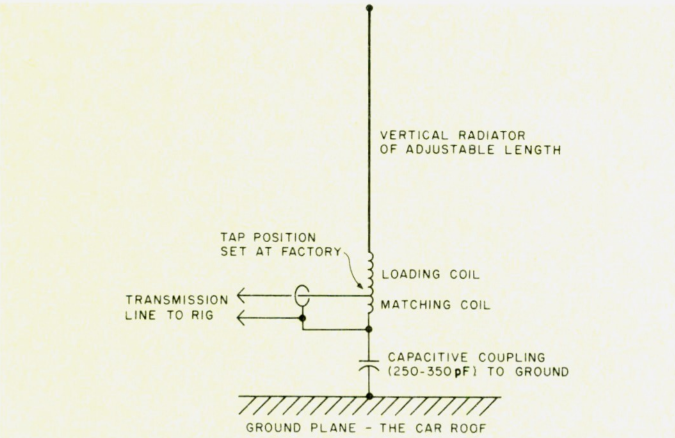

Fig. 2. Shortened loaded vertical, a CB mag-mount whip.

ink or dry transfers using the light pencil marks as a guide. With a little care, the results can be pretty professional. One real bonus of this technique is that the calibration is correct with the particular diode, resistors, and meter actually used, since the whole circuit is calibrated at once. That's important because the diode is not a perfect rectifier and the meter scale will be influenced slightly by the characteristics of the particular diode used.

An Application Example

The most obvious use for the rf resistance bridge is in making matching adjustments to antennas. Some antennas, dipoles, for example, are easy to adjust with an swr bridge since their feedpoint impedance at resonance is already close to the typical cable impedance. When a dipole is fed with either 52- or 73-Ohm coax, its swr at resonance is bound to drop to somthing like 1.5:1. This isn't true with shortened antennas such as mobile whips since their feed impedance may be only a few Ohms.

Input Power Watts	Dc Voltage Equivalent
5.0	22.90
4.0	20.49
3.0	17.74
2.0	14.49
1.0	10.24
0.5	7.24
0.4	6.48
0.3	5.61
0.2	4.58
0.1	3.24

Table 1. Wattmeter calibration. Input power levels corresponding to dc voltage equivalents. Values are calculated using $E = \sqrt{2RP}$*, where P = rf power (in Watts), R = total dummy resistance, and E = dc input voltage (where E is peak value of rf sinewave). Caution: With these dc inputs, the dummy load is dissipating twice the indicated rf power, so be careful not to overheat the resistors.*

There are two adjustments necessary to get a low swr with such an antenna: one for resonance and one for impedance matching. Making these two adjustments with only an swr bridge can be very difficult because a low swr will result only when both settings are correct. With a resistance bridge, the adjustment is much easier.

Consider the antenna shown in Fig. 2, a magnetically-mounted, base-loaded CB whip. The antenna really has two adjustment points, although the tapped loading coil is normally adjusted and sealed at the factory and all that is necessary for 27-MHz operation is a slight height adjustment. Putting this antenna to use on 10 meters or using a different length whip section may change things enough that a low swr cannot be achieved without a change to the coil size or tap position.

For example, I am using one of these antennas on the roof of my house as a loaded ground plane. The eight 1/4λ radials laid out on the roof do not provide the same type of ground return as the roof of an automobile. In addition, a 5′ whip is being used as a radiating element in place of the original 3′ length. This longer length lets me use a smaller loading coil with lower losses. I built this test instrument partly because of the difficulty I was having trying to tune this antenna with only an swr meter and grid dipper.

Adjusting such an antenna is a lot simpler with the rf resistance bridge, but first the bridge must somehow be connected to the base of the antenna. It would be nice to locate the bridge physically at the base of the antenna but this isn't always practical. For one thing, the bulk of the operator's body would probably upset the antenna tuning. If the bridge is connected to the antenna through a length of coaxial cable then that cable length must be chosen carefully because the impedance seen looking into a transmission line depends on three things: the line impedance, the load impedance, and the line length.

Luckily, it happens that a section of transmission line which is some multiple of a half wavelength in length will have an input impedance almost exactly equal to its load impedance. Using such a line makes it possible for the bridge to be located at some convenient position and still indicate the antenna base impedance. At 28.5 MHz, a half wavelength in free space is 16′ 5″ and in coaxial cable it will be about 2/3 of that or 10′ 11″.

If you have a section of cable this length, it is easy to check its electrical length with the bridge. First put a 10-Ohm resistor directly on the bridge and check for the null at 10 Ohms. Then insert the cable section between the bridge and resistor and see that the bridge still reads a resistive 10 Ohms. If it is a little off, as indicated by an incomplete null somewhere near 10 Ohms on the dial, you may want to change the transmitter frequency a bit to adjust the operating wavelength to the line's physical length.

Just for fun, you might try a quarter wavelength of cable and verify that it transforms the 10 Ohms into 270 (52-Ohm cable). In fact, you might get out a good article on transmission-line matching sections and try a number of things with different loads and line lengths—it's fun and really brings that dry old theory to life.

With the antenna fed through some multiple of a half wavelength of cable, the radiator length can be adjusted for resonance as indicated by a complete null of the meter reading. The resistance indicated at resonance is the feedpoint impedance of the antenna, and the ratio of that impedance to 52 Ohms is the swr on the cable—assuming you're using 52-Ohm cable. If the swr is more than 2:1 (antenna impedance greater than 100 or less than 25 Ohms), then you may want to change the coil tap position. It probably is easier to change the inductance below the tap by squeezing or separating the coil turns there slightly than it is to unsolder and move the tap itself. These adjustments can be pretty fine and you probably won't end up changing the coil size by a whole turn's worth anyway.

With the inductance changed, look for the new null on the bridge and, once again, adjust the antenna height until the feedpoint impedance is pure resistance. Depending on whether that resistance is closer or further from the 52-Ohm target, you now know in what direction the coil must be altered to effect an acceptable match.

Conclusion

Of course, there are many other tuning applications for this instrument besides CB antenna conversions. You will find it more useful than an swr bridge for any application which requires both resonating a load and transforming its impedance. As a bonus, you can use it to measure swr when the load impedance is mostly resistive. The internal dummy load lets you adjust and modify antennas without danger to your transmitter and without putting a big signal on the air. You'll also find that the dummy load and calibrated wattmeter are a valuable QRP tune-up aid. Last, but not least, you can develop a real understanding of transmission-line matching techniques by using the bridge to verify some of the theory you read when studying for your ticket! ■

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Reader Service for facing page 5

Arnal Cook N9AKX
1591 S. Lane Ave., Apt. 23C
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Police Freqs for the TR-2400

—a sleepless night for the mod squad

I do not need to extol the bounty of convenience and luxury Kenwood's new TR-2400 hand-held 2-meter transceiver has brought to VHF enthusiasts. Most hams, no doubt, have seen or read of its features—notably 10 channels of programmable memory and its ability to scan these memories, stopping on active or inactive channels. Being strictly a VHF enthusiast, my mind began to drift when my TR-2400 arrived to what the next advance in radio/scanner technology would bring forth. It didn't take very long to imagine the first tri-band programmable hand-held scanner.

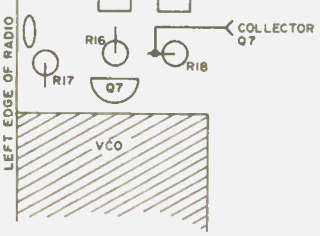

Fig. 1. Vco location.

After all, the TR-2400 had broken the ground, at least in a single-band version.

I also began to ponder the possibilities of converting the TR-2400 to the "action band." One sleepless night was spent tracing the schematic lines and deciphering its method of operation. I would like to thank Trio-Kenwood Corporation for their practice of supplying block diagrams and full schematics with their products. I wish all manufacturers would make it a policy to do the same with every unit. This ham, for one, distrusts "black boxes."

Several possibilities emerged to modify the TR-2400 so that reception in the 154- to 158-MHz range would be possible. Three of them will be outlined here, from simple to complex. The simplest of these is currently working in my rig. The second requires moderate circuit modification, but may not work depending on the range of the vco. The third method requires additional parts and good instruments to adjust, but is sound in theory. I present these here in hope that someone else will follow my theories, try to implement them, and report their results. I cannot because I begin Navy pilot training at Pensacola, Florida, within two weeks of writing this draft and don't have the time!

Theory in Operation

The operation of the TR-2400 is fairly straightforward as frequency synthesizers go. Referring to your owner's manual (pages 14 and 15) with the following description may be helpful, but not necessary, to follow the principle of the synthesizer.

Transistors Q7 and Q8 and associated power supply pass transistors Q2 and Q3, respectively, form a complementary electronic switch—i.e., when Q2 is ON during receive, Q3 is OFF, and vice versa during transmit. Q2 controls the fixed frequency receive beat oscillator/tripler (X1, Q1). Q3 controls the transmit beat oscillator/tripler (X2, Q4). During transmit, positive bias on the base of Q7 causes it to conduct to ground and turn off Q2 and Q8, which turns on Q3 and Q4.

The output of Q4 (138.5 MHz) and the VHF voltage controlled oscillator (vco, Q10) are mixed, filtered, and amplified by Q5 and Q6. This forms a downconverter, much like the i-f system when in a receiver. As shown on the block diagram in the manual, the output of Q6 is always between 5.5 and 9.5 MHz for 2-meter operation (144.0 − 138.5 = 5.5 MHz). The full range is 5.4 MHz to 9.995 MHz. In receive mode, pass transistor Q2 activates Q1 (127.8 MHz) and D3. The output of Q1 is lower than Q4 by 10.7 MHz, which is the i-f frequency. In order to keep the output of Q6 between 5.5 and 9.5 MHz, the vco must drop its frequency by 10.7 MHz, too. Most of this drop is accomplished by D3 bypassing C27 when forward biased, effectively *increasing* the value of C26 (the value of two capacitors in series is lower than the smallest value; bypassing one of them therefore increases the value of capacitance in the circuit). This lowers the vco frequency by about 10.7 MHz.

IC Q20 is a binary-encoded 3½-stage decade programmable counter (i.e., it divides by any integer, not just powers of two). Actually, as used here, only 3 decades are programmable: units (A1-D1), tens (A2-D2), and hundreds (A3-D3). The thousands half stage (A4-B4) is wired at one thousand (i.e., A4 goes to Vdd and B4 goes to ground, a binary one). Frequency division of the signal from Q6 is therefore 1000 plus whatever is loaded into Q20 by the microprocessor, Q25 (and interface ICs Q23 and Q24). Divisors range from 1080 at 143.900 MHz to 1999 at 148.495 MHz, the limits of the TR-2400.

The phase comparator reference frequency (5 kHz) is derived from X3 (10.240 MHz) and fixed binary divider IC Q22. To get 5 kHz in this case, a divisor of 2048 is used, which is 2^{11}, hence pin Q11 on the schematic. 10,240 kHz ÷ 2048 = 5 kHz.

The divided outputs from both IC Q22 (reference) and IC Q20 (signal) are fed to IC Q21, the phase comparator. Any difference between phases in the two signals (usually caused by a difference in frequency) causes an error voltage to appear at pin 1, "AMP OUT." This output is proportional in magnitude to the phase difference of the two signals. This error voltage is applied to D2 (actually a varactor diode) to tune the vco frequency and hence correct the phase difference the comparator in IC Q21 senses. Simultaneously, this voltage is fed to four varactors in the front end (D1-4) to ensure peak tuning across the band in the receiver front end. The error voltage was measured at nearly 1/2 volt per megahertz of frequency change.

Back to the beginning for a moment. The transmit/receive switching voltage used to drive Q7 and Q8 is closely associated with the biasing voltage for diodes D9 and D8/D27. These diodes select the routing of the vco output signal to either the receiver (D9) or the transmitter (D8/D27) as it is needed.

To complete the theory of operation, the deviation for transmitting is developed in the vco. Output from microphone amplifier IC Q13 is applied to D5 in the vco, another varactor. Thus, modulation is true FM, produced directly at the VHF frequency without the use of frequency multipliers.

Conversion

The most commonly used portion of the VHF-hi public service band of usual interest lies almost exactly 10 MHz above the 2-meter amateur band (154 to 158 MHz). The transmitter frequency from the vco (143.9 to 148.495 MHz) is an appropriate injection frequency to the receiver for nearly the same range (+10.7 MHz = 154.6 MHz to 159.195 MHz).

The only trick necessary to accomplish this higher injection frequency is to use the higher-frequency transmitter beat oscillator (Q4) with the receiver and turn off the receiver beat oscillator (Q1) and D3. Two wires can be rerouted through the S. TONE switch (if not being used) to shift the receiver up band. No critical or sensitive circuits are disturbed, so performance is virtually ensured.

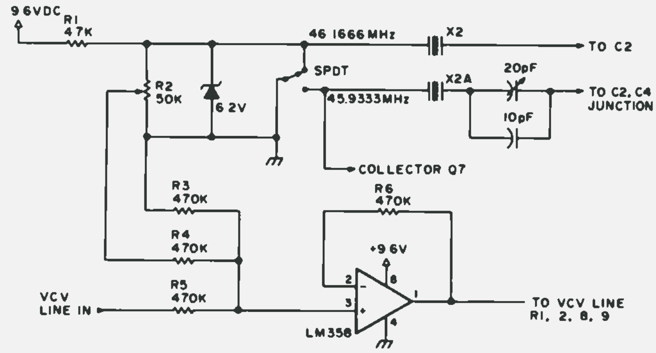

Fig. 2. Suggested circuit. Note: LM358 is a dual op amp in an 8-pin DIP designed for single-ended power supplies.

In operation, the collector of Q7 is bypassed to ground, which switches the oscillators, as needed, but not the radio circuits.

The Mod

Turn the radio off and the TX offset to BU OFF. Remove the four rear screws, back cover, battery cover, battery pack, and the two screws beneath the battery holder. Disconnect the battery. Locate the empty area in the center of the rear circuit board where the tone board would go. Find the red (V+) and black (ground) wires and short them together (use a piece of insulated wire if you like). The red line will be disconnected from V+ in a moment. Replace the back cover without screws.

Turn the radio over, face up. Carefully lift the face plate up and off to the right. All these ICs are CMOS and could possibly be destroyed by static charges on loose fingers or tools. There is no need to touch these, *so don't!* Note: You will be on a remote lead of the microprocessor (PA2), but this lead has static protection (C9, R66).

Find the S. TONE switch assembly in the top, center. Just to the right of this switch is a black wire marked B1. Follow this wire down to the bottom edge of the board. Remove this one end of the wire from this point by cutting or unsoldering it. This disconnects the red wire on the bottom board from V+. Lay the black wire aside.

In the lower left corner is a shielded portion of the circuit. This is the vco. At the top of this box is transistor Q7 and its associated resistors. To the right, in the 2 o'clock position, is R18. See Fig. 1. The wire lead of R18 is the connection point for the end of the black wire removed above. The lead on R18 has a ceramic coating for insulation, part of which must be removed to make a place to solder the black wire. This coating will chip away easily under a pen knife, razor blade, or even serrated plier tips if done very gently. After removing the insulation, solder the black wire to the resistor lead quickly. These small resistors won't handle much heat for long. Don't break the circuit. This is just a convenient attachment point.

That is the entire modification. Put the case together, careful not to pinch any wires, and connect the battery pack. Be careful not to overtighten the screws. Turn the radio on before moving the TX OFFSET switch from BU OFF.

Operation

This modification causes the ON AIR indicator to be on when the S. TONE switch is depressed. The transmitter is *not* on. The microprocessor (pin PA2) reads the collector of Q7, which you just shorted to ground, as the transmitter.

Only the transmit beat oscillator is on. While in this mode, I suggest you keep the F LOCK ON and the TX switch in the STOP position to avoid inadvertent transmission while monitoring. If you do transmit, the transmission will be in the amateur band as usual.The transmitter is *not* shifted up band by this modification.

To receive the desired new channel, subtract 10.7 MHz from the known frequency (e.g., 155.61 MHz − 10.7 = 144.91). Make sure the S. TONE is off (up position) and program the radio as usual for the corrected frequency (e.g., 4.910). Now depress the S. TONE switch. As the ON AIR flag appears, your radio is tuned to the new channel.

While in this mode, the keyboard will not function, just as if you were transmitting; thus, there is no band scan or memory scanning. These features may be regained by the more complex modifications, or by isolating pin PA2 of the microprocessor and keeping it near Vcc (which I do not recommend). If the radio is turned on with the S. TONE switch already depressed, an incorrect display is likely to occur. Simply turn the S. TONE switch *off*, then *on* again to correct the readout. Receiver sensitivity in the new band will fall off because varactors D1-D4 (front end) are not being properly tuned for this higher range. However, sensitivity remained sufficient to receive my local sheriff's department near the edge of the county.

Other Theories

The best theory requires some careful circuit work, but has great promise. Basically, if you add 2000 to the divisor at IC Q20, all frequencies would be shifted up by exactly 10.0 MHz. This is easily done by lifting B4 from ground and connecting it to Vdd, or A4. Thus, programming would be just as on 2 meters—just the last 4 digits of the frequency, without the need for a correction factor. Using this higher divisor would allow using the receive beat oscillator and keep band and memory scan capability.

The easiest way to keep the vco working 10 MHz higher than usual above the receive beat oscillator is to isolate D3 in the vco by breaking the control line from Q2. An additional switch would be needed to switch it back in for normal two-meter operation.

A more extensive circuit addition may yield better results. The AMP OUT line from IC Q21 goes from about 1.2 volts to 3.4 volts (a range of 2.2 volts) from 143.9 MHz to 148.5 MHz (a spread of 4.6 MHz), or roughly +.5 volts/MHz. Thus, to go 10 MHz higher would require about 5 volts more, in addition to 3.4 volts, for a maximum swing of 8.4 volts. This is below the battery voltage and is therefore feasible, but may not be practical. There are several limiting factors that must be checked before implementing either modification: 1. capacitance range and response curve of D2 for these voltages; 2. maintaining the supply voltage; and 3. will IC Q20 handle an input frequency of 20 MHz?

The output of the AMP OUT line of IC Q21 is limited to Vdd, the supply voltage from regulator Q9. This is 6 volts, or about 10 MHz of total possible spread, using 1 volt as a minimum figure and linear mode of operation from D2. One possible solution to this limited voltage swing is an amplifier stage with a voltage gain of 2 connected to the battery line. The output would feed varactors D2 and D1-D4 in the front end. This may tune not only the vco over the full 15 MHz, but also the front end to maintain sensitivity. However, it may be impractical to use the unregulated battery voltage. Low batteries and varying load conditions (e.g., audio) may cause voltage fluctuations and instability in the vco.

Still one more option exists. Alternating X2 with a crystal for 45.9333 MHz would shift the transmit beat oscillator exactly 10.0 MHz above the receiver oscillator instead of 10.7 MHz. These crystals would be switched in or out by means of their ground connection. These two crystals (X2 and X2A) would differ by less than 250 kHz, so the bandwidth of the oscillator should not be a problem. The accurate tuning of these crystals is imperative. To tune the front end, an op amp could be used in a voltage summing circuit. (See the suggested circuit in Fig. 2.)

The trimpot would be adjusted to add a preset value to the vcv (varactor control voltage) line to feed the front end (only) when switched in. When not in use, both sides of the pot would be grounded so it would add zero volts for normal operation. Note: X2A may also work on the receive oscillator side if Q1 is broadband enough, and D2 will work on a higher voltage. If so, change R3, 4, and 5 (Fig. 2) to 220k and connect the vcv line to D2 as well. Eliminate the connection to Q7. This will restore memory scan again.

It is my hope that someone else will pick up on these ideas and work them out to completion. In emergencies, such capability to switch between ham and police or fire department channels could prove very valuable.

Good monitoring! ■

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Jim Gray W1XU
73 Magazine Staff

Those Amazing Bobtails

—the current-fed connection

The Bobtail antenna system described in the references has created quite a stir. Various combinations of construction methods and feed systems have been suggested through a great deal of correspondence between various amateurs.

A nagging problem has been the lack of a satisfactory explanation of the operation of the antenna when it is current fed. It is hoped that this article may shed some light on this subject and spur others on to try this excellent antenna.

To begin, we need a couple of definitions: 1) Voltage feed—feeding an antenna at a point where a voltage loop (or maximum) occurs. 2) Current feed—feeding an antenna at a point where a current loop occurs.

Antenna theory shows that whenever you have two vertical radiating elements spaced 1/2 wavelength apart, the radiation will be reinforced in a direction perpendicular to a line drawn between the antennas. By using three vertical radiating elements (or four, five, or more) all spaced 1/2 wavelength apart, the radiation will be reinforced in the same directions as before, approximately proportionally to the number of radiating elements. Such an antenna is known as a curtain. Because our antenna has only three elements, it is known as a short, or Bobtail, curtain.

Curtain antennas of the type described are bidirectional, with radiation patterns that look like elongated figure-eights viewed from the top of the antenna looking down. The figure-eight pattern extends perpendicularly from a line drawn between the antennas, and when many elements are phased, the figure becomes longer and skinnier and the result is a bidirectional beam: a *broadside array*.

In order to understand the operation of the Bobtail curtain antenna, one must consider the antenna currents in terms of their magnitude and phase relationship. Ideally, in an antenna of this type, all radiation is from the vertical elements, and little or no radiation occurs from the horizontal sections (flat-top portion) because these exist merely to achieve the proper phase relationship between the vertical elements.

Heretofore, the Bobtail has been *voltage* fed by means of a coupling network attached to the bottom of the center element, although it is possible, if desired, to attach the coupling network to the bottoms of either of the vertical end elements.

For many reasons, including convenience, ease of matching, simplicity, elimination of coupling networks, and other factors, it has been considered desirable to find another way of feeding the Bobtail, and such a method has been reported as having been used with success by a number of different amateurs. Here's how it works:

In Fig. 1 observe that the Bobtail array, as before, consists of the three quarter-wave vertical elements at A, B, and C. The two end elements at A and C are essentially a portion of the flat-top and connected directly thereto.

The center vertical element is separated from the horizontal flat-top portion by a small insulator at G, and the conductors of a coaxial feedline are attached to the flat-top and to the vertical element, across the insulator, with the center conductor connected to the vertical, and the braid connected to the exact center of the flat-top, at B.

Vertical element A is separated by 1/2 wavelength from element B, and vertical element B is separated by 1/2 wavelength from vertical element C. Flat-top sections A-B and B-C act as phasing lines to make the current relationships in the antenna come out properly, i.e., the current in section A-B is 180° out of phase with the current in B-C, and therefore they cancel.

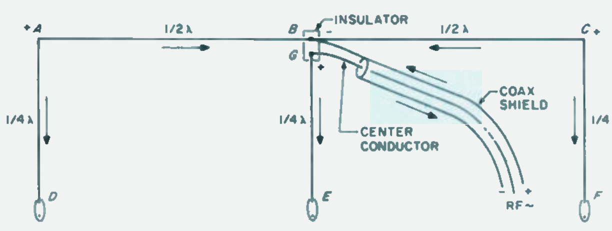

Fig. 1. The current-fed Bobtail.

The currents in the vertical elements are in phase and add because the current is traveling in the same direction at any given instant (but the currents are not equal in magnitude). The reason for this is that the vertical elements are each only 1/4 wavelength at the operating frequency. The current divides between the vertical elements in a ratio of two to one.

In order to satisfy the phase requirements, the magnitude of the current in the end elements must equal the magnitude of the current in the center element. Since there are two end elements and only a single center element, the current in the center element must be twice that in each of the end elements.

If you study Fig. 1, you will notice that for a particular given half-cycle, the + and − signs are as shown, changing sign at each 1/2-wave point. We have assumed the feedline to be exactly 1/2-wavelength long. The arrows between the plus and minus signs show the direction of current during the particular half-cycle we've chosen to illustrate. During the next half cycle, note that the polarity at each of the half-wave points will change and the current arrows will reverse direction, but also note that, once again, the currents in flat-top sections A-B and B-C will cancel. The currents in the vertical elements will again add in-phase in spite of the fact that their direction is reversed. Thus, on each half of every full cycle the vertical elements always add in-phase and the flat-top sections always cancel.

Interesting Side Notes

If you turn a current-fed Bobtail upside down, it looks like a much more familiar antenna system. By eliminating the phasing line (flat-top) and substituting ground, you have three 1/4-wave verticals spaced a 1/2-wave apart. This is very common practice in antenna systems, for example, in the broadcast industry for directional beaming.

The disadvantage of all but perfect ground systems is the resistance loss in imperfect conductors. Consider, now, what happens when we use the Bobtail array: The "ground" becomes the horizontal wire or flat-top—nearly loss-free compared to ordinary ground and, better still, elevated above earth by at least a 1/4 wave.

What this means is that the antenna becomes more efficient and the radiating portion is raised. The high-current portion of an antenna is the portion which does the biggest share of the radiating and that is why it is best to get it as high and as in the clear as possible. The Bobtail array accomplishes these things and, therefore, is a good antenna compared to one in which the radiating portion is low and the losses in ground resistance are high.

One more item. Radiation from a Bobtail is *vertically* polarized and therefore, when placed as in the configuration shown in Fig. 1, exhibits not only gain, but a very low angle of "take-off," as is typical of many vertical radiators. Hence, it's a good DX antenna.■

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Shoot the Moon!

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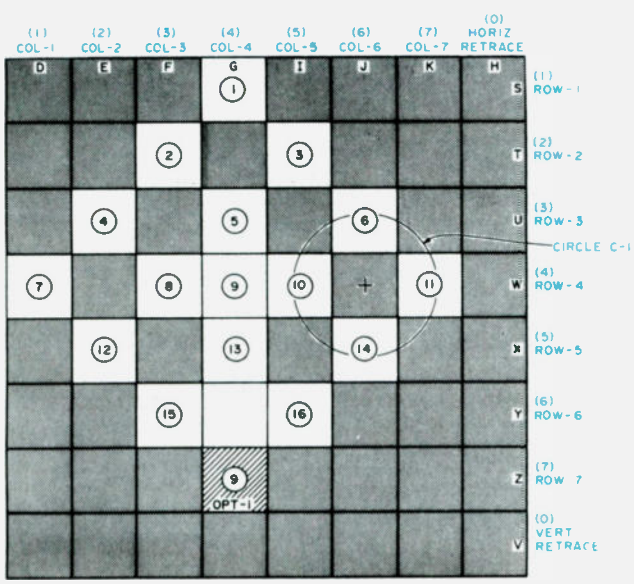

Fig. 1. Video monitor screen presentation. White squares with numbers are the maximum number of squares that can be lit. Dark areas are never lit. One possible moon image is shown by circle C-1. This would light squares 6, 10, 11, and 14. Adjust your lens or lenses for approximately this kind of spot size. The numbers correspond to the LDRs in Fig. 10.

Is your OSCAR or EME array all automated for tracking? Mine is, but I still wanted a means of visually tracking in a manual mode. This article details the simple "moon" camera I came up with to look at the moon while I stayed comfortably in my basement (Indiana winters get cold!). It also makes a fine motion detector or low-resolution surveillance camera.

Take a look at Fig. 1 for a moment. What I have is the screen of a TV set or, in my case, a video monitor. There is no reason why you can't feed the video output of my simple camera to one of the TV game modulators and pipe it into any TV set as rf on whatever channel the game modulator outputs on.

As shown, the spot or image of the moon has been concentrated into a round circle that just illuminates one or more of the photosensitive devices (more on them later). Whenever light shines on these devices, their resistance is greatly lowered and I sense that change to light a square on the monitor screen. In order to have the different positions on the screen represent different aiming positions of the antennas, there are two main requirements.

The first and easiest is that the camera be physically boresighted to the antenna. That's just a fancy way to say that it has to be aligned to look where the antenna is looking.

Secondly, the photo devices must be arranged in an array that duplicates what you want to see on the screen and then scanned in step with the monitor scanning. These last two requirements are met easily using the circuitry and board layouts provided by this article.

Since I have started you out at the photo-sensing end, let's begin there on the circuitry and boards. The first thing you will notice is all the boards are round instead of square or rectangular. This allows for mounting in a round enclosure (details later, under Mechanical Assembly). The first board to consider is the LDR Board, shown in Figs. 2 and 4. I used light-dependent resistors (LDRs) as photo devices; mine are about ¼" in diameter at the light-input end. This allows the array of 16 LDRs you see the pattern for to fit easily on my round board.

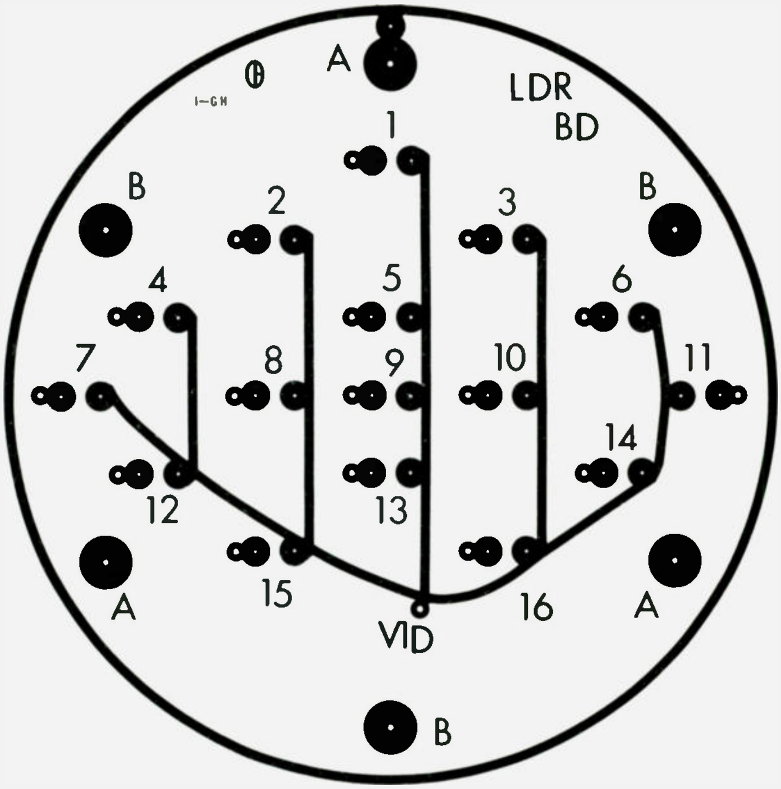

Fig. 2. Foil side of LDR board.

To mount the LDRs in the board, you need sockets of some kind. This avoids direct soldering and the possible altering of the resistive characteristics of the LDR. I highly recommend an item called a matrix pin by AMP, Inc.; it is their part number 380598-2. These are single-terminal push-in sockets and are sold by many parts houses and the magazine advertisers. Just drill out the circles to hold the sockets of your choice and load the board up as shown.

All leads come to the board from the copper side and pass through their holes, leaving a small amount of the stripped lead on the copper side to solder to. When this board is complete, there should be seventeen leads 4" to 5" long coming off the copper side. (Use different colors to avoid confusion.) 16 leads are to one side of each LDR, and one lead is common to all LDRs and is called the video lead (VID). There is really no easy way to test the board at this point, so set it aside and go to the counter chain schematic in Fig. 3. The corresponding foil and component sides are shown in Figs. 5 and 6.

The counter chain should go together quickly, and it can be checked out fully when completed—less any other boards. Load the board as shown and then check the test points using a frequency counter or oscilloscope at each test point against Table 1. The starting point is at the 555 IC, as this is the master clock. It should run at 122.88 kHz, and you adjust to that using the PC board thumbwheel pot, Ra. The set you use for a monitor will more than likely lock up (have steady sync) if the clock is from 122.0 to 123.5 kHz, but you may have something called flutter due to a difference between your divided-down vertical (59.57 to 60.3 Hz in the clock range just given) and the proper 60-Hz rate used to avoid beats against the power line 60 Hz.

The wide range of tolerance on most TV sets allows you a lot of leeway

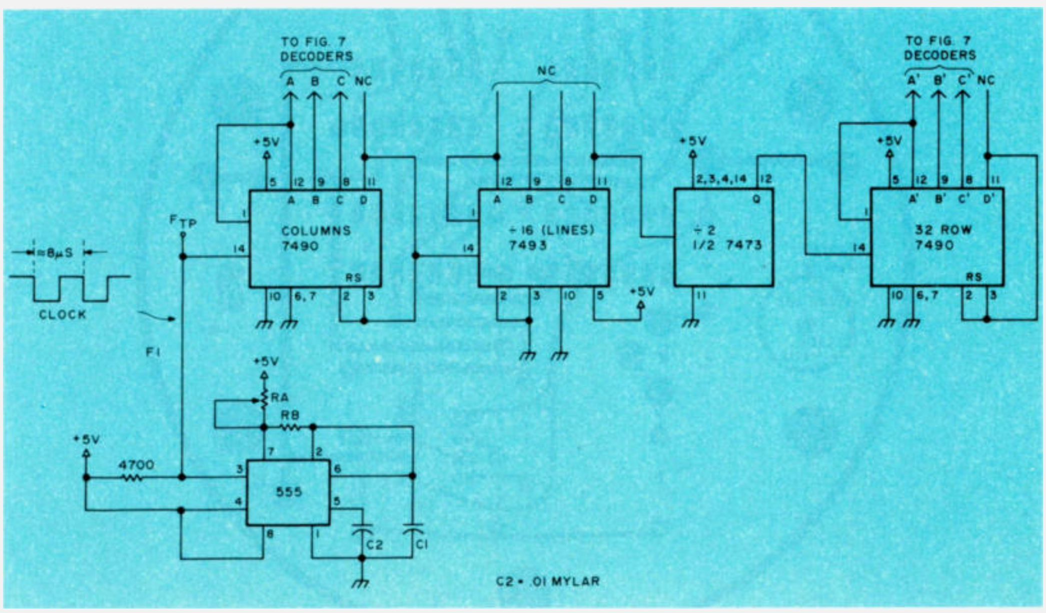

Fig. 3. Counter chain. Set for a frequency of 125 to 126 kHz at F_{TP} test point. For this application, C1 = 220 pF, Ra = 10k thumbwheel PC pot, Rb = 18k, ¼-W fixed resistor. General formula is: f = 1/T = (1.44)/Ra + 2Rb) × C.

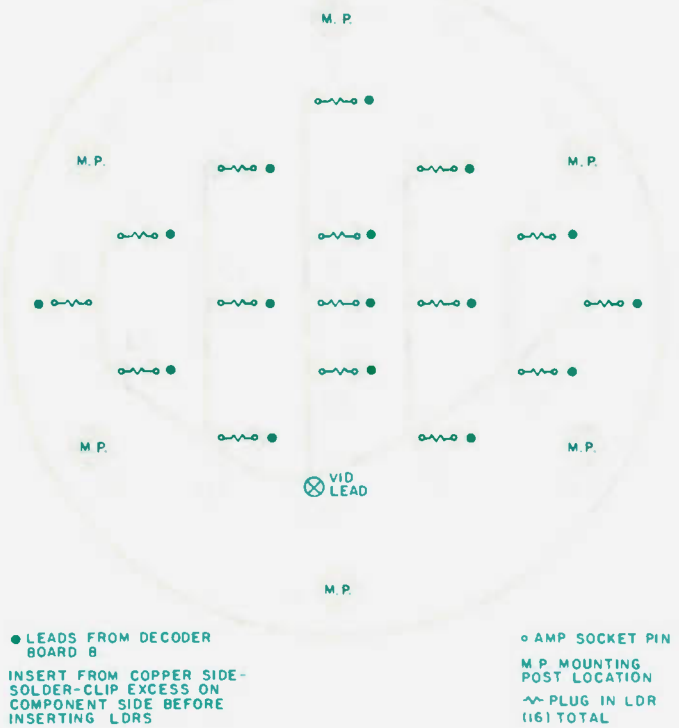

Fig. 4. Component side of LDR board. M.P. designates mounting post (threaded spacer) locations. Use alternate locations between any board pair, thus only three spacers looking like a triangle between any board pair. Small circles are socket pins for LDRs. Solid dots are leads from decoder board B and should be inserted and soldered from the copper side and excess lead on component side clipped off flush with board. Resistor symbols are LDR locations.

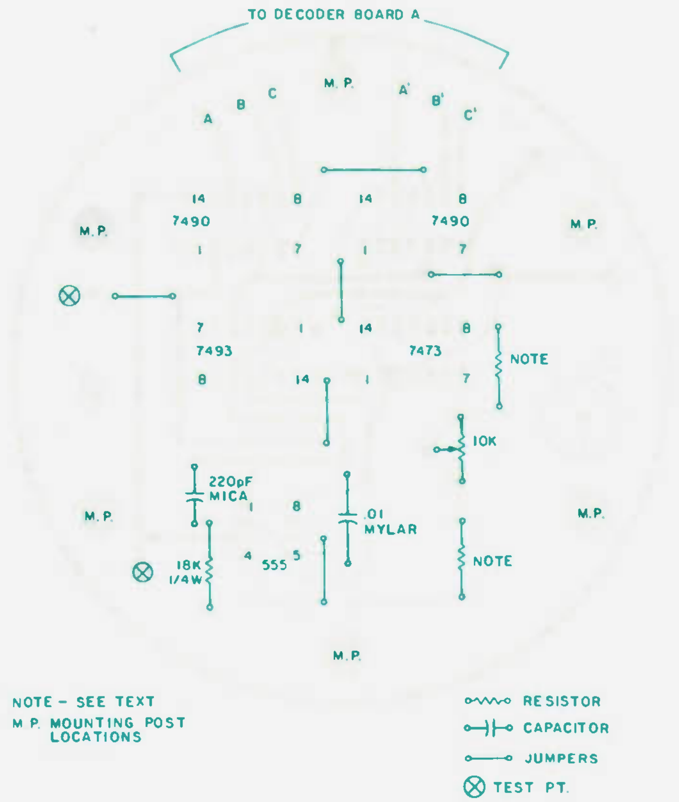

Fig. 6. Component side of counter chain board. Standard schematic symbols are used to show component mounting locations. Solid lines connecting dots indicate jumper leads. Circled x indicates test point.

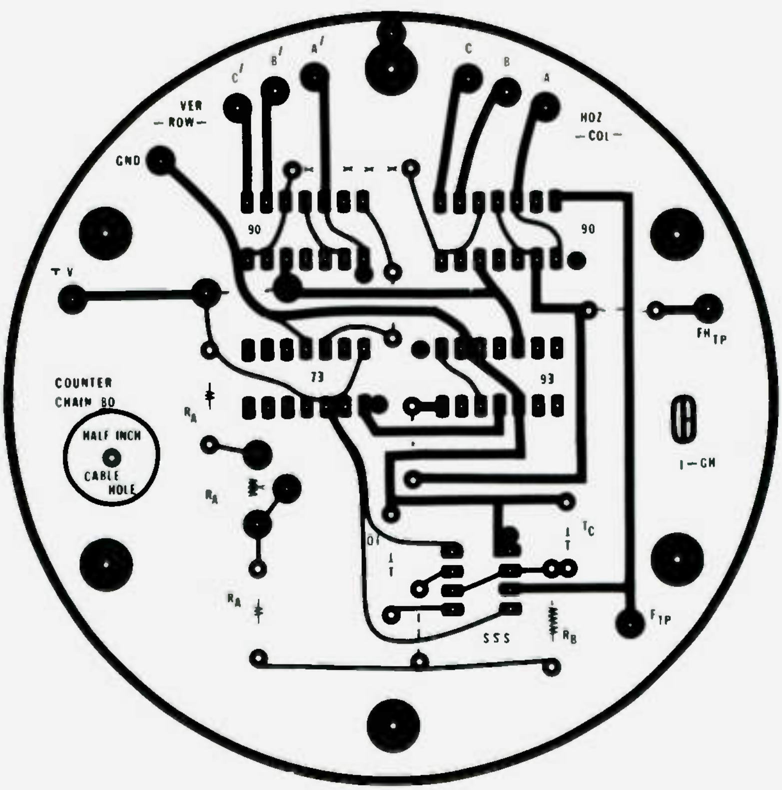

Fig. 5. Foil side of counter chain board.

in the setting of Ra where the set will lock up and look alright. If you can't get things as good as you want using a 10k pot for Ra and jumpers in the fixed Ra positions, a smaller pot can be used along with fixed resistor(s) to allow Ra to effectively tune slower. You would have to find the two extremes of Ra settings that create a locked-up picture, measure the resistance of Ra in each case, and use the difference as the new Ra value. Then fixed resistors make up the jumpers. Remember, the total must be 10k.

Example: If the set locked up alright on resistor Ra settings of 2500 Ohms to 7500 Ohms, use a new Ra of 5k and one fixed resistor of 2500 Ohms in either fixed Ra (jumper) position. Your new range then becomes 2500 to 7500 Ohms.

Ignoring the +V and ground leads needed by all boards except the LDR board, there are only six leads leaving the counter chain board (A, B, C, A′, B′, C′), and they all go to the points lettered the same on

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decoder board A (Fig. 7). If these points are outputting according to Table 1, the 7442 decoders (IC1, IC2) will decode the BCD line codes into one of ten outputs. Since the D line is not used off the 7490s, the 7442 becomes a one-of-eight decoder. In IC1, positions 1 to 7 represent seven vertical columns across your monitor screen. Position 0 is left as horizontal retrace and is covered on the video/sync board. IC1 runs the sequence of 1 to 7, then 0, 32 times before any change occurs in the vertical scan decoder. This means 32 lines that are identical in vertical coding across the screen. This is accomplished by placing a fixed divide-by-32 chain between the horizontal and vertical counters.

In the case of the number 1 LDR, if light is shining on it each of the 32 lines will go white from a black screen as it scans over the column position 4 (center). When this happens 3 times, a white square is formed at the top center of your screen. When you have all your camera boards together but no optics or lenses over the LDRs, the monitor screen will light white squares in the same pattern as the LDRs are laid out on the board if

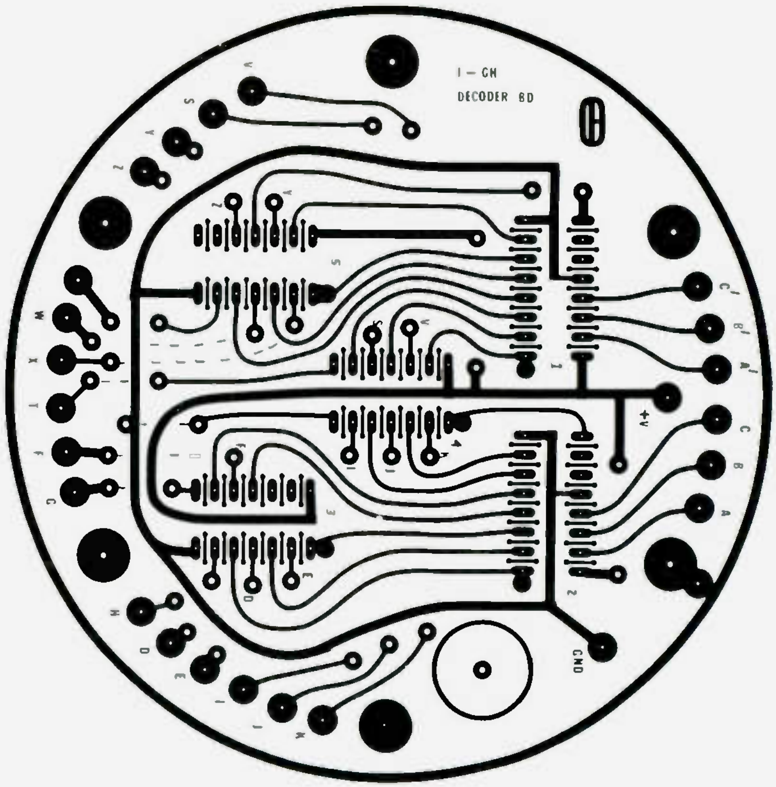

Fig. 8. Foil side of decoder board A.

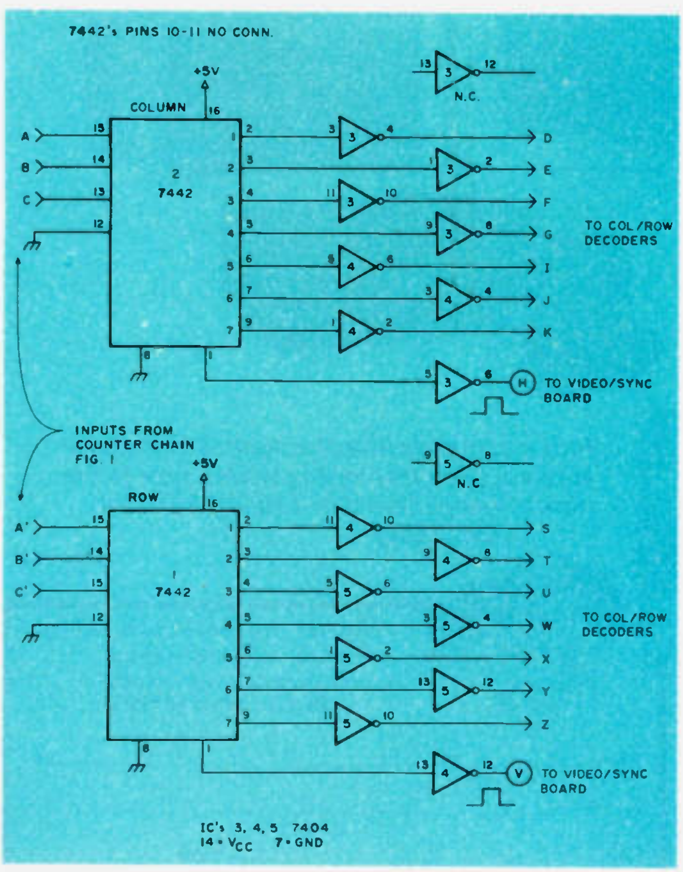

Fig. 7. Schematic of decoder board A.

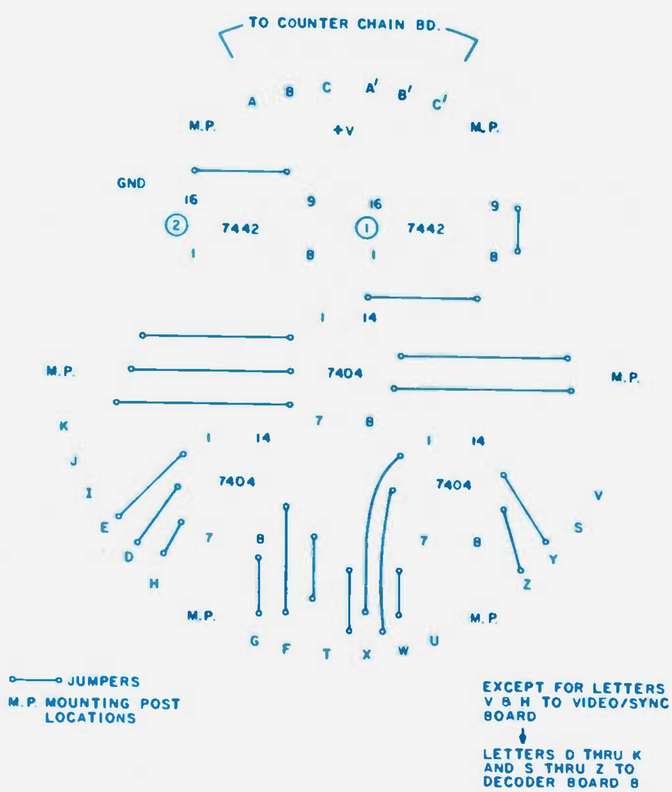

Fig. 9. Component side of decoder board A. Letters V and H are leads to video/sync board. Letters D to K and S to Z are leads to decoder board B (except V and H). Solid lines connecting dots are jumpers on component side.

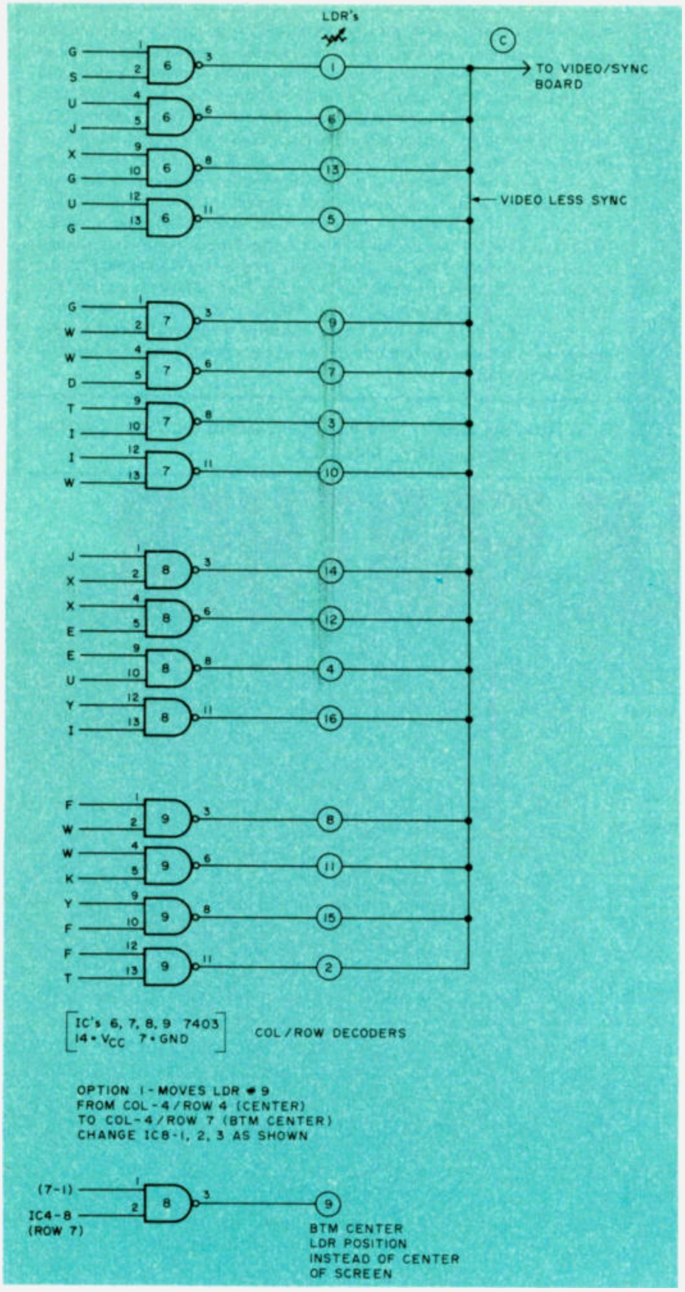

Fig. 10. Schematic of decoder board B. Option 1 moves LDR #9 from column 4/row 4 (center) to column 4/row 7 (bottom center). Change IC8 pins 1, 2, and 3 as shown, and load LDR at bottom center.

light is falling on all the LDRs. This will be a final check that all is working, before the mechanical assembly.

The row decoder (IC2) does the same job as the column divider (IC1) but at a slower rate, to handle horizontal rows. Therefore, it advances one position after each 32 horizontal lines. This happens seven times, forming 7 horizontal rows of 32 lines each. If more LDRs and decoding were used, the camera has a possible 7 × 7 or 49-position resolution. The complexity is not worth it, and the camera functions just fine using only 16 of these 49 possible locations. This is accomplished by allowing the focused moon image to be larger than one square of resolution and using multiple lit boxes to show where the image is relative to center screen (on target). A perfectly aimed antenna will produce a white + sign at the center of the monitor screen.

IC3, IC4, and IC5 are merely inverters to get the low 1-of-8 outputs of the 7442s back to highs that can be gated together in further TTL logic. Figs. 8 and 9 show the foil and component sides of decoder board A.

The last of the decoding occurs in Fig. 10, decoder board B, where 7403 gates are used to detect which of the 49 squares the monitor is scanning over and enable the proper LDR for that segment. Figs. 11 and 12 show the foil and component sides of decoder board B.

For the positions that have no LDRs, as you will see more clearly next on the video/sync board, there will be no LDR enabled and the video (VID) line will be at or very near +V. This +V on the VID line will represent a black screen on the monitor in the final video composite. For those squares that have an LDR sensor, each has a corresponding 7403 gate section. When the gate is enabled, the open collector output tries to pull +V down to ground through a load resistor. All the LDRs are in parallel by the video line, but only one at a time can be considered in the circuit—the one enabled by the scanning chain.

Going briefly to point C on Fig. 13, the video/sync board, you will see a 10k resistor to +V in the base circuit of the first video stage. The circuit is really a voltage divider consisting of that 10k at all times, in series with either (1) an LDR that is in series with the output transistor of its 7403 gate to ground, or (2) the 10k alone with no enabled LDR for those positions not having LDRs.

Remember, I said +V on the VID line meant a black screen. Automatically, you have 33 positions representing no LDRs and a black screen. In the 16 positions having LDRs, the LDR represents the lower resistor in a voltage divider and as such will cause the voltage at point C to be very close to +V (LDR off—no light), or very close to ground (LDR on—light shining on it). My LDRs swing from several megohms (dark) to about 400 Ohms (light). That means the voltage divider changes from (1) +V through 10k through megohms to ground, causing the junction of the 10k and LDR to be very close to +V, to (2) a series of +V through 10k through 400 Ohms, causing the junction of the 10k and LDR to be very close to ground. This junction voltage controls the base of the first video stage.

Following through the video for an example of one LDR with light on it, the VID line and point C will be low or near ground. The first video stage is just an emitter follower, so no inversion occurs and the base of the second video also will be low and the transistor at or near cutoff. When it is cutoff, the collector rises to at or near +V, and this represents white on the screen.

The last stage is also just an emitter follower to allow enough current to drive a 75-Ohm cable and the 75-Ohm load presented by either the game modulator or the video monitor input. If the monitor has a gain or video drive control, jumper A to C in the last video emitter circuit and omit the onboard gain pot, RL. If the monitor has no control or the game modulator no input gain adjust, use RL and jumper B to C to allow some means of adjusting overall composite video level.

The base of the final video stage has control from two more points that should be covered here. The two transistors with H and V for inputs are the sync mixer and make up the final composite video. Each time the H line goes high (every horizontal line, position 0) or the V line goes high (every vertical scan or field, position 0), the base of the final video is dropped to approximately 0.2 volts, or close enough to be called ground. This is sync-voltage output in my camera.

If the video example were reversed, using a dark or absent LDR position, the second video stage can turn on only to the point where its collector is at 1.4 volts. This is caused by the two diodes in its emitter for 0.6 volts apiece and the 0.2 volts from emitter to collector on the second stage. This 1.4 volts becomes our black level, and allows for the normal video composite of sync being blacker than black. If you consider my composite video as 0.2-volts sync, 1.4 volts-black, and 5.0-volts white, then divide it down with the level control, you will end up with video composite of very close to the standard of 1.0-volt video, 0.4-volts sync. It at least seems to be close enough for a perfect picture with stable sync, and I felt that trying to get any closer was not worth the time or extra components. Foil and component layouts for the video/sync board are shown in Figs. 14 and 15.

That about completes the electronics package, and if you have a power problem, the 74Cxx equivalents can be used for all the TTL devices except the final 7403 decoders. The 555 is running well below its maximum +18 volts, but seems content and quite stable on +5 volts.

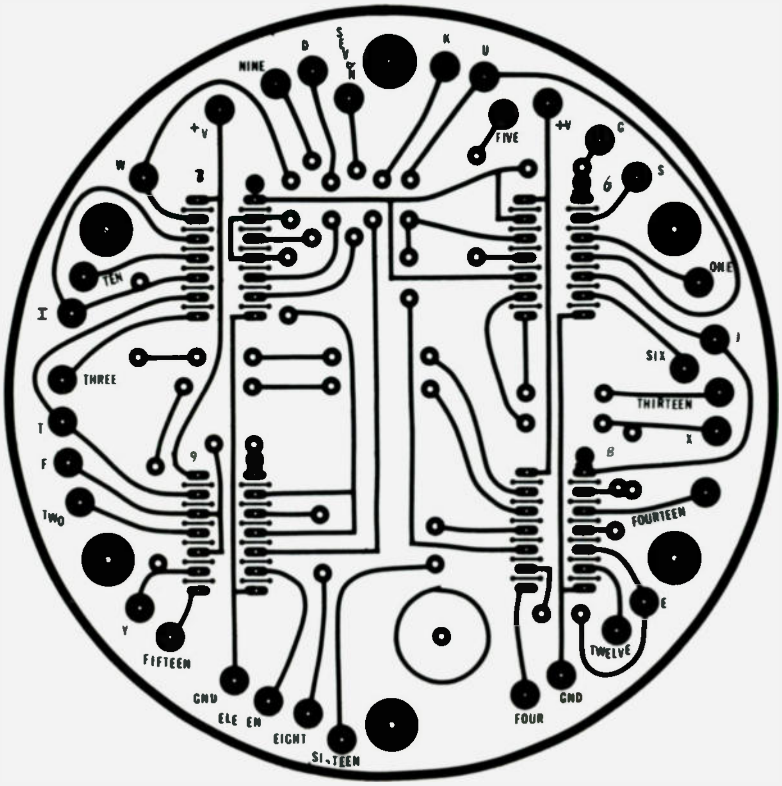

Fig. 11. Foil side of decoder board B.

Mechanical Assembly

The area of mechanical assembly will vary, as with most ham projects, along with its uses. For that reason, I'll outline how I did mine and you can carry on or modify from there. As illustrated in Fig. 16, the housing on my camera is PVC plastic pipe! That's why all the boards are round and separated by three spacers between each board. You can, thereby, build up a board-over-board sandwich by skipping every other hole of the six given per board to set the spacers on.

Looking straight into the LDR board, it is spaced from the board below it by 3 spacers in a triangle. The next board below, by 3 in an inverted triangle, and so on. I used 4-inch i.d. black pipe, and would suggest that whatever you use be black inside to avoid light reflections and stray light. You can buy end caps for the pipe, and I used one as is on the rear of the camera. It was stuck on with rubber cement for easy removal. One hole in this cover allowed the RG-59 feedline to exit through, and a second would have to be provided if the on-board level control is used—I did not use it.

The front cover I made from another end cap, but I sawed off the entire lip from the horizontal center line down. This allowed me to add small aluminum brackets to one side. To the

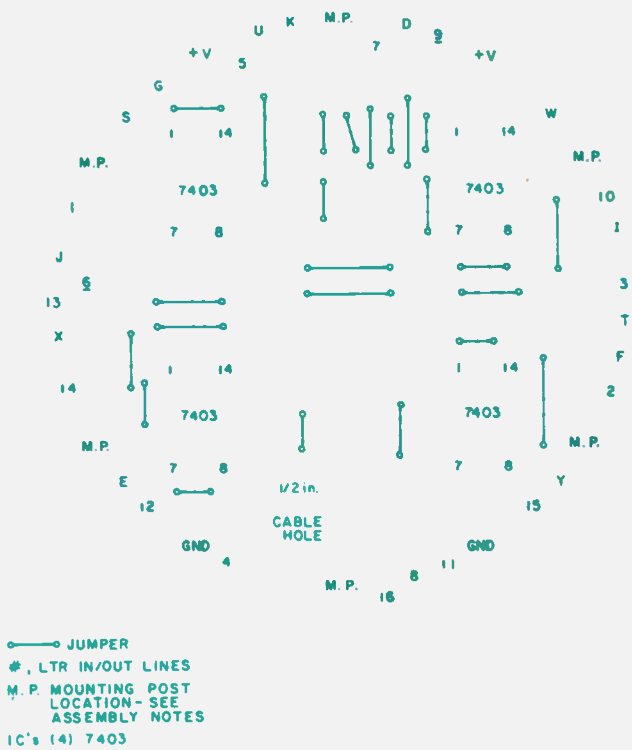

Fig. 12. Component side of decoder board B. Numbers and letters indicate proper placement of input/output leads to other boards. Solid lines connecting dots are jumper leads on component side.

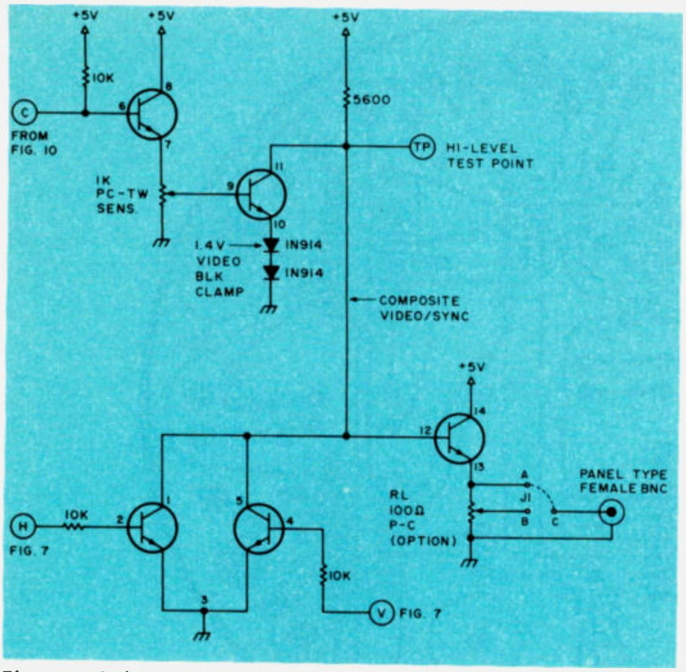

Fig. 13. Schematic of video/sync board. All transistor devices shown are small-signal NPN devices in an RCA IC, CA3046. Numbers shown around the e-b-c of devices indicate pin numbers of that IC for reference and troubleshooting. Note: If cable is terminated in 75 Ohms at the monitor or a drive-level pot (usually 50 to 100 Ohms in monitors), use J1 from A to C and omit pot RL. If no drive level is used on your monitor, jumper B to C and use RL as your drive control to prevent overload.

bracket is attached a rod that runs down the side toward the rear to a small, sealed, metal box that holds a 4-rpm dc motor I had lying around. It is much like the ones the advertising signs use, and I think it was for 6-V dc battery operation. Plus 5 volts runs it just fine, if a bit slow. This allows me to remotely rotate a "lens cover" of sorts on and off the end of the pipe to keep rain, snow, dirt, etc., out of the lens area.

On the topic of lenses, or optics, I am still trying for a better setup, but one of my prime criteria was that it be cheap. After all, I'm trying to avoid using an SSTV or FSTV monitor camera because of cost, so why use a camera lens that costs more than the system electronics? So far, the best combination I have found is with dime-store magnifying glasses with their handles removed.

I fixed-mounted one that was right at 4 inches o.d. at the center of a 6-foot piece of PCV pipe, and that allows me to slide the electronics in and out towards it from the rear. I also have a 3.5-inch lens mounted in a 4-inch collar that I can slide in and out from the front of the pipe to form a compound lens system. That is the area of experimentation at the moment, and I don't mind admitting my physics classes were too long ago. Optics was never really my bag, nor was photography, so all help offered will be gratefully accepted.

The limitation of this system would seem to be use only during full moonlight, but that depends on the response of the photo device you use and the lens system you end up with. As it stands now, I can track in some very hazy conditions, and even clouds don't confuse things too much. Next to try is a full-blown infrared system, I think!

For all the OSCAR fans who read on when the name was mentioned in paragraph one, I have not gone bananas enough to try visually tracking an OSCAR satellite with the LDR system. However, the same electronics system is being tried, mounted in the same waterproof-type housing with two full caps. The difference is that the 7403 outputs will be used to activate PIN diodes (or similar switching devices) on the downlink antenna system. I am trying to build onto the outdoor, steerable OSCAR antennas something like my Twinlead Terror antenna system (*73 Magazine*, November, 1977, p. 54), and then do the video add-on at the monitor end using the sync/white commands coming down the 75-Ohm cable. The video then would be derived from some form of the receiver agc. I mentioned this earlier, in the Twinlead Terror article (which got titled, "Cheap Ears for OSCAR").

You can do some positively wild things with scanned and electronically-steered antennas when you have only receiver power levels to worry about. It becomes even easier when you have a full-duplex, two-band arrangement like the OSCAR uplink/downlink. The receive antennas scan at a high enough rate to be above audio, so you can easily filter out the switch-rate whine. All you hear is the additive result, but each antenna's agc product is

Signal	Location	Measured Frequency	
1. F_{tp}	555 IC pin 3	122.880 kHz	(for H = 15,360 Hz, V = 60 Hz)
2. A	Column IC pin 12	61.440 kHz	
3. B	Column IC pin 9	30.720 kHz	
4. C	Column IC pin 8	15.360 kHz	
5. D	÷ by IC pin 11	960 Hz	
6. Q	÷ by IC pin 12	480 Hz	
7. A'	Row IC pin 12	240 Hz	
8. B'	Row IC pin 9	120 Hz	
9. C'	Row IC pin 8	60 Hz	

This has the horizontal sync running about 400 Hz low, but allows the vertical sync to be correct to avoid vertical "flutter." This is a compromise to reduce system electronics, but all sets tried pulled in easily to the lower horizontal rate. The following is a representation of the VID line with light shining on all LDRs. L is TTL low pulses. Scope Horz. rate = 1/60 sec per full horizontal scan or about 3 ms per cm on a 6-cm Horz. scale.

HHHLHHHSHHLHLHHSHLHLHLHSLHLLLHLSHLHLHLHSHHLHLHHSHHHOHHHS

H is TTL high, S is sync (app. 0.2 volts), O is option LDR 9

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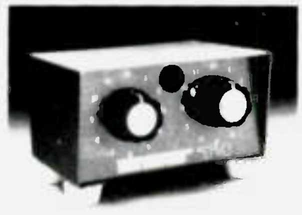

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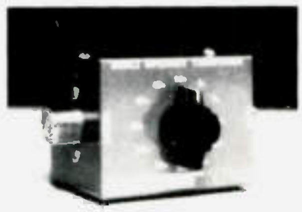

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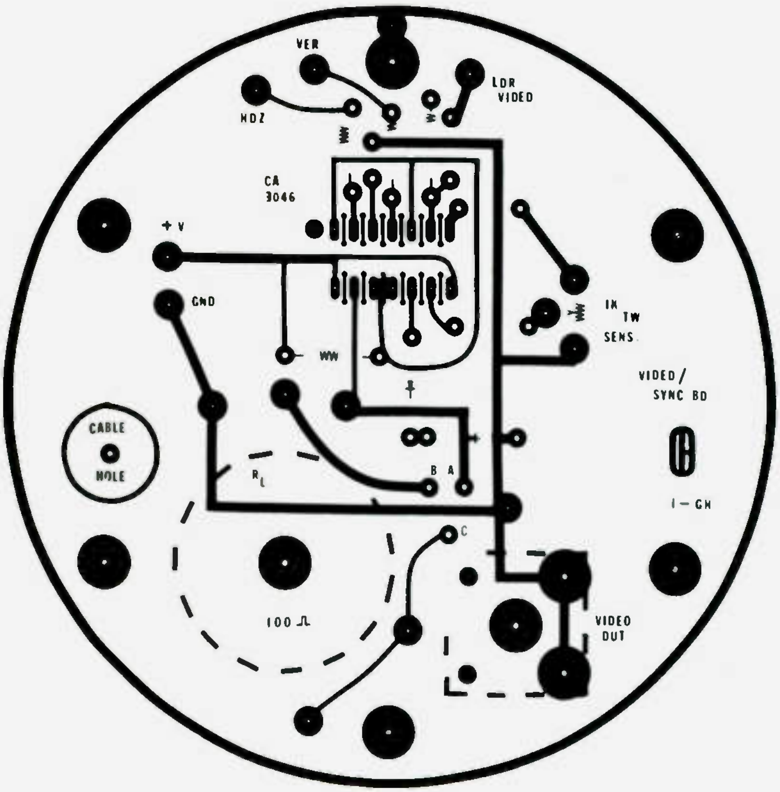

Fig. 14. Foil side of video/sync board.

sampled, and only the highest is used to light the white box on the monitor—sort of a sample, hold, choose-the-highest-figure, and use-for-display system.

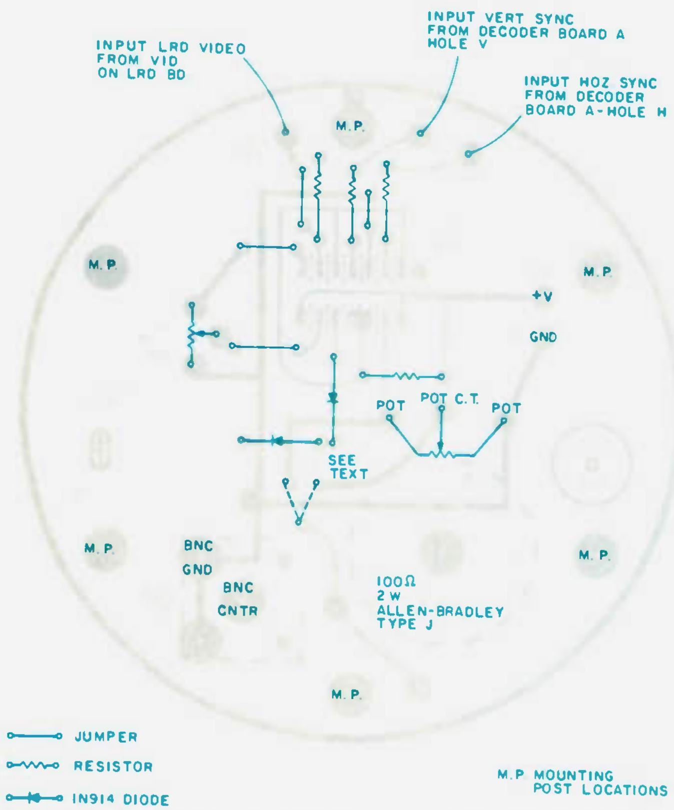

Fig. 15. Component side of video/sync board. Schematic type symbols are used to show loading placement of components. Solid lines connecting dots are jumpers on component side.

I am still deciding whether to use steer antennas to produce center-box white scheme, or sample and display all levels as boxes in the same arrangement in which the antennas are mechanically set up. The latter has the advantage of being able to tell what polarity sense the signal really is, at the antennas, by observing what box(es) are lit the brightest, and to what polarity you have those antennas aligned. It does require small changes in the video stage of the camera, however, so you don't get just saturated white or black off positions intentionally chosen for the EME arrangement.

I have tried several sample-and-hold circuits and antenna positionings so far and have found none to be the perfect result I want. Many such circuits are already around as described in the articles over the past couple of years and 10-meter antennas are easy to build, so you may have your system running before I have mine complete. I am working hard on the EME version at the moment, but should get back on the OSCAR version soon.

The cost of the A-to-D converter IC is quite attractive now, and with my love for digital circuits I am going to try one more sample-and-hold circuit using that type of device. It is an analog in, 3 digits in BCD output device covered a bit further as an antenna readout device for use with CDE Ham 3 rotator controls in *Ham Radio*, January, 1979, p. 56. The device used there is an AD 2020 by Analog Devices, Norwood, Massachusetts.

If there are any questions, please include an SASE, and I'll sure try to help you. If you come up with other uses (surveillance, etc.), please write, as several people have already approached me with ideas beyond what I had in mind. I'll try to act as a go-between as best I can for any new ideas for my camera. Good lookin'. ■

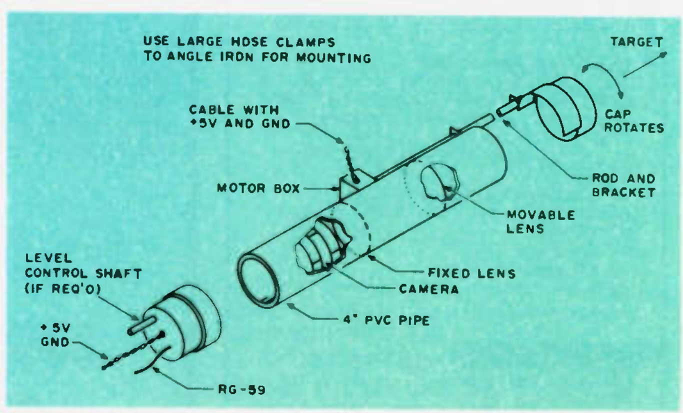

Fig. 16. Mechanical assembly of the camera.

Reader Service for facing page ✓331→

The Standard for Comparison

New **AZDEN® PCS-300**

2-M Handheld FM Transceiver

Shown Actual Size

8 MHZ COVERAGE • 142 to 149.995 MHz in 5 kHz steps, including CAP and MARS.

IDEAL SIZE & WEIGHT DISTRIBUTION • 7.3″ high by 2.5″ wide by 1.8″ deep; 1.4 lbs.

MICROCOMPUTER CONTROL • All frequency operations are done by means of a microcomputer keyboard with acquisition tone.

LCD DISPLAY WITH TIMED LAMP • Draws almost no current. Lamp times out automatically after 20 seconds.

16 KEY AUTOPATCH • Keyboard works as a Touchtone® pad while transmitting.

PL TONE SWITCH • Actuates optional subaudible tone module.

PROGRAMMABLE "ODD SPLITS" • Transmit and receive on any possible frequency combination. Reset in seconds.

9 CHANNEL MEMORY WITH SCAN • Eight addressable channels and one externally accessible up/down channel retain frequency and standard offset. Backup drain is a scant 10 microamps!

AUTOMATIC INCLUSIVE OR EXCLUSIVE PROGRAMMABLE BAND SCAN • Limits may be reset in seconds. Scans either inside or outside the limits.

BUSY AND VACANT SCAN MODES • Scan for either an occupied or empty frequency.

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HIGH OR LOW POWER • 3 watts high, 1 watt low. Low power is continuously adjustable from 0.5 to 3 watts.

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AUTOMATIC FRONT END TUNING • RF stage is varactor tuned for superior sensitivity and selectivity.

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SUPERIOR RECEIVER • Sensitivity is 0.25 uV for 20 dB quieting, 0.2 uV for 12 dB SINAD.

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STANDARD ACCESSORIES • Heavy duty NICAD battery pack (500 mAh), belt clip, hand strap connector, flexible rubber antenna, earphone, ac charging unit, and special stand for table-top operation.

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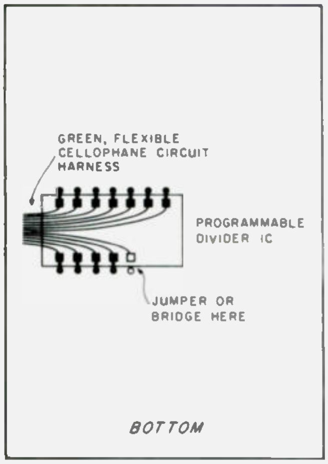

Fig. 1.

Being a group that takes pleasure in passing along useful information to fellow hams, Technical Clinic sends this public information bulletin on the 10-minute frequency modification for the new Icom IC-2A hand-held. The short and simple job will allow operation (depending on individual radio characteristics) from 141.000 MHz to 149.995 MHz.

TC was pleasantly surprised to discover that Icom has made another rig that lends itself to tinkering. This happened while one was on the bench for a product development experiment.

You will need only solder and a low-wattage soldering iron. The two-step operation is as follows:

1. De-solder the brown jumper wire from the MHz BCD thumbwheel switch. This will allow the MHz switch to run through its whole range.

2. Solder a small piece of wire (or form a solder bridge) at the position where the cellophane PC harness terminates at the programmable divider IC, as shown in Fig. 1. This allows the radio to recognize a request for 148 and 149 MHz.

That's it. You now have a radio with MARS/CAP capability which has not had any of its normal operation impaired one bit. It is hoped that all present and future owners of this rig will take full advantage of this mod once their individual warranties expire.■

ANNOUNCING
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Amateur Antennas, Towers, Rotators, Microphones and Headsets—heard the world 'round.

SOCIAL EVENTS

Listings in this column are provided free of charge on a space-available basis. The following information should be included in every announcement: sponsor, event, date, time, place, city, state, admission charge (if any), features, talk-in frequencies, and the name of whom to contact for further information. Announcements must be received two months prior to the month in which the event takes place.

ARLINGTON HEIGHTS IL
FEB 7

The Wheaton Community Radio Amateurs will hold their annual hamfest on February 7, 1982, beginning at 8:00 am at the Arlington Park Race Track EXPO Center, Arlington Heights IL. Tickets are $3.00 at the entrance and $2.50 in advance. There will be free flea-market tables, expanded floor space, parking, awards, and a large commercial area, including the new computer section. Talk-in on 146.01/.61 and 146.94. For commercial info, call WB9TTE at (312)-766-1684; for general info, call WB9PWM at (312)-629-1427. For tickets, send an SASE to WCRA, PO Box QSL, Wheaton IL 60187.

TRAVERSE CITY MI
FEB 13

The Cherryland Amateur Radio Club will hold its ninth annual Swap 'N Shop on Saturday, February 13, 1982, from 8:00 am through 2:30 pm at the Immaculate Conception Middle School gymnasium, 218 Vine Street, Traverse City MI. General admission is $2.50 and single tables are $3.00. Talk-in on 146.85 and 146.52. For further information, contact Jerry Cermak K8YVU, Chairman, 3905 Slusher Road, Traverse City MI 49684. An SASE will be appreciated.

MARLBORO MA
FEB 14

The Algonquin Amateur Radio Club will hold an electronics flea market on February 14, 1982, at the Marlboro Junior High School cafeteria, Marlboro MA. Sellers will be able to set up from 9:00 am to 10:00 am and doors will be open from 10:00 am until 2:00 pm. Admission is $1.00. Tables are $5.00 if a written reservation is made before February 7, 1982, and $7.50 for any tables remaining after that date. Refreshments will be available. Talk-in on .01/.61 and .52. For reservations, contact Mac W1BK, 128 Forest Avenue, Hudson MA 01749.

MANSFIELD OH
FEB 14

The Mid-Winter Hamfest/Auction will be held on Sunday, February 14, 1982, at the Richland County Fairgrounds, Mansfield OH. Doors will open to the public at 8:00 am. Tickets are $2.00 in advance and $3.00 at the door. Tables are $5.00 in advance and $6.00 at the door. Half tables are available. Features will include prizes, an auction, and a flea market, all in a large heated building. Talk-in on 146.34/.94. For additional information, advance tickets, and/or tables, send an SASE to Harry Frietchen K8HF, 120 Homewood Road, Mansfield OH 44906, or phone (419)-529-2801.

VERO BEACH FL
FEB 20

The Treasure Coast Hamfest will be held on February 20, 1982, at the Vero Beach Community Center, Vero Beach FL. Admission is $2.00 in advance and $2.50 at the door. Features will include prizes, drawings, a QCWA luncheon, and tailgating. Talk-in on 146.13/.73, 146.52/.52, 146.04/.64, and 222.34/223.94. For additional information, write PO Box 3088, Beach Station, Vero Beach FL 32960.

FAYETTEVILLE WV
FEB 21

The Plateau Amateur Radio Association will hold its fourth annual hamfest on Sunday, February 21, 1982, at the Memorial Building, Fayetteville WV. The doors will open at 9:00 am. Admission is $2.50 and children will be admitted free. Flea market tables are $2.00. All activities will be indoors and will include ARRL displays, forums, exhibits, door prizes, and women's programs. Hot food, refreshments, and free parking will be available. Talk-in on .19/.79 or .52. For more information, contact Bill Wilson WA8YTM, 302 Central Avenue, Apartment 2, Oak Hill WV 25901, or phone (304)-469-9910 or (304)-469-9313.

LANCASTER PA
FEB 21

The Lancaster Hamfest will be held on Sunday, February 21, 1982, at the Guernsey Pavilion, located at the intersection of Rtes. 30 and 896, east of Lancaster PA. Doors will open at 0800. General admission is $3.00; children and XYLs admitted without charge. Each 8-foot space with a table is $5.00 (limited to two tables for non-commercial use and six tables for commercial use). All inside spaces are by advance registration only, and the registration deadline is February 10, 1982. All vendors must set up between the hours of 0600 and 0800; reservations will not be held past 0900 hours without prior arrangement. There will be free tailgating in specified areas outside (if weather permits) on a first-come, first-served basis. Food will be served at the hamfest. Talk-in on 146.01/.61 or 146.52. For advance registration or more information, write SERCOM, Inc., PO Box 6082, Rohrerstown PA 17603.

ELKIN NC
FEB 21

The fifth annual Elkin Winter Hamfest will be held on Sunday, February 21, 1982, at the Elkin National Guard Armory, located one mile from Interstate 77 at exit 85, Elkin NC. Breakfast and lunch will be served at the hamfest by the Foothills ARC of Wilkesboro NC and the Briarpatch ARC of Galax VA. Talk-in on 144.77/145.37, 146.22/146.82, and 146.52. For table reservations, ticket inquiries, or other information, contact Earl Day WB4GQP, 131 Harris Avenue, Elkin NC 28621, or phone (919)-835-3509.

MORRIS PLAINS NJ
FEB 25

The Split Rock Amateur Radio Association will hold its annual equipment auction on Thursday, February 25, 1982, at the Morris Plains VFW Post #3401, located on Route 53 in Morris Plains NJ. Doors will open at 7:00 pm to unload and inspect equipment and the auction will get underway at 8:00 pm sharp. Admission is free. Please limit your items to working electronic equipment—no junk—and make sure any loose parts are bagged or boxed. The club will take a flat 10% commission on all sales of individual items up to $50. Above $50, the club will take a $5.00 commission on each individual sale. All commissions are payable in cash only. There will be refreshments available and the site has plenty of parking. In case of inclement weather, the auction will be held on Thursday, March 4, 1982, at the same location and times. The Morris Plains VFW Post is located approximately 1 mile north of the intersection of Routes 202 and 53 in Morris Plains NJ. For more information, write PO Box 3, Whippany NJ 07981.

GLASGOW KY
FEB 27

The annual Glasgow Swapfest will be held on Saturday, February 27, 1982, beginning at 8:00 am CST at the Glasgow Flea Market Building, 2 miles south of Glasgow on Highway 31E. Admission is $2.00 per person with no extra charge for exhibitors. One free table will be provided per exhibitor with extra tables available at $3.00 each. There will be a large heated building with plenty of free parking. No meetings or forums will be held—just door prizes, free coffee, and a large flea market. Talk-in on 146.34/.94 or 147.63/.03. For additional information, contact Bernie Schwitzgebel WA4JZO, 121 Adairland Ct., Glasgow KY 42141.

VIENNA VA
FEB 28

The Vienna Wireless Society will hold the 9th annual ARRL-approved WINTERFEST™ '82 on February 28, 1982, beginning at 8:00 am at the Community Center, 120 Cherry Street, Vienna VA. Tickets are $3.00 and include one chance for the prize drawing. Prizes will include a Kenwood TS-830S HF transceiver, an Icom IC-25A 25-W mobile 2-meter rig, and a Santec HT-1200 hand-held, as well as accessories and books. Excellent food service will be available. Featured will be dealers' and manufacturers' displays, an indoor flea market, and outdoor frostbite tailgating. Tables are

$5.00 and $10.00. Talk-in on .31/.91 and 146.52. For additional information, send an SASE to WINTERFEST™ '82, Vienna Wireless Society, PO Box 418, Vienna VA 22180, or phone Ray Johnson at (703)-938-8313.

DAVENPORT IA
FEB 28

The Davenport Radio Amateur Club will hold its 11th annual hamfest on Sunday, February 28, 1982, from 8:00 am to 4:00 pm in the Davenport Masonic Temple, Highway 61 (Brady Street) and 7th Street, Davenport IA. Tickets are $2.00 in advance and $3.00 at the door. Tables are $5.00 each, with a $2.00 charge for an electrical hookup (limited number). Hotel discounts, food, and drinks will be available. Talk-in on 146.28/.88, WØBXR. For advance tickets and table reservations, write Dave Johannsen WBØFBP, 2131 Myrtle, Davenport IA 52804.

LAPORTE IN
FEB 28

The LaPorte Amateur Radio Club Winter Hamfest will be held on Sunday, February 28, 1982, at the Civic Auditorium, LaPorte IN, beginning at 8:00 am Chicago time. The donation is $2.50 at the door and reserved tables are $2.00 each. For reservations, write PO Box 30, LaPorte IN 46350.

AKRON OH
FEB 28

The Cuyahoga Falls Amateur Radio Club will hold its 28th annual electronic equipment auction and flea market on Sunday, February 28, 1982, from 8:30 am to 4:00 pm at North High School, Akron OH. Tickets are $2.00 in advance and $2.50 at the door. Sellers may bring their own tables or rent a table for $2.00. There is plenty of space and lots of free parking. Prizes include a Kenwood TS-130S, an Icom 3AT, and an Icom 2AT. A 16K TRS-80 Model III will be raffled at $2.00 per chance. Talk-in on 146.04/.64. For more details, contact CFARC, PO Box 6, Cuyahoga Falls OH 44222, or phone K8JSL at (216)-923-3830.

LIVONIA MI
FEB 28

The Livonia Amateur Radio Club will hold its 12th annual LARC Swap 'n Shop on Sunday, February 28, 1982, from 8:00 am to 4:00 pm at Churchill High School, Livonia MI. There will be plenty of tables, door prizes, refreshments, and free parking. Talk-in on 146.52. Reserved table space of 12-foot minimum is available. For further information, send an SASE (4 × 9) to Neil Coffin WA8GWL, c/o Livonia Amateur Radio Club, PO Box 2111, Livonia MI 48151.

PHILADELPHIA PA
MAR 7

The Penn Wireless Association, Inc., will hold its Tradefest '82 on Sunday, March 7, 1982, at the National Guard Armory, Southampton Road and Roosevelt Boulevard (Rte 1), 2 miles south of exit 28 on the Pennsylvania Turnpike, Philadelphia PA. General admission is $3.00 and a 6' × 8' seller's space is $5.00 (bring table) with an additional $3.00 for a power connection (limited number). There will be prizes, displays, refreshments, rest areas, and surprises. Talk-in on 146.115/.715 and .52. For additional information, contact Mark J. Pierson KB3NE, PO Box 734, Langhorne PA 19047.

WINCHESTER IN
MAR 14

The Randolph Amateur Radio Association will hold its 3rd annual hamfest on Sunday, March 14, 1982, from 8:00 am to 5:00 pm at the National Guard Armory, Winchester IN. Tickets are $2.00 in advance and $3.00 at the door. Table space is $2.50 and table space with table is $5.00. Setup times are 6:00 pm to 8:00 pm on Saturday and 6:00 am to 8:00 am on Sunday. For reservations or additional information, contact RARA, PO Box 203, Winchester IN, or phone W9VJX at (317)-584-9361.

✓See List of Advertisers on page 114

The Father of FM

—the tragic story of Major E. H. Armstrong

Armstrong in WWI uniform. (Photo by Bradley B. Hammond)

Jeanne Hammond

Atop the Palisades at Alpine, New Jersey, across the Hudson River from Yonkers, stands a tall,

Armstrong's radio tower atop the Palisades at Alpine, New Jersey, as seen from Yonkers. (Photo by Jeanne Hammond) three-armed tower. It is accepted as part of the landscape by those who live on the river's east bank and is seen daily by thousands of commuters on Conrail's Hudson Division trains, yet few know what this tower is or how it has affected their lives.

The tower and its accompanying radio station were built in 1938 at a cost of over $300,000 by Edwin Howard Armstrong, pioneer radio inventor, to demonstrate the superiority of his new system of radio broadcasting—frequency modulation (FM). After Promethean battles with the broadcasting industry, which fought to preserve its investment in the established system (amplitude modulation—AM), FM was finally accepted and today is the preferred system in radio, the required sound in TV, and the basis for mobile radio, microwave relay, and space communications.

As little known as the significance of the tower is the man who built it. Armstrong was born in New York City in 1890. When he was twelve years old, the family moved to 1032 Warburton Avenue—known to family and friends simply as "1032"—in Yonkers. The house, which still stands just up from the Greystone railroad station, was declared an historical landmark in 1978 by the Yonkers Historical Society.

Next door, on the north side of the house at the corner of Odell Avenue, was 1040 Warburton Avenue, the home of Armstrong's maternal grandparents. The members of the two families were a gregarious lot, and Howard's childhood was a happy one filled with large gatherings of relatives, many of whom were teachers. Learning was prized. "Quick, boy! How much is nine times five, minus three, divided by six, times two, plus nine?" His great uncle, Charles Hartman, principal of New York City Public School 160, would quiz his nephew to encourage his mental agility.

When Howard was fourteen years old, his father, who was American representative of the Oxford

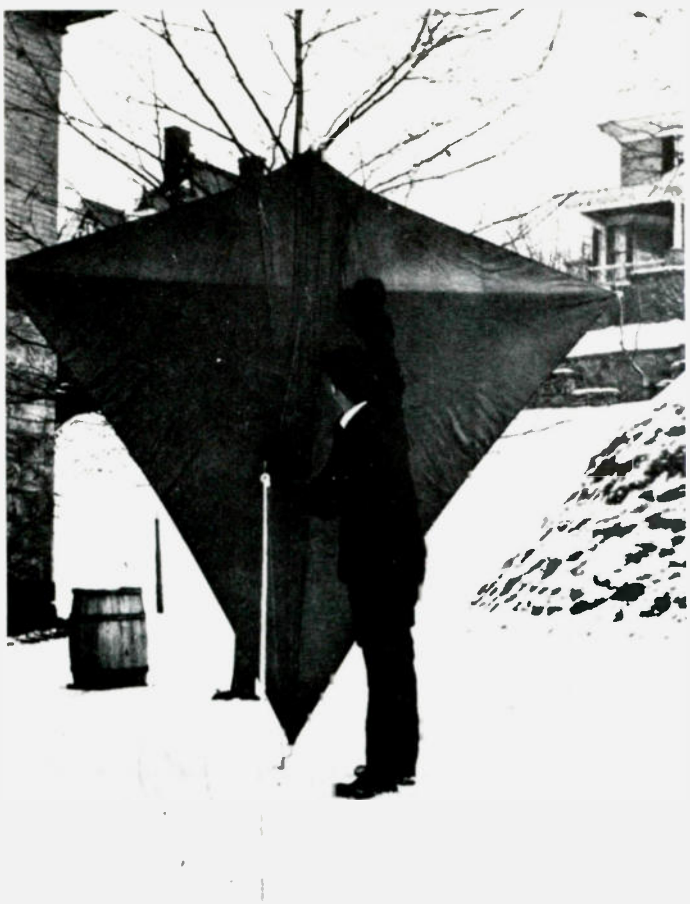
Howard Armstrong, about six years old, with his sister, Ethel.

1032 Warburton Avenue, Armstrong's boyhood home in Yonkers. His earliest experiments were carried out in the cupola on the third floor.

His bedroom/workroom in the cupola looked out on the spot on the Palisades where his radio station would later be. (Photo by Bradley B. Hammond)

University Press, bought him (on one of his yearly trips to London) a book, *The Boy's Book of Inventions.* Reading of Guglielmo Marconi's sending of the first wireless message across the Atlantic so excited his imagination that he determined then and there to become an inventor.

In his attic room in the cupola overlooking the Hudson River, Howard Armstrong began tinkering with radio. In those days, broadcast sound consisted of Morse code signals picked up with earphones. The incipient young inventor set out to make them louder. He was dogged in his search and developed at this early age a capacity for infinite patience in his experiments which was to mark his life's work. "Genius is one percent inspiration and ninety-nine percent perspiration," he



Armstrong constructed large antenna kites which he flew from the upper stories of "1032" in an attempt to improve reception.

The young inventor at work on the "1032" pole.

used to say in later years, quoting Thomas Edison.

Armstrong explored many paths in his attempts to strengthen the sound. Reaching up into the air to better catch the broadcast signals, he flew from the upper stories of 1032 large antenna kites which he had built with the help of his Yonkers friend, Bill Russell. He built a 125-foot antenna pole, the tallest in the area, in the south yard. His younger sister, Edith ("Cricket"), helped in the construction, holding the guy wires and handing him buckets of paint as he swung aloft in a boatswain's chair. Neighbors watched with awe and apprehension. His mother, however, had complete faith in her son. When a neighbor telephoned to say that Howard was at the top of the pole and it made her nervous to watch, "Don't look, then," was her confident reply.

Howard attended Public School 6 in Yonkers and Yonkers High School, and went on from there to Columbia University, commuting on a red motorcycle his father had given him as a high school graduation present. His interest in radio led him to the study of electrical engineering.

In his junior year at Columbia, Armstrong's diligent search for improved radio reception paid off. He invented the regenerative-oscillating, or feedback, circuit which greatly increased radio signals, made them loud enough to be heard across a room and led the way to transatlantic radio telegraphy. His sister, Ethel, remembers vividly the night it happened. "Mother and Father were out playing cards with friends and I was fast asleep in bed. All of a sudden Howard burst into my room carrying a small box. He danced round and round the room shouting, 'I've done it! I've done it!' I really don't remember the sounds from the box. I was so groggy, just having been wakened. I just remember how excited he was."

Major Armstrong's sister, Ethel, and her husband, Bradley Hammond, listen to a crystal set with their evening meal, around 1920. (Photo by Bradley B. Hammond)

Later, another inventor, Lee DeForest, challenged Armstrong's priority for this discovery and the issue was twice argued before the US Supreme Court—which found in DeForest's favor. However, the scientific community has always credited Armstrong for the invention and he received a gold medal for it from the

Thomas J. Styles, Armstrong's longtime associate, Ethel, Howard, and his mother. (Photo by Bradley B. Hammond)

Billboard in Yonkers dating around 1921. (Photo by Bradley B. Hammond)

Armstrong and his wife, Marion, by the "1032" pole. (Photo by Bradley B. Hammond)

Institute of Radio Engineers. Years later, the report accompanying the presentation to him of the Franklin Medal, by the Franklin Institute in Philadelphia, also credited him with the invention of the regenerative circuit.

After graduation from Columbia in 1913, Armstrong worked as an instructor at the college. When the US entered the war in 1917, he joined the Army Signal Corps and rose to the rank of Major—his preferred title for the rest of his life. While in the service, he invented the superheterodyne circuit which amplified even further the sound of radio transmission. This invention brought him into contact with David Sarnoff, who later became President of Radio Corporation of America and whose bright and attractive secretary, Marion MacInnis, he later married.

After the war, Armstrong returned to Columbia where he worked as an assistant to Professor Michael I. Pupin, famed physicist and inventor. When Pupin

Close-up of the tower. (Photo by Bradley B. Hammond)

the ALL NEW tempo S-15...more radio ...less money

TEMPO'S ALL NEW S-15 SYNTHESIZED HAND HELD OFFERS IMPORTANT FEATURES AT A PRICE THAT DEFIES COMPARISON.

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- * 5 WATT OUTPUT (1 watt low power switchable)
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Tempo S-4
The first 440 MHz hand held and still a winner...offers the perfect way to get into an uncrowded band. Check one out at your local Tempo dealer or write Henry Radio. $289 S-4T...$319
NEW REDUCED PRICE!

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Henry Radio offers a fine line of UHF and VHF hand held transceivers for commercial applications. The operating frequency of the FMH-12 and FMH-15 is 135 to 174 MHz and the FMH-40 and FMH-44 is 440 to 480 MHz. They are extremely sturdy, their superb dependability has been thoroughly proven and the price is much lower than you might expect. Please call for complete information.

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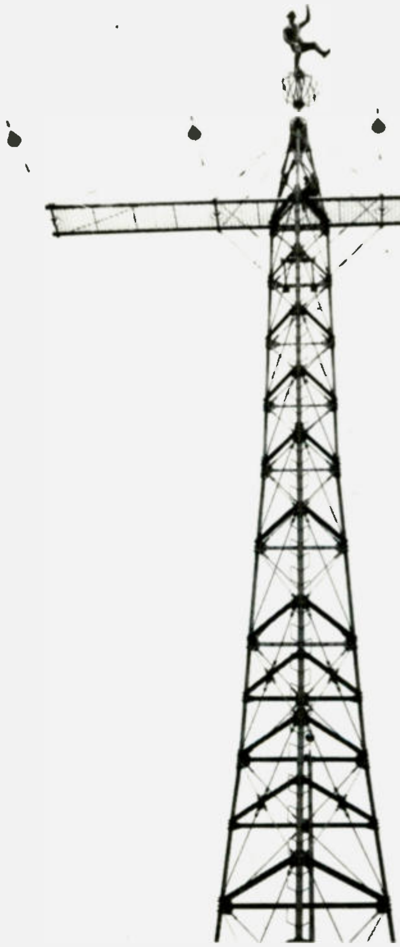

In 1923, to celebrate the opening of New York's first radio station—and to impress his fiancee—Armstrong cavorted atop the new WJZ transmitter tower. (Photo by George Burghard)

Armstrong receives the Medal of a Chevalier de la Legion d'Honneur *for his contributions to wartime wireless, from General Ferrie, head of French military communications.*

died, Armstrong took over his professorship and, financing his own research—his inventions had by now made him wealthy—concentrated on the elimination of static.

In 1933, Armstrong secured four patents which were to be the basis for frequency modulation. This was an entirely new system of broadcasting. Unlike amplitude modulation which varies the amplitude or power of radio waves to transmit sound, frequency modulation varies the number of waves per second over a wide band of frequencies. As static is transmitted by amplitude modulation and cannot break into the wide band of frequencies of frequency modulation, the latter is virtually static-free. Armstrong, who enjoyed aphorisms, liked to quote defeatists who said, "Static, like the poor, will always be with us." He proved them wrong.

The first public broadcast of FM was made in 1935 from the home of his friend C.R. (Randy) Runyon at 544 North Broadway in Yonkers. Runyon was a ham who operated under the call letters W2AG and broadcast from a tower in the yard of his house. The tower and the house are no longer standing. The Runyon living room served as a studio for a demonstration of different kinds of sound that were broadcast to a meeting of the Institute of Radio Engineers at the Engineer's Building on West 39th Street in New York City. Water was poured, paper was crumpled, and live and recorded music were beamed from the Runyon tower to the audience forty miles away.

Although the engineers marveled at the fidelity of the sound, FM did not immediately take off and it would be some time before it would become a commercial success. "If you build a better mousetrap the world doesn't necessarily beat a path to your door," Armstrong said ruefully in later years as he fought for the acceptance of his new system of broadcasting. As a matter of fact, FM was so revolutionary that an entire industry had to scrap its hardware and start over before its potential could be realized. Understandably, the establishment was less than enthusiastic at the prospect.

However, for several years RCA gave Armstrong experimental broadcast privileges in its studio at the top of the Empire State Building. But in 1937, saying that they wished to devote the space to the development of TV, they asked Armstrong to withdraw.

More determined than ever to prove the superiority of FM, Armstrong built his own station in Alpine, New Jersey. The site he chose had been visible to him as a boy from his attic cupola at 1032, and it served his purpose well. It was one of the highest

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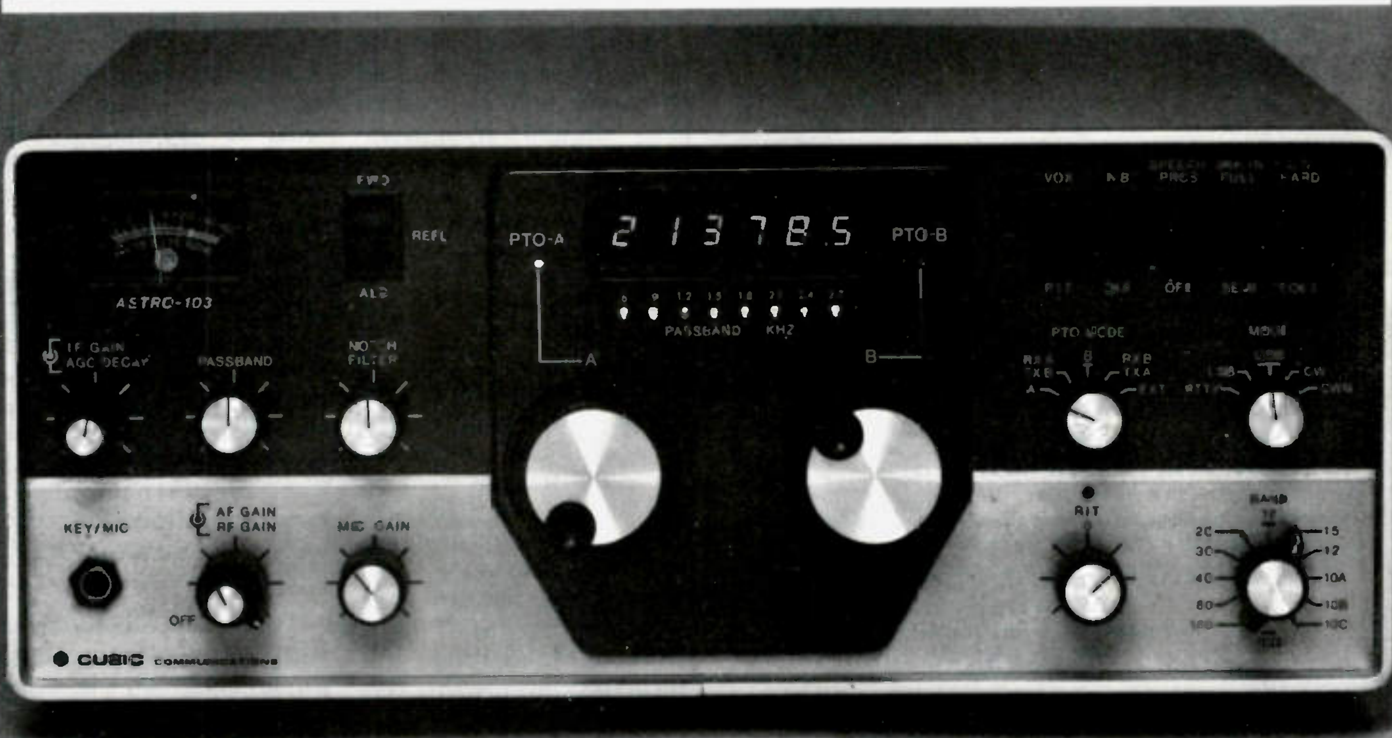

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points in the region and had unobstructed space around it for the broadcast of the station's signal.

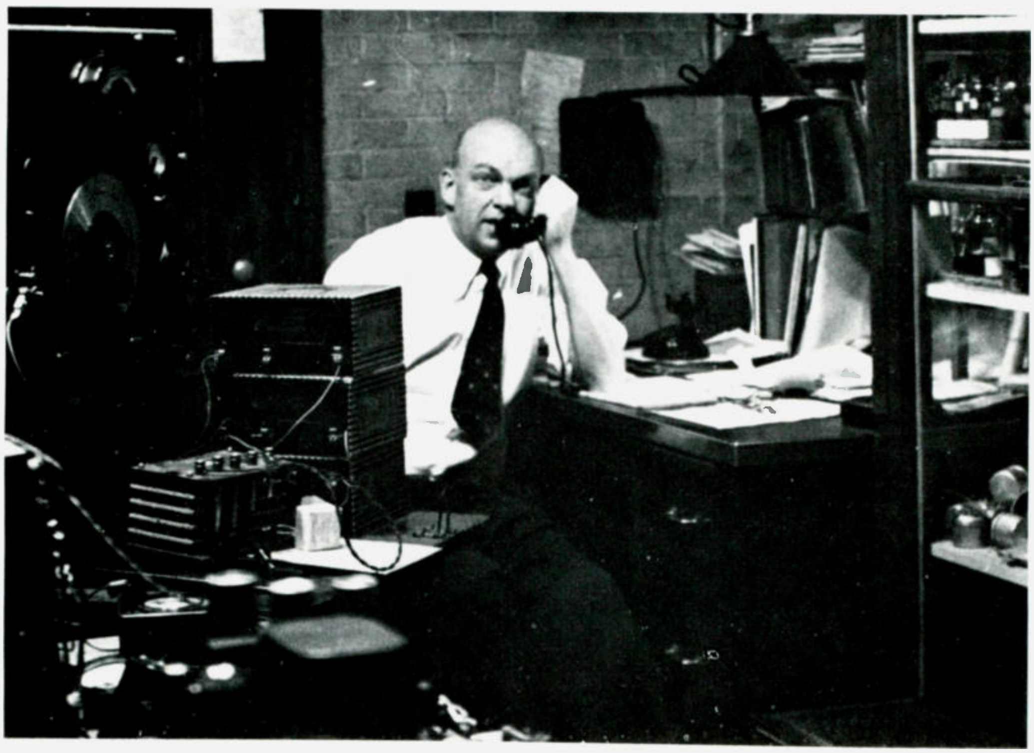
Programs originating with WQXR in New York City were transmitted by wire to Alpine and broadcast first under the call letters W2XMN and later, WE2XCC. Today, the station is owned by UA Columbia Cablevision Company of Oakland, New Jersey, and is operated for closed circuit TV transmission.

During the Second World War, Armstrong devoted himself to military research and allowed the government to use his patents royalty-free. He received the Medal of Merit for his contributions.

After the war, Armstrong turned his attention once more to the promotion of frequency modulation. He saw it grow in popularity as a broadcasting medium as more FM stations went on the air and more FM sets were sold to receive the programs. However, few outside the industry had ever heard of Edwin Howard Armstrong—the man who invented it. Furthermore, manufacturers began to build and sell FM equipment ignoring his patents. Goaded perhaps by the bitter memory of losing his regenerative patent years before, Armstrong became embroiled in twenty-one infringement actions to adjudicate his FM patents. Battling giant corporations with batteries of lawyers used up his resources. Finally, in 1954, ill, disillusioned, and his fortune gone, Armstrong took his own life.

After his death, his widow, Marion, set out to finish what he had started. She continued the lawsuits, sitting in the courtroom each day following the arguments and watching as testimony was given. Her first victory, over RCA in 1954, gave her funds to continue the other suits. In 1967, with the victory over Motorola, she had won all twenty-one and established clearly and decisively that Edwin Howard Armstrong was the inventor of frequency modulation.

Today, the Alpine tower stands as a monument to the brilliant man whose inventions touch our lives every day. His contributions are perhaps best summed up by Lawrence Lessing in his biography of Armstrong, *Man of High Fidelity* (J. B. Lippincott Company, Philadelphia and New York, 1956). "The lonely man listening to music in the night, the isolated farmer hearing nightly the news of the world, the airplane pilot guiding his craft safely through the ocean of the sky, the astronaut now in his capsule gathering in the whispers from space, the earthbound emergency crew contending with some mission of mercy or disaster, the army on the move and the man in his armchair, charmed or instructed for an hour by a great play, a symphony, a speech, a game of ball—all owe a debt to this man who, in some forty years of high fidelity, fashioned the instruments illimitably extending these powers of human communication."■



Armstrong at his desk at W2XMN.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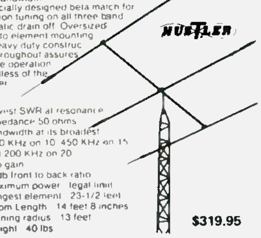

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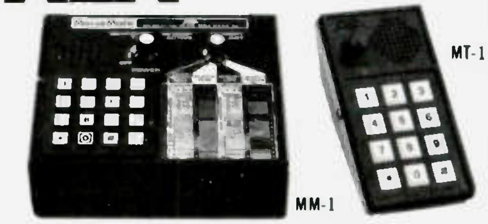

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The Art of Listening

—audio accessories explored

A high-quality station receiver having attributes of acceptable selectivity, sensitivity, stability, image and spurious signal rejection, and accurate readout forms the heart of any installation—amateur or SWL. Due to cost considerations, front-panel control space limitations, and other factors, not all desirable features can be included. In this article, we look at important audio-related accessories that can be used in tandem with a good set for outstanding performance and versatility. These include proper headphones and speakers, audio filters, and tape recorders. The front-panel phone jack provides the umbilical connection for these devices. The Kenwood R-1000 receiver pictured here has one interesting feature of special interest to SWLs: The function switch at upper left controls a timer used to turn on the radio for scheduled listening or to control a recorder through a remote terminal. (Photo courtesy of Trio-Kenwood Communications, Inc.)

In this interesting and highly-readable article, W8FX highlights in a casual, non-technical way some important considerations in choosing key audio accessories for your station. Whether a licensed amateur or a serious shortwave listener, we think you will be interested in what he has to say about speakers, headphones, tape recorders, and filters for the ham shack.

No transceiver or receiver is perfect, and none comes complete with all possible accessories to fill every operating need. The design of such a radio would certainly push the technical state of the art, not to mention that it would most certainly be cost-prohibitive. Various accessories and modifications narrow the gap between needs and reality and allow one to tailor performance accordingly.

There are many receiver audio add-ons one can build or purchase: external speakers, headphones, tape recorders, audio interference filters, phone patches, radioteletype (RTTY) and Morse code readers, slow-scan television (SSTV) viewers, and monitorscopes, to name but a few performance-enhancing accessories.

In this article, we will look at construction and selection considerations for the first four groups listed above. Our review will highlight a number of commercial phone-jack products from the standpoint of their contributions to material reception improvement and making on-the-air operating a more convenient and enjoyable pastime.

Let's begin with the main link between your rig and your ears—the speaker.

Speakers: A Special Breed

Anyone who rates himself or herself a hi-fi buff knows just how important the speaker is to overall audio system performance. Unfortunately, the speaker's importance to receiver or transceiver performance is too often forgotten—by the individual ham and by manufacturers as well. Most amateur equipment made today, whether of domestic or Japanese origin, contains but an undersized, inexpensive, and inadequate loudspeaker. This results in poor audio performance from otherwise excellent equipment. Deficiencies are magnified when equipment is stacked, since the speaker is normally mounted on the top or bottom of the radio where its output will be muffled by the operating desk or other equipment above or below the radio.

Most radios have provisions for using an external speaker, and I recommend you use one to help attain the overall performance you expect from your set.

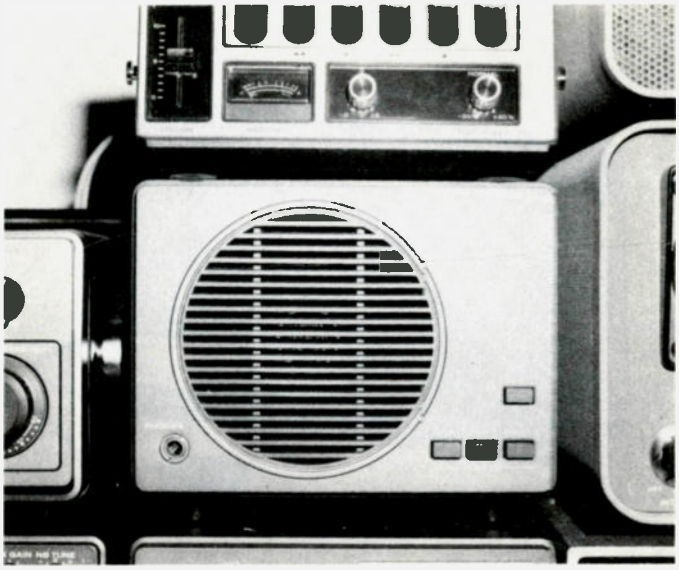
Fixed station external speakers. It's a good idea to obtain the matching accessory speaker at the time of the receiver or transceiver's purchase. However, you should be able to use almost any communications speaker as long as the voice coil impedance matches that of your set's output, normally 8 Ohms (4-16 Ohms is the usual range).

Only a *communications*-type speaker should be used, however, as the restricted frequency response of these units is optimized for speech reproduction. Hi-fi speakers, though perhaps of superior overall quality, will unduly accentuate any low-frequency hum as well as high-frequency noise and background hiss.

Of late, I've observed that accessory speakers offered by some manufacturers are marginal in size and quality; hooking up one of these units will not produce the improvement one would expect from an external speaker. A possible remedy is to scour the next hamfest or swap meet for one of the 8- to 12-inch boat-anchor speakers of the 1950s and 1960s bearing such names as National, Hallicrafters, Collins, and Hammarlund. These units, if in good condition (voice coil intact and speaker cone undamaged), will run rings around the 4- to 5-inch jobs seen today. A little clean-up, and possibly a paint job, will do wonders to restore a unit to respectability.

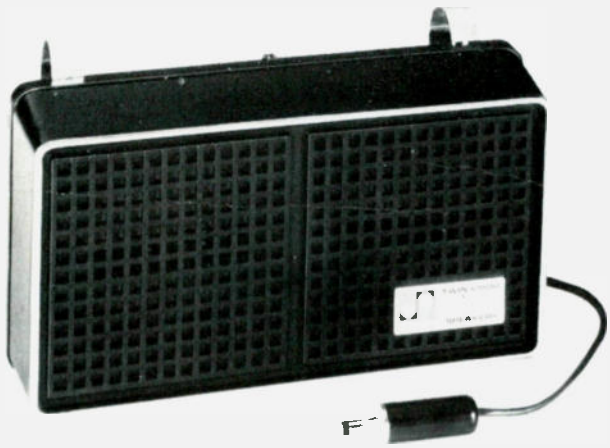
You can "roll your own" versions of these increasingly difficult-to-find accessory speakers, too; your effort will likely be rewarded with superior speech quality and intelligibility. Send for the catalog of McGee Radio and Electronics, 1901 McGee St., Kansas City MO 64108. It's chock full of speaker and enclosure possibilities at moderate prices. Select a 6-inch-diameter or greater unit that will handle 5 to 10 Watts of audio power.

For the experimentally inclined brasspounder, Skytec offers an unusual designed-for-application CW speaker. This acoustically tuned unit develops virtually single-signal selectivity for excellent Morse reception. The CW-1 combines an acoustic filter resonant at about 750 Hz with a loudspeaker in a small enclosure; a sleeve in the output opening may be extended



An external speaker is a near-must in view of the minimal speaker usually provided in most amateur gear produced today. The Kenwood SP-180 shown here is designed for use with the TS-180 series of gear; it has a few "bells and whistles" of its own. These include three selectable tone filters and two-channel selectable input. The headphone output can be routed through the tone filters, too.

Skytec CW-1 speaker is an unusual device that is expressly designed for receiving CW radiotelegraphy. The unit combines an acoustic filter resonant at about 750 Hz with a loudspeaker to closely approximate "single-signal" selectivity. (Photo courtesy of Jim Bowles W6DLQ, Skytec)



HDP-1228

Mobile installations can benefit most of all from a carefully-chosen and properly-installed external speaker. Built-in speakers found in most HF and VHF/UHF mobile sets are inadequately sized and positioned to compete with road noise, car sounds, and passenger chatter. Inexpensive CB-type units usually work well, or a specially-designed unit such as this Heathkit® portable twin speaker can be used. Unit includes a visor mount to help direct sound downward to overcome road noise. (Photo courtesy of the Heath Company)

to vary the resonant frequency slightly.

How does it work? In the Skytec speaker, back radiation from a vertically-mounted loudspeaker near the base is deadened by sound-absorbent material. A cylindrical sound chamber (tube) is coupled to the front of the speaker through only a small hole in a plate that otherwise closes the lower end of the tube; the tube's upper end is open to the room. At the frequency at which the chamber length is acoustically one quarter wave long, it is resonant and acts as a matching section between the high impedance (to sound) of the small hole at the speaker end and the low impedance to the room of the open end. Audio energy transfer is very efficient at this frequency but it falls off sharply off-resonance.

Using this special-purpose speaker, desired signals can be peaked considerably (on the order of about 20 dB), while adjacent channel signals still can be heard in the background. This feature allows the band to be conveniently scanned without the need to switch back to the regular station speaker. The speaker can be used in conjunction with standard intermediate frequency (i-f) filters and narrow-bandpass audio-frequency (af) filters, as well. However, the filters must be compatible; that is, bandpasses must be centered on the same frequency. Thus, other filters may or may not be used to advantage with the CW-1, depending on whether their peaks may be set such that the audio pitch that results is within the speaker's response capability.

You also may want to route your radio's output to a remote location such as the workshop, patio, bedroom, or yard. A general-purpose PA type speaker (weatherproof for outdoor use) will usually fill the bill. It's advisable to allow switching between the in-shack speaker and the extension, and also for separately controlling the volume on the remote speaker. An FM wireless mike module also may be used to broadcast received signals to any standard FM receiver in the home or around the yard—more on this possibility later.

You may have noticed that many of the bells and whistles now standard on the latest transceivers and receivers are finding their way into accessories of all kinds. For example, the external speaker for my Kenwood TS-180S is not just a speaker, but a triple audio filter, audio distribution point, and headphone jack box; it can handle the outputs of two receivers, or a receiver and a transceiver. The two af filters are fixed-tuned and push-button-selectable to attenuate either low-frequency (below 400 Hz) or high-frequency (1.5 kHz or 3 kHz up) signals. The headphone output is switchable through the filters, as is the output from either audio source. A line-out jack on the rear apron provides a convenient source of filtered audio for RTTY, SSTV, monitorscope, and other applications where receiver audio is required.

The speaker's fixed filters can't compete with sophisticated "active" audio filters, but can do a good job augmenting existing i-f filtering. The narrowing of the af bandwidth to attenuate the noise component after i-f processing can materially enhance reception.

Speakers for the mobile rig. Practically all mobile amateur transceivers contain small internal speakers. The harsh sound and restricted size and range of most puts a crimp in the quality of reception of *all* signals. Although many radios have the speaker installed on the top of the rig so that the driver will hear it best, most sets aim the speaker downward—the worst possible direction. The set's full audio output is directed where it is largely absorbed by floor mats and carpeting. Even with solid-state equipment, cranking up the audio gain to overcome road noise and passenger conversation can result in microphonic-type squeals from the transceiver due to acoustic coupling back through the rig's innards.

Thus, even more so than in fixed-station operation, an external speaker is clearly desirable. Extension speakers markedly improve intelligibility when positioned and aimed better than the rig's internal speaker and will probably be more efficient than the set's speaker. This fact allows the transceiver's usual 2- to 3-Watt audio stage to be throttled back, resulting in less overall distortion—a real problem with some of the less-weighty mobile rigs, particularly handie-talkies.

A hi-fi speaker, such as that used for automobile FM/AM/tape-deck use, should not be used for the same reasons discussed previously. Instead, a 3- to 5-Watt communications-type speaker should be purchased, one designed expressly for the speech range, 300 to 3000 Hz or so. An inexpensive source of this kind of speaker is the CB market, still flooded with a mass of unsold accessories as well as two-way radios. The quality of CB-type units varies all over the spectrum, but with speakers sometimes going for $4 to $5 at discount and parts-store sales as well as hamfests and CB coffee breaks, it's not too much of a risk to try one out. Other sources of quick-and-easy mobile speakers are the small speaker boxes which are a part of many telephone amplifiers, such as the Radio

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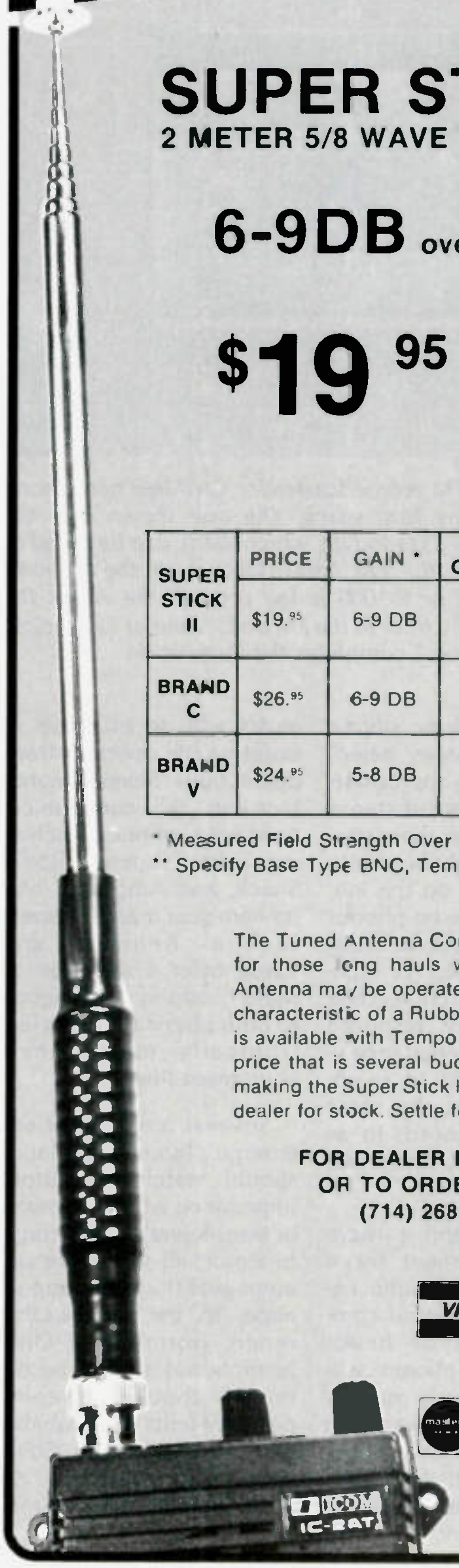

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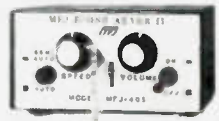

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Shack 43-230 and similar units. Though small, these units seem to be adequate for casual FM-style mobile work. Old police or taxicab speakers in good condition also can be used.

For the operator who likes to occasionally use his handie-talkie in the family buggy, Heath's HDP-1228 clip-on sun visor speaker is a good bet. The 7-oz. dual speaker has two large mounting fingers (similar to those used on visor mirrors) to hold the speaker onto the visor just above the driver's head. This method of mounting allows optimum positioning of the speaker to direct the sound downward where it's needed to overcome road noise. An eight-foot-long cord and mini-plug allow easy connection to the HT or any other mobile transceiver. (This item, manufactured by Superex Electronics Corp., may have been discontinued by Heath, as I haven't seen it advertised in recent catalogs.)

Just about any CB-type external speaker will yield adequate results. However, there is one new amateur unit on the market that warrants mention: the Kenwood SP-40. This is a compact, but high-quality, lightweight (.44-lb.) speaker having a power handling capability of 3 Watts with a frequency response of 400 to 5000 Hz. Although speaker size is only 57 mm, the little unit appears to be quite efficient and free of annoying resonances and vibrations that too frequently plague lesser CB counterparts. The speaker leg has a magnet so that it easily can be mounted on any magnetic substance. If the speaker is to be installed in a location where the magnet can't be used, mounting screws or double-faced adhesive tape also can be used. Somewhat on the expensive side (about $25), the unit nevertheless represents good value (I own two, one for each automobile). The speaker's aircraft-instrument styling makes it an especially attractive complement to any mobile installation.

Headphones for the Ham Shack

Loudspeakers are great for armchair-copy SSB work and for casual, FM-style operating. But there are a number of advantages in owning and using a good set of headphones as an adjunct to the trusty station speaker.

Many DX signals are too weak and QRM-obscured to be properly copied on a loudspeaker; a good set of phones will be of considerable value in increasing your ability to pull weak and near-buried signals out of the pack, particularly on CW. Room, household, and outside distractions also will be markedly reduced, allowing maximum concentration on the signal being copied. The overall effect of using headphones can be about equivalent to doubling received signal strength, when compared with straight loudspeaker listening. This may mean the difference between a solid DX contact and none at all.

A secondary, yet important, reason for using headphones is that the phones isolate the ham shack from the rest of the household, whose members may not appreciate the objectionable whistles, squawks, and other noises that are music to the ham's ears. This is especially important when practicing code, since Morse blasting forth at 750 Hz can have a very shrill and unnerving quality that readily penetrates walls, ceilings, and floors—not to mention *people!* Apartment and condo dwellers are well aware of how unpopular Morse can be with the neighbors.

I built a small FM rebroadcaster for cord-free headphone monitoring in my ham shack. The unit shown uses the 100-mW Ramsey FM module, which easily can be tuned to a clear spot on the FM band. Output of the station's TS-180S, FRG-7, or R-1000 is fed through the Autek Research QF-1 audio filter to the FM unit. A pair of lightweight "radio headphones" completes the installation.

Communications phone requirements. Many beginners start out by appropriating the closest set of stereo hi-fi phones for their rigs, with little thought of whether the unit can do the job. Most decent stereo phones can be used, but because they are designed for high-fidelity reproduction, their wide frequency response may elevate internal receiver hum and noise to an objectionable level; also, some lead-switching needs to be done to adapt them for monaural use.

Far better, and a more suitable investment for a lifetime amateur radio career, is a good pair of *communications*-type headphones. Such phones will boast a relatively narrow frequency response, high sensitivity, and easy physical adjustment. They also will be designed for comfortable wearing over extended periods, and the earmuffs will be effective in isolating the operator from distractions. Several manufacturers sell communications-type phones, including Telex, Superex, Radio Shack, and Amplivox. Major ham gear manufacturers such as Kenwood and Yaesu offer a selection of radio headphones designed to both physically and electronically match their equipment lines.

Several considerations emerge. Input impedance should match the output impedance of the receiver or transceiver's audio stage. In almost all solid-state amateur gear this is low impedance, in the 4-to-16-Ohm range; normally, 8-Ohm headphones should be obtained, though lower-impedance units will probably work nearly as well. Some older ham gear was designed for high-impedance phones, usually 1k to 5k Ohms, however; imped-

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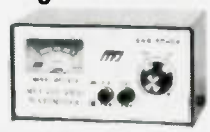

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A good pair of headphones will last a lifetime of hamming. Though communications-type phones are usually recommended, high-quality stereo headphones are often preferred because they usually sport extra-soft, oversize cushions and padded, adjustable headbands. An adapter cord or plug would be required to convert a stereo phone such as this Radio Shack unit for monophonic use with your receiver or transceiver. (Photo courtesy of Radio Shack)

ance matching is more critical in such instances. Most military surplus headphones, often attractive because of their rugged construction and oversize earmuffs, are 500-to-600-Ohm units, though they are sometimes seen in higher- and lower-impedance versions.

Sitting in front of a ham rig for many hours at a stretch is fatiguing. Doing this while wearing an uncomfortable set of headphones, sporting a tight and close-fitting headband, is torturous. For reasons of retaining one's sanity and a pleasant disposition, it's critically important to purchase earphones having good earmuffs; the muffs keep the signal in and distractions out. Thick, but soft, flexible pads are what are required; they should be held fairly tightly against the head by the headband's pressure, though not so tightly as to be noticeably uncomfortable. One should be careful in purchasing used headphones, even if they're OK electrically, because old earmuffs eventually become shopworn and stiff, primarily due to their having been soaked in the operator's perspiration. Deterioration of the high-frequency response is the result, along with a reduced isolation ability. Overly large, heavy headphones should be avoided due to the discomfort caused by carrying their weight over an extended period.

Some features to look for include a coiled cord, individual headset volume controls, interchangeable or easily-replaceable earmuffs, type of headband construction (single, double, padded, etc.), and a means of adjusting the headband. These factors may be either pluses or minuses, depending on individual operator preferences.

I have found that buying headphones is one task that is best done in person, not by mail. It's important to try out the phones, if possible with the radio with which they will be used, both from the standpoint of equipment compatibility and operator comfort. All the printed specs in the world are useless if you can't comfortably wear the phones over a long timespan. If possible, borrow several different phones from friends and check out their suitability in your own station before making your choice.

Except for mobile work, where a *single* headphone may be worn in conjunction with a boom mike/headset combo, a *pair* of headphones is universally used. Since the human hearing system tends to cancel out noise which is applied equally to both ears, adding the second headset allows recognition of signals several dB lower in level than with a single headset. Also, most people do not have equal or symmetrically balanced hearing in both ears; dual phones tend to minimize this anomaly.

A few headphone operating tips should prove helpful:

1) Try using a pair of fitted earplugs under the headphones. Desired signals will come through the earplugs fairly well, while noise will be suppressed. Using earplugs is particularly effective when working on an extremely noisy band for a long stretch. You also may find fatigue is reduced.

2) Experiment with reversing the audio leads to one headphone. The human ear tries to cancel out noise which is presented in-phase to both ears; swapping the normally in-phase headsets can produce a substantial readability improvement while letting the signal of interest through with minimum impediment. If results are favorable, you may wish to install a switch to conveniently reverse phase for routine listening.

3) Learn to "ride gain" on your set's rf and af gain controls, avoiding "blasting," which will have the temporary but undesirable effect of desensitizing the ears. Generally, best CW copy is had by running with the af gain wide open (or nearly so) and working with the rf gain control, keeping levels low enough to avoid receiver and headset overloading. A good receiver agc system makes doing this a lot easier.

4) When operating on CW, carefully adjust the set's main tuning or beat frequency oscillator (bfo, if the set has one) to produce a strong yet pleasant audio tone. Don't opt for a too-low pitch; around 750 Hz is usually about right, give or take 100 Hz, or so.

5) If you're an inveterate SSB contester, consider the use of a boom mike/headset combo. This device replaces, or supplements, the transceiver's existing mike and speaker. The boom is attached to the back of one of the headphones and curves around the operator's cheek, thereby positioning the mike directly in front of the mouth for close-talking and essentially hands-free operating. A press-to-talk (PTT) switch is part of the cord itself, though most boom-mike assemblies can be "hot-wired" and a foot-switch used for PTT switching for true hands-off operation. Use a double-headset type for fixed-station operation and ensure that mike and headphone impedances are right for the transceiver or receiver/transmitter pair with which the combo is to be used. Avoid cheap CB-type boom assemblies like the plague!

6) If you want to try cord-free headphone operation, purchase a pair of lightweight, cordless FM radio headphones—the kind that has a built-in FM or AM/FM radio inside the headphone

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itself—and feed your rig's output to a small wireless FM broadcaster module. Doing this allows true cord-free flexibility in the ham shack by doing away with clumsy, entangling headphone cords. The setup also has the benefit of allowing one to monitor band or net activity anyplace in the home or yard by tuning in the rebroadcaster on any standard FM receiver. Ramsey Electronics, 2575 Baird Rd., Penfield NY 14526, sells a simple, 300-foot-range kit for $3.95. Food for thought!

Using stereo phones. We have cautioned against using stereo hi-fi headphones in the ham shack, regardless of their quality and comfortability. Headphones with extremely wide frequency response characteristics simply reproduce additional interference, detracting from desired signals. Nevertheless, many hams will wish to use a pair of existing stereo phones for reasons of economy or personal preference. Hands-on experimentation will reveal if the pair will, in fact, be suitable for use.

Unfortunately, you can't just plug a set of stereo phones into your ham rig. Almost all such headphones use a so-called standard three-conductor (including ground) plug, one circuit being used for each channel. Most amateur equipment uses a two-circuit (including ground) jack for use with *monaural* communications headphones. This fact requires replacement of the headphone's 3-circuit plug with a single-circuit plug and the paralleling of the two separate leads so that the receiver's output will be fed to both headset units. Alternately, the stereo headphone's plug can be left intact and an adapter purchased or fabricated to convert the stereo-configured cord to monaural use. Using an adapter has the advantage of allowing the headset to be used as a stereo unit whenever desired, without making further wiring changes.

If you *do* purchase a set of stereo headphones to use with your ham rig, consider a suitable pair that has an internal "stereo-mono" switch. This feature alleviates the need for an adapter plug. I own a Calrad 15-135 headset that does a creditable job both in the ham shack and with a small stereo set, and it boasts individual earphone volume controls, a coiled cord, and comfortable muffs.

I've indicated that the stereo headphones' wide frequency response may be annoying when used with ham gear. This may be particularly aggravating if you try to use a pair of stereo phones in tandem with an active audio filter, since the filter may emphasize residual ac hum and noise present in the receiver or transceiver's audio output. You can minimize this problem by adding a 50- to 150-Ohm, 1/2-Watt resistor in series with the headphone lead to cut down their low-frequency response and overall sensitivity. The exact value to use must be determined by experiment.

Tape Recorders

Though by no means necessary accessories, tape recorders represent often overlooked but very useful station adjuncts. There are countless practical uses for recorders, many of which are suitable for the ham shack. In fact, many amateurs wouldn't be without one any more than they would be sans mike or key.

Ham shack applications. Small recorders have a wide range of applications in the ham shack that is limited primarily by the individual operator's ingenuity and imagination. Recorders can be used for such diverse purposes as recording DX and other important contacts, verifying transmitted audio quality, recording messages and traffic, code practice, making short CQ and other transmission tapes, signal reporting, and SSTV signal origination, to name but a few popular uses. Let's look at some of these:

Using a high-quality pair of communications-type headphones has several advantages. Switching from speaker to headphones can materially improve the readability of received signals and keep distracting room noise out. Lightweight units with soft cushions that are peaked for communications-range audio are best. Low-impedance models, such as the Yaesu headset shown here, are suitable for most modern solid-state receivers and transceivers. (Photo courtesy of Yaesu Electronics Corporation)

1) *Taping contacts.* This represents the most common, obvious use of the recorder. The machine is simply connected to the receiver's output jack, either through a Y-plug across the speaker or, in some sets, to an auxiliary tape-output jack. The tapes made can serve as documentation for exceptionally rare QSOs and as a logging aid in fast-paced DXing and contest work. (In the latter application, a reference time is recorded at the beginning of the tape so that log entry times can be conveniently determined.)

2) *Signal reporting.* Another common use is to provide "live" signal reporting to others. Most hams are genuinely surprised to learn how they really sound over the air, particularly at a far-distant location. They are usually highly appreciative of an offer to play back their signal to them as much more meaningful than a simple readability-and-strength report. If you make a practice of providing on-the-air playback, keep the engineering practice up to snuff: hardwire the connections (no mikes placed up against the set's speaker), and ensure that your wiring arrangements permit professional switching between mike and recorder. Random bleeps and fast-forward monkeychatter are not well received over the air. A recorder with an accurate tape counter is a near-must.

3) *Transmitted signal quality checking.* A good

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The uses for a tape recorder in the ham shack are legion: taping QSOs, CQs, code practice, traffic for relay, etc. The recorder is probably of most use to the SSTV enthusiast in editing programs and recording QSOs—though recorders for SSTV work must be a cut above the average home-type cassette. The Sony C-104, shown above, is ideal for these purposes.

way to find out how *your own* signals sound is by using your recorder to tape them. You will need an auxiliary receiver for the purpose, one whose antenna can be disconnected or which has an attenuator to eliminate front-end overload by your own signal. You can record your actual on-the-air transmissions and QSOs, of course, but if you do any extensive "hello . . . testing" for the specific purpose of making a tape check, be sure to use a *dummy load* rather than radiating a signal.

4) *Code practice.* You easily can make custom code-practice tapes using your key, keyer, audio oscillator, and/or keying monitor in your transceiver or transmitter to feed the recorder's input. If you have an open-reel machine, you can in most cases vary the recorder's speed in a 2:1 ratio, that is from 1-7/8 to 3-3/4 ips, or from 3-3/4 to 7 ips. This capability allows code tapes recorded for the level of instruction desired (audio pitch will change, naturally). The recorder also can be used to tape on-the-air code practice sessions regularly broadcast by W1AW, the ARRL station at Newington, Connecticut, for later playback and practice.

5) *Traffic handling.* Using a recorder as a running backup in traffic handling is a good idea practiced by many experienced brass-pounders. If you handle a great deal of traffic, you know that a telephone call or other unwanted interruption can make you miss part of a message or cause you to hold up your net while you get a "fill." Using the recorder, you can effectively tape your own fills.

6) *Taping CQs and other transmissions.* There is nothing wrong with prerecording phone CQs, if the practice isn't overdone and technical quality is maintained. For the most part, tape-recorded CQs are not necessary, and those using them often sound a bit silly. However, for contesting and some DX work, there *are* time-saving possibilities. A related application lies in making extended antenna adjustments and TVI checking. Since radiating an unmodulated carrier is illegal (except for short periods), you may want to prerecord a signal which can be played through your transmitter again and again. For both these applications, special continuous-loop tapes are available; these come in various lengths to fit the desired transmission message length. Again, the watchword is moderation—don't overdo a good thing!

7) *SSTV recording and playback.* The tape recorder is a "must" for the SSTVer, who finds a wide range of specialized applications. These include generation of gray scale, test pattern, and other reference signals; immediate playback of the other fellow's over-the-air picture; and building a library of interesting programs from two-way contacts. By far the most important use is in prerecording one's own "programs" for later broadcast. This allows for careful preparation and capturing of artwork and photography, tape editing, and review. The judicious use of a simple tape machine has enabled many SSTVers to produce very smooth, interesting and professional-quality program material that's a pleasure to watch.

8) *Computer interface.* Small cassette recorders provide the basic means of programming home-type microcomputers. If you're equipped with a microcomputer with an electronic RTTY and/or CW interface, the recorder provides the means to set up the computer for RTTY or Morse transmission and reception, and it also serves other ancillary functions. For example, in the author's Macrotronics M-650/PET 2001 system, the recorder is used to prerecord messages for later transmission and to record received messages. So-called "brag tapes" and artwork can be stored on the tapes and exchanged with others.

Besides these specific uses, it's often handy to use a tape recorder to verbally document equipment settings and alterations, meter readings, and test results. The work being done is described as *you're doing it,* with the recorder doing the "writing." Subsequent playback of the tape, and written transcription to a notebook or log if required, may be helpful in interpreting and analyzing results and in learning from past mistakes.

Technical considerations. Authentic high-fidelity sound reproduction isn't a necessity in a ham shack recorder, though a few requirements *do* exist. The recorder should be of reasonably good quality (not a child's toy, to be sure), feature low distortion, have an auxiliary input for direct connection to the receiver's speaker, and include a recording level meter and tape counter. A "pause" or "edit" control is also a desirable feature. Requirements are tighter if the unit is going to be used to record SSTV signals or interface with a microcom-

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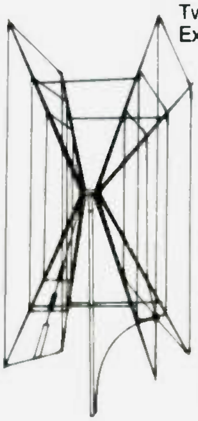

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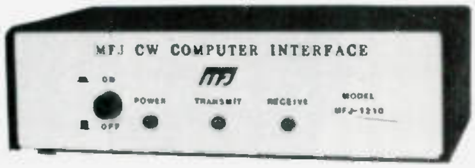

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puter; in these cases, a top-quality recorder having low wow and flutter should be selected. Other desirable, though not absolutely essential, features include a monitoring and/or auxiliary speaker jack, public address (PA) mode, automatic shutoff or track reverse, and fast forward and reverse capability. A monophonic unit is fine; there is little advantage in using a stereo unit.

Several tape formats are suitable: eight-track, reel-to-reel, and cassette. The eight-track recorder, operating at 3-3/4 ips, uses 1/4-inch tape in a track configuration that allows eight mono channels or four stereo channels to be recorded. Since the cartridge is actually an endless tape loop, it will run continuously if left to play out. Very short length cartridges are available, making this format excellent for phone CQs and even short SSTV "takes." The eight-track format does have its drawbacks, however, in terms of less-than-optimum audio quality, a tendency for tapes to become jammed internally, and the objectionable "click" and momentary loss of audio when tracks are switched.

The open-reel recorder is hard to beat for quality. Its distortion figures and frequency response are best among the three formats. Various combinations of reel size, tape length, speed, and available accessories add up to maximum versatility and flexibility. Recorder mechanical design is relatively straightforward (when compared with eight-track and cassette models), and maintenance is less difficult and costly to perform. However, the open-reel recorder—at least a good one—is expensive, and tapes are not as convenient to use as in the other two formats, manual tape threading being required on most models.

Tape recorders find many useful applications in the ham shack. A growing use is connection with digital microcomputers, where they are used for loading and recording of cassette programs and data. Radioteletype (RTTY) and Morse code interfaces are available from several sources for popular home computers such as the Apple, PET, and TRS-80, shown here. In addition to the basic program-loading function, the recorder can be used to digitally record on-the-air transmissions and to prerecord outgoing messages (including "brag tapes") for later broadcast. (Photo courtesy of Radio Shack)

The cassette machine is the most popular for ham shack use today, for reasons of relatively low cost, operating convenience, and steadily increasing quality. The cost of a small cassette unit is certainly not prohibitive, with usable machines available for as little as $25 to $30. Even high-quality monophonic portables come in at less than $100. The ever-increasing popularity of cassette machines is due in large measure to the ease with which tapes can be selected, loaded, recorded, and removed from the recorder, features that are very attractive for station use. Tapes in practically any length can be obtained for recording periods up to 120 minutes or more, using the standard cassette speed of 1-7/8 ips. The biggest disadvantages are that cassette editing isn't practical, the low tape speed mitigates against top quality recording, and accurate cueing is difficult. Most portable machines have an audio response that is entirely adequate for ham-band and shortwave signal reproduction, however.

An SSTVer, I opted for the Superscope C-104, a very high quality mono portable that includes such desirable features as cueing capability, pause control, nicad operation, built-in condenser mike, PA function, and variable tape speed. The front-panel controls and meter make it especially convenient for stacking above the station speaker or receiver—you don't have to look down on the recorder to operate it, as one must do with most small portables.

Standard front-loading stereo decks offer excellent potential though probably represent an overkill in quality. A stereo deck or recorder obtained at a reasonable price could likely be put to good use in the shack, though the second channel would be wasted. The micro-cassette recorders also offer good possibilities. Many of these units are quite small, can be operated vertically, and thus can be sandwiched in between equipment units on the operating console.

In using a recorder in your station, you may experience trouble with rf pickup, making it unusable when transmitting. The problem can be acute in solid-state units and comes about because of audio rectification of your signal by the set's amplifier stages.

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ERC SL-55 audio filter is said to improve SSB and CW reception under severe conditions. The unit contains three separate filters: independent and continuously-adjustable bandpass filters as well as a fixed low-pass filter that can be cascaded with the others. The unit generates 1 Watt of audio and has an input/output impedance of 8 Ohms. (Photo courtesy of Electronic Research Corporation of Virgina)

Simple RFI-preventive measures, such as installing an rf choke and bypass capacitor in the recorder's mike and/or auxiliary input leads and bypassing the audio output leads and ac line, will often do the trick, unless you have a very poor station ground or are using a voltage-fed antenna that produces an inordinate amount of stray rf in the shack.

Various patch cords, connectors, switches, and jumpers may be required to conveniently use the recorder with your equipment; these only can be determined after deciding which functions the recorder is to fill. Using shielded cable for all audio connections should go a long way in reducing rf feedback, noise, and hum pickup.

Audio Filters

The congestion on the amateur bands has placed a premium on receiver/transceiver selectivity. Simple fixed-bandwidth i-f crystal filters were good enough for the 40s and 50s, but not good enough to adequately handle present-day QRM conditions. Densely-packed and overlapping SSB stations, closely-spaced CW signals, and RTTY reception through potentially obliterating heterodynes demand complex i-f filters or other means of achieving a high level of receiver selectivity.

Many upper-end receivers of 50s and 60s vintage contained special i-f circuitry using double-conversion techniques to allow the operator to peak the desired signal or null out an offending one. At the time, the best way to improve selectivity on inexpensive receivers was to add an outboard i-f-stage "Q-multiplier," which enabled the operator to either peak a desired signal or null out an offending one by manipulating one of several panel controls. The Q-multiplier (the best-known being Heath's QF-1) was capable of doing a good job, but some practice was required in using it. It went out of favor as the once-standard 455 kHz i-f frequency was largely abandoned for higher and lower i-f frequencies in double-conversion configurations. The transition from tube to solid-state designs also had a lot to do with the Q-multiplier's demise.

The basic means of attaining the desired amount of receiver selectivity today is by means of an i-f stage crystal or mechanical filter. Most high-quality transceivers use a filter with a steep shape factor to reduce out-of-passband signals and noise; the same filter is usually used on transmit. If your receiver or transceiver has provisions for optional i-f filters for reduced-bandwidth SSB and CW reception, it's a wise investment to obtain them—especially the CW filter. Some manufacturers, such as Kenwood, also offer provision for adding a second (dual) SSB filter assembly to further sharpen the response curve and improve the i-f stage's signal-to-noise (S/N) ratio. Addition of the second filter also has a beneficial effect on transmit, allowing a greater degree of speech compression to be used without a significant increase in sideband splatter and resultant bandwidth.

While most i-f filter arrangements don't offer true single-signal reception, those receivers and transceivers that have provision for shifting the center frequency of the i-f crystal filter (variously known as i-f-shift or passband tuning, depending on the manufacturer) offer additional possibilities for minimizing QRM and further improving overall S/N ratio.

Even in those sets having adequate i-f filtering, the addition of an audio filter can enhance performance. The audio filter acts in two ways: 1) It cuts down on the wideband noise generated by the set's i-f chain, preventing amplification by the set's audio stages, and 2) it further narrows the receiver's overall response curve, often allowing true single-signal reception. Both characteristics significantly aid reception when the QRM level is up and when working under weak-signal conditions.

Passive audio filters. A fixed-tuned, passive (non-amplifying) audio filter can do a great deal to improve the selectivity of a receiver, especially one without an i-f filter; in some inexpensive sets, an audio-stage filter is the *primary* selectivity-determining device. Many hams found that war surplus radio range filters inserted in their radios' headphones lead did a good job in separating closely-spaced CW signals, though the filter frequency of most of these units was a bit high-pitched to suit many and receiver tuning and stability became critical when using very narrow bandpass filters.

More sophisticated designs have been developed over the years, using large fixed-value inductors to achieve the desired degree of selectivity at audio frequencies. The radio handbooks are full of good passive filter designs, especially for use on CW. A particularly good one is the six-element L/C CW bandpass filter designed by Ed Wetherhold W3NQN. It appears on page 8-27 of the 1980 ARRL *Radio Amateur's Handbook*. Other W3NQN designs appear in the December, 1980, *QST*. Another practical filter approach is that of Del Crowell K6RIL that appeared in the March, 1968, CQ *Magazine* in his article, "Adding CW Selectivity for Transceivers."

Passive filters are brute-force devices, however; they are lossy—very noticeable if one wants to drive a loudspeaker. Though easy to build, the passive devices rely on large, cumbersome and often hard-to-find toroidal inductors. Also, there is no flexibility in setting the center frequency and bandpass curve or changing these characteristics during operation. A far more satisfactory approach lies in the use of the *active* audio filter.

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Active audio filters. The active, or tuned, amplifying audio filter uses RC networks in conjunction with solid-state amplifiers to *synthesize* the inductor characteristics. The simulated inductance is resonated with a capacitor to produce a tuned-filter effect. What makes this kind of filter so popular with hams is that the filter can be constructed with variable Q and variable center and cutoff frequencies; this allows convenient front-panel control of the filter's operating characteristics that the operator can precisely tailor to suit his mode of operation, personal preferences, and band conditions.

The current spate of solid-state active filter designs are descendants of the classic National Radio "Select-o-Ject" audio filter that was immensely popular about 30 years ago. This tube-type accessory was a handy, quick-and-dirty supplement to a receiver having little real selectivity. Present-day active filters offer a number of specialized features that make them of great interest to both CW and SSB operators.

An active audio filter can be built from one of the many designs regularly featured in the ham magazines; several are in the *Handbook*. At least a dozen firms sell these very cost-effective QRM-suppressors that allow even a modest receiver or transceiver to come to life in the selectivity department, particularly on CW. Manufacturers include Autek Research, Kantronics, M&M Electronics, Datong, Electronic Research Corp. of America, Palomar Engineers, MFJ Enterprises, and several others.

Typical handbook and commercial designs enable operation on either CW or SSB, though a few less-expensive filters are for CW-only or SSB-only use. The majority are self-contained and include their own power supply or draw power from the receiver or transceiver's accessory jack. Most are connected to the set's audio output jack and contain a small internal audio power amp to directly drive a speaker or headphones. The filters enable the operator to adjust selectivity from a few Hz, for razor-sharp CW performance, up to a completely flat response. Many have separate high-pass and low-pass operating modes, especially useful on SSB; others have a deep notch feature that is used to null out an interfering signal or heterodyne without degrading the desired signal. A few sophisticated models allow dual (simultaneous) notching and filtering; at least one model contains a built-in noise limiter.

Using the active filter on SSB is a gratifying experience, especially if in conjunction with a modest set—though top-of-the-line models will benefit as well. By proper control-knob manipulation, it's possible to dramatically improve signal readability under conditions of QRM, static, splatter, and the like—reducing operator fatigue and making listening a great deal more pleasant. SWLs, 10-meter AMers, and CB operators should be interested in the capabilities of the active audio filter, too. Selectivity on the crowded AM shortwave and standard broadcast bands is considerably improved, and stations just a few kHz apart can be separated with little cross-channel interference.

The real thrill comes when using one of these filters on CW. Used in conjunction with a set's existing CW i-f filter, results can be truly impressive. With the active filter, the desired signal can be peaked with an effective bandwidth measured in *tens of cycles*, even in the presence of close-by strong signals that have managed to bull their way through the radio's i-f strip. Even with a sharp i-f CW filter installed, it's possible to actually *tune through* the set's i-f passband with the audio filter and discover several individual CW signals that can be brought up to solid-copy levels that were unreadable or scarcely detectable without the filter. Of course, there is a limit to the degree of selectivity one can crank in; with too much selectivity, filter "ringing" becomes objectionable. Also, using the notch feature, very pronounced unwanted signal rejection (sometimes 70 dB or more) can be attained by proper control manipulation.

Palomar Engineers' CW filter connects between the receiver and a set of stereo headphones. There are actually two filters, a narrowband one with an 80-Hz bandwidth (centered at 800 Hz) and a wideband one that cuts out hum and high frequency interference but passes most of the receiver audio signal. The narrowband signal goes to one ear, the wideband to the other, giving simulated-stereo reception. The effect is to offer a signal "mix" that is an improvement over either filter alone: The off-frequency signals appear in one headphone, the desired signal in both. The operator's mind concentrates on the desired signal and rejects the interference. Long operating periods are said to be less fatiguing using such an arrangement. (Photo courtesy of Palomar Engineers)

Space-age filtering. A couple of takeoffs on active filtering techniques have surfaced in recent years. One is the concept of simulated-stereo reception,

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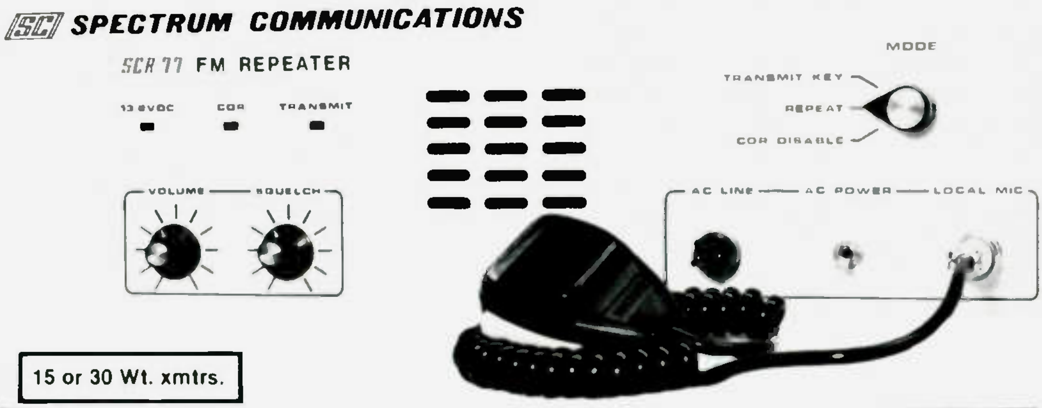

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An "outboard" active audio filter can yield surprising performance benefits in conjunction with even the most expensive receiving equipment. Assuming such a filter is used with a receiver or transceiver having reasonably good i-f selectivity with good "skirts," weak and QRM-plagued SSB signals can be made to "jump out of the noise" in many cases. And in the sharpest modes, several CW signals may be copied within the set's passband and tuned in separately. Autek filter shown here is based on a design pioneered by the firm in 1972. (Photo courtesy of Autek Research)

described by Max Blumer WA1MKP in his October, 1974, *Ham Radio* article, "Enhancing CW Reception Through a Simulated Stereo Technique." In this approach, an active filter is used. Unprocessed receiver audio is fed to one ear, and filtered (processed) audio is fed to the other ear. This technique allows you to read slightly off-frequency CW stations while simultaneously hearing the desired signal, in the clear, in the other ear. The brain does the ultimate filtering—it "hears" all the signals, but the processed signal stands out solidly, with the others mentally rejected. The bottom line is that the filter allows greatly improved reception of the desired signal, but also allows you to hear off-frequency replies to your CQs; it's also easier to scan the band using the simulated-stereo technique. A stereo headphone is required for this type of filter, which is offered commercially by both Palomar Engineers and MFJ.

Especially interesting is the automatic-tracking audio filter offered by Datong. In addition to some impressive narrowband tuning capabilities, the FL-1 frequency-agile audio filter features fast *automatic* suppression of interfering heterodynes in the range of 280 to 3000 Hz by means of its search-lock-and-track notch filter. The tracking notch can be left in the circuit with no audible effect until a whistle appears; the circuit then goes after it and will suppress it within 1 second.

How does it work? Two phase-sensitive detectors control signals used for automatic tuning. One produces a voltage proportional to the degree of mistuning, and the other produces a logic level indicating the presence of a signal within the filter passband. In the absence of such a signal, the integrator becomes a sweep generator. But when a signal is detected, the sweep stops, the unit's lock lamp illuminates, and the integrator becomes part of an automatic frequency control (afc) negative feedback loop. The filter then remains locked to the "captured" signal and will track it, if required, throughout the filter's range of 280 to 3000 Hz. This capability allows the routine use of an extremely narrow (20 Hz) notch which does not noticeably affect received signals and which would be nearly impossible to manually tune and maintain in tune. Of interest to CW ops, an attenuated afc voltage is also used in the manual tuning mode to allow the filter to automatically track *drifting* CW signals over a 100-Hz range!

Whether you opt for a simple or complex filter, you'll likely be glad you made the investment. Dollar-for-dollar, an audio filter is one of the best accessory aids you can buy for your receiver or transceiver.

Wrap-Up

In this article, we have discussed a wide range of basic, yet important, phone-jack accessories: headphones, speakers, recorders, and filters, with a view to obtaining maximum usefulness from dollars spent on station equipment. For most hams, this group of reception accessories probably represents the most important initial accessory investment. For this reason, and for space limitations, we've not discussed exotica which might otherwise fit the article's "phone-jack" scope, such as SSTV viewers, RTTY/Morse decoders, monitorscopes, phone patches, and the like. We'll reserve discussion on these "second-level" accessories until a later time.

In the final analysis, *you* must decide which, if any, accessories to build or buy. Hopefully, the criteria, suggestions, and observations provided in this article will help make your decisions both logical and wise. ■

Further Reading

The following reference sources provide additional information, theory, and construction details. Several contain further references to other information sources you may wish to consult:

Jim Ashe, "How to Use Hi-Fi Headphones," *Popular Electronics*, July, 1972.

Ronald M. Benrey, "Adapting Stereo Phones for Hams," *Electronics Illustrated*, May, 1972.

Fred Blechman K6UGT, "How to Use a Tape Recorder in Your Shack," *Electronics Illustrated*, July, 1962.

Max Blumer WA1MKP, "Enhancing CW Reception Through a Simulated Stereo Technique," *Ham Radio*, October, 1974.

Len Buckwalter, "CB Scene" column in *Popular Electronics*, May, 1974.

Richard Humphrey, "Accessories for Your CB Rig," *Popular Electronics*, October, 1973.

Del Crowell K6RIL, "Adding CW Selectivity for Transceivers," *CQ Magazine*, March, 1968.

James R. Kates WB8TCC, "Put a Tape Recorder to Work in Your Shack," *CQ Magazine*, December, 1977.

The Radio Amateur's Handbook, Newington, Connecticut, American Radio Relay League, 1980 edition.

Charles Schauers W6QLV/4, "Ham Clinic" column in *CQ Magazine*, May and June, 1961.

Karl T. Thurber, Jr. W8FX, "Ham Shack Accessories: What You Really Need," *Ham Radio Horizons*, December, 1979.

Karl T. Thurber, Jr. W8FX, "Hi-Tech Gear for Hams and SWLs," *Popular Electronics*, August, 1980.

William G. Welsh W6DDB, "Headsets and Ham Radio," *73 Magazine*, February, 1972.

Edward E. Wetherhold W3NQN, "Modern Design of a CW Filter Using 88- and 44-mH Surplus Inductors," *QST*, December, 1980.

OSCAR ORBITS

● The Amsat Software Exchange has recently been formed and is now accepting orders. The first program being made available is the orbital prediction program written by Dr. Tom Clark W1IWI. It is available for most popular machine environments, with other versions being developed. Presently available are TRS-80 disk and cassette versions, Apple/II diskette, Microsoft BASIC, and PL/I-80. This program will accommodate the elliptical orbit tracking required for the Phase III satellites. For complete information on versions available as well as new additions and ordering information, send an SASE to: AMSAT Software Exchange, Box 338, Ashmore IL 61912.

● The early months of amateur radio's newest satellite, UoSAT-OSCAR 9, were full of developmental work. The Surrey, England-based ground crew concentrated on generating and relaying to the bird a computer program that will allow the craft to stabilize itself via on-board torquing coils and a gravity gradient boom. Once this is accomplished, the experimental part of the mission will commence.

● AMSAT, the people who organize ham radio's space communications program, received a "royal boost" from JY1, Jordan's King Hussein. While visiting the US in early November, the King expressed his support to AMSAT President Tom Clark W3IWI.

● Although the AMSAT financial picture has been brightened by several large donations, there is still a need for grass-roots support by the entire ham population. You can find out more about AMSAT by writing to: The Radio Amateur Satellite Corporation, PO Box 27, Washington DC 20044.

Information for this column comes from the *AMSAT Satellite Report*.

OSCAR 8 ORBITAL INFORMATION FOR FEBRUARY

ORBIT #	DATE	TIME (GMT)	EQ. CROSSING (DEGREES WEST)
19928	1	0045:59	79.1
19942	2	0050:31	80.2
19956	3	0055:03	81.4
19970	4	0059:35	82.5
19984	5	0104:07	83.7
19998	6	0108:39	84.9
20012	7	0113:11	86.0
20026	8	0117:43	87.2
20040	9	0122:15	88.4
20054	10	0126:47	89.5
20068	11	0131:19	90.7
20082	12	0135:51	91.8
20096	13	0140:22	93.0
20109	14	0001:43	68.4
20123	15	0006:15	69.5
20137	16	0010:47	70.7
20151	17	0015:18	71.8
20165	18	0019:50	73.0
20179	19	0024:22	74.2
20193	20	0028:53	75.3
20207	21	0033:25	76.5
20221	22	0037:56	77.6
20235	23	0042:28	78.8
20249	24	0046:59	80.0
20263	25	0051:30	81.1
20277	26	0056:02	82.3
20291	27	0100:33	83.4
20305	28	0105:04	84.6

OSCAR 9 ORBITAL INFORMATION FOR FEBRUARY

ORBIT #	DATE	TIME (GMT)	EQ. CROSSING (DEGREES WEST)
1776	1	0131:01	157.0
1791	2	0120:57	154.5
1806	3	0110:54	152.0
1821	4	0100:50	149.5
1836	5	0050:47	147.0
1851	6	0040:43	144.5
1866	7	0030:39	142.0
1881	8	0020:36	139.5
1896	9	0010:32	136.9
1911	10	0000:29	134.4
1927	11	0125:45	155.8
1942	12	0115:41	153.3
1957	13	0105:38	150.8
1972	14	0055:34	148.2
1987	15	0045:30	145.7
2002	16	0035:27	143.2
2017	17	0025:23	140.7
2032	18	0015:20	138.2
2047	19	0005:16	135.7
2063	20	0130:32	157.0
2078	21	0120:29	154.5
2093	22	0110:25	152.0
2108	23	0100:21	149.5
2123	24	0050:18	147.0
2138	25	0040:14	144.5
2153	26	0030:11	142.0
2168	27	0020:07	139.5
2183	28	0010:04	137.0

OSCAR 8 ORBITAL INFORMATION FOR MARCH

ORBIT #	DATE	TIME (GMT)	EQ. CROSSING (DEGREES WEST)
20319	1	0109:35	85.7
20333	2	0114:07	86.9
20347	3	0118:38	88.1
20361	4	0123:09	89.2
20375	5	0127:40	90.4
20389	6	0132:11	91.5
20403	7	0136:42	92.7
20417	8	0141:13	93.8
20430	9	0002:33	69.2
20444	10	0007:04	70.4
20458	11	0011:35	71.5
20472	12	0016:06	72.7
20486	13	0020:37	73.8
20500	14	0025:07	75.0
20514	15	0029:38	76.1
20528	16	0034:09	77.3
20542	17	0038:40	78.5
20556	18	0043:10	79.6
20570	19	0047:41	80.8
20584	20	0052:11	81.9
20598	21	0056:42	83.1
20612	22	0101:12	84.2
20626	23	0105:43	85.4
20640	24	0110:13	86.5
20654	25	0114:44	87.7
20668	26	0119:14	88.9
20682	27	0123:44	90.0
20696	28	0128:15	91.2
20710	29	0132:45	92.3
20724	30	0137:15	93.5
20738	31	0141:45	94.6

OSCAR 9 ORBITAL INFORMATION FOR MARCH

ORBIT #	DATE	TIME (GMT)	EQ. CROSSING (DEGREES WEST)
2198	1	0000:00	134.5
2214	2	0125:16	155.8
2229	3	0115:13	153.3
2244	4	0105:09	150.8
2259	5	0055:05	148.3
2274	6	0045:02	145.8
2289	7	0034:58	143.3
2304	8	0024:55	140.8
2319	9	0014:51	138.3
2334	10	0004:47	135.8
2350	11	0130:04	157.1
2365	12	0120:00	154.6
2380	13	0109:56	152.1
2395	14	0059:53	149.6
2410	15	0049:49	147.1
2425	16	0039:46	144.6
2440	17	0029:42	142.0
2455	18	0019:38	139.5
2470	19	0009:35	137.0
2486	20	0134:51	158.4
2501	21	0124:47	155.9
2516	22	0114:44	153.4
2531	23	0104:40	150.8
2546	24	0054:37	148.3
2561	25	0044:33	145.8
2576	26	0034:30	143.3
2591	27	0024:26	140.8
2606	28	0014:22	138.3
2621	29	0004:19	135.8
2637	30	0129:35	157.1
2652	31	0119:31	154.6

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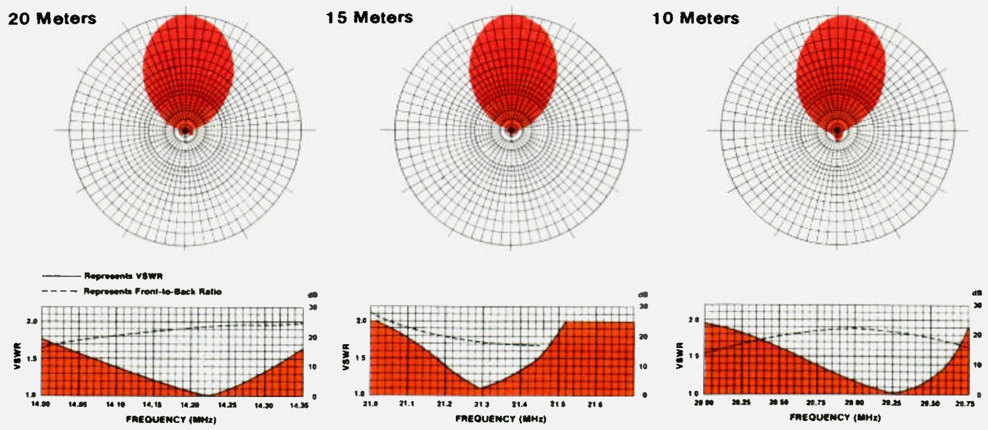

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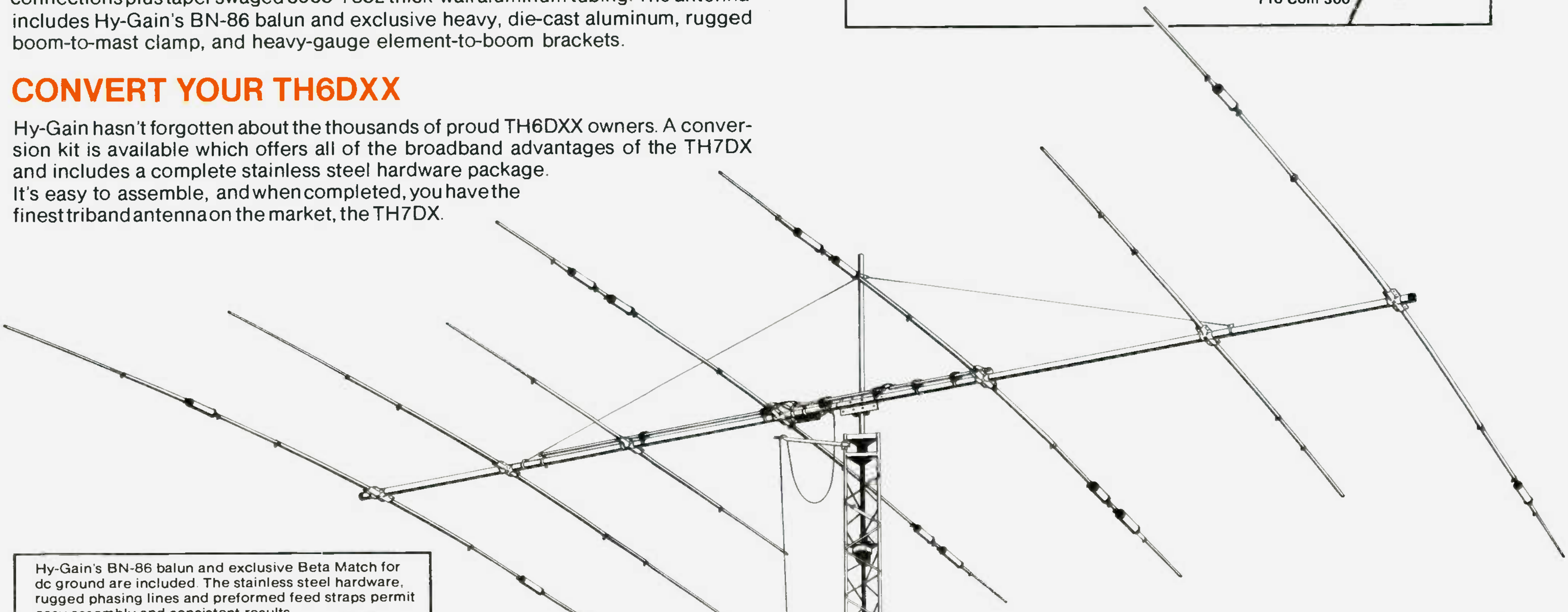

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Are you contemplating the challenge of operating on the amateur microwave bands? What about getting in on the excitement of receiving satellite TV signals? These and similiar projects usually require a dish-style antenna. You could buy one or, better yet, you can build one. This article will tell you how.

I wanted to put a signal on the 1296-MHz band. To do the job right, I needed a dish antenna. I took the plunge at a hamfest, buying a surplus military job made of spun aluminum, about 6 feet in diameter. It was one of those good deals you can't pass up.

Now my "good deal" sits in the corner collecting dust, waiting to be sold at the next hamfest. I managed to get a signal on 1296 using a dish two meters in diameter that I built myself. The design is one which uses easily-obtained materials and has a total cost of less than $100. Best of all, it need not be a long, involved project. In fact, you can build a dish like mine in a single weekend.

Photos by Tim Daniel N8RK

Photo A. The finished dish is light enough to be moved easily; the author stores his away each winter.

Some Theory

Before we jump into the details of construction, it would be a good idea to look at the basics of dish design. The dish, resembling an oversized child's snow saucer, is a paraboloid. Its unique geometric properties cause it to collect a beamwidth of energy from a distant source and reflect it to a central point known as the focal point, or focus. Similarly, a signal radiated towards the dish from the focus will be effectively radiated by the antenna.

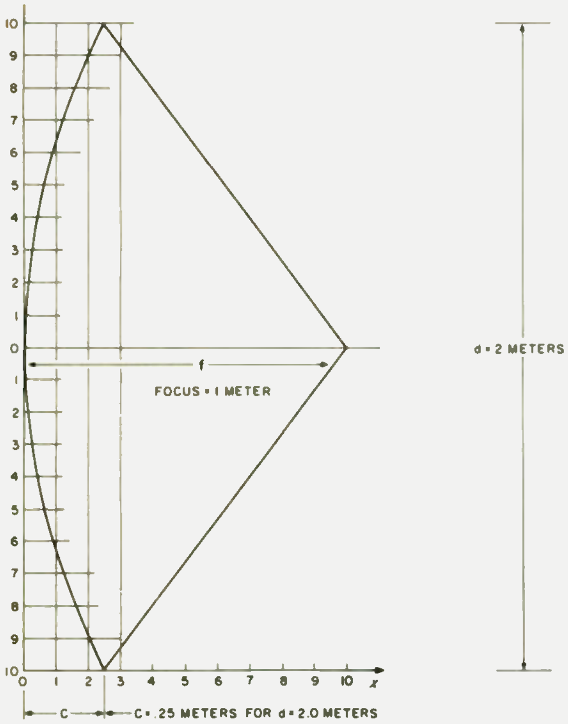
The important dimensions of a paraboloid are shown in Fig. 1. The reason my "good deal" dish turned out to be a piece of junk was that the relationship between the focal point and the diameter was all wrong.

Known as the f/d ratio, this relationship is very important when it comes time to feed the dish. Experience shows that dishes with f/d ratios of 0.5 and greater can be fed easily with a horn-style array. (My commercial dish's f/d ratio was about 0.25 and was difficult to feed.)

The diameter (d) is important in determining how much gain the antenna will have. Obviously, a dish 6 feet in diameter will collect more signal than a 3-foot dish. Each time you double the diameter, the gain increases by a factor of four (6 dB). The actual gain of a dish depends on its efficiency and the frequency it is used on. Assuming a reasonable efficiency of 50%, a 2-meter dish should have about 25 dB of gain over a dipole source at 1296 MHz. The 3-dB beamwidth will be about 8 degrees. Fig. 2 shows these relationships.

Once you have chosen the desired diameter, you'll know where the focal point should be to achieve an f/d ratio of about 0.5. In the case of a 2-meter dish, f will be at one meter.

The exact curvature needed to obtain a paraboloid with the desired focus and diameter can be found using the equation $y^2 = 4fx$. By calculating a number of points for x and y, you'll have an accurate plot of the shape required. Let's try an example for a dish with the focus at one meter: The x value corresponding to the y point of 0.5 is found by solving the equation $0.5^2 = 4(1)x$. A little algebra yields: $x = 0.5^2/[4(1)]$.



$$y^2 = 4fx$$

y = 1, x = .25	y = .5, x = .0625
y = .9, x = .2025,	y = .4, x = .04
y = .8, x = .16,	y = .3, x = .0225
y = .7, x = .1225	y = .2, x = .01
y = .6, x = .09	y = .1, x = .0025

Fig. 1. Dish dimensions. Width (c) is found by solving: $f = d^2/16c$.

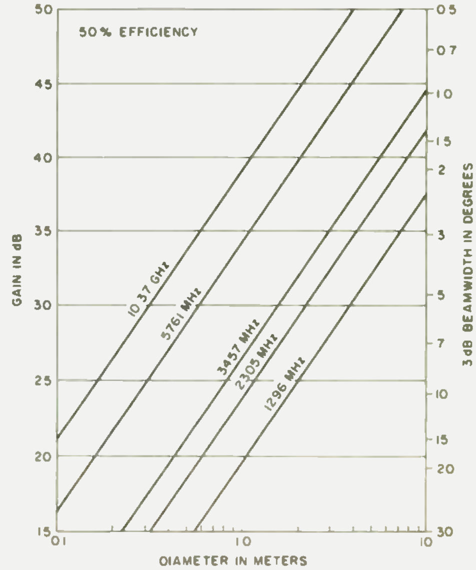


Fig. 2. Dish diameter/gain relationship.

Punching the calculator keys, we come up with the answer x = 0.625 meters. Fig. 1 also shows that the total width of the dish, c, is found with the equation $f = d^2/16c$.

That's all there is to designing the reflective part of the dish. Now let's look at how to build it. For starters, you should be prepared to work with metric measurements of length. I found that the use of meters and centimeters helps to ensure accurate results. For noncritical measurements, we'll refer to English units.

Once you have a set of x and y values, it is time to fabricate a surface that accurately depicts them. Any irregularities will impair the antenna's gain. At 1296 MHz, deviations of up to 1.5 cm are tolerable. As the frequency increases, this tolerance decreases. Using care, this dish can be built with deviations of less than 0.5 cm.

Making the Ribs

The structural elements that give the dish its strength and special shape are eight wooden ribs. I made mine from scrap 3/4-inch white pine. Each rib was cut from a 40" × 14" piece. Any available substitute should work, provided that it is reasonably light and can be cut to the needed shape.

Carefully draw a center line lengthwise, 5.8 cm from one edge of the board, as shown in Fig. 3. Work from this line to lay out a parabola, using the points generated by the $y^2 = 4fx$ equation. The more points you use, the more accurate your paraboloid will be. Carefully draw a line to connect the points on the inner surface. The outer surface should have a shape like the one shown. The lower flat edge will be at the center of the dish, while the upper end will be at the edge, fastened to a ring of aluminum tubing.

After checking the layout, the eight ribs can be rough-cut to about 0.2-cm accuracy using a band or saber saw. Final trimming should be done by sanding. Be sure to keep the flat edge parallel to the center line.

The ribs are all joined at the dish's center by a 3/4-inch-thick plywood mounting plate like the one shown in Fig. 4. Ribs A and B are mounted first, using 1-1/2-inch wood screws. All the other ribs must be shortened to obtain equal inside diameters. Ribs C and D have 3/8" removed from the inside end. Ribs E, F, G, and H are shortened 3/8" and mitered with two 45° angles as shown in Fig. 4(a).

Finally, all the remaining ribs are fastened to the mounting plate, first with glue and then with wood screws.

To add strength to the dish's outer edge, I encircled it with 1/2-inch aluminum tubing. Four six-foot lengths were used. To bend the tubing into a circle, one end is plugged, then the tube is filled with sand and carefully bent into shape. This was easier to accomplish than I thought it would be. An undersized piece of tubing is used for coupling between the sec-

Photo B. A feedhorn can be easily constructed. The pickup is a simple, monopole element.

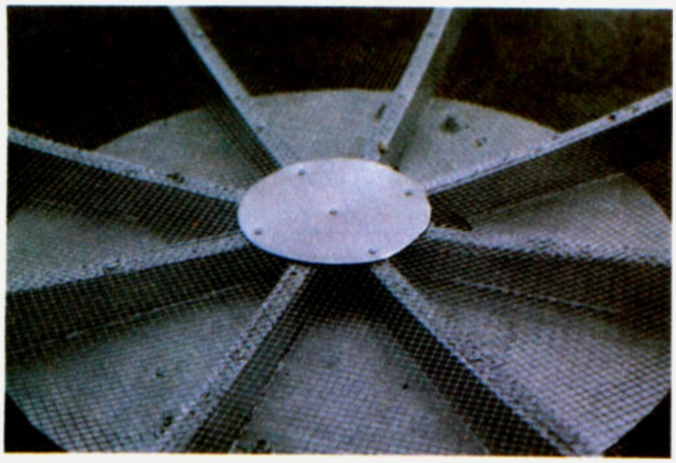


Photo C. A circular plate holds the reflective screening in place at the dish's center.

tions. The shaped lengths are fastened to the dish perimeter with 5-cent conduit clamps as shown in Fig. 4(b). Since the ribs give the dish its shape, getting the outside circle perfect is not necessary.

Covering the Frame

The next step is to cover your frame with a reflective surface. I used 1/4-inch hardware cloth because it was cheap and available.To make the job easier, I cut the cloth into eight slightly oversized triangles. Staple a triangle between two adjoining ribs and then trim the excess outer edge to size. Next, tie-wrap the perimeter to the aluminum tubing using nylon cord with cable-wrapping technique. Be sure to wear gloves when working with the hardware cloth.

Once all the screen is in place, eight flathead screws are used to hold it on each rib. (The staples are no longer needed and can be removed.) Since eight layers of hardware cloth overlap at the center, they must be trimmed and then securely fastened beneath a seven-inch diameter disc.

At this stage, all the essential parts of the reflector are complete. Since my dish is going to be mounted in an exposed location, I decided to strengthen it by adding bracing between the ribs about midway from the center. A framework was fastened to the center plate so that the whole antenna can be bolted to a mast.

Feedhorn Ideas

Because of the f/d rati of 0.5, the obvious fee choice becomes a horn. The theory behind horn design is not trivial. To make matters worse, there often is a vast difference between a design on paper and one that works. The horn shown in Fig. 5 has been field-proven on the 1296-MHz band by K9KFR and others. Horns of this type have about 8 dB of gain. Other types of feeds can be used; one good source of information is the RSGB book, *VHF-UHF Manual*, by Jessop and Evans.

Unless you can find a tin can that meets the dimensions shown in Fig. 5, you will need to make one. Using light-weight aluminum stock, I made a cylinder from a 18″ × 28.25″ piece. Next, a cap is fashioned to fit into one end. Small vee-shaped tabs are bent 90° and riveted to the cylinder wall. The result is a tube with an inside length of 16″ and a diameter of 9″.

The location of the tuned element is critical. A type-N connector should be mounted 2″ from the rear wall. A 1/4-wave driven element (1.8″ of 1/4-inch copper tubing or 1/8″ welding rod) is adjusted by filing. Using approximately one Watt of power with an in-line wattmeter, file for best vswr. *Caution: The horn is emitting microwaves; keep hands and eyes away from the opening.* Be sure to use hardline for all connections.

It should come as no surprise that at this point the antenna is almost finished. Now the horn is mounted on the antenna frame with four sections of telescoping aluminum tubing.

The exact distance between the dish center and the horn must be found experimentally. The focal point will *not* be at the horn's outside edge, it will be inside the cylinder. To find the exact focus, the dish should be aimed at a signal source and the horn moved up and down until the received signal is at a maximum. If your 1296 receiving gear includes a low-noise amplifier, then one excellent signal source is "sun noise." Aim the dish at the sun, and your receiver should give a noticeable output.

The antenna's polarity is determined by the position of the driven element. Rotating the horn 90° changes the antenna from vertical to horizontal or vice versa. When the driven

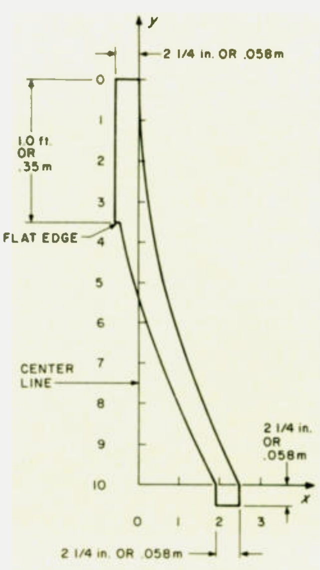


Fig. 3. Rib detail.

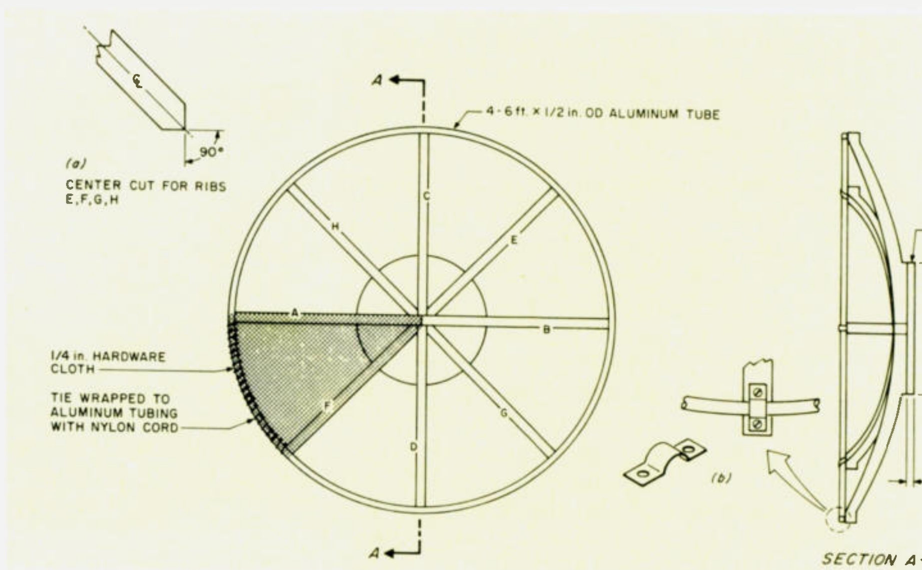


Fig. 4. Assembly of the ribs.

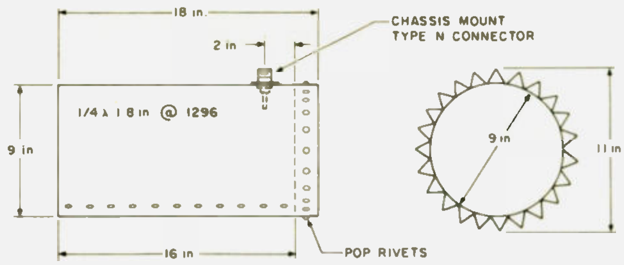


Fig. 5. Feedhorn design.

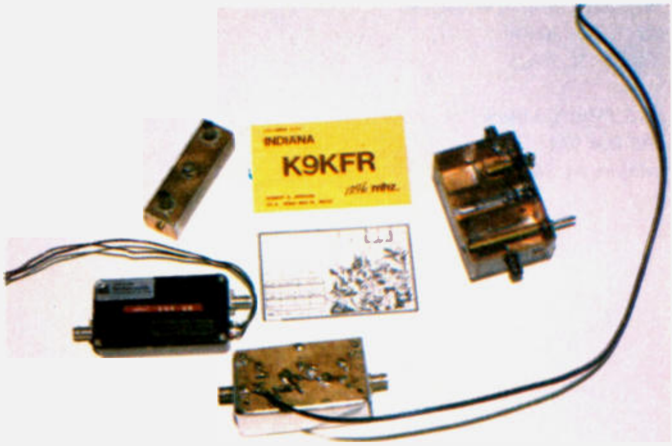


Photo D. Building a 1296-MHz dish need not be difficult, but it will require some home-brewing.

element is horizontal relative to the Earth, the antenna is horizontally polarized and is set for 1296-MHz tropo operation. Once the focus and polarity are set, bolt everything into place and start enjoying your new antenna.

Life on 1296

You might be interested in the rest of my 1296-MHz station. For receiving, I use a preamplifier made with an MRF901 transistor, followed by a Microwave Module that converts the signal to 28 MHz where an amateur transceiver is used. On transmit, a home-brew varactor tripler provides 3/4-Watt output on 1296 when driven with a ten-Watt, 432-MHz signal. This may not seem like much power, but I make the most of it by using hardline between the dish and the shack. Thanks to my dish antenna, the 1296 effort has been a success. The first two contacts were with K9KFR and WA8JHW, each more than 100 miles away.

This article is being written in the winter, and the dish has been stored away, safe from ice and other hazards. When warm weather returns, you can be sure that W8DJY will be back on 1296. In the meantime, plans are being made for a much bigger dish and a more powerful transmitter.

As you can see, building a dish need not be difficult. This project was the result of a lot of help and ideas from fellow VHF-UHF enthusiasts, including WB8EEX, whose garage proved invaluable, W8ULC, who handled the fancy footwork on the tower, and K9KFR, who patiently helped get a feed that worked.

About the only thing that can't be changed is the basic parabolic shape. Make the most of the materials that are available in your area; be brave; experiment! If you have questions, please include an SASE. See you on 1296! ■

Richard Christian WA4CVP
Rt. 1, Box 209-W
Creola AL 36525

S. F. (Mitch) Mitchell, Jr. WA4OSR
PO Box 973
Mobile AL 36601

Job's Own LNA

—rolling your own takes patience

Yes, it *is* possible to home-brew a workable LNA (Low Noise Amplifier) for your home-brew satellite TV receiver! But to do it, you must have the patience of Job and start with a full head of hair!

We'll let you, the reader, decide as you read the article just how much patience we have.

In ham radio receiver terms, the LNA is the "front end" of the satellite receiver. Commercial units generally have about 40 to 50 dB of gain at 4 GHz. They usually are constructed of one or two stages of GaAsFET transistors and several stages of bipolar transistors to achieve the amplification desired. The GaAsFET transistors are a special type of transistor with a very low noise figure. They get their name from the material used to achieve the low-noise figure, gallium (Ga) arsenide (As).

This article describes the trials and tribulations that we went through in building the LNA for our satellite-TV receiving system. Although we had access to absolutely no test equipment for 4 GHz until after it was known to be working, we were very successful in getting the complete system going. We wish to share our hard-earned information with *73* readers who are considering building their own systems.

First, a little history. Our initial attempt to build an LNA used a commercially-available board which, for reasons to be discussed, will be nameless. The board was supposedly designed to work with Nippon Electric Company (NEC) NE21889 GaAsFETs. These FETs are expensive at $103.25 for two, but they have a noise figure of 1.2 dB at 4 GHz.

So, being the scroungers that we are, we attempted to substitute cheaper (higher noise figure) GaAsFETs. The result was two blown FETs that cost $62.50 and two grown men crying. We then bit the bullet and ordered two of the NEC FETs from its US distributor, California Eastern Labs (CEL).

With cold, dry weather, we were in a real dilemma. How do you protect a hundred bucks worth of minute transistors from static electricity while you are soldering them into the circuit? We finally decided that we needed a work area with a good ground and high humidity. Richard's front bathroom was selected to be converted to a reduced static work area. We turned on the hot water in the shower to steam things up.

A piece of copper braid wrapped around my wrist and grounded to the cold water pipes provided the ground needed. A large piece of copper-covered PC board also was grounded to the cold water pipe and was used as the work surface. We let the soldering pencil

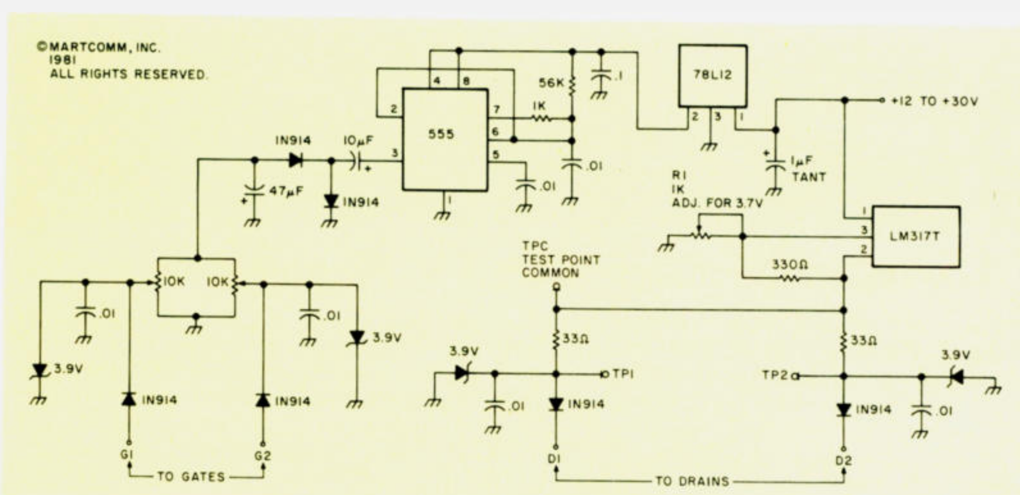


Fig. 1. Bias supply schematic.

heat up and then unplugged it from the ac line and grounded it with a jumper to the work surface for more static protection. I quickly soldered the first transistor in before the iron could cool. After I stopped shaking, we reheated the soldering pen and I soldered in the second transistor. It's amazing what lengths you will go to when a hundred dollars worth of FETs are at stake.

The LNA was mounted in a box made of double-sided PC board, with feedthrough capacitors supplying the correct operating voltages from a very simple resistive divider power supply. Next, we gave the LNA a try. It wailed like a banshee! In other words, it acted more like an oscillator than an amplifier.

How did we tell that it was oscillating without using test gear? We discovered that any oscillation within the 3.7-to-4.2-GHz band is immediately obvious on a TV connected to the receiver. If the oscillation is strong, there will be very prominent black bars on the screen regardless of where the local oscillator is tuned. If the oscillation is weak, there will be a very weak but still visible black bar. Black bars will occur twice, 70 MHz apart, within the tuning range of the local oscillator, if you are using a single conversion receiver (since you get both the signal and its image).

If the oscillation is outside the tuning range of the TV, however, it will not show up on the TV screen. If you can't see it on the TV and if you don't have a spectrum analyzer to test with, how do you know that it is still oscillating? Noise, noise, and more noise at the 70-MHz i-f stage.

What to do with the oscillating LNA? Start over! We wrote California Eastern Labs for their Application Note AN80903 that describes an LNA using the NE21889s. A prompt response from CEL brought it to us. In the CEL design, the LNA was mounted in a machined-brass enclosure. We could not immediately locate any half-inch-thick brass to make the enclosure, but Richard, scrounging through his junk pile, located a short piece of copper bus bar which was suitable. A little persuasion was applied to a local machine shop and presto, we had two nice machined-copper enclosures.

Since we thought it would be impossible to remove the GaAsFETs from the first LNA board without destroying them, we ordered two more NE21889s from CEL. At $103.25 for the pair, this project was getting expensive!

Richard arranged for a local print shop to make negatives for the printed circuit board to within .002 inch of the dimensions specified in the CEL Ap Note. We quickly made a board and waited for the second pair of transistors to arrive.

While waiting for the transistors, we did some serious thinking about a power supply for the LNA. As previously mentioned, we had already zapped two "cheap" FETs. We wanted a reliable LNA power-supply design that would protect the expensive little buggers. Many hours of design, building, and testing of circuits by Richard resulted in the LNA power supply board described here. We call it our "How Not to Gas Your FETs Bias Supply Board." It was designed specifically for a two-stage LNA using the NEC 21889 FETs.

Some criteria for the design: It should—

- Supply +3 volts for the drain and −3 volts for the gates.
- Power two stages of GaAsFETs.

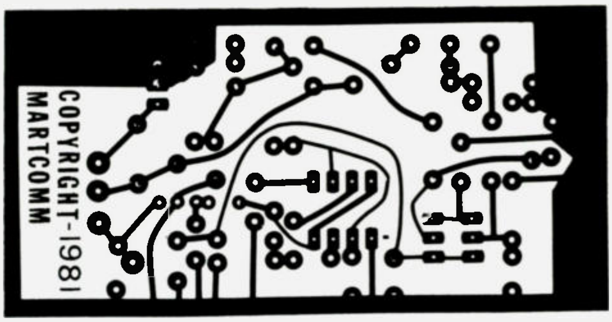


Fig. 2(a). PC-board layout.

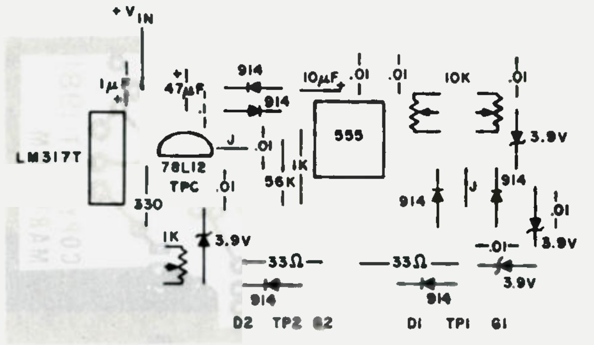


Fig. 2(b). Parts placement.

- Require only one pair of wires for the LNA so the supply voltage, with proper blocking, could be carried on coax cable.
- Provide reverse polarity and overvoltage protection for all gates and drains.
- Regulate gate bias and drain voltage with a main-supply voltage falling anywhere between +15 and +30 volts.
- Have most parts available from Radio Shack.

The circuit described in Fig. 1 meets all of the design criteria. The input voltage, which can be from +15 to +30 volts, is applied to an LM317T adjustable voltage regulator, which reduces it to +3.7 volts. The +3.7 volts is then filtered by a 1-uF tantalum capacitor and fed through 33-Ohm current-limiting re-

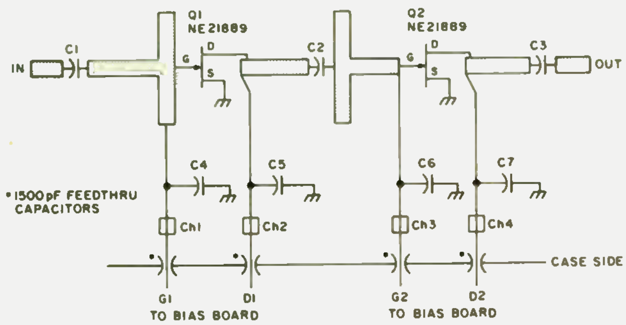


Fig. 3. Typical GaAsFET amplifier schematic.

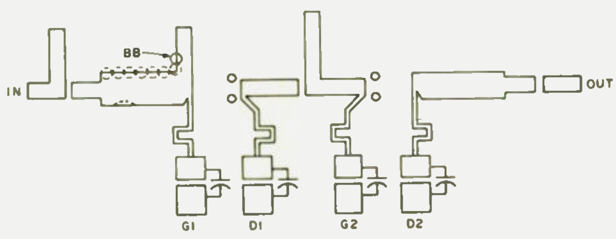


Fig. 4. Typical LNA board layout (not to scale).

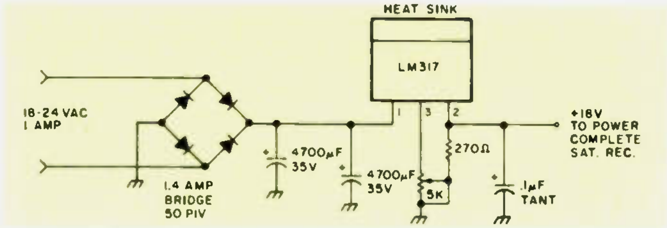


Fig. 5. Receiver power supply schematic.

sistors to the drains of the two GaAsFETs. The test points on each side of the 33-Ohm resistors are used to measure the voltage drop across the resistors and, therefore, the current being pulled by each FET. A voltage drop across the resistor of .33 volts equals 10 milliamperes of current being pulled by the FET. A 3.9-volt zener diode limits the maximum drain voltage, and high-frequency filtering is provided by the .01-uF capacitors. The voltage is then fed through 1N914 diodes for reverse voltage protection. This completes the drain supply.

We decided to generate the required negative voltage from the positive supply instead of going with a bipolar supply. Past experience has proved that for us, the negative-voltage regulator always fails first. With no negative bias, high-drain current would probably result, zapping the expensive FET. For the gate supply, the +15 to +30 volts is applied to a 78L12 regulator. The regulated +12 volts is used to supply a NE555 timer IC configured as a free-running multivibrator. The output of the 555 is rectified with a voltage doubler and filtered to give a negative voltage for the gate bias. The negative voltage is applied to two 10k-Ohm ten-turn pots. The zener overvoltage, diode reverse-polarity protection, and high-frequency filtering are the same as for the drain supply. A PC-board layout and parts overlay for the LNA power supply are shown in Fig. 2.

Everything was now ready for the arrival of the second pair of FETs. When they arrived, Richard soldered them in using a Radio Shack battery-powered, isolated-tip soldering pen that we had purchased for working with the GaAsFETs. By having Richard solder these in, we discovered that the guy who supplies the money for the FETs shakes the most when soldering.

After assembly of the bias supply board, but before connecting it to the LNA, apply +15 to +30 volts. With a voltmeter, adjust pot R1 for +3.7 volts at the test point TPC (Test Point Common). This will result in approximately +3 volts to the drains after the .7-volt drop across the reverse-polarity protection diodes. Set the 10k bias pots for −3 volts at points G1 and G2.

The supply is now ready for connection to the LNA, using the isolated-tip, battery-powered soldering iron, with the tip grounded to the LNA board. Refer to the "typical" LNA schematic, Fig. 3. Be very *careful* to connect the gate leads, G1 and G2, before connecting the drain leads, D1 and D2. With a voltmeter across the 33-Ohm resistor, + probe to TPC, − probe to TP1, adjust G1 bias for a .33-volt reading. This indicates that 10 milliamperes of current is being pulled by the

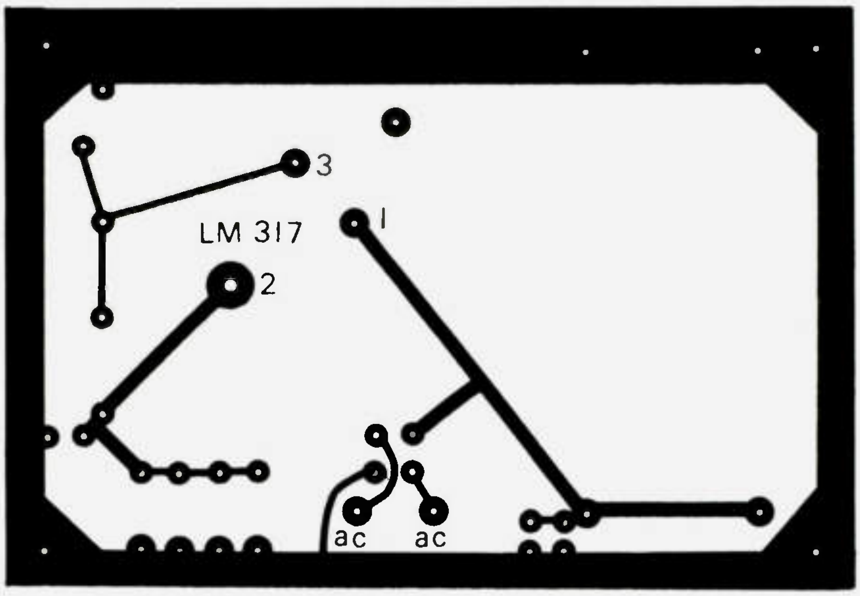


Fig. 6(a). Receiver power-supply PC board layout.

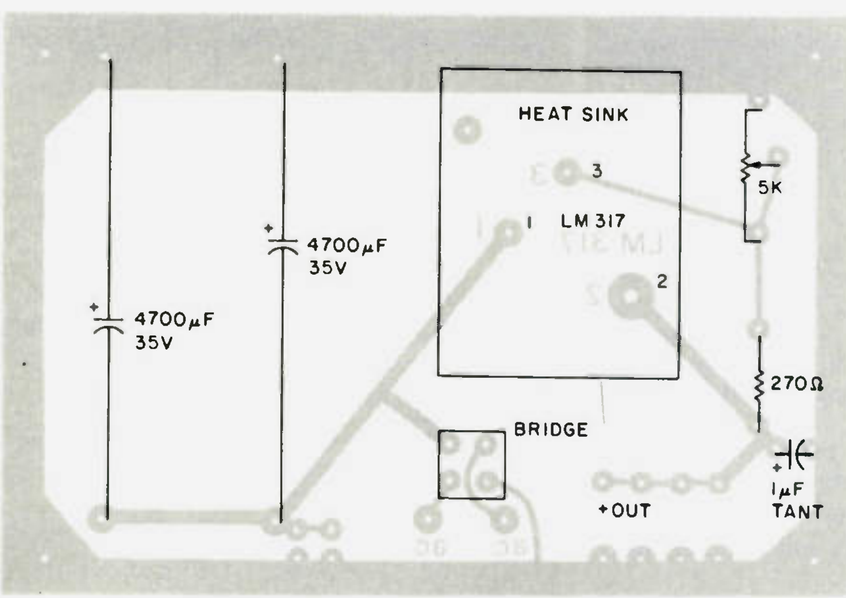


Fig. 6(b). Parts placement.

GaAsFET. Move the – probe to RP2 and adjust the G2 bias pot for a .33-volt reading. Now go back and check FET #1. As you adjust the bias pots, the current should *evenly increase!* If the current jumps or is erratic, the LNA is probably oscillating. How to stop oscillation is the subject of another article!

Using the above-described LNA power supply and tune-up procedure, the CEL LNA design came up beautifully, with no oscillation. Its two stages gave a solid, measured 21 DB of gain. We were unable to measure the noise figure directly, but the fellow with the test equipment said that it appeared to be very low, based on his evaluation of the ratio of gain to noise generated by the test equipment.

What type of picture do you get with a two-stage, 21-dB gain LNA that has an unknown noise figure? Very poor! After getting the first CEL LNA working, Richard was able to remove the NE21889s successfully from the commercial board. We built up a second board, using the cell design and our LNA power-supply board. Again, the CEL design came up with absolutely no problems. Now, by cascading the two boards, we were getting some results.

After optimizing the boards, which I will cover next, we have numerous transponders on SATCOM I above noise. We are located in the 32-33-dB footprint and the antenna is a home-brew 12-foot spherical. We have made comparisons of our four-stage CEL LNA and a 120-degree commercial LNA. Our home-brew LNA compares very *favorably* with the commercial unit.

Trimming an LNA for Best Noise Figure and Best Gain

After having gone through the misery of trying to build an LNA with almost no information and absolutely no test equipment, we now can describe some of the procedures we had to discover the hard way.

The first step is to prepare a work area so that you minimize the possibility of blowing those costly GaAsFETs. A piece of printed circuit board makes an ideal work surface. Again, you will need a good isolated-tip soldering pen. Ground the tip of the pen to the work surface with a jumper. The battery-powered pen sold by Radio Shack works great. You should ground yourself to the work surface with a piece of copper braid. You also will need an X-acto® knife, a BB or small ball bearing, a plastic tuning wand, and a steady hand. Glue the BB or small ball bearing to the end of the plastic tuning wand.

The LNA, as built, should produce watchable video in most areas of the country. With power on and a transponder tuned in, make sure that the correct current is set for each stage of the LNA (10 mA per stage for the NE21889). You should monitor the current of each stage as it is trimmed. Place the BB on the PC-board trace edge as per Fig. 4. Slowly move the BB around the outside perimeter of the striplines, keeping it in contact with the stripline. Monitor the quality of the received picture as you move the BB. When a point is found where the picture quality gets better, you need to add copper to the stripline. If the picture quality gets worse, you need to remove some of the stripline by making very light cuts. We only score the copper with the X-acto knife so that it can be soldered back together if needed. Make several trips around the striplines and note the effect before doing any adding or trimming. Make a log of the points where changes occur and see if they repeat each time you run the BB by them. After you are convinced of the points that need changing, then make the necessary adjustments. Copper can be added by salvaging a piece of foil from another piece of PC board or by using GC Electronics Silver Print paint.

After the adjustments are made, make a slight increase in the current for each FET stage while watching the picture quality. We have run the current up to 40 milliamperes on a stage with no oscillation. The first stage will probably have to operate at 8 to 12 milliamperes for best noise figure. Successive stages can operate at higher current levels for more gain.

The basic power-supply design (Fig. 5) and PC board layout (Fig 6) power the bias board and also our complete satellite TV receiver. There is nothing special about it except, again, that an effort was made to use parts available from Radio Shack. ■

Printed circuit boards are available from Martcomm, Inc., PO Box 74, Mobile AL 36601, for the power supplies and the LNA. The LNA board is $20.00, the LNA bias supply board is $12.00, and the receiver power-supply board is $10.00. Add $1.75 per order for first class postage.

You may request the CEL LNA Application Note AN80903 by writing to California Eastern Labs at 3005 Democracy Way, Santa Clara CA 95050. A copy of the Note is supplied with each LNA board ordered from Martcomm, Inc.

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Billy L. Nielsen WB4APC
Rte. 2, Box 253E
Radcliff KY 40160

Microwave Master

—you might not need a mountaintop

With the growing interest in satellite television reception, weather picture reception, and higher frequency utilization, the need for a better understanding of microwave principles becomes more important than before.

To better understand microwave techniques, we must first understand the frequency bands and the characteristics of the microwave spectrum in relationship to other lower frequency radio waves. As we know, radio waves travel mostly along the ground path and are not readily affected by mild changes in the weather or atmosphere. When we get into the microwave region, the characteristics are entirely different.

To begin, let us take a look at what microwaves are. Radio wayes above the 1000-MHz level are called microwaves. It is a common practice to relate to this portion of the frequency spectrum in terms of Gigahertz (GHz), with a frequency of 1000 MHz being equal to one Gigahertz. The basic spectrum of microwave frequencies is made up of three very basic bands. These bands are: the S-band centered at about 3000 MHz (10 cm), the X-band at about 10,000 MHz (3cm), and the K-band at about 27,000 MHz (1.1 cm).

Table 1 shows the relationship between the bands by wavelength in both centimeters and inches, and Table 2 shows some of the services operating there. You will notice from the table that a full wavelength at the microwave frequencies is not very long. When we get into working with the construction of microwave equipment and subassemblies, these measurements will have a very significant meaning.

The first cavity magnetron was developed in Great Britain in 1940, after the publication in 1936 of two papers on hollow waveguides. These papers are: "Hyper-frequency Waveguides—General Considerations and Experimental Results" by G. C. Southworth, and "Transmission of Electromagnetic Waves in Hollow Tubes of Metal" by W. L. Barrow. During the period of early development around 1940, most of the experimental work was carried on in the Radiation Laboratory at the Massachusetts Institute of Technology. During this time, almost all experimental work in microwaves was directed towards the design and use of microwave radar equipment, due to the small size of antenna equipment required in the microwave region.

After the second world war, more efforts were made in other areas to the extent that today, almost all long-range telephone communications are relayed by microwave links. As scientific advances began in outer space, the role of microwaves became even more important. In fact, microwave technology has made possible many of the products used today in our homes, business, and in private industry. An example of a modern use of microwave technology is the microwave oven found in many homes and businesses.

Microwaves are also used in many of the security alarm systems found in business use and have been used by private industry for some time for cleaning of parts, removal of broken screws and bolts, and for controlling signal devices at railroad crossings and drawbridges. Another use with which almost everyone is familiar is the radar speed control devices used by police forces all over the country.

To understand microwave principles, we must first take a look at some of the characteristics of microwaves in relation to other forms of radiation. We must also learn what variables affect the microwave signal itself.

To begin, microwaves normally travel in one or all of four basic paths. These four paths are direct wave, reflected wave, surface wave, and sky wave. In most microwave installations, the direct wave is the desired path, although the reflected wave also may be of importance in some instances.

The direct wave is so named because of its direct path from one point to another. With optimum conditions, the most reliable communications can be ob-

Band	Frequency (MHz)	Wavelength cm	Inches
S-band	3,000	10	4
X-band	10,000	3	1.2
K-band	27,000	1.1	.44

Table 1. Microwave bands.

Service	Frequency	Wavelength cm	Inches
Amateur	1296 MHz	23	9.1
WEFAX	1691 MHz	17.8	7
MDS TV	1900-2500 MHz	15.8-12	6.2-4.7
Satellite TV	3700-4200 MHz	8-7	3.2-2.8

Table 2. Some services operating in the microwave frequencies.

tained through the use of the direct wave.

The sky wave normally is considered to be a wave that has been reflected from the ionosphere, a region that extends from an altitude of approximately 30 miles on out to about 250 miles. In the area of satellite television or weather fax, a signal which is transmitted from a satellite is not considered to be sky wave but, instead, falls under the classification of a direct wave that has been retransmitted.

Surface waves are waves that travel along the surface of ground or water. They are mostly predominant at the lower frequencies. At microwave frequencies this mode of propagation is usually insignificant and in most cases may be disregarded.

The reflected wave is a wave that has been reflected from the land or water surface of the area between the transmitter and receiver antenna sites. A factor that determines the strength of the reflected wave is the type of surface that the wave is reflected from. Land is considered to be a poor reflector and will scatter the wave in many directions. Water is a good reflective surface and generally will reflect the entire wave in one direction. The reflected wave is only important when the reflected signal is picked up at the receiving antenna with a strength comparable to the strength of the direct-wave signal. At this particular occurrence, the reflected wave may either boost the direct-wave signal or cancel it almost completely. The determining factor at this time is whether the two signals are in phase with each other. If the two signals are in phase, or nearly in phase, or if the two signals are of nearly equal strength, the combined signal can be twice as strong.

However, if the two signals are nearly 180° out of phase with each other, there will be a reduction in signal strength since the reflected signal will cancel some of the strength of the direct-wave signal.

A phase difference between the direct wave and the reflected wave is usually introduced by the difference in the distance each wave travels. This difference may vary from installation to installation and can be anything from a fraction of a wavelength to many wavelengths. When the path difference is an odd number of wavelengths, the two signals (direct and reflected) will arrive at the receiving antenna in-phase. This is especially true when the wave is reflected at small angles of incidence, which cause a phase reversal of 180°. In the case of horizontal polarization, the phase reversal is nearly 180° regardless of the magnitude of the grazing angle. This is also true for almost all instances of vertical polarization in most point-to-point communications systems.

An interesting fact about microwave energy is that the signal tends to be slightly curved. This is because the signals travel through the atmosphere at speeds that depend on temperature, atmospheric pressure, and the amount of water vapor present in the atmosphere.

The following three conditions will have an effect on the microwave signal: The *higher* the temperature, the *faster* the signal; the *lower* the atmospheric pressure, the *faster* the signal; and the *lower* the water vapor content, the *faster* the signal.

With these influences, the net result is that the signal speed changes with altitude. Under normal conditions, the variation is a small and uniform increase in speed of the signal with an increase in altitude. In this manner, it readily can be seen that in a way, the microwave signal acts very much like a light beam. Just as a light beam can be reflected or bent, so can a microwave signal be reflected or bent.

Using the above information, we also can see that microwaves can be very reliable for communications systems. The most important factor is to ensure as direct a line-of-sight path from the transmitter antenna to the receive antenna as possible. With prior study of the potential path, it is really not too difficult to plan a microwave system. The thing to keep in mind is that the complete path of the microwave signal must be free of any obstructions such as trees, hills, or tall buildings. When transmitting over water, the reflected wave may play an important role in the received signal. When you are designing over-water point-to-point systems, it is very important to ensure that this reflected signal does not arrive at the receive antenna in an out-of-phase or nearly out-of-phase state.

A simple rule-of-thumb method can be used to determine possible antenna heights, especially for over water paths. The antenna heights chosen must satisfy the following relation: $\sqrt{2H_1}+\sqrt{2H_2}=S$, where H_1 and H_2 represent the antenna heights in feet above sea level and S represents the distance in miles between the antennas.

The next step is to calculate a correction height using the formula $H=\sqrt{S/F}$, where H is in feet, S is the distance between the antennas in miles, and F is the operating frequency in MHz. The required antenna height for each antenna is the sum of the tentative height and the correction height for each antenna, or, more simply stated, $H_1 + H$ and $H_2 + H$. If the values obtained are not convenient, then select new tentative antenna heights and perform a new calculation.

For example, if we assume a transmitting antenna height of 1400 feet and a receiving antenna height of 2000 feet at a distance of 100 miles, the computation would be: $\sqrt{2(1400)} + \sqrt{2(2000)} = 100$ (miles). The square root of the H_1 component is 52.92; the H_2 square root component is 63.25. This gives us a total of 116.17 miles. It is then quite evident that one or both of the contemplated antennas are too high. By using the S value of 100 and working backwards with the formula, using H_1 as the base antenna and recomputing for H_2 height: 100 − 52.92 = 47.08 squared = 2216.53 divided by 2 = 1108.26 feet. Therefore, the

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new height that meets the relation is 1108 feet for H_2. By the same token, we could have kept antenna H_2 at the height desired and recomputed the height for H_1.

Using the corrected figures for antenna heights of 1400 feet for H_1 and 1108 feet for H_2, we now can compute the correction heights for both antennas at a frequency of 1296 MHz: $H = 660\sqrt{100/1296} =$ 183.33333 feet. This gives us a final figure of antenna height for H_1 of 1400 + 183.33 or a total of 1583.33 feet and for H_2 1108 + 183.33 or a total of 1291.33 feet. Given the figures above, we can now look for possible sites to install antennas.

Of course, we may not always find the ideal spots for our antenna construction. In this case, we go back and recalculate using different antenna heights (plus elevation above sea level) to obtain a relative figure equal to the desired distance figure. Sometimes just one or two feet may make the difference at the receive end.

In any attempt at microwave, if at first you do not succeed, try again at another location or change the height of one or both of the antennas. In selecting a good antenna site, a very good aid to locate the ideal sites is a topographical map of the area locality of choice. A source of information for obtaining topographical maps is at your state capital. Try writing a letter either to the State Department of Natural Resources or the State Forestry Division. There is a fee required for copies of these maps, but it is usually very small when one considers the information that can be obtained and the time that can be saved. Happy hamming on the microwave bands.■

HAM HELP

I am in need of the schematic and alignment information for a Gonset G-77 transmitter and information on a TU-8-B plug-in unit used with BC191/375 transmitters. I will copy and return your originals.

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St. Louis MO 63132

I am looking for employment in the electronics field, in the Knoxville-Chattanooga, Tennessee area. My background includes 25 years of experience with rf circuits, and 1st phone license with radar endorsement, and an Extra amateur license.

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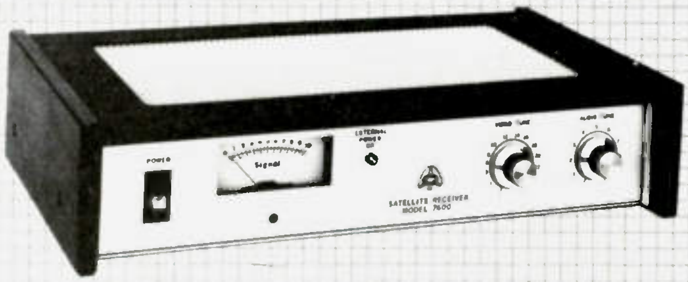

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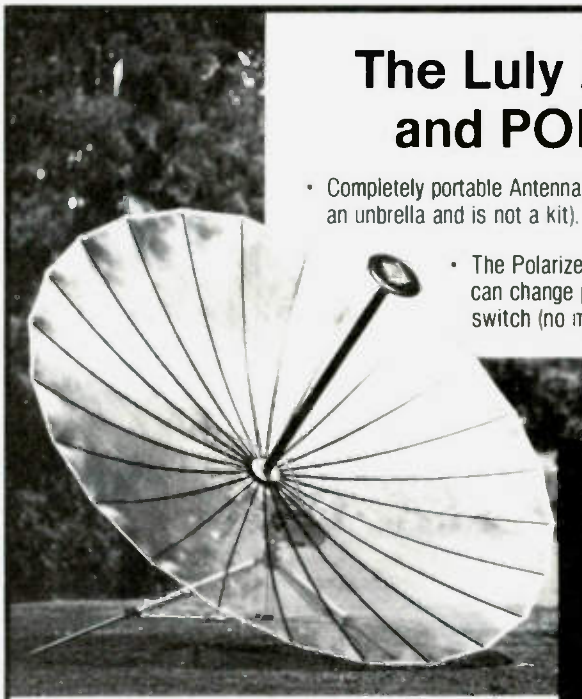

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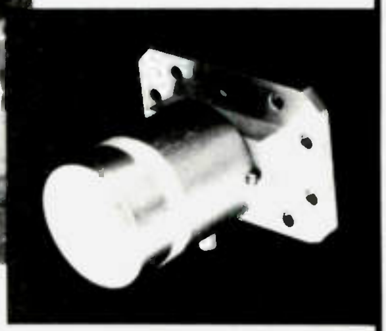

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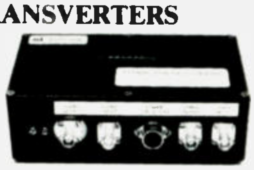

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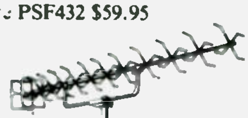

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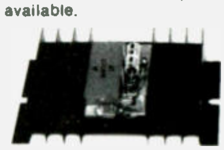

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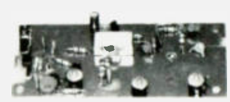

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CW Interface

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It is one thing to obtain software to decode Morse code with your computer, but it is quite another to process the audio signal delivered by your receiver in such a way that the computer can use it. This article will describe one approach to solving this hardware problem and also describe the construction and operation of an interface circuit using these principles.

I will assume that you already have software for decoding Morse and will describe the needed hardware. An example of such a program was presented by Thomas[1] in the December, 1977, issue of *73*. For our purpose, we will assume that your software requires a TTL signal that is logic low during the key-down intervals and logic high during the key-up intervals.

Proper operation of your decoding algorithm will require the presence of one logic level during the key-down interval and the opposite logic level for the key-up state. The computer must see only one or the other of these states at any one time, and they must change only when the state of the desired signal changes. State changes should not be affected by interfering signals or random noise.

An extremely simple circuit could successfully be used to interface a computer to a ham receiver if the audio signal produced by the receiver were perfect (absolutely noise-free and of constant level and frequency), but the circuit must be considerably more elaborate if the computer is to perform properly with the imperfect signals typical of ham-band operation.

Typical receiver output during CW reception on today's ham bands presents a difficult problem when attempting to decode the signal with a computer. Even if the operator is using a selective receiver (400-Hz bandwidth) designed for CW reception, several different signals usually will be present in the audio. The signal that the operator is trying to copy probably will be tuned for his preferred pitch, while the others will be present at other frequencies. The desired signals probably will be the strongest, but the others may be fairly strong also.

In addition to these interfering Morse signals, there will be noise. In the signal output that is available to the computer interface circuit, we will have, in general, voltage due to our one desired signal and also considerable voltage due to all the other signals and noise being processed by the receiver. In order to decode the desired signal successfully, we must have a way to detect the voltage due to our desired signal while ignoring as best we can the other signals and noise.

Desirable Interface Qualities

We can summarize several design objectives for our receiver-computer interface. First of all, it should be (as always) small, inexpensive, and easy to construct and operate. Second, it should respond only to one very narrow band of audio frequencies, for maximum immunity to adjacent signal interference and noise. Third, the output should be bistable and TTL-compatible for proper interpretation at the computer input port; the output should be either logic high (+3.5 to +5 volts) or low (0 to +0.6 volts) and never in between. Fourth, the decision threshold of the detector should be adjustable to allow the interface to operate properly with both high- and low-level audio so that the operator is not forced to operate a certain audio gain setting which may not always be convenient. And fifth, the interface should work while the speaker of the receiver is operating, so that the operator can hear the code while it is being decoded to allow detection of computer errors (decoding errors can be expected under adverse reception conditions).

Theory

Fig. 1 is a block diagram of one approach to doing the required processing of the receiver audio. The first stage is a limiter which produces a known signal level at the beginning of the circuit; this allows the rest of the device to be designed optimally for this level. The limiter is followed by a 4-pole active bandpass

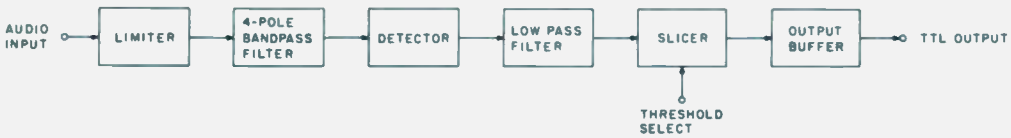

Fig. 1. Interface block diagram.

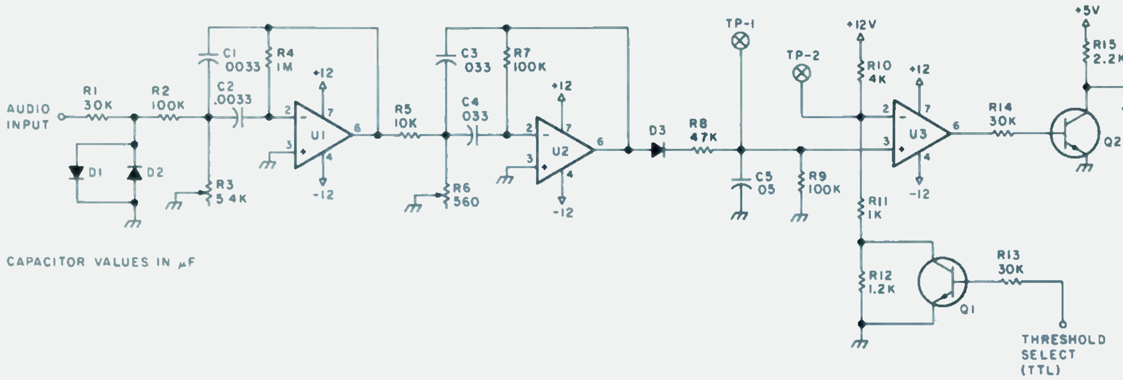

Fig. 2. Interface schematic.

filter. The filter is tuned to 950 Hz and has a design bandwidth of 80 Hz. This filter works by amplifying the signal about 16 times at its center frequency and attenuating signals not within its passband. This ensures that the detector stage only sees voltage due to the desired signal. The detector itself is merely a half-wave rectifier (a diode), and it is followed by a simple RC low-pass filter so that the output of the filter follows the pulse shape of the signal as closely as possible. The output of this stage will be maximum when the signal is present and minimum when there is no signal present.

The slicer stage decides whether there is a signal present or not. It does this by comparing a preset threshold voltage to the voltage it receives from the detector and filter. Whenever the received signal exceeds the preset threshold, the slicer quickly switches its output state from -10 V to +10 V.

Under ideal conditions, the output voltage at this point in the circuit would never exceed this preset threshold when only noise and interfering signals were present. If the voltage exceeds the threshold only when the desired signal is indeed present, no errors will be generated. If this is not the case (and usually it is not), errors will be generated whenever the combined level of the interference and noise exceeds the threshold. (The slicer will change state.) As soon as the voltage subsides, the slicer will revert to the correct state. For optimum operation of the overall hardware/software system, your decoding algorithm should be designed to ignore these spurious but unavoidable brief state changes due to noise.

Finally, the output buffer converts the signal levels produced by the slicer (which are incompatible with the computer input gates) to correct TTL levels.

The Circuit

Fig. 2 shows the schematic of one circuit that meets the design objectives outlined above. I know that not many people build anything exactly as it is described in a magazine article (neither do I), so I will not only describe this circuit but will also give a little of the thought behind the design choices that I made.

Diodes D1 and D2 form the limiter, and these should be silicon types to give a limited signal of about ±0.6-V peak at this point. R1 is used to keep the input impedance of this interface high so that it may be used across an existing high-impedance output of your receiver (the anti-VOX output on a Drake R-4, for instance), in parallel with whatever you normally connect to that output. So, this circuit can simply be added to your existing layout with little effect. Also, because the signal level is limited to 0.6 V, only about a 1-volt peak of audio signal is required at the input to this device. On my receiver, the anti-VOX output puts out more than enough voltage at moderate speaker volume levels. Another advantage of permanently connecting the interface to a high-impedance point in your receiver is that the speaker and headphone outputs can be used or disabled without affecting the connection to the interface.

Components R2 through U2 make up the 4-pole active bandpass filter. My first prototype used only a single-stage filter (2-pole), but I found that it was allowing too much interference from adjacent signals. I therefore decided to go to a 4-pole design, with the resultant much steeper skirts to the passband. The filter design itself was arrived at with the help of articles by Stark[2] and Stewart[3] in past issues of *73*, regarding active filter design. Each stage of the filter is designed for a Q of 10. The center frequency of stage 1 is 975 Hz and that of stage 2 is 930 Hz. This yields a 3-dB passband of about 80 Hz and very steep skirts and requires only 2 ICs. (Strictly following the criteria used by Stark would have yielded filter stages with higher Qs, but also would have required a total of 4 ICs and several more resistors in the design. My approach sacrifices some skirt steepness but eliminates many components. That was my choice.)

Each filter stage is designed for a gain of 4.8 so that at the overall filter center frequency of 950 Hz the complete filter has a gain of about 16. With the 0.6-V peak input, about 10-volts peak output is developed at the detector. If you would like to try your own hand at designing the filters (perhaps you'd like to use capacitors you have in your junk box or a different center frequency), use the procedures given in either of the above two articles but be careful to keep the first resistor (R2) around 100k or greater so that the input is not loaded down. R1 and R2 form a voltage divider, and smaller values of R2 will require more drive voltage from your receiver for full limiting.

Diode D3 is the detector, and R8, C5, and R9 form the simple low-pass filter. The filter components were arrived at by experiment, the goal being use of a physically small capacitor at C5 and optimum following of the keyed signal pulse shape at speeds up to about 30 wpm. These values meet these criteria well.

U3 is the slicer, and the resistor network R10, R11, and R12 with Q1 produce a software-controllable variable threshold. Using the indicated resistor values, when Q1 is not conducting, the threshold at pin 2 of U3 will be about 1.8 volts.

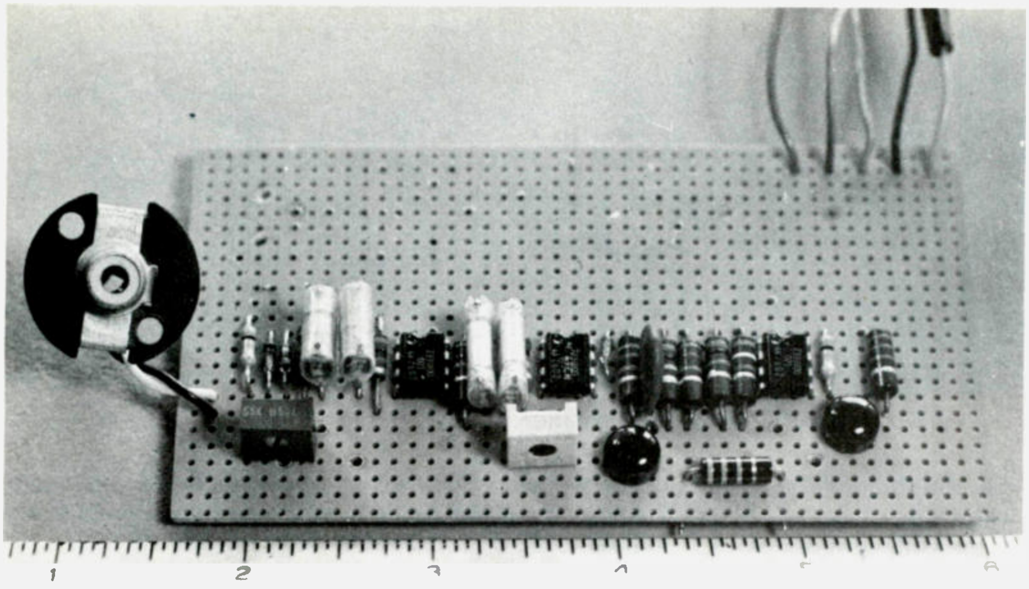

Photo A. Interface prototype.

When Q1 *is* conducting, the threshold will be lowered to about 1.0 volt. Thus, by tying the input to R13 to one bit of an output port, you can control the slicer threshold through software. This could have been done with a mechanical switch, but I wanted to mount this circuit deep within the bowels of my computer, controlled only by my commands via the keyboard. This approach took a while to design, but it requires very little additional space on the circuit board.

Under normal conditions, one would use the higher threshold for the best performance. But when you are operating with a signal level that is not strong enough for full limiting and noise conditions are favorable, you can extend your operating range by lowering the threshold to about 1 volt.

The output of U3 is either about +10 or −10 volts depending upon the detector output to U3. These levels could not be applied safely to the TTL input port of a computer, so the buffer stage, Q2, was added to provide a signal that always remains within the TTL operating range of 0-5 V. The output of Q2 can be tied directly to one bit of an input port.

With this circuit, the idle, or no signal, state of the output is logic high (+5 V). When a signal is present, the output drops to 0 V.

Construction

Photo A shows the prototype of this circuit in final form. My next step will be to reassemble it on a plug-in vectorboard for mounting directly inside my computer. As you can see, it requires a total area of about 2 by 4½ inches on the board. None of the components dissipates an appreciable heat, so it is safe to mount them adjacent to each other (but be careful not to short any leads). The wires visible in the upper-right portion of the board are for my temporary power and computer connections to the circuit.

All resistors used in the circuit need be no larger than ¼ Watt. I used what I had in my junk box, so some of the resistors in the photo are ½ Watt. Capacitors C1 through C4 should be high-quality polystyrene or mylar™ (and not disc ceramic) as pointed out by Stark. Try to get values for R2, R4, R7 as close to those listed as possible—although the final adjustments of R3 and R6 will compensate for any variations from the optimum values. The values for the two trimpots, R3 and R6, need be considered only approximate, and the final adjustment of these two can be expected at about mid-range if the indicated values are used.

Diodes D1 and D2 must be silicon types (small signal) and D3 can be either silicon or germanium. C5 can be disc ceramic. Q1 and Q2 are any general purpose silicon transistors capable of operating with a 2-mA collector current and a beta of at least 100 (type 2N3566 were used here).

As you can see from the photo, it is not necessary to etch a PC board. All three ICs are type 741. Power supply voltages of +12, −12, and +5 volts are required, but these should be available readily in most computers.

Alignment and Check-Out

The only alignment required is that of properly tuning each filter stage. For this, you will need some type of known frequency audio input. Apply an input to the circuit at 975 Hz, at a level of 1 volt or greater, and adjust R3 for maximum output at pin 6 of U1. Change the input frequency to 930 Hz and adjust R6 for maximum as measured at pin 6 of U2. You then should find that the 2-stage filter has a center frequency of about 950 Hz and an 80-Hz passband. With an input signal level sufficient for full limiting, about 10 volts (peak) signal should be available at the output of U2. Under these same conditions, the voltage at TP-1 should be about 3 volts (dc). As a final check, you can confirm that the output of Q2 is +5 V with no signal applied and 0 V when a 950-Hz signal is present.

Operation

Once the above initial alignment is completed, no further adjustments need be made. When operating the interface, all one must do is tune the desired CW signal properly so that it falls within the filter passband and adjust the receiver's audio level to an optimum value. These two tasks, however, are not quite as easy as they sound.

The easiest way to tune your receiver for optimum operation of the interface requires an oscilloscope. While there is another technique, it has some severe limitations. I will first cover tuning with an oscilloscope, and then the alternative if a scope is not available.

Oscilloscope Method

For the moment, let us assume that you have a dual-trace oscilloscope at your disposal for operation of your receiver-computer combination. Connect one channel to TP-1 in the circuit and the other channel to TP-2. Use dc coupling for both. Use a vertical sensitivity of 500 mV per division for both channels and a sweep speed of 10 ms per division. Adjust the baselines of both traces to exactly the same point near the bottom of the graticule. You should then obtain a display similar to that shown in Photo B when a properly tuned signal is being received.

In the example, both traces have their zero baselines one division from the bottom of the graticule and the vertical and horizontal settings are as recommended above. The trace visible about one division above the center of the graticule is the TP-2 threshold voltage (about 1.8 V). The other trace shows the leading edge of a CW pulse that is being received. This display shows just about ideal reception conditions and is what you should strive for in your tuning. At the baseline of the signal trace, we can see that there is almost no noticeable noise between CW pulses. This situation is rare but does happen occasionally. (Indeed, the photo was taken during reception of a very strong off-the-air signal at about 25 wpm.)

The first step in tuning is to tune the receiver until the tone of the desired CW signal is centered in the filter passband, as evidenced by a maximum signal amplitude for the signal pulse on the oscilloscope display. This will take some care, due to the narrowness of the filter passband. After this condition has been achieved, the next step is to optimize the level of the receiver audio which is being fed to the interface. Making this choice optimally will require a little experience on your part (which will come with time), but I can give you a few hints.

Your primary goal is to maximize the signal-to-noise ratio at the slicer (which is what the TP-1 signal shows). This condition will give you the minimum error rate out of the slicer stage, and hence within the decoding algorithm in the computer. Since you have a limiter in the first stage of the interface, you will notice that you can increase the level of the desired signal only up to a point, beyond which it will no longer increase.

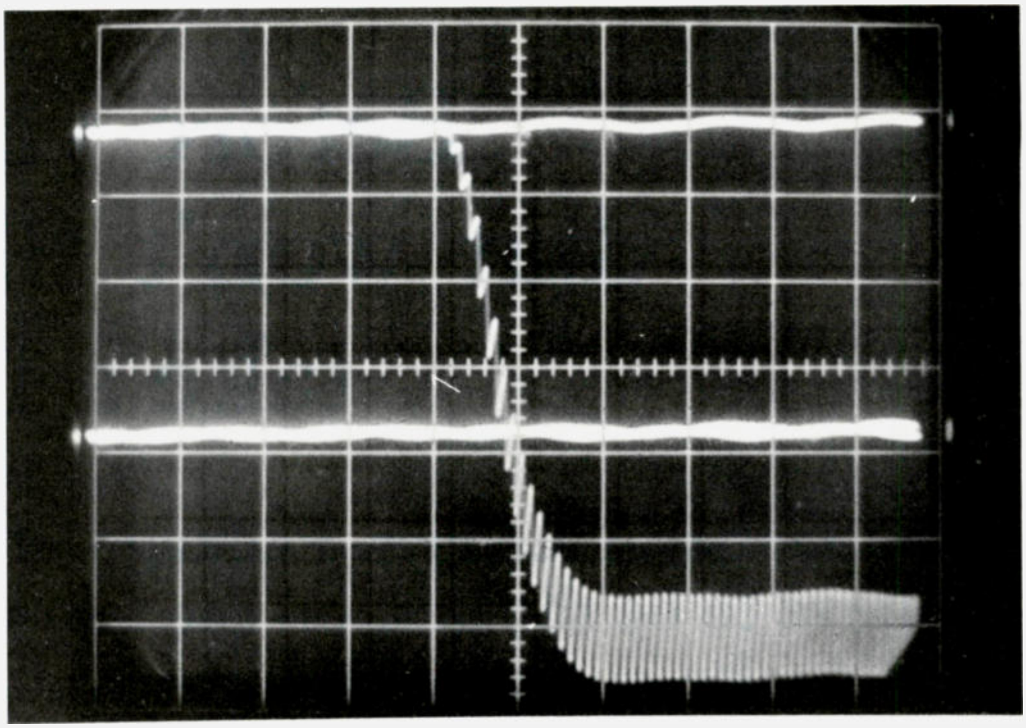

Photo B. Oscilloscope display.

You will notice also, however, that if you continue to increase the drive level, the amplitude of the noise and interference evident between pulses *will* increase. This is undesirable. Therefore, you want a condition where the signal gives the greatest difference between the peak of the signal and the peaks of the noise and interference as viewed on the scope. Next, decide whether the normal (high) threshold voltage is best or if the lower threshold would be better. Ideally, the threshold of the slicer should be halfway between the signal peak and the noise peaks. Then, by monitoring the oscilloscope display, you can ensure that the signal remains optimally tuned even if your receiver drifts a small amount or if the noise and interference conditions change.

When using this type of display, it is convenient to have the current slicer threshold (TP-2) superimposed on the display with one channel of the scope, but it is not absolutely necessary. If you have only one single-channel scope, just remember where you have set your threshold, or use an external voltmeter to monitor it while you display the TP-1 signal.

Alternate Tuning Method

As you probably have guessed by now, without an oscilloscope it would be very difficult to adjust the receiver for the optimum conditions described above. This does not mean that you cannot tune it to work fairly well most of the time, however. A VTVM attached to TP-1 also will give an indication of when you have reached maximum signal strength, but its fluctuations with the signal will be much more difficult to interpret. You also will have very little ability to judge the noise conditions between the pulses, but, if you are having a problem, you can compensate for these by doing a little trial and error with the detection threshold and seeing which one works better. You will find that you must tune the receiver slowly in order to find the very narrow passband of the filter.

Summary

This circuit evolved over several months of experimentation and testing, and I think it is a good compromise between circuit complexity and satisfactory performance. I think you will find, however, that while the computer can do a very good job of decoding well-sent Morse code under good reception conditions, the machine is no match for the human brain when it comes to poorly-sent code or very adverse noise or interference conditions. ■

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1. Thomas, William L., "Decode Morse—With an 8080," *73*, December, 1977.
2. Stark, Peter A., "Design An Active RTTY Filter," *73*, September, 1977.
3. Stewart, Dr. John F., "At Last! A Use For Your Computer," *73*, April, 1978.

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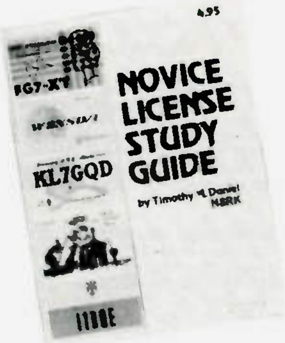

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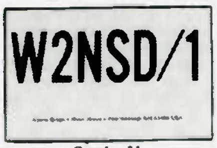

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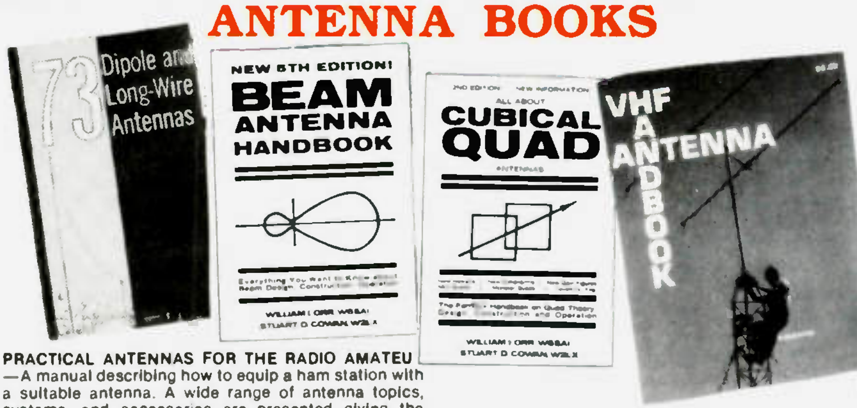

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by answering these questions.

A What is your education?
- 1 High School
- 2 Some College
- 3 College Graduate
- 4 Post Graduate

B What is your yearly income?
- 1 Less than $10,000
- 2 $10,000-$15,000
- 3 $15,000-$20,000
- 4 $20,000-$25,000
- 5 $25,000-$30,000
- 6 More than $30,000

C How much have you spent on amateur radio in the last 12 months?
- 1 Less than $100
- 2 $100-$500
- 3 $501-$2000
- 4 More than $2000

D What brand(s) of antenna(s) do you own?
- 1 A&A
- 2 Antenna Specialists
- 3 Avanti
- 4 B & W
- 5 Bassette
- 6 Bila
- 7 Buttern
- 8 Cushcraft
- 9 Da[illegible]
- 10 [illegible]onna
- 11 Gem
- 12 Gotham
- 13 Heath
- 14 Hustler
- 15 Hy-Gain
- 16 [illegible]
- 17 [illegible]
- 18 [illegible]reco
- 19 Larsen
- 20 Luna
- 21 Mor-Gain
- 22 Mosley
- 23 Sk[illegible]ane
- 24 Stewart
- 25 Te[illegible]
- 26 TET
- 27 [illegible]ar Gordon
- 28 Western Electronics
- 29 Wilson
- 30 Other

E What brands of HF and VHF equipment do you own?
- 1 Azden
- 2 Clegg
- 3 Collins
- 4 Drake
- 5 Heath
- 6 Hy-Gain
- 7 Icom
- 8 [illegible]
- 9 Kenwood
- 10 [illegible]
- 11 Mel[illegible]o
- 12 NCG
- 13 Santec
- 14 Swan Cubic
- 15 Tempo
- 16 Ten-Tec
- 17 Wilson
- 18 Yaesu
- 19 Other

F Are you now on RTTY?
- 1 Yes
- 2 No

G If not, are you interested in getting RTTY?
- 1 Yes
- 2 No

H Would you favor a no-code license if ham clubs were placed in charge of licensing?
- 1 Yes
- 2 No

I Would you like to see articles on satellite TV in 73?
- 1 Yes
- 2 No

J Which of these magazines do you read regularly?
- 1 73
- 2 Ham Radio
- 3 QST
- 4 World Radio
- 5 Popular Electronics
- 6 Radio Electronics
- 7 CQ

K How many people read your copy of 73?
- 1 1
- 2 [illegible]
- 3 3
- 4 4
- 5 5
- 6 6 or more

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3	8	[illegible]	[illegible]	23	128	133	138	143	148	253	258	263	268	273	378	383	388	393	398
[illegible]	[illegible]	14	19	24	129	134	139	144	149	254	259	264	269	274	379	384	389	394	399
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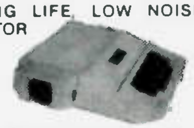

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REVIEW

KDK FM-2025A TWO-METER FM TRANSCEIVER

When you think about two-meter transceivers, what brand names come to mind first? Chances are, you'll name one of the big "full line" imported labels. There is nothing wrong with this except that you may be overlooking some of the other guys. What about firms like Azden and KDK? Both concentrate on selling a specific but high-quality line of radios. Until recently, I dismissed firms like these as "also-rans." Then I had a chance to review KDK's new FM-2025A two-meter FM transceiver. Now I'm a firm believer.

The FM-2025A is the latest in a series of two-meter mobile rigs that are manufactured by Kyokuto Denshi Company and imported into the United States under the KDK name. The 2025 represents a rather substantial departure from the earlier models, which included the 2015R, a great rig once you modified it. The staff at KDK has learned its lesson well; the FM-2025A offers many of the features that today's ham expects yet it remains simple and straightforward to operate.

Diode Matrix Programming

Like many of its modern day counterparts, the 2025A utilizes microprocessor control. In what seems like a step into the past, KDK has chosen to use a binary-coded-decimal diode (BCD) array to act as a program for the computer. Shades of the venerable Icom IC-22S. Or is it? Twenty-five diodes are used to program such functions as the low-frequency band edge, high-frequency band edge, transmit high-frequency band edge, a choice of 5-kHz or 12.5-kHz steps, the standard repeater offset, and band-scan step size. The unit comes factory programmed in a manner that will appeal to the vast majority of North American users. However, if you move overseas or have a need to operate outside of the US amateur allocation, it's a straightforward task to reprogram the KDK to meet your new needs.

If you are like me, most of your two-meter operating is done on a few local repeaters with occasional forays to other machines if you're traveling. Perhaps the easiest way to use the KDK is to program your favorite machines into the memories. There are two sets of memory, five channels each. You can use the channels independently or in a duplex mode where you receive on the "A" channel and transmit on the "B" selection. Since I frequent only a few repeaters, I find myself using the duplex mode. That way, I don't have to worry about switching the repeater offset selection when I change frequencies.

If you use more than five channels on a regular basis, then you may want to make full use of the ten memories by employing the offset switch for everything but the repeaters with oddball splits. The FM-2025A includes a nicad battery that provides internal backup for the memory when the radio is switched off. The infinitesimal 57-nano-ampere current drain allows the battery to last for as long as one year between charges.

Scanning

The FM-2025A offers two modes of scanning. You can search the ten memories for an open frequency or for a frequency in use. When the channel changes status, the receiver starts scanning again. If you want to lock the rig on frequency, just flip the scan control to the HOLD position.

The same options are available in the band-scan mode. The scanning starts with the frequency stored in memory A5 and proceeds upward to a limit determined by the contents of B5. But you can't fool the rig; if the B5 frequency is lower than the A5 selection, there will be no scanning.

The nice thing about the KDK's band scanning is its zero detector. This ensures that receiver scanning stops only on the center of a signal. The only difficulty I encountered came when I tried to scan near 144.000 MHz. An internal spur caused a false locking there.

One useful 2025A extra is a built-in tone switch. An internal switch allows you to select between a continuous tone or a half-second tone burst. There is no need to run out and buy a new encoder if your favorite machine goes private. There is easy access to adjustments for the tone generator's frequency and output level.

Procedures like this are explained well in the instruction manual. Unlike many manuals that accompany new gear, the KDK book is written with the assumption that the reader has some intelligence; it presents more than just an idiot's guide to installation. You'll even find four pages of technical and adjustment information plus a larger-than-usual schematic diagram.

The KDK's construction is nothing short of rugged. The vast majority of the rig's circuitry is on two boards, with the digital-based control circuitry on one and the rf blocks on the other. The lack of interconnecting wiring harnesses and cabling leads me to believe that the 2025A will easily withstand a harsh mobile environment.

The back panel includes a jack for an external speaker (and once you have tried this you will never settle for a built-in speaker again), antenna and power connectors plus an accessory connector that includes microphone input, audio output, transmit-receive switching, and connection to the 13-volt dc power supply.

Moving back inside, I noticed that all of the frequency generation and most of the audio circuitry was centered around integrated components. The rf section still utilizes a fair number of discrete semiconductors, but the chip-based technology is rapidly closing the gap.

Plus and Minus Points

With a growing trend towards higher power for two-meter transceivers, the 2025A holds it own with a choice of two power levels, either one of which can be set between 3 and 25 Watts. If you need still more power, then consider an amplifier; you also get the added advantage of a receiver preamplifier that way. Unlike most of the other new FM rigs appearing on the market, KDK retains the traditional d'Arsonval meter movement for the power-out and signal-strength measuring chores. I can't knock the newfangled LED bar displays without trying them, but I do know that the old-fashioned meter makes the radio look more "professional."

Among the bells and whistles that you won't find on the 2025A is a priority channel. Nor is there a provision for up/down scanning via switches on the microphone. For me, the lack of these features had no effect on my operating style.

Perhaps the biggest drawback of this easy-to-use radio is the close proximity of the volume/squelch, mode, and memory-select knobs. They are all the same size and easily confused if you don't glance down at the rig.

On an overall basis, I give the FM-2025A high marks. It represents a substantial step forward in ease of operation.

The KDK VHF FM-2025A transceiver.

While it doesn't resemble the mission-control-panel look prevalent on a lot of new rigs, it is a sophisticated, feature-laden radio. It should be especially popular with amateurs who want a radio they can tinker with. The 2025A certainly proves that KDK is more than just the "other guys" when it comes to building radios.

In late 1981, the FM-2025A was priced at $299. For more information, contact *KDK Distributing Co., 617 South Gallatin Road, Madison TN 37115*. Reader service number 476.

Tim Daniel N8RK
***73 Magazine* Staff**

DFD SYSTEMS RT-89 RTTY SYSTEM

The DFD Systems RT-89 package is a disk-based RTTY system for Heath/Zenith H89 and H8/H19 computer systems. It runs under the Heath Disk Operating System (HDOS), providing unmatched features and flexibility for the serious RTTY enthusiast. The system is designed to operate on a single-drive, 48K machine with plenty of space left over for disk read/write files and memory buffer space. All input/output operations are buffered and interrupt driven, allowing true full duplex (send-while-receive) operation and real-time disk file read/write capabilities without loss of data.

There are 66 commands implemented to configure the system and control program operation. In addition, a special file, "RTTYINIT.TTY", is automatically read at program startup time to establish the initial system environment. This file can be individually tailored by the user to automatically boot the system in any desired configuration.

RT-89 will operate at speeds of 60, 66, 75, and 100 wpm in the Baudot mode, or at any standard ASCII baud rate from 110 to 19,200. Automatic synchronous idle (diddle) may be selected at any of these speeds in either mode, and an automatic downshift-on-space (DSOS) feature is selectable in the Baudot mode. All CW identification is automatic, including an ID at nine-minute intervals during any single transmission. This feature can be disabled with a keyboard command if desired. In addition, a CWID shift control and transmitter on/off control are available from the computer.

An automatic disk log is maintained each time the transmitter is keyed, and manual entries may also be inserted on the log at any time with the N= command. The time of day is automatically recorded with each log entry, so the system log can also be used as the station log if desired!

System line width can be varied from 20 to 80 characters since the H89/H19 terminal has a full 80x25 line display. The screen is split into four functional areas: a receive window, a transmit and command window, a split-screen and status-display bar, and a "times square" moving-marquee format on the 25th line that displays the transmitted data as it is actually transmitted. This latter feature is useful when the transmit buffer has been preloaded or a disk file is being transmitted, since the transmit window displayed the buffer contents as the transmit buffer was loaded, and the 25th line actually displays the buffer data as it is being sent. Therefore, the operator always "sees" what is being transmitted over the air at any given time. The sizes of the receive and transmit/command windows are dynamically variable and may be changed at any time during system operation. In fact, any commands may be issued at any time (except during transmit), so there is never a need to stop the program to reset any parameters as there is on some other systems.

The system may be directed to ignore carriage returns in the receive window, thus "packing" a maximum amount of data on the screen. The carriage returns are not ignored, however, on the printer or disk files, so the actual format of the received data is not lost (you can write on the printer, read and write on disk, and receive and transmit all at once, in real time, due to the interrupt-driven I/O structure).

Any number of files can be written to or read from disk at any time, and the printer may be turned on and off at will, independently for received and transmitted data!

A variable-length "word-correction buffer" is provided to allow correcting of keyed input data prior to its release to the system. The length of this buffer may be set from 1 to 80 characters, and facilitates backspacing over entry errors and correcting them before transmission. There are actually two cursors displayed on the screen: a flashing underline cursor which indicates where the word correction buffer starts, and a destructive block cursor indicating the next location that will be occupied by keyed input. In addition, the system can be directed to automatically "wrap around" when the end of a line is reached and no carriage return is keyed. In this event, the system will automatically move the last word keyed to the next line, if it is incomplete, and issue the carriage return itself.

An unusual and very enjoyable feature provides the ability to process RTTY pictures. The system may be placed in the PIX mode, and overlining will be allowed on input and output files and the printer. In addition, three off-line programs are included with the package that will allow one to edit PIX files with the standard HDOS text editor, and automatically compress and expand those PIX files to conserve disk space. PIX files received over the air are actually compressed before they are written to disk, and compressed PIX files on disk that are read for transmission are automatically expanded by the system at transmit time!

In addition to the unlimited disk file capability, there are three temporary single-line buffers that can be loaded and read out using the three colored function keys on the H89/H19 keyboard. These are handy for holding calls of current stations in QSO or repetitive contest information. Other function keys can be used to insert the current date and/or time in the transmit buffer. (The time of day is also always maintained on the split-screen bar.)

In operation, the TX or TXF commands will put the system in transmit mode, and a CONTROL-C will terminate the transmit mode. Data can be entered into the transmit buffer while in receive mode, and that data will be transmitted the next time TX (transmit) mode is entered. TXF (transmit fast), on the other hand, will not send the data in the transmit buffer, but will only send data keyed from the keyboard. TXF, therefore, is used to answer a quick question or to send a quick message without sending the data in the transmit buffer. After TXF, more data can be entered into the transmit buffer, if desired.

Disk-based commands include opening and closing disk files for either read or write, displaying directories, deleting files, exchanging files, and swapping disks in drives 1 and 2.

Performance

The FT-89 system has performed very well for more than a year of operation on both the HF and VHF bands. The system was designed to support Navy MARS message traffic as well as amateur traffic, and has now replaced all mechanical teletype equipment at Navy MARS stations NNN0AFL and NNN0ZVW. No system problems or failures have yet been encountered at either station.

The system includes complete operational documentation and directions for interfacing the computer to a terminal unit. The system has been successfully interfaced with a HAL ST-6, commercial and home-brew Flesher TU-170s, and the iRL-500. The iRL-500 interface was the easiest to accomplish since it already had inputs and outputs to directly interface to the computer at RS-232 voltage levels.

Each RT-89 system is personally generated for each purchaser to include the station callsign. This callsign is permanently displayed on the split-screen bar during system operation and is used in generating the CW identification. Minimum hardware requirements are an H8 (with an H19 terminal) or H89 computer, a single disk drive, and 48K memory. HDOS is also required to operate the system. The package consists of the programs on a 5¼" diskette and an instruction manual. The cost is $39.95. For further information, contact *DFD Systems, 4805 N. 107th Street, Omaha NE 68134*. Reader Service number 477.

Dick Jugel K0DG
8014 Taylor Circle
Omaha NE

INTERFERENCE HANDBOOK

Whether the alphabet-soup nomenclature is TVI, RFI, or EMI, interference is a constant threat to the radio amateur, lurking in the shadows, waiting to turn docile neighbors into a horde of angry enemies. Even though the war against interference has just begun, there is hope for the ham-radio army. Radio Publications' new book, *Interference Handbook*, is destined to become a bible for the tactics-minded foot soldier. The author of *Interference Handbook* knows what he is talking about; William Nelson WA6FQG is the veteran of sixteen years of trench warfare as an RFI investigator for Southern California Edison Company.

RFI has plagued us ever since Marconi made his first transmissions nearly a century ago. While modern-day legislators and manufacturers grapple over a long-term solution, the problem gets worse and the poor radio amateur is caught in the middle. The approach that *Interference Handbook* takes is best summarized by the quote: "The purpose of this handbook is to outline the many sources of interference; explain how to eliminate or reduce them; and tell you how to protect yourself against RFI. The causes and cures of RFI are discussed in nontechnical language that is easy to read and understand."

The topics discussed range from interference caused by home appliances and the RFI emitted by power lines to the misunderstood role that hams and CBers play in causing and solving interference problems. Along the way, the author gives case histories based on his years as an investigator.

Tips for locating interference with inexpensive gear are accompanied by descriptions of commercial and homemade cures. The contents will be of interest to anyone who deals with electronics. This could include the members of a radio club interference committee or a music lover who is plagued with automobile ignition noise. The book is rounded out with a listing of addresses for gaining help from manufacturers.

Interference can work both ways as evidenced by recent experiences at the *73 Magazine* ham shack. Several months ago, a pulsating noise of unknown origin kept us bewildered (and off the air) for several weeks. More recently, a neighbor has complained about TVI that may be the result of our station. In both of these cases, a volume like the 247-page *Interference Handbook* would have helped to reduce the mystery and aggravation for everyone involved.

A paperback edition of *Interference Handbook* is available from the publisher, *Radio Publications, Box 149, Wilton CT 06897*, or *73's Radio Bookshop, Peterborough NH 03458.*

Tim Daniel N8RK
***73 Magazine* Staff**

LETTERS

QRZ CONTEST?

The weekend is here, I can't wait to get my cup of coffee, go downstairs and turn on the rig, and relax with some CW. Cranked up the old workhorse, my TR4-C, switched on the keyer. I love CW, my phase of enjoying ham radio, and spend most of the time on 20 meters and a little on 40 meters.

Here comes the audio, and what? Not again! The entire band loaded! Another contest? I thought they just finished one; you know how time flies. I must admit I have been in only one contest, in the early 60s, and cannot remember what it was for, but learned it was not for me. There are no redeeming factors in them that I can see. A field day or emergency preparedness operation so as to be able to get a station on the air fast in almost any location, portable, of course, to assist those in need of help, I am all for without exception, but to sit for 12 or 24 hours at a key or a microphone causing a traffic jam worse than the California freeways ever saw is a gross waste of time and energy.

I enjoy a good rag chew—or at least to find out more than a QTH and a name that's in the *Callbook*—talking over your experiences, experiments, good or bad, is a greater way to enjoy one's on-air time.

Let's think about it; contest weekend as it appears to me seems to relate itself to the opening of hunting season, the night before everyone participating making final preparations, checking their "guns" for the big day. From cannons to peashooters they are all ready. The clock is ticking away the last few minutes before the action begins. The beams are poised at each other, power supplies humming away, fingers begin twitching, one ready to send, one ready to record the contacts, then bang! A solid wall of rf rips through the ether and for the next day the battle for the climb to the top rages on. Stepping on each other, over, under, and around. When the period of time for the contest is over and the electromagnetic radiations clear, the battlefiled can be seen strewn with broken and mangled coffee cups, smoking ballpoint pens, splinters of pencils, and scraps of paper. The casualties are entering the "hospitals" with keyer finger, tennis wrist, another form of keyer finger, and ear-ring: a new one, being a depression in a circular fashion around both ears, manifested by a constant series of tone bursts that won't subside.

Why so many contests? Aren't there enough awards to be gotten on one's own without the additional promotion of contest after contest? I would like someone to reply and let me know.

Now don't get me wrong. I have gotten a few of those symptoms myself. What I am trying to say is those who prefer contests are good hams, they enjoy their phase of ham radio, a great hobby filled with very nice people. But all I ask for us in the apparent minority is that on those special weekends, those who sanction such contests *think*, think of the other hams who are not participating and leave at least 10 or 15 kHz aside for those of us who would like to just get on and relax with a good QSO, be it CW or SSB.

Why should the bands be totally monopolized during these periods? A lot of us just do not have the time to spend on the bands and really look forward to our weekend operation.

Gary L. Jackson N2ACX
Delron NJ

N2ACX UR 599 NH DE WB8BTH BK.

THANK YOU, ERIC

As a subscriber, I feel it is my duty to inform you of the good job you are doing. I am a new subscriber to your magazine and I love it! I am 13 years old and a General class ham. My father is also a ham and he likes your magazine, too. Between my father and I we receive *QST*, *Ham Radio*, *CQ*, *73*, and *CVRA-SERA Journal*. We enjoy your magazine the best. The $25 is well worth it. I find many interesting articles in your magazine. In *QST*, *Ham Radio*, and *CQ* I rarely find a really good article. Many times the advertisements are the best things in *QST*! I can't say *QST* is a bad magazine—it has many important references. The other magazine (journal), *CVRA-SERA Journal*, is a great magazine. I find it and *73* the most interesting.

Thank you for your time. I just wanted to tell you how great your magazine is. Keep up the good work!

Eric Lassiter KA4KEG
Danville VA

WIN SOME, LOSE SOME

The last of the ham radio publishers bit the dust! I never thought you would pass us off for the quack electronics, but my new December issue with satellite TV, computer scanners, and all really opened the old eyes. I think I'll go back to model trains. I get enough of the electronic garbage at work all day. NO renewal for me next spring.

Ed Chenoweth K4HYG
Zephyrhills FL

Sorry to lose you, Ed, but we do have to bring news of what is happening in electronics to those amateurs who are helping the hobby to grow. . . who are interested in things beyond spark gaps. I realize that not all hams are going to be inventing and pioneering new techniques, but

I had hoped that those who are more interested in taking a free ride on the shoulders of those who are doing the work would at least be honorable enough to read about it and cheer them on instead of trying to shoot them down.—Wayne.

KNIT PICKING

Seldom do I write to the editor of a magazine, but every once in a while something will catch my eye. Such was the case when you asked in the October *73 Magazine* what we could do to spur the growth of ham radio.

Let me state that I am flatly opposed to no-code licenses. We already have them in the form of citizens band communications (I use the word "communications" with some reservation in this case), and I for one don't want 15-meter phone sounding like that. I really can't imagine that you do either.

Now to the basic question: What can we do?

1. We can exert pressure on the Federal Communications Commission through our elected representatives to take the tricks out of amateur exams. For example, a friend recently took (and passed) the Extra class examination in Boston. Part of his code proficiency test involved the apparent word "Springfield," but on the tape it was sent "Cpringfield." Granted, this quickie will determine if the examinee is paying absolute attention, but does it prove anything else? Is this the type of thing one would encounter in a normal QSO (which the tape is supposed to emulate)? I think not.

2. We can stop regarding ourselves as an elitist group. While my previous reference to citizens band could be construed as elitist—and perhaps it is—we must recognize that our hobby is no better than that of anyone else. If a CBer wants to be a CBer, then so be it. If an audiophile gets enjoyment from his "thing" then let him. We should not continue with the attitude that everyone in electronics either should "progress" into the ham fraternity or be relegated to second class. Perhaps if we are less pushy more people would *want* to join us.

3. Along the same lines, we should make more of an effort to help the newcomer. We spend a lot of time and effort getting people into ham radio through Novice classes, but how many Novices have given up on our hobby because the Techs, Generals, Advanceds, and Extras were too busy with their own interests to give a hand *after* the newcomer got that much-anticipated ticket? If you're not really sure of what you're doing and there's no one to help, amateur radio can be pretty confusing. Take the time to help a Novice; you may be saving tomorrow's Extra class licensee.

4. Again, along the elitist line, we need to have more of those "in the know" willing to make what they know readily available. It does not seem consistent to this writer that an editor of a widely-read ham publication could advocate the spread of our hobby on the one hand and then ask $1,000 or more for a speaking engagement at a hamfest on the other. Granted, Dayton and Birmingham can probably afford this tariff, but Windsor (our local hamfest) can't, and Windsor is more likely to touch a greater number of new and prospective hams in central Maine than are Dayton and Birmingham combined. Please don't take this as a personal attack, Wayne, but you *did* ask for constructive ideas.

5. We need more affordable equipment designed for beginning amateurs. Unfortunately, our hobby is pricing itself out of the reach of many would-be joiners because they can't afford a Kenwood TS-530, an Icom 720A, or an Astro 150. What we need are more Ten-Tec Century 21s that let the little guy get his feet wet with new (a Novice doesn't need the problems which often come with used gear), reasonably priced, and effective equipment.

6. Finally—for now, at least—we need effective representation in the FCC. Some government commissions are required to reflect in their membership the interests of those that they regulate. Why not a ham as a required commissioner, and a CBer, too? Who knows better what we want than one of our own? Certainly not some politician from the "in" party who had the misfortune of losing in the last election.

Well, Wayne, there you have it. I hope this letter will prompt others to put on their thinking caps and come up with more and different ideas. I wouldn't even object if theirs were better.

Bill Crowley K1NIT
Hallowell ME

No offense, Bill; the $1,000 goes for a special fund for promoting amateur radio, not into the general coffers. Without that limitation I've found that I am getting dozens of invitations to talk... few of which would be possible for me. Thus, this is a filter... and also a benefit for amateur radio. You're right about the tricky exams... there is no excuse for them. There will be cheaper ham gear for beginners when we have enough beginners to make it profitable to make the stuff. Remember that plenty of equipment has been put on the market in the past, but it has not been continued due to an almost total lack of newcomers. And look what happened to the newcomer magazine, Ham Horizons!*—Wayne.*

THE HEATH SNOOZE

I have just finished the conversion of my Heathkit clock as stated in the November issue of *73 Magazine* ("Extra Accuracy for Heathkit Clocks," page 124).

There were no conversion or cross-reference lists at any of the local Radio Shack stores for a switch with part number 275-430. I could have used another RS switch, but keeping with amateur radio practice I quickly realized that the Alarm Set Switch (SW3) could be used and the old Snooze Alarm Switch (SW2) wired in its place. It is a little cumbersome to use in setting the alarm, but then I don't use this function. My clock works as stated in the article.

The wiring is done in the same manner as Art N5AEN stated, and the new SW3 is wired as shown in the clock manual.

Others may be interested in this miser's scheme to beat down the rising cost of ham radio.

I've enjoyed *73 Magazine* and will continue to do so.

Jack Garner KB7HH
Phoenix AZ

THE BIG ZAP

When I read *QST*, I first look at the silent keys. With your *73*, I read the editorial. I was especially interested in the radar devices you use and test. My mobile friends tell me the devices are not very good anymore. The policeman with the gun pops it on and gets a reading and you are hooked. No more carrier to seek out. I don't travel much anymore, but I do have a new approach to traffic tickets.

I propose a tape-deck player and a specially-prepared deck that starts with fifteen seconds of soft music, and then a convincing commercial announcer who breaks in with the news that the USA is being attacked by USSR missiles and the President is on his way by helicopter to the Virginia underground shelter... all citizens are to go to any nearby shelter. News flashes give reports of missiles twenty minutes from Chicago, Detroit, Washington...

I think by this time the trooper is on his way and you are free to go to your destination.

Just don't get stopped by the same guy the second time.

Ed Kirchhuber K4JK
Elkmont AL

Fiendish... I like it! The radar gun? I've only run into one once in New Hampshire so far, so it isn't much of a problem here. In that case, I got plenty of warning before I even got close due to the sensitivity of the superhet detector and was safely not transmitting on two meters when I went through the check point. Your detector should pick it up a half-mile to a mile away and give you plenty of warning to stop transmitting so you won't rack up a speeding ticket even when you are moseying along at 55 per. The officer generally takes a shot at a car ahead of you and you pick up that blast. This also gives you a chance to check your speed... which averages around 70 mph on most of our interstates.—Wayne.

GUS TRAVELS AGAIN

Those of you who have been around ham radio for more than a few years undoubtedly remember Gus Browning's fabulous DXpeditions of the 50s and early 60s. Well, W4BPD is back at it again and will be sending us monthly reports on the progress of his current round-the-world trip. Welcome aboard 73, Gus!

This little episode is being written while we are at anchor down in Florida awaiting a few minor repairs to be completed on the boat, but by the time you read it we will be somewhere in the Caribbean. We have named the ship *DX* since DX is what it's all about with us. Our mail address from now until this trip is completed is just "DX, 29039, USA."

A friend of mine talked with me up at DXPO 80 last September and asked me the question, "Have you ever thought about another DXpedition, Gus?"

You know what my answer was ("I have the time if you have the money"), and he said that money was no problem! It ended up that a boat was purchased and the old rat race of getting it shipshape for a real DXpedition began. The result is that here we are about to take off for the *complete* Caribbean tour; we'll go to every country down there that we can get permission to operate from. (They tell me that licensing is no problem at almost every one of them.)

This feller Wayne Green must have lots of pull somewhere because both on our way from Annapolis to Beaufort, South Carolina, and then again from Beaufort down here, I saw a sign on the Inland Waterway on the left side each time with the numbers 73 on a *green* background. And this Wayne Green don't fool around, neither, because when I mentioned writing a series of letters for *73 Magazine*, he said, "Don't stand there, start writing." So here I am doing just that.

This DXpedition should be considerably different from the others I have been on. This is planned to be an island-hopping DXpedition with inland excursions when it's possible and worthwhile from a DX viewpoint. We will be going by the seat of our pants all the way. This DXpedition by boat sure will be a lot better than the other ways I have used before, and it sure will be lots cheaper to charter a ship than to spend anywhere from $100 on up per day the way I've done it many times before. Since 99% of our traveling will be sailing, using the wind for power, it will be very interesting to see how our overall expenses compare with those of trips when other means of transportation were used.

The purpose of the first portion of this trip will be twofold: We will be shaking down the boat and we will be trying to see how we get along with each other being cooped up over long periods of time in a small space. There are three of us—myself, my XYL, Peggy, and Sam, a WA3 from the Washington DC area who purchased the boat. So far we are quite compatible, though at times a little touchy with each other, which we all expected before we ever got started.

Our tentative plans are to cover the Caribbean, probably taking until the next hurricane season, which starts next June. Then we will sail back to Beaufort to have the boat gone over with a fine-tooth comb and to visit all the grandchildren, the kids, and our friends. We'll restock the boat's larder, tighten up all the bolts and nuts, and then take off for the Panama Canal, the big, wide Pacific, and all those countries out there waiting for us to Dxpedite. If things are still "go," then we will continue on around the world, hitting as many spots as we can along our line of travel. We won't mind deviating from this line of travel a few hundred miles when, from a DX viewpoint, it looks like that's what we should do.

The very first thing we all agreed upon was that we wanted this trip to be a safe one. Since we have no set date to be anywhere along our route, we can always wait for the weather to get right before we depart from spot A to go to spot B. If all three of us like a certain place and want to spend a few more days or even weeks there, we will do just that. This will more or less be a leisure trip with DXpeditioning a first priority on our list. Right now, we are at the creeping stage; we hope to be at the walking stage when I write the next installment, and at the running stage from there on out.

We have a very good ship, an O'Day 37 (measuring 37 feet long and 11 feet across). How would you like to make something like this your complete home for up to five years? It will be on the rough side, but we will be in there trying our best to stick it out. Our ship is fully equipped with all the very latest gear. We have a satellite navigator that does a better job of pinpointing our position than most maps. We have a good radio direction finder, a good VHF transceiver, and, of course, a sextant, which I have practiced on for months. I still need more practice to get good on it. We have a huge pile of maps and charts but will need many more when we get to the Pacific and other oceans on our way around the world.

We will be taking it easy along the way and hamming as much as possible. We plan to use both CW and SSB on equal terms, going by the apparent needs of the fellows. We have the full Ten-Tec line of gear, their Omni-C, Hercules linear, electronic keyer, and antenna tuner for the long wires we may put up for the low bands. I cannot get over the Ten-Tec's fast break-in, the no tuning when you change bands, and the almost silent receiver when you disconnect the antenna. As a back-up, we have Ten-Tec's Delta. Our antenna is a TET and it will get a real test of endurance on this trip. As you can see, we're delighted with the equipment we have.

QSLs will go out three different ways. When we have time after the trip, every QSO in the logs will go out via bureaus. The second way of QSLing will be direct to those who send their cards to out "DX 29039 USA" headquarters and contribute $1.00 to help us defray the cost of QSLs, postage, and Girl Friday making them out. The third method will be direct from the spot where we work you or, if necessary, from the next spot we operate, to those making a $2.00 contribution to help us with expenses. (We do not expect to come anywhere near breaking even on our expenses.)

I don't think we can help anyone with 300 or more countries, but we might be able to help you if you have 200 or so. Maybe we will help some of you on 40, 80, or 160 meters. Later on we may use other means and ways of communications. We are, of course, open to your suggestions. We may or may not follow them, but "try us"—hi.

On CW, look for us 25 kHz from the low end, except on 160, 80, and maybe even 40. On SSB, when we are not under FCC rules, we will try using more or less these frequencies: 28490, 21190, 14105, 7090, 3790 kHz; and on 160—who knows, hi. But once we settle down on the frequencies we want to use, these will be where we will always be found, plus or minus QRM. I can promise you I will never get mad at anyone on the entire trip. A real nuisance to us may have a difficult job getting our QSL for his contact—the last laugh will be us doing the laughing, hi.

Up to now, there has been very little contributing or donating by anyone, so I am under obligation to just a few and I know who they are. I don't mind tail-enders or any other way you can come up with to get your call in my log. I try to work the weak ones first, so if you are QRO please go QRP if you want to work us first, hi. At times we will QSY into the Novice bands and will usually be tuning in the parts of the band Generals can use. But you had better have wide shift-split capabilities, or you may miss us. Occasionally, we will use transceive, but don't depend on this mode for many contacts with us. I say get yourself an outboard vfo and join in with the real DXers.

There will not be any of this list type of stuff on this DXpedition—if you want to QSO, get in there and work me. I don't want any of this stuff: "Gus, so and so said you are Q5-S7"; I want to hear that report and call myself without any assistance from helpers on the sidelines.

That's it for this episode, fellows—73 de Gus BPD.

Gus Browning W4BPD

HAM HELP

I am in need of technical information for the RCA AR88D receiver. I am also looking for a 24-hour brass ship's clock.

Mickey McDaniel W6FGE
940 Temple St.
San Diego CA 92106

I am searching for information on the use of electric limit switches with a Triasto TX-455 crank-up tower.

Don Greenwood KC8GZ
2687 Timothy Place
Wooster OH 44691

FUN!

John Edwards KI2U
78-56 86th Street
Glendale NY 11385

HAMS AND COMPUTERS

Shh! Keep this quiet! Don't tell anyone, but I think microcomputers are taking over amateur radio.

Take last Friday, for instance. I'm working this station on CW—AF2M, I think the call was—and he's telling me about his rig, the weather, and all those other things that make QSOs so interesting. Then, all of a sudden, something must have blown in his shack because he just keeps sending "599, 599, 599 . . ." After about 10 minutes of having my signal verified, it dawns on me—AF2M is a machine! Egad! This is worse than CB. At least on the chicken band you pick up animals, not androids.

It's scary. So scary, in fact, that I decided to write a column about ham radio and microcomputers. Here it is but don't tell anyone. I hate to be an alarmist. Where the heck did I put my nightlight?

ELEMENT 1—CROSSWORD PUZZLE
(Illustration 1)

Across

1 Letters and numerals
8 Below high frequency (abbr.)
9 Direct memory access (abbr.)
10 Computer lingo
13 Package type (abbr.)
15 Operating position
18 ____ line
19 Former big-time computer manufacturer (abbr.)
20 Program that revises (2 words)
22 And off
23 Data processing (abbr.)
25 Bulletin board (abbr.)
27 Semiconductor type (abbr.)
29 GOSUB

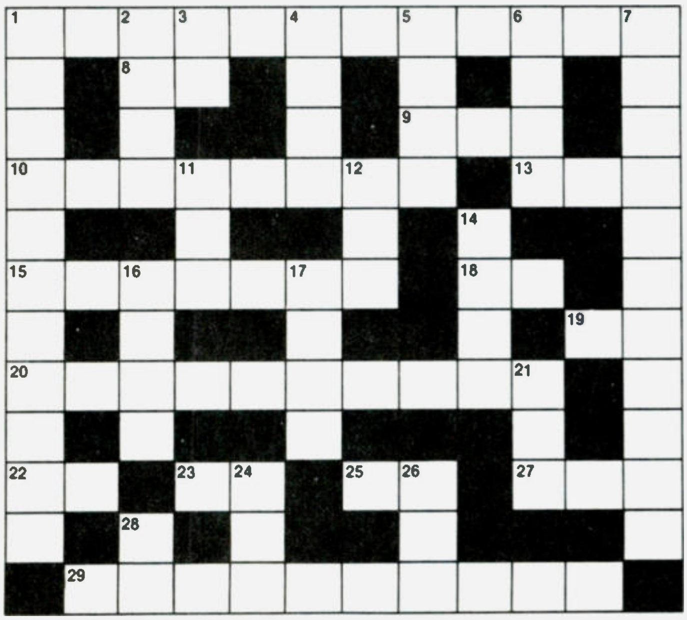


Illustration 1.

Down

1 Computer use
2 Scheme
3 Below VHF (abbr.)
4 They bought micro for shuttle (abbr.)
5 Statement of condition
6 "Only" type of memory
7 User
11 Crummy software often runs out of this
12 Golly
14 Instruction
16 To follow immediately
17 Bright diodes (abbr.)
21 Memory type (abbr.)
24 Cycles in a second
26 Smallest computer unit
28 μ

ELEMENT 2—MULTIPLE CHOICE

1) Computers can exchange information by using a code known as ASCII. What does this acronym stand for?
   1. American Standard Code for Interchanging Information
   2. American Standard Code for Information Interchange
   3. American Standard Code for Interconnecting Information
   4. American Standard Code II

2) Who was Herman Hollerith?
   1. Father of the punch card
   2. Father of punched paper tape
   3. Inventor of the floppy disk
   4. Inventor of the CRT

3) What are "Napier's Bones"?
   1. The remains of August Napier, inventor of the first analog computer
   2. The first pocket calculator, named for the device's ivory color
   3. A figment of the imagination
   4. Ivory rods which, when placed next to each other, can be used for multiplication calculations

4) An "automaton" is:
   1. A mechanism under the constant control of its own resident intelligence
   2. A mechanism under the constant control of a human or other external intelligence
   3. A mechanism under the constant control of a programming routine previously supplied by an external intelligence
   4. A waste of time

5) How many laws of robotics did Isaac Asimov detail in his book *I, Robot*?
   1. One 2. Two 3. Three 4. Four

ELEMENT 3—TRUE-FALSE

	True	False
1) HAL, the computer in *2001: A Space Odyssey*, was built at the Hal Plant in Urbana, Illinois, on January 12, 1997.	____	____
2) Speaking of HAL, his name stood for Heuristically-programmed ALgorithmic computer.	____	____
3) The word "robot" was coined by Czechoslovakian author Karel Capek in his play *R.U.R.*	____	____
4) An early electronic computer, ENIAC (1946), contained 19,000 vacuum tubes.	____	____
5) After ENIAC, there was a computer called MANIAC.	____	____
6) PASCAL, the computer language, was named after Blaise Pascal, a 17th century French philosopher.	____	____
7) The "Computerist's Code" states that a computer user should never use his equipment to harm anyone.	____	____

8) BASIC is a high-level language. ______ ______
9) Bubble memory uses microscopic magnetic bubbles. ______ ______
10) CPU stands for "Control Programming Unit." ______ ______

ELEMENT 4—HIDDEN WORDS
(Illustration 2)

Hidden in this puzzle are words representing 15 different computer terms. The words are formed in any direction—horizontally, vertically, or diagonally, forwards or backwards. As you find each word, circle it.

G	W	Z	M	A	T	R	L	O	A	D	E	P	T	I
A	I	A	R	I	A	D	A	B	A	E	A	O	A	S
R	D	I	B	R	L	W	N	C	I	B	A	U	D	R
B	D	A	A	Y	A	X	I	H	N	U	C	E	L	E
A	I	Y	R	O	M	E	M	F	E	G	G	N	U	A
G	E	R	A	P	B	N	R	I	C	V	S	A	M	T
E	A	R	C	I	S	T	E	E	D	K	G	T	N	T
J	O	B	O	O	T	S	T	R	A	P	T	H	D	R
R	W	D	M	U	N	A	R	E	A	A	G	R	I	A
E	H	S	P	I	D	P	X	S	G	T	L	V	A	H
T	H	I	I	J	E	R	C	S	A	R	Y	E	S	C
N	N	O	L	T	N	A	D	D	R	E	S	S	K	W
I	E	S	E	J	L	A	D	D	P	T	N	E	E	O
R	D	G	R	O	E	F	S	G	S	Y	D	O	N	L
P	W	R	E	H	Y	R	A	N	I	B	A	R	R	F

Illustration 2.

READER'S CORNER

Do you have a ham-related puzzle you would like to share with FUN's readers? Then send it in for a chance to see your name in print. This month's contribution is by Joe Strolin K1REC, of Norwalk, Connecticut.

MAGIC SQUARE
(Illustration 3)

Circle any number, then cross out all numbers in the same row and column. Do this until only one number is left, to get the message.

Send in your answers. We'll print the name and call of everyone who solved the puzzle.

14	15	13	16
13	14	12	15
21	22	20	23
23	24	22	25

Illustration 3.

THE ANSWERS

Element 1:
See Illustration 1A.
Element 2:
1)—2. And you know what great stuff American Standard makes.
2)—1. Ever noticed how these cards are only a little larger than a dollar bill? That's because HH used the dollar bill of his time (1890) as the template for his card. He invented the card and its reader for use in the US census.
3)—4. Scottish inventor John Napier (1550-1617) developed this precursor to the slide rule.

Illustration 1A.

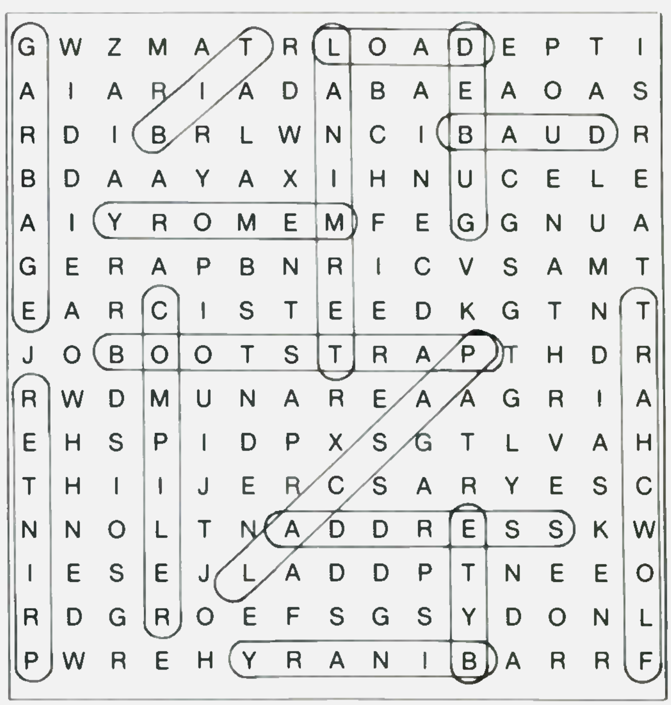


Illustration 2A.

4)—3. 1 is an android, 2 is a robot, and 4 is what noting the differences is.
5)—3. And if you break one of the three, you'll get a robot fine.

Element 3:
1)—True Long way from the ST-5000, Dr. Chandra.
2)—True Try saying that 10 times, fast.
3)—True Rossum's Universal Robots.
4)—False Ha-ha; slightly under 18,000.
5)—True Engineers just love snappy acronyms.
6)—True Blaise Pascal (1623-1662), who, after a day of philosophizing, would tinker with his adding machine.
7)—False The computerist's what?
8)—True Also the most popular, as if you didn't know.
9)—True And if you look through a microscope, you can even see them move.
10)—False Central Processing Unit.

Element 4:
See Illustration 2A.

SCORING

Element 1:
Twenty-five points for the completed puzzle, or ½ point for each question correctly answered.

Element 2:
Five points for each correct answer.

Element 3:
Two and 1/2 points for each correct answer.

Element 4:
Two points for each word found.

Are you digitally inclined?
1-20 points—Still mad at the government for outlawing spark.
21-40 points—Thinks computers might have a future.
41-60 points—Likes to play with display computers in stores.
61-80 points—Owns a nice, sensible computer system.
81-100 + points—Home-brews own computer.

AWARDS

Bill Gosney KE7C
Micro-80, Inc.
2665 North Busby Road
Oak Harbor WA 98277

WAT AWARD

The Cabin Fever Radio Club of Tok, Alaska, offers a certificate for contacting three amateurs in Tok. There are no band or mode restrictions. However, all contacts must be made after December 15, 1980, to be considered valid.

To apply, prepare a list of contacts in order by callsign. Include the name of the station operator, the date and time worked in GMT, and the mode and band of operation. QSLs not required. Amateurs located in Tok include AL7O, AL7BO, AL7BV, and WL7APG.

Send your application with $2.00 or 10 IRCs to: Cabin Fever Radio Club, Box 451, Tok AK 99780.

WORKED ALL FORGOTTONIA

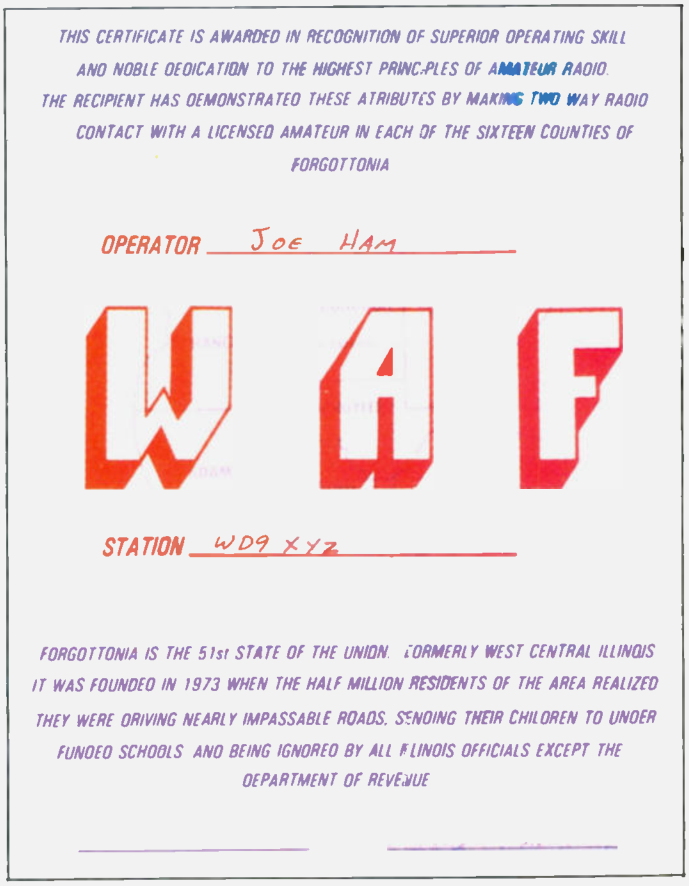
Announcing the awards program sponsored by LEARC, the Lamoine Emergency Amateur Radio Club of Macomb, Illinois. The Worked Forgottonia award is issued amateurs who confirm contact with three (3) licensed amateurs of Forgottonia. The Worked *ALL* Forgottonia is awarded operators confirming contact with at least one amateur in each of the sixteen counties of Forgottonia.

What is Forgottonia? It is the 51st state! It consists of the following counties, formerly west central Illinois: Adams, Brown, Calhoun, Cass, Fulton, Greene, Hancock, Henderson, Knox, McDonough, Mercer, Morgan, Pike, Schuyler, Scott, and Warren counties.

All contacts must be made after June 28, 1980, to be valid. From the letter we received from the club, the award evidently is issued at no charge since no remittance was mentioned. Forward your list of verified contacts and a 9" x 12" SASE to the attention of AG9Y, c/o LEARC, 1224 Maple Avenue, Macomb IL 61455.

JUNIATA VALLEY

In March, the Juniata Valley Amateur Radio Club (JVARC) will be celebrating its 25th year as a bona fide club. In honor of the event, they will be operating a special event station. The club station is K3DNA, located in Lewistown PA (Mifflin county). Having started operation in January, their heavy operation is scheduled for the month of



March. The station will operate on different bands, CW and phone, according to the operators' wishes. One contact with any club member will entitle the operator to receive the club certificate.

VK1 ACHIEVEMENT AWARD

The A.C.T. Division of the Wireless Institute of Australia is proud to announce the creation of its newest award, the VK1 Achievement Award. This award has the aim of increasing interest in the VK1 prefix and in promoting Canberra and Australia internationally.

As there are only 300 VK1 licensees, the award will not be an easy one to achieve, particularly on some bands and modes.

The VK1 Award is available to licensed amateurs throughout the world. To qualify, stations within Australia must work 20 stations in VK1 land on HF and on VHF. Stations outside Australia must work a minimum of 10 VK1 stations for the HF segment of the award.

To apply, submit your list of contacts,. including the GMT time and date worked, the band and mode of operation, and any reports or ciphers exchanged.

To be valid, all contacts must be made on or after January 1, 1978. Endorsements may be given at the time application is made. Five IRCs or $2.00 in Australian currency covers the cost of the award and should be sent to the Award Manager, c/o WIA, PO Box 46, Canberra A.C.T. 2600, Australia.

By the way, the VK1 Award is also made available to shortwave listening stations on a heard basis. QSL confirmation is required.

SNOWFLAKE MADNESS

The Michigan Technological University Amateur Radio Club and the Copper Country Radio Amateur Association announce a radio celebration of our Winter Carnival festivities in the northernmost part of Michigan's Upper Peninsula.

Tech's Winter Carnival is probably the most spectacular winter festival in America, with fantastic snow sculptures, dogsled races, lots of skiing, and other festive events.

In association with the Copper Country Chamber of Commerce, they are issuing a certificate to all amateurs who make contact with any ham in the Copper Country between 0000Z January 25 and 0000Z February 1. Only one contact is required for the certificate.

Suggested frequencies are: 3.975, 7.105, 7.285, and 21.385. Listen for CQ WINTER CARNIVAL.

Send your QSL along with 2 (two) 20-cent stamps to: Kevin J. Nietzke WD8DQR, 2005D Woodmar Drive, Houghton MI 49931.

WORKED BROWARD COUNTY CITIES

The Broward Amateur Radio Club, Inc., sponsors the new WBCC award available to licensed amateurs who submit proof of two-way contact as follows:

A) Residents of Broward, Colliers, Dade, Glades, Hendry, Lee, Martin, Monroe, or Palm Beach counties must work all 29 of the following cities listed below.

B) All other amateurs must work 15 of the 29 cities within Broward county.

To be valid, all contacts must be verified by at least two fellow amateurs and application must show all logbook information as well as the QTH of the station worked.

To apply, mail your application with $1.00 US funds and two first-class stamps (DX stations; send 10 IRCs) to: BARC Award Manager, WD4RAF, 1921 NW 41st Street, Oakland Park FL 33309.

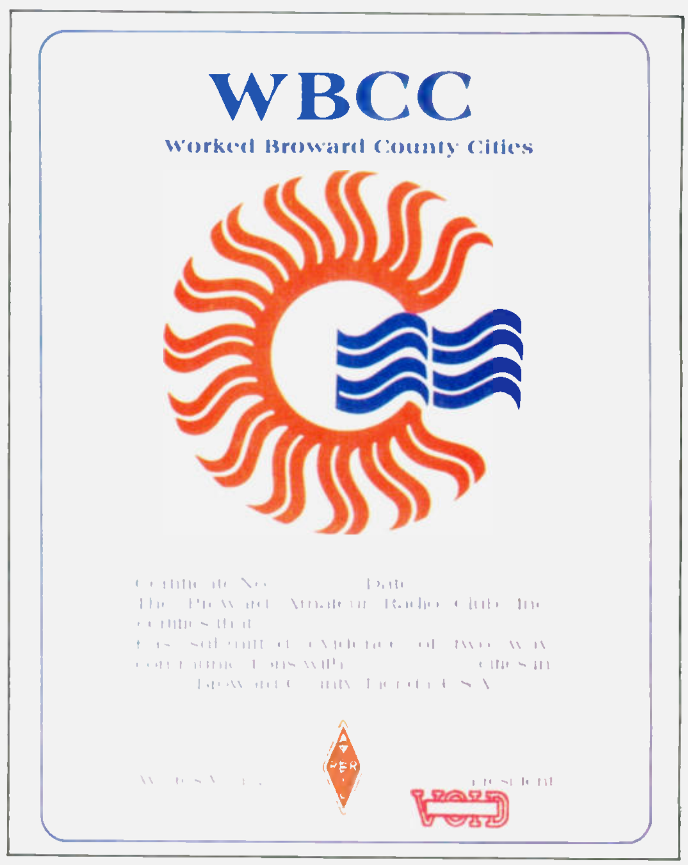
Qualifying city contacts include: Coconut Creek, Cooper City, Coral Springs, Dania, Davie, Deerfield Beach, Fort Lauderdale, Hacienda Village, Hallandale, Hillsboro Beach, Hollywood, Lauderdale-by-the-Sea, Lauderdale Lakes, Lauderhill, Lazy Lake, Lighthouse Point, Margate, Miramar, North Lauderdale, Oakland Park, Parkland, Pembroke Park, Pembroke Pines, Plantation, Pompano Beach, Sea Ranch Lakes, Sunrise, Tamarac, and Wilton Manors.

THE SOUTH EAST QUEENSLAND TELETYPE GROUP AWARD

This award is open to all transmitting and listening amateurs who gain award points in the following manner:

Australian amateurs must score 5 points and overseas amateurs must score 3 points.

(a) To qualify, a station must, where possible, copy the official station of the South East Queensland Teletype Group, VK4TTY, during a news broadcast and in the case of a transmitting amateur par-



ticipate in the callback (2 award points). A portion of the printout of the news broadcast together with the date, time, frequency, and broadcast number are to accompany the request for the award.

(b) Additionally, a transmitting amateur must work three member stations of the South East Queensland Teletype Group on RTTY (1 point each). Log extracts and/or printouts are to be included with the award application, and each member station may be counted only once towards the award.

(c) Listening amateurs should, in lieu of (b), forward log extracts and/or printouts of three contacts involving different member stations of the South East Queensland Teletype Group (1 point each).

Applicants for the award should forward the above information together with one dollar Australian or 5 IRCs to cover postage and printing costs to the Secretary, SEQTG, PO Box 274, Sunnybank, Queensland 4109, Australia.

WORKED ALL BERMUDA AWARD

The WAB Award is issued to amateurs throughout the world by the Radio Society of Bermuda. To qualify, applicants must submit proof of having worked a minimum of nine (9) parishes in Bermuda as listed below:

1. Sandys
2. Southampton
3. Warwick
4. Paget
5. Pembroke
6. Devonshire
7. Smith's
8. Hamilton
9. St. George's

The award is an antique map of Bermuda (20" x 23") suitably inscribed with the recipient's name and callsign and is signed by His Excellency, the Governor of Bermuda.

The award is not available to stations who worked Bermuda via mobile including maritime or aeronautical mobile. No band or mode endorsements are available. Only one mobile or portable from within Bermuda may be used in making claimed contacts on your application.

QSL cards are required as proof of contact and they must be sent to the awards manager with sufficient postage for their safe return. The Bermuda Award is issued free of charge! Submit your applications to: Award Manager, PO Box 275, Hamilton 5, Bermuda.

WORKED ALL DU AWARD

This award is available to all licensed amateurs who can show proof of having contacted at least one station from each of the call areas in the Republic of the Philippines (DU1 to DU9, except DU5).

Contacts may be made on any band or mode and special endorsements will be issued upon request for All-Phone, All-CW, Single-Band, or Five-Band accomplishments.

Contacts for the DU Award must be made on or after January 1, 1970. To apply, forward a list of contacts which have been verified by two officers of a radio organization. Your application must show all logbook information for each contact. Send the list and $4.00 US funds only (no IRCs please!) to: Edwin Zambrano DU1EFZ, PO Box AC-166, Quezon City 3001, Philippines.


All ASEAN Award xx class

This award is given to 73 Magazine for establishing two way contacts with radio amateur stations in member countries of the ASEAN namely; Indonesia, Malaysia, Singapore, Thailand, and the Philippines.

Awarded March 25, 1980 by the ORIENTAL DX CLUB, Quezon City, Philippines.

Edwin Zambrano
President, ODXC

WORKED ALL ASEAN AWARD

The WAAA program requires the applicant to work other amateurs in the member countries of the Association of Southeast Asian Nations:

Work 5 Philippine contacts, 1 Malaysian contact, 2 Indonesian contacts, 1 in Thailand, and 1 station in Singapore.

Special endorsements will be given for All-Phone, All-CW, Single-Band, and Five-Band contacts.

Have your list of contacts verified by at least two radio club officials and be sure all contacts were made after January 1, 1970, to be valid. Forward appropriate logbook information along with your application along with $4.00 US funds only (no IRCs) to the Award Manager: Edwin Zambrano DU1EFZ, PO Box AC-166, Quezon City 3001, Philippines.

KAHANER REPORT

Larry Kahaner WB2NEL
PO Box 39103
Washington DC 20016

By now you probably know that the FCC gave up in its attempt to rewrite the Amateur Radio Service rules. After spending thousands of dollars and consuming thousands of man-hours, the whole idea was thrown in the trash compactor.

We may never learn exactly what led to the shelving of the massive revamp nor will we ever realize any benefit from all that work. However, several FCC employees said privately what we all know intuitively about the project: It was just too big and too complicated to be completed.

You must admit the main premise was sound. Whenever a government agency wants to put its rules into plain English, we should all support it. In this case, it went a little too far. Opponents called the rewrite overly simplistic and said that many of the fine points of amateur radio were lost in the translation. They also claimed that the question and answer format—which worked so well for the rewritten CB rules—just didn't work for hams. Amateurs, they declared, were intelligent and took offense at the condescending stance of Q & A.

Moreover, the bulk of hams who responded to the petition for rulemaking took umbrage at the very beginning of the rewrite proposal which dropped the famous reasons for amateurs' existence: promoting international goodwill, experimentation, and so on.

FCC officials told us that the rewrite contained many errors and mistakes—not just typos, but in substance as well. And although FCC proposals always contain errors, in this case it would have been just too much work to set things right. Normally, the commission works with opponents and proponents alike until the regulations are honed to where everyone can live with them. But for the ham rewrite, there was too much to do, too few staff to do it, and no funds available to keep the project alive.

On one hand, the FCC should be applauded for realizing that it would take resources beyond its means to complete the task and dropping it now before any more time and money was wasted. On the other hand, perhaps the commission should be scolded for even beginning a course of action that came under fire from hams at the onset. Even those in the commission expressed doubts as to whether it was necessary to rewrite the rules. It's certainly apparent that much of the impetus for change was political (see Kahaner Report, September, 1981). That should never be a reason for a government agency to do anything with taxpayers' money.

So, it seems that hams fought the measure and won. But the question arises—who lost?

OUR OWN CHANNEL 9

Paul Moratto KC5JK/6, from Universal City CA, mailed the FCC a petition for rulemaking requesting that it designate a particular 2m frequency to be used exclusively as an emergency and assistance channel. Paul also sent us the petition asking for our comment. Here goes.

It's a great idea, Paul, but it's not necessary. Hams don't need the FCC to set aside a special channel for emergency use. Hams can do it on their own.

If hams can set up a national simplex channel (.52) and work out an entire repeater coordination scheme which only few hams don't adhere to, they can certainly decide for themselves if they want one frequency designated for emergency and assistance use only.

In his petition, Paul noted: "Various law enforcement officials have stated that the 2-meter amateur band is rarely monitored due to that fact that *no emergency frequency* has been officially designated exclusively for such communication." Frankly, Paul, I doubt that police departments would be willing to shell out bucks for a scanner that would pick up 2 meters or even buy crystals to place in scanners they may already own. Indeed, cops have enough to listen to without keeping an ear open on another frequency. If and when ham radio ranks reach that of CBers, maybe they'll listen—but right now it's not worth it.

Besides, even if they heard a distress call, they couldn't respond unless they were licensed hams. Many police are, but many aren't.

Any hams out there want to start work on a national emergency channel? Be my guest. Although I can't answer for the FCC, I'll bet they'll tell Paul exactly what I just told you: "If you want to do it, do it. You don't need us."

CONTESTS

Robert Baker WB2GFE
15 Windsor Dr.
Atco NJ 08004

RSGB 7-MHZ CONTESTS

Phone Section
Starts: 1200 GMT February 6
Ends: 0900 GMT February 7
CW Section
Starts: 1200 GMT February 27
Ends: 0900 GMT February 28

Licensed radio amateurs and listeners throughout the world are invited to take part in this year's RSGB contests. Log and cover sheets may be obtained from RSGB Headquarters, 35 Doughty Street, London, England WC1N 2AE. Please include an SAE.

The general rules for RSGB HF contests, published in the January, 1982, issue of *Radio Communication*, will apply. Please note, however, that unmarked duplicate contacts will be penalized at 10 times the number of points claimed, and that logs containing in excess of 5 unmarked duplicate contacts will automatically be disqualified. Duplicate contacts should be included in your logs, marked as such, and without any claim for points.

Only RSGB members within the British Isles are eligible, while anyone else worldwide may enter. The only valid operating class is single operator.

EXCHANGE:

RS(T) plus serial number starting at 001.

FREQUENCIES:

Phone—7.04 to 7.1 MHz; CW—7.00 to 7.04 MHz.

SCORING:

Non-European stations with British Isles count 15 points per QSO. European stations with British Isles count 5 points per QSO. British Isles stations with European stations count 5 points per QSO, 15 points per non-European contact. British Isles stations may not work each other.

Multiplier for British Isles stations is the number of different countries worked—ARRL DXCC list applies. In addition, each VE, VK, W, ZL, and ZS call area counts as a country for this purpose.

Non-British Isles stations count one multiplier for each different British Isles prefix worked, maximum of 42. Please note that GB does not count!

Final score for all is QSO points times the total multiplier.

AWARDS:

The Thomas (G6QB) Memorial Trophy will be awarded to the leading British Isles entrant in the CW contest. Certificates will be sent to the entrants placed first, second, and third in the British Isles, European, and non-

CALENDAR

Feb 6-7	**RSGB 7-MHz Contest—Phone**
Feb 6-7	**South Carolina QSO Party**
Feb 6-7	**Arizona QSO Party**
Feb 13-14	**WAS SSTV Contest**
Feb 13-14	**QCWA QSO Party—CW**
Feb 20-21	**ARRL DX Contest—CW**
Feb 26-28	**CQ Worldwide 160-Meter Contest—SSB**
Feb 27-28	**RSGB 7-MHz Contest—CW**
Mar 6-7	**ARRL DX Contest—Phone**
Mar 13-14	**QCWA QSO Party—Phone**
Apr 17-18	**ARCI QRP Spring QSO Party**
Jun 12-13	**ARRL VHF QSO Party**
Jun 26-27	**ARRL Field Day**
Jul 10-11	**IARU Radiosport**
Aug 7-8	**ARRL UHF Contest**
Aug 14-15	**European DX Contest—CW**
Sep 11-12	**ARRL VHF QSO Party**
Sep 11-12	**European DX Contest—Phone**
Nov 6-7	**ARRL Sweepstakes—CW**
Nov 13-14	**European DX Contest—RTTY**
Nov 20-21	**ARRL Sweepstakes—Phone**
Dec 4-5	**ARRL 160-Meter Contest**
Dec 11-12	**ARRL 10-Meter Contest**

European sections of each contest.

ENTRIES:

Log sheets should be headed: date, time (GMT), callsign of station worked, RS(T) and number sent, RS(T) and number received, if multiplier, and QSO points claimed. A summary sheet is required showing the countries or prefixes worked. Each log must be accompanied by the following declaration: "I declare that my station was operated in accordance with the rules of the contest and in accordance with the terms of my license." The declaration must be signed and dated. Closing date for receipt of logs is April 3rd for the phone section and April 24th for the CW section. Address entries to: RSGB HF Contests Committee, PO Box 73, Lichfield, Staffordshire WS13 6UJ England. In the case of any dispute, the ruling of the Council of the RSGB shall be final.

RECEIVING SECTION:

Rules are generally the same, as applicable. British Isles entrants should log only overseas stations in contact with British Isles stations and must record the report and serial number given by the overseas station and the time in GMT. European stations logged count 5 points; outside Europe, 15 points. No more than 20 QSOs made by any one British Isles station may be logged.

Overseas listeners should log British Isles stations and must record the reports and serial numbers given and the time in GMT. European listeners claim 5 points per QSO logged; others, 15. A bonus of 20 points may be claimed for each British Isles numerical prefix logged. GB prefixes do not count, and not more than 20 QSOs made by the same British station may be logged.

ARIZONA QSO PARTY

Starts: 2000 GMT February 6
Ends: 0800 GMT February 7

Sponsored by the Arizona Amateur Radio Club. Each station may be worked only once per band.

EXCHANGE:

RS(T) and state, province, country, or AZ county.

FREQUENCIES:

SSB—1815, 3895, 7230, 14280, 21365, 28560. CW—1805, 3560, 7060, 14060, 21060, 28060. Novice—3725, 7125, 21125, 28125.

SCORING:

Count 1 point per SSB QSO and 2 points for each CW or "exotic" mode QSO. AZ stations multiply QSO points by number of states, provinces, and countries. Others multiply QSO points by number of AZ counties. The AARC club station W7IO also counts as 1 multiplier for non-AZ stations. Anyone working all AZ counties and W7IO may double the multiplier.

AWARDS:

Certificates for the highest scoring station in each state, province, country, and AZ county.

ENTRIES:

Show each station worked, RST and exchange, plus time and frequency. Include a summary sheet of your scoring and other information. Include a large SASE for results. Mailing deadline is March 6th and should be addressed to: AARC, c/o Gary Kent KB7VE, 16647 N. 34th Avenue, Phoenix AZ 85023.

RESULTS

RESULTS OF THE 1981 OHIO QSO PARTY

Ohio Stations		Score
WB8MZZ		1,501,640
KB8EI		820,155
WB8JBM		666,000
WD8ALG		448,707
KA8HXX		428,736
KC8JH		339,000
KF8K		206,550
N8AKF		163,674
KA8IAH		148,830
KA8CTL		104,636
KB8AC		100,940
N8JJ		47,120
W8DXT		45,628
WA8WFX		39,285
WD8MCO		33,178
KB8WB		31,820
KA8IGM		31,620
WB8MIP		28,968
W8HFK		26,048
N8DCJ		23,408
N8BJQ		12,810
W8OJM		3,335
W8VPV (Club Station)		183,012
Out of State		**Score**
WAØAVL/9	IL	11,086
W4FOA	VA	10,480
KA2EPS	E NY	5,550
K9GDF	WI	4,008
W2EZ	W NY	3,900
KA8LPV	MI	3,810
K8EIO/3	MD/DC	3,430
NO4P	KY	3,360
WB3IET	W PA	3,240
W4OVT	GA	2,940
WB4ZPF	VA	2,875
NØCLV	KS	2,314
N1BDB	CT	2,180
W4KMS	VA	1,692
WB3FNS	MD/DC	1,628
N4CD	VA	1,552
KG9Z	IL	1,482
WB9CWE	IL	1,364
WA3JXW	E PA	1,232
WA3GNW	E PA	828
WB9NRK	WI	780
K2NC	W NY	737
WB1GLH	MA	672
W4LEP	TN	588
WA9MRU	IL	576
WB7TJI	ID	351
KA1VE	MA	340
N5AFV	OK	306
KA2EGO	N NJ	208
AK7J	ID	165
KF2T	N NJ	132
KB9TI	IL	90
K1BV	CT	50

SOUTH CAROLINA QSO PARTY

Starts: 1800 GMT February 6
Ends: 2359 GMT February 7

The QSO party is again sponsored by the Colleton County Contestors. The same station may be worked on each band and mode, simplex only. SC mobile stations that change counties are considered new stations. Novice and Technician stations please sign /N or /T.

EXCHANGE:

RS(T) and state, province, country, or SC county.

SCORING:

Phone contacts are worth 2 QSO points, CW contacts are worth 3 points. The multiplier for SC stations is the number of states, provinces, and DX countries worked. Others multiply QSO points by the number of SC counties worked (46 maximum).

FREQUENCIES:

Phone—3895, 7230, 14280, 21365, 28560. CW—3560, 7060, 14060, 21060, 28060. Novice—3725, 7125, 21125, 28125.

AWARDS:

Certificates to top-scoring station in each SC county, state, province, and DX country. Novices and Technicians compete only with other Novices and Technicians.

ENTRIES:

Include a summary sheet with your entry showing scoring and other information. Indicate each new multiplier in your log as it is worked. Novice and Technician indicate class on your entry. Include a large SASE for results. Mailing deadline is March 5th; send to: Colleton County Contestors, c/o Elliott Farrell, Jr. WA4YUU, PO Box 994, Walterboro SC 29488.

QCWA QSO PARTY—CW

Starts: 0001 GMT February 13
Ends: 2400 GMT February 14

This is the 25th annual QCWA QSO party with separate weekends for CW and phone. Contacts with the same station on more than one band can be scored only once. Contacts made with "captive" stations, such as when operating in local nets, are not valid.

EXCHANGE:

QSO number, operator's name, and QCWA chapter identification (official number or name). Members not affiliated with a chapter should use "AL".

FREQUENCIES:

Any authorized amateur frequency is permissible. The following suggested frequencies have been selected to minimize interference to others: 3530-3560, 7030-7060, 14030-14060, 21040-21070, and 28040-29070. These are selected as a starting place. When pileups occur, don't be afraid to go either side of these frequencies.

SCORING:

Each contact made with another QCWA member will count as a single point. This year's contest has two multipliers. The first is the same as in years past: each chapter is a multiplier of one. The second is that DX sta-

QSL OF THE MONTH

Call us chauvinists, but the beautiful rendition of the New Hampshire countryside on this attractive card wins WB1GGQ his choice of any book in *73*'s Radio Bookshop.

Is your card a winner? To enter, place your card in an envelope along with your book selection and mail to *73 Magazine*, Pine Street, Peterborough NH 03458, Attention: QSL of the Month. To be eligible, your entry *must* be sent in an envelope and *must* be accompanied by your book selection.

tions are a multiplier of two. DX stations are defined as Europe, Africa, South America, Asia, and Oceania—the same as for WAC of ARRL. Contacts within your own country count only as a chapter multiplier. Final score is then the total QSO points times the sum of the number of chapters and DX stations worked.

AWARDS:

Plaques for the top phone and top CW scorers. Certificates will be given for the 2nd through 5th runners-up in both the phone and CW Parties. Standings and scores will be published in the *QCWA News*, issue of summer, 1982.

ENTRIES:

Logs should include the following information: time (GMT), call, QSO numbers, name, chapter number or name, state or country. It is the responsibility of each contestant to provide a legible log, no carbon copies, and to list all claimed contacts. The total contacts for each page will be recorded at the bottom of each page. The total contacts for the Party should be recorded at the top right of the first page of the log. Log sheets will not be returned. Make sure you have correct postage when you mail your logs. Send logs no later than March 31st to: Pine Tree Chapter 134, Glenn Baxter K1MAN, Long Pond Lodge, Belgrade Lakes ME 04918. Separate logs and scores must be submitted for the CW and phone parties.

Work as many QCWA members as possible and apply for the several special QCWA certificates which you have qualified for in the QCWA Parties: Worked 50 States, Worked 60 Chapters, Worked 100 Members, and Worked 500 Members.

WAS SSTV CONTEST

Starts: 0900 EST February 13
Ends: 2100 EST February 14

Sponsored by amateur television's *A5 Magazine*. Use all authorized and recognized SSTV operating frequencies within the HF bands. Attempt to work as many SSTV operators from other states as possible during the 36-hour contest period. The emphasis is on quality, not just quantity.

SCORING:

Count 25 points per contact with 10 bonus points awarded for live exchanges of "mugshots," color two-way contacts, or 256 or 128 (1/2-speed) mode transmissions. Add 100 points for each new state listed. Alaska and Hawaii contacts count a bonus factor of 500 points!

EXCHANGE:

Station calls and signal reports must be exchanged in video format by either camera, keyboard, or light-pen generators.

AWARDS:

First-place winnner receives a 3-year subscription (or renewal) to *A5 Magazine*, a framed Specialized Communication Certificate, and his photo published on the front cover of the magazine. Second- and third-place winners receive 1-year subscriptions and certificates. All contestants will receive gold certificates with submitted logs.

ENTRIES:

Submit actual or copies of contest log sheets by no later than March 1st to Contest Manager, *A5 Magazine*, PO Box H, Lowden IA 52255. Official results will be published in the May/June issue of *A5 Magazine*. Those winners attending the Dayton, Ohio, Hamvention will be awarded certificates at the regular ATV Forum meetings.

CQ WORLDWIDE 160-METER CONTEST—SSB

Starts: 2200 GMT February 26
Ends: 1600 GMT February 28

EXCHANGE:

RS plus a three-digit contact number starting with 001. US stations include state and Canadians include province.

SCORING:

US and Canadian stations count 2 points per QSO with other W/VE/VO stations; DX contacts are 10 points each.

DX stations count 2 points per QSO with stations in the same country and 5 points with stations in other countries. QSOs with W/VE/VO stations are 10 points each.

All stations count one multiplier point for each US state, VE province, and DX country. KH6 and KL7 are considered DX. Final score is total QSO points times the sum of multipliers.

AWARDS:

Certificates to the top scorers in each state, VE province, and DX country. Additional awards if the scores or returns warrant.

Two plaques are being awarded by the West Gulf ARC, both for single operators, one for the highest scoring US station and the other for Europe. The World Champion in the contest will receive the John Doremus WØAW Memorial Plaque from friends of WØAW. This plaque may be won only once by the same station in a three-year period.

PENALTIES:

Three additional contacts will be deleted from the score for each duplicate, false, or unverifiable contact removed from the log. A second multiplier will also be removed for each one lost by this action.

Violation of the rules and regulations pertaining to amateur radio in the country of the contestant, or the rules of the contest, or unsportmanship conduct, or taking credit for excessive duplicate contacts or multipliers will be deemed sufficient cause for disqualification. Disqualified stations or operators may be barred from competing in *CQ* contests for a period of up to three years.

ENTRIES:

Sample log and summary sheets may be obtained from *CQ* by sending a large SASE with sufficient postage to cover your request. It is not necessary to use the official form; you can use your own. Logs should have 40 contacts per page and show time in GMT, numbers sent and received, and separate columns for QSO points and multipliers. Indicate the multiplier only the first time it is worked.

Mailing deadline for SSB entries is March 31st. Logs can be sent directly to the 160 Contest Director, Don McClenon N4IN, 3075 Florida Avenue, Melbourne FL 32901 USA. Alternatively, they can be sent to *CQ*, 160-Meter Contest, 76 North Broadway, Hicksville NY 11801 USA.

NEWSLETTER CONTEST WINNER

Humor is a key part of this month's newsletter winner. *The National Hampoon*, published by the Cleveland-based South East Amateur Radio Club, is chock full of puns, good-natured put-downs, and inside jokes. Editor KA8KTR is not above poking fun at himself or the 33-year-old club. Besides being fun to read, *The National Hampoon* provides a deluge of information about what individual club members are doing. Don't let your club's members fall into the trap of not reading each newsletter. Try adding some life and humor; the readers will anxiously await the arrival of the next issue.

W2NSD/1 NEVER SAY DIE

editorial by Wayne Green

from page 8

"This section shall not apply to receiving, divulging, publishing, or utilizing the contents of any radio communication which is transmitted by any station for the use of the general public; or which refers to ships, aircraft, vehicles, or persons in distress; or which is monitored pursuant to section 4(f)(6) and which is received, divulged, or used in any investigation or enforcement action by the Commission."

Explanation

This amendment conforms §605 to §4(f) to accommodate proposed language to permit use of volunteer monitors.

Here is another way that amateurs could help the Commission cut down on their costs. Not that they are spending a lot monitoring the ham bands these days anyway . . . and who needs 'em? But with the rules changed so that amateurs could set up a monitoring system, we would be able to clean up a lot of miseries which are now plaguing our bands.

We have tens of thousands of retired hams and several thousand more handicapped hams, all with loads of time on their hands and an eagerness to be of value. Well, here is a service that these hams could provide which would be priceless to us. I've talked with the FCC commissioners about this and they seem to be enthusiastic about the concept. You see, not only could hams be organized to monitor the ham bands, but they could also assist the FCC monitors in watching over some of the non-amateur bands, too.

If we once started getting into this monitoring idea, it would not be long before innovative hams would start coming up with automatic band scanners and receivers which would be connected to microcomputers and would program themselves to listen for unrecognized transmissions. With digital receivers and frequency counters, it is only one more step to a system which will keep track of what signals are okay on what frequencies and spot the anomalies quickly so they can be identified.

Not only would this be of great help for digging out emergency signals fast, but it would be even better protection against illicit transmissions involved with spying and drug traffic and so on. Coded transmissions? We have some mighty sharp ham cryptographers who would love to have challenges like that.

Why should the government spend wads of money doing something which we not only could do but probably could do better, and which we would enjoy doing?

Yes, a ham monitoring system would take some organization, but it wouldn't be difficult to handle. Much of the work could be done over the air, with unknown signals spotted and triangulated via a ham net. And with hams everywhere, even the UHF channels could be watched over in every part of the country. This would raise hell with crooks using CB or HTs on commercial channels to coordinate crimes. There would be no safe frequency or place in the country for them. Pity.

FRIENDLY CLUBS

Several letters from readers have made mention of a situation which I've noticed in some clubs I've visited . . . a lack of friendliness. Oh, it isn't intentional . . . but it is a drag. I suggest that club officers take a good critical look at the way their club is working and start doing something about it.

When someone new comes to a club meeting he (or she!) should be met by members and introduced around. Each person should have an identification badge so newcomers will know to whom they are talking. Members of the club should be aware that it is their responsibility to go out of their way to be friendly with any newcomers . . . to talk with them . . . show them around. Have the glad hand out.

When the newcomer arrives, try to find out about him . . . his call, if licensed . . . or if he is not yet licensed and might be interested in coming to the club license classes . . . what bands he works . . . and so on. Then get up at the meeting and introduce the newcomer and tell about his background so the others will know him. Make a big deal out of the newcomer and he will be back. You won't be able to keep him away with a stick.

In case you haven't noticed it, darned few hams are outgoing. The gregarious ham is unusual. Most hams are loners who may do just fine on the air, but are afraid to talk on a one-to-one basis. You should recognize this and gear your club meetings to overcome this situation. If you have a table where they can show their new and exciting QSL cards . . . that's a conversation breaker. Another table where they can show something they've built is another winner. Perhaps a spot to show off newly-purchased ham gear . . . stuff that is just recently on the market. Everyone is always interested in new rigs and gadgets. Anything you can work up in ways to get members showing and telling will break the ice and help everyone have a good time . . . and it is a good time at meetings which will bring 'em back alive next month.

This isn't the time to get into the details on how to run a ham club, but I will just touch on some of the basics. Remember that when you are running a ham club you are in show business. You want to keep for the board of directors as much of the dull business aspect of the club as you can, letting the meetings be times when you are entertaining the members.

What is entertaining? Well, demonstrations of unusual modes of communications are winners. You probably have someone in the area who is working with slow scan and can knock the socks off the members with color slow scan. Or perhaps some members are into computerized RTTY communications. Anything on 10 GHz? Any new antennas popped up which can be shown on a blackboard and explained? Slides of a Dxpedition are great fun.

How much do the members know of what is going on in the 450-MHz band? How about 220 MHz? Anyone working with SSB on 2m? How about aurora DXing, meteor-scatter DXing, moonbounce?

Manufacturers will go a long way to show their products when they have something new. Keep your eye on the new products section of *73* and see what you can generate. They want to show their products and they also want to get feedback from your members on possible new products. They need both the sales and the input.

DEREGULATION

The interest in deregulation by the Commission got started back in 1974, triggered by the *en banc* hearing at which a group of amateurs testified as to the need for deregulation. This turned out to be a matter of doing the right thing at the right time . . . as the Commission was just at that time getting interested in the concept. The hearing made clear the need for deregulation of amateur radio, and the Commission started with our service, intending to use it as an example of what could be done.

The hearing, by the way, was in response to the then-new regulations on repeaters, which were particularly onerous. Lacking any initiative from the ARRL, I got representatives together from repeater groups all around the country to testify before the Commissioners. If anyone is interested, I have a tape of this historical confrontation. The ARRL refused to participate, putting the effort down as naive and useless. The result was the biggest change in our rules ever brought about.

Of considerable significance is a recent paper (August, 1981) from the FCC. This is a working paper on deregulating the personal and amateur radio services. The paper is quite candid . . . surprising in its frankness. There are some interesting concepts . . . "many . . . agree that the goals of expanding technical skills and manpower and advancing the radio art have fallen on hard times in recent years." It goes on, "If there is criticism of amateurs for not being technically more advanced, it could be misdirected. Perhaps one should place some of the responsibility on the regulations, not the licensees. Substantially more regulatory flexibility than the service now has would be desirable."

Frankly, that's an understatement.

The other day, on my way down to Florida to give a talk to a group of accountants who are using TRS-80 systems, I stopped by Tufts Electronics in Hudson, New Hampshire. Chuck recently moved from down near Boston to tax-free New Hampshire, thus saving nearby Massachusetts hams a bundle on their purchases. The new Yaesu FT-208R HT had just arrived, so I bought one.

As I punched up the channels on the synthesizer, programming the unit to scan several local repeaters and a simplex channel or two, I got to thinking about the whole two-meter US vs. Japan situation. Having been in the 2m ham field for over 40 years, I remember how things got started.

The first FM rigs were converted commercial systems, mostly by Motorola and G.E.—monsters, dumped on us when the commercial two-way specs were changed, rendering tens of thousands of taxi and police transceivers obsolete. Then came a rig from I.C.E. (in Texas) which never got to first base... mostly because it didn't work very well. The next try was from Galaxy (Missouri). Though unstable and much too large, it sold reasonably well. The engineering design was dismal. Ed Clegg, who had been building VHF equipment for us for years, came up with one of the better FM rigs of the time, but by then some of the Japanese equipment was starting to arrive.

Icom was designing very nice equipment, and it was selling well. Unfortunately, the company was taken to the cleaners by a crooked Arizona importer/distributor. Nothing daunted, Mr. Inoue, the president of the firm, came to the US and shopped around for a new importer. He also asked a lot of questions about what kind of new equipment was wanted... and listened carefully to the answers. The result was the IC-230, the first synthesized ham rig. Before that, the best-selling rigs were from Standard and featured ever more crystal sockets. I got to where I had to have hundreds of crystals on hand to cope with all of the repeaters going on the air...and the many different rigs.

Mr. Inoue said that he would some day be able to put a synthesizer into an HT for us. Well, we knew it would happen, but it seemed like a dream. You know, there was a small outfit out near Buffalo, New York, which came up with a synthesizer early in the game, but they never really followed up on it. It started out as a club project and then changed into a business. I think if they'd played their advertising right they could have developed into a large business by now with perhaps $50 million in sales.

Another firm which had a crack at it and dropped the ball was Vanguard, down on Long Island. Andre developed a synthesizer to plug into the older rigs, but didn't take it the next step.

It isn't really fair to put down US firms for losing the ball on FM equipment...or any other ham gear for that matter. You see, the Japanese went right on by us in the number of licensed hams, so their firms had a great advantage. Not only did they have more hams, but their hams were much more enthusiastic and active than we were. Amateur radio really took hold in Japan when they got rid of the Morse code requirement. Clubs sprang up in high schools all over the country, and today they have double to triple the number of active hams that we have. Further, their spirit is almost unbelievable.

Have you even thought of going on a DXpedition? Well, the Japanese have organized DXpeditions where they have had about 400 active hams going along and getting on the air! When you read the Japanese club magazine you find that it is packed for dozens of pages a month with pictures of club activities and outings. We don't appear to have a single club in the US which even comes close to the enthusiasm which has spread through Japan...at least I'm not familiar with any. I've asked several times for pictures of any outstanding club activities for publication in *73*... nothing yet.

One of the facts of business is that the more of the product you make, the cheaper it is to manufacture. When you double the production of a piece of equipment, the cost of making it goes down 15-25%. So this bunch of eager buyers in Japan has done two things to the ham equipment market. First, their enthusiasm has encouraged the Japanese firms to keep up a continuing development of new equipment. The volume of sales has forced American firms out of the market because the Japanese equipment has been both better and cheaper in most instances.

Where the shoe really begins to hurt is that we are now seeing the results of the over 500,000 Japanese hams and their enthusiasm. These chaps have now gone from high school through college, on into industry, and are wiping out the American consumer electronics industry. Their rate of graduation of engineers, technicians, and scientists has zoomed past ours.

In this respect, amateur radio has let America down. If you stop and think about it, most technical career people get started in their teens. By stopping the growth of amateur radio in 1963, with little since then, we have managed to kill off virtually a whole generation of technical people. Unless a person gets interested in electronics in high school, there is little reason for him to go into electronics as a career. So now we have a bunch of philosophy and liberal arts majors wandering around looking for work... while our electronics industry is getting wiped out by Japan.

There really isn't much we can do about the situation right now. We will be outgunned in technicians for some time to come. If we are going to get back into the driver's seat, we are going to have to figure out some way to get a whole generation of teenagers interested in technical careers. That's quite a challenge.

In the meanwhile, as I go further and further into the instruction book for the 208, I wonder what next in HTs. With the LCD display of the frequency, the 208 should have a substantially longer battery life than the 207. I like the scanning system... just what I've wanted for years, wherein it scans, stops on a busy channel for a few seconds, and then continues scanning. You can set it up for a priority channel... for instance, I generally monitor 147.540 for simplex calls. They've even made the battery compartment so that you can open it without a coin.

I picked up a mailing piece at Tufts which was rather clever... and sad. The headline on it was, "Where have all the amateur radio stores gone?" Then there are drawings of eleven graves with headstones for the eleven Greater Boston ham stores which have gone out of the ham business (or just plain out of business) in recent months.

With the recent even further drop in new licensees... down around 35%... ham stores all around the country are folding. The ones that seem to be failing the most are those which had little slogans such as, never undersold... call for low, low prices... 20% off... and so on. You know, unless we do something about all this, amateur radio will soon be little more than a retirement playground for elderly hams.

I admit to getting a bit frustrated when I visit some ham clubs and find that many of the members... old-timers, of course... are prepared to resist any efforts to bring in new hams as much as they can. They don't want the QRM... and they don't much enjoy talking to young hams... and don't want them trying to join their club. They would like to raise the code speed to 50 wpm and have everyone coming in pass the Extra class license exam... and then get restricted to the CW bands for a few years. They like *QST*, not *73*. These chaps are turning amateur radio from a friendly fraternity into an old farternity.

Apropos of the mention of the 1963 debacle, I looked back over my editorials and found that I had indeed predicted at the time that one of the results of the proposed rules change would be the demise of a great many dealers... and manufacturers. About 75% of the ham dealers

WARNING

Due to numerous complaints received from readers who have dealt with Electronic Specialties, Inc., of Miami, Florida, we have discontinued their advertisements and urge all readers to use caution when dealing with this firm.

went out of the ham business as a result... and most of the manufacturers. It's interesting to see the old ads for Hammarlund, Hallicrafters, National, Johnston, Squires-Sanders, Central Electronics, Lakeshore, Multi-Elmac, United Transformer, Stancor, Bud, Gonset, Polytronics, and so on. It sure wiped 'em out.

The 208 is a great rig... but it is not a breakthrough into anything really new. If we're going to get amateur radio pepped up, we have to get into the 80s and digital communications techniques. We really have nothing new to be excited about. FM is a bore for most of us... and heck, DX has been around for a lifetime. What have we that is really new and fun? We need something to get our juices flowing.

What have you got?

HAM WATCH REPAIR

Eventually, those Casio C-80 and C-90 watches run out of battery and need to get a battery refill. The replacement of the batteries isn't a really big deal... you can probably do it. Or, of course, you can fire it back to Casio for their $10 repair charge. Many jewelers are afraid of digital watches and claim they can't fix them. Tsk.

You can run into a problem with the Casio watches in that they often do not start when you replace the batteries. You have to short out the battery cover and a nearby metallic dot marked "AC" with a wire, tweezers, or even a paper clip to get the watch to start again. Jewelers have gotten instructions on this, but often just don't want to be bothered... or didn't read the instructions.

The C-80 and C-90 Casio watches, which I've written about before, are the ones which did the most to put both Texas Instruments and Commodore out of the watch business. Casio came out with a $50 watch which knocked the socks off everything else on the market. More and more of us around the magazine are wearing the C-90, beeping away every hour in unison.

My thanks to WB9OJD for the battery information on the watch.

GETTING RICH

Firms which are publicly held have a problem that privately owned firms don't have to worry about: making ever more money to keep the stock prices high.

This came to mind when I got a letter the other day... and not the first one... saying that the reason I want ham growth is so that I can make more money from *73 Magazine*. Let's take a good look at that cop-out.

First point. If I *were* interested in money, spending time on trying to get amateur radio growing would be one of the last ways I would invest my time. The real money today is in microcomputers, and the maximum return for hours spent is obviously in that field. Every time I start a new computer magazine, I generate a couple of million dollars more cash flow for us and bring employment to a bunch more people. I also help the microcomputer field to grow by virtue of the communications I bring about.

No, from a business point of view, I could care less whether amateur radio grows or not. If I were to fold up *73 Magazine*, we'd make more money using the people and facilities for the much, much more profitable computer publications. But I'd miss a lot of fun... and amateur radio would lose a lot of articles and enthusiasm.

Point Two. Even if we got into a great growth pattern and *73 Magazine* started to make a huge profit, the money would go toward my real goals, not to me. My goals are to provide education through my publications and through any other media available. If I had a million to spare right now, I would quickly put it into the development of Hawthorne-Green Institute, a college to teach electronics, communications, and computing.

I seriously doubt if many readers spend much less on themselves than I do. I do have to buy clothes so I look well, even if I begrudge the expense. That's part of being in business. My entire life revolves around the business. I grab breakfast at my desk, have a business lunch almost every day... or else I eat an apple and cheese at my desk. Dinners are often with advertisers, at ham clubs, computer shows, or on trips to visit manufacturers. I don't think my wife and I get together to eat dinner at home ten days a year. She, too, is wrapped up in our business, and we share a two-room apartment in the old house that is our headquarters building.

I'm serious about trying to get American technology back into the lead and I think I have the key to this. If you were in my shoes, wouldn't you feel that was a worthy goal? Further, I think it is a goal I can achieve.

Probably the "richest" time of my life was back in the mid-50s when I was the editor of CQ and also the president of a small hi-fi manufacturing firm. I made a big $15,000 at that time, which is a whole lot more than I'm making now in today's dollarettes. I was able to support a home, family, a seaplane, an Arabian horse, a small yacht, and two Porsches. One of the things which I learned was that toys like those own you, not the other way around. The horse had to be exercised every day... and trained. The Porsches needed constant service, most of which had to be self-provided. The damned yacht had to be scraped and painted every year or so, the engine worked on, and so on. The plane? You have no idea of misery until you own your own plane. It cost more per year to own and run than any two of the other toys. It was fun and I'm glad I did it, but I'm all over wanting yachts and planes.

Money has value only for what it can do towards my goals. If I can generate more, I can do more... and there is far more satisfaction in that than having a pocketful of hundred-dollar bills... or a bankful.

I have this dream of being able to help get amateur radio into more countries... as a way of helping those countries to grow. Countries have a desperate need for electronics and communications experts... technicians, engineers, and scientists. The best way, by far, for getting these needed people is via infection of teenagers with the virus of electronics... and that means amateur radio. It works!

If the United States is going to stay on top over the next generation or two, we need to invest in technical people. I'm working on that via my push to get amateur radio and computer clubs into every high school in the country. I'm also working on it via my Hawthorne-Green Institute concept... a college which is geared to the 1980s and 90s... one which will feature high-speed concentrated education in both technical matters and business. My aim is to provide the education which will bring us tens of thousands of entrepreneurs, all with electronics and computer backgrounds. Let's see *any* country get ahead of us then!

So, when someone puts me down as looking to make money, agree with them... and point out that so far I have a good record of investing that money for the benefit of amateur radio and computing... and, I hope you'll agree... for our country.

My ideas on how a college should be are spreading. I'm getting calls and visits from educators who are interested in the plan and who see it as a way to guide their schools into solvency in the next few years. With many private colleges failing, some radical change is needed. My talks on the subject in Brazil and South Africa brought great interest, with invites to come back and get together with government officials to further pursue the idea.

No, if I was into a personal fortune, one of the first things I would do would be to stop writing editorials, which I'm sure would immediately increase our circulation by about 50%. The next would be to stop my crusades, such as the very costly one twenty years ago to sell sideband to the readers—who hated it and felt that AM was the *only* way to go. Or the effort in 1969 to get amateurs interested in a little-known mode: NFM and repeaters. While I published hundreds upon hundreds of articles on repeaters and NFM, organized FM symposiums, put out a repeater bulletin, and dozens of books... the readers revolted, with about 20,000 dropping the magazine in disgust. Oh, most of 'em came back, sending me notes saying that, golly, I'd been right, sorry about that. But it was rough going for several years.

Not having a house or "family life" to take up my time, and not having a yacht, plane, horses, and dogs, I have the time to read so that I can keep up on computer technology... time to keep dozens of business projects going.. to personally use computers, video cameras... to go skiing occasionally, to travel... and even get on the air more than you might think. I have the time to write my editorials and even articles for other magazines. I can get to Florida to give a talk on computers to an accounting group (expenses paid), to participate in a workshop on how to start special interest magazines (at the Folio show in New York) . . . to get to South Africa and address data processing professionals on the impact of microcomputers . . . and so on. I do have to give up some things which are important to most people in order to do what I enjoy . . . pursuing my goal of education for as many people as possible.

It doesn't take money to do many of the things I do—just time management. I was able to set the 10.5-GHz record for states worked with borrowed equipment because I was willing to go up a damned mountain at all hours of the day and night for skeds . . . freezing my galuccis off.

Of course, if I get a lot of static about getting rich, I can always find some sucker to buy me out and go for a twenty-year sail around the world, charging $50 a contact to the Honor Roll hams, and live like a king. An enterprising ham can make $50,000 a year or more that way, as we have seen in the past.

RTTY LOOP

Marc I. Leavey, M.D. WA3AJR
4006 Winlee Road
Randallstown MD 21133

One of the fastest growing phases of RTTY these days, at least as evidenced by the questions I receive from readers of this column, is "computerized," or at least video, RTTY. More and more, the amateur is getting away from the old grease-monger of mechanical teleprinter and turning to one of the new microcomputer systems.

One of those systems hams appear to be turning to is the new Radio Shack TRS-80C(R), the so-called "Color Computer." Based on the powerful Motorola 6809 central processing unit, the TRS-80C appeals to the ham on many levels. Until recently, however, little was available in the way of RTTY software for this computer.

Now, Clay Abrams K6AEP, an author whose works are well-known to the readers of *73*, is offering some rather nice software for the TRS-80C at reasonable prices. Appealing to both the RTTY and SSTV enthusiast, Clay has put together some rather nice packages.

For the slow-scan television (SSTV) operator, Clay has three programs of varying degrees of capability. SSTV 7.2 converts the TRS-80C to an SSTV keyboard for sending frames of five lines each consisting of six characters. The next step up is SSTV 7.3, which expands the previous system to include an SSTV keyboard, color keyboard, video mixing, and joystick graphics. His ultimate system is SSTV 7.4, which allows gray-level picture transmission and reception, color-picture reception, tape-save ability, and many other features. The cost? SSTV 7.2 is only $20, and SSTV 7.3 and 7.4 are $30 each.

Not interested in SSTV, huh? Well, Clay has a few good RTTY programs, too! His bottom-line RTTY program, RTTY 7.01, allows RTTY transmission and reception in Murray and ASCII at all common rates. Three transmit buffers, an RY buffer, and a CW identifier are also provided. All this for $20. Clay's top-line program, RTTYCW, provides RTTY transceive, CW transceive, random code groups, split-screen display, multiple buffers, and tape saving. Requiring an external demodulator and CW interface, the program sells for the lofty sum of $30.

Interested? Drop Clay a line at Clay Abrams Software, 1758 Comstock Lane, San Jose CA 95124. Be sure to mention that you read about it in RTTY Loop, OK?

Interest in older machines is still around. Chuck Euola K8YPU, of Redford Township, Michigan, is using an Altair 680b. This M6800-based computer was introduced shortly after the Altair 8800, the "original" 8080 computer. Chuck is interested in receiving RTTY with his 680b, and wonders if some of the programs published to run with other 6800 systems will work. Other than changing the I/O address, the biggest problem you may have is with the slow speed of the 680b, as the clock runs at 500 kHz, roughly one half to one quarter of most other 6800 systems. However, you might try halving the constant in a delay loop, as calculated for a 1-MHz system, and then fine tuning as necessary. The program published in this column back in July, 1978, should work reasonably well.

Not everybody likes a computer, though. I have a letter here from Richard E. Christina, in Pahrump NV, who writes, "I need a transmitter strictly for RTTY . . . I would like about 200 Watts, 100% duty cycle, tubes, vfo . . . I do not desire to use a computer at this time."

Well, Richard, first of all, let's get our apples and oranges straight. The computer, if you use one, replaces the mechanical teleprinter, not the transmitter and receiver. No matter what method you use to display the RTTY signal, from an ancient Model 12 to a Whiz-Bang 6880 Micro-Term, you still need a transmitter, receiver (or transceiver), and antenna to get on the air.

Now, to the point of your question. A look through the back issues of *73* or any other amateur radio magazine or handbook will turn up many circuit descriptions for CW transmitters. Basically, that's all a RTTY transmitter is: a CW, i.e., continuous wave, transmitter in which the frequency determining element is modified by the digital RRY information. Adding that modification to the vfo, for example, involves a simple diode-capacitor combination, called a "shift pot," that we have covered in this column several times in the past few years.

As for the teleprinter itself, finding information on this machine or that can also take some doing. I have another letter here from K. D. Hardin KC5II, out in Albuquerque NM, who recently purchased a Teletype® Model 3320 and is looking for data on hooking it up. The 3320 is the "I/O" version of the Model 33, and is a very useful machine. This machine is designed to work in a 20-mA loop, and connection is via either a nine-position terminal strip or a twenty-pin plug, located on the back of the call control unit. This is the right rear corner of the machine, as you face it. Fig. 1 is a diagram of the nine-pin strip, terminal strip 151411, at the rear of the machine.

Unfortunately, not all Model 33s are alike, and minor differences in the call control unit can lead to major difficulties in hooking the machine up. Manuals are available from several sources; see the ads in this magazine for current availability.

I have a note here from Jeffrey A. Maass K8ND, who relates that RTTY DXers will have an opportunity to add Anguilla (VP2E) to their DX totals between February 23 and March 3, 1982. A group of contesters will travel to Anguilla to participate in the ARRL CW and SSB DX contests between February 15 and March 10,1982, and will be taking along a complete RTTY station. Amateurs using the calls VP2EV (QSL to K8ND), VP2EJ (QSL to WA8CZS), and VP2ED (QSL to

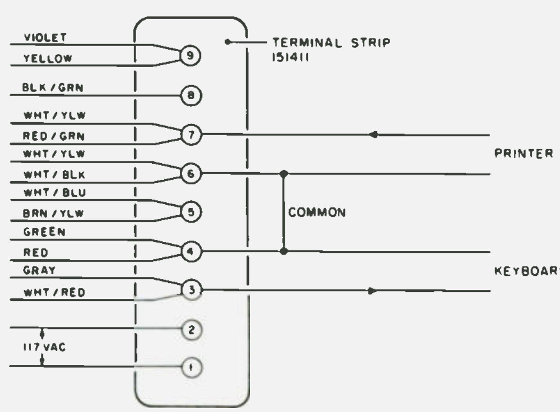


Fig. 1. Model 33 teletype hookup.

WB8VPA) will be operating in the time slot detailed above. Good luck!

By the way, the number of you interested in RTTY DXing does seem to be growing. Not only for two-way communications, but for looking for those rare press and commercial stations, too! Lt. Mike Anderson, with the U.S. Navy in Europe, is one of those folks. So I am happy to let you in on a little tip. A few months back, I mentioned Tom Harrington's book, *World Press Services Frequencies*, in this column. Available from the *73* Radio Bookshop at $5.95, this book contains listings of hundreds of commercial and governmental RTTY stations. One of the services promised by Tom was to keep buyers updated of recent "finds" and changes to the listing. Well, I have received his latest listing, and it is quite a gold mine for the individual interested in RTTY monitoring.

Well, this month brought Groundhog Day! Did the groundhog poke his head out of Baudot, see his shadow, and ASCII for six more weeks of winter? Who can say? (Murray can!) Find out here, in RTTY Loop!

NEW PRODUCTS

TEN-TEC 2-KW ANTENNA TUNER

Another first for Ten-Tec is a new 2-kW antenna tuner/swr bridge/power meter. The new tuner uses a reversible "L" configuration with a silver-plated roller inductor, high-voltage variable capacitor, and selectable fixed capacitors for greater versatility in impedance matching. The design automatically provides a low Q minimum loss path when properly adjusted. Power ratings are 2 kW PEP and 1 kW CW. Frequency range is 1.8-30 MHz. Model 229 matches conventional 50-Ohm unbalanced outputs of transceivers or linear amplifiers to a variety of balanced or unbalanced load impedances. Antennas such as dipoles, inverted "V"s, long random wires, windoms, beams, rhombics, mobile whips, Zepps, Hertz, and similar types can be matched. A built-in balun converts one antenna to a balanced configuration if desired.

The built-in swr bridge and dual-range power meter indicates swr from 1:1 to 5:1 and power from 10 to 2000 Watts.

Front-panel controls are variable capacitor with spinner knob, roller inductor with spinner knob, 11-position bypass/hi-lo capacitor select switch, 4-position antenna selector switch, swr sensitivity, forward/reverse switch, 2000/200-Watt power range switch, and swr/power meter switch.

Rear panel includes coax input connector, four coax antenna connectors, three thumbscrew-type connectors for single wire and balanced line, ground connector, and 12-V dc input for dial lighting power.

Styling matches the Ten-Tec Omni transceiver and Hercules linear amplifier with black and bronze front panel with blackout lighting, satin-finish wraparound aluminum bezel, black textured vinyl-clad aluminum clamshell top, and bottom with fold-down stainless steel bail. Size: 6½" H × 12¾" W × 13½" D. Wt.: 9 lbs.

For full information, write *Ten-Tec, Highway 411 East, Sevierville TN 37862.*

The MFJ-401 Econo Keyer II.

The Ten-Tec 2-kW antenna tuner.

MFJ-401 AND MFJ-405 ECONO KEYER II

The MFJ-401 and MFJ-405 Econo Keyer II from MFJ Enterprises is a new full-feature economy keyer using the Curtis 8044 IC for reliability. The MFJ-401/405 Econo Keyer II has a much easier to use design and layout than the old Econo Keyer line. All controls are located on the front panel where they are easy to find and use.

The MFJ-401/405 Econo Keyer II has front-panel controls for both speed and volume. The on/off switch and auto/semi-auto switch is on the front panel. This switch lets you use the Econo Keyer II like a bug or it can be used to make tuning more convenient. A red LED indicates when the MFJ-401/405 Econo Keyer II is on. It may be used with an internal 9-volt battery or any source of 5-9 V dc. Circuitry is provided for both grid block and direct keying. This features lets the keyer work well with tube-type and solid-state rigs.

The MFJ-405 Econo Keyer II has a built-in clear lucite paddle and a jack on the back for an external iambic paddle. The MFJ-401 does not have a built-in paddle, but all other features are the same.

For more information, contact *MFJ Enterprises, Inc., PO Box 494, Mississippi State MS 39762.* Reader Service number 478.

LNR DOWNCONVERTER FOR SATELLITE COMMUNICATIONS

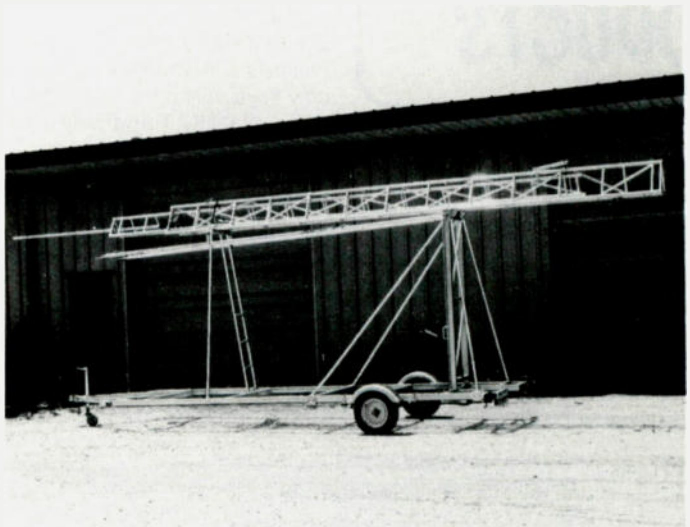
The new Model DC4-E1 is a high-performance, low-profile rf to i-f converter especially designed for small terminal satellite Earth stations. Available in single thread and redundant configurations, this unit offers low phase noise and good frequency stability for digital and voice carriers, such as QPSK and FM-SCPC. The DC4-E1 is compact, measuring only 1-3/4" in height, and is designed for 19" rack mounting. Interfaces are coax connectors, so that the signal may be carried on low-cost coaxial cable. FET LNA power on the rf input connector is available as an option.

Low translation phase noise is ensured by an internal crystal-controlled phase-locked oscillator. Additionally, designed optimization ensures minimal intermodulation distortion. Each converter module is self-contained, including power supply. The unit is designed for unattended operation and has a remotable summary alarm and front-panel monitors for key operating parameters. LNR is a

The LNR frequency converter.

leading manufacturer of telecommunications equipment for satellite Earth stations.

For more information, please contact *LNR Communications, Inc., Marketing Department, 180 Marcus Blvd., Hauppauge NY 11787.* Reader Service number 480.



The Aluma Tower trailer.

NEW TOWER TRAILER

For those special situations that require communications tower mobility, Aluma Tower Co. introduces an all-steel trailer for transporting and erecting any Aluma Tower Co. aluminum or steel tower. Ideal for Field Day, civil defense, remote signal testing and many other situations, the tower/trailer combination is easily towed. Once in place, the tower is tilted up and cranked into position. The trailer acts as a secure base.

For more information, contact *Aluma Tower Co., 1639 Old Dixie Highway, Box 2806, Vero Beach FL 32960.* Reader Service number 482.

The HAL portable RTTY/CW terminal.

PORTABLE RTTY/CW TERMINAL

HAL Communications Corp. is pleased to announce the new CWR685A Telereader portable RTTY/CW terminal. Featuring compact size and 12-V dc operation, the CWR685A is just the thing for the traveling RTTY amateur who wants to "take it with him." A green phosphor 5" display is built into the small 12-3/4" × 11" × 5" main cabinet, as is a RTTY modem for 3 shifts, both "high" and "low" tones. The keyboard is separate and connects with a 3-foot cord to the main unit. Advanced features such as programmable HERE IS messages, type-ahead transmit buffer, and automatic transmit-receive control are included with the Telereader. The CWR685A can easily be slipped into a suitcase for a ham outing. In the home shack, the Telereader consumes little space and can be connected to an external monitor and parallel ASCII printer for even more versatility.

For more information, contact *HAL Communications Corp., Box 365, Urbana IL 61801.* Reader Service number 479.

SUPERCW

Frontier Enterprises has introduced SUPERCW, a computer-aided instruction program for the TRS-80 Model I or III microcomputer. Sound and graphics are combined to teach the user International Morse Code. By progressively increasing the copy speed, SUPERCW brings the user to 20 words per minute in as little as 72 hours of practice.

The disk-based SUPERCW package requires a 32K, 1-disk system. Features include random or plain text practice, sample testing, and provision for multiple users. For more information, contact *Frontier Enterprises, 3511 Gallows Road, Falls Church VA 22047.* Reader Service number 483.

MOBILE HT CHARGER

Mobile amateurs can operate and recharge their hand-held radios anytime with the new HT Power-Charger™ from Valor Enterprises. They simply insert the charger into the lighter socket and attach the mating plug to the radio. It will charge hand-held radios in less than an hour. The HT Power-Charger is not just a dropping resistor and diode, but a pair of transistors in a variable current regulator that is self-adjusting depending on the batteries' state of charge.

Mobile amateurs will appreciate the convenient package—all circuitry is enclosed in the plug with no box dangling on the cord. The HT Power-Charger features a built-in LED to indicate lighter socket function, with a five-foot connecting cable and plug to mate with the radio. There are six models designed to fit most popular amateur hand-held radios.

For more information, contact *Valor Enterprises, Inc., 185 W. Hamilton Street, West Milton OH 45383.* Reader Service number 481.

Valor Enterprises' mobile HT charger.

✓See List of Advertisers on page 114

HAM HELP

I am in need of a schematic or instruction manual for a MARC multiband radio receiver. I will pay copying and mailing expenses.

Scognamiglio Vincenzo
Piazza Trieste e Trento, 17
80046 S. Giorgio A Cremano
Naples, Italy

I am in need of information on the Galaxy V MK3, conversion details for an Aerotron transceiver, and information on interfacing a TRS-80 to a Model 15 printer via an M-80 interface.

Tom Van Schuyler WA2LOJ
57 Needle Lane
Levittown NY 11756

I am in need of manuals for a Gonset 3136, an Ameco 50-220-MHz vfo, and a Seco 520 antenna tester.

Orlo Taylor WA8HWM
18412 N. 148th Ave.
Spring Lake MI 49456

I need help interfacing a DEC (Digital Equipment Corp.) dot matrix printer, LA-30 (1972 vintage). I have no schematic or configuration info, and can't seem to shake one loose anywhere. I will pay for copies and postage.

Stephen F. Gent WB2VKL
Berry Rd
Fredonia NY 14063

I am in need of a service manual or wiring diagram for a Hallicrafters S120A receiver. I will copy your original and return it to you.

Bill Suffich W4UUC
55 So. Carlen St.
Mobile AL 36606

I would like to phone QSO with anyone into weather fax recording.

Dante Ventriere KA4JRE
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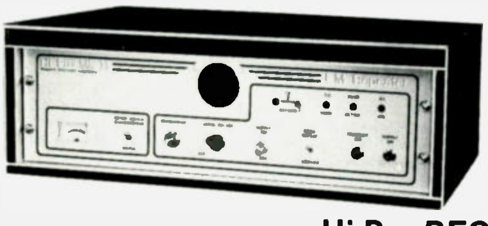

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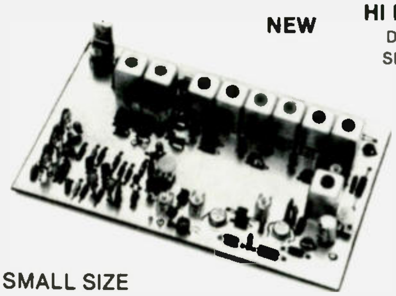

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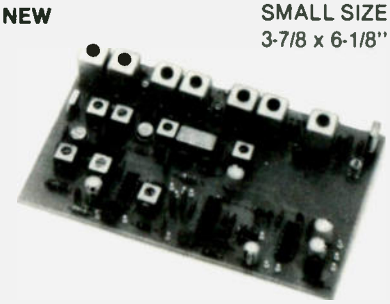

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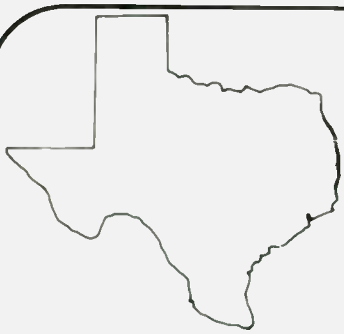

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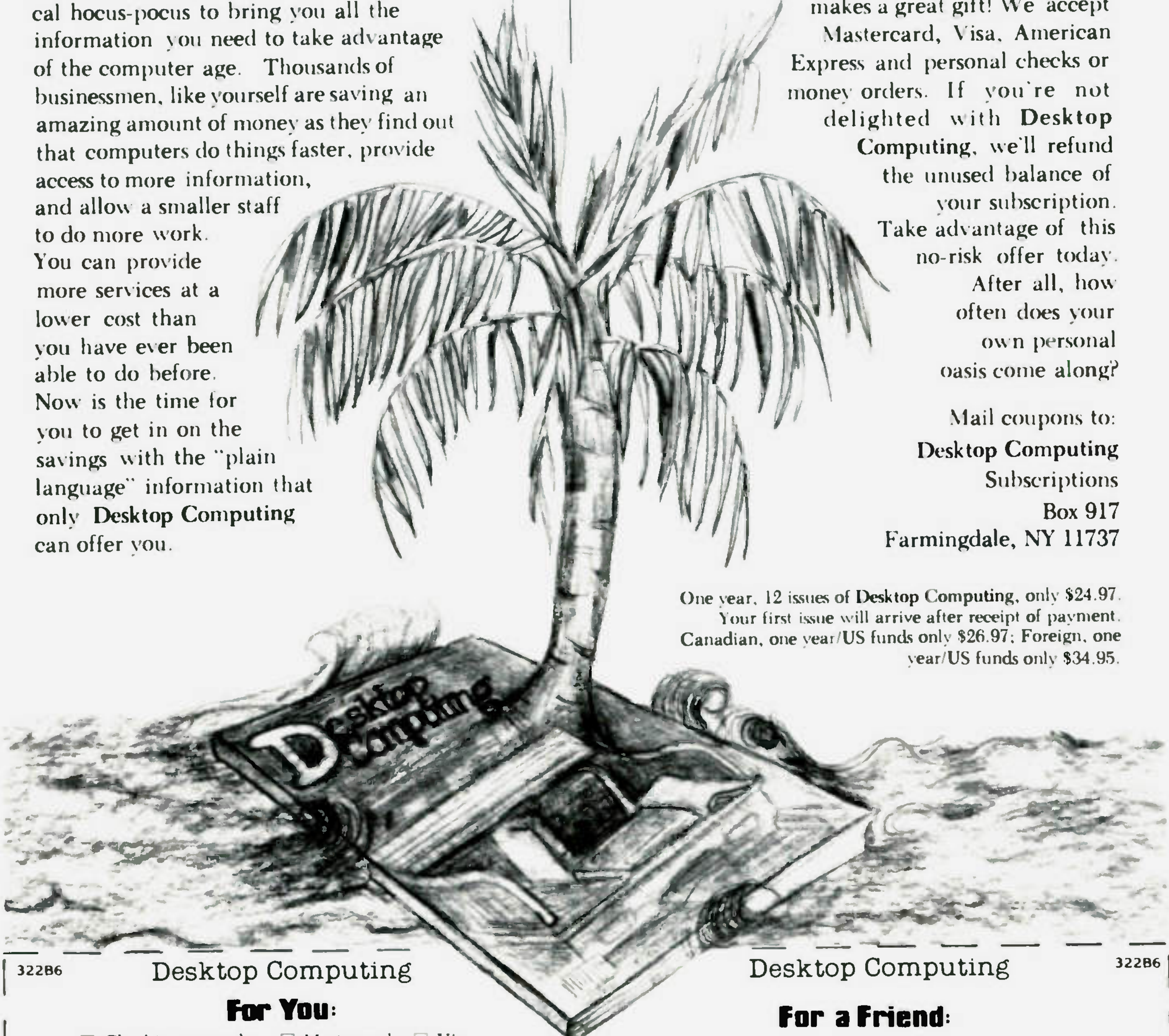

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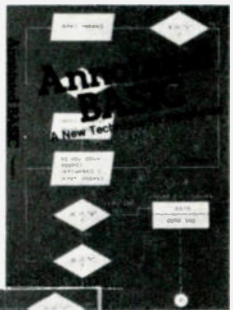

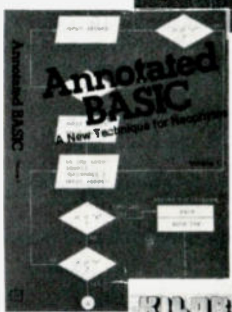

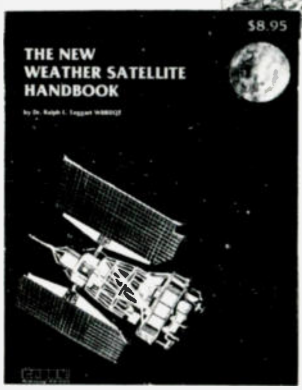

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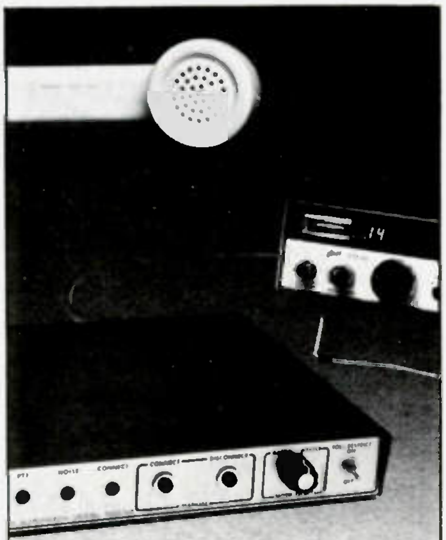

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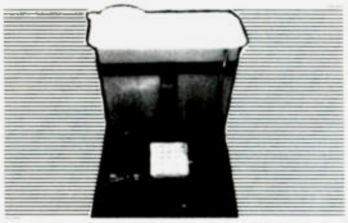

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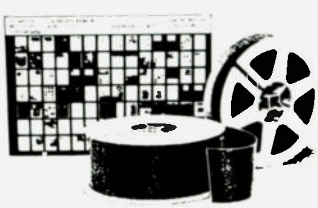

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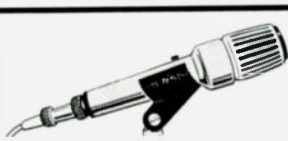

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NEW! Bearcat®† 350

The Ultimate Synthesized Scanner!

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Bands: 30-50, 118-136 AM, 144-174, 421-512 MHz.

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Bearcat® 300

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Bands: 32-50, 118-136 AM, 144-174, 421-512 MHz.

The *Bearcat* 300 is the most advanced automatic scanning radio that has ever been offered to the public. The *Bearcat* 300 uses a bright green fluorescent digital display, so it's ideal for mobile applications. The *Bearcat* 300 now has these added features: Service Search, Display Intensity Control, Hold Search and Resume Search keys, Separate Band keys to permit lock-in/lock-out of any band for more efficient service search.

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Your final cost is a low $254.00

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Frequency range 32-50, 146-174, 420-512 MHz.

The *Bearcat* 250 performs any scanning function you could possibly want. With push button ease you can program up to 50 channels for automatic monitoring. Push another button and search for new frequencies. There are no crystals to limit what you want to hear. A special search feature of the *Bearcat* 250 actually stores 64 frequencies and recalls them, one at a time, at your convenience.

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List price $449.95/CE price **$289.00/$25.00 rebate**
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Frequency range 32-50, 118-136 AM, 144-174, 420-512 MHz.

The *Bearcat* 20/20 automatic scanning radio replaces the *Bearcat* 220 and monitors 40 frequencies from 7 bands, including aircraft. A two-position switch, located on the front panel, allows monitoring of 20 channels at a time.

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List price $349.95/CE price **$229.00/$15.00 rebate**
Your final cost is a low $214.00

6-Band, 18 Channel • Crystalless • AC/DC

Frequency range: 32-50, 144-174, 421-512 MHz.

The *Bearcat* 210XL scanning radio is the second generation scanner that replaces the popular *Bearcat* 210 and 211. It has almost twice the scanning capacity of the *Bearcat* 210 with 18 channels plus dual scanning speeds and a bright green fluorescent display. Automatic search finds new frequencies. Features scan delay, single antenna, patented track tuning and more!

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List price $299.95/CE price **$194.00/$10.00 rebate**
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List price $449.95/CE price **$299.00**

8-Band, 16 Channel • Liquid Crystal Display Search • Limit • Hold • Lockout • AC/DC

Frequency range: 30-50, 138-174, 406-512 MHz.

The world's first no-crystal handheld scanner has compressed into a 3" x 7" x 1¼" case more scanning power than is found in many base or mobile scanners. The *Bearcat* 100 has a full 16 channels with frequency coverage that includes all public service bands (Low, High, UHF and "T" bands), the 2-Meter and 70 cm. Amateur bands, *plus* Military and Federal Government frequencies. It has chrome-plated keys for functions that are user controlled, such as lockout, manual and automatic scan. Even search is provided, both manual and automatic. Wow...what a scanner!

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List price $189.95/CE price **$124.00/$10.00 rebate**
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Frequency range: 33-47, 152-164, 450-508 MHz.

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Low cost 6-channel, 3-band scanner!

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Conversion Compression	.3dB Typ.	

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NF Min	F=2GHz	dB 2.4 Typ.	MAG F=2GHz	dB 12 Typ.	$5.30
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Ft Gain Bandwidth Product at Vce=8v, Ic=10ma. GHz 4 Min. 6 Typ.
Vcbo 25v Vceo 11v Vebo 3v Ic 50ma. Pt. 250mw

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Projected Peak Pt. Voltage mv.	Vpp Vf=Ip	480min. 550Typ. 630max.	440min. 520Typ. 600max.
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Microwave Equipment

Manufacture	Model	Description	Price
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The CT-90 is the most versatile, feature packed counter available for less than $300.00! Advanced design features include; three selectable gate times, nine digits, gate indicator and a unique display hold function which holds the displayed count after the input signal is removed! Also, a 10mHz TCXO time base is used which enables easy zero beat calibration checks against WWV. Optionally; an internal nicad battery pack, external time base input and Micro-power high stability crystal oven time base are available. The CT-90, performance you can count on!

SPECIFICATIONS:

Range:	20 Hz to 600 MHz
Sensitivity:	Less than 10 MV to 150 MHz Less than 50 MV to 500 MHz
Resolution:	0.1 Hz (10 MHz range) 1.0 Hz (60 MHz range) 10.0 Hz (600 MHz range)
Display:	9 digits 0.4" LED
Time base:	Standard-10.000 mHz, 1.0 ppm 20-40°C. Optional Micro-power oven-0.1 ppm 20-40°C
Power:	8-15 VAC @ 250 ma

7 DIGITS 525 MHz $99.95 WIRED

SPECIFICATIONS:

Range:	20 Hz to 525 MHz
Sensitivity:	Less than 50 MV to 150 MHz Less than 150 MV to 500 MHz
Resolution:	1.0 Hz (5 MHz range) 10.0 Hz (50 MHz range) 100.0 Hz (500 MHz range)
Display:	7 digits 0.4" LED
Time base:	1.0 ppm TCXO 20-40°C
Power:	12 VAC @ 250 ma

The CT-70 breaks the price barrier on lab quality frequency counters. Deluxe features such as; three frequency ranges - each with pre-amplification, dual selectable gate times, and gate activity indication make measurements a snap. The wide frequency range enables you to accurately measure signals from audio thru UHF with 1.0 ppm accuracy - that's .0001%! The CT-70 is the answer to all your measurement needs, in the field, lab or ham shack.

PRICES:

CT-70 wired, 1 year warranty	$99.95
CT-70 Kit, 90 day parts warranty	84.95
AC-1 AC adapter	3.95
BP-1 Nicad pack + AC adapter/charger	12.95

7 DIGITS 500 MHz $79.95 WIRED

PRICES:

MINI-100 wired, 1 year warranty	$79.95
AC-Z Ac adapter for MINI-100	3.95
BP-Z Nicad pack and AC adapter/charger	12.95

Here's a handy, general purpose counter that provides most counter functions at an unbelievable price. The MINI-100 doesn't have the full frequency range or input impedance qualities found in higher price units, but for basic RF signal measurements, it can't be beat! Accurate measurements can be made from 1 MHz all the way up to 500 MHz with excellent sensitivity throughout the range, and the two gate times let you select the resolution desired. Add the nicad pack option and the MINI-100 makes an ideal addition to your tool box for "in-the-field" frequency checks and repairs.

SPECIFICATIONS:

Range:	1 MHz to 500 MHz
Sensitivity:	Less than 25 MV
Resolution:	100 Hz (slow gate) 1.0 KHz (fast gate)
Display:	7 digits, 0.4" LED
Time base:	2.0 ppm 20-40°C
Power:	5 VDC @ 200 ma

8 DIGITS 600 MHz $159.95 WIRED

NEW READ RECEIVER FREQUENCY

SPECIFICATIONS:

Range:	20 Hz to 600 MHz
Sensitivity:	Less than 25 mv to 150 MHz Less than 150 mv to 600 MHz
Resolution:	1.0 Hz (60 MHz range) 10.0 Hz (600 MHz range)
Display:	8 digits 0.4" LED
Time base:	2.0 ppm 20-40°C
Power:	110 VAC or 12 VDC

The CT-50 is a versatile lab bench counter that will measure up to 600 MHz with 8 digit precision. And, one of its best features is the Receive Frequency Adapter, which turns the CT-50 into a digital readout for any receiver. The adapter is easily programmed for any receiver and a simple connection to the receiver's VFO is all that is required for use. Adding the receiver adapter in no way limits the operation of the CT-50, the adapter can be conveniently switched on or off. The CT-50, a counter that can work double-duty!

PRICES:

CT-50 wired, 1 year warranty	$159.95
CT-50 Kit, 90 day parts warranty	119.95
RA-1, receiver adapter kit	14.95
RA-1 wired and pre-programmed (send copy of receiver schematic)	29.95

DIGITAL MULTIMETER $99.95 WIRED

PRICES:

DM-700 wired, 1 year warranty	$99.95
DM-700 Kit, 90 day parts warranty	79.95
AC-1, AC adaptor	3.95
BP-3, Nicad pack +AC adapter/charger	19.95
MP-1, Probe kit	2.95

The DM-700 offers professional quality performance at a hobbyist price. Features include; 26 different ranges and 5 functions, all arranged in a convenient, easy to use format. Measurements are displayed on a large 3½ digit, ½ inch LED readout with automatic decimal placement, automatic polarity, overrange indication and overload protection up to 1250 volts on all ranges, making it virtually goof-proof! The DM-700 looks great, a handsome, jet black, rugged ABS case with convenient retractable tilt bail makes it an ideal addition to any shop.

SPECIFICATIONS:

DC/AC volts:	100uV to 1 KV, 5 ranges
DC/AC current	0.1uA to 2.0 Amps, 5 ranges
Resistance:	0.1 ohms to 20 Megohms, 6 ranges
Input impedance:	10 Megohms, DC/AC volts
Accuracy:	0.1% basic DC volts
Power:	4 'C' cells

AUDIO SCALER

For high resolution audio measurements, multiplies UP in frequency.

- Great for PL tones
- Multiplies by 10 or 100
- 0.01 Hz resolution!

$29.95 Kit $39.95 Wired

ACCESSORIES

Telescopic whip antenna - BNC plug	$ 7.95
High impedance probe, light loading	15.95
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Direct probe, general purpose usage	12.95
Tilt bail, for CT 70, 90, MINI-100	3.95
Color burst calibration unit, calibrates counter against color TV signal	14.95

COUNTER PREAMP

For measuring extremely weak signals from 10 to 1,000 MHz. Small size, powered by plug transformer-included.

- Flat 25 db gain
- BNC Connectors
- Great for sniffing RF with pick-up loop

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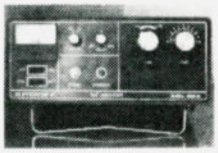

- Big power on 2 meters!
- Self-contained A.C. power supply
- 500 watts from 4-CX-250 B final

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- Roller inductor
- Power/VSWR meter
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Bright Green 9 Digit Frequency Display Ext Antenna Jack Ext Speaker Jack Large Top Mounting Bracket Scan Rate Fast 8ch/sec
Slow 4ch/sec
Scan Delay Time Variable 0-4 sec

*NAV $399.00

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Panasonic RF-3100

- AC/battery FM/MW/SW radio
- 31 band operation
- All quartz synthesized tuning
- 5 digit frequency readout
- Limited 2 year warranty

NAV 369.95 **CALL NOW!** **$299.95**

KENWOOD DM81 Dip Meter

- Frequency range 700 kHz-250 MHZ (7 band)
- Function — inductive coupling capacitive coupling
- Compact size

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KENWOOD HC-10 Digital Clock

Attractive, functional layout, with switch buttons on slanted panel. Cabinet is trigonal prism shaped for stability. With a pleasing color combination and modern styling, the HC-10 will enhance the appearance of any ham shack.

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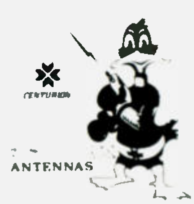

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Assembled and Tested **$37.50**

Kit $29.95 Complete
(For rotary dial add $1.50 per phone)

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25 Volts @ .18A
5 Volts @ .8A
15 Volts @ 1.25A
Isolated independent outputs
Positive or negative operation
Constant Voltage Regulation
25 Volt line adjustable with 10 turn pot from 23.5 V to 28 Volts. 120 Volt - 60 Hz input Fused - H=3¾" W=5½" D=4"

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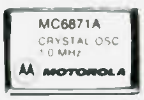
Has both 1 MHZ and 2 MHZ TTL - outputs —Hermetically sealed —Ultra high stability over wide temp. range—originally cost over $40.00 each — we made a super purchase from a major computer manufacturer — 5 Volt operation - fits standard 24 pin socket - Manufactured by Motorola oscillator division.



MC6871A

7.50 w/data **3/20.00**

NEO 2137 by NEC

- Microwave R.F. transistor (N.P.N.)
- Micromold Package #37
- Dual Emitter leads
- FT to 4.5 GHZ
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- Cleared for high reliability space applications

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LM309K	+5 v. 1.5 amp TO-3	1.00
LM120K	-5 v. 1.5 amp TO-3	1.00
7805	+5 v. 1 amp TO220	1.00
7812	+5 v. 1 amp TO220	1.00
7905	-5 v. 1 amp TO220	1.00
7912	-12 v. 1 amp TO220	1.00

UNIVERSAL TIMER KIT

* Adjustable from 1 sec to 1 hr.
* Control up to 1 amp

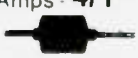
"Turn Things On Or Off"

Kit includes all parts necessary to build this exciting kit. Uses Children's T.V. programs - Darkroom exposures - Amateur 10 min. I.D.er - Egg Timer - Intermittent Windshield Wiper. Absolutely endless uses. Complete kit including power supply, p.c. board DPDT relay, and all parts to make timer operational.

$8.95

Fixed Inductors

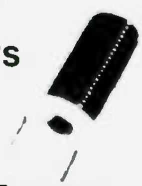
.39 uh - **6/1.00** 12.5 uh - **8/1.00**
500 uh - Hash Filter @ 2 Amps - **4/1.00**



Molded Choke

13 uh - **8/1.00** 50 mh - **6/1.00**
1.2 mh - **8/1.00**

Variable Inductors



30-40 uh
.9 uh - 1.2 uh
11 uh to 20 uh
.25 uh - .35 uh
.85 uh - .95 uh

4/1.00

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GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	21	7	7	7	7	7	7	7	7A	14	21	21A
ARGENTINA	14A	14	7	7	7	7	14	21A	21A	21A	21A	21A
AUSTRALIA	21A	14	7B	7B	7B	7B	7B	14	14	14	21	21A
CANAL ZONE	14	14	7	7	7	7	14	21	21A	21A	21A	21
ENGLAND	7	7	7	7	7	7	14	21A	21A	21A	14	7A
HAWAII	21A	14	7	7	7	7	7	7	14	21	21A	21A
INDIA	7	7	7B	7B	7B	7B	14	14A	14	14B	7B	7B
JAPAN	14A	14	7B	7B	7B	7	7	7B	7B	7B	14B	21A
MEXICO	21	7A	7	7	7	7	7	14	21A	21A	21A	21
PHILIPPINES	14	7A	7B	7B	7B	7B	7B	7	7	7B	14B	14
PUERTO RICO	14	7	7	7	7	7A	14	21	21A	21A	21	21
SOUTH AFRICA	14	7	7	7B	7B	7	14	21A	21A	21A	21	21
U. S. S. R.	7	7	7	7	7	7B	14	21A	21	14	7B	7B
WEST COAST	21A	14	7	7	7	7	7	14	21	21A	21A	21A

CENTRAL UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	21	7A	7	7	7	7	7	7	7A	14	21	21A
ARGENTINA	21	14	7A	7	7	7	7	21	21A	21A	21A	21A
AUSTRALIA	21A	14A	14	7B	7B	7B	7B	7B	14	14	21	21A
CANAL ZONE	14	14	7	7	7	7	14	14	21A	21A	21A	21
ENGLAND	7B	7	7	7	7	7	7B	21	21A	21	14	7B
HAWAII	21A	21	14	7	7	7	7	7	14	21	21A	21A
INDIA	7B	14	7B	7B	7B	7B	7B	7B	14	7A	7B	7B
JAPAN	21A	14	14B	7B	7B	7	7	7	7	7B	14	21A
MEXICO	14	14	7	7	7	7	7	14	14	21A	21A	21
PHILIPPINES	21A	14	7	7B	7B	7B	7B	7	7	7B	14B	14A
PUERTO RICO	21	14	7	7	7	7	7A	21	21A	21A	21A	21
SOUTH AFRICA	14	7A	7	7B	7B	7B	7	14	21A	21A	21A	21
U. S. S. R.	7B	7	7	7	7	7B	7B	14	21A	14	7B	7B

WESTERN UNITED STATES TO:

GMT:	00	02	04	06	08	10	12	14	16	18	20	22
ALASKA	21A	14	7	7	7	7	7	7	7	14	21	21A
ARGENTINA	21A	14A	14	7	7	7	7B	14	21A	21A	21A	21A
AUSTRALIA	21A	21	14	7A	7B	7B	7B	7B	14	14	21	21A
CANAL ZONE	21	14	14	7	7	7	7	14	21	21A	21A	21A
ENGLAND	7B	7	7	7	7	7	7B	7A	21A	21	14	7B
HAWAII	21A	14A	14	7	7	7	7	7	14	21	21A	21A
INDIA	14	14	7B	7B	7B	7B	7B	7B	14	7A	7B	7B
JAPAN	21A	21A	14	7B	7	7	7	7	7	14B	14	21A
MEXICO	21	14	14	7	7	7	7	14	14A	21	21A	21A
PHILIPPINES	21A	21	14	7A	7B	7B	7B	7	7	14	14	21
PUERTO RICO	21	14	7A	7	7	7	7	14	21	21A	21A	21A
SOUTH AFRICA	14	7	7	7B	7B	7B	7B	14	14A	21A	21A	21
U. S. S. R.	7B	7B	7	7	7	7B	7B	7B	14A	14	7B	7B
EAST COAST	21A	14	7	7	7	7	7	14	21	21A	21A	21A

First letter = day waves Second = night waves
A = Next higher frequency may also be useful
B = Difficult circuit this period F = Fair G = Good
P = Poor * = Chance of solar flares; # = of aurora

FEBRUARY

SUN	MON	TUE	WED	THU	FRI	SAT
	1 G/G	2 G/G	3 F/F*	4 F/F*	5 F/P	6 G/F
7 G/F	8 G/F	9 F/F	10 G/G	11 G/G	12 G/G	13 G/G
14 G/F	15 G/G	16 G/G	17 G/F	18 F/F	19 F/F	20 G/G
21 G/G*	22 G/F*	23 P/P	24 F/P	25 G/F	26 G/G	27 G/G
28 G/G						

NO CUT CORNERS!

FT-208R - 2 Meters
FT-708R - 70 CM

LIQUID CRYSTAL DISPLAY
The LCD frequency readout provides high readability night and day, along with very low current drain.

KEYBOARD FREQUENCY ENTRY
All operating frequencies are entered from the front panel keyboard. Unusual repeater splits, scanning, and memory programming are all controlled via the keyboard.

UP/DOWN MANUAL SCAN
The FT-208R scans in either 5 kHz or 10 kHz steps, while the FT-708R steps are 25 kHz and 50 kHz. Automatic halting on a busy or clear channel is provided, with automatic pause and restart feature. Scan either the band or the memories.

LIMITED BAND SCAN
You can program upper and lower frequency limits, then command the transceiver to scan that segment or exclude that segment.

TEN MEMORY CHANNELS
The memories may be used for either simplex or repeater operation. No need to throw a "5 UP" switch for those 15 kHz channels, either!

LONG-LIFE MEMORY BACKUP
A Lithium cell provides the memory backup function. Now you won't dump memory when switching battery packs.

LOW CURRENT DRAIN
Typical standby current drain is 20 mA, for long battery life.

450 mAH BATTERY PACK
With more capacity than competing packs, the FNB-2 battery pack gives you those precious extra minutes of operating time that might prove critical in an emergency!

HI/LOW POWER SWITCH
In the high power position, the FT-208R packs a wallop at 2.5 watts output, while the Ft-708R output is 1 watt. Switch to low power for 1 watt output on the FT-208R, 200 mW on the FT-708R, for even greater battery life.

PRIORITY CHANNEL
A priority channel may be programmed from the keyboard, allowing you to check a favorite channel while operating on another.

AUTOMATIC BAND AND MEMORY SCAN WITH PAUSE/RESTART
Automatic scanning of the band or memories (or a segment of the band) with pause and restart feature.

16 BUTTON DTMF PAD
For autopatch operation, a 16 button dual tone pad is built into every FT-208R and FT-708R.

PROGRAMMABLE SPLITS
The popular ±600 kHz shift is standard (±5 MHz on the FT-708R) on the FT-208R. Odd splits of up to 4 MHz may easily be programmed from the keyboard. Additionally, a split memory/dial mode provides a third method of operating on unusual splits.

OPTIONAL 32 TONE CTCSS
Easy interface is provided to the synthesized SSY-32 CTCSS Encoder, providing all 32 common subaudible tones for repeater operation.

LOCK SWITCH
The keyboard lock switch allows you to disable entry from the keyboard, thus preventing inadvertent frequency change.

FULL LINE OF ACCESSORIES
A Yaesu tradition, a full line of accessories is available to maximize your enjoyment of the FT-208R and FT-708R.

For more than a quarter of a century, Yaesu has produced reliable, high-performance communications equipment for the Amateur and Land Mobile services. Contact us today for full information on our cost-effective line of HF, VHF and UHF transceivers — at Yaesu we want you to get your message across!

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Eastern Service Ctr., 9812 Princeton-Glendale Rd., Cincinnati, OH 45246 • (513) 874-3100

Dyna-"mite."

Photo shown is TR-7730 in 16-key autopatch UP/DOWN microphone version.

Miniaturized, 5 memories, memory/band scan

TR-7730

The TR-7730 is an incredibly compact, reasonably priced, 25-watt, 2-meter FM mobile transceiver with five memories, memory scan, automatic band scan, and other convenient operating features. The TR-7730 is available in two variations: a 16-key autopatch UP/DOWN microphone (MC-46) version, and a basic UP/DOWN microphone version.

TR-7730 FEATURES:

- **Smallest ever Kenwood mobile**
  Measures only 5-3/4 inches wide, 2 inches high, and 7-3/4 inches deep, and weighs only 3.3 pounds. Mounts even in the smallest subcompact car, and is an ideal combination with the equally compact TR-8400 synthesized 70-cm FM mobile transceiver.
- **25 watts RF output power**
  HI/LOW power switch selects 25-W or 5-W output.
- **Five memories**
  May be operated in simplex mode or repeater mode with the transmit frequency offset ±600 kHz. The fifth memory stores both receive and transmit frequency independently, to allow operation on repeaters with nonstandard splits. Memory backup terminal on rear panel.
- **Memory scan**
  Automatically locks on busy memory channel and resumes when signal disappears or when SCAN switch is pushed. Scan HOLD or microphone PTT switch cancels scan.
- **Automatic band scan**
  Scans entire band in 5-kHz or 10-kHz steps and locks on busy channel. Scan resumes when signal disappears or when SCAN switch is pushed. Scan HOLD or microphone PTT switch cancels scan.
- **Extended frequency coverage**
  Covers 143.900-148.995 MHz in switchable 5-kHz or 10-kHz steps.
- **UP/DOWN frequency control from microphone**
  Manual UP/DOWN scan of entire band in 5 kHz or 10 kHz steps is possible when using either autopatch or basic UP/DOWN microphone versions.
- **Offset switch**
  Allows VFO and four of five memory frequencies to be offset ±600 kHz for repeater access or simplex.
- **Four-digit LED frequency display**
  Indicates receive and transmit frequency.
- **S/RF bar meter and LED indicators**
  Bar meter of multicolor LEDs shows S/RF levels. Other LEDs indicate BUSY, ON AIR, and REPEATER offset.
- **Tone switch**

Optional accessories:

MC-46 16-key autopatch UP/DOWN microphone
SP-40 compact mobile speaker
KPS-7 fixed-station power supply

More information on the TR-7730 and TR-8400 is available from all authorized dealers of Trio-Kenwood Communications
1111 West Walnut Street
Compton, California 90220

KENWOOD
...pacesetter in amateur radio

Synthesized 70-cm FM mobile rig

TR-8400

- **Synthesized coverage of 440-450 MHz**
  Covers upper 10 MHz of 70-cm band in 25-kHz steps, with two VFOs.
- **Offset switch**
  For ±5 MHz transmit offset on both VFOs and four of five memories, as well as simplex operation. Fifth memory allows any other offset by memorizing receive and transmit frequencies independently.
- **DTMF autopatch terminal**
  On rear panel, for connecting DTMF (dual-tone multifrequency) touch pad (for accessing autopatches) or other tone-signaling device.
- **HI/LOW RF output power switch**
  Selects 10 watts or 1 watt output.
- **Virtually same size as TR-7730**
  Perfect companion for TR-7730 in a compact mobile arrangement.
- **Other features similar to TR-7730**
  Five memories, memory scan, automatic band scan (in 25-kHz steps), UP/DOWN manual scan, four-digit LED receive frequency display (also shows transmit frequency in memory 5), S/RF bar meter and LED indicators, tone switch, and same optional accessories.

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